during the early pre-reproductive phase of the life cycle. In nature competitive effects are likely to be even more severe as our trees had the benefit of a wide spacing during establishment. ASHTON (1976) quotes estimates of over 2 million germinants per hectare following fire generation of *E. regnans*, decreasing to about 40 trees per hectare in a fully stocked stand at maturity (200 years). In such stands the probability that any particular genotype will survive to maturity might therefore be sensitive to very small differences in competitive ability.

It is important to note that if such selection, coupled with density dependent mortality (HARPER 1977), is a major determinant of population structure, then in a situation where regeneration is poor or seed widely distributed, some selfed progeny of *E. regnans* may be quite capable of successful growth and reproduction. At age 12½ years, 13% of our selfs were classified as dominant or codominant *(Figure 3)*, despite the increasing competition from the other plots.

Conclusions

The series of observations reported in this paper (to be followed by as yet unpublished results from more comprehensive experiments planted in 1979) suggest that the eucalypt breeder and plantation grower must consider developing positive strategies for minimising the deleterious effects of inbreeding on growth rate. It is suggested that under natural regeneration conditions selection by self-thinning of the stand, operating in favour of more vigorous outcrossed individuals, is an important mechanism for maintaining the mixed breeding system of the species.

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Short Note: Multiple Populations and Sublines

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Summary

Multiple populations and sublines are two concepts that have developed in recent years for tree breeding. They relate to subdividing breeding populations, and are defined as follows: multiple populations represent different selection criteria, to ensure that at least one such population will correspond roughly to any future selection goal; sublines represent replicate breeding populations that can be intercrossed to ensure completely outbred offspring at any time in the future.

Key words: tree breeding, breeding populations, breeding strategy, multiple populations, sublines.

Zusammenfassung

Multiple Populationen und Sublines sind zwei Konzepte, die in den letzten Jahren für die Pflanzenzüchtung entwickelt worden sind. Sie lassen es zu, Züchtungspopulationen zu unterteilen und werden wie folgt definiert: multiple Populationen stellen verschiedene Selektionskriterien dar, um sicherzustellen, daß am Ende eine solche Population annähernd jedem zukünftigen Selektionsziel ent-

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sprechen wird; Sublines repräsentieren nachgebildete Züchtungspopulationen, die zwischengekreuzt werden können, um eine komplette aus Fremdung hervorgegangene Nachkommenschaft zu jeder Zeit in Zukunft sicherzustellen.

Forest tree improvement programs throughout the world are proceeding to advanced-generations of selection and breeding. Several problems in breeding and terminology are being encountered which do not usually manifest themselves in the first generation of improvement programs.

Two problems in forest tree breeding which have received attention in recent years are:

(i) Uncertainty as to future economic weights of prospective selection criteria (NAMKOONG, 1976).

(ii) The question of future inbreeding and narrowing of the genetic base which can arise from pursuing genetic gains through selection in closed populations (NAMKOONG, 1974; VAN BUIJTENEN, 1976; BURDON *et al.*, 1977).

In discussing the former problem Namkoong proposed maintaining "multiple populations," each of which would be subjected to a different selection criterion (or criteria). The expected value of the entire breeding operation could be maximized by using a subset of the multiple populations which were closest to the desired criteria at that time. Also, diversifying the populations, at least one such population should have roughly the desired characteristics at any time in the future when new selection criteria might emerge. Furthermore, when breeding for a multiplicity of environments, different subpopulations of the species could be exposed to different selective pressures in the respective environments (NAMKOONG, 1980). When breeding is continued in future generations, these sub-populations can be divided into unrelated "sublines." Within these, unintentional inbreeding and genetic drift might be accepted, with the assurance that future crossing among such entities would represent effectively complete outcrossing.

Initially the proposals and the terminology were tentative, but with the passage of time and with active implementation of the "breeding group" and the "sublining" concepts (VAN BUIJTENEN and LOWE, 1979; LOWE and VAN BUIJTENEN, 1981) it seems appropriate to define some terms firmly and precisely. There are some difficulties in achieving consistency with other plant breeding terminology and there seems to be no easy resolution of those difficulties. Accordingly, we propose to retain the terms introduced above, defining them as follows:

Multiple populations: Populations within a breeding program among which it is sought to amplify or at least maintain genetic divergences. These may be *either:* "divergent," where different selection criteria are used to increase divergence which may or may not have been present at the outset, *or* "parallel," in which initial differences are maintained by imposing selection criteria which maintain populational divergence. Genetic and phenotypic differences among populations are thus expanded or at least maintained.

Sublines: Subunits of a breeding population (or a gene resource) which represent parallel or replicate populations that —

(i) differ only due to genetic sampling error or random drift.

(ii) unless a qualification is stated, remain strictly unrelated (or disconnected), except due to common ancestry effects arising from random samling in large base populations.

(iii) need not be closed.

The term would cover cases where introduction of parents to subunits of a breeding population is done expressly to counteract chance divergences that have arisen among the subunits.

Admittedly, the usage of "sublines" does not altogether accord with the traditional concept of "line breeding" (ALLARD, 1960) in which the lines are strictly closed, but there does not seem to be any succinct alternative to the term. Moreover, current plant breeding trends seem to be against maintaining strictly closed populations. Also, the practicability of maintaining pure inbred lines in many forest trees is very doubtful.

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