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TROPICAL FORESTRY PAPERS. No. 8

(Formerly 'Fast Growing Timber Trees of the Lowland Tropics')

An Annotated Bibliography of
Genetic Variation in

EUCALYPTUS CAMALDULENSIS

Compiled by K.G. ELDRIDGE

DEPARTMENT OF FORESTRY
COMMONWEALTH FORESTRY INSTITUTE
UNIVERSITY OF OXFORD

CSIRO
DIVISION OF FOREST RESEARCH
CANBERRA
1975

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England.

FOREWORD

by

Professor J.L. Harley, F.R.S.

Dr. K.G. Eldridge of the Department of Forest Research, C.S.I.R.O., Canberra, spent a period of study at the Commonwealth Forestry Institute during 1975. During this period he made use of the Library of the Institute to help him prepare a bibliography on Eucalyptus camaldulensis (Dehnh.). In his work he not only drew upon his own wide knowledge of this species but also the great fund of information available to him in Australia. It was also of value for him to prepare the bibliography in Oxford where information on the species grown as an exotic in many parts of the world was available.

The results of his work are now published jointly by C.S.I.R.O. and C.F.I. as Tropical Forestry Paper No. 8, which it is hoped will give a clear and critical review of genetic variation in E. camaldulensis.

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An Annotated Bibliography of Genetic Variation in *Eucalyptus camaldulensis*

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SCOPE AND USE OF THE BIBLIOGRAPHY

The aim of this bibliography is to provide access to and to review information on the genetic resources of *Eucalyptus camaldulensis* Dehnh., a tree of great importance in Mediterranean, sub-tropical and tropical countries. It is particularly important for the production of domestic products, such as poles, posts and timber, but above all, and increasingly, fuel wood.

The references are confined to natural distribution, genetic variation, reproductive biology, tree breeding, seed supply and the related subjects listed in the Subject Index. Information on silviculture is limited to a brief outline in the General Summary since the silvicultural practices for *E. camaldulensis* as an exotic are not unique but apply to several species of *Eucalyptus* in many parts of the world. Species trials, nursery and propagation techniques, and seed germination are excluded for the same reason.

In addition to formally published papers in scientific journals, unpublished papers for conferences and other reports have been included. Some of the best information on genetic variation in *E. camaldulensis* (and other forest trees) is unpublished and therefore inaccessible to many of the researchers and administrators responsible for deciding on the best source of seed.

Copies of all the unpublished reports in this bibliography are held by the Commonwealth Forestry Institute, Oxford, or the CSIRO Division of Forest Research, Canberra.

The chief sources of references were Forestry Abstracts and the Commonwealth Forestry Institute's Catalogue of World Forestry Literature. Most of the summaries and all the comments were written by the author after referring to the original papers.

The format of the entries is in four parts (e.g. entry no. 2) of which the first and third parts are always included and the second and fourth only sometimes. The first part is the citation which is explained below. The second part is a quotation of the whole or part of the author's summary or abstract, designated AUTHOR'S SUMMARY indented, and in quotation marks. The third part is my summary and review of the facts and opinions expressed in the paper. The fourth part, in brackets, introduces additional facts or expresses some of my own opinions on the subject under discussion in the paper.

The method of citing references in the bibliography is almost the same as that used by Forestry Abstracts, including an indication of the language: De, German; En, English; Es, Spanish; Fr, French; Gr, Greek; He, Hebrew; It, Italian; La, Latin.

If a paper has been cited by Forestry Abstracts the entry in this bibliography concludes with the reference in the form FA 36, 1327, which means Forestry Abstracts volume 36, abstract number 1327. A few recently-published papers have not yet been referred to in Forestry Abstracts.

The references are listed in alphabetical order and numbered 1-106. The Subject Index lists under each subject heading the serial numbers of the papers containing information on that subject. The ODC number (the Oxford System of Decimal Classification for Forestry) is included after each subject heading. The subjects covered in a paper are indicated at the end of the citation in the form Subjects 2, 7, 8, 15.

A SUMMARY OF INFORMATION ON EUCALYPTUS CAMALDULENSIS

Taxonomy

The name Eucalyptus camaldulensis (Dehnhardt, 1832) was given in honour of the Count of Camaldoli who had grown the tree successfully in his garden near Naples in Italy since 1822 (Cleland, 1956). Osborn (1937) confirmed Blakely's (1934) decision that E. camaldulensis Dehnh. has priority over the more descriptive epithet E. rostrata (Schlectendahl, 1847); "rostrata" means beaked, referring to the elongated top of the flower bud. The synonym E. rostrata is still in use and was preferred by Forestry Abstracts as recently as 1967.

In southern Australia the common name is red gum or river red gum, referring to the rich red-brown colour of the heartwood and kino (gum), to its occurrence along watercourses, and to the nature of the bark (i.e. gum-barked). In central and northern Australia the name ghost gum appropriately invokes the whiteness of the bark. However,

ghost gum should be restricted to E. papuana F. Muell. (Hall et al., 1970). Old red gums are beautiful trees and have been subjects for some of Australia's best-known painters, Hans Heysen, Albert Namatjira and Sidney Nolan.

E. camaldulensis is in the part of the genus called Section Macrantherae, Series Exsertae by Blakely (1934), and Subgenus Symphyomyrtus, Section Exsertaria by Pryor and Johnson (1971).

The description published by Blakely (1934), "Operculum ovoid to rostrate ....", acknowledges considerable variation in an important taxonomic character. Although the type specimen has pointed flower buds several botanical authorities have accepted both pointed and rounded buds in their concept of the species (Pryor and Byrne, 1969).

Varietal or sub-specific names are not commonly used for E. camaldulensis although Blakely (1934) published formal descriptions of five varieties. Pryor and Byrne (1969) considered these names to be of little value as they expressed only minor or local variants, were not based on adequate sampling in the field, and were only a few of many such variants which could have been named.

Distribution

A succinct account of the distribution of E. camaldulensis was given by Hall (1972a). "River red gum is the most widely spread of all eucalypts, being absent only from the tablelands and coastal areas of eastern, south-eastern and south-western Australia. Even in the desert areas it may be found along drainage channels. With this wide distribution is a variation in rainfall of 8-50 inches, but it should be noted that in the lower rainfall areas, especially below about 15 inches, the tree relies on stored water from seasonal flooding or a high water table. Some of the finest specimens are to be found along the banks and on the flood plains of the Murray River, especially where it forms the boundary between Victoria and New South Wales."

Silviculture

The extensive riverain forests of E. camaldulensis in south eastern Australia have been under forest management for many years. Silviculture of the natural forests, including regeneration by aerial seeding after clear felling and the influence of periodic flooding, has been reviewed by Jacobs (1955) and Dexter (1967).

The much greater activity on the silviculture of E. camaldulensis as an exotic was summarised in "Eucalypts for Planting" (F.A.O., 1955). The book is being revised by Dr. M.R. Jacobs. The best current information on eucalypt plantation silviculture was prepared by the late Professor M.V. Laurie (F.A.O., 1974) for the African savanna region. Nursery techniques, site preparation,

fertilizing, irrigation and mechanical weeding are described and illustrated. Kaul (1970) provided details on afforestation with eucalypts, particularly E. camaldulensis, in arid regions of the world.

Utilization

In Australia the wood of E. camaldulensis is used for firewood, railway sleepers, heavy construction timbers, fence posts, flooring and foundations for wooden houses. The red-brown wood of old trees has a close-textured, interlocked grain with frequent pockets of gum (kino) which reduces its breaking strength below that expected for its basic density of about 0.8 g cm^{-3}. The heartwood is durable in the ground (class 2) but is not among the most durable (class 1) of Australian timbers (Wallis, 1970).

Wood harvested from E. camaldulensis grown as an exotic is usually from young trees with little heartwood. It is used mainly for firewood and poles. Wood from young fast-grown plantations is usually less suitable for sawing than wood from old trees due to greater problems with shrinkage and growth stresses (F.A.O., 1955; Chudnoff and Tischler, 1963; Hillis, 1972).

GENETIC VARIATION IN EUCALYPTUS CAMALDULENSIS

The research on genetic variation of E. camaldulensis introduced by this bibliography started with the realisation that the species has great value for wood production especially on difficult dry sites in many parts of the world.

Current literature indicates that no outstanding land races or hybrids of E. camaldulensis superior to the best natural provenances have yet arisen in cultivation and been incorporated in large scale plantations. The successful "Mysore Hybrid" in India and "12ABL" in the Congo which were suspected to be E. camaldulensis hybrids are now regarded as unrecognised Queensland provenances of E. tereticornis Sm. (Pryor, 1966; Martin, 1971); Another suspected hybrid of E. camaldulensis, E. x algeriensis Trabut., was found to be similar to naturally occurring forms of E. rudis Endl. (Pryor, 1968).

Until the mid 1960s there was little research aimed at making use of genetic variation to improve the yield and quality of E. camaldulensis plantations. The provenance trials reported in the papers of this bibliography are based mainly on the authenticated seed collections made by the Forestry and Timber Bureau, Australia, with the support of the Food and Agriculture Organisation of the United Nations since 1966. Many of the trials were coordinated through FAO (Lacaze, 1970). The same seed lots are under test in many countries.

Early results of these trials have shown that some less well known provenances produced much more wood than the commonly-used provenances. Genetic variation demonstrated in provenance trials

shows this highly variable species to have become genetically adapted to the wide range of sites on which it grows in Australia. The masses of data accumulating and the variable forms of reporting results indicate an urgent need to prepare a consolidated account of the variation of the species.

A northern and a southern form of E. camaldulensis has been recognised in several studies (Karschon, 1967, 1974; Pryor and Byrne, 1969; Banks and Hillis, 1969; and others). The northern form, of which Katherine, Northern Territory, and Petford, Queensland, are outstanding provenances, generally has rounded opercula, broad glaucous juvenile leaves, lignotubers, fairly straight stems and white bark, and is successful when planted in tropical and sub-tropical areas with summer rainfall. The southern form, of which Lake Albacutya, Victoria, is an outstanding provenance, has rostrate opercula, narrow non-glaucous juvenile leaves, few or no lignotubers, rather crooked stems, grey bark, and is successful when planted in more temperate areas with winter rainfall, especially the Mediterranean region.

The boundaries between the northern and southern forms have not been clearly defined. The following approximate dividing lines have been suggested: latitude 20°S (Larsen, 1967); 32° (Karschon, 1967; Burley, Wood and Hans, 1971); 27°, or between 23° and 30° (Pryor and Byrne, 1969); 23½° on the east coast to 18° on the west coast (Karschon, 1974); about 26° (Pryor, 1975). If there is clinal variation in the characteristics used to distinguish the northern and southern forms it is unlikely that any real boundary exists.

Subdivision of E. camaldulensis into convenient sub-specific taxa requires much more research. The question of whether the patterns of genetic variation in the species are continuous, discontinuous, or both, remains to be resolved (Karschon, 1967; 1971a; Pryor and Byrne, 1969).

For the present, and perhaps always, the names of the original seed sources, such as the Katherine provenance, will be adequate for describing the E. camaldulensis used in man-made forests.

A major handicap to further understanding of the genecology of E. camaldulensis is the lack of an adequate map of its distribution.

From the botanical point of view, detailed studies of more samples of the species from the whole of its natural range are required before drawing definite conclusions about the present patterns of genetic variation and their evolution.

From the silvicultural point of view, additional provenance testing is required of seed collected in those regions from which outstanding provenances have already been obtained. The success of certain provenances, Petford, Katherine and Lake Albacutya, should not mean that the question of provenance selection in E. camaldulensis is closed. These provenances are only the best so far. There may be

even better populations waiting to be put to use.

Recently the best individual trees within the best provenances have been selected for seed orchards and seed production areas which will produce large quantities of seed in a few years. The deleterious effects of inbreeding which might result from too limited a genetic base (usually only 10 trees) of the original provenance collections must be acknowledged when planning seed production for planting large areas of one provenance.

ACKNOWLEDGEMENTS

The bibliography was prepared while the author was a visitor in the Department of Forestry, University of Oxford. Financial support was provided by the Commonwealth Forestry Institute, Oxford, and by the Forestry and Timber Bureau, Canberra, and the C.S.I.R.O. Division of Forest Research, Canberra. The advice and encouragement of J. Burley, R. Karschon, R.H. Kemp, J.-F. Lacaze, Z.O. Momoh, M.B. Shado, J.W. Turnbull, P.J. Wood and other colleagues in several countries are gratefully acknowledged.

SUBJECT INDEX

The entries are serial number of subject (1. to 15.), subject, ODC number (the Oxford System of Decimal Classification for Forestry), and serial number of paper (1 to 106).

11. Seed orchards, and selection of plus trees for seed orchards
ODC 232.311.3 and 165.62 3, 17, 21, 27, 58, 68, 78, 100

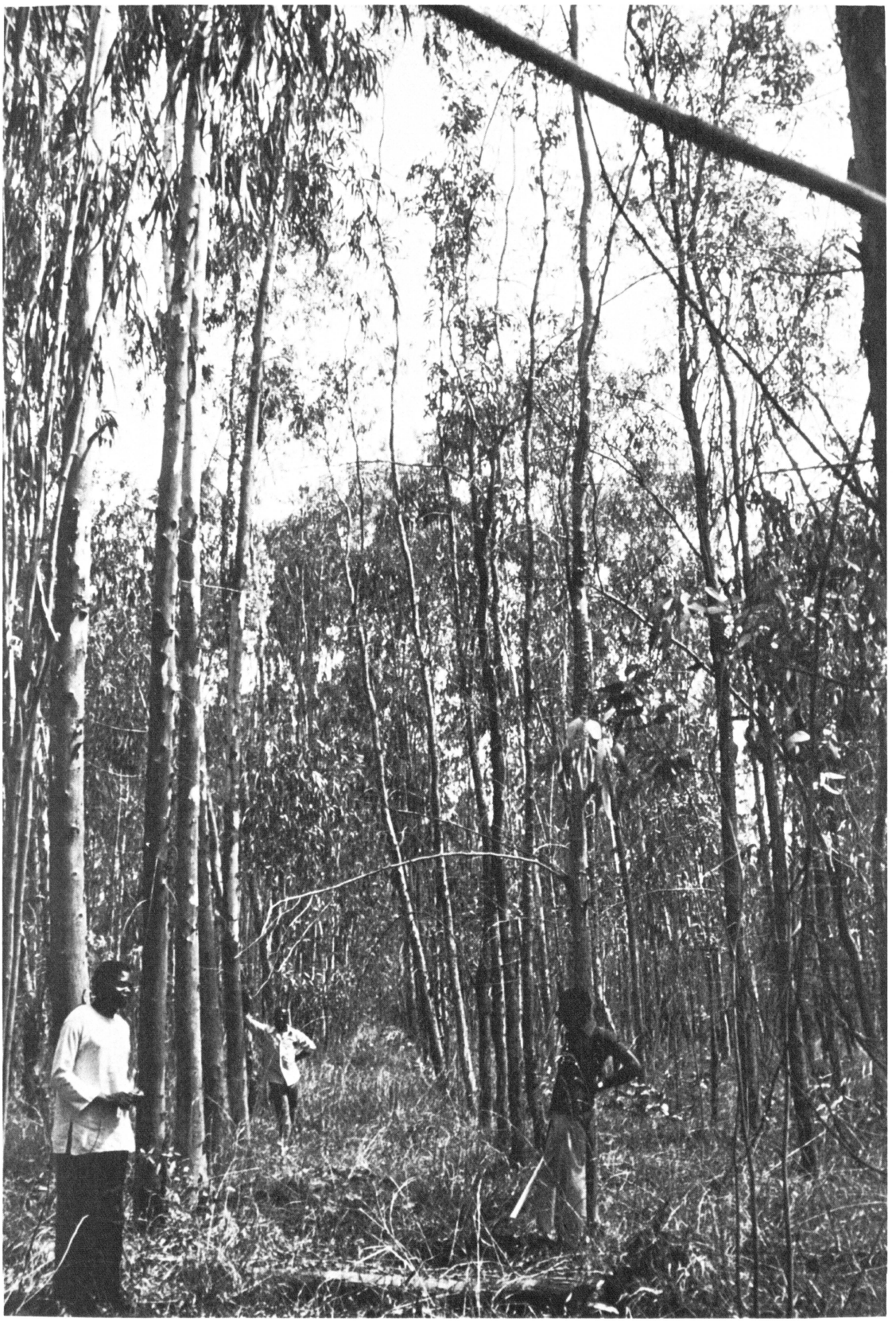
12. Seed collection and sources of commercial seed
ODC 232.312 3, 17, 27, 58, 68, 84, 98, 99

13. Autecology and silvicultural characteristics in the natural range
ODC 181 and 231 3, 4, 5, 8, 22, 25, 33, 38, 43, 46, 47, 51, 53, 54, 55, 56, 50, 61, 69, 80, 85, 87, 88, 99

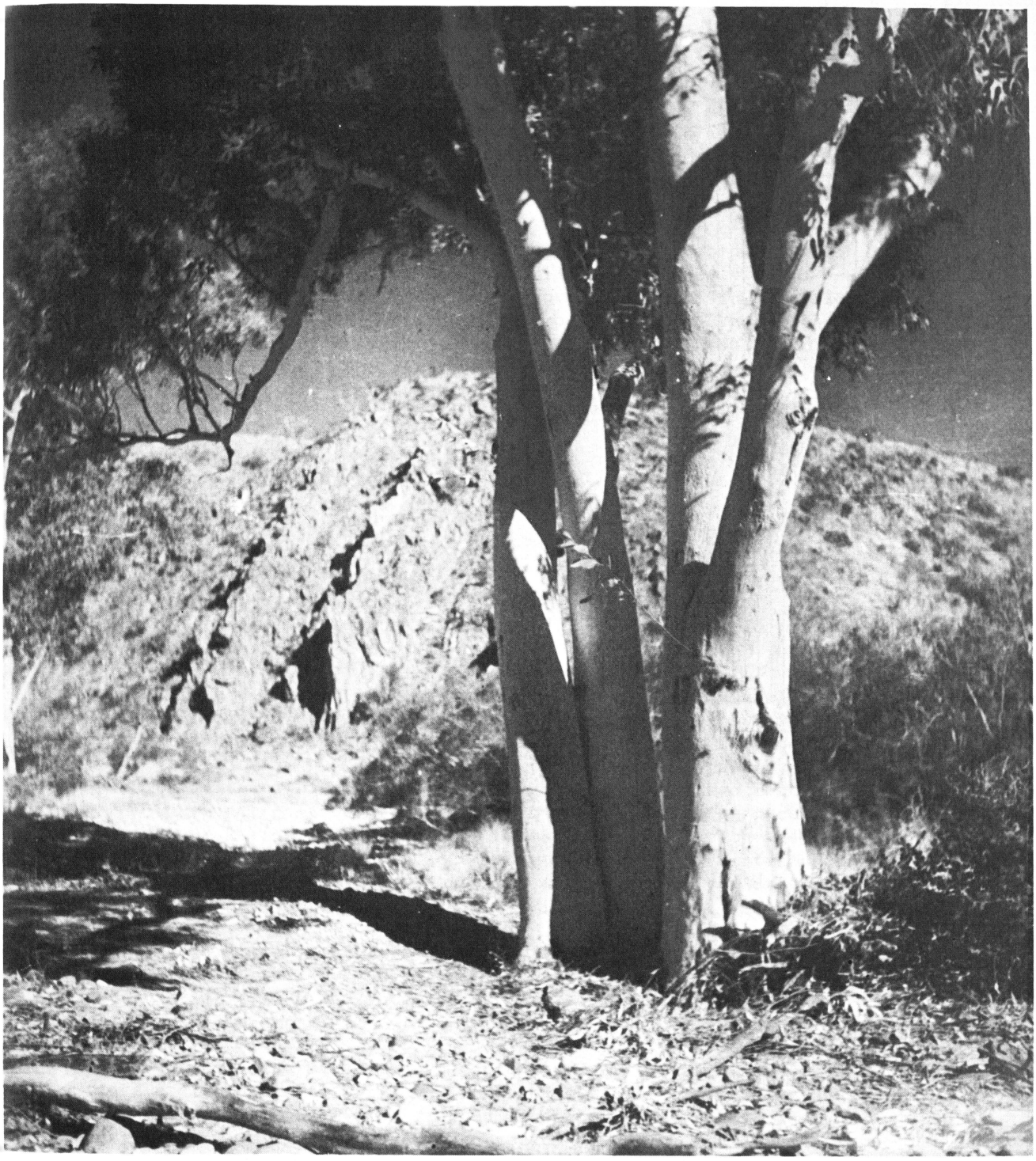
14. Silvicultural characteristics as an exotic; plantation establishment
ODC 181 and 232.4 3, 8, 12, 16, 19, 21, 23, 25, 26, 34, 36, 37, 38, 43, 44, 45, 47, 48, 50, 55, 62, 63, 74, 66, 75, 76, 79, 80, 84, 85, 86, 90, 92, 95

15. Methods of statistical analysis
ODC --015.5 1, 2, 4, 8, 13, 14, 15, 21, 36, 37, 44, 45, 50, 52, 57, 58, 60, 76, 79, 81, 88, 90, 92, 92, 93, 94

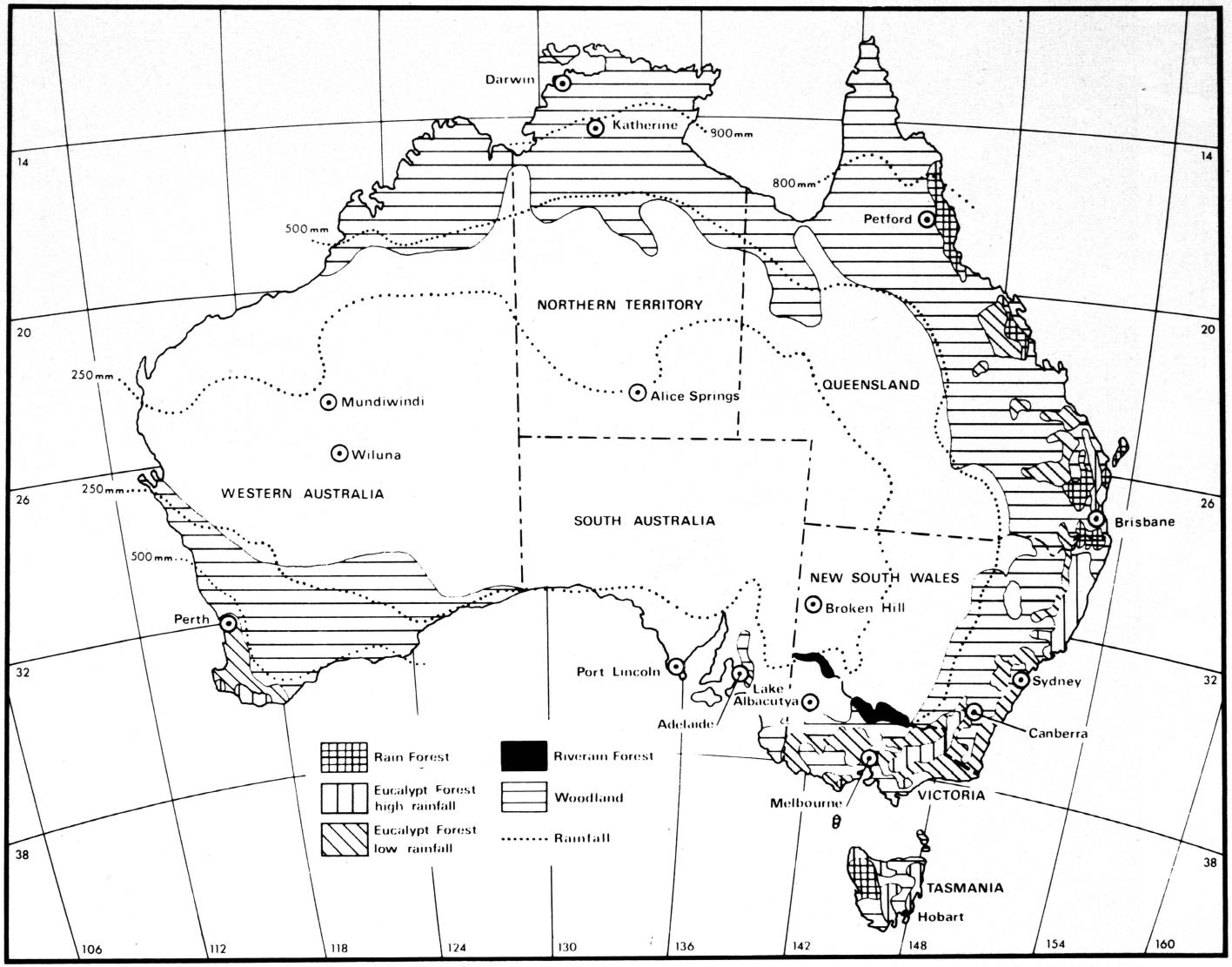
Eucalyptus camaldulensis beside the Murray River near Mildura, Victoria, showing the typical branching habit of open-grown trees and the mottled grey bark of the southern form of the species. (Australian Information Service photograph.)



An eight year old provenance trial of Eucalyptus camaldulensis at Afaka, near Kaduna, Nigeria, showing the much greater growth of the Petford, Queensland, provenance (left) compared with the adjacent plot of the Lake Albacutya, Victoria, provenance (right). Similar results have been obtained in several trials in tropical, summer rainfall areas. In Mediterranean, winter rainfall areas the situation is reversed - the Lake Albacutya provenance is greatly superior to Petford.



The white bark of the northern form of Eucalyptus camaldulensis looks quite different from the mottling of soft grey, green, brown and yellow shades of the bark of the southern form. These trees were growing in a desert watercourse in the Macdonnel Ranges, Northern Territory. (C.P. Mountford photograph.)


Darwin
Katherine
900mm
800mm
500mm
Petford
NORTHERN TERRITORY
QUEENSLAND
250mm
Mundiwindi
Alice Springs
Wiluna
WESTERN AUSTRALIA
250mm
SOUTH AUSTRALIA
Brisbane
500mm
NEW SOUTH WALES
Broken Hill
Perth
Port Lincoln
Lake Albacutya
Sydney
Adelaide
Canberra
Melbourne
VICTORIA
TASMANIA
Hobart
Rain Forest
Eucalypt Forest high rainfall
Eucalypt Forest low rainfall
Riverain Forest
Woodland
Rainfall
14
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32
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106
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1. ANDREW, I.A. (1972). The application of multivariate statistical techniques to the analysis of variation within and between fast growing tropical tree species. M.Sc. thesis, Department of Forestry, University of Oxford. 154 pp. Subjects 2, 7, 8, 15.

   FROM AUTHOR'S SUMMARY. "Variation in 13 leaf morphological traits, among and between 16 populations of Eucalyptus camaldulensis Dehn. grown in a provenance trial in Rhodesia, was investigated. The two most important characteristics of inter-provenance variation were leaf area and absolute width, and leaf length and relative narrowness. Four ecotypes were discerned, differences among which were correlated with environmental variation among the source locations in Australia."

   (See also Andrew, 1973.)

2. ANDREW, I.A. (1973). Variation in leaf morphology among provenances of Eucalyptus camaldulensis Dehn. grown in Rhodesia. Rhodesian Journal of Agricultural Research 11, 155-169 (En, 16 ref.) Subjects 2, 7, 8, 15.

   AUTHOR'S SUMMARY. "Thirteen morphological characters were examined in juvenile leaves of 16 provenances of Eucalyptus camaldulensis Dehn. grown in a replicated trial in Rhodesia. Variation among and within provenances was analysed by means of multivariate statistical techniques and the two most important components of inter-provenance variation were found to be leaf area and absolute width, and leaf length and relative narrowness. Four ecotypes were discerned, differences among which were correlated with environmental variation among the source locations in Australia."

   The aim of the analyses was to classify the provenances by juvenile leaf morphology and to examine whether variation between provenances in foliar characteristics was related to geo-climatic factors.

   The detailed measurements and analytical techniques of multivariate analysis demonstrated variation between the provenances and that they could "probably" be grouped into four "ecotypes". The author found the main patterns of variation in foliar characteristics in the Rhodesian trial to be "in accord with" those observed in the species in its natural range and in plantations elsewhere.

   Andrew suggested three "ecotypes" among four widely separated provenances from northern Australia, but observed clinal variation among the eleven provenances from the Murray River basin of south eastern Australia.

(Many more provenances would need to be examined before agreeing with the implication that the pattern of variation in this species is discontinuous (ecotypic) in the inadequately sampled northern area, and continuous (clinal) in the better sampled southeastern area. However, Andrew's use of sophisticated analytical techniques will be a useful guide to others considering procedures for analysis of genetic variation in forest trees.)

3. ANON. (1973). Eucalyptus camaldulensis Dehnh. in the Mediterranean and Africa. Forest Genetic Resources Information No. 2, FAO Forestry Occasional Paper 1973/2, 41-42 (En) FA 36, 1327. Subjects 2, 7, 8, 11, 12, 13, 14.

The article summarises the progress on the FAO Mediterranean project on E. camaldulensis provenance research coordinated by J.-F. Lacaze. (See Also Lacaze, 1970.) "The clear and consistent evidence of the superior survival and/or growth of certain provenances" is a notable achievement and shows that these provenances are the best among the 30 tested in young trials on 24 sites. However, no comment is offered on the limitations of the material tested : there may be even better provenances among the many other Australian populations not sampled and tested.

The establishment of seed stands of the best provenances was recommended using seeds of the original samples as a basis for mass producing seeds. In the short term this practice will probably produce better seed than previously available for large plantations in many countries. However, the writer did not mention the long term disadvantages of the very restricted genetic base of ten mother trees in the original samples. Similarly the 40 plus-trees propagated for a clonal seed orchard of the Lake Albacutya provenance were also derived from only ten mother trees in the original Australian collection.

4. AWE, J.O. (1973). Provenance variation in Eucalyptus camaldulensis Dehn. M.Sc. thesis, Dept. of Forestry, Australian National University. 259 pp. (En, 87 ref.) Subjects 1, 2, 6, 7, 8, 13, 15.

FROM AUTHOR'S SUMMARY. "Seedlots from six provenances of E. camaldulensis were used to determine the effects of a range of temperature regimes on the germination behaviour of the species. At the same period (stage) of seed germination, there was a marked north-south division at the temperature regime of 18/13°C - the seeds of the southern provenances germinated rapidly but little or no germination was recorded for the seeds of the northern provenances.

Progenies of E. camaldulensis from several provenances were grown under a range of environmental conditions - three temperature and three photoperiod regimes. Temperature had significant effects on growth of E. camaldulensis, and the optimum temperature for many of the seedling growth characteristics and dry weight productions was the medium temperature (27/22°C). In these studies there were marked differences in seedling characteristics between provenances, suggesting a positive natural selection in northern regions of individuals with adaptation to harsher environmental conditions. There were some differences between provenances in their reaction to variation in photoperiod. The provenances differed in seedling height growth at 12- and 14-hour photoperiod, for example, at these photoperiods Todd River provenances had the greater height growth and Katherine provenance the least. However, it was demonstrated that in the case of Todd River provenance, seedlings responded in height, but not in dry matter production."

The thesis contains an account of physiological studies of variation in seed germination, seedling growth, frost resistance (see Awe and Shepherd, 1975), and root development from nine provenances of E. camaldulensis.

5. AWE, J.O.; SHEPHERD, K.R. (1975). Provenance variation in frost resistance of Eucalyptus camaldulensis Dehn. Australian Forestry 38 (1), 26-33. (En, 16 ref.) FA 37 (in press) Subjects 7, 13.

The frost resistance of four widely separated provenances was compared using seedlings in a well-controlled artificial frost chamber. The experiments used hardened seedlings to simulate the effect of frost in winter, and unhardened seedlings to simulate unseasonal spring and summer frost.

As expected from other experiments the two southern provenances were more resistant to frost than the northern provenances when the seedlings had been hardened by two weeks of low night temperatures. However, it was the northern provenances which were more resistant when the seedlings were unhardened. "The results suggest some complex variations in frost sensitivity have arisen in the species in response to natural selection".

(The ecological implications of greater frost resistance of the unhardened northern provenances would require frost experiments on more provenances and detailed records of the frequency of unseasonal frosts throughout the range of the species.)

6. BANKS, J.C.G.; HILLIS, W.E. (1967). A survey of the anthocyanins in Eucalyptus camaldulensis. Australian Forest Research 3(1), 50-53 (En, 5 ref.) FA 30, 136. Subjects 1, 2, 7, 8.

AUTHORS' SUMMARY. "A chromatographic examination was made of the anthocyanins in the red seedlings leaves of E. camaldulensis. Three anthocyanins were observed, (a) cyanin (cyanidin 3, 5-diglucoside), (b) chrysanthemin (cyanidin 3-glucoside) and (c) a compound resembling pelargonin. A correlation was found between the anthocyanin present and seed origin. This was most evident in the river systems of the central coast of Western Australia where cyanin was the only anthocyanin present except in the De Grey river where there is an unique occurrence of 'pelargonin'. In the Murray river system and in South Australia chrysanthemin predominates. No correlation was evident in the remaining range of the species examined."

This introductory note is based on study of glasshouse seedlings of 30 provenances from throughout Australia. The examination of only one seedling per provenance for all but five provenances was justified by the statement that "exploratory tests have shown that variation within populations of E. camaldulensis is limited." However, the results present for one of the five provenances shows considerable difference between two frosted seedlings in concentration of two anthocyanins. The possibility that the difference between "provenances" was due not to genetic differences but to the varying pretreatments of the seedlings, frost or salinity or "natural" conditions, was not adequately resolved.

More detailed information supporting "geographic ecotypes" was provided in a later paper (Banks and Hillis, 1969).

7. BANKS, J.C.G.; HILLIS, W.E. (1969). The characterization of populations of Eucalyptus camaldulensis by chemical features. Australian Journal of Botany 17, 133-146 (En, 15 ref.) FA 31, 243. Subjects 1, 2, 3, 7, 8.

AUTHORS' SUMMARY (extracts). "Samples of E. camaldulensis were collected throughout its natural habitat. Mature leaves from 103 and seeds from 62 localities were examined as well as seedling leaves of 53 progenies. The 47 polyphenols from the different acid-hydrolysed tissues were characterized chromatographically and a few identified .... The mature leaves yielded the most significant data. The seeds and seedling leaves provided useful supporting evidence."

The presence or absence of eight compounds allowed the

samples to be split into six groups using computer dendrograms for groupings. In four of the groups all samples originated within discrete geographical boundaries. On the basis of these studies the authors concluded that "E. camaldulensis is made up of a number of more or less isolated populations" which they described as ecotypes or "chemo-ecotypes". Although some of the boundaries were not easily defined, the populations in extreme parts of the continent were found to have major differences in polyphenol composition, for example the northwest and the southeast of Australia.

"The dominant feature ..... was the grouping ..... into a northern and a southern division, and within each division a further grouping into geographical regions or phytochemical provenances, which agree with the drainage system pattern." The four which could be readily defined are Kimberley, Pacific, South-west and South-east. The other two subdivisions were defined more arbitrarily, perhaps intuitively.

The authors found some evidence that the variety "camaldulensis" (Blakely, 1934) was distinguishable from the other four varieties by polyphenols, but the evidence was not sufficient for retention and use of these taxa.

"It is unfortunate that this major paper has not been followed by a proposed complementary study on morphological variation in E. camaldulensis in Australia.)

8. BARRETT, R.L.; CARTER, D.T. (1970). Eucalyptus camaldulensis provenance trials in Rhodesia (Part 1, early results). Rhodesia Forestry Commission, Research Bulletin No. 2 (Part 1) 50 pp. (En, 16 ref.) FA 33, 4280. Subjects 2, 5, 6, 7, 8, 13, 14, 15.

The most comprehensive report yet available on a series of E. camaldulensis provenance trials in one country. Although the results are only at 2½ years and therefore tentative, the thorough treatment of the background of the trials is particularly valuable. In addition to maps and environmental information on the Rhodesian planting sites and Australian collections sites, there is a condensed version of the field collection notes made by Egon Larsen and others. Experimental design, nursery, planting and tending practices and tabulated results are given in full.

The objective of the trials was to find a straighter-stemmed form of E. camaldulensis which would be at least as fast growing and tolerant of adverse conditions as the form already used in Rhodesia.

In 1966 36 provenances were planted in 3 replicated and 2

unreplicated trials on a range of sites. The Petford, Queensland, provenance was superior in stem straightness and growth rate to all other provenances and had satisfactory frost resistance. The existence of a northern and southern type in the species was confirmed.

Flowering was observed in all provenances at 2½ years. Queensland and Northern Territory provenances averaged 14% of trees in flower compared with only 3% in southern provenances.

The main conclusion from these early results is that Rhodesia has not been growing the best provenance of E. camaldulensis, and that seed should be obtained from stands in certain areas of northern Australia, particularly near Petford, to provide well-adapted, broadly based material for genetically improved plantations.

(Although rather long, the report would repay detailed study by the serious student of genetic variation in E. camaldulensis and other trees. In addition to the account of establishment and results, the authors comment on the adequacy of sampling in seed collection and measurements. Their reports of later results will be of great interest.)

9. BARRETT, R.L.; MULLIN, L.J. (1968). A review of introductions of forest trees in Rhodesia. Rhodesia Forestry Commission, Research Bulletin No. 1, 227 pp. (En, 102 ref.) FA 30, 2133. Subject 7.

Includes an account of growth data on 18 plots of E. camaldulensis aged 1 to 6 years in species trials on several sites in Rhodesia. Some unreplicated comparisons of provenances are included.

10. BLAKE, S.T. (1953). Botanical contributions of the Northern Australia Regional Survey. I. Studies on Northern Australian species of Eucalyptus. Australian Journal of Botany 1, 185-352 (En, 24 ref.) FA 15, 1143. Subjects 1, 2, 3.

Blake considered that the five varieties of E. camaldulensis proposed by Blakely (1934) "pass into one another by imperceptible gradations" and he could not refer any of his Northern Australian specimens to any of the varieties. (Blake's distribution map does not adequately represent the occurrence in Western Australia.)

11. BLAKELY, W.F. (1934). A Key to the Eucalypts. The Worker Trustees, Sydney. (Third edition 1965, Forestry and Timber Bureau, Canberra). 339 pp. (En, many ref.) FA 31, 304. Subjects 1, 2, 5.

Blakely was the first botanist of the twentieth century to use E. camaldulensis Dehnh. in a publication in preference to E. rostrata Schlecht. He acknowledged considerable variation in morphological characters and listed five new varieties, acuminata, brevirostris, obtusa, pendula, and subcinerea. Some of Blakely's hybrids were considered by Pryor and Johnson (1971) to be hybrids with E. camaldulensis - E. x algeriensis, E. mcintyrensis, E. oxypoma, E. x studleyensis, and E. x trabutii.

12. BODEN, R.W. (1964). Hybridisation in Eucalyptus. Indian Forester 90, 581-586 (En, 7 ref.) FA 26, 1786. Subjects 1, 10, 14.

Boden examined stands of the "Mysore hybrid" in Madras and Mysore States and found that while there was probably a degree of hybridisation with E. camaldulensis and other species, the dominant trees had the phenotype of E. tereticornis. He considered that collection of seed from the larger trees "May eventually result in almost pure stands of E. tereticornis". (See also Pryor, 1973.)

13. BOHRA, R.K.; KAUL, R.N.; DAS, M.N. (1970). Provenance trials on Eucalyptus camaldulensis in Western Rajasthan. Journal of the Indian Society of Agricultural Statistics 22(1), 91-92 (En) FA 35, 6005. Subjects 7, 15.

An abstract of a conference paper on the analysis of the early results of a trial of 33 provenances of E. camaldulensis. The percentage survival and diameter of young trees was best for the seed lots from dry inland areas of Australia where climatic conditions are most similar to Western Rajasthan. The statistical analyses included dividing the 33 provenances into groups and then testing for group to group variation.

14. BURLEY, J.; BURROWS, P.M.; COOLING, E.N.G. (1966). Three applications of diallel patterns to tree breeding in Zambia. Proceedings of the Sixth World Forestry Congress, Madrid vol. 2, 1665-1671 (En, 36 ref.) Subjects 7, 8, 10, 15.

One of the applications proposed for diallel crossing patterns was a detailed plan to make interspecific hybrids of

four species of Eucalyptus, and to obtain estimates of genetic parameters.

A diallel pattern of 490 crosses was recommended. In each of seven Zambian populations 20 superior trees were selected and grafted and 10 crosses were to be made for each of the 49 possible combinations of the populations. The design for field planting and procedures for statistical analysis were given. Estimates of the average degree of dominance within species and in the hybrids would be obtained.

The estimates of genetic variances would be valuable for planning future tree breeding. In addition the diallel crossing sought new combinations of the high growth rate and straight stems of E. grandis, and to a lesser extent E. saligna, with the hardiness under adverse conditions of E. camaldulensis and E. tereticornis. However, the exact details of the original source of the seven populations in Australia was not known and there was some doubt about the purity of the species.

(Another approach to obtaining a superior type of tree would have been to make provenance trials and look for a natural provenance of one of the species with the desired combination of characteristics. It is usually easier to obtain large quantities of seed of a superior provenance than of a particular, outstanding cross.)

15. BURLEY, J.; WOOD, P.J.; HANS, A.S. (1971). Variation in leaf characteristics among provenances of Eucalyptus camaldulensis Dehn. grown in Zambia. Australian Journal of Botany 19, 237-249 (En, 4 ref.) FA 33, 3842. Subjects 7, 15.

AUTHORS' SUMMARY. "Eight morphological characters of leaves were examined in 2-year-old trees of 25 provenances of Eucalyptus camaldulensis Dehn. grown in a replicated trial in Zambia. Provenances differed significantly in leaf length and width, base angle, and oil gland density but significant effects were attributed to trees within provenances. Leaf curvature also varied between provenances, trees and branches. The tip angle and the number of veins did not vary significantly. Leaf length and oil gland density were related to maximum temperature at seed source rather than to latitude but the reverse occurred for leaf width. Significant amounts of variation were explained by a linear combination of temperature and latitude but not by longitude, altitude, or rainfall. Information on seven traits was combined in principal component analysis in which the first component (a measure of leaf shape) accounted for 36% of total observed variation while

the second (weighted largely on leaf length) accounted for 26%.

Mapping of both univariate and multivariate results indicated that there are two major ecotypes and gave some evidence of clinal and ecotypic variation within them. The conclusions support those of other workers both in natural populations in Australia and in exotic populations elsewhere."

The paper reports a study of leaf characters which aimed "to determine more precisely the extent and pattern of differentiation among populations". The authors expected similar patterns of variation would be found in quantitative characters of greater economic importance, such as growth rate, which would take several years to assess. A secondary objective of the study appears to have been to explore the application of multivariate analysis to provenance research.

(A reprint of the article includes an errata slip and several other corrections which dispense with the need for the authors' explanations (p. 248) of "some striking anomalies" in the cluster analysis.)

16. CHUDNOFF, M.; TISCHLER, K. (1963). Fibre morphology of Eucalyptus camaldulensis Dehn. and the relation to wood anatomy to certain physical and mechanical properties. La-Yaaran supplement 1, 1-23 (En, 30 ref.) FA 26, 1164. Subject 8, 14.

An anatomical study of wood of fast grown E. camaldulensis revealed differences in specific gravity which were not related to growth rate. The author considered the variation was probably due to hereditary factors and that vegetative propagation would yield good quality boards with little or no waste due to drying effects.

17. CLAUDOT, J. (1963). (Contribution of Morocco on the genetic improvement of introduced eucalypts in the Mediterranean Basin). Proceedings of the World Consultation on Forest Genetics and Tree Improvement, Stockholm Vol. 1, FAO/ FORGEN 63 - 4/9, 1-15 (Fr, 27 ref.) FA 25, 183. Subjects 5, 8, 10, 11, 12.

Plantations of E. camaldulensis in Morocco had a great variety of forms with respect to habit of stem and branches and the characteristics of flower buds and fruits. Some of the variation appeared to be due to hybridisation with E. rudis and

E. tereticornis. It was in such material that selection of outstanding individual trees was commenced using the criteria of (a) height, (b) straightness, (c) branching and self pruning, (d) freedom from felling shakes and suitability for peeling.

Three trees aged about 30 years were selected for all four categories, and some other trees at a lower intensity. The first trial of six open pollinated progenies was planted in 1957 and another with 16 progenies in 1959. The author reported that the general form was improved, for example the percentage of trees with forks above 1.3 m was reduced to 10 to 14% in the selected progeny compared with 20 to 23% in the controls. It is difficult for the reader to assess the value to the reported 20% gain in basal area and 14% gain in volume at four years as there are no details of plot size, replication or statistical analyses, and it appears that the soil moisture conditions of the experimental planting sites were highly variable.

Experience with self pollination of two trees was reported. In the first case 27 plants were obtained by hand pollination of a grafted tree and 19 survived to the third year after planting. They had much greater uniformity of habit than 17 seedlings from open pollination of the same tree, but only half the average height. In the second case two trials were planted in 1961 from seedlings raised from open pollinated seed collected in a grafted seed orchard composed of a single clone (see Franclet, 1957). The selfed plants were more uniform than a "routine" control, although some individuals were exceptionally tall.

(Claudot's paper is one of the few publications on E. camaldulensis containing information on the consequences of selection within a planted population.)

18. CLELAND, J.B. (1956). Eucalyptus camaldulensis and E. longirostris (rostrata). The Victorian Naturalist 73, 10-14 (En, 10 ref.) Subjects 1, 7, 8.

In a diffuse account of the naming of E. camaldulensis Cleland regretted, 20 years too late, the change from the familiar name E. rostrata. His regrets were mainly on the ground that the Type specimen in the Vienna Herbarium did not represent the common southern form of the species. He observed that the opercula of the flower buds of the Vienna specimen were conico-acuminate, whereas most southern trees had beaked (rostrate) opercula. He considered the Type specimen may have been a minor mutant or perhaps a hybrid. However, even Cleland regarded the variety name he proposed for southern river Red Gum, "E. camaldulensis var. longirostris", "would be carrying things to an extreme".

In gathering evidence for his conclusion that "it is a

pity the name (camaldulensis) was ever revived" Cleland seems to have overlooked the obvious fact that no one specimen can represent so variable a species. R.H. Anderson and J.H. Maiden (quoted by Cleland), Osborn (1937), and others had no doubt that the Vienna specimen was river red gum.

Cleland quoted Prof. D.G. Catcheside's opinion that the variation in shape of buds and juvenile leaves in E. camaldulensis "parallels in a striking way the clinal variation seen in species which have been subjected to experimental analysis (Plantago maritima and Achillea millefolium)".

Cleland considered that the seeds for Count Camaldoli's trees of E. camaldulensis planted near Naples in 1822 were probably collected near Condobolin on the Lachlan River, New South Wales, by Charles Fraser a member of Alan Cunningham's 1817 expedition.

19. CONTARDI, H.G. (1954). (Variability in Eucalyptus rostrata). Revista de la Facultad de Ciencias Agrarias, Universidad Nacional de Cuyo, Mendoza 4(1), 47 (Es) FA 18, 3721. Subjects 8, 14.

A short note on the great variation in survival and growth of E. camaldulensis in a plantation in San Juan province, Argentina. The variable survival was attributed to genetic variation in resistance to drought, frost and high osmotic pressure (low soil water potential). Some trees were growing well on "patches of white saltpetre". Progeny tests would be required to test whether the variation was genetic.

20. DEHNHARDT, F. (1832). (Catalogue of the Plants in the Camaldoli Garden.) 2nd ed. (La) Subject 1.

Contains the original Latin description of E. camaldulensis Dehnh. on page 20.

21. DESTREMEAUX, D.-X.; JOLLY, H.; KORBA, M. (1973). (The results of a comparative trial of provenances of Eucalyptus camaldulensis at Sidi Slimane.) Annales de la Recherche Forestiere au Maroc 13, 121-154 (Fr) FA 35, 6004. Subjects 2, 7, 8, 11, 14, 15.

A long paper reporting the 5-year assessment of one provenance trial in Morocco. The trial had 25 provenances in 6 replications of 36-tree plots in a balanced lattice design. In

five provenances individual progenies were kept separate.

Lake Albacutya was clearly the outstanding provenance for volume, but only average for stem straightness. In common with other provenances of the Rivery Murray System it had persistent bark.

The results of two-year-old trials in Portugal, Greece and Italy are reproduced from Lacaze (1970) without comment in the text. The six charts all show the greatly superior diameter growth of the Lake Albacutya provenance.

The method of raising seedlings, site preparation and the date of planting are omitted. No statistical analyses are included and there is no conclusion or summary. A great deal of detail is included in tables and graphs, much of it unnecessary. For example, the individual plot means are given for all characters and a description of the soil of each of the 156 plots.

Selections were made of the largest tree in each of the six plots of the Lake Albacutya provenance. These trees were grafted in 1973 to contribute to a seed orchard. Grafts of another 30 selected trees were also available from similar selections in Italy and Tunisia.

A progeny trial of open pollinated seed of 22 "plus" trees selected by Franclet and Pryor was planted in 1971. No results are given. It appears that all the trees selected for the seed orchards and tested in the progeny test were derived from the ten mother trees of Egon Larsen's 1964 collection at Lake Albacutya. This is too small a genetic base for the future plantations of the whole Mediterranean Basin.

22. DEXTER, B.D. (1967). Flooding and regeneration of river red gum, Eucalyptus camaldulensis Dehn. (Paper, 9th Commonwealth Forestry Conference, New Delhi, 1968.) Bulletin, Forests Commission, Victoria No. 20, 35 pp (En, 16 ref.) FA 29, 3676. Subjects 2, 13.

An account of the development of methods to overcome the previously poor regeneration of E. camaldulensis after utilization of natural forests on the River Murray flood plains. Considerable information had been accumulated from research on conditions for seed germination in the field and laboratory. The author emphasises the importance of periodic flooding and the effects of grazing by cattle and other animals.

23. DIMITRI, M.J.; ALBERTI, F.R. (1949). (A new horticultural variety of Eucalyptus camaldulensis and polymorphism observed in the species). Lilloa 17, 5-10. (Es) Subjects 8, 9, 14.

A new horticultural variety aureo-marginata with golden-edged leaves, is proposed and illustrated. Many herbarium specimens from Argentine plantations are listed in support of the new variety, and the polymorphism of buds and fruits which the authors have observed. (Progeny tests would be required to test whether the variation was genetic.)

24. DOULL, K. (1973). Bees and their role in pollination. Australian Plants 7, 223-236 (En) Subject 5.

The paper includes an account of the foraging behaviour of European honeybees and some observations of the pollination of eucalypts. Honeybees were observed to gather E. camaldulensis pollen at the rate of 12 to 15 mg or 2½ to 3 million grains per load.

The author points out that prior to the introduction of the European honeybee in 1826 the bees which pollinated eucalypts in Australia were mainly small solitary species, not colonial. He has observed one species of solitary bee whose life cycle is apparently adapted to coincide with the flowering cycle of the eucalypt in which it nests.

25. F.A.O. (1955). Eucalypts for Planting. FAO Forestry and Forest Products Studies No. 11, 403 pp. (Editions in En, Fr, Es, numerous ref.) FA 17, 1289. Subjects 1, 2, 10, 13, 14.

A considerable amount of information was collated in this book concerning the botanical, silvicultural and technological characteristics of E. camaldulensis. In 1955 there was little information available on genetic variation in the species, apart from the five varieties and two possible hybrids recorded by Blakely. However the author was clearly aware of the potential importance of genetic variation as the concluding sentence of his review of the species indicated: "The enormous polymorphism of this species encourages close study in order to select the strains which offer optimum technical and commercial advantages in each country."

26. F.A.O. (1974). Tree planting practices in the African savannas. Forestry Development Paper No. 19. F.A.O. Rome. 185 pp. (En, 190 ref.) FA 37 (in press). Subjects 2, 7, 10, 14.

This valuable book, largely the work of the late Prof. M.V. Laurie of Oxford, contains the most comprehensive and up-to-date account of the forestry context in which the genetic resources of E. camaldulensis are being used in tropical Africa. A summary inside the cover states "While the manual does not pretend to be exhaustive, it is hoped that it will provide some practical guidance to those attempting savanna afforestation as well as stimulating research in the study and development of savanna resources." Much of the detailed information on afforestation techniques would be applicable in other parts of the world in environments other than savannas.

There are sections on geographic background to afforestation, choice of site and species, afforestation methods, and economic aspects. In the index E. camaldulensis is referred to more frequently than any other species.

The E. camaldulensis provenances from Katherine, Petford and Lake Albacutya were regarded as outstanding in young trials in northern Nigeria. The provenance trials in other African countries had so far provided less information than those in Nigeria.

27. FRANCLET, A. (1957). (Initial work on genetic improvement of eucalypts). Annales de la Recherche Forestier au Maroc 4(1), 63-86 (Fr, 8 ref.) FA 19, 2737. Subjects 5, 10, 11, 12.

Out of 4000 30-year-old E. camaldulensis trees two trees were selected for volume, form, absence of felling shakes and suitability for peeling. Seeds and coppice shoots were collected to commence a programme of genetic improvement which was described in detail and illustrated by a diagram.

The first seed orchard was established as a pilot project in 1956 with a single clone. It was intended to have several such orchards with only one clone each, partly to investigate the effects of selfing which would reveal the clones derived from interspecific crossing. Several clones producing vigorous homogeneous progeny were to constitute future clonal orchards.

Franclet reported the successful artificial crossing of E. camaldulensis and E. viminalis and other species, and described the pollination technique used at heights up to 12 m above the ground.

Much of the paper reports the development of techniques for striking cuttings of E. camaldulensis resulting in 24% success from more than 3000 attempts.

28. GEMIGNANI, G. (1968). (Preliminary observations on Australian provenances of Eucalyptus camaldulensis.) Document, 3rd Session Mediterranean Forestry Research Committee, Sub-Commission on Mediterranean Forestry Problems, Rome 1968, FAO/FO:SCM/FR/68-8A, 1-8 (Fr) Subject 7.

Two provenance trials of E. camaldulensis were established in central and southern Italy in 1967 and one in Sicily in 1968. Each contained 24 seed lots planted as 25-tree plots in randomised complete blocks replicated six times. Thirteen of the seed lots were composed of the bulked seed from several trees and the others were the progeny of individual trees of two provenances.

After the first year the rankings of the provenances at all three localities were similar. Lake Albacutya, Victoria, had the best growth and form followed by Port Lincoln, South Australia. The northern provenances had poor form on all sites and distinctly inferior resistance to frost at the most northerly site (43^{o}N).

(The two-year results reported by Lacaze (1970) for these trials showed the growth of the Lake Albacutya provenance to be even more outstanding than in the first year.)

29. GIORDANO, E. (1961). Problems of seed provenance in the Mediterranean (Italy). Second World Eucalyptus Conference, Sao Paulo, Report and Documents vol. 1, 458-467 (En) FA 26, 422. Subject 7.

E. camaldulensis was described as one of the most adaptable species introduced into Italy, but with the drawback of being very irregular in habit and growth. Three Australian and five other provenances were compared in trials aged five years on four sites. The consistent superiority in habit and growth of some of the provenances encouraged planning for further trials of more provenances.

30. GIORDANO, E. (1962). (Observations on some eucalypt hybrids in the Foggia District.) Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 5, 7-12 (It, 4 ref.) FA 24, 174. Subject 10.

Three suspected hybrid trees were investigated by measuring segregation of morphological characters in their seedling progeny. On this basis the three trees were considered to be spontaneous natural F_1 hybrids of E. maidenii x E. camaldulensis. Another segregating progeny was thought to result from backcrossing a E. viminalis x E. camaldulensis with E. camaldulensis.

31. GIORDANO, E. (1967). Preliminary observations on the rooting capacity of cuttings of 20 provenances of Eucalyptus camaldulensis. F.A.O. Symposium on Man-Made Forests, Canberra, Documents vol. 3, 1509-1518. (En, 5 ref.) FA 30, 2179. Subject 7.

The rooting ability of cuttings of six month old seedlings of 20 provenances was compared in a greenhouse at 15° to 20°C. From each provenance 35 seedlings were divided into basal, middle and apical sections which were set in coarse sand. In general, rooting was twice as good from apical cuttings (65%) as from middle and basal cuttings (32%).

The seedlings of the Katherine provenance and two other Northern Territory provenances rooted poorly. The author pointed out that the poorer rooting of the northern provenances may not have been due to an inherently inferior capacity to form roots but due to the rooting environment being too cool for them. Resolution of this question would require rooting experiments at a range of temperatures.

32. GIORDANO, E. (1974). (Observations on the origin of Eucalyptus camaldulensis introduced in Italy.) Informatore Botanico Italiano 6(1), 85-93. FA 37 (in press). Subjects 1, 2, 3, 7, 13, 14.

Reviews the phylogeny and the morphological and chemical variability of E. camaldulensis in Australia, and describes trials of 24 provenances on three sites in Italy. Data are tabulated on the height and girth increment 5 years after planting. Greenhouse experiments on the rooting of cuttings of 17 of the provenances are also reported. The results show differences in silvicultural characters between provenances from northern Australia and those from New South Wales, Victoria and South Australia, similar to the differences in leaf chemistry reported by Banks and Hillis (cf. FA 31, 243). Implications for the choice of provenances suited to Italian conditions are briefly considered.

33. GROSE, R.J.; ZIMMER, W.J. (1958). Some laboratory germination responses of the seeds of River Red Gum, Eucalyptus camaldulensis Dehn. syn. Eucalyptus rostrata Schlecht. Australian Journal of Botany 6, 129-153 (En, 3 ref.) FA 20, 1724. Subjects 2, 6, 7, 8, 13.

No relation was found between environment of collection site in Victoria and optimum conditions for germination of E. camaldulensis seeds. There was some evidence of variation in germination response between individual trees. (See Awe, 1974, for variation in germination response for more widely separated collection sites.)

34. GRUNWALD, C.; KARSCHON, R. (1974a). Effect of seed origin on coppice regeneration in Eucalyptus camaldulensis Dehn. Silvae Genetica 23, 141-144 (En, 9 ref.) FA 36, 4649. Subjects 7, 14.

AUTHORS' SUMMARY. "Tree growth of Eucalyptus camaldulensis varied with the origin of the seed, thereby determining the amount and rate of coppice regeneration after cutting.

The number of coppice shoots, height of the tallest shoot and biomass were directly related to tree height and girth before coppice cutting".

The paper is mainly about the development of coppice and the strong correlation of coppice development to the size of tree before cutting. It is tempting to conclude that any fast-growing E. camaldulensis tree will coppice well, since the four provenances studied were from widely separated parts of Australia. However, further research would be required to be quite sure there are no fast-growing provenances which coppice poorly.

35. GRUNWALD, C.; KARSCHON, R. (1974b). Morphological differences between two populations of Eucalyptus camaldulensis Dehn. from New South Wales. Proceedings, Joint IUFRO Meeting, S.02.04.1-3, Stockholm, 351-354 (En, 4 ref.) FA 37 (in press). Subjects 3, 7.

A short addition to Karshon's hypothesis (Karschon, 1971) on the origin of polymorphism in this widespread species which occurs as linear populations along seasonally dry water courses. The authors suggested that the distinct differences in leaves and buds of two populations (called "progenies") from the Broken Hill area of New South Wales may be due to their different age, the more glaucous population being considered to be older.

(Since the exact origin of the seed collections was not precisely defined as to location or number of trees per stand, and cannot now be authenticated, any evolutionary argument based on this material must be highly speculative.)

36. HAFEEZ, M.; SHEIKH, M.I. (1972). Eucalyptus camaldulensis Dehn. provenance trials in West Pakistan. Pakistan Journal of Forestry 22, 407-416 (En, 5 ref.) FA 34, 6906. Subjects 7, 14, 15.

A report of the first well-designed, replicated provenance trials in Pakistan. The three trials of up to 18 provenances, with 4 replications of 32-tree plots, were irrigated for 6 months each

year.

The authors listed 22 provenances, several of which were apparently composed of mixtures of up to four Australian collections from one area (see Qadri, 1969).

The provenances were ranked for survival, height, diameter and basal area, at six years for the three sites. Statistically significant differences between provenances were reported but, without the actual mean values or least significant differences or range tests it was not clear how oustanding the best provenances were.

Six provenances were stated to have given the best performance and merit introduction on a large scale. The absence of the Petford provenance among the six may indicate that the same provenances will not be best for both irrigated and dry plantations. (See also Qadri, 1969.)

37. HAFEEZ, M.; SHEIKH, M.I. (1973). Eucalyptus camaldulensis provenance trials in West Pakistan at age 6 years. In: Tropical Provenance and Progeny Research and International Cooperation (edited by J. Burley and D.G. Nikles) pp. 284-287. Commonwealth Forestry Institute, Oxford. (En, 5 ref.) FA 36, 3166. Subjects 7, 14, 15.

A short report of the six-year results of three replicated provenance trials of up to 18 provenances of E. camaldulensis. The plots were irrigated for six months each year. (For greater detail see Hafeez and Sheikh, 1972.)

38. HALL, N. (1972a). The Use of Trees and Shrubs in the Dry Country of Australia. Australian Government Publishing Service, Canberra. 558 pp. (En, many ref.) FA 34, 5179. Subjects 2, 13, 14.

An account of the environment of the arid and semi-arid parts of Australia and of the principles and practices of land use, conservation, and tree planting for shade and shelter. As with Kaul (1970) and FAO (1975), the index contains far more references to E. camaldulensis than to any other tree.

39. HALL, N. (1972b). Summary of meteorological data in Australia. Forestry and Timber Bureau, Canberra, Leaflet no. 114, 72 pp. (En, 4 ref.) FA 35, 1187.

40. HALL, N.; JOHNSTON, R.D.; CHIPPENDALE, G.M. (1970). Forest trees of Australia. 3rd edition Australian Government Publishing Service, Canberra. 334 pp. (En, many ref.) FA 32, 2104. Subjects 1, 2.

The descriptions of eucalypts in this book aim to distinguish between species rather than draw attention to variation within species. The entry on E. camaldulensis includes a map of Australia showing the approximate limits to the distribution of the species.

41. HALLAM, N.D.; CHAMBERS, T.C. (1970). The leaf waxes of the genus Eucalyptus L'Heritier. Australian Journal of Botany 18, 335-386 (En, 37 ref.) FA 32, 5435. Subjects 1, 7.

Electron microscope studies of E. camaldulensis from ten populations showed phenotypically different forms. The leaf wax of specimens from the north-west and from an arboretum near Adelaide had a distinctive pattern of tubes and plates, while the specimens from several other parts of the continent had plate wax only.

The authors did not establish whether the observed variation was a response to differing environments in which the specimens were grown or primarily of genetic origin.

42. HILLIS, W.E. (1966). Variation in polyphenol composition within species in Eucalyptus L'Herit. Phytochemistry 5, 541-556 (En, 42 ref.) FA 28, 3282. Subjects 1, 2, 3, 7, 10.

The paper explores the use of variation in polyphenol composition in the study of relationships between species of Eucalyptus. The main purpose was to find out whether the amount of variation within species was small enough to make the assessment of polyphenols useful in taxonomic comparison of species and exploring possible lines of evolution. Samples of mature leaves of one tree of E. camaldulensis from each of 32 localities throughout its range were analysed for polyphenol content. Since there was only a small amount of variation in polyphenols in this widespread and morphologically variable species the polyphenol technique was considered promising for eucalypt chemotaxonomy. Samples with distinctive polyphenols were obtained from several areas, including the Pentland-Mareeba-Hughenden area in north Queensland (see Karschon, 1971a). Hybridisation was the suspected cause of these deviations.

43. HILLIS, W.E. (1972). Properties of eucalypt woods of importance to the pulp and paper industry. Appita 26, 113-122 (En, 48 ref.) FA 35, 564. Subjects 13, 14.

Includes a brief account of variation in density, fibre length, extractives and other wood properties of E. camaldulensis, and among many other eucalypts.

44. JACKSON, J.K. (1974). Silviculture and mensuration. Savanna Forestry Research Station, Nigeria. FAO FO : SF/NIR 16 Technical Report No. 7, 65 pp. (En, 42 ref.) Subjects 7, 10, 14, 15.

The paper is mainly concerned with growth and yield, establishment techniques, and the biogeographical background to the Savanna Region of Nigeria. Provenance trials of E. camaldulensis are summarised and the outstanding results are given as (1) superior growth of the Petford provenance in the Median Guinea and Northern Guinea zones, for example at Afaka at five years the Petford provenance produced more than three times greater volume (16.6 m^3/ha/yr) than the worst provenances; (2) good survival of the Katherine provenance in the dry Northern Sudan zone where all other provenances failed; (3) the general superiority of the northern, summer rainfall areas of Australia as seed sources.

(Jackson gave no information to support the statement "Further trials of Eucalyptus camaldulensis on a rather smaller scale included provenances from the north of Western Australia, and from Queensland. None however proved superior to the Katherine and Petford provenances." Jackson considered that E. camaldulensis was "fairly well covered" by existing provenance trials. Although the trials reported were certainly excellent, several sites and many provenances were not tried. Considerable benefit could be expected by thorough testing of some additional collections from promising regions in Australia. The subject of E. camaldulensis provenance should not be regarded as closed in northern Nigeria.)

45. JACKSON, J.K.; OJO, G.O.A. (1973). Provenance trials of Eucalyptus camaldulensis in the Savanna region of Nigeria. Federal Department of Forest Research, Nigeria; Savanna Forestry Research Station, Research Paper No. 14, 22 pp. (En, 17 ref.) FA 35, 4330. Subjects 7, 14, 15.

AUTHORS' SUMMARY. "Provenance trials of Eucalyptus camaldulensis were planted at seven sites in Nigeria in 1967. There were considerable and significant differences

in the growth of the various provenances. For the Northern Guinea Zone the highest yields were obtained from the Petford provenance, followed by those from Bullock Creek and Katherine, the latter being preferable as its form is better. On the Jos Plateau the Petford provenance was not planted, and Bullock Creek and Katherine were the best. On a very poor site in the Sudan Zone the Katherine provenance was the only one to survive satisfactorily. Under temporary irrigation near Lake Chad several provenances produced high yields, but growth varied a great deal on different parts of the experimental area.

Except under irrigation, provenances from the northern parts of Australia, with summer rainfall, performed much better than those from southern parts, with winter rainfall. The yields of the best provenances were up to three times as large as those of the worst, and it is clear that growing trees of suitable provenances is one of the simplest and most effective means of increasing productivity in plantations."

This detailed and comprehensive report of well-designed and well-conducted provenance trials would be a good model for presentation of results of other trials. The Annual Report 1973-74 of the Savanna Forestry Research Station describes this paper as a "final" report. The 16 provenances were compared on 7 contrasting sites using 25-tree plots replicated 5 times with a balanced lattice design. Tables show the conditions at locations of seed collection and planting. Data are given for survival, height, diameter, basal area, volume, incidence of die back (due to boron deficiency), and a score for stem and branch form up to age five years.

Thinning of one third of the trees from all plots in 1971 made subsequent analysis more difficult but did not obscure the extreme variation between provenances.

46. JACOBS, M.R. (1955). Growth Habits of the Eucalypts. Forestry and Timber Bureau, Canberra. 262 pp. (En, many ref.) FA 18, 2567. Subjects 2, 5, 6, 13.

As the book is concerned with growth and regeneration of natural forests it does not include information on genetic variation. There is less demand for such information for naturally regenerated forests than for plantations where the seed source can be controlled and improved.

47. KAPLAN, J. (1974). The ecology of Eucalyptus camaldulensis Dehn. in Israel. La-Yaaran 24 (1-2), 7, 30-31 (He, En) FA 36, 5493. Subjects 7, 13, 14.

Summary of a Ph.D. thesis, Hebrew University, Jerusalem. An investigation was made of the water relations of two provenances - an Israel provenance originating from cooler and wetter parts of South Australia, and a provenance from a hot, arid inland area at Broken Hill, New South Wales. The Broken Hill plants were more xeromorphic than the local seed source, and continued higher transpiration and growth at low levels of soil moisture. The Broken Hill provenance was found to be superior for afforestation in dry areas of Israel.

48. KARSCHON, R. (1960). Lime tolerance and seed provenance in eucalypts. Document, 4th Session, Working Party on Eucalyptus, FAO Joint Sub-commission on Mediterranean Forestry Problems, Lisbon FAO/SCM/EU/60-9b, 7 pp. (En) FA 22, 239. Subjects 7, 14.

An account of two small elimination trials of 7 provenances of E. camaldulensis on calcareous soils known to induce iron chlorosis in some eucalypts. "Ecotypic variation" was demonstrated at 3 and 5 years when 3 provenances were growing well and 5 had failed.

49. KARSCHON, R. (1966). Inter-provenance variation in Eucalyptus camaldulensis Dehn. (preliminary results). Document, Mediterranean Forestry Research Committee, FAO Joint Sub-Commission on Mediterranean Forestry Problems, Madrid 3 pp. (En). Subjects 2, 7.

50 provenances from Australia were examined for one year in a nursery in Israel. Contrary to previously published observations on the species (e.g. Jacobs, 1955) Karschon found abundant lignotubers in all the Northern Territory and north Queensland provenances, but few or none in provenances from the southeast and southwest of the continent. The considerable variation in leaf size, shape, colour and oil was not clearly related to geographic origin.

50. KARSCHON, R. (1967). Ecotypic variation in Eucalyptus camaldulensis Dehn. National and University Institute of Agriculture, Ilanot; Contributions on Eucalypts in Israel III, 35-53 (En, 19 ref.) FA 28, 5165. Subjects 2, 7, 14, 15.

AUTHOR'S SUMMARY. "Variation according to seed source of selected attributes was investigated in 21 provenances (36 progenies) of Eucalyptus camaldulensis Dehn. (E. rostrata Schlect.) representing most of the natural range of the species in Australia.

Significant differences between provenances were found to occur in all the attributes measured.

Two groups of ecotypes are recognised: (i) A northern group (north of lat. 32°S) with usually high lignotuber frequency, glaucous foliage and high oil gland density; within this group can be distinguished a Western Australian sub-group distinguished by low frequency or absence of lignotubers and a low length-width ratio of the foliage. (ii) A southern group with usually low frequency or lack of lignotubers, green yellow to green-yellow green foliage and low oil gland density."

The two groups of ecotypes which Karschon recognised "for the time being" were based on collections which represented much but not all of the natural range of the species. He advocated study of material from many more places between his 21 provenances before deciding on the relative importance of continuous (clinal) and discontinuous (ecotypic) variation in the species.

Karschon found that several characteristics of E. camaldulensis in Israel plantations corresponded closely with the Angaston provenance from near Adelaide, South Australia.

51. KARSCHON, R. (1968). Variation in frost resistance in ecotypes of Eucalyptus camaldulensis Dehn. Document, Mediterranean Forestry Research Committee, FAO Joint Sub-Commission on Mediterranean Forestry Problems, 3rd Session, Rome 1968. FO : SCM/FR/68-8B, 8 pp. (En, 7 ref.) FA 30, 5255. Subjects 2, 7, 13.

The aim of the study was to determine whether lignotubers were essential in overcoming frost damage to the stem of E. camaldulensis seedlings. Three northern provenances (which the author called "progenies") were used. The plants were hardened by the late winter conditions of the nursery before being subjected to artificial frost.

The lignotuberous provenance from the area with the lowest temperatures, Alice Springs, Northern Territory, was distinctly more resistant to frost than the other two. One of these, Katherine, N.T., had lignotubers and the other, Murchison River, Western Australia, did not. Both were very susceptible to frost. Karschon concluded that lignotuber occurrence does not

affect frost resistance, and that minimum temperature at the original seed source was much more important.

52. KARSCHON, R. (1970). On the probable origin of some Near-Eastern forms of Eucalyptus camaldulensis Dehn. Israel Journal of Agricultural Research 20, 101-105 (En, 10 ref.) FA 32, 204. Subjects 7, 15.

AUTHOR'S SUMMARY. "Available evidence suggests that at least three distinct populations of Eucalyptus camaldulensis Dehn. are represented in the area under review: (i) a population in Palestine and northern Sinai, from the southern parts of Australia, first introduced to Miqwe Yisrael around 1883; (ii) a population in Golan, of unknown origin, introduced from Hauran; (iii) a population in southern Sinai, of apparently tropical origin; possibly introduced from Egypt."

The author examined leaf dimensions, oil glands, and colour of leaves. A multivariate analysis of four variables distinguished three groups among the samples. Evidently Mediterranean E. camaldulensis is from more than one source in Australia.

53. KARSCHON, R. (1971a). Lignotuber occurrence in Eucalyptus camaldulensis Dehn. and its phylogenetic significance. Flora, Jena 160, 495-510 (En, 20 ref.) FA 33, 4076. Subjects 2, 3, 7, 8, 13.

The first objectives of the paper were to examine the transient nature of lignotubers to tree growth. A further objective was to investigate the phylogenetic implications of the occurrence of lignotubers in E. camaldulensis.

Detailed assessments were made on 28 provenances in a nursery for two years and on four provenances in a field trial for four years.

In young plants in the nursery lignotuber frequency and development rate were not related to vigour. In older saplings in the field trial lignotubers did not affect growth rate although they could be seen for longer on slow growing trees.

The highest frequency of lignotubers was for north Queensland seed sources, where all the seedlings of one provenance had lignotubers. However, that seed source from near Hughenden may not be pure E. camaldulensis. Hillis (1966) quoted E. Larsen's suspicion that the E. camaldulensis of this area were "polycrosses with E. tereticornis and possibly E. alba". Northern Territory

provenances had a high frequency of lignotubers, the Murray River system medium to low, and the western part of Western Australia lowest. Karschon suggested that a convenient boundary between the northern and southern divisions of the species (variously described in other papers as groups of ecotypes, types, subspecies, races, groups) would be from about 23½° latitude on the east coast to about 18° on the west coast.

(The importance of this paper is in the author's stimulating ideas for studies of the evolutionary processes which have led to the striking and useful genetic variation found in E. camaldulensis. Its value is not in its conclusions that the apparently discontinuous variation in E. camaldulensis is the result of historical factors, that the Pentland-Hughenden area in North Queensland was probably the centre of origin of the species, nor that migration was to the west and south, nor that some characters should be regarded as primitive and others derived. The evidence is inadequate for such conclusions. The 28 seed collections do not cover the whole range of the species, the discussions about disjunctions are of limited value in the absence of a detailed, accurate map of the distribution of the species, and there is no fossil record beyond the recent period.)

54. KARSCHON, R. (1971b). Low-temperature effects on ecotypes of Eucalyptus camaldulensis Dehn. Leaflet, Division of Forestry, Volcani Institute of Agricultural Research, Ilanot, No. 40, 7 pp. (En, 10 ref.) FA 33, 2175. Subjects 7, 13.

Following mild natural frosts, assessments were made on nine-month-old seedlings of the variation in leaf colour and dry matter content among six provenances (which the author called "progenies"). The seedlings of tropical origin developed much more red colour than those from further south. The tropical seedlings also had a lower dry matter content, a condition related to frost sensitivity by investigators of other plants.

55. KARSCHON, R. (1972a). A summary of ecotypic variation in Eucalyptus camaldulensis Dehn. Oxford University Forestry Society Journal 7 (2), 9-13 (En, 15 ref.) Subjects 3, 7, 13, 14.

A useful summary of studies, mainly by Karschon himself, of the evolution of the species, morphological variation of seedlings, frost and heat resistance, and the results of provenance trials.

56. KARSCHON, R. (1972b). Monographs on eucalypts in Israel : The Katherine, N.T., ecotype of Eucalyptus camaldulensis Dehn. La-Yaaran 22, 36-39 (He) 50-54 (En, 20 ref.) FA 34, 5005. Subjects 2, 7, 13.

A summary of information on the distribution and ecology of E. camaldulensis along the Katherine River, Northern Territory, and its characteristics as an exotic including reference to its superior performance in provenance trials in the tropics.

57. KARSCHON, R. (1973). Growth of Eucalyptus camaldulensis Dehn. in Israel as related to latitude and longitude of seed origin. In: Tropical Provenance and Progeny Research and International Cooperation (edited by J. Burley and D.G. Nikles), pp. 269-274. Commonwealth Forestry Institute, Oxford. (En, 5 ref.) FA 36, 3166. Subjects 7, 15.

An assessment at six years of one of four provenance trials of E. camaldulensis in Israel. Southern provenances grew faster and more crookedly than those from the north of Australia. The author includes some speculation on the effects of photoperiod on growth. There are comprehensive tables of correlation coefficients of growth and seed origin, details of the 36 seed sources, and provenance means with a convenient statistical range test.

58. KARSCHON, R. (1974). The relation of seed origin to growth of Eucalyptus camaldulensis Dehn. in Israel. Israel Journal of Agricultural Research 23 (3-4), 159-173 (En, 24 ref.) FA 36, 7616. Subjects 2, 7, 8, 11, 12, 15.

AUTHOR'S SUMMARY. "Data are presented on the performance at age 5-6 of 43 progenies of Eucalyptus camaldulensis Dehn. from 27 seed sources in Australia on three contrasting sites in Israel. Differences in growth were found between progenies from different seed sources, and between single-tree progenies from the same seed source, indicating both the occurrence of ecotypic variation and the existence of elite trees in natural populations of Australia. The possibility is emphasized of obtaining very marked yield increases by proper choice of seed sources and seed trees. Significant juvenile-mature correlations make it possible to predict the ranking of the progenies at 5-6 years of age from early growth data. Under the subtropical conditions of Israel, yields were positively related, and straightness of bole negatively related, to latitude of seed origin in Australia, while survival was positively related to longitude."

A full and objective report of the design, layout, assessment, analysis and results of a large provenance experiment in Israel. Tables provide details of the locations of seed collection and planting sites, and the size, stem form and survival of trees at 5 or 6 years in 5 plantations.

The outstanding growth of the Lake Albacutya, Victoria, provenance on all sites confirmed its early promise and its low genotype-environment interaction. Some other provenances, however, varied greatly in the ranking of their performance from one site to another, indicating geno-type-environment interaction and edaphic ecotypes. The provenances from Silverton near Broken Hill, New South Wales and Mundiwindi, Western Australia, seemed particularly well suited to calcareous soils. The faster growth of southern provenances was correlated with more crooked stems than northern provenances.

The significant differences reported for growth and stem form between single-tree progenies from one population are of special interest. Progeny trials demonstrating genetic variation within populations of eucalypts are not as common as provenance trials, and yet they are essential for planning selection of plus trees and establishment of seed orchards.

59. KARSCHON, R. BOLOTIN, M. (1964). (Influence of seed source on the rate of growth of Eucalyptus. Document, 1st Session FAO Joint Working Party on Techniques of Forest Extension and Restoration, France, No. FA/FOREX - 64/17, 4 pp. (Fr, 8 ref.) Subjects 1, 7.

A short note on the varying yields of six provenances of E. camaldulensis in unreplicated plots of two species trials in Israel, and the need for attention to provenance in planning afforestation. The provenance from Stephens Creek, near Broken Hill, New South Wales, is referred to as var. subcinerea.

60. KARSCHON, R.; PINCHAS, L. (1969). Leaf temperatures in ecotypes of Eucalyptus camaldulensis Dehn. In: "Festschrift Hans Leibundgut", Beiheft zu den Zeitschriften des Schweizerischen Forstvereins 46, 261-269 (En, 12 ref.) Subjects 7, 13, 15.

The aim of the paper was to assess ecotypic variation in heat resistance of E. camaldulensis through a study of leaf temperature in relation to soil moisture, leaf colour and provenance.

The leaves of irrigated trees in summer were found to be cooler than the surrounding air and leaves of unirrigated trees were warmer. The magnitude of the difference in each case was related to leaf colour and seed origin. Glaucous leaves were cooler than smooth leaves both before and after irrigation. The leaves of trees originating from a place considered to be hotter, Katherine, Northern Territory, were slightly cooler than those from a place considered to be cooler, Alice Springs, N.T. when growing in the same unirrigated stand in Israel.

The authors concluded that glaucousness in E. camaldulensis may be a means of resisting heat and drought as well as resisting frost, and that "differences between ecotypes in the rate of heating of the leaf surface strongly suggest possible differences in heat resistance and the possibility to select heat-resistant provenances according to the climatic data of the seed origin."

(Their assumption that the temperature differential between the leaf and the ambient air is a measure of heat resistance seems to have been based on the observation that leaves of irrigated plants of E. camaldulensis were cooler than those of unirrigated plants. Since the authors did not relate this cooling effect to the ability to survive or grow at high temperatures their conclusions about variation in heat resistance do not appear to be justified, as their next paper (Karschon and Pinchas, 1971) confirmed.)

61. KARSCHON, R.; PINCHAS, L. (1971). Variations in heat resistance of ecotypes of Eucalyptus camaldulensis Dehn. and their significance. Australian Journal of Botany 19, 26-272 (En, 19 ref.) FA 33,5902. Subjects 2, 3, 7, 8, 13.

The authors examined the heat resistance of leaves of 11 provenances in plantations in Israel. They tested the hypothesis that populations of E. camaldulensis originating from the cooler southern parts of Australia might have inadequate heat resistance for successful growth in the hotter parts of the Mediterranean basin.

Their technique was to place intact twigs with several leaves into large thermos flasks at fixed temperatures for 30 minutes and assess the damage three days later.

Variation within populations of about 3°C in lethal temperature was related to waxy glaucousness of leaves. Waxy leaves were more resistant to heat.

The amount of variation in heat resistance between provenances was small. None of the provenances was severely damaged at 47°C and all were killed by 51°C, a small range (4°C) compared

with the quoted range of mean maximum temperatures of the hottest month of the seed origins (13°C).

Apparently all the provenances examined had sufficient heat resistance for successful growth in the Mediterranean basin.

(Their conclusion that "summer heat is apparently not an agent in natural selection" is based on the assumption that "mean maxima are probably related to the absolute maxima". In fact the absolute maxima vary much less than the mean maxima. The highest shade temperature ever recorded at the authors' most southerly origin (Port Lincoln, South Australia, lat. 34°40'S) was 45.4°C, and 43.8°C at their most northerly origin (Katherine, Northern Territory, lat.14°25'S). One of the highest temperatures recorded anywhere in Australia was 50.7°C close to the E. camaldulensis forests of the River Murray at Mildura, Victoria, lat. 34° 11'S. These and other temperature records (Hall, 1972) show that the trends with latitude of mean maximum of the hottest month and absolute maximum are opposite: although the mean maxima increase going north, the absolute maxima decrease. The authors did not need to invoke tropical speciation and a former migration of heat resistant E. camaldulensis from north to south to explain the almost uniform heat resistance of populations from throughout the continent. The high absolute maximum temperatures in both the north and south are sufficient for natural selection now, and heat resistance of the southern populations should not be regarded as a primitive character since it could result from current selection pressure in situ.)

62. KAUL, R.N. (1965). An approach to provenance trial in relation to tree introduction in arid lands. Annals of Arid Zone (Jodhpur) 4, 164-171 (En, 8 ref.) FA 28, 468. Subjects 7, 14.

An outline of some principles of provenance research including reference to a trial of four provenances of E. camaldulensis in which the local (Jodhpur) seed source was best.

63. KAUL, R.N. (1970). Afforestation in Arid Zones. W. Junk, The Hague. 435 pp. (En, many ref.) FA 32, 2488. Subjects 2, 14.

The index to this book has more references to E. camaldulensis than to any other species of tree. The chapter by R.D. Johnston and N. Hall is a good introduction to the geography, soils, vegetation land use, and tree planting in the drier parts of Australia.

64. KAUL, R.N.; ROY, R.D. (1967). Chlorophyll stability index, a suitable criterion for rapid screening of tree provenances in arid zones. Experientia 23, 37-38 (En, 3 ref.) Subject 7.

An account of a promising technique for simplifying provenance testing by screening for drought hardiness in the nursery. Chlorophyll stability index (CSI) was used as a measure of drought hardiness of seedlings and related to rainfall and temperature at the 16 original locations of seed collection of E. camaldulensis in Australia.

Plants with low CSI were generally from areas with low rainfall (correlation of CSI and rainfall, r = 0.87), but there was no relation with mean temperature (r = -0.35). CSI was strongly correlated with survival of seedlings (r = 0.84).

(The paper also shows that rainfall at the original source in Australia would have been just as good a criterion as CSI for initial screening of E. camaldulensis provenances for drought resistance.)

65. KEMP, R.H. (1969). Trials of exotic tree species in the Savannah Region of Nigeria. Part I. Aims, procedure and summary of results. Federal Department of Forest Research, Nigeria; Savanna Forestry Research Station, Research Paper No. 4, 15 pp. (En, 17 ref.) FA 32, 2374. Subjects 7, 14.

A well-presented background paper for research on the exotic species which will be the future wood supply for the 35 million people of the Savanna Region in Nigeria. Provenance trials of E. camaldulensis are mentioned but no details are given.

66. KEMP, R.H. (1970). Trials of exotic tree species in the Savanna Region of Nigeria. Part II. Short notes on selected species. Federal Department of Forest Research Nigeria; Savanna Forestry Research Station, Research Paper No. 6, 63 pp. (En, 65 ref.) FA 33, 4254. Subject 7, 14.

Short accounts of site requirements, establishment practices and growth of 46 species, including E. camaldulensis, in trials in the Savanna Region of Nigeria. At an early stage of provenance trials some of the 18 provenances of E. camaldulensis already had better stem and crown form than the established strains in Nigeria. (See Jackson and Ojo, 1973.)

67. KHAN, M.A.W. (1965). Flowering seedlings of Eucalyptus camaldulensis and E. rudis. Indian Forester 91, 203 (En) FA 26, 4896. Subject 5.

Four out of 690 seedlings of E. camaldulensis had flowers at the age of 7 months. A photograph shows a 54 cm high seedling with 15 flower buds.

68. LACAZE, J.-F. (1970). (Studies on the ecological adaptation of Eucalyptus.) Operational report for 1970 on project No. 6; Document, 4th Session Committee on the Coordination of Mediterranean Forestry Research; FAO Joint Subcommission on Mediterranean Forestry Problems, Ankara, No. FO : SCM/ FR 70/2/10, 25 pp. (Fr) (Unpublished). Subjects 2, 7, 8, 11, 12.

A major international project on ecological adaptation of E. camaldulensis was initiated at an FAO meeting in 1962. The first step was seed collection in Australia in most, but not all, of the natural range of the species. The collection was by Australian and Tunisian foresters. Seeds were distributed to a total of 18 countries where 24 cooperative trials had been established by 1970. Most of the trials are on sites already known to be suitable for the species. Details of the environment of the planting sites and of the seed sources are given in tables. No justification is given for the arbitrary regions of provenance and sub-provenance shown in the map of locations of seed collections.

The continued use of Australian seed lot numbers through the records of all the experiments is a good practice. If each cooperator used his own numbers international exchange of information would be difficult.

The object of the trials was to find out the best source of seed for each place. The French Government has provided a central facility for coordination and data processing through Station d'Amélioration des Arbres Forestiers, Centre de Recherches Forestieres, previously at Nancy and now at Orléans.

Variation within provenances was investigated in the three provenances where the progeny of several mother trees were kept separate. Variation between families was noted but not examined in detail.

The ranked data for height and diameter at 1-2 years are presented in 36 graphs. The Lake Albacutya, Victoria, provenance was 22% to 87% better than the mean of the other 33 provenances in the same trial at 2 years for height and diameter in 7 trials in the Mediterranean Region (winter rainfall, temperate). The

Petford, Queensland, and Katherine, Northern Territory, provenances showed early promise in the trials in Congo and Nigeria (summer rainfall, tropical), but did not stand out as much from other provenances as Lake Albacutya did in the Mediterranean trials. Other provenances which were outstanding on particular sites in the Mediterranean region were Port Lincoln, South Australia, and Wiluna, Western Australia, on calcareous soils and Murchison River, Western Australia, on a particularly dry sites. Plantations were not a superior source of seed, contrary to the experience with several other forest trees grown as exotics.

Lacaze's observations of initial genetic gain of the order of 50% for height and diameter at 1 or 2 years have proved to be no exaggeration as trials in Israel (Karschon, 1974) and Nigeria (Jackson and Ojo, 1973) approach merchantable size.

Lacaze emphasised the necessity, shown by these experiments, for field trials to determine the best provenance of a forest tree for a particular area. The natural stand and the environment at Lake Albacutya gave no clue whatever to the spectacular success of this provenance in Mediterranean plantations. Outstanding provenances have been found but others that are even better may be waiting to be put to use. In some countries attention is being given to testing many more provenances which were collected recently in Australia but which were not included in earlier trials.

Encouraged by the early results the cooperators in the project have continued to the next stage, seed production from the best provenances. An unpublished report on the project, July 1973 (see also Anon., 1973), sets out three activities:-

(1) planting large plots of the best provenance for future seed production;

(2) making grafted seed orchards from plus trees selected in Morocco, Tunisia and Italy;

(3) seed collection from 18 selected trees near Lake Albacutya for seedling seed orchards.

In future the project will need to give high priority to joint publication of results. The reports already available from certain countries (e.g. Jackson and Ojo, 1973; Karschon, 1974) are of great interest to foresters in many countries.

69. LARSEN, E. (1967). Geographic variation in Eucalyptus camaldulensis Dehn. ANZAAS 39th Congress, Melbourne, Section M Abstracts, M28 (En). Subjects 1, 2, 7, 13.

AUTHOR'S SUMMARY. "Eucalyptus camaldulensis occurs in all

parts of mainland Australia, but is almost everywhere restricted to water-courses. This distribution pattern provides a logical basis for a division of the species according to the major river systems, and an almost limitless further division into isolated populations in the tributaries.

The aim of this study was to determine if a division into major taxonomic units is possible and significant. Material was collected of about 10 trees in each of 60 localities, supplemented with 200 specimens from other areas, and of related species. Various morphological characters of the parent trees and their progenies were measured or scored, and the data analysed statistically by computer. Seedlings were subjected to rough tests for tolerance to frost and soil salinity.

This data, and data from a parallel study of leaf and seed polyphenols by Hillis and Banks, provided justification for establishing 5 or 6 forms, but the transformation of this into a conventional taxonomic classification is difficult.

E. camaldulensis has been regarded as a non-lignotuberous species, but a high percentage of seedlings from north of latitude 20° have lignotubers. The seedlings varied greatly in rate of height growth and in tolerance to frost and salinity."

(This preliminary note is Larsen's only publication on his pioneering work on genetic variation in E. camaldulensis, cut short by his death on a seed collecting expedition in 1969.)

70. MAIDEN, J.H. (1905). Further notes on hybridisation of the genus Eucalyptus. Proceedings of the Linnean Society of New South Wales 30, 492-501 (En, 16 ref.) Subjects 1, 10.

Maiden examined specimens of E. algeriensis Trabut, which Trabut considered to be a hybrid of E. rostrata Schlecht. x rudis Endl. (E. camaldulensis x rudis). Maiden found the specimens to be "not sufficiently removed from the very variable E. rudis to warrant its being designated a new species". However, Blakely (1934, 1955 and 1965 editions) considered that "in morphological characters (E. algeriensis) does not appear to differ significantly from E. camaldulensis".

71. MARTIN, B. (1971). (Genetic improvement of exotic species introduced in the People's Republic of Congo; Eucalyptus,

continued) Revue Bois et Forets des Tropiques 138, 3-26 (Fr) FA 33, 2378. Subjects 1, 7.

The eucalypt known as 12ABL which had been grown in the Congo for some years was though to be a form of E. camaldulensis. It was derived from a single tree in Madagascar. When a trial of 25 provenances of E. camaldulensis was established in the Congo in 1967, none of the provenances matched 12ABL. Professor L.D. Pryor subsequently suggested the origin as a north Queensland form of E. tereticornis. When Queensland provenances of this species from Herberton and Mt Garnet were grown in the Congo there was a striking resemblance to 12ABL, which was confirmed as E. tereticornis and not E. camaldulensis.

72. MENDONZA, L.A. (1970). (The effects of self-pollination in Eucalyptus camaldulensis Dehn.) IDIA Suplemento Forestal 6, 41-45 (Es, 14 ref.) FA 33, 2074. Subjects 5, 6, 8.

The effects of self-pollination were studied by comparing the seedling progeny of three isolated trees with the open-pollinated progeny of seven plantation trees in Argentina. The three trees considered to be naturally selfed were so isolated from other eucalypts that anything but selfing would be impossible.

Within the limits of this experimental material it was concluded that the effects of self-pollination in E. camaldulensis were not severe. Inbreeding manifested itself through decreased germination in the selfed progenies (49% cf 84%) and a higher proportion of abnormal seedlings (30% cf 5%). However in the seedlings that developed, survival and growth were almost the same in the selfed and control progenies and nearly all abnormal seedlings had developed normal appearance and size after eight months.

73. MOGGI, G. (1958). (Phenological research on some eucalypt species.) Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 2, 43-58 (It, 3 ref.) FA 21, 1570. Subjects 5, 6.

Observations of the flowering and fruiting cycle of E. camaldulensis, and six other eucalypts, were made in plantations near Rome. The 24 month cycle was well illustrated by a diagram of monthly change in the cycle which was divided into six stages. The development of buds and fruits was slow except for two periods of rapid growth.

Inflorescences were initiated in May in a short period of very rapid growth. The buds developed slowly for a year until

another period of rapid growth in which they reached full size and flowered in July. The last seeds were shed from the mature capsules in April the next year.

74. MOORE, K.M. (1975). The Glycaspis spp. (Homoptera : Psyllidae) associated with Eucalyptus camaldulensis. Proceedings of the Linnean Society of New South Wales 99, 122-128 (En, 10 ref.) FA 37 (in press). Subjects 1, 2.

The writer examined the distribution of three species of lerp insect (Glycaspis blakei, G. brimblecombei, G. eremica) in relation to subspecific variation in their host plant, E. camaldulensis. Previous studies had suggested that each species of lerp might be confined to one part of the range of the eucalypt and that the insect might be used to help identify subspecific taxa of E. camaldulensis. The study reported in this paper concentrated on sampling the areas of overlap in the distribution of the three species of lerp.

It was found that the lerp species intermingled in certain areas and were non-selective since two or three species could coexist on the one tree. Since the area of intermingling showed some correlation with the 31°C. summer isotherm the author concluded that "a temperature effect on the distribution of the three Glycaspis spp, is thus indicated as the most probable limiting factor." Nevertheless, their known distributions and overlap may indicate, in a broad sense, the approximate areas of distribution for more than a single taxon of E. camaldulensis."

75. OJO, G.O.A. (1973). Introduction of exotics with particular reference to Eucalyptus in Nigeria. Federal Department of Forest Research, Nigeria; Savanna Forestry Research Station, Research Paper No. 24, 13 pp. (En, 17 ref.) FA 37 (in press). Subjects 7, 14.

Includes an account of the results of one provenance trial of E. camaldulensis, at Afaka at three years. More information is available in Jackson and Ojo (1973) and Ojo and Jackson (1973).

76. OJO, G.O.A.; JACKSON, J.K. (1973). Eucalyptus camaldulensis provenance trial in Nigeria at six years. In: Tropical Provenance and Progeny Research and International Cooperation (edited by J. Burley and D.G. Nikles), pp. 279-283. Commonwealth Forestry Institute, Oxford (En, 3 ref.) FA 36, 3166. Subjects 7, 14, 15.

A condensed account of the results at 4 years of 7 well-replicated trials of 16 provenances of E. camaldulensis. Northern Australian provenances, especially Petford and Katherine, grew taller and straighter than southern provenances. (For greater detail see Jackson and Ojo, 1973.)

77. OSBORN, T.G.B. (1937). Some notes on the nomenclature of certain common species of Eucalyptus. Proceedings of the Linnean Society of New South Wales 62, 73-77 (En, 16 ref.). Subject 1.

The paper justifies Blakely's (1934) rejection of E. rostrata Schlecht. in favour of E. camaldulensis Dehnh. Osborn examined the evidence for and against changing the names of six well-known species of Eucalyptus. He rejected three of the changes, and accepted three including the priority of camaldulensis over rostrata.

His main reason for preferring camaldulensis was that Dehnhardt (1832) had published his brief but identifiable Latin description under that name 15 years before Schlechtendahl (1847) published his description of rostrata. Osborn noted that J.H. Maiden readily identified the Type specimen of camaldulensis in Vienna Herbarium and pencilled in "rostrata", on the sheet, although as Cleland (1956) later observed, it lacks fruits and juvenile leaves, and the flower buds are immature and have rounded opercula.

Osborn regretted the change, "While the validity of the change is unquestionable according to the rules of Botanical nomenclature, the complete evidence provides, it seems to me, a strong argument for the establishment of a limited list of nomina specifica conservanda."

78. PANETSOS, C.P. (1969). Phenological research on Eucalyptus camaldulensis Dehn. in Greece. Forest Research Institute, Athens, Bulletin No. 27, 16 pp. (Gr, 11 ref.) FA 32, 4007. Subjects 5, 6, 11.

AUTHOR'S SUMMARY. "Periodic observations were carried out at monthly, or fifteen days intervals during flowering period, on a sample of ten trees from 15 to 20 years old growing near Athens.

Flowering takes place from the middle of May to the beginning of July and in the next year after the initiation of inflorescences. At the end of September, that is three or four months after flowering, the developed

capsules contained seeds which exhibited germinability approximately 95%.

The duration of flowering of each plant lasts from 10-20 days, while among the ten studied plants a range of 45 days was recorded, so consequently the flowering period of certain plants does not coincide with others and probably they produce seeds by self-fertilization. The importance of this finding is emphasised in the discussion in connection with the establishment of seed production areas and seed orchards. The flowering time of the superior trees that are going to be selected should be important criterion among others, so that the production of seeds by self-fertilization will be avoided."

79. PANETSOS, C.P. (1970). Provenance test of Eucalyptus camaldulensis Deh . in Greece. Dasos 49-50-51/70, 1-8 (Gr, 8 ref.) FA 33, 2403. Subjects 7, 14, 15.

AUTHOR'S SUMMARY. "Provenance test of Eucalyptus camaldulensis provenances was initiated in spring 1967 in West Peloponnesus in Greece.

Two tests, one adjacent to the other, but with different methods of site preparation, were established and data on height, circumference, survival and die-back damages were obtained three years later.

Highly significant differences were found for height, circumference, and die-back damages between provenances in both tests, while no difference for survival was detected for any provenance.

Significant differences for height and circumference were also found between the two tests, due to the method of site preparation, but no provenance-environment interaction was exhibited.

Provenances from N.S.W. and Vic. seem to outgrow provenances from the other parts of Australia. Provenance 6845 from Lake Albacutya, Vict. is the best among the 28 provenances used in the two tests, showing highly significant difference from all the others."

(An English version of this paper was presented as a Document of the 4th Session of the Mediterranean Forestry Research Committee, FAO Joint Sub-committee on Mediterranean Forestry Problems Ankara 1970, FO : SCM/FR-70/2/1.)

80. PENFOLD, A.R.; WILLIS, J.L. (1961). The Eucalypts - Botany, Cultivation, Chemistry and Utilization. Leonard Hill, London. 551 pp. (En, numerous ref.) FA 23, 179. Subjects 1, 2, 10, 13, 14.

Although the authors provide considerable information on several aspects of E. camaldulensis, its growth habits and uses, there is little on genetic variation apart from the mention of five subspecies and a possible hybrid.

81. POUSUGG, R.C. (1975). Early results of a species trial of Eucalyptus in Thailand. Thai-Danish Pine Project 1969-1974, 18-22 (En). Subjects 7, 15.

Five tropical provenances of E. camaldulensis were included in a species trial planted in 1973 on contrasting sites in northern and southern Thailand. The 36-tree plots were laid out as randomised blocks with five replications. After one growing season the height and survival of E. camaldulensis provenances were clearly superior at both localities compared with 30 seed lots representing 15 other eucalypt species. Statistical analysis indicated significant variation between the provenances at each site although no provenance was clearly superior to the others and the ranking differed at each site.

82. PRYOR, L.D. (1963). Provenance in tree improvement with particular reference to Eucalyptus. Proceedings of World Consultation on Forest Genetics and Tree Improvement volume 1, paper no. 3/2, 6 pp. (En, 4 ref.) FA 25, 456. Subjects 2, 7.

Pryor observed that nearly all exotic plantations of E. camaldulensis were derived from only a few southern provenances which were most unlikely to be the best available from this widely ranging and morphologically variable species. He predicted that cooperative international provenance trials would bring great benefits through the discovery of superior sources of seed.

83. PRYOR, L.D. (1966). A report on past performance and some current aspects of the cultivation of quick-growing species (mainly Eucalyptus) in India. Indian Forester 92(10), 615-622 (En) FA 28, 2066. Subject 10.

Pryor had no doubt that the "Mysore Hybrid" was in fact E. tereticornis and that E. camaldulensis was not involved. He accounted for observed variability by natural polymorphism within

the species, and occasional physical mixture of other species. The name "Mysore Gum" was proposed.

84. PRYOR, L.D. (1968). Eucalyptus in West Pakistan. Pakistan Journal of Forestry 18, 45-56 (En, 3 ref.) FA 29, 5459. Subjects 1, 10, 12, 14.

The paper includes an account of the identity of past introductions of eucalypts to West Pakistan with particular reference to the red gum group, E. tereticornis, E. camaldulensis, E. rudis and the cultivated hybrids of the last two known as E. x algeriensis. "This group of species is likely to be the most important in future Eucalyptus (plantations in West Pakistan and places with similar environments) and there is a large reservoir of as yet unused genetic material available within Australia."

The problems of hybridisation, inadequate records, and inadvertent mixing of seeds had resulted in plantations of uncertain and variable composition. Pryor advocated a return to the pure species E. tereticornis and E. camaldulensis at least as a yard stick "for unless they are superseded there is no point in turning to other species" (or hybrids).

85. PRYOR, L.D. (1970). Present performance and prospects for future development of plantations of Eucalyptus. Savanna Forestry Research Station, Nigeria. FAO FOR : SF/NIR 16 Technical Report no. 2, 10 pp. (En) FA 34, 229. Subjects 7, 10, 13, 14.

A report, by the most experienced observer of eucalypts as exotics, on progress towards better "technical bases upon which the afforestation of suitable areas can be founded".

Pryor commended the Nigerian E. camaldulensis provenance experiments as a model for subsequent tests, and agreed with the decision to set up seed-producing plantations of one or two of the best provenances.

He considered that the fast-growing trees known as "E. saligna" in Nigeria were likely to be hybrids of E. grandis and E. camaldulensis, and recommended making plantations of E. camaldulensis with rows of E. grandis as a source of hybrid seed.

86. PRYOR, L.D. (1973). Report of the consultant on eucalypts. FAO/SIDA Forestry Project Identification Mission for

India, FO : TF/IND 112 (SWE), Project Working Document No. 3, 7 pp. (En). Subjects 1, 10, 14.

Pryor observed that the "Mysore Gum" or Mysore Hybrid" is more likely to be an unrecognised Australian provenance of E. tereticornis than a hybrid with E. camaldulensis or other species. He considered that "the variation on the plantations simply expresses the ordinary within-population variance in some natural stands of E. tereticornis". Although the shape, size and glaucousness of leaves on young trees of the "Mysore Gum" was markedly variable on infertile soils, the leaves were relatively uniform on fertilized plots in the same plantation. (See also Boden, 1964; Pryor, 1966.)

87. PRYOR, L.D. (1975). Eucalypts. In: The Methodology of Conservation of Forest Genetic Resources, FAO/UNEP, FO : MISC/75/8, 79-83 (En, 7 ref.) FA 37 (in press). Subjects 2, 7, 13.

The article reviews the need for action on conservation of the genetic resources of E. camaldulensis in Australia. The common type of occurrence of the species along sandy intermittent watercourses in the inland does not appear to be threatened at present as the intensity of land use is light.

Certain unique stands, such as one on limestone near Port Lincoln, South Australia, require special action for preservation. "To know what stands of this kind exist ..... would require more survey than at present, so that particular sites of special importance can be identified".

88. PRYOR, L.D.; BYRNE, O.R. (1969). Variation and taxonomy in Eucalyptus camaldulensis. Silvae Genetica 18, 64-71 (En, 8 ref.) FA 31, 305. Subjects 1, 2, 3, 7, 8, 10, 13, 15.

The purpose of this important paper was to suggest some further ideas about the nature of the species and its patterns of genetic variation. The main taxonomic questions were whether the total population should be regarded as a single species or split into subspecies or even species, and how to treat clinal variation.

Fifty seedlings were raised in a Canberra nursery from the open pollinated seed of 22 trees in a total of nine populations located between 14° and 35°S latitude. Measurements were made in the nursery of height growth, sensitivity to frost and frequency of lignotubers.

Variation was disclosed within and between populations

with the northern provenances having faster growth, greater susceptibility to frost and more lignotubers than the southern provenances. The lower coefficient of variation in growth and frost damage of the northern provenances led the authors to suspect great inbreeding or less intense natural selection in the northern provenances. They recognised that the amount of variation within populations, though lower in the north, provided considerable scope for selection for frost resistance since every seed lot contained some individuals more resistant than others.

The authors suggested that because lignotubers were so common throughout the genus, the absence of lignotubers in the southern populations of E. camaldulensis might be considered a derived character due to a process suppressing their development. They also considered the possibility that the species had evolved from the mingling of two formerly separated species.

Pryor and Byrne concluded that E. camaldulensis was one distinct species composed of northern and southern populations which were clearly distinguishable at their extremes. However, doubts on the boundary between the two populations required that the formal designation of subspecific taxa must await further study particularly in the broad transition zone from about 22° to 30°S latitude.

89. PRYOR, L.D.; JOHNSON, L.A.S. (1971). A classification of the Eucalypts. Australian National University, Canberra. 102 pp. (En, many ref.) FA 33, 5861. Subject 1.

Three of the five Blakely varieties were considered to belong in the proposed subspecies "obtusa", one in subspecies "camaldulensis", and one required further study.

90. QADRI, S.M.A. (1969). Provenance trials of Eucalyptus camaldulensis Dehn. in West Pakistan. Documents of the Second World Consultation on Forest Tree Breeding, Washington, vol. 1, 861-872 (en, 5 ref.) FA 31, 2371. Subjects 7, 14, 15.

E. camaldulensis is one of the few tree species raised successfully under irrigation in West Pakistan. The author visited Australia in 1964-65 collecting seeds in conjunction with Egon Larsen of the Forest Research Institute, Canberra. Seedlings were raised from 30 provenances but due to heavy casualties in the nursery several adjacent sources had to be combined making 21 provenances. The seedlings were planted in 1966 at three localities between latitudes 25° and 34°N under irrigation. The 21 provenances were compared in four replicates of 30-tree plots in

randomised complete blocks.

The Katherine and Newcastle Waters provenances from the Northern Territory were consistently superior in ranking for growth and survival at two years. (See also Hafeez and Sheikh, 1972.)

91. RAKOTOMANAMPISON, A. (1973). Provenance trials of Eucalyptus camaldulensis (in Madagascar). In: Tropical Provenance and Progeny Research and International Cooperation (edited by J. Burley and D.G. Nikles), pp. 275-278. Commonwealth Forestry Institute, Oxford. (En) FA 36, 3166. Subjects 7, 15.

A short report of one replicated trial of 16 provenances of E. camaldulensis planted in 1971 in Madagascar. The Petford provenance was the tallest at this early stage (one year old). The Katherine provenance was not included.

92. REYNDERS, M.I. (1970). (Information on species trials in the tropical zone of Mexico.) Programa integrada para la ensenanza, la investigacion y la extension agricola-Chapingo, Mexico. FAO No. SF/98/MEX 6, 15 pp. (Es). Subjects 7, 14, 15.

Two species trials including more than 60 eucalypt seed lots were planted in the tropical lowland part of Mexico at latitudes 18° 36'N and 22° 07'N near the Gulf of Mexico in 1968. One Mexican and 15 Australian provenances of E. camaldulensis were compared in the trials which were set out as randomised blocks of 9-tree plots with three replications.

The northern provenances of E. camaldulensis had the best survival and height growth of all the species in both trials at 1.6 years, together with two Queensland provenances of E. tereticornis of similar performance. Two Western Australian provenances from Mundiwindi and Wiluna had consistently good survival and growth, equal to the now well-known provenances from Petford, Queensland, and Katherine, Northern Territory. The local Mexican provenance was the poorest of the E. camaldulensis in both trials.

93. RUDMAN, P. (1970). The influence of genotype and environment on wood properties of juvenile Eucalyptus camaldulensis Dehn. Silvae Genetica 19, 49-54 (En, 25 ref.) FA 32, 205. Subjects 8, 15.

In a controlled environment study of morphological and wood characters the data were resolved into genetic and environmental components. Seven "randomly chosen" clones were made from seven seedlings presumably of the one provenance. One rooted cutting of each close was raised in a warm glass house and one in a cool glasshouse of a phytogtron. The marked differences between clones in fibre length (0.56 to 0.66 mm) provided conclusive evidence of the existence of genetic variation in this character.

94. RUDMAN, P.; HIGGS, M.; DAVIDSON, J.; MALAJCZUK, N. (1969). Breeding eucalypts for wood properties. Documents of the Second World Consultation on Forest Tree Breeding, Washington, vol. 1, 447-464 (En, 28 ref.) FA 31, 2371. Subject 8, 15.

A preliminary outline of substantial research on variation in wood density and fibre length of several eucalypts species as a guide to tree improvement programmes. Seven clones made from E. camaldulensis seedlings were grown in two controlled environments until six feet tall. Highly significant genetic differences were found in fibre length but not density. (See also Rudman, 1970).

95. SAVANNA FORESTRY RESEARCH STATION, Samaru, Zaria, Nigeria, Annual Report 1973-74. Federal Department of Forest Research, Nigeria. 32 pp. (En, 65 ref.) Subjects 7, 14.

Contains a summary and table of the results of the E. camaldulensis provenance trials reported in full by Jackson and Ojo (1973).

96. SCHLECHTENDAHL, D.F.L. von. (1847). (Determination and description of plants collected by Dr. Behr in South Australia.) Linnaea 20(6), 559-672. (De, La). Subject 1.

Contains the original Latin description of E. rostrata Schlecht. on pages 655-656.

97. SINGH, B.; VERMA, B.; MONAPPA, K. (1969). A study on the growth performance of some Eucalyptus species for development of fuel reserves in the ravine lands. II. Van-Vigyan, Dehra Dun 7, 12-18 (En, 6 ref.) FA 31, 4290. Subject 7.

Reports significantly faster growth at two years of E. camaldulensis originating from Bangalore compared with a Jodhpur source in a species trial in Gujarat State, Western India.

98. TURNBULL, J.W. (1973a). Report on Northern Territory - Kimberley seed collection expedition, May-June 1972. Forest Genetic Resources Information, FAO Forestry Occasional Paper 1973/1, 26-28 (En) FA 35, 2927. Subjects 6, 7, 12.

An account of a ten-week expedition jointly sponsored by the Australian Government and FAO in which 25 provenances of E. camaldulensis were collected. Seed and botanical specimens were collected in sparsely inhabited parts of northern South Australia, Northern Territory and the Kimberley area of northwest Western Australia where seed is unobtainable except by special expedition. The 48 kg of seed of precisely known origin was expected to be sufficient to supply the research requirements of many countries for several years.

99. TURNBULL, J.W. (1973b). The ecology of variation of Eucalyptus camaldulensis Dehn. Forest Genetic Resources Information No. 2, FAO Forestry Occasional Paper 1973/2, 32-40 (En, 11 ref.) FA 36, 1327. Subjects 2, 6, 7, 10, 12, 13.

The paper reviews the current information available for choice of seed sources for E. camaldulensis plantations and gives an account of the natural distribution of the species and the range of climatic and other conditions in which it is found. There is a useful table of climatic data for 30 stations throughout the natural range.

Turnbull agreed with previously published reports that northern populations are significantly different from southern populations but considered "the concept of two sub-species is deceptively simple". As a further subdivision of the species he proposed the use of eight geographic regions of occurrence based on the main drainage systems between which there was unlikely to be gene flow. These "provenance groups" are similar to the six photochemical provinces of Banks and Hillis (1969) and "correspond largely to morphological observations on seedlings and adult material (Larsen, unpublished)."

"The selection of seed from different drainage systems within a broad climatic classification offers the best overall guide for the choice of material for initial provenance trials."

100. VENKATESH, C.S.; ARYA, R.S.; SHARMA, V.K. (1973). Natural selfing in planted Eucalyptus and its estimation. Journal of Plantation Crops 1, 23-25 (En, 6 ref.) FA 36, 4475. Subjects 5, 11.

"Controlled hand pollinations carried out during several flowering seasons on selected trees of E. tereticornis and E. camaldulensis confirmed them to be self-fertile. Unemasculated flower clusters isolated in bags also were seen to be capable of producing viable seed. Certain spatially isolated trees were seen to regularly set fruit and seed each year, although they had no cross pollen sources available to them within reasonable pollinating distance."

The main material of the paper concerns natural selfing due to cleistogamy in several trees of E. tereticornis.

101. VENKATESH, C.S.; SHARMA, V.K. (1974). Some unusual seedlings of Eucalyptus; their genetic significance and value in breeding. Silvae Genetica 23, 120-124 (En, 11 ref.) FA 36, 3152. Subjects 4, 6, 8.

Atypical seedlings of E. camaldulensis and E. tereticornis were observed in laboratory germination of open pollinated seed from trees selected for a breeding programme. The four types of atypical seedlings were (1) twins, (2) malformed or partly atrophied, (3) with three cotyledons, and (4) albino or deficient in chlorophyll. The frequency of each of the various subdivisions of the four types of atypical seedling among several thousands was 1% or less, except for 21% chlorophyll deficient.

Chromosome counts of the twins were advocated since it is possible that one of the two may be haploid, arising adventitiously from the haploid nucellar tissue. If this were the case diploid homozygous plants could be produced by doubling the chromosomes and used for heterosis breeding (as for hybrid corn) avoiding the long delay of several generations of inbreeding. However, the authors pointed out that the haploid condition was unlikely because they observed only twins and not the larger number of seedlings they would have expected from adventitious growth from nucellar tissue.

The other types of atypical seedlings could provide useful markers in studies of inbreeding in eucalypts.

102. WALLIS, N.K. (1970). Australian Timber Handbook. 3rd ed. Angus and Robertson, Sydney. 379 pp. (En, many ref.)

103. WILLAN, R.L. (1973). Forestry : improving the use of forest genetic resources. Span 16(3), 119-122 (En, 10 ref.) FA 35, 2816. Subjects 7, 8.

As part of a general review of forest genetic resources the author outlines results of the E. camaldulensis trials reported by Lacaze (1970). Willan's paper is the only one reviewed in this bibliography which includes photographs of the striking morphological differences to be found in the crowns and stems of E. camaldulensis plantations. Variation in leaf shape is illustrated by two Victorian provenances, Lake Albacutya and Shepparton, and variation in stem straightness by the progeny of "selected" and "unselected" trees.

104. ZUCCONI, L. (1958a). (The reproductive cycle of Eucalyptus camaldulensis Dehn.) 3rd Session of Working Group on Eucalypts, FAO Sub-Commission for coordination of Mediterranean Forestry Problems, Madrid, FAO/SCM/EU/16-Aa, 6 pp. (Fr). Subjects 4, 5.

This paper is a preliminary version of Zucconi (1958c) and gives an account of development morphology and embryology of ovaries, female gametophytes, embryos, sporogenesis, and notes that counting the 11 chromosomes is easy.

105. ZUCCONI, L. (1958b). (Observations on the morphology of the inflorescence of three species of Eucalyptus). 3rd Session of Working Group on Eucalypts, FAO Sub-Commission for Coordination of Mediterranean Forestry Problems, Madrid, FAO/SCM/EU/16-Ab. 4 pp. (Fr). Subjects 4, 5, 8.

An account of variation within species in the number and arrangement of flower buds in the inflorescence of E. camaldulensis, E. botryoides Sm., and E. trabutii Vilmorin. Zucconi found that four of the 15 trees of E. camaldulensis she examined consistenly had 11 flower buds per inflorescence compared with the more common number of 7 for this species. The 15 trees were presumably from plantations in Italy but no details were given. The possibility of hybrid origin for the apparent intra-specific variation cannot be excluded.

106. ZUCCONI, L. (1958c). (Organogenesis of the flower and embryology in Eucalyptus camaldulensis Dehn.) Pubblicazioni del Centro di Sperimentazione Agricola e Forestal 2, 59-86 (It, 18 ref.) FA 21, 1460. Subjects 4, 5.

This detailed study of the morphogenesis of floral organs and phenology of E. camaldulensis provides a great deal of the background information required for studies of the sources of genetic variation in the species. The paper is well illustrated with photographs of many anatomical sections and drawings of the development of flower bud primordia, inflorescences, female gametophytes, microsporogenesis, flower buds, embryos, seeds and fruits. Data are provided on the monthly increase in size of flower buds showing the rapid growth in spring and quiescence in winter.