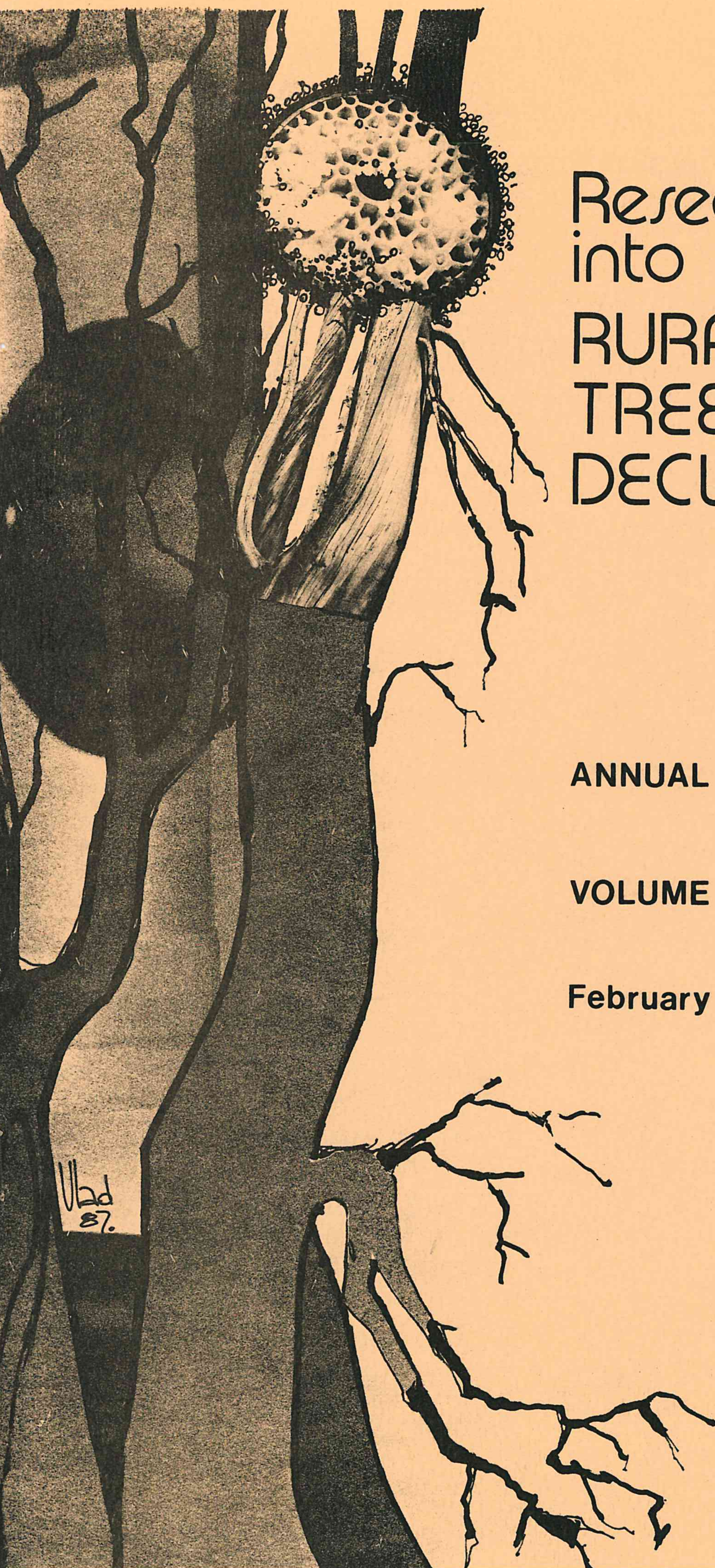

Research into RURAL TREE DECLINE

ANNUAL NEWSLETTER

VOLUME THREE

February 1987

Judging by the contributions to this newsletter, research into rural tree decline continues to thrive. Readers will note that volume 3 has gone slightly upmarket, with all articles having been retyped so that the volume could be printed. Thanks are due to the CSIRO Division of Forest research for this production. Note too that the newsletter has acquired an International Standard Series Number. In compliance with this scheme, copies of all volumes of the newsletter are being lodged in the National Library of Australia.

I hope that the concept of the newsletter will remain unchanged however, notwithstanding its slightly altered appearance. Remember that its effectiveness depends on input from all readers - please correspond with contributors and circulate the newsletter among any interested people to whom I have not sent copies. My circulation list is printed on the back page, and comprises those people from whom I have received contributions or requests for copies within the last two years.

The newsletter is not alone in undergoing a slight change in circumstances. Yes I've finally finished my PhD, and have just commenced a two year CSIRO postdoctoral award. I have briefly outlined my planned project in this volume, and hope to attract lots of correspondence.

Thanks to all volume 3 contributors for your articles. I hope your efforts will be rewarded.

Jill Landsberg

CSIRO Division of Forest Research
PO Box 4008, Queen Victoria Terrace
Canberra A.C.T. 2600

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"Eucalypt dieback on the Northern Tablelands of New South Wales."
1983/4 M.Sc. thesis summary.

Christopher Nadolny
Department of Botany
University of New England, Armidale NSW 2351.

This study was initiated to describe the nature and extent of eucalypt dieback on the Northern Tablelands of New South Wales. The typical symptoms of eucalypt dieback involved general deterioration of the crown with thinning of foliage and progressive death of twigs and branches. Most of the declining trees were severely defoliated by a variety of native insects, especially paropsine and scarabaeid beetles. Partial recovery usually occurred in the form of bursts of epicormic shoots, but the new growth was also liable to deterioration. Affected trees usually died with few intact leaves remaining. Occasionally trees wilted while still bearing a significant portion of their leafy crown. Wood decay was common in the affected eucalypts but the rotting of live sapwood was only occasionally evident. Semi-quantitative scales were constructed to facilitate the assessment of tree vigour and foliage cover. Ordinal scale

A broadscale road survey of the Northern Tablelands was undertaken during 1980 to ascertain the extent of eucalypt dieback and the species affected; 48 species of naturally occurring eucalypts were encountered. The stretch of country in which most dieback had occurred ran from Bendemeer and Yarrowitch in the south to Tenterfield in the north. Dieback was largely confined to pastoral areas and the more heavily cleared areas tended to be worst affected. Saplings were more affected by dieback than mature trees. Few of the trees in the areas surveyed were past maturity. All eucalypts of the eastern forests and the gorge communities were relatively healthy. Dieback was less prevalent in western areas. After the autumn of 1980 some trees on the Tablelands showed acute drought effects, but the great majority of woodland trees were relatively unaffected. No eucalypt species suffered dieback over its entire geographical range. Ten species of eucalypts showed severe or extensive dieback; these included all the common species on the central tract of the Northern Tablelands. *Eucalyptus nova-anglica* was the species most seriously affected by dieback, and the condition of this species was usually worse than that of other associated eucalypts. Most of the species that were not seriously affected by dieback did not grow in areas where dieback was prominent.

The eucalypts on "Kiparra", a property near Armidale, were permanently tagged and visually assessed to examine the association of dieback with specific site and tree factors. Five common species of eucalypts were present: *E. melliodora*, *E. blakelyi*, *E. caliginosa*, *E. nova-anglica*, and *E. bridgesiana*. Practically all the trees on the property were affected by dieback, but the average vigour ratings of *E. nova-anglica* and *E. bridgesiana* were lower than those of the other 3, more numerous species. Canonical correlation analysis indicated that greater vigour of *E. melliodora* was associated with: larger tree girth, higher position on slope, proximity to neighbouring trees, and absence of mistletoe. Greater vigour of *E. blakelyi* was associated with the presence of a sheep camp, larger tree-girth and higher position on slope. Greater vigour of *E. calignosa* was associated with larger tree-girth.

Other permanent plots were set up to monitor the changes in vigour of trees on 14 sites in the Armidale-Wollomombi district. There was a general recovery of trees during the period of observation (March 1980 to March 1983). After damage from accidental human interference was excluded the average vigour of the trees that were still alive at the end of the period of observation had increased in every plot. The trees that were initially severely affected by dieback continued to die while the less affected trees usually recovered to some extent. The vigour of E. melliodora was generally greater than the vigour of E. blakelyi; relative differences in the improvement of E. melliodora and E. blakelyi during the period were associated with a strong preference of Christmas beetles (Anoplognathus spp.) for the latter species. Differences in vigour between associated E. melliodora and E. caliginosa were not marked.

In the absence of stress the vigour rating of trees fluctuated seasonally in association with shoot growth, leaf fall and flower production. Leaf-grazing insects periodically damaged eucalypt crowns, immediately affecting the vigour rating. Trees with lower vigour ratings tended to be grazed to a greater extent. During the period there were numerous localized insect outbreaks each involving one or a number of insect species. Some insects, in particular scarabaeids, appeared to emerge almost simultaneously over large areas.

A field trial was set up at "Kiparra" to test the responses of trees to an insecticide (monocrotophos) and a fungicide (metalaxyl) active against pythiaceous fungi. Prior to the application of metalaxyl the soil beneath the trees was tested for the presence of pythiaceous fungi. Phytophthora cryptogea was the most common species isolated, but there was no relationship between the presence of pythiaceous fungi and the vigour of trees. Application of metalaxyl significantly reduced the recovery of pythiaceous fungi. There was a significant response to insecticide in E. blakelyi, and a significant positive interaction between insecticide and fungicide treatments in E. melliodora, but no response to the fungicide by any eucalypt species. It is argued that the water from the aqueous solution of fungicide was likely to have caused the interaction.

P. cryptogea was the only species found in a prelininary survey of Phytophthora spp. in the Armidale district. The effects of the fungus on potted seedlings were tested. The fungus caused only minor damage to E. nova-anglica seedlings, and no significant damage to seedlings of E. blakelyi or E. caliginosa. The results support other studies which indicate that P. cryptogea is a weak pathogen.

The factors likely to contribute to stress on trees and the process of dieback are critically discussed. It was concluded that excessive defoliation resulting from outbreaks of leaf-grazing insects was likely to have been the most important immediate cause of dieback, though other factors have contributed to the dieback of trees locally. These factors include: infestation by mistletoes, damage attributable to human activity (e.g. herbicide spray drift), wind-damage and girdling of trunks by cattle. The process of decline is influenced by the growing conditions of the eucalypts; recovery is retarded by adverse weather, shortfalls in the supply of water and mineral nutrients and possibly by other factors, e.g. interference from pasture plants and the presence of secondary disease-causing agents.

The factors likely to have contributed to development of insect outbreaks are discussed. These factors include: (a) long term changes associated with agricultural development, e.g. a reduction in the habitat available for natural enemies of the insects and reduced spatial heterogeneity (both floristic and structural); (b) weather conditions favouring breeding and survival of the insects; and (c) changes in the condition of eucalypts associated with chronic defoliation, e.g. a reduction in the average age of leaves.

It is argued that lignotuberous advanced growth is critical for the survival of eucalypt populations during periods of intense dieback.

Research Activities

G.R. Enders and J.A. Duggin
Department of Ecosystem Management,
University of New England, Armidale, NSW 2351.

Introduction:

1986 was a slow year for dieback research in this Department, contrary to our original expectations. Our research grant entitled:

> "Regeneration and Maintenance of Native Woodlands in Dieback Affected Areas of New England",

terminated in July, with a progress report to the Rural Credits Development Fund. The following report is taken from this July Progress Report.

Landholder survey of woodlot sites

Morgan, (1981 RCDF Progress Report), listed six factors to consider when selecting woodlot areas, based on his initial survey findings:

1. Highest priority should be given to fencing large, natural and floristically diverse areas on properties.

2. Second priority should be given to fencing degenerate woodlands in which regeneration of trees and shrubs is likely to occur.

3. Woodlot size is at a viable minimum of c. 2 ha in areas of existing tree cover, and c. 20 ha in treeless areas, although woodlot size is best equated to a useful paddock size for other property activities.

4. Edge to area ratio should be minimized by fencing woodlots to be as compact a shape as possible.

5. A water supply (for livestock and native fauna) should be contained within the woodlot, or near to it.

6. Woodlot management should be aimed at increasing and maintaining internal structural and floristic diversity, with the objective of maximizing ecosystem resilience to perturbation.

Morgan based these recommendations on his findings that the health and resilience (and hence persistence through time) of woodlots were positively related to their size, structural diversity, species richness, and surrounding land use. In order to further quantify the effects of managment and land use intensity on woodlot health and resilience, a survey was conducted over the landholders on whose properties the 140 woodlot health sites were originally established.

The success of this survey, and hence the degree to which it could be correlated with Morgan's data set, was limited by the relatively poor response rate, although considerable attempt was made to obtain a high recovery of survey forms, including the use of direct interviews. It was felt in retrospect that landholder interest and participation were on average quite low. This was possibly due to the high intensity of research activity into eucalypt dieback in recent years, using field based survey techniques, and with a fairly low rate of return of extension information to landholders. Table 1. below depicts the number of useful woodlot data sites, and the response to the land use survey, for each land system.

Table 1. **Response to landholder survey of woodlot sites.**

Land System	No.Woodlot Sites	Land Use Survey No.Responses	% Response
Thalgarrah Sediments	39	30	77
Armidale Basalts	17	10	59
Salisbury Plains	30	21	70
Backwater Granites	25	6	24

Data were collected on four main subject areas of woodlot history and management:

(i) Development history; tree clearing and pasture establishment,

(ii) Grazing history; type, number and rotation of livestock,

(iii) Tree health; dieback and regeneration of eucalypt trees, and,

(iv) Tree management; an assessment of landholder awareness of tree decline and regeneration management.

The initial results of this survey indicate a wide range in land development, livestock managmeent and landholder attitude to rural tree decline. Although basic management techniques are quite similar, the extent and intensity to which they are applied, or have been applied in land development, varies considerably. Table 2 portrays some important land use variables for each of the land systems surveyed. These figures support the assumption that land use intensity for agriculture is effectively stratified by biophysical factors reflecting the capability of the land for that use. The land system survey approach does this by stratifying land on the basis of ecological variables such as parent material, soil type, landform and vegetation association, all of which are important in determining the basic producitivity of the land.

On this basis, the Salisbury Plains land system has been divided into two sub-systems which better reflect inherent capability for agriculture. Sub-system A comprises the open basalt alluvial and colluvial and sedimentary soil parent materials of the main plateau between Uralla and Walcha. Sub-system B comprises the more dissected sedimentary geology landform to the east of the main plateau, where depth of soil formation is somewhat less, and influence of cool easterly air flows more common. Sub-system A is considered to have a higher capability for pastoral agriculture than Sub-system B.

Table 2. **Variables of land use intensity for the four land systems surveyed.** Note Salisbury Plains Land System is divided into two sub-systems, A and B.

	Thalgarrah Sediments	Armidale Basalts	Salisbury Plains: A	Salisbury Plains: B	Backwater Granites
Average property size (ha)	1445	1923	1223	802	558
Percent properties pasture improved.	60	90	100	88	50
Percent properties aerial fertilised	70	100	100	100	83
Average frequency of fertiliser application.(yrs)	3.1	2.0	1.3	3.0	2.2
Average stocking rate (DSE/ha)	3.8	7.3	7.2	5.0	2.1

This table depicts quite clearly that the land systems of higher agricultural capability, viz. Armidale Basalts and Salisbury Plains: A, have a higher percentage of properties with pasture improvement and which utilise aerial fertilisation, and in which the frequency of fertiliser application is also higher than the other three land systems. This higher intensity of use is also reflected in the livestock grazing rate, where these land systems have a much higher ratio of animals per unit area (Dry Sheep Equivalents/hectare).

Overall, it was felt at the time of survey (1984) that landholder attitudes were in the main ambivalent toward tree retention and management. A very few of the survey respondents (approx. 1%) felt any need to reserve and manage trees and tree regeneration as an integral part of property management, and many seemed endowed with 'pioneering' attitudes of tree suppression and removal, particularly in regard to lignotuberous regeneration. Until a major reversal in landholder attitude is effected on the tablelands, Government and private attempts to revegetate degraded rural land, e.g. by establishing woodlots, will be a difficult process. Of greatest importance here is the ongoing management of these woodlots and rural trees. The results of this survey have indicated that unless woodlots are managed to maintain and enhance their structural and floristic diversity, their health and long term survival may be impaired.

<u>1985 Resurvey of lignotuberous regeneration</u>

The twenty regeneration sites established in 1982 were resurveyed during April 1985. The most striking impact of this sruvey was the considerable size growth in all tree species over all the non-forested sites. In addition, seedling recruitment had occurred, with an estimated 5% of the 800 plants measured being non-lignotuberous seedlings. The salient results of this survey, in which lignotubers were again excavated, are presented in Table 3 below.

After some trial analysis, it was decided to regroup the sites into land management classes of Forest (FRST), pasture and woodland (PAST), (incorporating sites originally classed as woodland), and travelling stock resrves (TSR). Table 3 hence displays recalculated values for the 1982 survey.

Table 3. Mean growth in tree height (cm) and lignotuber weight (g) (for all tree species) over the time period 1982-1985 for three land management classes; Forest (FRST), Open pasture and woodland (PAST), and Travelling stock routes/reserves (TSR).

		1982 Average	1985 Average	Net Increase	Percent Increase
FRST:	Tree height (cm)	34.10	41.40	7.30	21.41%
	Lignotuber weight (g)	22.60	19.70	-2.90	-12.83%
PAST:	Tree height (cm)	42.90	73.50	30.60	71.33%
	Lignotuber weight (g)	19.50	66.30	46.80	240.00%
TSR:	Tree height (cm)	51.00	85.40	34.40	67.45%
	Lignotuber weight (g)	23.80	51.30	27.50	115.55%

These results indicate a considerable overall growth in both tree height and lignotuber weight over the time period 1982-1985. Exception to this growth is expressed in the forested sites, where no statistically significant change occurred in mean height or mean lignotuber weight from 1982-1985, although a slight numerical decrease occurred in the latter. All other increases in these mean growth parameters were statistically significant for at least a 95% confidence interval of the two sample t-test.

This lack of growth in the forested sites could be expected due to the suppression of growth in regeneration by the mature forest overstorey, as described by Henry and Florence (1966).

Again using the two sample t-test, in 1982 no significant differences were apparent between these mean growth variables for the three regrouped land management variables; FRST, PAST, and TSR. However by 1985 the FRST parameters differed from both PAST and TSR with at least a 95% confidence. However, the PAST and TSR mean values did not differ significantly.

The growth in lignotuber size and tree height over the time period 1982-1985 reflects the relatively low post-drought stocking rates and favourable climatic conditions for growth, including very low population levels of phytophagous insects. This is particularly so when it is considered that recruitment of new (and hence small) seedlings has presumably subdued the numeric value of mean increases in height and lignotuber wiehgt.

Of interest to this study is the dramatic increase in mean lignotuber weight of the excavated sample in the PAST and TSR land management classes. Figure 5 demonstrates that most of this increase is due to growth in the smaller size classes, with 52% of the 1982 sample (N=83) contained in the range 0-10 g, and only

21% of the 1985 sample (N089) contained in the same range, even though smaller lignotubers were present in the latter sample due to seedling recruitment. Figure 5 also shows a wider distribution of lignotuber weights in 1985 than in 1982, although both samples were taken over similar representative height classes.

This study demonstrates the ability of lignotuberous regeneration to achieve rapid growth under favourable environmental conditions, and so contribute to the function of the woodland canopy. The relative ability of regeneration to achieve this function forms the subject of the Thalgarrah eucalypt regeneration exclosure experiment discussed later in this report. In that study an attempt was made to experimentally control two of the more important environmental variables affecting regeneration survival and growth, i.e. grazing by domestic livestock and leaf herbivory by insects.

Reference:

Henry, N.B., and R.G. Florence, 1966. Establishment and development of regeneration in spotted-gum ironbark forests. Aust. Forestry 30: 304-316.

Ongoing Research

Although funding for specific dieback research has terminated in this Department, it is anticipated that our long-term monitoring programmes of tree crown condition and regeneration growth will be continued where possible. The main results of our Thalgarrah regeneration exclosure trials will be compiled as part of a Master's Degree project, over the coming year. It is anticipated that publication of the salient results will follow.

```
MIDDLE OF     NUMBER OF
INTERVAL      OBSERVATIONS

   0.0          43   *******************************************
  20.0          22   **********************
  40.0           7   *******
  60.0           6   ******
  80.0           4   ****
 100.0           0
 120.0           0
 140.0           0
 160.0           0
 180.0           0
 200.0           0
 220.0           1   *
```

MTB > Histogram: 1982 non-forest lignotuber weights

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MIDDLE OF     NUMBER OF
INTERVAL      OBSERVATIONS

   0.0          19   *******************
  20.0          25   *************************
  40.0          14   **************
  60.0           6   ******
  80.0           2   **
 100.0          10   **********
 120.0           4   ****
 140.0           0
 160.0           1   *
 180.0           1
 200.0           1   *
 220.0           0
 240.0           0
 260.0           2   **
 280.0           0
 300.0           2   **
 320.0           0
 340.0           2   **
```

MTB > Histogram: 1985 non-forest lignotuber weights

Figure 5. Sample distribution of lignotuber weights from PAST and TSR sites for 1982 and 1985 survey. Interval is in Grams (g). (Analysis done by UNE MINITAB package.)

Causes of Eucalyptus wandoo Blakely decline in the Upper Great Southern of Western Australia

Paul Brown, Joanna Tippett, Paul Albone

Department of Conservation and Land Management
Research Branch
PO Box 104
COMO WA 6152

This project has been funded by the Rural Credits Development Fund for a two year period which began in March 1986.

There has been no detailed information available on any of the agents associated with crown decline of E. wandoo in WA. Therefore, the first phase of this project was to describe, collect and record photographically the various types of external and internal damage to wandoo and to identify the casual agents associated with each damage type. This includes both the study of:

i) organisms associated with damage to the bark and wood; and

ii) the identification and quantification of the damage caused to the wandoo by leaf defoliating organisms.

Bark/wood Symptoms

A total of 34 external bole/branch symptom types have been photographed and described, some of which appear to be superficial. The amount and type of internal damage associated with the external symptoms was described and analysed by felling and disecting trees at each of the permanent plots established.

A total of 10 species of insects (of which 8 are borers) have been recorded causing damage to bark and wood of live E. wandoo. However, only two - Tryphocaria punctipennis and a Xyloryctid moth larvae - appear to cause branch death in living trees by girdling branches. Although uncommon, three species of fungi have been found associated with bark lesions which are thought to be causing death of wandoo branches and twigs. Only one root disease Armillaria luteobubalina has been recorded.

Leaf Defoliation

Following a technique developed by Ian Abbott, 480 newly developed leaves on ground coppice of E. wandoo, were tagged in November 1986 within both grazed farmland and ungrazed woodland. Every three months leaf outline and area of lamina damaged by insects and fungi will be traced and percentage damage calculated. Insect species and their characteristic leaf damage will be photographed, preserved and identified.

Dieback of rural Eucalypts: dietary quality of foliage and insect herbivory.
Abstract of a PhD thesis submitted in October 1986.

Jill Landsberg
Research School of Biological Sciences, Australian National University
PO Box 475, Canberra City ACT 2601

Dieback of native trees on farms in Australia - rural tree dieback - is often associated with chronic defoliation by insects. Where this association occurs, trees with severe dieback are commonly found growing adjacent to healthy trees which appear, in other respects, to be very similar to the trees with dieback. I investigated possible reasons for this variation in susceptibility for Eucalyptus blakelyi, a common species of eucalypt on pastoral lands in the southern tablelands of south eastern Australia.

The values I obtained when assessing the extent of insect damage to foliage were very dependent on the technique of assessment. For example, when I compared several commonly used techniques I found a ten-fold difference between the highest and lowest values I calculated for samples from the same trees.

Dieback-affected E. blakelyi trees were more heavily grazed by insects than were healthy trees growing nearby. The foliage from the dieback trees tended to be younger, which contributed to its greater susceptibility to insect grazing, but foliage from dieback trees was also damaged to a greater extent than foliage of a similar age from healthy trees.

Dieback trees' foliage also tended to be nutritionally superior for insects, compared with healthy trees' foliage. Some of the differences in dietary quality reflected differences in the average age of the foliage of healthy and dieback trees. But when statistical models were used to equalize the effects of differences in tree phenology, leaves on dieback trees still tended to contain more water and nitrogen, and to be rounder and to have lower specific weights. Many of the dietary quality variables were correlated with each other. This is probably why multiple regression equations incorporating seasonal means of several quality variables were grossly different between years, although they explained a high proportion of the variance in seasonal herbivory.

In a series of glasshouse experiments, I investigated whether differences in the nutritional quality of foliage were genetically determined, or caused by environmental stress. Using seedlings and grafted plants derived from dieback and healthy populations of trees, I tested the influence of: depletion of nutrients, addition of excess phosphate, drought, waterlogging, and saline waterlogging on the nutritional quality of foliage. Differences in the foliar properties of plants from different genetic sources were not consistent with the differences between the source populations. Most of the environmental stresses applied caused a reduction in foliar quality, (decreased water and nitrogen contents, and increased specific leaf weights). I hypothesize that the enhanced nutritional quality of the foliage of dieback-affected trees is more likely to be a consequence of benign growing conditions (e.g. improved soil fertility), than of environmental stress. Field data for soil properties and the effect of drought on mature trees are consistent with this view.

I attempted to test whether seedlings grown under a favourable nutrient regime would be more damaged by insects, in a field experiment in which seedlings were grown in boxes placed on platforms in the canopies of mature trees. Unfortunately common brushtail possums (Trichosurus vulpecula) severely damaged many of the seedlings before I could measure insect damage. (The possums selectively browsed

on nutrient-rich seedlings. Limited data suggest that the animals may have selected for foliage with a high concentration of sugar and a low concentration of tannin.)

Defoliation appears to enhance the susceptibility of regrowth foliage to damage by insects. The foliage that regrew on three mature trees that I had artificially defoliated was nutritionally superior to the foliage it replaced, and was much more heavily damaged by grazing insects. There was a transient increase in the tannin content of the regrowth foliage, but this was apparently ineffective in defending it from subsequent herbivory. The dietary quality of the regrowth foliage was more similar to that of the foliage on dieback, rather than healthy trees. Therefore I suspect that the enhanced nutritional quality of the foliage of dieback trees may be maintained, in part at least, by a feedback between repeated cycles of defoliation by insects and compensatory growth by trees.

This thesis was written as a series of manuscripts, all of which have been submitted to journals for publication.

Research Acitivities

Margaret Lowman and Harold Heatwole

Department of Zoology, University of New England, Armidale NSW 2357

We have just finished a five-year study of insect herbivory in New England eucalypts, including both healthy and dieback trees. The data is still being analyzed, but we envisage comparisons of insect grazing levels between sites, species, tree individuals, and canopy heights. Several publications are in press concerning aspects of our eucalypt-insect fieldwork, including a book entitled Dieback - Death of an Australian Landscape (H. Heatwole & M.D. Lowman, Reed Publ., Sydney, $19.95). The book is a general story of tree decline in Australia, intended for landowners, and other members of the public interested in the Australian landscape. It discusses many aspects of current research into dieback, as well as most of the major factors implicated in the dieback syndrome. The book is distributed in most major bookstores in Australia, but please write to our department if you have trouble obtaining a copy.

The performance of Uraba lugens Walker in relation to nitrogen and phenolics present in its food plant, Eucalyptus camaldulensis Dehn.

J.D. Farr
Dept. of Entomology, Waite Agric. Res. Inst., Glen Osmond, South Australia 5064.

Uraba lugens Wlk. feeds and performs variably on a wide range of species in the genera Eucalyptus, Angophora and Tristania, feeding on the mature and newly mature leaves. The performance of U. lugens was investigated in relation to the influence of nitrogen and phenolic components present in its food plants, using fresh and synthetic diets. The seasonal and annual variation of these components in E. camaldulensis foliage, a good food plant for U. lugens, was also examined. This was done in order to test the hypothesis that nitrogen is normally a limiting nutrient for phytophagous insects (White 1978), but may become more available when its food plant is subjected to "water stress", leading to increased survival of early instars and therefore a population increase or "outbreak".

Larvae fed water stressed E. camaldulensis were potentially more fecund, although survival did not increase. For artificial diets incorporating leaf powder of either good (E. camaldulensis) or poor (E. platypus) food plants, the amino acids proline and valine increased larval performance compared with the respective base diets. Proline and valine are amino acids known to increase markedly in water stressed plants. However, although proline concentrations varied markedly (9.0 - 235.7 μg/g dry wt. of leaf), valine concentrations (3.5 - 12.5 μg/g dry wt. of leaf) remained relatively constant throughout the study period.

The major influencing factor on the performance of U. lugens was the phenol quercetin, which decreased nitrogen assimilation to a much greater degree than the other phenols studies (caffeic, chlorogenic and gallic acids).

In the food plant E. camaldulensis total nitrogen and phenols were negatively correlated. Total nitrogen reached its maximum level (15.7 mg/g dry wt. of leaf) in early spring and declined to its minimum (11.08 mg/g dry wt. of leaf) in winter. But total phenols reached maximum levels (126.7 mg/g dry wt of leaf) in winter and minimum levels (83.0 mg/g dry wt of leaf) in early spring. The variation of soluble nitrogen and individual amino acids present in E. camaldulensis foliage were also examined.

The results of this study suggest that nitrogen may always be adequate for U. lugens but the level of its assimilation may not be at certain times. Therefore for a phytophagous insect sensitive to its food plant's allelochemics, the balance between levels of deleterious and advantageous components of the plant may determine its performance (excluding the influence of predators and parasites which do not appear to be critical factors in the dynamics of U. lugens populations). Water stress leads to better growth rates and higher fecundities of U. lugens. This may be a result of the plant's reduced capacity to alter the nitrogen/phenolic ratio in its leaves (Graham 1983) as unstressed plants appear to do as foliage damage levels increase (Morgan 1984). Therefore, water stress may render the nitrogen component of a plant's foliage more "assimilable" to its phytophagous insect population, through the effect of drought on the ability of the plant to produce sufficient of the compounds that protect it from its pests.

Papers in preparation - provisional titles as follows:

Farr, J.D. The influence of phenols on nitrogen assimilation by _Uraba lugens_ Walker (Lepidoptera: Nolidae).

Farr, J.D., Morgan, F.D., Taylor, G.S. Seasonal and annual variation of nitrogen and phenols present in mature foliage of _Eucalyptus camaldulensis_ Dehn., a preferred food plant of _Uraba lugens_ Wlk. in South Australia.

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Graham, R.D. (1983). Effects of nutritional stress on susceptibility of plants to disease with particular reference to trace elements. Adv. Biochem. Res. 10: 222-276.

Morgan, F.D. (1984). Psylloidea of South Australia. Handbook of flora and fauna of South Australia. D.J. Woodman, Gov. Printer.

White, T.C.R. (1978). The importance of a relative shortage of food in animal ecology. Oecologia (Berlin) 33: 71-86.

Research activities

C.P. Ohmart
CSIRO Division of Forest Research, PO Box 4008, Canberra ACT 2600

This is text from a report I filed in 1987 for the Director of Research Council Research Working Group No. 8 (Forest Entomology)

Insect/eucalypt foliage interactions

I have completed work concerning the effects of nitrogen concentrations in Eucalyptus balkelyi foliage on the performance of Paropsis atomaria (Coleoptera: Chrysomelidae). A project completed in 1985 concerned the effects of foliar N concentrations on female fecundity. The basic conclusion drawn from the project was that there is a dose-dependent relationship between N and fecundity; the higher the N concentration of foliage fed on by female beetles the more eggs they lay. The detailed results are published in Ohmart et al. 1985, Oecologia **68**:41-44. Ohmart et al. (in press, J. Aust. Ent. Soc.) summarizes the results of my work over the past three years in terms of the effects of N on the population dynamics of P. atomaria.

During the summer of 1985/86 Dr Stig Larsson, a forest entomologist at the Swedish University of Agriculture in Uppsala, worked with me looking at the effects of essential oils in E. blakelyi foliage on growth rate and development time of P. atomaria larvae. Growth rate and development time are not influenced by foliar oil concentrations. However, larvae feeding on high oil plants gain significantly more weight than those feeding on low oil plants.

Another project on which Stig and I worked was designed to determine at what point in time from leaf emergence an E. blakelyi leaf becomes unsuitable for P. atomaria larvae. We discovered that larvae begin to reject leaves at a point in time before these leaves actually become unsuitable for their development. This point is reached in a matter of days for 1st instar larvae and in a couple of weeks for 4th instar larvae.

Stig and I have drafted two manuscripts discussing the above projects in detail and hope to send them off for publication soon.

Sampling techniques for estimating insect defoliation in eucalypt canopies

In cooperation with Dr Bill Thompson of my Division and Dr Meg Lowman of the University of New England I am examining certain aspects of designing sampling schemes for estimating defoliation in eucalypt canopies by measuring defoliation on individual leaves. On a property near Walcha, NSW, Meg and I systematically removed all foliage on two open-grown E. nova-anglica; one was suffering from canopy dieback, the other appeared normal. We have measured the amount of defoliation on individual leaves from over half the canopies of each tree (>80,000 leaves). Using this data set Bill and I are running Monte Carlo-type analyses to determine the most appropriate methods for sampling defoliation on these two trees. Coupled with other concurrent studies we will be able to recommend statistically valid sampling schemes for measuring defoliation in eucalypt canopies under certain circumstances. We hope to have the results in manuscript-form soon.

Pollination ecology of eucalypts in southeastern Australia

In cooperation with Dr Rod Griffin of my Division I am working on a series of projects designed to describe the pollination ecology of certain eucalypts. By the publication of this newsletter we will have completed the main part of the program in which I am most involved. This project was designed to assess the relative abundance and importance of insect pollinator groups visiting flowers of E. regnans, E. pauciflora, and E. stellulata. We have completed two years of study on each tree species and have recently drafted a manuscript which presents the results of this project. In most instances the larger Dipterans (Calliphorids and Tachinids) were the most abundant group and the one most likely to be effective in pollination. The second most important group was the native bees.

The flowers of the eucalypt studied are extreme generalists, attracting a vast array of pollinator groups. Knowledge of pollination ecology of eucalypts is not only important from a production forestry point of view, due to the role of pollinators in seed orchards, but also in relation to the current controversy of whether honey bees should be excluded from national parks. The policy now being adopted by most states is that honey bees are harmful to native flora and fauna and until bee keepers can demonstrate otherwise they will be excluded from putting hives in national parks.

Future projects

Dr Paul Kriedemann, an expert in photosynthesis and gas exchange in plants, has recently joined my Division. With his and Bill Thompson's cooperation we will be looking at the effects of defoliation on carbon assimilation in eucalypts as well as the effects of defoliation on carbon and nitrogen allocation. From this work we will produce a process-based computer model which can be used for economic and risk analyses in relation to insect defoliation. We will initially concentrate on E. nitens and defoliation by Chrysophtharta bimaculata in Tasmania. We hope to work on other eucalypts such as E. grandis in the future.

I will be spending May - October 1987 working with Dr Stig Larsson at the Swedish University of Agriculture in Uppsala. We will be studying the effects of N fertilization of Pinus sylvestris on tree susceptibility to defoliation by Neodriprion sertifer 'Hymenoptera: Diprionidae).

As of January 1987, Dr Jill Landsberg, a recent graduate of the Australian National University, has joined my Division on a 2 year CSIRO postdoctoral fellowship. She will be continuing her work on the role of insects in eucalypt dieback. Specifically she will be examining the influence of habitat on the effects of natural enemies on defoliators in the canopies of isolated individual woodland eucalypts verses those in groups of trees in pastures verses those in groups of trees in natural woodlands.

The biology and ecological impact of bag shelter moths in the Western Australian wheatbelt

Richard J. Hobbs, John van Shagen and Jonathan Majer.

CSIRO, Wildlife & Rangelands, LMB 4, P.O. Midland, W.A. 6056
School of Biology, WAIT, Bentley, WA 6102

We present details of a project which will commence in January, 1987 and will assess the impact of caterpillar herbivory on productivity, survival and nutrient relations of *Acacia acuminata*.

Background

The bag shelter moth *Ochrogaster contraria* (Walk.), formerly known as *Teara contraria*, is common in the WA wheatbelt, where its abundance is rapidly increasing, according to some local shires. The caterpillars of this species produce conspicuous bag shelters in *Acacia* shrublands and *Eucalyptus* trees. These silken bags are partly filled with excrement and cast skins, which can cause severe irritation to the skin of predators and humans. At night the caterpillars move out to feed and often defoliate entire trees. The recent population increase is having a serious effect on *Acacia acuminata* trees, especially along road verges.

This study proposes to examine the following questions:

1. Are infestations of *O. contraria* greater in cleared areas in which *Acacia acuminata* (Jam wattle) has regrown in dense stands, compared with similar plants in natural York gum/Jam communities?

2. Does herbivory by caterpillars significantly reduce growth and productivity of *A. acuminata*?

3. Are increased abundances of bag shelter moths linked with declines in predator populations?

4. Does herbivory significantly alter the rates of release and cycling of major nutrients?

This study will require detailed observations on the relatively little known ecology of the moth, together with experimental manipulations such as removal and exclusion of caterpillars.

METHODS

Biology

In order to investigate the ecological impact of *O. contraria* the biology of the animals needs to be studied in detail. Therefore the life-cycle of the moth will be examined, both in the field and the laboratory. Its density will be surveyed on *A. acuminata* in selected disturbed and undisturbed areas within, and in the vicinity of, Durakoppin Nature Reserve.

Herbivory

In each of the selected areas *A. acuminata* trees will be paired and caterpillars will be excluded from one tree of each pair. The removal of the bags will be achieved either chemically or by physical methods. Growth and damage will be measured on all paired trees in order to determine the degree of herbivory.

Abundance

To study the relationship between increased abundance of the bag shelter moth and the decline in predators, the life history of the moth needs to be examined to determine its predators and/or limiting organisms. This requires a detailed literature review of the history and some case studies, and a survey of such organisms in the reserve.

Nutrient Cycling

The influence of O. contraria on the cycling of major nutrients will be determined by obtaining soil, litter and vegetation samples. These will then be chemically analysed for basic nutrient content. This will be done for both trees without caterpillars and trees with caterpillars so a comparison can be made.

Defoliating insects in the southern jarrah forest of Western Australia

Ian Abbott
Research Branch, CALM, Como WA 6152.

1. Jarrah ground coppice is most vulnerable to leaf damage by the leaf miner Perthida glyphopa within the low rainfall zone and in recently burned stands. In 1985, c. 5% of leaf area was damaged by this species. Another 5% was attributable to about 10 species of beetles and moths, but no significant stand correlates were found. Some 13% of leaf area was damaged by a fungus; such damage was greatest in stands with high canopy cover.

2. Insect damage to leaves in pole crowns averaged 17%, nearly twice that of leaves in ground coppice. This was attributed to caterpillars of the Nolid Uraba lugens, which were 40 times more abundant in pole crowns than in ground coppice. Ants were found to be 20 times more abundant in ground coppice than pole crowns. It is suspected that ants are important predators of Uraba caterpillars. In January 1986, the ratio of numbers of individuals of leaf chewer: sapsucker: predator: parasitoid arthropods in pole crowns was c. 200 : 12 : 5 : 1.

3. Monitoring of tagged jarrah leaves has shown that significant premature abscission occurs if > c. 75% of leaf area is removed. A long term experiment assessing the effects of such recurrent losses of leaf area on wood growth has been started.

4. Surveillance of the expanding area of outbreak of Uraba in the southern jarrah forest has continued since the first outbreak of summer 1982/3. In spring 1986, significant incursions (but not outbreaks) of Perthida glyphopa were found in the northern jarrah forest east of Harvey.

Seasonality and abundance of arboreal invertebrates in western and eastern Australian forests and their relationship to avifauna

Jonathan Majer and Harry Recher

School of Biology, WAIT, Bentley, W.A., 6102
The Australian Museum, College Street, Sydney NSW, 2000

We have recently received support from ARGS to undertake a comparative study of arboreal invertebrates in western and eastern Australian forests. Although the project is slanted towards the use of trees by avifauna we will be gathering much needed data on the biomass, abundance and composition of invertebrates in forest canopies. The background to the project is given below.

Despite the compelling reasons for the need to understand the patterns of abundance, distribution and taxonomic composition of the invertebrate fauna, their data-base for most Australian forests are depauperate and the data for Australian forest canopies are still raising as many questions as the answers they provide. Although a lack of knowledge does not always justify initiation of a research programme, in this instance the lack of information on patterns of invertebrate abundance prevents a full understanding of patterns in the distribution, abundance and movement of forest vertebrates. In recognition of these problems, we independently initiated studies of the invertebrate faunas of eucalypt forests. J.M. has worked mainly in Western Australia where he has emphasised the invertebrate communities themselves while H.R. has worked in eastern Australia with an emphasis on bird/insect interactions. We now propose to collaborate and integrate our separate projects.

J.M. has undertaken considerable research on the invertebrates of Western Australian forests. This work has centred on the soil, litter and ground-surface invertebrates and has looked at seasonal patterns, nutrient cycling, and plant-animal interactions. More recently he has initiated a study of the biomass of ants and other invertebrates in forest canopies. This has been performed using 25m^2 pyrethrum knockdowns of the canopy fauna. this is an extension of studies J.M. has conducted with tree canopy invertebrates elsewhere in the world.

In order to understand the interactions and dynamics of foliage-gleaning birds in eastern Australian forests, H.R. has begun to look at the patterns of invertebrate abundance on eucalypt foliage (using a branch clipping technique) and has evidence that birds select trees as foraging substrates partly on the basis of invertebrate abundance and taxonomic composition. He and his jcolleagues have also shown that the timing of avian breeding seasons, movements of forest birds (dispersal and migration), and seasonal changes in flocking and foraging behaviour are correlated with seasonal patterns of invertebrate abundance.

We now plan to standardise and refine the techniques for sampling foliage invertebrates so that we can be confident that the sampling techniques used provide an accurate representation of the invertebrate populations present. Although in recent years a number of investigators have sampled invertebrates on eucalypts, usually only two basic procedures have been used. Most commonly, workers have used a variation of the clipping technique or sweeps using an insect net with consequent bias towards particular components of the invertebrate fauna. Clipping procedures, for example, by virtue of the disturbance associated in their collection and generally small amount of foliage collected in each sample probably underestimate the abundance of larger and more mobile species. Sweeps and knowckdowns will miss sessile insects (e.g. psyllids) or those in webs and cocoons (e.g. some spiders, lepidopteran larvae). There are also major problems with the patchy distribution of foliage invertebrates which most workers have been forced to ignore (probably by virtue of a lack of resources enabling extensive sampling) by grouping the material sampled.

While H.R. is on study leave at WAIT during 1986 we are testing the performance of two foliage sampling techniques: branch clipping and pyrethrum knockdowns. These have been selected as ones which we are already familiar with and which, from existing data complement each other in the range of invertebrates sampled.

They are also procedures where differences in field personnel are unlikely to affect results (in contrast to sweeps or visual counts which should be done by the same person or persons). We will have obtained sufficient information by the end of this year to have agreed on a standard methodology for the project proposed here. This will ensure that samples taken in eastern and western Australia are comparable, that the sampling biases inherent in each procedure are clearly defined, and that sampling accounts for the spatial variation in the distribution of foliage invertebrates.

The principal objective of the work proposed here is to quantify the patterns of spatial and temporal distribution of foliage invertebrates on canopy and subcanopy trees in temperate Australian eucalypt forests. The results obtained will also be used in studies of the temporal and spatial patterns in the use of forest trees by foliage-gleaning birds.

The studies of invertebrate patterns proposed here and H.R.'s work on foliage-gleaning birds also have a practical application. Commercial forest management in Australia is increasingly intensive and although these practices usually retain the basic structure of a forest (i.e. ground, shrub and tree vegetation) there is selection for commercially valuable tree species with a consequent shift in floristic composition. To assess the impact of such silvicultural practices on forest fauna and to develop plans of management which take into consideration the requirements of animals for particular kinds of trees, it is necessary to know which species of trees are selected by wildlife and the reasons for this selectivity. There is also a need to begin to consider the conservation and management of invertebrate faunas in their own right.

In summary, the aims of the project are:

1. To compare the efficiency of two sampling methods (Branch clipping versus chemical knockdown) for the estimation of the abundance and spatial patterns of foliage invertebrates. This work will be completed during 1986.

2. To compare the abundance, distribution and taxonomic composition of foliage invertebrates in representative eastern and western Australian forests using standardized procedures.

3. To compare the abundance, distribution and taxonomic composition of foliage invertebrates in different tree species in each forest.

4. To assess the seasonality of foliage invertebrates on trees in each forest.

5. To relate these results to the abundance of birds in forests in eastern and western Australia and to the pattern of bird usage in each forest.

Ecology of birds in eucalypt woodland

Hugh A. Ford
Department of Zoology, University of New England, Armidale, NSW, 2351.

During 1986 I finished collecting data on time-budgeting of insectivorous birds in eucalypt woodland near Armidale. These data will be used to calculate more accurately the energy demands of these birds.

I have also published the results of previous work on the density of birds in eucalypt woodland, their foraging behaviour and an initial crude estimate of their impact on insects in healthy woodland. Reprints of the following can be obtained from the author:

Ford, H.A., Bridges, L. and Noske, S. 1985. Density of birds in eucalypt woodland near Armidale, north-eastern New South Wales. Corella 9: 97-107.

Ford, H.A. 1985. The bird community in eucalypt woodland and eucalypt dieback in the Northern Tablelands of New South Wales. In Birds of eucalypt forests and woodlands: ecology, conservation, management. J.A. Keast, H.F. Recher, H.A. Ford and D. Saunders (eds.). RAOU and Surrey Beatty, Sydney.

Ford, H.A., Noske, S. and Bridges, L. 1986. Foraging of birds in eucalypt woodland in north-eastern New South Wales. Emu 86: 168-179.

A small exclosure experiment conducted by Gillian Dunkerley and Lynda Bridges indicates that birds reduce insect numbers on foliage of Symphomyrtus but not on Monocalyptus. This experiment will continue in 1987.

Natural enemies of the jarrah leafminer Perthida glyphopa
(Lepidoptera: Incurvariidae)

Z. Mazanec
Division of Entomology, CSIRO, P.O. Wembley WA 6014.

The jarrah leafminer has been damaging the leaves of jarrah, Eucalyptus marginata in the south-west of Western Australia for several decades. Population data collected over several generations show that during the leafminer's year-long life cycle some of its larvae are affected by at least 9 species of hymenopterous parasitoids. Other larvae are eaten by birds and those aestivating in the soil during summer are sought by arthropod predators.

Biological studies of the parasitoids show that none of them are specific to the jarrah leafminer and that all but 2 have a short life cycle and require a continuous supply of hosts. In the outbreak areas these parasitoids may achieve high population densities, but when the leafminer larvae complete feeding in September-October, the parasitoids must seek alternate hosts. Since such hosts are very scarce during summer, only a fraction of the parasitoids can survive. The position is reversed in the next generation, when this small number of parasitoids encounters a large number of leafminer larvae in August. The densities of parasitoids therefore fluctuate, but do not match those of the available hosts.

Predators are similarly restricted by the seasonal nature of the leafminer. The birds, selecting only the large larvae as prey, can only consume relatively small numbers due to the short term of their availability. Likewise, arthropod predators at ground level are limited by the specialized behaviour of the leafminer larvae: by transferring from leaves to the ground at night, and burying themselves before daybreak, they largely avoid the predators.

The continuation of the leafminer outbreaks indicates that natural enemies can neither prevent their initiation nor reduce the severity of the existing ones.

A new project and an appeal for field sites

Jill Landsberg and Cliff Ohmart

CSIRO Division of Forest Research, P.O. Box 4008, Queen Victoria Terrace, Canberra, ACT, 2600. (Phone 062 818284).

Background:

In 'Focus on Farm Trees' (edited by N.M. Oates, P.J. Greig, P.A. Langely and A.J. Reid and published by Capitol Press, Vic. 3128 in 1980) Dr Rob Davidson proposed that populations of insects that feed on farm trees will be best controlled in woodlots that most closely resemble a natural woodland environment. He suggested that, at a local scale, numbers of tree feeding insects are controlled mainly by their predators and parasites (such as birds and parasitic wasps and flies). Therefore, he reasoned that trees will be best protected from defoliating insects when they are growing in structurally diverse stands that provide shelter and nesting sites, and that contain a diverse shrub understorey providing nectar sources for adult parasitic insects.

Proposed research:

We plan to test Dr Davidson's ideas by performing manipulative field experiments with both laboratory-reared and natural populations of insects. These will involve confining insects to tree branches, some of which are accessible to, and others of which are protected from, predators and parasites. We will monitor growth and survivorship of these insects. We will also undertake experiments involving removing insects from trees by fogging with insecticide, and monitoring subsequent rates of recovery of the insect populations.

We plan to run experiments in one region during spring and early summer in 1987, and to repeat them in a second region during late summer and autumn in 1988. Unfortunately logistic constraints will probably limit us to working in eastern Australia. In the two different regions we need to locate three replicates of a group of stands of trees with these characteristics:

Stand a) A stand of trees growing in a structurally and floristically diverse remnant of native forest or woodland. Very few trees have been removed and the understorey consists of native grasses and shrubs that have seldom been grazed by domestic livestock during recent years.

Stand b) A stand of trees growing in a more modified remnant of native forest or woodland. Few trees have been removed, but the understorey is pasture, and it is often grazed by livestock.

Stand c) A stand of widely scattered trees growing amongst grazed pastures. Tree clearance has been extensive.

Each of the different stands should contain at least 20 trees of the same species. Within each group of the three different stands other factors such as tree species, climate, geology, landform and aspect should be as similar as possible. We welcome any suggestions from newsletter readers about where sites like these may be found.

The Growth of Jarrah (Eucalyptus marginata) on two sites Infested with Phytophthora cinnamomi

E.M. Davison, Dept. Conservation & Environment, 1 Mount Street, Perth, W.A.

F.C.S. Tay, LES, Murdoch University, W.A.

(Present address of both authors: Dept. Conservation and Land Management, Hayman Road, Como, W.A.)

The growth of pole size jarrah trees in uninfested forest (healthy area) was compared with the growth of matched trees in adjacent forest infested with P. cinnamomi (dieback area) and with similar size trees at the margin of the healthy and dieback areas (intermediate area). Measurements were made on two sites for at least four years (Table 1).

Between 1982 and 1985 the trees in the dieback area at Churchmans grew significantly ($P < 0.05$) faster than trees in the healthy area, whereas at the Karnet site trees in the dieback area grew more slowly, although this difference was not significant ($P < 0.05$) (Table 1). Trees in the intermediate areas grew faster than trees in the healthy areas on both sites. There was a highly significant difference ($P < 0.001$) between the two sites with differences occurring in both increments in different years, and in the pattern of increment changes during the four years of comparable measurements.

P. cinnamomi can infect fine roots, large roots and stems of jarrah and if a tree is badly infected, we would expect its growth rate to be reduced. In addition to infecting jarrah, however, P. cinnamomi also modifies the site by killing many of the understorey and midstorey species, and if jarrah dies and the area is salvage logged, there will be a further reduction in the vegetation density. Greenwood et al. (1985) have estimated that evapotranspiration from the midstorey and understorey may account for about half of the annual rainfall, and therefore if a proportion of the vegetation is killed, the site will become wetter. With reduced competition for water we would expect the trees to grow faster.

On the Churchmans site, where jarrah trees in the dieback area are growing faster than trees in the healthy area, the effect of P. cinnamomi in reducing competition appears to be much more important than root damage. At the Karnet site, however, even though the basal areas are similar to the Churchmans site, there is no growth response. The Churchmans and Karnet sites are similar, but the soil profile at Karnet drains more slowly than at Churchmans, and this poorer drainage will affect P. cinnamomi, jarrah and infection of jarrah by Phytophthora.

Zoospores are thought to be the most important infective propagule of P. cinnamomi in the jarrah forest (Shea et al. 1980). Increased soil moisture may increase the probability of their production and dispersal because sporulation occurs in moist soil (Gisi et al. 1980), zoospore release follows heavy rainfall (Shea et al. 1980) and zoospore dispersal is by water draining through the soil profile (Shea et al. 1983). Sporulation, however, will not occur in saturated soil and may be reduced in very wet soil because of inadequate aeration (Davison & Tay, 1987), but waterlogging per se will damage jarrah by decreasing the number of functional xylem vessels in tap root and stem (Davison & Tay 1985). Thus the drainage characteristics of a site will affect both the ability of jarrah to grow on that site as well as its infection by P. cinnamomi. We do not know whether the lack of response to reduced competition in the dieback area of the Karnet site is due to increased infection, waterlogging damage, or both.

Table 1. Growth of jarrah trees on dieback sites.

	Churchmans site			Karnet site		
	Healthy Area	Dieback Area	Intermediate Area	Healthy Area	Dieback Area	Intermediate Area
Numbers of trees	12	12	12	25	25	25
dbhub 1.3 m (cm)	20.6 (4.3)	20.5 (4.4)	20.5 (4.3)	23.1 (5.7)	23.2 (5.7)	23.2 (5.8)
B.A. (m^2ha^{-1}) trees only	23.6 (6.7)	20.2 (5.2)	17.1 (3.5)	25.2 (7.5)	20.2 (5.4)	15.8 (7.3)
trees and banksia	28.4 (7.5)	20.2 (5.2)	18.7 (3.6)	27.3 (6.3)	20.3 (5.7)	18.0 (6.5)
Annual girth increment (mm):						
1981	4.8 (4.2)	8.5 (6.4)	10.6 (4.6)			
1982	2.0 (1.7)	5.0 (3.8)	4.7 (2.6)	3.3 (4.0)	3.1 (2.0)	4.7 (3.5)
1983	5.5 (3.8)	10.2 (6.2)	8.5 (1.6)	14.9 (6.4)	10.6 (6.5)	15.2 (8.3)
1984	19.2 (11.6)	20.3 (11.8)	25.6 (9.2)	19.1 (8.1)	16.8 (10.2)	20.9 (10.3)
1985	5.9 (4.7)	9.7 (7.2)	9.3 (5.8)	5.1 (5.6)	4.5 (5.7)	6.2 (5.1)

Standard deviations are given in parenthesis

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Gisi, U., Zentmyer, G.A. & Klure, L.J. (1980). Phytopathology **70**, 301-306.

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Ecosystem conservation: native vegetation in rural areas

Richard Thackway
Australian National Parks and Wildlife Service, GPO Box 636, Canberra ACT 2601

ANPWS is developing an Index of Australian ecosystems, to provide a basis for the establishment of a comprehensive system of ecological reserves throughout Australia, including all major ecosystem types. Ecosystems have been defined as mappable parts of the biosphere whose components (climate, terrain, geology, soils and biota) are interacting. The Index will be in the form of a geographic data base developed in cooperation with State/Territory agencies, and incorporating the considerable work already done in this field.

The Index will help provide a basis for protecting an adequate sample of all major ecosystems. Native vegetation in rural areas is an integral component and constitutes an important support base for existing conservation reserve systems, in which some important ecosystems are either poorly represented, or not represented at all. Continuing rural tree decline represents the loss of valuable components of such ecosystems.

Given widespread budgetary constraints, one practical solution to the problem of developing a comprehensive integrated network of conservation reserves is to enlist the support of leaseholders and private landholders who are willing to use their land to supplement the existing network of reserves. Already several States operate such schemes, the success of which will largely be dependent upon relevant conservation agencies maintaining or increasing the allocation of management support resources.

ANPWS is attempting to approach the task of conserving rural native vegetation from a national perspective. Conservation of natural habitat (or ecosystems) attempts to secure the conservation of species, populations and communities. Seen in this context, the development of an Index of Ecosystems will provide a valuable tool for State/Territory agencies who monitor the conservation status of natural ecosystems and their associated wildlife. It is envisaged that access to such an Index by both government agencies and private landholders will improve the basis for selecting areas either for purchase as reserves or for allocation of extra management resources.

ANPWS has prepared a national overview of nature conservation schemes for the various State/Territory agencies. It is hoped that this review will assist State/Territory agencies, other interested organisations and land holders to assess the attributes of the various chemes which encourage leaseholders and private land holders to manage land for nature conservation values.

Assessing the conservation value of remnant habitat 'islands': Mallee patches on the Western Eyre Peninsula, South Australia.

C.R. Margules and A.O. Nicholls
CSIRO Division of Water and Land Resources, GPO Box 1666, Canberra, A.C.T., 2601.

The problem addressed in this paper is how to compare the conservation values of remnant vegetation patches in a given region to select a set of patches for a nature reserve network. The conservation value of a patch is defined as the degree to which it represents the range of regional vegetation variation.

A survey and numerical classification of mallee vegetation in remnant habitat patches on part of the Eyre Peninsula, south Australia, revealed six floristic groups. The survey sampled only a subset of the patches, so that the probability of finding each of the floristic groups in each of the remnant patches was estimated from statistical models. These models related the floristic groups to three mapped environmental variables, age of calcium carbonate layer, distance from the coast and latitude. Thus, a uniform set of information about the probabalistic floristic composition of each patch was generated so patches could be compared validly. The problem of defining adequate representation is discussed, and a determination is made of the minimum set of patches required to represent all communities according to different definitions of inadequate representation.

Pages 89-102 in 'Nature Conservation: the role of remnants of native getetation', ed. by D.A. Saunders, G.W. Arnold, A.A. Burbidge and A.J.M. Hopkins. Surrey Beatty and Sons Ltd., in association with CSIRO and C.A.L.M.

The Wog Wog habitat patch experiment

C.R. Margules
CSIRO Division of Wildlife and Rangelands Research, GPO Box 1666, Canberra, A.C.T., 2601.

A continuing debate in the field of nature conservation concerns the fate of species remaining on fragments of habitat isolated by clearing the surrounding habitat; so-called 'habitat islands'. Central to this debate has been the equilibrium theory of island biogeography (MacArthur and Wilson 1963, 1967), which makes certain predictions on the number of species a given sized island in a given position relative to the mainland, can hold. There is no need to describe the theory in any detail here as it has been summarized and reviewed many times over (e.g. Sauer 1969; Gilbert 1980; Williamson 1981). Briefly, the theory suggests that the number of species on an island tends twoard an equilibrium number. This equilibrium number is the result of a balance between immigrations and extinctions. Immigration and extinction rates vary with only two factors, island size and position. Immigration rates decrease with increasing distance of an island from the mainland, and extinction rates decrease with increasing area of an island.

This theory, transferred to habitat islands on the mainland, has been used to propose geometric design principles for the selection of nature reserves to maximize species diversity, in particular that single large reserves will conserve more species than a group of smaller reserves of equivalent area, and that if smaller reserves are unavoidable they should be close together rather than far apart, to allow immigration between reserves (Diamond 1975; Wilson and Willis 1975).

In ecological research the equilibrium theory has proven useful as a model against which to test ideas, and has enabled ecologists to formulate questions they might not otherwise have asked (Haila and Jarvinen 1982; Simberloff 1986). However, the general validity of the theory has been questioned widely (Sauer 1969; Simberloff 1976; Gilbert 1980; Williamson 1981). In addition, as far as implications for nature reserve selection go, theoretical and empirical evidence supporting the suggested reserve design principles is equivocal (Higgs and Usher 1980; Higgs 1981; Margules et al. 1982; Simberloff and Abele 1982; Simberloff and Abele 1982; Simberloff and Gotelli 1984). Most of this equivocal evidence comes from studies done at one point in time such as surveys of the numbers of species on real islands and existing habitat islands of various sizes. As Shaffer and Samson (1985) correctly point out, there is a dynamic component to the whole problem which involves higher probabilities of extinction on smaller habitat islands with their associated smaller population sizes. Unfortunately, whilst there are some theoretical models (MacArthur and Wilson 1967; Richter-Dyn and Goel 1972; Shaffer and Samson 1985), to date there is no experimental evidence on the ecological effects of creating habitat islands by altering or destroying the surrounding continuous habitat.

The Wog Wog experiment arose as a direct consequence of this lack of experimental evidence. It was designed to test two hypotheses:

1. There will be changes in species richness and species' population parameters on habitat islands following isolation.

2. As island size increases, the effects of isolation decrease.

These are hypotheses reflecting the broad issues concerning habitat fragmentation. During the experiment more specific hypotheses under the two listed above will be formulated and tested. Potentially, there is a very long list and as null hypotheses are rejected (if they are) it will be necessary to formulate new hypotheses. As an example, one hypothesis is that the number of litter dwelling spider species is the same on habitat islands following isolation as it was prior to isolation. If this hypothesis is rejected it gives rise to a new one; that the number of litter dwelling spider species is the same on large islands but different on small islands following isolation. A third associated hypothesis might be that the suite of litter dwelling spider species following fragmentation is the same on a group of small islands as it is on one large island of approximately the same size.

The experiment consists of six replicates of three island sizes; 0.25 ha, 0.875 ha and 3.062 ha, each size being 3.5 times the smaller one. Four of the replicates (12 islands) will remain as forest habitat islands when the existing forest is cleared for an exotic pine plantation. Two of the replicates are in an adjacent State Forest which will not be cleared. Details of the experimental design are available on request.

Data on the spiders, ants, millipedes, centipedes, scorpions, Carabid beetles, and breeding birds, as well as higher plants and mosses have been collected for two years. The islands will be created in January 1987, and the experiment will continue for a minimum of 5 more years.

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Eucalyptus oil and agroforestry research

Allan F.M. Barton
School of Mathematical and Physical Sciences, Murdoch University,
Murdoch, Western Australia 6150.

At Murdoch University in Western Australia research into eucalyptus oil has been continuing since 1981 under the direction of Associate Professor Allan Barton.

A major aim of the research is to look at the possibility of establishing a eucalyptus oil plantation in the southern half of Western Australia.

Eucalypt agroforestry has the appeal of being able to grow trees of commercial value in areas that have previously been cleared for different farming practises. With the increasing problem of soil salinity and erosion, farmers are keen to experiment in a venture that has the long term potential of relieving the problems created by extensive land clearing.

Methods of determining the oil and water content of leaves have been perfected so that analysis can now be carried out with greater speed and accuracy thus enabling a large number of species to be analysed.

To date around 240 species from the southern half of Western Australia have been analysed using solvent extraction and gas chromatography. Remaining species are gradually being added to the data bank.

Selected high yielding species have been planted in trial plots located on farming properties in the south-west of Western Australia. In establishing such plots the vigour and oil yield of each species under varying soil types and climatic conditions will be determined.

The high oil yielding species exist mainly as mallees which is advantageous for commercial production as it facilitates easy mechanical harvesting.

Cineole is the major compound found in the Western Australian oil mallees that is important to the essential oil industry.

Oil yield varies considerably not only between species but also within species, therefore it appears desirable to obtain a high yielding mallee and clone it. Tissue culture of oil mallees and the lignotuber development from the clones material are presently being researched.

Other areas of study at Murdoch include the effects of fertilizer application on oil yield and use of chemical analysis of eucalypts as a taxonomic tool.

The West Australian Department of Agriculture is also using the oil mallees in trials aimed at assessing the potential for salinity reclamation of land used for oil and fodder production.

Recently an Australian Special Rural Research Grant has been awarded to the eucalyptus oil programme to enable employment of a graduate research assistant who will continue to monitor the trial plots and investigate possible further uses of cineole.

Eucalypt regeneration project report
(November 1986)

David Curtis
Botany Department, University of New England, Armidale NSW 2357.

The broad aim of this project has been to study natural regeneration of eucalypts in dieback affected areas of the Northern Tablelands and then to design and test various methods of re-establishment. 11 farms in the Uralla-walcha-Armidale area are involved in the project and between 5-100 ha per farm has been fenced off from stock for its duration.

1. Natural regeneration

a) Lignotuberous advanced growth

182 advanced seedlings are being monitored on 5 sites, of 4 eucalypt species, 1 acacia and one other native shrub. Measurements are being taken about 3 times per year on growth, height and density changes after exclusion of grazing.

b) Flowering and seedfall pattersn

The flowering cycle of 112 trees of 13 eucalypt species is being recorded. 26 trees (10 species) have been fitted with seedtraps so that seedfall can be measured. Observations of each tree are made every 3 months. These measurements have been going on since late 1984 and will continue for at least one more year.

c) Early seedling recruitment

124 newly established seedlings were observed over spring/summer 1985. Their survival was monitored to the present (about 7% overall). Follow up observations are being made for new recruits in the current season. It is important when designing direct sowing techniques to first know what conditions favour early seedling establishment in the natural situation.

2. Re-establishment of eucalypts

a) Direct sowing trials

In 1985, 10 different sowing trials were commenced on several sites. In 1986 a further 8 were established. The trials embrace about 30 different sowing methods including: various soil preparations (grading, spraying with herbicide, ploughing with discs or using a chisel seeder into untreated pasture); different sowing rates; different sowing times (spring, autumn and winter); different mulches (woodchips, straw, shadecloth, etc.); 20 different species (generally the local ones have been sown); different follow up treatments (e.g. herbicide etc.); different sowing types (spot sowing, line sowing, broadcast, mechanical sowing, hand sowing) and different pasture types.

Some trials are giving promising results and detailed evaluation of these trials will be made in 1987.

b) Planting trials

Five planting trials have been established, with about 1300 seedlings of 24 species and 6 different treatments.

A major planting of 50,000 native and exotic trees around the water supply dam of Armidale is soon to be commenced by the New England Community Tree Planting Scheme. These plantings will also be monitored as part of this project.

Rural treegrowing and urban forestry in Victoria

Rob Youl
Planning Officer, Land Protection Division, Department of Conservation, Forests and Lands, 378 Cotham Road, Kew Victoria 3101.

(This paper was produced for the annual conference of the Royal Australian Institute of Parks and Recreation, Albury, 20 October 1986. Copies of the full paper are available from the author, or from the editor, on request).

Summary

The author offers a brief review of the trends in rural treegrowing and urban forestry over the last five years in Victoria.

On the rural side, we have or have had community projects, demonstration plantings, farm tree groups, a statewide grant scheme, direct seeding and a greatly enhanced appreciation of indigenous species and provenances.

In cities and towns we are starting to see more urban forests. These are simple stands of trees (often with understorey) being created especially along urban streams, on flood plains and around factories - they contrast with traditional grid plantings, evenues, arboreta and solitary specimens.

Furthermore, interest deepens in the protection of the existing urban remnants of the forests and grasslands that grew there before European settlement - soon we may be re-creating these plant communities.

Two rural and two urban projects are briefly discussed.

Finally the author comments on the role of economics in revegetation.

The Potter Farmland Plan
(December 1986)

Andrew Campbell
Project Manager, 62 Thompson Street, Hamilton, Vic 3300 (055) 722777

The Potter Farmland Plan is a four year project which is aiming to show how land degradation problems such as erosion, salinity and tree decline can be addressed on a whole farm basis. Fifteen demonstration farms are being established in western Victoria to illustrate practical measures which can be applied on individual farms, and to provide a focus for community attention to land degradation problems and the potential for positive action. This exciting new initiative is a three-way cooperative effort: it is funded by the Ian Potter Foundation, administrative support is provided by the Victorian Government, and on-ground works are carried out by farmers on their own land.

The Potter Farmland Plan began in Hamilton, western Victoria in November 1984. Three demonstration areas were defined at Wando Vale, Melville Forest and Glenthompson. A two day consultation with farmers, and representatives of the business community from the region was held in December to discuss the development of the project and determine the selection criteria for participating farms. Landowners in each of the demonstration areas were then invited to volunteer for participation in the project at public meetings in early January 1985. After two rounds of farm inspections, fifteen properties were selected, five at Melville Forest, six at Glenthompson and four at Wando Vale.

Whole Farm Plans are being prepared for each demonstration farm. Participating landowners are actively involved in formulating their own plans, which often formalise ideas they have had in the back of their minds for some time. The whole farm plans used in the PFP are the result of input from farmers, project staff, and specialists from the Departments of Conservation, Forests and Lands, and Agriculture and Rural Affairs. These plans will be substantially implemented over three years on seven properties. The remaining eight farms have been included either to complete treatment of sub-catchments on the boundaries of the other demonstration farms or to highlight particular aspects of whole farm planning. On these properties plans will be only partially implemented during the project, with landowners continuing with the program at their own pace after three years.

All other revegetation works are assessed in December and May, and trialling and demonstration is being carried out in the following areas of farm revegetation:

Site Preparation: (for tubed seedlings and direct seeding)	deep ripping vs cultivation vs no soil disturbance; various pre- and post-emergent herbicides using various equipment and at different concentrations;
Establishment:	tubed seedlings planted by hand and machine; transplanted indigenous seedlings; direct seeding - hand broadcast, machine broadcast, and drilled with a range of implements natural regeneration;
Protection:	fence design and layout; sheep, cattle, and rabbit guards of various types;
Design:	shelterbelt design, clumps and arrangement of individual trees.

A preliminary survey of landholder attitudes to whole farm planning and trees on farms, both in the immediate vicinity of the project and in a distant municipality has already been carried out. This will be repeated at a later date to assess the influence of the project on farmer and community attitudes over time.

Monitoring of the influence of strategic tree planting and pasture establishment on groundwater is also occuring in one catchment, and an economic analysis of the impact of project works at an individual farm level will hopefully be initiated during 1987. Operations will wind down at the end of 1987, and the Potter Foundation input will cease in late 1988.

Tagasaste (Chamaecytisus proliferus) provenances ex Canary Islands - establishment in W.A.

A. Hart
CALM, PO Box 104, Como WA 6152

Introduction

As readers are probably well aware, this species has undergone a substantial revival of interest at least in W.A. as a fodder tree for stock as well as windbreak and shelter usage.

To date, work has been carried out with seed from parent trees introduced at least thirty (30) years ago, about which the parentage is little known. The original introductions have in many instances gone wild and are now invading native jarrah/marri forest e.g. east of Mundaring and are a familiar site around old and new rubbish dumps.

It was felt that it would be useful back up information to have available, if other provenances were introduced for comparison with the old introduction(s) particularly in relation to fodder values.

Provenance details

A total of five (5) provenances were obtained in late 1984 from the Canary Islands.

The CALM serial numbers range from 500 - 504 inclusive. Unfortunately, detailed descriptions of the original habitats were not forwarded with seed.

Nursery propagation

1. Seedlings were raised at Hamel W.A. Nursery in Summer 1985/86. Numbers raised were:

Serial No.	No. Plants	Approximate Planting Location
500	16	W. Pinjarra
501	2	Hamel Nursery
502	5	Keysbrook
503	4	North Lake Road, Pinjarra
504	5	" "

2. Cutting material

Prior to outplanting, seedlings were harvested for leaf analysis and cutting material.

It is of interest that preliminary analyses[1] of leaf material indicates that S/N°504 has better 'P', 'S' & I.V.D.[2] values than the rest. Further leaf analyses is planned for 1987.

Cutting material rooted fairly readily such that 20 additional plants of all serial numbers are available for 1987 plantings.

This result suggests that suitable cuttings of Tagasaste could be established on favourable planting sites reducing costs of establishment and possibly having greater ability to withstand insect attack e.g. grasshoppers.

3. Plant root nodulation

   At the time of planting, root nodulation was inspected and recorded for each serial number.[3] This record is shown in attached Table 1.

4. Leaf form variation

   Juvenile and early adult leaf shapes were photographed for each provenance.

   The variation in leaf shape is shown in Fig. 1. Numbers on this figure refer to the provenance serial No.

Conclusion

1. The introduction of the provenances for investigations of leaf fodder values appears to have been justified.

2. The efficiency of rooting cutting material suggests that establishment trials with this type of propagation is warranted particularly on favourable sites and where insect attack could be a problem.

3. Further leaf fodder value analyses are justified to obtain better accuracy of differences evident so far.

4. A further report on the progress of these introductions is planned for late 1987.

1) Personal Communication from Mr P. Downes, C.S.I.R.O., Florat Park, W.A.
2) I.V.D. - invitro digestibility value.
3) Ms Caroline Peek, Dept. of Agriculture, Harvey, W.A.

TAGASASTE
SUMMARY OF PROVENANCE OF PLANTINGS 198

LOCALITY	SERIAL No.	DATE OF PLANTING	No. PLANTS	COLOR	SHAPE	COMMENTS	APPROX HT OF PLANTS 17/11/86	LEAF SHAPE (JUVENILE)	APPROX DIMENSION (CMS)
1. PINJARRA WEST	500	17/7/86	16	Pink	Oblong with club shaped nodules in clusters or singly	Strong root system similar to 502	38-75cm	Symmetrically ecliptical finely mucronate markedly hirsute bifacially	3.5cm long x 1cm wide
2. NORTH PINJARA	503	17/7/86	4	Pink	Club shaped but well developed oblong ones tend to be colorless	Fine root system - not as well nodulated	60cm	Finely mucronate narrowly obovate	2.0cm long x 0.75 wide
	504	17/7/86	5	Faint pink to pink	Elongated but shorter than 502. Others club shaped	Roots much finer than 502 less frequent & smaller nodules	60cm	Finely hirsute Bifacially attenuated mucronate narrowly elliptical	2.5cm long x 0.24 wide
3. WEST KEYSBROOK	502	17/7/86	5	Pink	Elongated to club shaped & branched	Nodules moderately plentiful - strong plants	150cm	Symmetrically elliptical hirsute below virtually glabrous above markedly mucronate	3.5cm long x 1cm wide
4. C.A.L.M. HAMEL Nursey	501	17/7/86	2	Pink	Several coralloid shaped - Others elongated but regarded as club shaped	One poorly nodulated - the other well nodulated	60cm	Markedly obovate mildly hirsute scarcely mucronate generally rounded	3.5cm long x 1cm wide

TABLE 1 NOTES:

1. S/No 503, 504 received one handful of straight UREA per tree at approx end of September 1986.
2. Two plants of each serial No. to be retained for later cross fertilisation if desired.
3. A total of 20 rooted cuttings as follows are available for 1987 plantings.

S/N 500 - 10 cuttings
501 - 2 cuttings
502 - 2cuttings
503 - 3 cuttings
504 - 3 cuttings

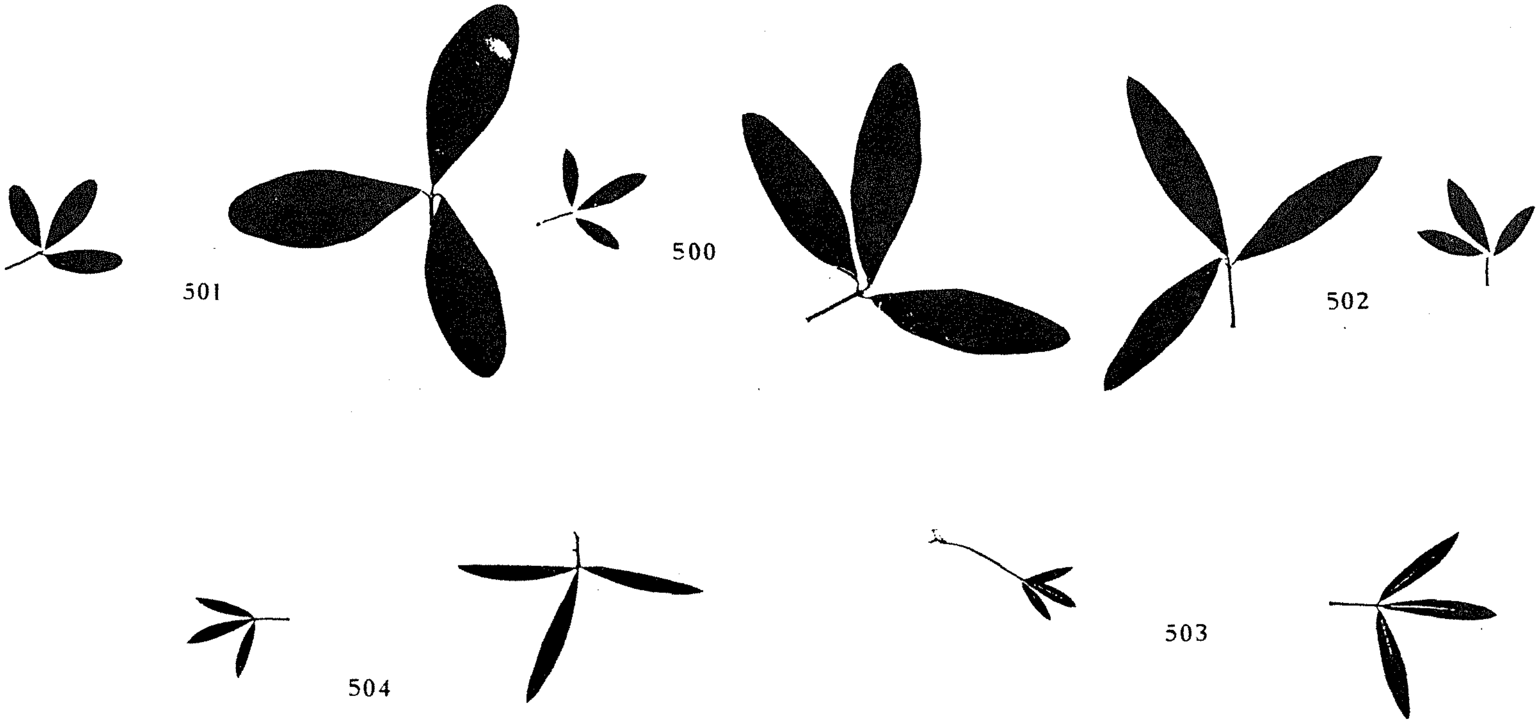

Fig 1: Leaf Form of Five Provenances of Tagasaste (Chamae. proliferus) Showing Variation from Obovate to Narrowly Elliptical with Mucronate Tip.

Gippsland tree seeders

James R. Lane
Chairman, 13 Waratah St., Walkerville, Vic 3959. Tel 056 63 2258

A syndicate to promote regeneration of native bushland by direct seeding was formed in South Gippsland late in 1986.

Objects of the group are:

To promote the reversal of tree decline.

To pursue the construction of a machine to be known as the Gippsland tree seeder, designed to cultivate and seed directly in one pass.

To undertake research into the establishment of indigenous and other species by direct seeding.

The promotion of tree seeding and associated procedures.

The manufacture and hire and/or sale of this machine and other implements or materials, including seeds and fertilisers, designed to further these objects.

To undertake contract tree seeding.

The sydnicate was initiated by David Debenham with the support of Malcolm Birch of the Victorian Department of Forests, Conservation and Lands. The initial members are:

Robert J. Mcleod, RMB 6541, Owen La., Gifford, via Sale 3850
Graeme L. McLennan, "Seaforth", Woodside, Vic. 3874.
John Mascadri, South Gippsland Hwy., Lang Lang, Vic. 3894.
David C. Debenham, Ten Mile Rd., Walkerville, Vic. 3959.
James R. Lane, Waratah St., Walkerville, Vic 3959.
Thomas J. Liley, Soldiers Rd., Yanakie, Vic 3959.

Malcolm Birch of DFCL is advising and supporting the project.

Construction of the machine is proceeding and is expected to be ready for trials early in 1987. It will be designed for attachment to the 3 point linkage of a small tractor and for transport in a utility or small trailer.

Standard Shelterbelt Mix. It is anticipated that the initial demand will be for ready establishment of shelter belts. A "Standard Shelterbelt Mix" of species was selected for each of the following areas:

1. Yarram, Woodside, Gifford Plains.
2. Well drained sands within 1 km of coast - Seaspray to Phillip Is.
3. South Gippsland Plains - Yarram to Wonthaggi.

The mix was chosen on the basis that all species should be indigenous or well known to thrive in the area, that species commonly growing in association should be chosen, and that seed sources should be readily available.

Weedicide trials M. Birch and D. Debenham undertook to design and execute hothouse trials, on the effects of varying concentrations of "Atrazine" on:

1. Germination of some of the proposed standard mix species.
2. Recently emerged seedlings in a weed infested microenvironment.

Eucalypt seed orchards - search for other workers in this field

A.J. Hart, C.A.L.M., W.A.

The writer is keen to make the acquaintance of any readers (or friends of readers) who may be involved in this type of work. Even those who may be at this stage just thinking of starting up Eucalypt orchards are invited to contact me at the following address:

P.O. Box 104
COMO WA 6152

Revision of Book "Growing Trees on Australian Farms"

Kurt W. Cremer
CSIRO Division of Forest Research, Canberra

This book, published in 1968, was written by Alan Brown, Norman Hall and eight colleagues of the Forest Research Institute and the Department of Forestry of the Australian National University. It sold 10 000 copies during 1969-79 and has been out of print since then. Because the interest in the subject and this kind of book has continued to grow strongly it was decided to produce a revised edition. Two commercial publishers have expressed interest in the venture.

I have agreed to co-ordinate this revision. It was decided to have a completely new structure and text, because most of the original authors are no longer available, the subject has expanded and changed greatly, and various new publications have appeared on related or possibly overlapping topics.

In planning this revision I have sought the views of numerous colleagues and

a) the Australian state government departments concerned with forestry, agriculture and conservation;

b) the members of the National Working Groups on Agroforestry.

Some 27 experts have agreed to contribute: about half of these are from CSIRO (mainly the DFR); six are from the ANU and Melbourne Universities; seven are from state government departments; and one is an independent farmer, author and wildlife expert.

The publishers advise that options for a good amount of colour pictures exist, but not <u>within</u> the text. The colour plates will be located as "wrap-arounds" for any of the 16^2-page components of the book. Black and white illustrations and tables can be placed anywhere. As it is not desirable to restrict the market for this book to farmers, additional attention will be given to tree planting in rural areas in general, including towns, and the title may be broadened, e.g. "Trees for Rural Australia".

The Commonwealth Department of Arts Heritage and Environment are collaborating in the production of the book with a grant and the writing of Topic 11: encouragement of and assistance with rural tree planting.

About half of the text has been drafted. The book should be available in 1988.

Circulation list for Volume 3

(Consists of contributors and other correspondents from Volumes 2 and 3)

I.J. Abbott, COMO WA 6152.
P. Albone, COMO WA 6152/
G.B. Applegate, ATHERTON, Q 4883
M.P. Austin, CANBERRA ACT 2601.
J. Banks, CANBERRA ACT 2601.
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D.A. Saunders, MIDLAND WA ??05.
D.W.Stringer,BAIRNSDALEVIC3875.
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F.C.S. Tay, COMO WA 6152.
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B. Walker, LYNEHAM ACT 2602.
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T.C. White, WAGGA WAGGA NSW 2650.
S.R. Wijesuriya, BENTLEY WA 6102.
F.R. Wylie, INDOOROOPILLY Q 4068.
R. Youl, KEW VIC 3101.