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HEALTH ASSESSMENT OF PROMISING SEEDLOTS OF 1993 *E. GLOBULUS* PROVENANCE TRIAL

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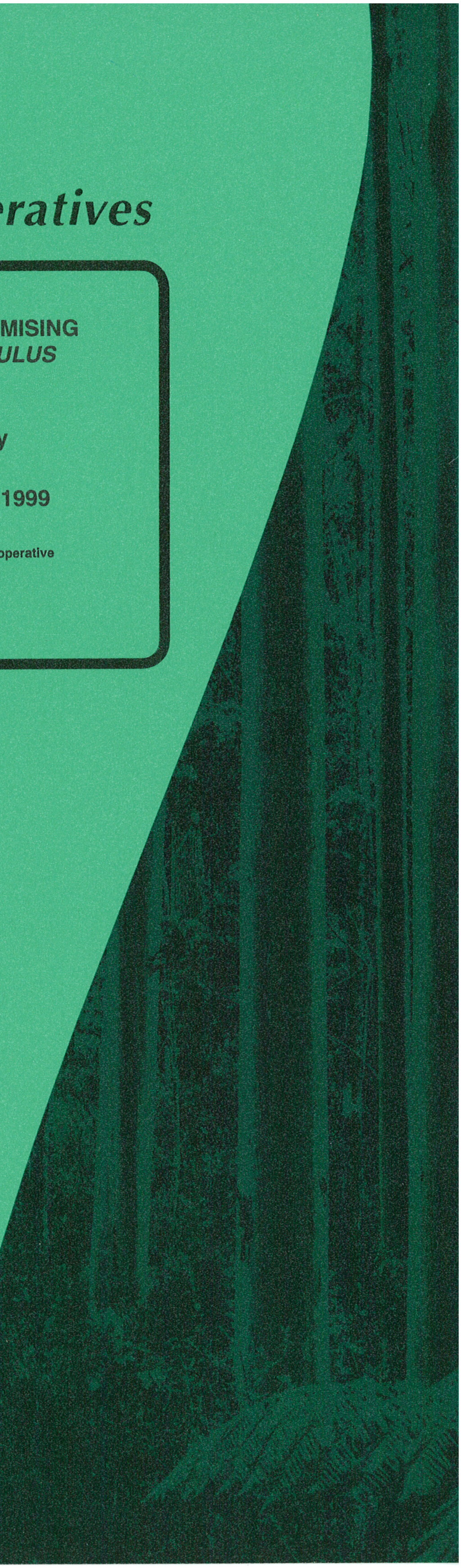

forest research

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INTRODUCTION

Interest in New Zealand has increased recently in both *Eucalyptus nitens* and *Eucalyptus globulus* subspecies as a potential resource for meeting the international market for short-fibre pulp. *E. globulus* is renowned for its superior fibre properties (Coterill and Brolin 1997) and recently has been the focus of considerable plantings overseas (Miller et al. 1992).

E. globulus was trialed extensively in New Zealand in the 1960's and 70's. Many reports concluded that tree health was a major constraint to growth here. Trials in 1979 at Rotoaira Forest showed the *E. globulus* to be very impressive right up until age 3-4, but by ages 6-7 it had declined, apparently due to insect attack, to very poor growth and survival. 1979 trials of *E. globulus* Bruny Is. Tasmania in Rotoehu Forest showed considerable leaf diseases on juvenile foliage and was heavily attacked by *Paropsis charybdis.* Although Chatelain (1981) thought the adult foliage was not as severely affected by *Paropsis charybdis* feeding as *Eucalyptus nitens* was, both species were eventually killed by repeated defoliation. Trials of *E. globulus* in Southland planted in 1978 performed reasonably (Wilcox et al. 1985). In that climate *Paropsis* was not such a problem, and the *E. nitens* outperformed the *E. globulus*.

Various reports indicate that insect pests caused the decline in popularity of *E. nitens* and *E. globulus* through the 1980's. In particular, *E. nitens* continued to suffer from *P. charybdis* in warmer climates, leaf spot diseases in humid climates such as the Bay of Plenty, and *Eriococcus coriaceus* in cooler climates, while for *E. globulus* it was combined attack from these organisms, plus the gall-forming Eulophid wasp, *Ophelimus eucalypti* (Clark 1938). The resurgence in interest in both these species in the 1990's seems to have been largely due to the progress with biological control of the insect pests *Paropsis charybdis* and *Phylacteophaga froggatti* (Miller et al. 1992). However with susceptibility of *E. globulus* to foliar diseases, the resurgence in interest in growing this species in the Bay of Plenty, may be premature.

There is evidence in the literature that suggests there are large variations in the genetic basis for resistance to attack exists in *E. globulus*. Farrow et al (1995) concluded that provenances in Australia of *E. globulus* ssp. *globulus* from Bass Strait islands and south eastern Tasmania were the most resistant to defoliation from *Phylacteophaga* *froggatti*, the Eucalyptus leaf blister sawfly. The Otway Ranges and South Gippsland (Victorian) provenances were shown to be quite susceptible to defoliation by insects. Growing in South Africa, the King Island provenance showed the most resistance to insect attack (Cotterill, pers. comm.). Recently Concheyro et al (1998) concluded that *E. globulus* ssp. *globulus* provenances from the Otway Ranges and South Gippsland showed more promising growth characteristics than the Bass Strait Island populations when growing in the Bay of Plenty. This potential disparity is worthy of further investigation because if the same provenances show different resistance to the same insects in Australia than when grown in New Zealand, the importance of undertaking thorough trials here increases.

Highly significant differences in resistance to *Mycosphaerella* leaf disease has been found between *E. globulus* subspecies and provenances (Carnegie et al. 1994). Provenances of *E. globulus* ssp. *globulus* were shown to be markedly more susceptible than *E. globulus* ssp. *pseudoglobulus*.

As an initial study in the Bay of Plenty, the health and growth of a subset of *E. globulus* provenances showing promising growth qualities were examined in a provenance of *E. globulus* ssp. *pseudoglobulus*, and four provenances of *E. globulus* ssp. *globulus* and compared to *E. nitens* and *E. fastigata*, currently in common use in New Zealand forestry.

METHODS

Eucalyptus globulus was assessed for tree health over a growing season, particularly in relation to insect attack, in the 1993 provenance trial situated at Omataroa Rd, Carter Holt Harvey Forests (previously operated by P.F. Olsen Ltd). Control plots of *E. nitens*, and *E. fastigata* (progeny from unimproved commercial seed-lots), were used as a comparison to the health of *E. globulus*. Based on straightness and DBH assessments at 4 years old, *E. globulus* ssp. *globulus* provenances appeared to be showing growth characteristics equitable with *E. nitens* from Tallaganda, NSW (Concheyro et al. 1998) (Table 1). Four of the most promising seedlots of ssp. *globulus* based on this growth assessment and covering a range of geographic seed origins, as well as ssp. *pseudoglobulus*, were chosen for more in depth health assessment.

Table 1. Seedlots chosen from the 1993 Omataroa Rd block provenance trial for more in-depth health monitoring.

Seedlot	Species	Seed Origin	Mean DBH 1997 (mm)
1	*E. globulus* ssp *pseudoglobulus*	Wiebens Hill, Victoria	133
5	*E. globulus* ssp. *globulus*	Lorne Point, Victoria	135
8	*E. globulus* ssp. *globulus*	King Island, Tasmania	135
9	*E. globulus* ssp. *globulus*	Flinders Is. Tasmania	133
10	*E. globulus* ssp. *globulus*	Jerralang North, Victoria	137
11	*E. nitens*	Central Victoria	123
12	*E. nitens*	Tallaganda, NSW	140
14	*E. fastigata*	Badja Mt. NSW	129

Each species/ provenance was originally represented by block plantings of 20 trees, at 3 x 4 m, replicated 3 times (see attached site plan, Appendix 1). Differential survival resulted in a variable numbers of trees remaining in each plot. We undertook detailed assessment of the foliage and branches from 6 centrally placed trees per block (i.e., those preferably not adjoining another species or provenance) with circumferences greater than 20 cm. This resulted in sampling 18 trees per provenance.

At four times through the 1998/99 growing season, late September, mid November, early January, and mid March, the selected trees in each selected block were assessed for:

- A **visual assessment of whole tree defoliation** was made from approximately 5 metres from the base of the tree. This estimates combined defoliation by both insects, diseases and abiotic factors. The scale followed that of Raymond's "Degree of defoliation by leaf feeders in the current season's growth" (4: little defoliation, 3: light defoliation, 2: moderate damage, 1: heavy damage) (see Raymond 1995).
- A **visual assessment of crown density** was made based on a slightly modified scale from that of Lundquist (1987), on a scale of 1 to 10, where 1 has a dense crown, 5 has crown thinning in lower branches, and 10 is all crown shed except for flushing tips.
- A single branch containing adult foliage from the western mid-crown of each selected tree was obtained by destructive sampling by an extended pruning saw. The number of nodes on the tip 50 cm of the leader, and number of leaves retained on those nodes was then counted to obtain an **estimate of leaf retention** on each branch.
- The leaves remaining on the leader were then assessed for overall **percentage leaf surface area lost** or damaged. This scoring was assisted by the diagrams on percent leaf infection from Carnegie (1994). The majority of leaf area lost or damaged by fungal leaf spots, *Paropsis charybdis* chewing, *Gonipterus scutellatus* chewing, *Strepsicrates macropetana* grazing were recorded.
- The presence versus absence of disorders on the sampled branch were also recorded. These were branch lesions (fungal), galls (*Ophelimus* sp.), psyllids (*Ctenarytaina* sp.) in the tips, and Gum Emperor Moth caterpillars, *Opodipthera eucalypti.*
- At the final assessment of the season, DBH (diameter at 1.4 m) measurements of every tree present in the selected blocks were measured to obtain the **DBH increment** over the previous approximately 18 months.

Data Analysis: Repeated measures Analyses of Variance were performed on plot means to test the significant of seedlot difference on the health scores. The analyses also incorporated tests between times of assessment, time by seedlot interactions, and least significant differences tests to provide pairwise comparisons between seedlots. The ArcSine transformation was used on percentage scores, while other variables were not transformed. The SAS procedure PROC MIXED was used for these analyses. Correlations among health scores and with DBH and DBH increment from March 1999 since previous assessments in December 1997, were also calculated and tested for statistical significance.

RESULTS

Assessment Method.

Two simple methods of visual assessment (degree of defoliation and crown density) of Eucalypt tree crown health in terms of foliage retention were used in the last three assessment periods, but only degree of defoliation was used at the first assessment. Both degree of defoliation and crown density were significantly correlated to each other (r= -0.48, P<0.0001). Degree of defoliation was strongly correlated to estimates of leaf retention on the leader of the randomly chosen branch (r=0.39, P<0.0001), whereas crown density was not so strongly correlated (r= -0.30, P<0.001). Overall, degree of defoliation showed significant (though not always strong) correlations to most of the measures of percentage leaf area lost and presence / absence of pests. In particular, degree of defoliation was significantly correlated to proportion of leaf area lost to *Paropsis charybdis* (r= -0.24, P<0.0001), *Strepsicrates macropetana* (r= -0.35, P<0.0001), leaf fungi (r= -0.20, P<0.0001), and the presence of psyllids (r= -0.27, P<0.0001), galls (r=0.29, P<0.0001) and branch lesions (r= -0.19, P<0.0001). The visual assessment of degree of defoliation based on a simple 1-4 scale therefore appears to be a useful measure to retain for rapidly summarising foliage health of Eucalypts in the future.

Crown Health Comparisons.

Degree of defoliation, crown density and leaf retention all show similar patterns relating to the amount of leaves present within the crown of the tree. The degree of defoliation was significantly influenced by both seedlot (F=9.8; df=7, 15; 15; P<0.0001), and sampling time (F=42.2; df=3, 45; P<0.0001) with no significant interaction term (F= 1.7; df=21, 45; P<0.07). The effect of sampling time reflects an increase in defoliation score between the sampling times of September, November and January. *E. nitens* NSW and *E. fastigata* were significantly less defoliated than the other seedlots, with *E. nitens* Victoria the worst. (Table 2). Crown density was significantly influenced by seedlot (F=7.1; df=7, 15; P<0.001) but not the single or interactive effects of sampling time (F=5.1; df=2, 30; P<0.01, F=1.2; df=14, 30; P<0.3). In crown density, *E. fastigata* was also significantly the best seedlot. Leaf retention was also significantly influenced by seedlot (F=8.4; df=7, 15; P<0.0003) and sampling time (F=27.6; df=3, 45; P<0.0001) with no significant interaction (F=0.9; df=21, 45; P<0.6). Again the same trend was obvious with *E. fastigata* and NSW *E. nitens* showing the highest leaf retention and lowest defoliation score (Table 2). In comparison, *E. globulus* from Tasmanian provenances were often the worst on average in terms of crown health, though not always significantly so.

Table 2. Mean scores per seedlot for 'degree of defoliation' (scale 1 to 4, 4 = least defoliation), 'crown density' (scale 1 to 10, 1 = most dense crown), and leaf retention on the leader of the sampled mid-crown branch, averaged over blocks and across the season. Scores followed by the same letter do not differ significantly (P=0.05).

Seedlot	Species	Degree Defoliation	Crown density	Leaf retention
1	*E. globulus* subsp *pseudoglobulus* Wiebens Hill, Vic.	3.2 de	8.3 ab	57.2 cd
5	*E. globulus* subsp. *globulus* Lorne Point, Vic.	3.3 bcd	8.3 ab	49.5 de
8	*E. globulus* subsp. *globulus* King Island, Tasmania	3.0 cdf	8.7 a	51.8 cde
9	*E. globulus* subsp. *globulus* Flinders Is. Tasmania	2.8 ef	8.8 a	55.9 cd
10	*E. globulus* subsp. *globulus* Jerralang North, Vic.	3.3 bc	8.2 ab	61.1 bc
11	*E. nitens* Central Victoria	2.6 e	8.3 ab	41.7 e
12	*E. nitens* Tallaganda, NSW	3.4 ab	7.8 b	68.9 ab
14	*E. fastigata* Badja Mt. NSW	3.8 a	5.9 c	76.9 a

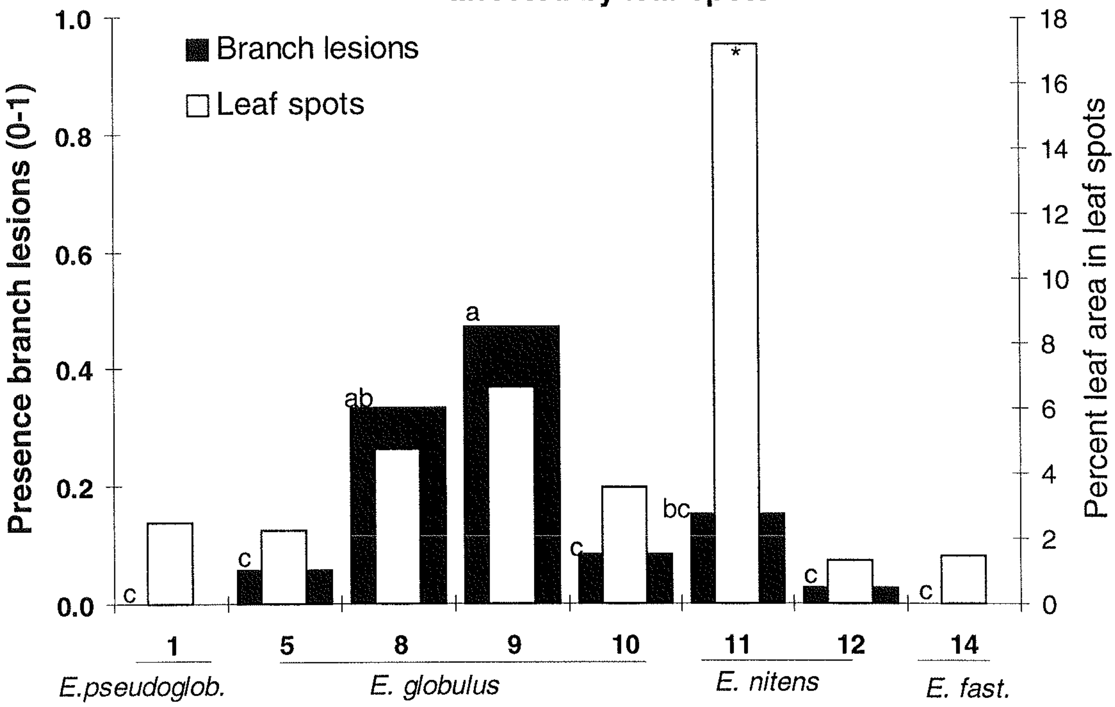
Fungal Pathogen Comparisons.

The percentage of leaf area lost or covered in leaf spots was significant influenced by both seedlot (F=4.3; df=7, 15; P<0.01) and sampling time (F=6.4; df=3, 45; P<0.001), but with no interactive effects (F=0.7; df=21, 45; P<0.8). On average the worst affected seedlot was Victorian *E. nitens*. This was due to the combined effects of *Aulographina eucalypti* leaf spots on adult foliage, and *Kirramyces eucalypti* (syn. *Septoria pulcherrima*) The data was re-analysed with a repeated measures analysis including leaf type (juvenile versus adult foliage), seedlot, and sampling time as fixed affects. In this analysis the effect of seedlot was less (F=2.7; df=7, 15; P<0.051), while there were significant affects of both leaf type (F=35.0; df=1, 65; P<0.0001) and sampling time (F=7.8, df=3, 65; P<0.0002) (Fig. 1). The September 1998 sampling period was responsible for the sampling time effect, with approximately twice as much leaf area estimated to be lost to leaf spots in this month in comparison to other sampling periods. In addition, the presence of juvenile foliage (heavily infected with *Kirramyces eucalypti* and *Mycosphaerella cryptica*) which was most common on Victorian *E. nitens*, explains the observed seedlot effect.

The presence versus absence of fungal lesions on the sampled branch also showed a significant effect of seedlot (F=7.1; df=7, 15; P<0.001) with no single or interactive effects of sampling time influencing this (F=1.5, df=3, 45; P<0.2; F=2.1;, df=21, 45;

P<0.02). The *E. globulus* ssp. *globulus* seedlots from Tasmania were significantly more affected by these fungal lesions than were any other provenance (Fig. 1).

FIG. 1: Effect of seedlot on severity of fungal attack: presence of lesions on branches, and percentage of leaf area estimated to be affected by leaf spots



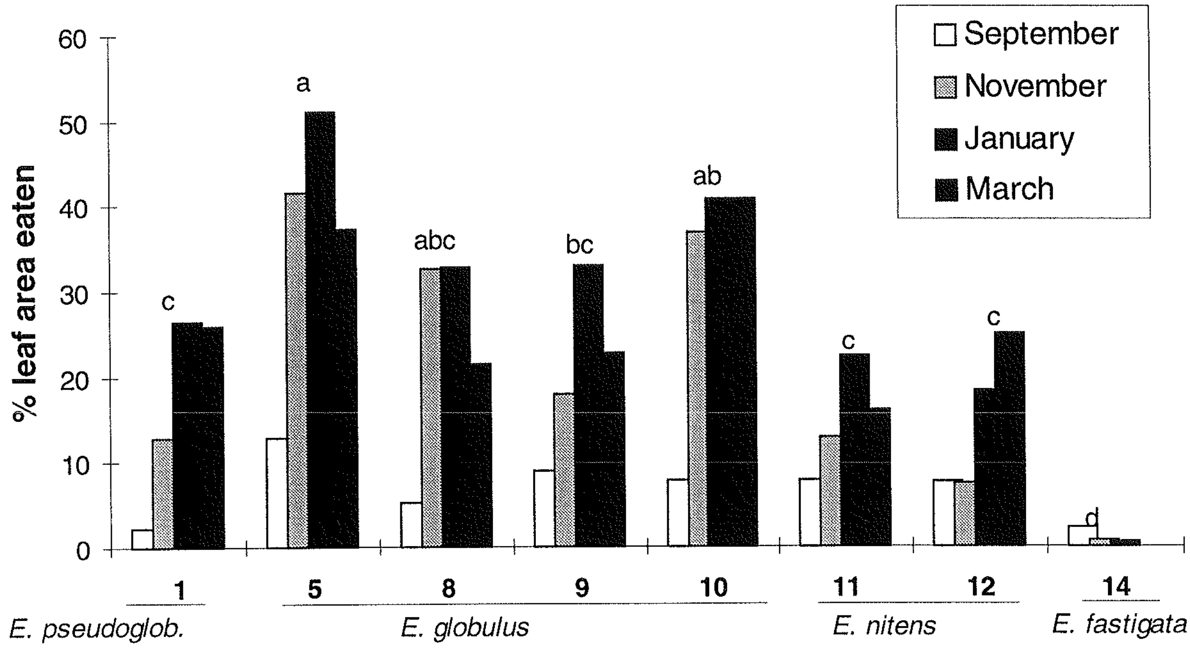
Insect Pest Comparisons.

The proportion of leaf area estimated to have been removed by *Paropsis charybdis* feeding was significantly influenced by both seedlot (F=6.9; df=7, 15; P<0.0009) and sampling time (F=18.4; df=3, 45; P<0.0001), with no significant interaction between them (F=1.7; df=21, 45; P<0.06). The most susceptible seedlots were *E. globulus* ssp. *globulus* from Lorne Pt. and Jerralang North, Victoria, followed by the King Island and Flinders Island, Tasmanian provenances (Fig. 2). The sampling time influence on *Paropsis* feeding damage reflected that damage was least during the September sampling, which is just prior to the emergence of the spring generation of beetles in the Bay of Plenty. Damage remained high for the rest of the season.

The proportion of leaf area estimated to be damaged by the leaf-rolling and feeding action of *Strepsicrates macropetana* was not significantly influenced by seedlot (F=2.3; df=7, 15; P<0.08) but was significantly influenced by sampling time (F=60.7; df=3, 45; P<0.0001), with no interaction between the terms (F=1.3; df=21, 45; P<0.2).

There was no seedlot that escaped attack by *Strepsicrates*. The sampling time effect reflected that damage increased significantly as the season progressed, reaching its most severe in the March sampling, where many tips of the sampled mid-crown branches had been destroyed, not by *Paropsis*, but by *Strepsicrates* larvae tunnelling into the growing tips and killing all emerging foliage.

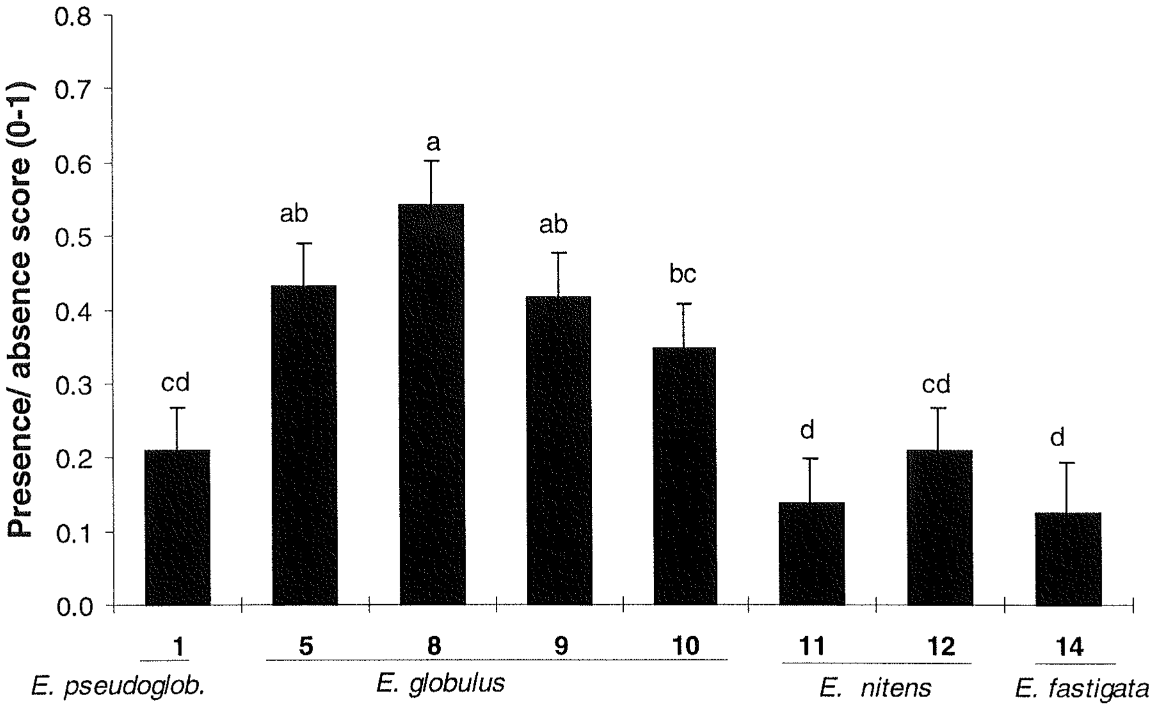
FIG. 2: Mean estimated percentage of leaf area eaten by *Paropsis charybdis* by seedlot and sampling date



The proportion of leaf area estimated as lost to *Gonipterus scutellatus* feeding was not significantly affected by either seedlot (F=0.5; df=7, 15; P<0.8) or sampling time (F=3.8; df=3, 45; P<0.02) or the interactive effects of both (F=1.2; df=21, 45; P<0.3). The mean percentage of leaf area lost was between 0.1 and 0.7 of a percent. Rarely was more than 10% of leaf area estimated to have been lost to *Gonipterus* feeding.

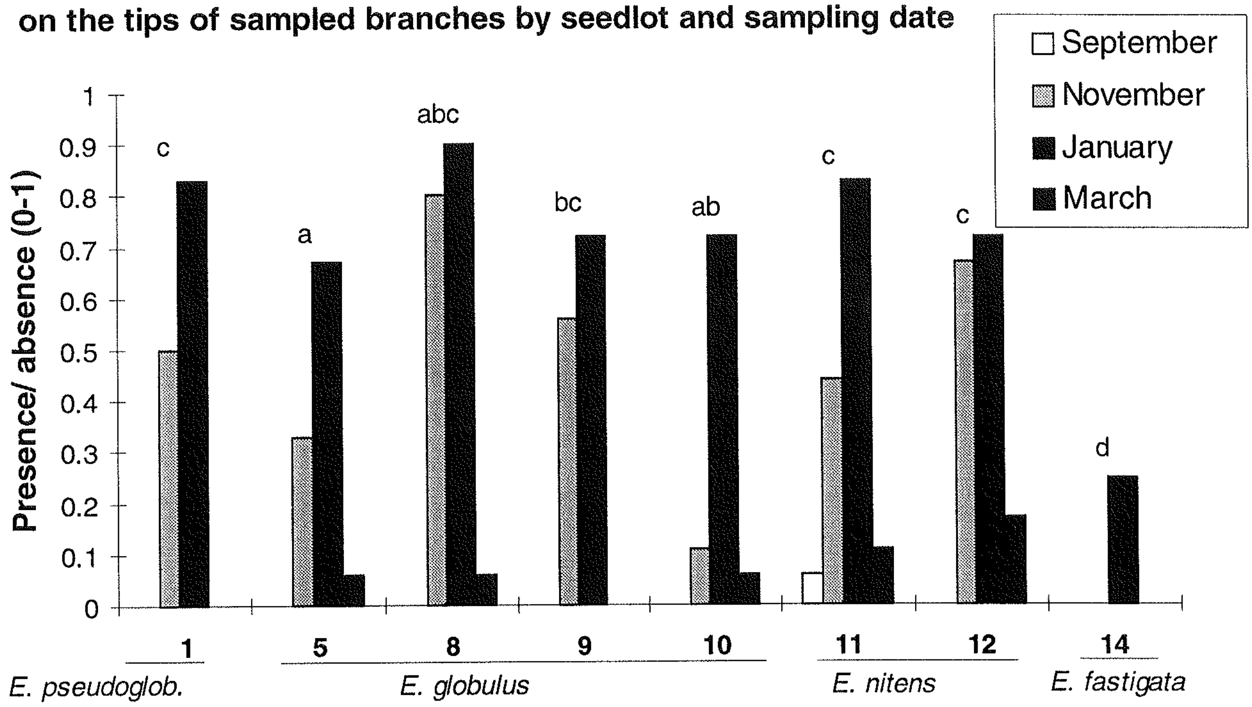
The presence versus absence of mid-rib galls and leaf galls, believed to be caused by the Eulophid wasp, *Ophelimus eucalypti* Gahan (previously known as *Rhicnopeltella eucalypti*) was always noted during branch sampling. There was a significant effect of seedlot on the presence of these galls (F=5.4; df=3, 45; P<0.003) as well as sampling time (F=77.2; df=3, 45; P<0.0001), but no interactive effects of both terms (F=1.1; df=21, 45; P<0.3). The most susceptible seedlots were both Tasmanian provenances of *E. globulus* ssp. *globulus* and the Lorne Pt. provenance of *E. globulus* ssp. *globulus*. The least susceptible were *E. globulus* ssp. *pseudoglobulus*, both *E. nitens* provenances, and *E. fastigata* (Fig. 3).

FIG. 3: Effect of seedlot on the mean score for the presence of Eulophid galls



The presence versus absence of free-living psyllids in the tips, usually *Ctenarytaina spatulata* Taylor (but occasionally also the blue gum psyllid, *Ctenarytaina eucalypti* (Maskell) on juvenile foliage), was also noted during branch sampling. There was a significant effect of seedlot (F=5.9; df=7, 15; P<0.002) and sampling time (F=118.2; df=3, 45; P<0.0001) as well as an interaction effect of both terms (F=2.5; df=3, 45; P<0.005) on the presence of psyllids. All *E. globulus* and *E. nitens* seedlots showed a strong presence of psyllids, but *E. fastigata* was significantly less affected (Fig. 4). Psyllids were present in highest densities during the summer sampling dates, November and January, and were only present on *E. fastigata* in March, hence the significant interaction term.

FIG. 4: Mean score for the presence of pysllids *(Ctenarytaina* sp.) on the tips of sampled branches by seedlot and sampling date



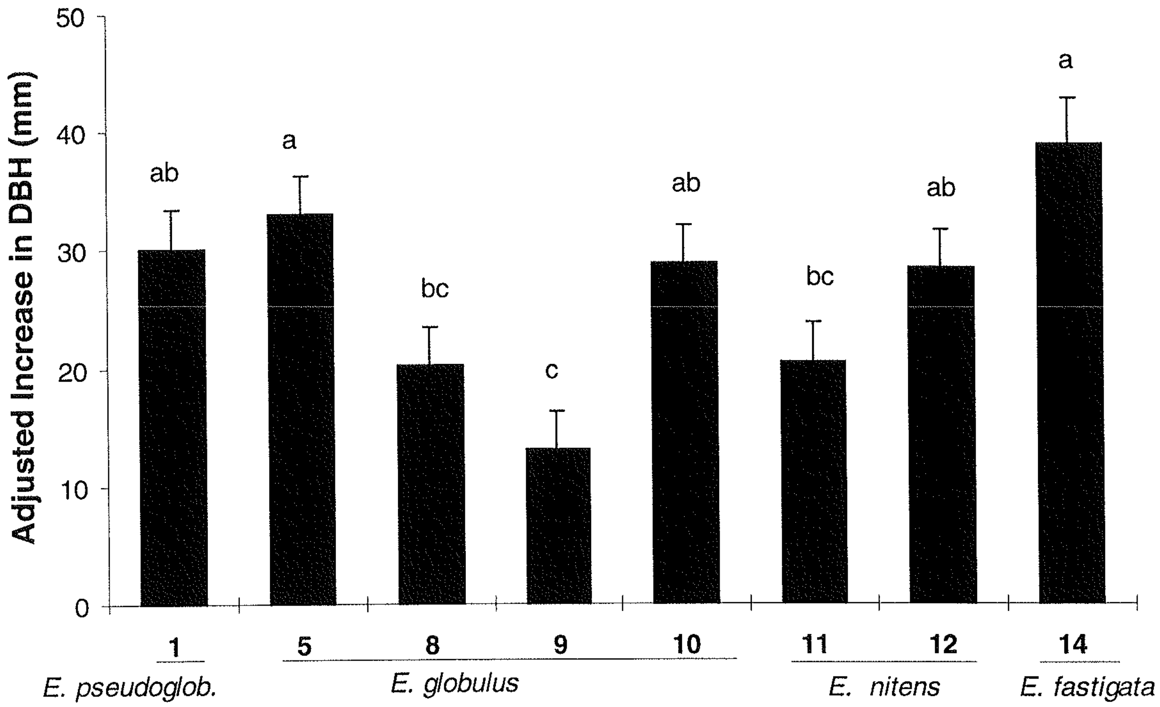
Growth Comparisons.

When this block was first assessed in 1997, DBH was only recorded in those trees that had diameters of 10 cm or over. In 1999, DBH was measured on all live trees, judged by the presence of foliage, in those seedlots of interest. This 1999 DBH was in agreement with the 1997 measures that there are no significant differences in growth according to DBH between seedlots (ANOVA $F=2.34$; $df=7, 22$; $P<0.08$).

The incremental increase in DBH trees measured both in December 1997 and March 1999 was obtained by simple subtraction. The DBH of these trees was strongly correlated to the incremental growth measured over the previous 18 months, as could be expected ($r=0.65$, $P<0.0001$). Mean incremental increase in DBH for each seedlot were then adjusted to take account of the trees that weren't measured in 1997. This was done by regressing incremental increase in DBH and DBH in 1999, and then using that relationship to predict the mean incremental DBH most likely for those trees where no 1997 value was available. Following this analysis a significant difference in growth between seedlots over the previous 18 months was revealed (ANOVA $F=5.2$; $df=7, 22$; $P<0.004$). Accordingly, *E. fastigata* had grown significantly more girth than other seedlots, with the least growth being recorded in seedlot 9 (*E. globulus* ssp. *globulus* Flinders Is.) (Fig. 5).

The incremental growth over the 18 month period was also shown to be highly significantly correlated to the recorded degree of defoliation (r=0.58; P<0.0001), but not to crown density (r= -0.1; P<0.3). The foliar health measures that showed the strongest negative correlations to incremental growth over the previous 18 months were proportion of leaf area lost to *Strepsicrates* attack (r= -0.22; P<0.017) and proportion of leaf area lost to foliar fungi (r= -0.26; P<0.004).

FIG. 5: Mean incremental increase in DBH between December 1997 and March 1999 (n = 60 trees per seedlot).



Species/ Provenance health Summary. (see Table 3)

E. fastigata was the 'healthiest' seedlot in this study. It was significantly the least affected species by insect attack, especially *Paropsis charybdis* chewing, psyllid presence, and midrib galling. In addition it had no fungal attack on branches and low levels of leaf spots. It had the highest leaf retention and the best measures of crown density, low defoliation, and incremental increase in DBH, which suggests a recent increase in growth has occurred.

E. nitens from Tallaganda, NSW, was the next healthiest species overall, showing the least *Strepsicrates macropetana* grazing, low attack from *Paropsis charybdis*, virtually no fungal attack on branches, and very low leaf spot incidence. Related to this, or because of this, incremental increase in DBH was one of the highest of the seedlots examined in this trial.

The *E. nitens* from Victoria showed many more health problems. Although having less attack by *Paropsis charybdis*, and few midrib galls, damage by *Strepsicrates macropetana* was very high, and the proportion of leaves affected by leaf spots also high. Possum damage was also bad in some blocks. This provenance had the poorest leaf retention and worst score for degree of defoliation of the crown. Interestingly this could not be attributed to *Paropsis* attack, but may be related to high susceptibility to some foliar pathogens.

The *E. globulus* ssp. *globulus* from King Island and Flinders Island in the Bass Strait showed a high susceptibility to pests and diseases. These provenances showed slightly higher levels of leaf spots, fungal attack on the branches, presence of psyllids, and mid-rib galls than the mainland provenances that were monitored. The degree of defoliation was deemed to be consistently higher, with a lower crown density than any of the other *E. globulus* ssp. provenances. The incremental increase in diameter at breast height was poor for these provenances.

The *E. globulus* ssp. *globulus* from Victoria showed low psyllid presence, low *Strepsicrates* attack (for the Lorne Pt. provenance), and low fungal attack on branches, but moderate presence of mid-rib galls and the highest *Paropsis charybdis* attack of all the seedlots. Despite this, incremental increases in DBH were good over the previous 18 months, which could be speculated as being related to good crown density.

The *E. globulus* ssp. *pseudoglobulus* seedlot from Victoria was intermediate in all its health ratings, but did show some promise due to low *Paropsis charybdis* chewing, low levels of leaf spots, and a complete absence of fungal attack on branches. The incremental increase in DBH for this seedlot was good.

Table 3. Summary of health assessments per seedlot based on health monitoring. Black = excellent health, Grey = intermediate health, white = poor health.

Seed-lot	Species / provenance	Degree defoliated	Crown density	Leaf retention	*Paropsis* feeding	*Gonipterus* feeding	*Strepsic-rates* feeding	Pysllids present	Galls present	Leaf spots	Branch lesions	Incremental DBH growth
1	*E.g. pseudoglobulus* Vic	Grey	Grey	Grey	Grey	Grey	Grey	White	Grey	Grey	Black	Black
5	*E.glob. globulus* Lorne Pt. Vic	Grey	Grey	White	White	Grey	Black	Grey	White	Grey	Black	Black
8	*E.glob. globulus* King Is. Tas	White	White	White	Grey	Grey	Black	White	White	Grey	Grey	Grey
9	*E.glob. globulus* Flinders Is. Tas	White	White	Grey	Grey	Grey	Grey	White	White	Grey	White	White
10	*E.glob. globulus* Jerralang Nth. Vic	Black	Grey	Grey	White	Grey	Grey	Grey	Grey	Grey	Black	Black
11	*E. nitens* Central Vic	White	Grey	White	Grey	Grey	White	White	Black	White	Grey	Grey
12	*E. nitens* NSW	Black	Grey	Black	Grey	Grey	Black	White	Grey	Grey	Black	Black
14	*E. fastigata*	Black	Black	Black	Black	Grey	Black	Black	Black	Grey	Black	Black

DISCUSSION

The monitoring of this single block provenance trial for one season suggests that the suspicions by Concheyro et al. (1998) are probably correct. In terms of growth, *E. nitens* from NSW had stood out as superior to the seedlots of *E. globulus*. It is likely that this has a strong correlation to health as the monitoring showed that this seedlot was the healthiest at this site, showing less insect and disease presence, and the densest crowns. The only exception to this being that psyllids were common on the growing tips. It is likely the species responsible is *Ctenarytaina spatulata*, a pest only recently recognised around New Zealand for its damage to flushing foliage and tips throughout the season.

Of most interest with this health monitoring were comparisons of the susceptibility of different sub-species and provenances of *E. globulus* to insect and fungal attack. Over all the measures, the provenances originating from Victoria were healthier than those from the Bass Strait Islands when growing in the Bay of Plenty. This difference seemed to have been reflected in current DBH right across the entire trial, with Victorian provenances being on average 12 cm larger in diameter at age five-six than the Bass Strait provenances. The same trend was apparent in the incremental DBH over the previous 18 months with at least 10 mm more diameter put on by the monitored trees in the Victorian provenances than in the Bass Strait provenances. *E. globulus* ssp. *pseudoglobulus* showed growth and health closer to the Victorian provenances of *E. globulus* ssp. *globulus,* than the Bass Strait ones.

Earlier research in New Zealand had attributed the decline in the health of *E. globulus* to the presence of *Ophelimus eucalypti* (Clark 1938). This pest was certainly present in the trial at Omataroa Rd, but the provenances studied were not severely affected by it. Leaves on which the midribs were galled had not been shed, so attack could be described as only low to moderate. Whether all the provenances had a degree of resistance to this gall wasp, whether this pest is not at high densities at Omataroa Rd, or whether natural enemies are controlling population density, is not known at this time.

Previous observations based on a eucalypt species trial in Rotoehu forest (Chatelain 1981), that *E. globulus* is less susceptible to defoliation by *Paropsis charybdis* than is *E. nitens,* is not backed up by this research. Monitorin of the Omataroa Rd trial over the past season has revealed that the defoliation attributed to larval or adult feeding by *Paropsis charybdis* was between a half and twice as much again in all the provenances of *E. globulus* ssp. *globulus* than it was on *E. nitens*. Defoliation by *Paropsis charybdis* on *E. globulus* ssp. *pseudoglobulus* was similar to that on *E. nitens*. The conclusion based on these results is that *E. globulus* trials in New Zealand will benefit from successful biological control of *Paropsis charybdis*, and in areas where control is inadequate, careful monitoring of valuable trials and protection through chemical means and augmentation of natural enemies is advisable.

The observations that Victorian provenances of *E. globulus* ssp. *globulus* showed the least fungal attack, while at the same time showing the highest susceptibility to *P. charybdis* feeding suggests that cross-resistance that could be effective against both pests and diseases is unlikely. Certainly none of the seedlots trialed at Omataroa Rd demonstrated a consistent resistance to both different types of insect pests, and to foliar and branch disease.

Acknowledgements

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Appendix 1:
Site plan of trial at Omataroa Rd, Carter Holt Harvey Forests, Bay of Plenty.

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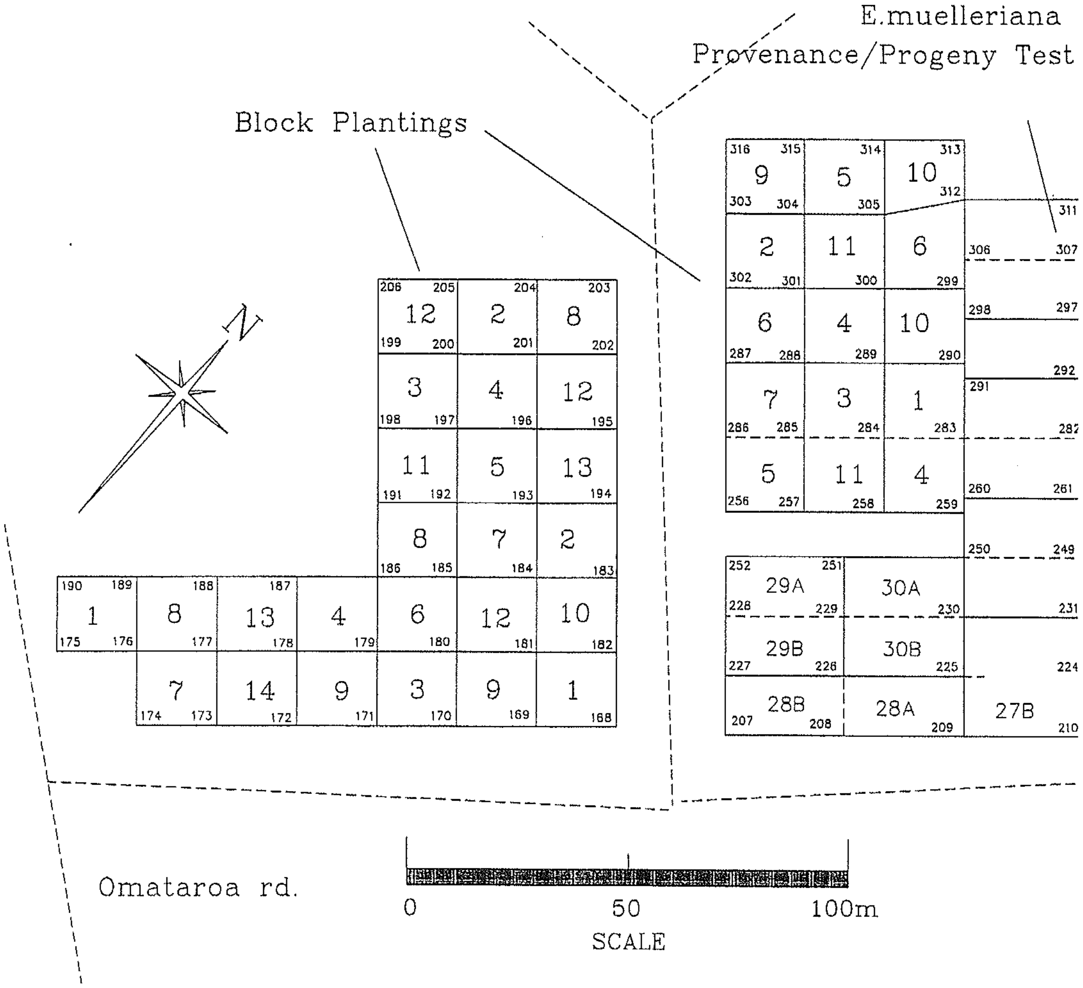
APPENDIX 1. SITE PLAN

map no 529

1993 E.globulus provenance block plantings

FR 211/1 WP 2269

Omataroa Forest   P.F.Olsen Ltd.



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