# MULGA RESEARCH CENTRE

## Occasional Report no.1

Germination Tests Using Different Temperature Regimes On Plant Species Used In Rehabilitation At Groote Eylandt, Northern Territory

**G.J. Barrett and J.E.D. Fox**

September 30th 1983


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20890-9-83

# Germination Tests Using Different Temperature Regimes on Plant Species Used In Rehabilitation at Groote Eylandt, Northern Territory.

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A Report Presented to Groote Eylandt Mining Company

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## INTRODUCTION

Germination trials were conducted on seeds provided by the Groote Eylandt Mining Company. All seed, except **Acacia crassicarpa**, had been collected on Groote Eylandt and normally comprise part of the seed mix used in minesite rehabilitation. The species range from trees (**Eucalyptus spp., Melaleuca spp., Grevillea pteridifolia, Acacia crassicarpa**) to small trees and tall shrubs (**Acacia spp., Alphitonia excelsa, Grevillea heliosperma, Petalostigma pubescens**).

Germination characteristics were assessed at four different constant temperatures between 15 and 30°C. The seeds were germinated at Bentley between March and June 1983.

METHODS

Where possible each trial consisted of four batches of fifty seeds. Those species for which fewer seeds per batch were used were:

| | |
|---|---|
| Acacia holosericea | 44 seed |
| Eucalyptus miniata | 25 seed |
| Grevillea hellosperma | 20 seed |
| Melaleuca viridiflora | 25 seed |

For some species two trials were conducted.

Seeds of Acacia spp. were given a heat pre-treatment as described by Preece (1971) . Boiling water was poured on the seeds in a test tube, this was then allowed to cool to room temperature. Seed of other species was shaken in a 3 per cent 'Milton' solution for two minutes to provide surface sterilization.

The seeds were then placed on filter paper covering moistened vermiculite in petri dishes. The vermiculite had been soaked in a dilute 'Benlate' solution beforehand. The petri dishes were then placed in dark growth cabinets set at constant temperatures of 15, 20, 25 and 30°C, one dish to each cabinet.

Seeds were inspected daily and moistened with deionized water as required. Any seeds which had germinated were recorded and removed. Germination was defined as a 2 mm protrusion of the radicle.

A table of germination characteristics and a graph showing the time course of germination are given for each trial.

Characteristics shown in the tables are as follows:

1. Final germination percentage
2. Days required to reach the final germination percentage
3. Germination rate (after Hartmann and Kester 1975). This is calculated as follows:

$$\text{germination rate (mean days)} = \frac{(n_1 \times t_1) + (n_2 \times t_2) + \ldots\ldots + (n_x \times t_x)}{\sum_x^1 n}$$

where: $n_1$ = no. of germinants at first day of observed germination

$t_1$ = time (days) from initiation to first germination

$n_2$ = number of germinants at second day of observed germination

$t_2$ = time (days) from initiation to second day of germination

$x$ = number of days to final germination observed, i.e. on completion of trial

$\sum_x^1 n$ = total number of seed germinated over the time of the trial.

4. Peak value. This is a measure of the steepest point in the germination gradient as determined by the maximum value for the following expression:

$$\frac{\text{cumulative germination percentage}}{\text{number of days from start}}$$

Peak value and Mean daily germination are used to derive the germination value of Czabator (1982).[6]

5. Mean daily germination (M.D.G.). This is taken as the final germination percentage divided by the number of days required to reach that percentage.

6. Germination value (G.V.). This is a combination of germination rate and peak value as determined by:

$$PV \times MDG = GV$$

7. Energy. This is a measure of the strength of the seed (Edminston and Ryan 1977). It is here calculated as the percentage germination after a certain number of days divided by the germination percentage after twice that number of days, times 100. The actual number of days used to calculate 'energy' varies between species (following Loneragan 1978) and is given in each table.

8. Germinative capacity. This is the germination percentage corresponding to the period of time used to calculate 'energy'. The number of days is given in each table.

9. Vigour. This is a value derived from the last two values and may be considered as an objective measure of the strength of the seed at least for seed of high viability. It is calculated as:

$$\frac{\text{Energy}}{\text{G. Capacity}}$$

For each graph symbols are given to denote the temperature treatment given. The symbols used are:

○ 15°C

△ 20°C

● 25°C

▲ 30°C

The following list gives the species tested with corresponding table and figure numbers:

| Species | Number of Table and Figure |
|---|---|
| **Acacia aulacocarpa** A.Cunn. ex Benth. | 1,2 |
| **Acacia crassicarpa** A. Cunn. ex Benth. | 3 |
| **Acacia holosericea** A. Cunn. ex Benth. | 4 |
| **Acacia latescens** Benth. | 5 |
| **Acacia oncinocarpa** Benth. | 6,7 |
| **Acacia torulosa** D. Muell. | 8,9 |
| **Alphitonia excelsa** (Fenzl.) Benth. | 10,11 |
| **Eucalyptus miniata** A. Cunn. ex Schau. | 12 |
| **Eucalyptus polycarpa** F. Muell. | 13,14 |
| **Eucalyptus tetrodonta** F. Muell. | 15,16 |
| **Grevillea heliosperma** R. Br. | 17 |
| **Grevillea pteridifolia** Knight | 18 |
| **Melaleuca leucadendron** (L.) L. | 19,20 |
| **Melaleuca symphyocarpa** F. Muell. | 21 |
| **Melaleuca viridiflora** Sol. ex Gaertn. | 22 |
| **Petalostigma pubescens** Domin. | 23 |

## SPECIES TESTED

Each species tested is dealt with seperately below

### Acacia aulacocarpa (Broad-leaved Wattle)

**A. aulacocarpa** is a small tree commonly growing to 4 or 5 m but it occasionally occurs up to 7 m tall. It is found in open forest or on beach sand plains. The phyllodes are curved and broad. The species flowers mainly in April and May but it may flower more than once in any one year.

Two trials were conducted for this species. Although the results of each trial vary considerably, it is apparent that 30°C in each case was the optimum temperature for germination. The final germination percentages were 54 and 90 per cent in the first and second trials respectively.

The first trial (Table 1, Figure 1) lost seeds to fungal infection, particularly in the 20 and 25°C batches, and this to some extent accounts for the difference between trials.

The fastest germination rate occurred at 30°C in both trials. In the second trial (Table 2, Figure 2) the germination rate declined with decreases in temperature, although this pattern was not apparent in the first trial.

Germination value, energy and germinative capacity were greatest at 30°C in each trial. Germination value at 30°C was 5.0 and 3.47 for the first and second trials respectively, energy was 56 and 64.3 and germinative capacity was 50 and 56.

Figure 1
Acacia
aulacocarpa

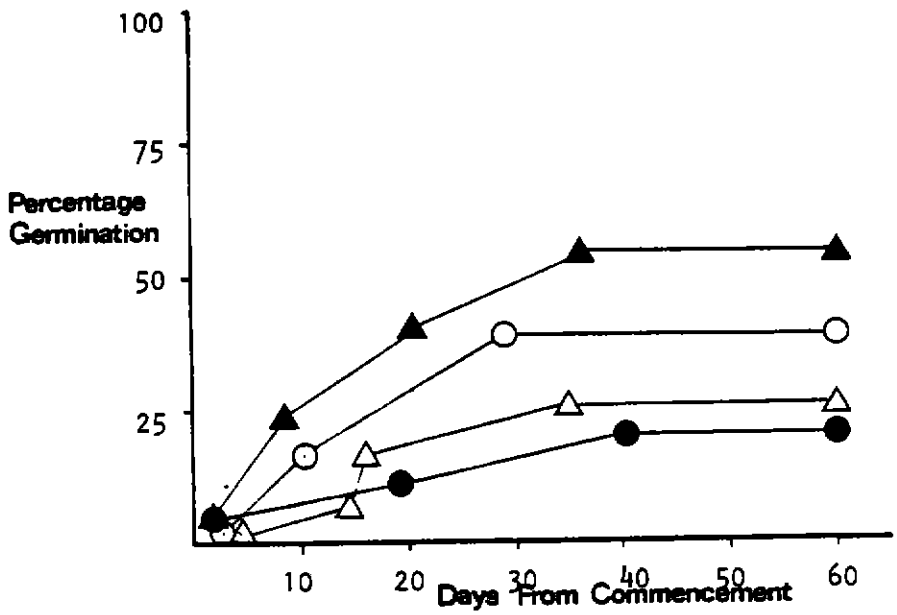



Figure 2
Acacia
aulacocarpa

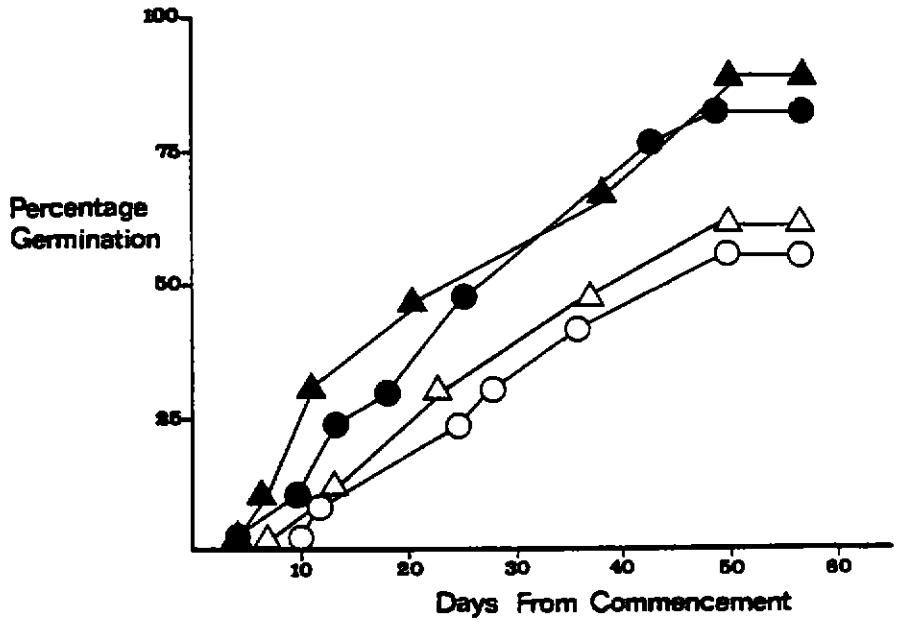


Table 1
Acacia aulacocarpa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 38 | 26 | 20 | 54 |
| 2. Days to 1 | 29 | 35 | 40 | 36 |
| 3. G. Rate (mean days) | 15.2 | 17.2 | 20.8 | 14.7 |
| 4. Peak Value | 1.60 | 1.00 | 2.00 | 3.33 |
| 5. M.D.G. | 1.31 | 0.74 | 0.50 | 1.50 |
| 6. G.V. | 2.10 | 0.74 | 1.00 | 5.00 |
| 7. Energy 15/30 (%) | 52.6 | 41.7 | 25.0 | 56.0 |
| 8. G. Capacity (%) 30 days | 38 | 24 | 16 | 50 |
| 9. Vigour | 1.38 | 1.74 | 1.56 | 1.12 |

Table 2
Acacia aulacocarpa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 56 | 62 | 84 | 90 |
| 2. Days to 1 | 50 | 50 | 49 | 50 |
| 3. G. Rate (mean days) | 28.2 | 26.7 | 24.6 | 23.9 |
| 4. Peak Value | 2.60 | 1.17 | 1.33 | 1.93 |
| 5. M.D.G. | 1.12 | 1.24 | 1.71 | 1.80 |
| 6. G.V. | 2.91 | 1.45 | 2.27 | 3.47 |
| 7. Energy 15/30 (%) | 37.5 | 40.0 | 46.4 | 64.3 |
| 8. G. Capacity (%) 30 days | 32 | 40 | 56 | 56 |
| 9. Vigour | 1.17 | 1.00 | 0.83 | 1.15 |

**Acacia crassicarpa**

A. crassicarpa is a slender tree to 10 m occurring in open forest. Phyllodes are grey-green and curved, up to 22 cm long and 4.5 cm wide. Flowering occurs from June to September. This species is similar in appearance to A. aulacocarpa but has larger phyllodes and longer leaf stalks. The seed for this trial was collected at Weipa, north Queensland.

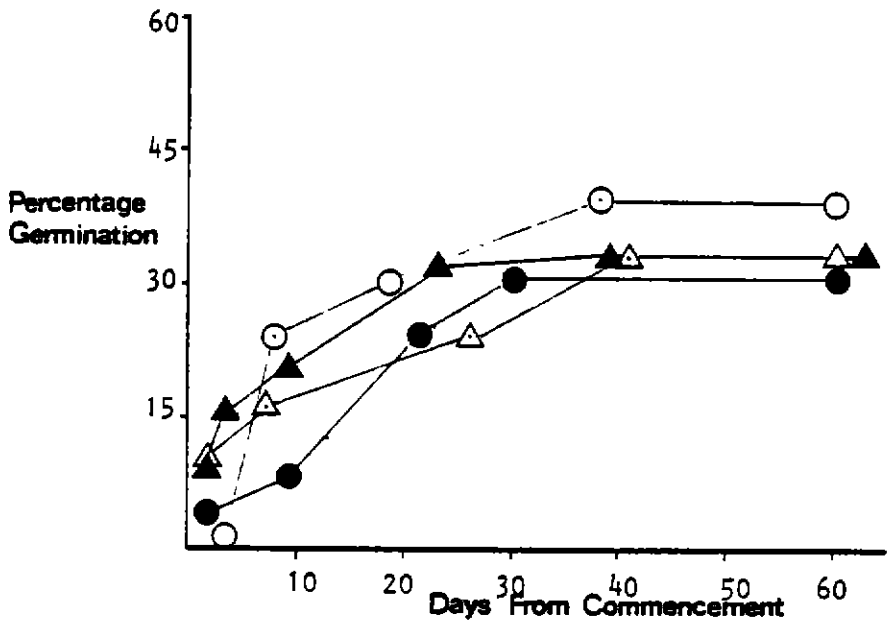
Germination was poor with the highest being 40 per cent at 15°C. The graph (Figure 3) does not indicate any obvious temperature preference in this species. The calculations provided in Table 3 also do not indicate any temperature trends. The overall final germination percentage was 34.5 per cent.

Peak value (5.00), germination value (4.15) and vigour (3.13) were greatest at 20°C.

Table 3
Acacia crassicarpa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 40 | 34 | 30 | 34 |
| 2. Days to 1 | 38 | 41 | 30 | 39 |
| 3. G. Rate (mean days) | 15.0 | 17.1 | 15.8 | 11.4 |
| 4. Peak Value | 3.43 | 5.00 | 2.00 | 4.67 |
| 5. M.D.G. | 1.05 | 0.83 | 1.00 | 0.87 |
| 6. G.V. | 3.60 | 4.15 | 2.00 | 4.06 |
| 7. Energy 15/30 (%) | 86.7 | 75.0 | 40.0 | 62.5 |
| 8. G. Capacity (%) 30 days | 30 | 24 | 30 | 32 |
| 9. Vigour | 2.89 | 3.13 | 1.33 | 1.95 |

Figure 3
Acacia
crassicarpa



Acacia holosericea (Soap Bush)

A. holosericea may be found as a tall shrub growing to 5 m but it is usually smaller. The phyllodes are very broad, grey-green in colour and with a furry texture. Flowering occurs from July to August. This species is common in rehabilitated areas on Groote Eylandt.

The seed of this species had high viability with all seeds germinating at 15, 20 and 25°C and 77 per cent at 30°C - an overall germination of 94.3 per cent. Germination was most rapid at 25°C, then 15, 20 and finally 30°C. At 30°C there may have been some loss of seed to fungal infection although Figure 4 indicates that germination was markedly slower at that tempertaure.

Values for peak value (11.38), mean daily germination (6.8), energy (100) and germinative capacity (100) all indicate that 25°C is the most favourable temperature for germination.

Figure 4
Acacia holosericea

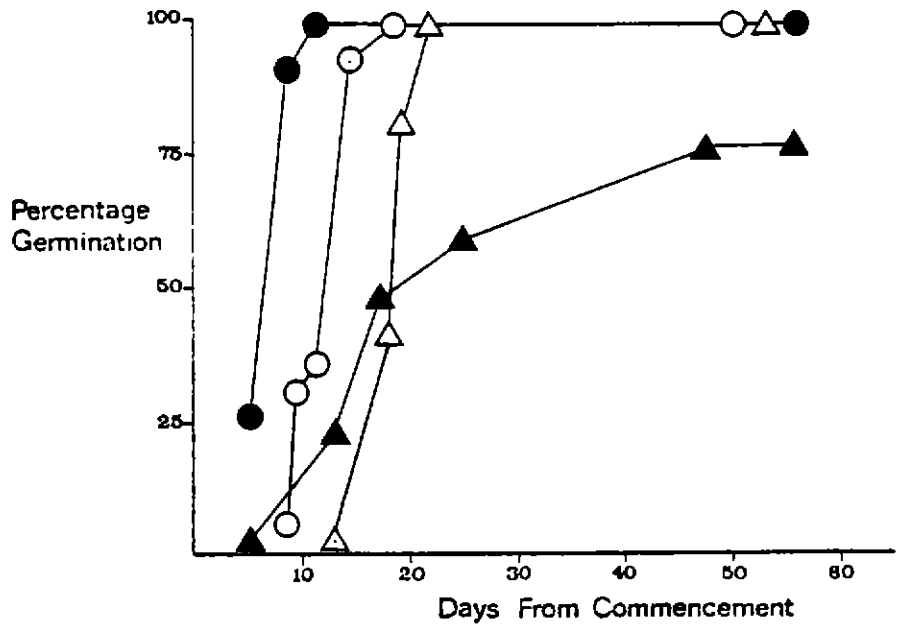


Table 4
Acacia holosericea

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 100 | 100 | 100 | 77 |
| 2. Days to 1 | 18 | 21 | 11 | 47 |
| 3. G. Rate (mean days) | 11.8 | 18.7 | 6.8 | 20.2 |
| 4. Peak Value | 6.64 | 4.90 | 11.38 | 2.82 |
| 5. M.D.G. | 5.56 | 4.76 | 9.09 | 1.64 |
| 6. G.V. | 36.9 | 23.3 | 103.4 | 4.6 |
| 7. Energy 15/30 (%) | 93.0 | 2.2 | 100.0 | 65.1 |
| 8. G. Capacity (%) 30 days | 100 | 100 | 100 | 63 |
| 9. Vigour | 0.93 | 0.02 | 1.00 | 1.03 |

**Acacia latescens (Ball Wattle)**

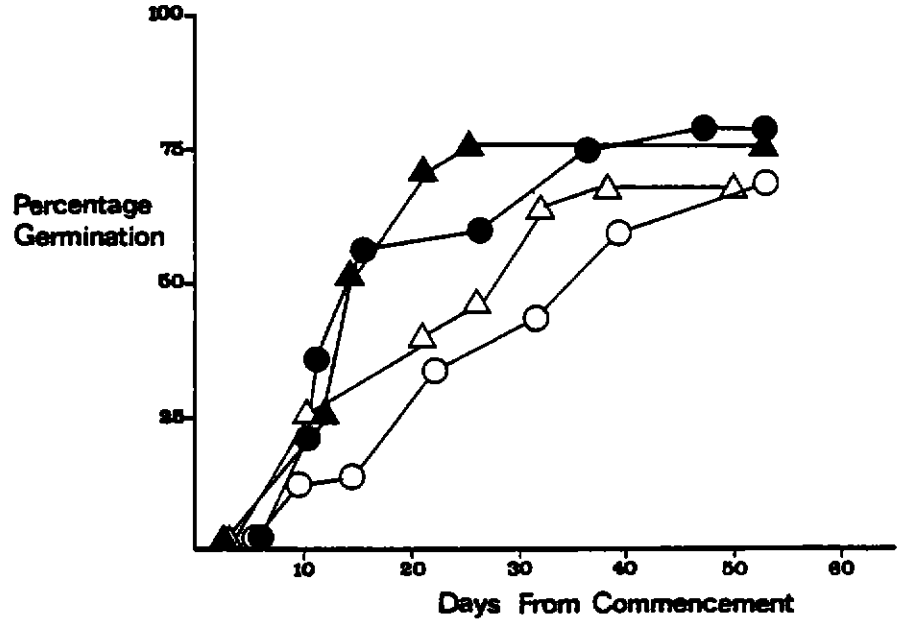
A. latescens occurs as a tall shrub or small tree in open forest. Phyllodes are thin and sickle shaped. Flowering is regular from March to April but may also occur more than once in a year.

Germination was highest at 25°C with a level of 80 per cent. Seed at all temperatures used germinated well with 68 per cent at 20°C being the lowest. The values for germination rate (Table 5) suggest a linear relationship with higher temperatures giving more rapid germination. Germination values showed a similar trend, being highest at 11.3 for 30°C and ranging down to 2.1 at 15°C. Energy and vigour were both greatest at 25°C with levels of 68.4 and 76 respectively.

Table 5
Acacia latescens

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 70 | 68 | 80 | 76 |
| 2. Days to 1 | 53 | 38 | 47 | 25 |
| 3. G. Rate (mean days) | 26.7 | 18.7 | 17.3 | 13.2 |
| 4. Peak Value | 1.55 | 2.60 | 3.73 | 3.71 |
| 5. M.D.G. | 1.32 | 1.79 | 1.70 | 3.04 |
| 6. G.V. | 2.05 | 4.65 | 6.34 | 11.28 |
| 7. Energy 15/30 (%) | 42.9 | 53.3 | 84.8 | 68.4 |
| 8. G. Capacity (%) 30 days | 42 | 60 | 66 | 76 |
| 9. Vigour | 1.02 | 0.89 | 1.28 | 0.90 |

Figure 5
Acacia
latescens



Acacia oncinocarpa (Cream-flowered Wattle)

A. oncinocarpa occurs in open forest. It is a small tree growing to 5 m. Phyllodes are narrow and slightly curved. Flowering occurs from March to April.

Two trials were conducted for this species. The first trial (Table 6, Figure 6) showed little difference between any of the temperatures with approximately half of the seeds germinating in each. The germination rate was highest at 30°C. Other germination characteristics showed no trend towards a particular temperature. Some drying out of the petri dishes occurred in the 25 and 30°C treatments and this may have influenced the results. In addition to this, some seeds were lost to fungal infection in the 25°C treatment.

The second trial (Table 7, Figure 7) showed significantly higher germination at temperatures of 20°C and over compared with the first. In this trial 20°C seemed to be the most favourable temperature (25.2) and both germination value (2.94) and energy (63.2) were greatest at that temperature.

Figure 6
Acacia
oncinocarpa

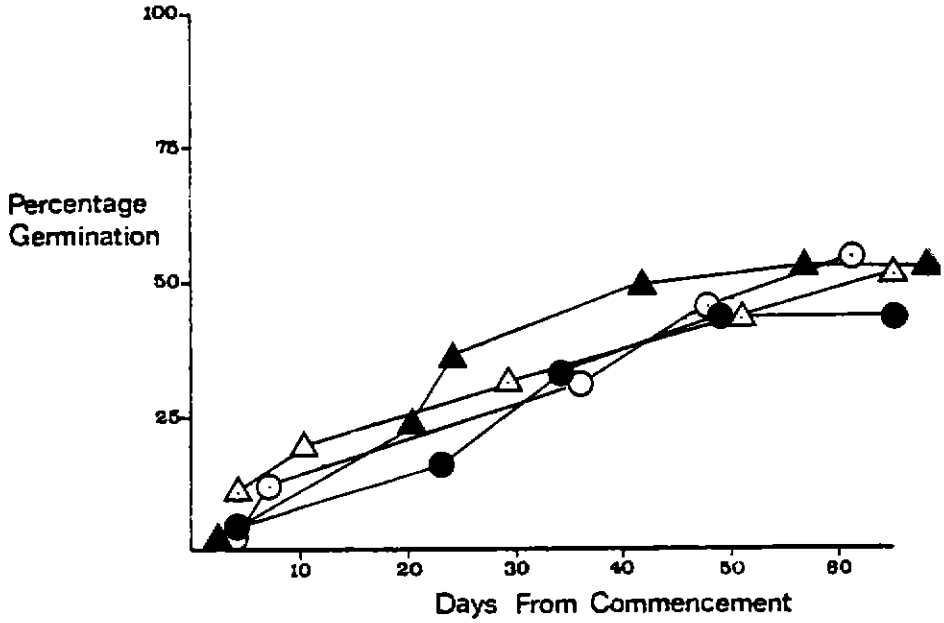



Figure 7
Acacia
oncinocarpa

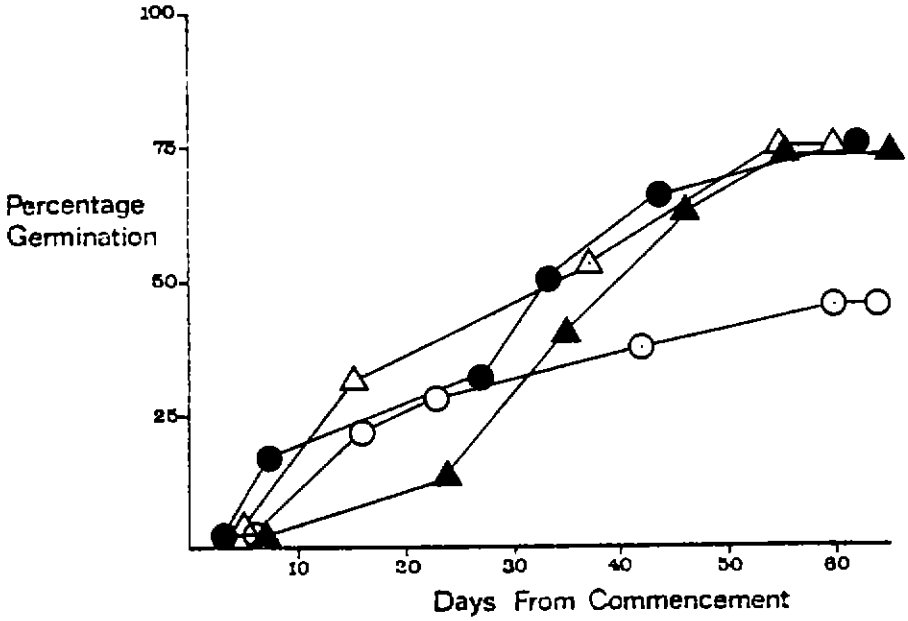


Table 6
Acacia oncinocarpa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 56 | 52 | 44 | 54 |
| 2. Days to 1 | 62 | 66 | 49 | 57 |
| 3. G. Rate (mean days) | 34.1 | 28.6 | 29.1 | 23.4 |
| 4. Peak Value | 1.71 | 2.50 | 1.00 | 1.50 |
| 5. M.D.G. | 0.90 | 0.79 | 0.90 | 0.95 |
| 6. G.V. | 1.54 | 1.98 | 0.90 | 1.43 |
| 7. Energy 30/60 (%) | 48.1 | 66.7 | 63.6 | 74.1 |
| 8. G. Capacity (%) 60 days | 54 | 48 | 44 | 54 |
| 9. Vigour | 0.89 | 1.39 | 1.45 | 1.37 |

Table 7
Acacia oncinocarpa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 46 | 76 | 76 | 74 |
| 2. Days to 1 | 60 | 55 | 60 | 55 |
| 3. G. Rate (mean days) | 26.7 | 25.2 | 27.2 | 34.3 |
| 4. Peak Value | 1.38 | 2.13 | 1.50 | 1.33 |
| 5. M.D.G. | 0.77 | 1.38 | 1.27 | 1.35 |
| 6. G.V. | 1.06 | 2.94 | 1.91 | 1.80 |
| 7. Energy 30/60 (%) | 60.9 | 63.2 | 55.3 | 35.1 |
| 8. G. Capacity (%) 60 days | 46 | 76 | 76 | 74 |
| 9. Vigour | 1.32 | 0.83 | 0.73 | 0.47 |

**Acacia torulosa (Deep-gold Wattle)**

A. torulosa is a small tree. Flowering occurs from May to July.

Two trials were conducted for this species. In the first trial (Table 8, Figure 8) the highest germination achieved was 98 per cent at 25°C. The most rapid germination rate was at 15°C although total germination was low (42 per cent). Germination value (4.16) was highest at 25°C and energy (47.4) at 30°C. Vigour (1.11) was highest at 15°C.

The second trial (Table 9, Figure 9) achieved greatest germination at 30°C (82 per cent). Germination decreased at lower temperatures, down to 54 per cent at 15°C. The germination rates for 20, 25 and 30°C were similar. Germination value, energy and vigour were generally greater at the higher temperatures.

Although the trials considered jointly are inconclusive it appears that the optimum temperature for germination is likely to be in the range 25-30°C.

Figure 8

Acacia torulosa

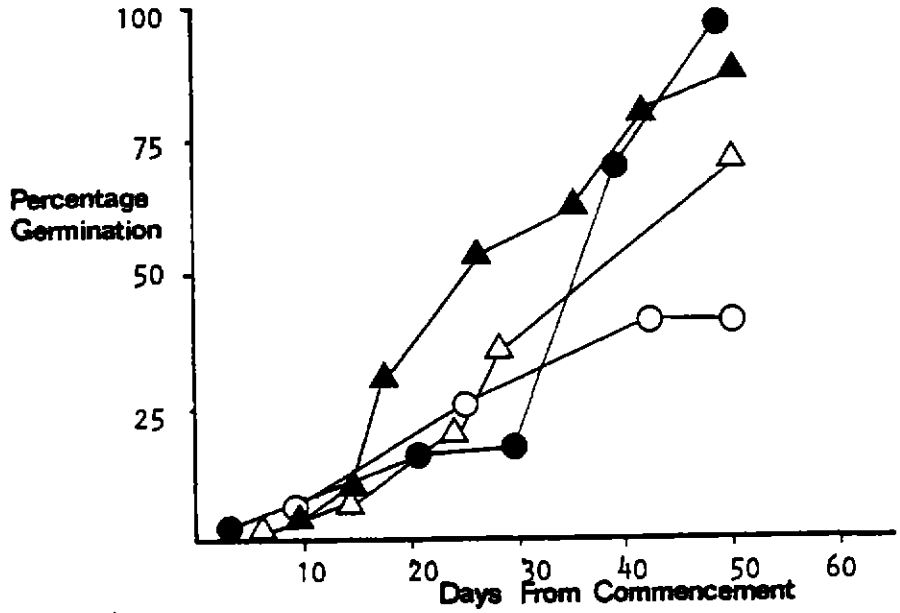



Figure 9

Acacia torulosa

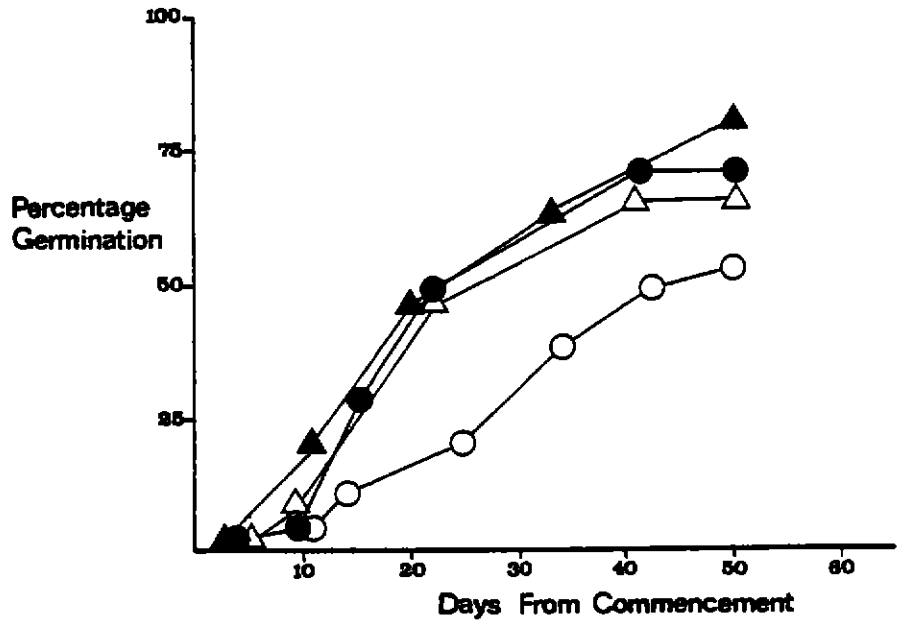


Table 8
Acacia torulosa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 42 | 72 | 98 | 88 |
| 2. Days to 1 | 43 | 50 | 48 | 50 |
| 3. G. Rate (mean days) | 24.4 | 31.2 | 33.0 | 25.9 |
| 4. Peak Value | 1.04 | 1.47 | 2.04 | 2.09 |
| 5. M.D.G. | 0.98 | 1.44 | 2.04 | 1.76 |
| 6. G.V. | 1.02 | 2.12 | 4.16 | 3.68 |
| 7. Energy 20/40 (%) | 42.1 | 14.3 | 22.2 | 47.4 |
| 8. G. Capacity (%) 40 days | 38 | 56 | 72 | 76 |
| 9. Vigour | 1.11 | 0.26 | 0.31 | 0.62 |

Table 9
Acacia torulosa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 54 | 66 | 72 | 82 |
| 2. Days to 1 | 50 | 41 | 42 | 50 |
| 3. G. Rate (mean days) | 28.6 | 21.0 | 21.1 | 23.5 |
| 4. Peak Value | 1.16 | 2.09 | 2.20 | 2.29 |
| 5. M.D.G. | 1.08 | 1.61 | 1.71 | 1.64 |
| 6. G.V. | 1.25 | 3.36 | 3.76 | 3.76 |
| 7. Energy 20/40 (%) | 31.8 | 62.5 | 66.7 | 64.7 |
| 8. G. Capacity (%) 40 days | 44 | 64 | 66 | 68 |
| 9. Vigour | 0.72 | 0.98 | 1.01 | 0.95 |

**Alphitonia excelsa (Red Ash)**

**A. excelsa** occurs on Groote Eylandt in open forest as a small tree 3 to 4 m tall. Leaves are dark green on the upper surface from January to May.

Two trials were conducted for this species. In the first trial (Table 10, Figure 10) germination was poor, the highest level being 42 per cent at 25°C ranging down to 22 per cent at 15°C. The germination rate was most rapid at 25°C (16.6). Germination value was greatest at 30°C (2.1), energy at 25°C (73.7) and vigour at 20°C (2.07). All values for the 15°C treatment were low.

In the second trial (Table 11, Figure 11) a generally better germination was achieved. Germinations of 62 and 60 per cent occurred at 25 and 20°C respectively. Germination occurred more rapidly at 30°C and was slowest at 15°C. Germination value was greatest at 25°C (6.77). Energy (100) and vigour (3.33) were greatest at 30°C. Again, all values for the 15°C treatment were low.

The seed of **A. excelsa** were susceptible to fungal infection and this may have reduced germination, particularly at the higher temperatures.

Figure 10

Alphitonia excelsa

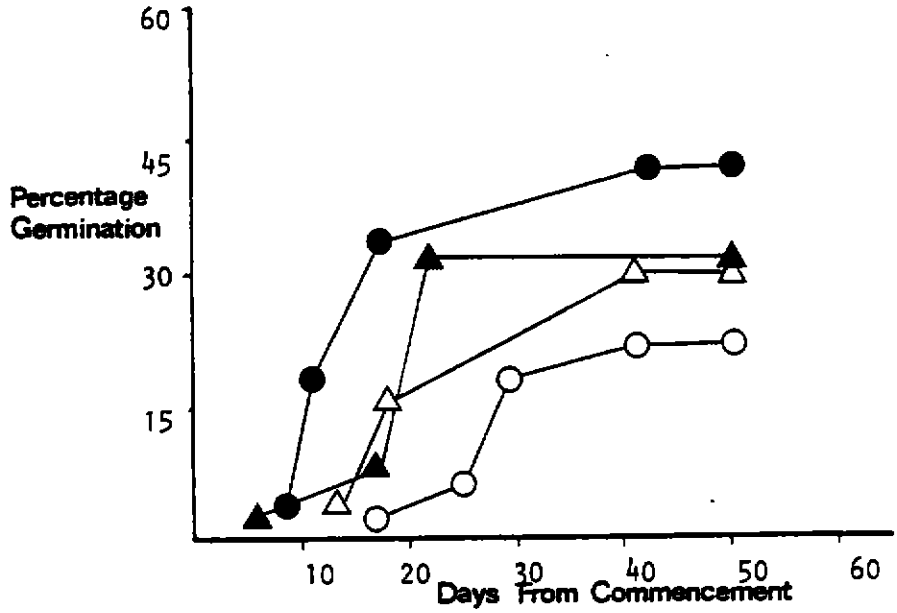



Figure 11

Alphitonia excelsa

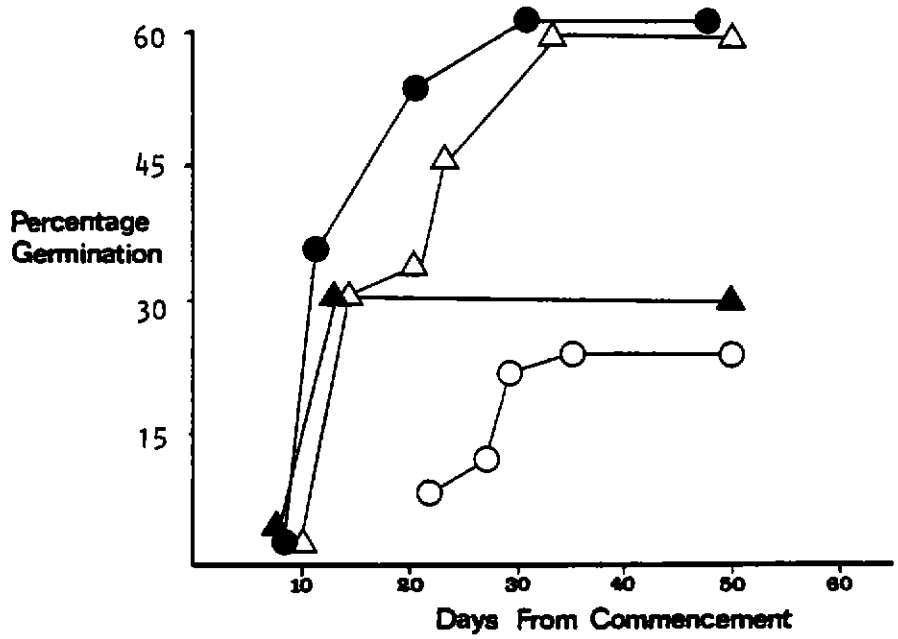


Table 10
Alphitonia excelsa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 22 | 30 | 42 | 32 |
| 2. Days to 1 | 41 | 41 | 43 | 22 |
| 3. G. Rate (mean days) | 28.1 | 23.6 | 16.6 | 18.3 |
| 4. Peak Value | 0.62 | 0.89 | 2.00 | 1.45 |
| 5. M.D.G. | 0.54 | 0.73 | 0.98 | 1.45 |
| 6. G.V. | 0.33 | 0.65 | 1.96 | 2.10 |
| 7. Energy 15/30 (%) | 0 | 45.5 | 73.7 | 18.8 |
| 8. G. Capacity (%) 30 days | 18 | 22 | 38 | 32 |
| 9. Vigour | 0 | 2.07 | 1.94 | 0.59 |

Table 11
Alphitonia excelsa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 24 | 60 | 62 | 30 |
| 2. Days to 1 | 35 | 33 | 30 | 13 |
| 3. G. Rate (mean days) | 26.7 | 18.9 | 14.5 | 10.5 |
| 4. Peak Value | 0.76 | 2.14 | 3.27 | 2.31 |
| 5. M.D.G. | 0.69 | 1.82 | 2.07 | 2.31 |
| 6. G.V. | 0.52 | 3.89 | 6.77 | 5.34 |
| 7. Energy 15/30 (%) | 0 | 55.5 | 71.0 | 100.0 |
| 8. G. Capacity (%) 30 days | 22 | 54 | 62 | 30 |
| 9. Vigour | 0 | 1.03 | 1.15 | 3.33 |

Eucalyptus miniata (Woollybutt)

E. miniata is a tree growing in open forest to 20 m tall. It is often found growing in asociation with E. tetrodonta. The lower trunk of the tree has reddish to almost black bark with the upper trunk and branches smooth and white. Leaves are smooth and leathery. Flowering occurs from May to July.

Total germination was greatest (68 per cent) but also the slowest, at 15°C. Total germination decreased as temperature increased. Germination was low at 30°C (16 per cent) but the most rapid germination rate (4.5) occurred at this temperature. Germination value (44.5) was highest at 20°C. Energy (100) and vigour (6.25) were greatest at 30°C.

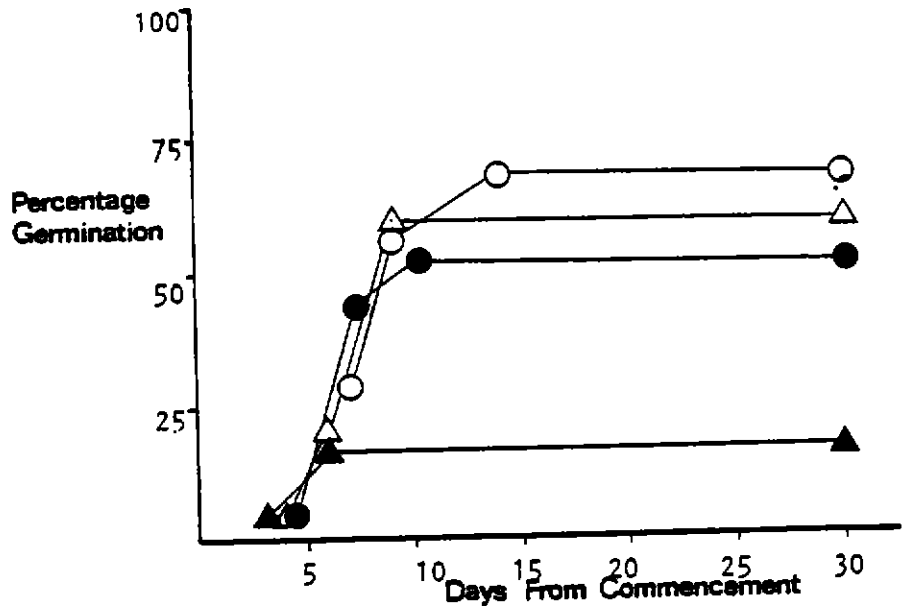
E. miniata appears to germinate best at lower temperatures.

Table 12
Eucalyptus miniata

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 68 | 60 | 52 | 16 |
| 2. Days to 1 | 14 | 9 | 10 | 6 |
| 3. G. Rate (mean days) | 8.7 | 7.1 | 6.3 | 4.5 |
| 4. Peak Value | 6.22 | 6.67 | 6.29 | 2.67 |
| 5. M.D.G. | 4.86 | 6.67 | 5.20 | 2.67 |
| 6. G.V. | 30.2 | 44.5 | 32.7 | 7.1 |
| 7. Energy 6/12 (%) | 0 | 33.3 | 61.5 | 100.0 |
| 8. G. Capacity (%) 12 days | 60 | 60 | 52 | 16 |
| 9. Vigour | 0 | 0.56 | 1.18 | 6.25 |

Figure 12

Eucalyptus miniata



Eucalyptus polycarpa (Bloodwood)

E. polycarpa is found in a variety of habitats on Groote Eylandt from dry jungle, to open forest, on rocky hillsides and in swamps. In the latter it occurs in association with E. bigalerita. It is a tree with bright green leaves. Flowering occurs in May.

Two trials were conducted for this species. Germination was very high in each. In the first trial (Table 13, Figure 13), 98 per cent germination was achieved at 15, 20 and 30°C and 94 per cent at 25°C. Overall germination was 97 per cent. Germination was rapid at all temperatures with the final germination percentage at 30°C occurring after only three days. All germination values were high, ranging from 280 to 1570 as temperature increased.

In the second trial (Table 14, Figure 14) 100 per cent germination was achieved at 15°C and 98 per cent at 20, 25 and 30°C. The germination rate was slightly slower than in the first trial but showed the same trends in being more rapid at higher temperatures. Germination value (469) was highest at 25°C with energy (100) and vigour (1.06) highest at 30°C.

It is apparent that this species will germinate readily at all temperatures in the range 15–30°C. The germination rate increases with temperature.

Table 13

Eucalyptus polycarpa

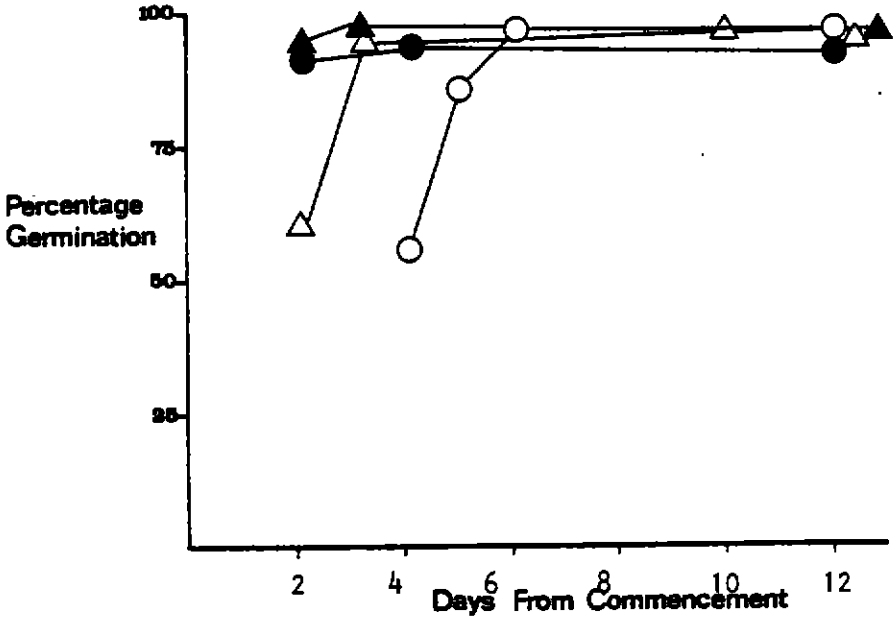



Table 14

Eucalyptus polycarpa

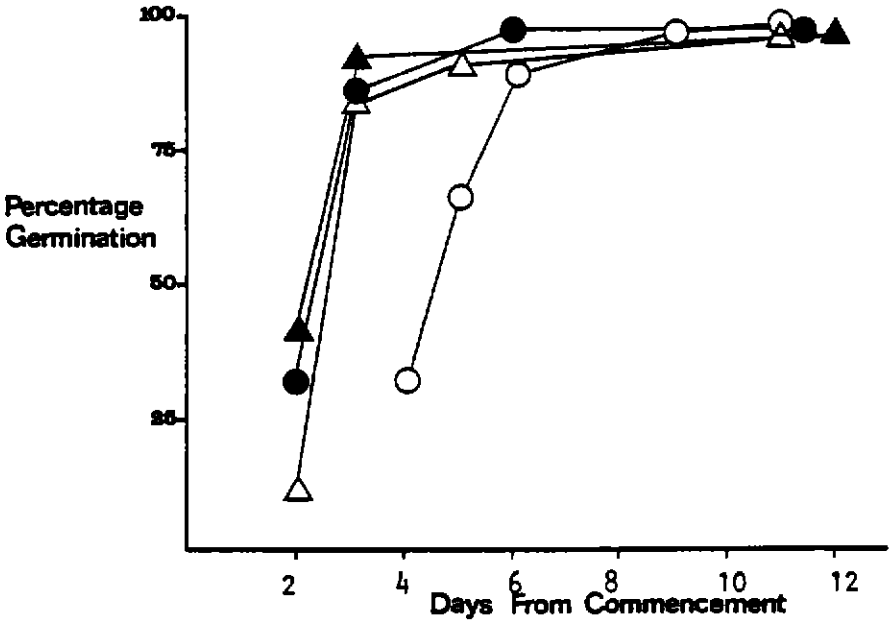


Table 13
Eucalyptus polycarpa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 98 | 98 | 94 | 98 |
| 2. Days to 1 | 6 | 10 | 4 | 3 |
| 3. G. Rate (mean days) | 4.55 | 2.51 | 2.04 | 2.02 |
| 4. Peak Value | 17.2 | 33.0 | 46.0 | 48.0 |
| 5. M.D.G. | 16.3 | 9.8 | 23.5 | 32.7 |
| 6. G.V. | 280 | 323 | 1081 | 1570 |
| 7. Energy 3/6 (%) | 0 | 97.9 | 97.9 | 100.0 |
| 8. G. Capacity (%) 6 days | 98 | 96 | 94 | 98 |
| 9. Vigour | 0 | 1.02 | 1.04 | 1.02 |

Table 14
Eucalyptus polycarpa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 100 | 98 | 98 | 98 |
| 2. Days to 1 | 11 | 9 | 6 | 12 |
| 3. G. Rate (mean days) | 5.28 | 3.35 | 2.90 | 2.90 |
| 4. Peak Value | 15.0 | 28.0 | 28.7 | 31.3 |
| 5. M.D.G. | 9.09 | 10.89 | 16.33 | 8.17 |
| 6. G.V. | 136 | 305 | 469 | 256 |
| 7. Energy 3/6 (%) | 0 | 89.4 | 87.8 | 100.0 |
| 8. G. Capacity (%) 6 days | 90 | 94 | 98 | 94 |
| 9. Vigour | 0 | 0.95 | 0.90 | 1.06 |

Eucalyptus tetrodonta (Stringybark)

**E. tetrodonta** is a very common tree of the open forest. It is often found in association with **E. miniata** and **E. polycarpa** but sometimes grows in almost pure stands. Leaves are grey-green. Flowering occurs from July to September.

Two trials were conducted for this species. Germination was poor in both at all temperatures. In the first trial (Table 15, Figure 15) germination ranged from 36 per cent (15 and 20°C) to 28 per cent (30°C). Germination was most rapid at 30°. Germination value (21), energy (92.9) and vigour (3.32) were all greatest at 30°C.

The second trial (Table 16, Figure 16) produced better germination which ranged from 36 per cent (15°C) to 54 per cent (30°C). Germination rates at 20, 25 and 30°C were similar, with the rate at 15°C being markedly slower. Germination value was highest at 30°C (40.5) whilst energy (8) and vigour (1.89) were greatest at 20°C.

The results suggest that though temperature may govern the rate of germination it may not be as important in relation to the final germination percentage. It also appears that there may have been a high percentage of non-viable seed. The overall final germination was only 33.5 per cent in the first trial and 46 per cent in the second trial.

Figure 15

Eucalyptus tetrodonta

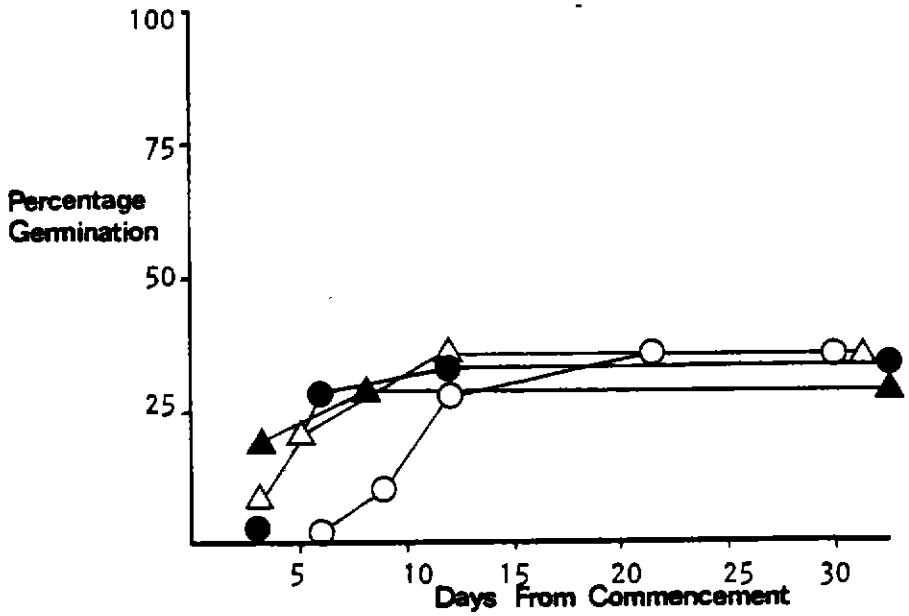



Figure16

Eucalyptus tetrodonta

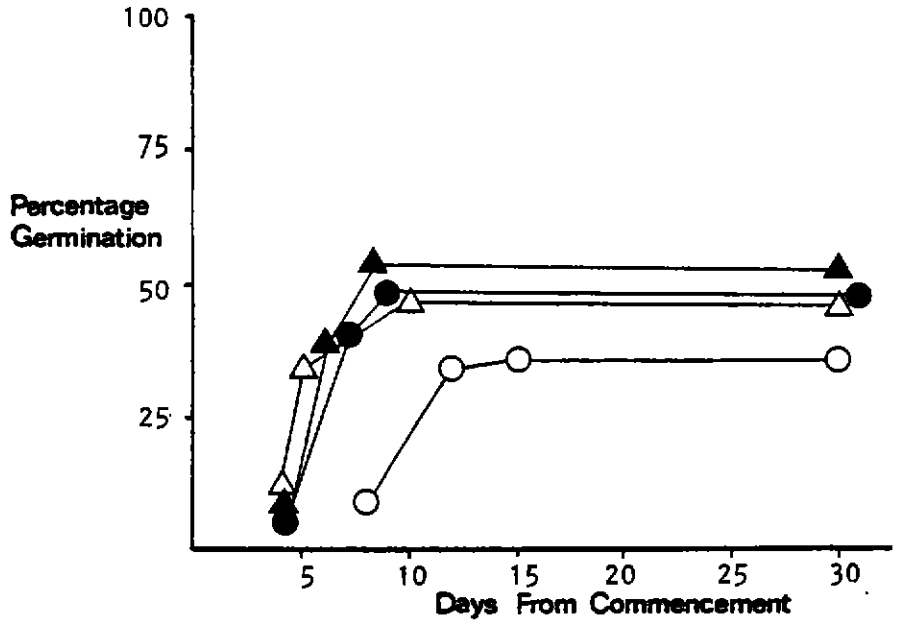


Table 15
Eucalyptus tetrodonta

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 36 | 36 | 34 | 28 |
| 2. Days to 1 | 22 | 12 | 12 | 8 |
| 3. G. Rate (mean days) | 11.50 | 6.56 | 5.35 | 3.71 |
| 4. Peak Value | 2.31 | 4.00 | 4.67 | 6.00 |
| 5. M.D.G. | 1.64 | 3.00 | 2.83 | 3.50 |
| 6. G.V. | 3.8 | 12.0 | 13.2 | 21.0 |
| 7. Energy 6/12 (%) | 7.1 | 61.1 | 82.4 | 92.9 |
| 8. G. Capacity (%) 12 days | 28 | 36 | 34 | 28 |
| 9. Vigour | 0.25 | 1.70 | 2.42 | 3.32 |

Table 16
Eucalyptus tetrodonta

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 36 | 46 | 48 | 54 |
| 2. Days to 1 | 15 | 10 | 9 | 8 |
| 3. G. Rate (mean days) | 10.11 | 5.35 | 5.92 | 5.85 |
| 4. Peak Value | 2.83 | 6.80 | 5.71 | 6.00 |
| 5. M.D.G. | 2.40 | 4.60 | 5.30 | 6.75 |
| 6. G.V. | 6.79 | 31.28 | 30.26 | 40.50 |
| 7. Energy 6/12 (%) | 0 | 87.0 | 70.8 | 66.7 |
| 8. G. Capacity (%) 12 days | 34 | 46 | 48 | 54 |
| 9. Vigour | 0 | 1.89 | 1.48 | 1.24 |

Grevillea heliosperma (Red Grevillea)

G. heliosperma is a straggly, tree-like shrub with long, grey-green leaves. Flowering occurs from April to July, and sometimes later.

Germination of this species was poor at most temperatures but 75 per cent germination was achieved at 25°C. No seeds germinated at 15°C. Germination value (11.12) and energy (46.2) were greatest at 25°C and vigour (2.22) greatest at 20°C.

Based on the single trial it appears that G. heliosperma is very temperature dependant with an optimum temperature occurring around 25°C.

Table 17
Grevillea heliosperma

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 0 | 15 | 75 | 35 |
| 2. Days to 1 | 0 | 15 | 27 | 17 |
| 3. G. Rate (mean days) | 0 | 13.0 | 13.3 | 11.1 |
| 4. Peak Value | 0 | 1.0 | 4.0 | 2.5 |
| 5. M.D.G. | 0 | 1.0 | 2.78 | 2.06 |
| 6. G.V. | 0 | 1.0 | 11.12 | 5.15 |
| 7. Energy 9/18 (%) | 0 | 33.3 | 46.2 | 14.3 |
| 8. G. Capacity (%) 18 days | 0 | 15 | 65 | 35 |
| 9. Vigour | 0 | 2.22 | 0.71 | 0.41 |

Figure 17

Grevillea heliosperma

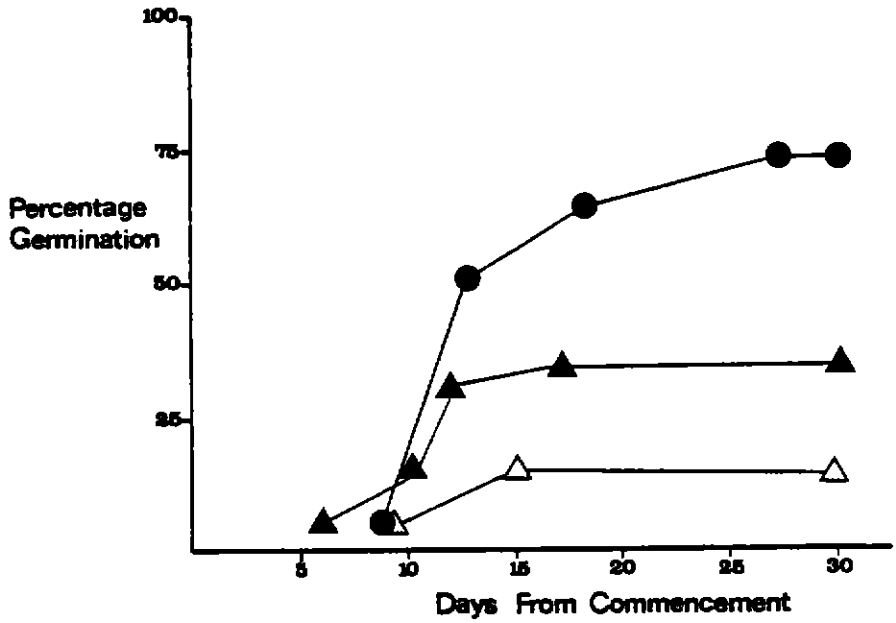
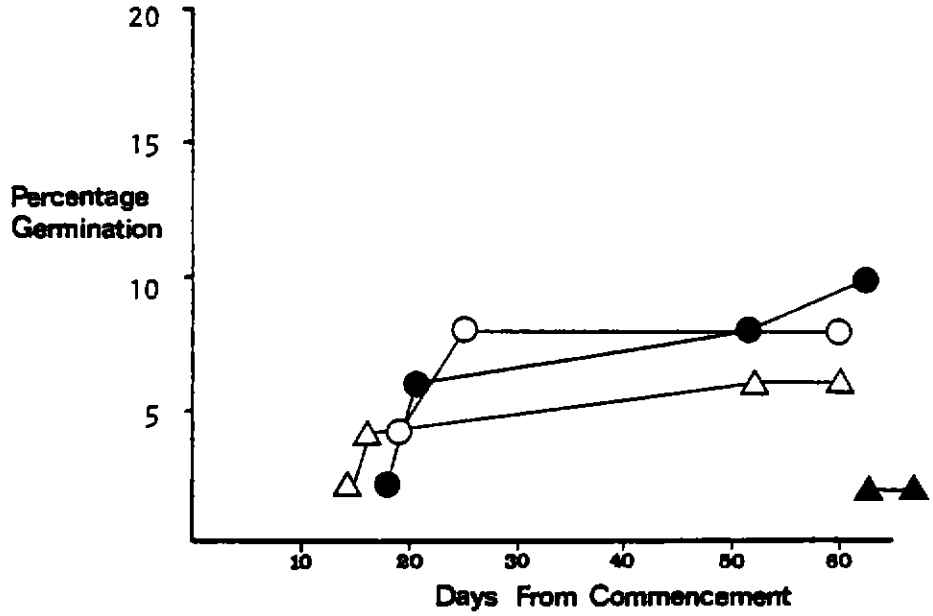



Figure 18

Grevillea pteridifolia



**Grevillea pteridifolia (Fern-leaved Grevillea)**

G. pteridifolia is an upright tree to 7 m with fine, deeply divided leaves. Flowering occurs from June to September.

Germination of this species was extremely poor, ranging from 2 per cent (30°C) to a maximum of only 10 per cent (25°C). The overall germination was 6.5 per cent. Some drying out of the petri dishes occurred at the higher tempertures during the course of the trial although not till after some time had elapsed. This possibly could have reduced germination at those temperatures.

The results give no indication of a temperature effect. The seeds appear to be either of low viability or in need of some form of pre-treatment.

Table 18
Grevillea pteridifolia

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 8 | 6 | 10 | 2 |
| 2. Days to 1 | 25 | 52 | 62 | 63 |
| 3. G. Rate (mean days) | 21.0 | 27.3 | 34.2 | 63.0 |
| 4. Peak Value | 0.32 | 0.25 | 0.30 | 0.03 |
| 5. M.D.G. | 0.32 | 0.12 | 0.16 | 0.03 |
| 6. G.V. | 0.10 | 0.03 | 0.05 | 0 |
| 7. Energy 20/40 (%) | 50.0 | 100.0 | 100.0 | 0 |
| 8. G. Capacity (%) 40 days | 8 | 4 | 6 | 0 |
| 9. Vigour | 6.3 | 25.0 | 16.7 | 0 |

**Melaleuca leucadendron**

Two forms of M. leucadendron occur on Groote Eylandt. One form has a grey bark with a long narrow leaf much shorter than the inflorescence; the other has a white bark with a long narrow leaf much longer than the inflorescence. The former flowers in September and the latter in April. Both occur around the edges of swamps. It is not known from which form seeds were collected for use in this trial.

Two trials were conducted for this species. The first trial (Table 19, Figure 19) showed a poor germination ranging from 22 per cent (15°C) to 44 per cent (25°C). The germination rate varied considerably and was much more rapid at higher temperatures. Germination value (45.6) and energy (100) were greatest at 30°C. Overall germination was 36.5 per cent.

The second trial (Table 20, Figure 20) produced a similar pattern but greater germination. Germination ranged from 32 per cent (15°C) to 56 per cent (25°C). Overall germination was 44 per cent. Germination rate was again most rapid at 30°C (5.81). Germination value was greatest at 25°C (19.6) and energy at 30°C (96.2). Seeds at 20°C had the highest vigour (2.54).

Germination appears to be more rapid, although not necessarily greater, at higher temperatures. The low germination is likely to be due to low viability. In the first trial, seeds were observed to be either distinctly light or dark. Fifty per cent of each were used in that trial and few of the light seeds germinated, suggesting they were mainly aborted ovules.

Figure 19

Melaleuca leucadendron

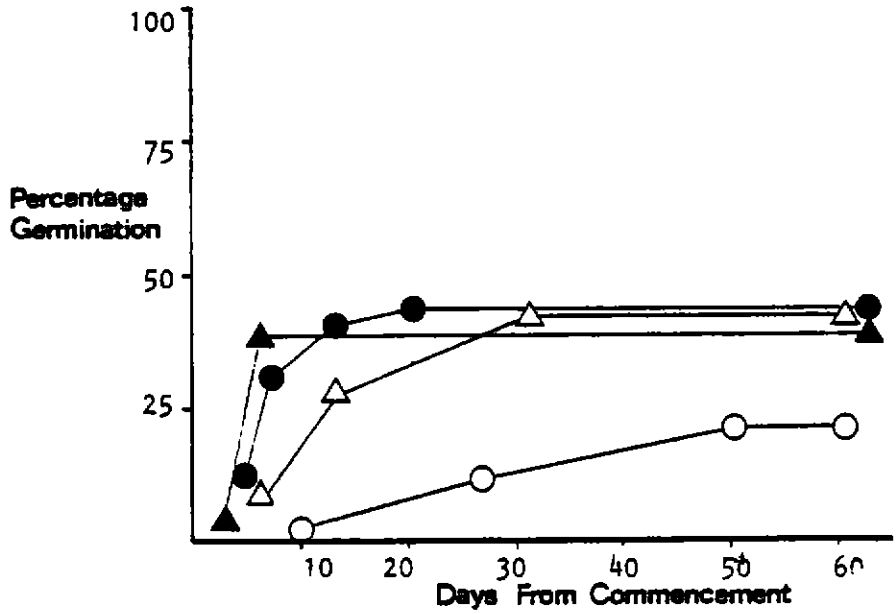



Figure 20

Melaleuca leucadendron

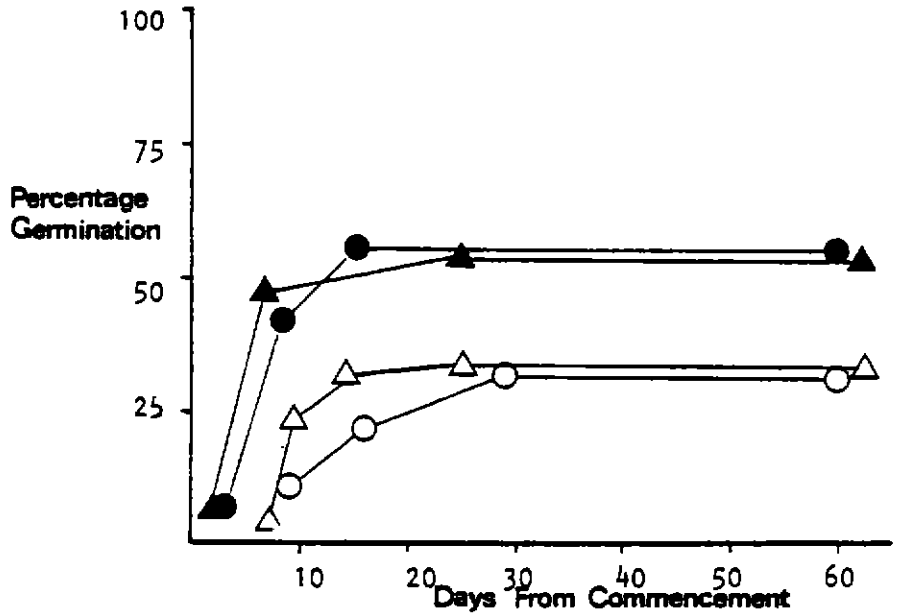


Table 19
Melaleuca leucadendron

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 22 | 42 | 44 | 38 |
| 2. Days to 1 | 51 | 31 | 20 | 6 |
| 3. G. Rate (mean days) | 30.55 | 13.76 | 8.50 | 4.42 |
| 4. Peak Value | 0.47 | 2.15 | 4.29 | 7.20 |
| 5. M.D.G. | 0.43 | 1.35 | 2.20 | 6.33 |
| 6. G.V. | 0.20 | 2.90 | 9.44 | 45.58 |
| 7. Energy 10/20 (%) | 25.0 | 41.2 | 68.2 | 100.0 |
| 8. G. Capacity (%) 20 days | 8 | 34 | 44 | 38 |
| 9. Vigour | 3.13 | 1.21 | 1.55 | 2.63 |

Table 20
Melaleuca leucadendron

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 32 | 34 | 56 | 54 |
| 2. Days to 1 | 29 | 25 | 15 | 25 |
| 3. G. Rate (mean days) | 15.00 | 9.94 | 7.75 | 5.81 |
| 4. Peak Value | 1.40 | 2.67 | 5.25 | 8.00 |
| 5. M.D.G. | 1.10 | 1.36 | 3.73 | 2.16 |
| 6. G.V. | 1.54 | 3.63 | 19.58 | 17.28 |
| 7. Energy 10/20 (%) | 42.9 | 81.3 | 85.7 | 96.2 |
| 8. G. Capacity (%) 20 days | 28 | 32 | 56 | 52 |
| 9. Vigour | 1.53 | 2.54 | 1.53 | 1.85 |

Melaleuca symphyocarpa (Liniment Tree)

M. symphyocarpa is a tree to 7 m tall. Leaves are bright green, short, oval and very shiny. It occurs in swamps and flowers in September.

The highest germination occurred at 15°C (72 per cent). Only 8 per cent of seed germinated at 30°C although germination was the most rapid at this temperature. Germination value (18.7) and energy (100) were greatest at 20°C. Vigour was greatest at 30°C (9.38).

M. symphyocarpa appears to germinate better at lower temperatures, in contrast with what one may have expected for a species from an area with a monsoonal climate. As it occurs only in swampy areas it may require year round moisture to enable germination to occur when temperatures are cooler during the dry season.

Table 21
Melaleuca symphyocarpa

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 72 | 42 | 44 | 8 |
| 2. Days to 1 | 29 | 10 | 15 | 14 |
| 3. G. Rate (mean days) | 11.94 | 7.57 | 8.09 | 7.25 |
| 4. Peak Value | 4.62 | 4.44 | 3.75 | 1.0 |
| 5. M.D.G. | 2.48 | 4.20 | 2.93 | 0.57 |
| 6. G.V. | 11.46 | 18.65 | 10.99 | 0.57 |
| 7. Energy 10/20 (%) | 45.7 | 100.0 | 77.3 | 75.0 |
| 8. G. Capacity (%) 20 days | 70 | 42 | 44 | 8 |
| 9. Vigour | 0.65 | 2.38 | 1.76 | 9.38 |

Figure 21

Melaleuca symphyocarpa

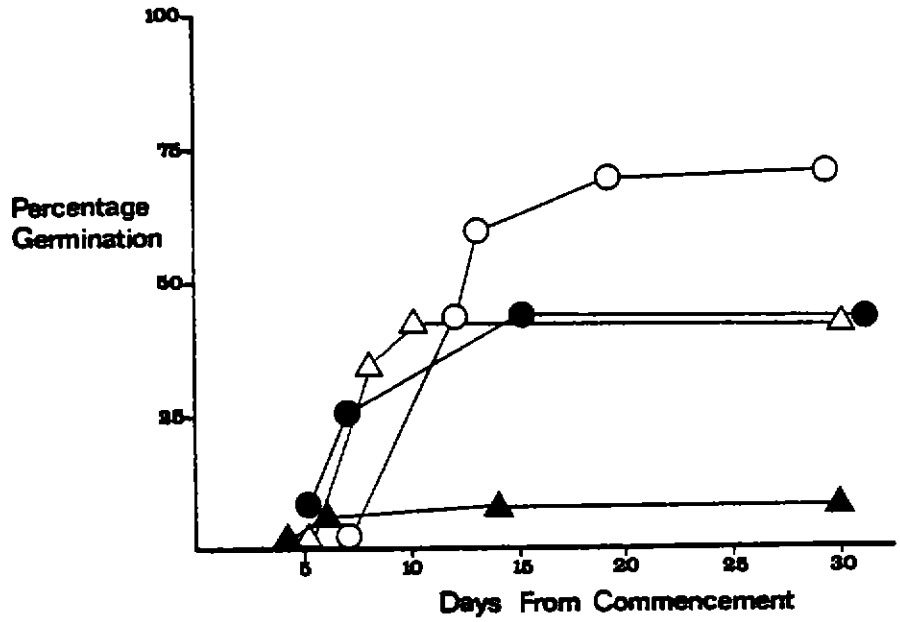
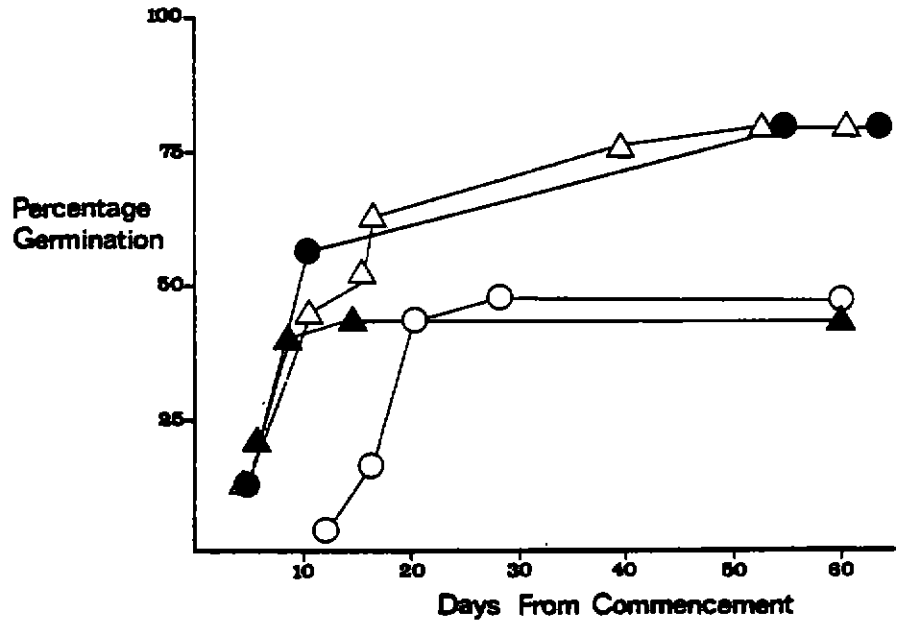



Figure 22

Melaleuca viridiflora



**Melaleuca viridiflora (Broad-leaved Paperbark)**

M. viridiflora is found in open forest or in swamps where it often occurs in association with **Banksia dentata.** Form depends on habitat and it ranges from a low shrub to a large tree. Leaves are very broad. Flowering occurs from December to March.

Germination was greatest at 20 and 25°C (80 per cent). However, germination occurred most rapidly at 30°C and the highest levels for germination value (14.7), energy (100) and vigour (2.27) were recorded at that temperature.

The final germination percentages indicate that M. viridiflora may germinate most successfully in the temperature range 20-25°C.

Table 22
Melaleuca viridiflora

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 48 | 80 | 80 | 44 |
| 2. Days to 1 | 28 | 53 | 54 | 14 |
| 3. G. Rate (mean days) | 17.83 | 15.55 | 17.25 | 6.91 |
| 4. Peak Value | 2.20 | 4.40 | 5.78 | 4.67 |
| 5. M.D.G. | 1.71 | 1.51 | 1.48 | 3.14 |
| 6. G.V. | 3.76 | 6.64 | 8.55 | 14.66 |
| 7. Energy 15/30 (%) | 8.3 | 81.3 | 87.5 | 100.0 |
| 8. G. Capacity (%) 30 days | 48 | 64 | 64 | 44 |
| 9. Vigour | 0.17 | 1.27 | 1.37 | 2.27 |

**Petalostigma pubescens (Quinine Bush)**

P. **pubescens** occurs in open forest as a shrub or small tree to 3 m tall. Leaves are small and shiny. Flowering occurs from March to July.

Germination of this species was poor. No seeds germinated at 15°C and the highest germination was only 32 per cent at 30°C. The germination rate was very slow at all temperatures. Other germination characteristics were generally best at 30°C but only marginally so.

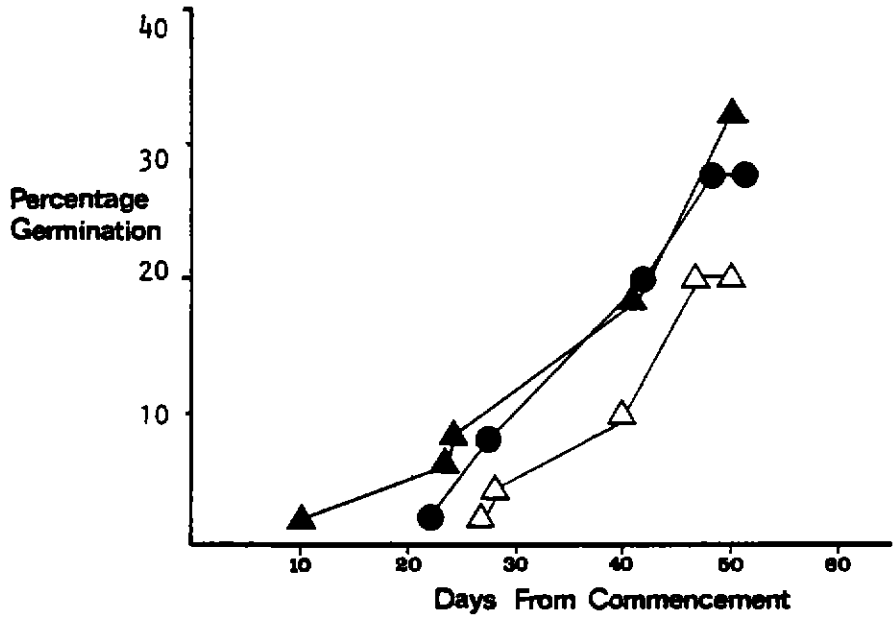
The low germination of P. **pubescens** suggests either low viability of seed or that some form of pre-treatment is necessary.

Table 23
Petalostigma pubescens

| Measurement | Temperature | | | |
|---|---|---|---|---|
| | 15 | 20 | 25 | 30 |
| 1. Final % | 0 | 20 | 28 | 32 |
| 2. Days to 1 | 0 | 47 | 48 | 49 |
| 3. G. Rate (mean days) | 0 | 38.7 | 36.3 | 35.6 |
| 4. Peak Value | 0 | 0.43 | 0.58 | 0.65 |
| 5. M.D.G. | 0 | 0.43 | 0.58 | 0.65 |
| 6. G.V. | 0 | 0.18 | 0.34 | 0.42 |
| 7. Energy 30/50 (%) | 0 | 20.0 | 35.7 | 37.5 |
| 8. G. Capacity (%) 50 days | 0 | 20 | 28 | 32 |
| 9. Vigour | 0 | 1.0 | 1.28 | 1.17 |

Figure 23

Petalostigma pubescens



ACKNOWLEDGEMENTS

The following students assisted in the work :

K.S. Arnold, S.M. Baker, S.M. Bergl, R.L. van Brakel, D.R. Carpenter, V. Clingan, E.S. Crawford, P.J. Davidson, R.D. Flugge, R. Galloway, H.P. Hoffmann, C.M. Hughes, R.J. Kotula, C.H. Mackay, T.I. Maddocks, K.A. Meney, A.F. Pelham, C.S. Ralph, J.F. Spice, P.J. Terry, P. Thomas, J. Turner and W.G. Wales.

The late Mr Richard Ryan provided technical support in maintenance of growth cabinets.

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