ing them in a sterilised medium. With *Zantedeschia* the fungicide treatment is especially important, as the corms decay easily if damaged. The tubers should be in a dormant state.

FOLIAGE CUTTINGS

Lachenalia aloides 'Pearsonii' may be increased by cutting the mature foliage horizontally into strips 8 cm wide, treating with hormones, and setting the sections into sand boxes, lower edge in the sand, in a cool greenhouse. Numerous small bulbs will form on this edge and, in due course, may be separately boxed.

Haemanthus katherinae may be propagated in this manner, inserting the leaf cuttings in mid-summer. I have propagated from a partly decayed corm of *H. natalensis* by sterilising with Benlate (benomyl) and placing in sand. Some 25 cormlets developed in 2 years and it is still producing. I would expect *H. mutliflorus* and *H. katherinae* to behave in the same way.

MIST PROPAGATION

Generally speaking only a few herbaceous perennials get any benefit from mist propagation and, in the cases of pelargoniums (all types) and silver-leaved plants, mist is positively harmful and leads to a lot of stem rot.

GERMINATING EUCALYPT SEEDS

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Abstract. The optimum germination temperatures were determined for *Eucalyptus* species which failed to germinate satisfactorily at 25°C, using a range of temperatures (15 to 35°C), and including pre-chilling for some species. A broad relationship was found to occur between the optimum temperature for germination and the climatic conditions in which a species occurs naturally.

INTRODUCTION

There are over 500 species of *Eucalyptus*; some are tall trees while others are shrubs. Most species are native to Australia but a few are also native to the Phillipines, New Guinea, and Timor. Two species, *E. deglupta* and *E. urophylla*, do not occur naturally in Australia. In New Zealand some species have naturalized, e.g. *E. tereticornis* (forest red gum); others are grown as ornamentals, e.g. *E. ficifolia* (red flowering gum), or for timber, e.g. *E. saligna* (Sydney blue gum).

The earliest mention of eucalypts naturalizing around Auckland, New Zealand (Karaka District) appears to be that of

Urquart in 1883 (12) who noted that *E. globulus* (Tasmanian blue gum) had spread the most freely. Simmonds in 1917 and 1925 (11) recommended species for shelter and timber and gave instructions on cultivation. Hall in 1935 (5) provided a key to 73 species growing in New Zealand. Palmer (7) lists 29 species, of which 21 are not listed by Hall.

Eucalypts belong to the Myrtaceae family which also includes pohutukawa, tea-tree, bottlebrush, and feijoa. The flowers of eucalypts never have typical petals and their colour is largely due to the stamens. They are bisexual and the ovary, which becomes the capsule, contains many ovules and sterile structures. Not all of the ovules become fertilized. The fertilized ovules have developed into seeds by the time the fruit (capsule) has become comparatively dry and woody. On extraction the capsule sheds, besides the seeds, the unfertilized ovules and sterile structures called "chaff". For some species the seed and chaff are indistinguishable. Even when they are different it is not easy to separate them (see Figure 1). Consequently, eucalypt seeds are normally sold and sown with the chaff. The amount needed to produce the required number of plants is calculated on the number of viable seeds per 10 grams (or per ounce) of seeds and chaff. This can vary from 450 for *E. ficifolia* to 3,500 for *E. cinerea* (Argyle apple, silver dollar).

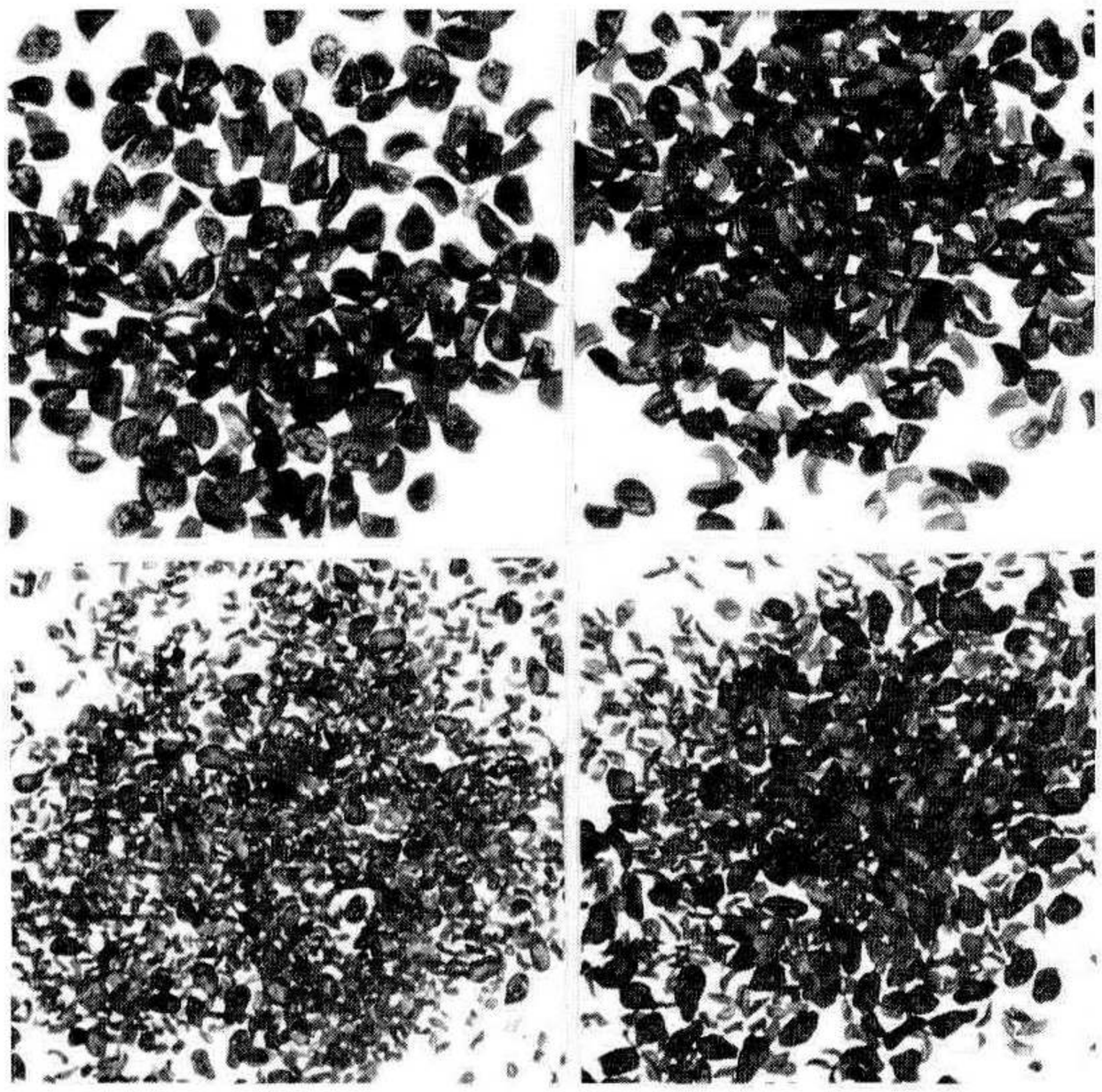

Figure 1. Showing seed and chaff of *Eucalyptus pauciflora* subsp. *niphophila*, upper left; *E. pauciflora* subsp. *pauciflora*, upper right; *E. nicholii*, lower left; and *E. perriniana*, lower right.

The Seed Section of the Forestry and Timber Bureau, Canberra, Australia had been collecting, testing and distributing seed for a number of years before I joined the staff in 1968. After collection, the capsules were spread out to dry and to allow the seed to be extracted. This also reduced the moisture content of the seeds. Extracted seeds were treated with a fumigant to kill insects before being stored in sealed jars at room temperature. Germination tests were made using a standard test at 25°C except for a few species which were pre-chilled. Some lots had very low germination or none at all. Larsen (6) presented a table giving the number of viable seeds per ounce, together with the method of testing, based on the lots in the seed store. He commented on the possibility of dormancy being present in lots with very low germination.

It was evident that for some lots not all the viable seeds had germinated, and the true viability of the lots was not being determined. My aim in the work reported here was to rectify this and to revise Larson's table, as well as to determine the optimum temperatures for germination.

THE VIABILITY TESTING TECHNIQUE

Tests are normally made on a weighed quantity of the seed lot rather than by seed number, because of the mixture of seed and chaff. The lots are well mixed and divided down to obtain the representative working sample. At the Forestry & Timber Bureau four replications of between 0.1 to 0.5 grams are used, allowing for approximately 50 viable seeds per replicate.

The sowing technique used by Larsen (6) was the one I adopted, i.e. the seeds were placed on damp filter paper over vermiculite saturated by tap water in a petri-dish.

All the seed lots in the store were re-tested at the temperature (25°C) used by Larsen, together with the lots collected since then. Germination counts were made twice a week. When little or no germination occurred for 2 weeks the remaining seeds were squashed. If the contents were white and firm it was deduced that the seeds were viable but that the optimum conditions for germination had not been met. The lots were then re-tested at 15°, 20°, 30° and 35°C. If none of these tests were satisfactory the lots were re-tested at 20°C after pre-chilling for periods of two, four and six weeks.

RESULTS

As the work progressed, a species name label was pinned to a map of Australia at the collection site of each seed lot.

The pins were colour-coded to denote the optimum germination temperature of each lot.

The first count of seedlings at the optimum temperature was made within one week and the final count usually within 2 to 3 weeks but for some species this was up to six weeks. Germination is epigeal and counts were made when the cotyledons were emerging from the seed coat and the radicle was 5 to 10 mm long. Abnormal seedlings were not included in the germination figure. Two tables were made, one giving details of the germination test and the other the estimated number of viable seeds per 10 grams (see Table 1). They covered over 350 species, based on tests on 2,250 seed lots. The first table appeared in a booklet by Scott (9) together with other observations made during the testing, while the second, as well as the results of more tests and an up-dated first table are included in the book by Boland *et al.* (3).

Table 1. Example of number of viable seeds and recommendations for sample weight, test temperatures, and test duration. (Data from Boland *et al.* (3).)

Species	Approx. no. viable seeds per 10 gr	Weight of replication (g)	Temperature (°C)	Time of first count (days)	Time of final count (days)
E. cinerea	3480	0.15	25	3	14
E. coccifera	1550	0.30	15	10	28
E. deglupta	40300	0.01	35	5	14
E. ficifolia	450	1.20	20	5	14
E. saligna	5380	0.10	25	5	14

An optimum germination temperature was found for all the species except four, each of which comprised only one or two seed lots. The viability of these was tested biochemically by the technique described in the International Rules for Seed Testing (1) as the "Topographical Tetrazolium Test". A state of dormancy probably existed which the germination conditions used did not break (dormancy sometimes is present in freshly collected seed, which may germinate after some months).

DISCUSSION

From the coloured pin-heads on the map it could be seen that optimum germination temperatures were related to the distribution of the species. *E. camaldulensis* (river red gum) which has a wide distribution across central, north, and north-western Australia and grows under a wide range of climatic conditions from tropical to temperate, germinated best at 30°C, although 25°C and 35°C were quite satisfactory also (Figure 2). *E. pauciflora* ssp. *niphophila* (alpine snow gum) which grows up to 6,500 feet in the Australian Alps required pre-chilling for four weeks. *E. ficifolia* (red-flowering gum) has a very restricted natural occurrence in a narrow coastal belt in the south of

Western Australia, where the climate is mild temperature; its optimum germination temperature is 20°C. *E. deglupta* from the tropics of New Guinea required a germination temperature of 35°C (Figure 2). *E. coccifera* (Tasmanian snow gum) grows at high altitudes on the central and southern mountains of Tasmania, where the climate is montane to sub-alpine; its optimum germination temperature is 15°C (Figure 2) although some lots require pre-chilling. *E. cinerea* (Argyle apple, silver dollar) with an optimum germination temperature of 25°C, occurs in the south of New South Wales in an area where the summers are warm to hot and the winters fairly mild. *E. robusta* (swamp mahogany) occurs in swamps and edges of salt-water estuaries in a coastal belt beginning in the south of Queensland and continuing to the south of New South Wales. This varies from subtropical to warm temperate. The seeds germinate satisfactorily at 15°, 20° and 25°C (Figure 2).

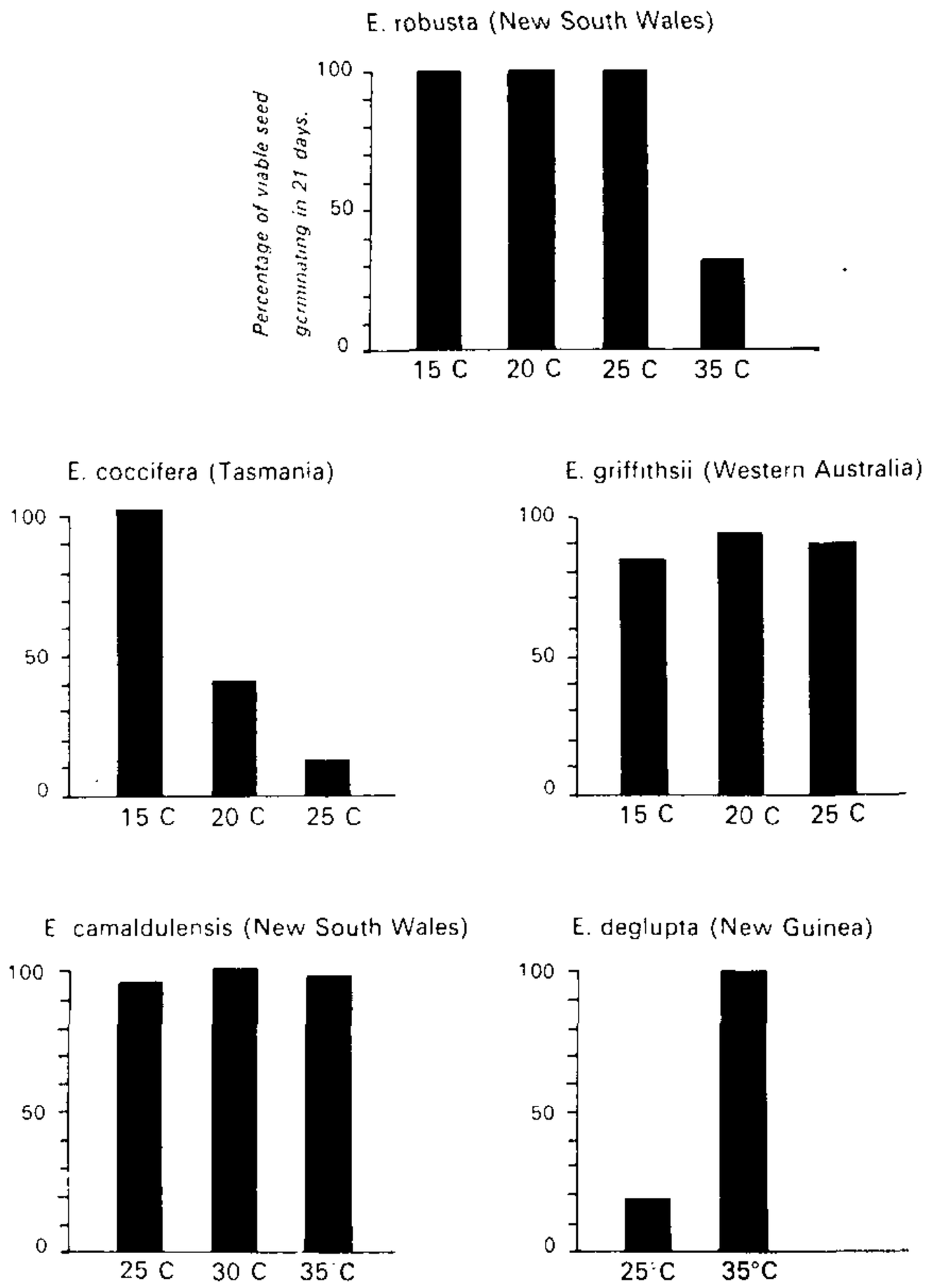

Figure 2. Examples of the germination of seed of eucalypts at various temperatures.

When a species does not germinate satisfactorily at 25°C, tracing its origins gives a clue to the likely optimum temperature. Hall *et al.* (5) and Blakely (2) provide information on distribution of species.

In re-testing all the lots in store it was found that those less than 10 years old had maintained their viability without special storage conditions. After ten years there was a gradual decline until by 20 to 30 years there was a complete loss of viability. Exceptions were *E. deglupta* and *E. microtheca* (Coolibah) which lose viability rapidly unless stored in sealed containers at a low temperature (5°C).

Details of nursery practice are described by Boland *et al.* (3) and Schopmeyer (8).

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