A DESCRIPTION OF "COMPUTE-A-EUC" :
A REGIONAL LISTING OF ALL EUCALYPT SPECIES.

by

John Ross Harley Hook, M.B, B.S. (Melb.)

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DECLARATION

Except where otherwise indicated, this dissertation is my own work.

J.R.H. Hook

J. R. H. HOOK

January 1979.

THE PURPOSE OF THESE NOTES, AND ACCESS TO "COMPUTE-A-EUC".

THE NOTES THAT FOLLOW DESCRIBE A COMPUTER-BASED LISTING SYSTEM WHICH OPERATES ON A MINI-COMPUTER AT THE CENTRE FOR RESOURCE AND ENVIRONMENTAL STUDIES, LIFE SCIENCES BUILDING, AUSTRALIAN NATIONAL UNIVERSITY, CANBERRA.

WHILE THIS DESCRIPTION IS INTENDED TO SET OUT THE FEATURES AND USES OF THE SYSTEM, IT DOES NOT CONTAIN DATA OR ALLOW ANY DEGREE OF ACTUAL SELECTION BETWEEN EUCALYPT SPECIES.

THIS IS THE FUNCTION OF THE PROGRAMME ITSELF. THE MATERIALS REQUIRED FOR ITS OPERATION ARE AVAILABLE FROM THE BIBLIOGRAPHER AT THE CENTRE, AND APART FROM THESE NOTES THEMSELVES, ARE AS FOLLOWS:

1. Magnetic computer tape labelled 'JOHN HOOK'. This tape holds the 'Compute-a-Euc' main programme at file 5.
2. Magnetic tape labelled 'Binary File'. This tape holds the coded data in one large file (file 1).
3. Large map of Australia. The map shows the province boundaries outlined on p.5a in relation to towns, roads and other physical features, to allow accurate placement of an area of interest in the appropriate province.

OTHER MATERIAL AVAILABLE:

1. Listing in BASIC of 'Compute-a-Euc' main programme. This is not required for operation of the programme; it has been included to allow inspection of the scanning and selection procedures.
2. Complete list of data on the binary file. This is not required for normal programme operation; it has been included to allow inspection of the actual data used for species selection, and examination of the codes for any particular species.

ACKNOWLEDGEMENTS

I would like to thank Professor L. D. Pryor and Mr. J. Briggs, of the Department of Forestry, Australian National University, for information concerning a number of the rarer eucalypt species, and for their valuable comments on the project; and Miss Felicity Adams and Miss Catherine Hook for their cheerful assistance with the lengthy task of placing on magnetic tape the coded information.

ABSTRACT

'Compute-a-Euc' is a computer-based system designed to assist in the identification of species and subspecies of the genus Eucalyptus. It is intended for use by both botanists and those with a minimum of specialist training who wish to become more familiar with eucalypts.

It is in essence an index to Eucalyptus species, based on geographical occurrence and a number of readily apparent field characteristics. It has been developed as a guide to recorded natural distributions and field appearance, rather than as a 'key' eventually yielding the name of a single taxon. Through its use the work of scanning individual descriptions is reduced, and access given directly to a 'short list' of species between which botanical comparisons are appropriate.

The output from the system is in the form of a computer-generated list of those species and subspecies that match a combination of descriptive variables selected by the operator. The order in which taxa appear and their nomenclature are based primarily upon the classification of Pryor and Johnson (1971).

The principal feature by which species are selected is their geographical distribution. The area in which eucalypts occur naturally - Australia, New Guinea and a number of islands to the near north - is subdivided into seventy-seven regions or 'provinces'. The operator may specify one or a combination of these provinces as the basis of the list.

Further subdivision may be selected according to thirty-three essentially non-botanical field characters. These relate to the size and form of the plants, their bark type, their preferred habitat and the form of the plant community in which they typically occur.

This information was compiled from a broad range of the available descriptive literature, and especially the following publications of the Australian Forestry and Timber Bureau:

CHIPPENDALE G.M. (1973) Eucalypts of the Western Australian Goldfields. Canberra: Australian Government Publishing Service.

HALL N, JOHNSTON R.D. & MARRYATT Rosemary. (1963) The Natural Occurrence of the Eucalypts. 2nd ed. Leaflet 65. Canberra: Forest Research Institute.

HALL N, JOHNSTON R.D. & CHIPPENDALE G.M. (1970) Forest Trees of Australia. Canberra: Aust. Govt. Publ. Service.

HALL N. et al. (1970 - 75) Forest Tree Series. Leaflets 1 - 191. Canberra: Aust. Govt. Publ. Service.

HALL N, BROOKER M.I.H. et al. (1977 - 78) Forest Tree Series. Leaflets 192 - 216. Melbourne: Commonwealth Scientific and Industrial Research Organization.

Reference:

PRYOR L.D. & JOHNSON L.A.S. (1971) A Classification of the Eucalypts. Canberra: The Australian National University.

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CHAPTER 1

THE SCOPE OF THE PROJECT.

The importance of the genus Eucalyptus in Australia can hardly be overstated. Its member species constitute a characteristic and most significant element of the Australian flora, dominating a great many plant communities and ninety-five percent of the country's forested areas (Hall, Johnston and Chippendale, 1970). They can be found from the arid continental interior to the alpine tree-line, and make a major contribution to the Austalian wood industry. Eucalypt timbers are world-renowned for strength and durability.

As might be expected of such a widespread genus, it is one with many species. The precise number varies depending on which of the many published taxonomic combinations are accepted as valid. They number approximately four hundred and fifty, and in sixty or so of these there are two or more subspecies. These subspecies may correspond to distinct 'races', or represent extreme forms of a species which gradually changes across its range, perhaps in response to a change in some environmental factor (Pryor, 1976). Exploration of relatively inaccessible regions, especially in Western Australia, still results in the discovery and description of new Eucalyptus species.

Eucalypts not infrequently hybridise. A number of hybrids have been described, and occasionally misinterpreted as distinct species. Hybrids display morphological features intermediate between those of the parent species, and this aids their recognition.

With such a preponderance of plants of the one genus, identification of locally-important species is unusually dependent on relatively fine botanical distinctions. Many visitors to the country, and not a few Australians, voice the opinion that Australia's gum trees 'all look the same'. Under such circumstances identification of species can present many problems to those with little specialist knowledge or experience. Yet correct identification is a satisfying and important exercise: timber properties, correct propagation techniques, growth habit and suitability to certain soil types may all vary widely between species.

'Compute-a-Euc', a guide to the species of eucalypt that may be encountered in various parts of Australia, is designed to assist a wide range of users who wish to become more familiar with the genus and correctly identify its species. Many of the references available organise their descriptions of Eucalyptus species either alphabetically or on the basis of botanical affinities. Both of these arrangements can be difficult to use in the field in the absence of much knowledge of the species of the area. 'Keys' to the whole genus can suffer from similar disadvantages: distinctions between species may be made on the basis of botanical features that either require experience to interpret or that may not always be present on trees in the field. The key of Blakely (1965), while a most useful reference, can be difficult to use in the field for both these reasons.

In view of such difficulties it was felt that a system based primarily on the natural occurrences of species would, like the regional keys, offer the advantages of being easily applied and selective. As many eucalypts are of quite circumscribed occurrence, indexing and initial segregation by location is a good starting point for identification, providing ready access to the large amount of reference information and reducing the number of species requiring botanical comparison to more manageable and less daunting proportions.

This is the objective of 'Compute-a-Euc': to be a practical system giving quick access to a 'short list' of relevent species. Such a list is, in fact, the output from the system. The operator selects one or a number of pre-defined regions or 'provinces', into which Australia and a number of islands to the north are divided - this region being the total extent of the natural occurrence of the genus Eucalyptus - and obtains in the list the names of species and subspecies recorded as being found in the selected area.

To increase selectivity, and to assist familiarization with the eucalypts of a given area, species may be further subdivided according to a number of readily-apparent features. These are the size and form of the plant, the appearance of its bark, its characteristic habitat within the area of occurrence and the type of plant community in which it is found. All these features to a greater or lesser extent segregate species into smaller and smaller groups.

'Compute-a-Euc' may be used before venturing into the field to give a preliminary idea of the names of the species of the region, what they look like and where they are characteristically found. Thus for specified regions one may obtain lists of those species which are tall trees more than thirty metres in height, or which are smooth-barked; which occur above nine hundred metres of altitude, or which typically grow along streams; which are found along the coast, or typically in moist 'wet sclerophyll' forests. With the assistance of such lists identification becomes much easier.

Alternatively after a trip during which specimens have been collected, 'Compute-a-Euc' can be used to restrict as far as possible the number of species that the specimen may have come from. By combining the selective features - by obtaining a list, for example, of all the 'stringybarks' in the region visited that occur between six hundred and nine hundred metres of altitude on the undulating country of tablelands in dry sclerophyll forest - the number of species may be limited to a very manageable number between which botanical selection is much easier.

To summarize; 'Compute-a-Euc' scans a data file representing the whole range of Eucalyptus species for those that in nominated circumstances deserve further consideration. From personal experience manual scanning of the literature can be a very time-consuming and tedious way of selecting against species that do not occur in the location in question, or do not match the appearance of the chosen tree in the field. A computer however is well suited to such work.

CHAPTER 2

THE "COMPUTE-A-EUC" VARIABLES.

2.1 Provinces

The core of the 'Compute-a-Euc' system is the use of area of natural occurrence to select species for listing. In such a system it is necessary to define in advance areas or 'provinces', in respect of which species can be recorded as present or absent. The regions chosen, their size and extent have very important effects on the form, content and value of the final lists. For this reason much care was taken to define provinces that would be as far as possible the most useful and appropriate basis for distinction. In choosing the boundaries of these provinces, a number of considerations were taken into account.

Firstly, it was decided to make the provinces conform to the State boundaries. The State boundaries are relatively well-defined 'on the ground' and serve as useful landmarks when in the field. Also many descriptions and 'floras' give their information in terms of State occurrences, and this is a valuable cross-check on accuracy during coding.

Next, the size of the provinces had to be kept within appropriate limits. If province area was made too large, the value of regional groupings tended to diminish as the number of species included within the boundaries increased. On the other hand too small a province size tested the accuracy of the source data, increasing the possibility of error in coding species as present or absent because the sources did not map occurrences at the level of detail required for smaller areas. The size eventually chosen was such that mainland Australia is covered by seventy-one provinces, Tasmania by five and the islands to the north, referred to by Pryor and Johnson as Malesia, by one, to make a total of seventy-seven (Pryor and Johnson, 1971).

The size of provinces was adjusted to some extent, however, so that areas with a great diversity of species were covered by generally smaller provinces than the inland arid regions with comparatively few species. The size was nevertheless kept consistent with the accuracy with which occurrences were mapped in the sources.

This description of 'Compute-a-Euc' is accompanied by an outline map showing province boundaries (see Figure 2.1). At the Centre for Resource and Environmental Studies, Australian National University, there is a master map which shows these boundaries in relation to roads, towns and other physical features of Australia.

Further care was required in the placing of province boundaries. It seemed appropriate to try to align the provinces with major vegetation patterns. To take an example from New South Wales, many species occur in north-south bands that represent relatively uniform habitats because of the major impact on climate of the Great Dividing Range. This segregation is reflected in the traditional subdivision of New South Wales into coastal, tablelands, slopes and plains regions, and at first it seemed wise to preserve these in the pattern of provinces.

However it proved difficult to map their precise extent accurately for coding purposes. Also it became increasingly apparent that the distribution of species from coast to tablelands and slopes is continuous, making it very difficult to draw a boundary that preserves a characteristic vegetational grouping without in fact bisecting other such groupings. Many coastal species extend a considerable distance up the coastal escarpment onto the tablelands, and including them in a coastal zone includes many 'tableland' species also. For such reasons the intention to make the province boundaries highly selective in themselves was discarded in favour of a more straight-forward and easily used grid pattern for mapping occurrences. However the selective value of these well-known vegetation patterns has not been abandoned.

Firstly the province boundaries, although straight, are aligned in such a way as to be parallel to the main axis of the Dividing Range in New South Wales and Queensland, so that coastal species tend to fall into a limited number of provinces. Secondly the 'habitat' section of 'Compute-a-Euc' contains variables which themselves distinguish between 'coastal', 'tablelands/plateau' and 'west of Divide' eucalypts. The last-named category was introduced specifically to cover those species in New South Wales and south-east Queensland which have a low altitude occurrence, but which are found excusively on the inland side of the Dividing Range. Though applicable only to species of these areas,

Malesia
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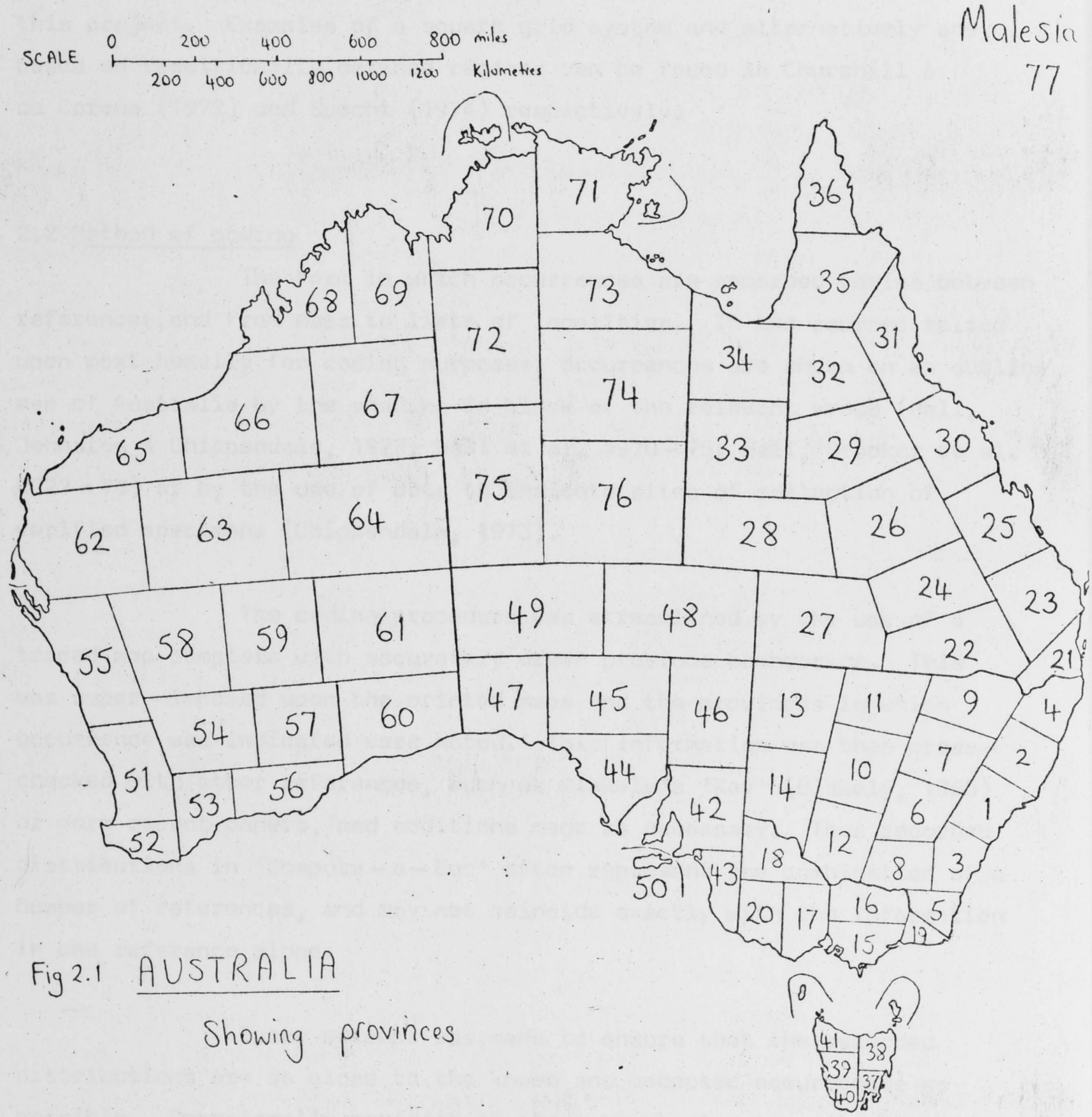

Fig 2.1 AUSTRALIA

Showing provinces

the inclusion of such a variable was felt to be justified by its high selectivity value and the large number of species that do occur in these regions.

The grid eventually adopted for mapping occurrences in 'Compute-a-Euc' is considered the most functional for the purposes of this project. Examples of a square grid system and alternatively one based on traditionally defined regions can be found in Churchill & de Corona (1972) and Specht (1974) respectively.

2.2 Method of coding

The form in which occurrences are recorded varies between references, and from maps to lists of localities. In the sources relied upon most heavily for coding purposes, occurrences are shown on an outline map of Australia by the shading in black of the relevent areas (Hall, Johnston & Chippendale, 1970; Hall et al. 1970-75; Hall, Brooker et al. 1977-78) or by the use of dots to indicate sites of collection of verified specimens (Chippendale, 1973).

The coding procedure was streamlined by the use of a traced map complete with accurately drawn province boundaries. This was super-imposed upon the printed maps and the provinces in which occurrence was indicated were noted. This information was then cross-checked with other references, such as Blakely's 'Key' (Blakely, 1965) or more recent papers, and additions made as necessary. Thus recorded distributions in 'Compute-a-Euc' often represent the combination of a number of references, and may not coincide exactly with the information in one reference alone.

Every attempt was made to ensure that the recorded distributions are as close to the known and accepted occurrences as possible. Occasionally revision of the concept of a taxon has involved changes to the area in which it is accepted as occurring. In such cases the main guide to the taxonomic status of various combinations was Pryor & Johnson (1971). Exceptions to this general rule are listed in Appendix II.

Inevitably during coding cases arose in which the margins of the mapped occurrence fell either on or very close to the boundary between two provinces. In such situations the species concerned was always recorded as occurring in the adjoining province, however negligible its apparent occurrence there. This was done for a number of reasons.

In the first place, a line is most often an inadequate representation of the margin of an occurrence, and a species may in fact occur, although uncommonly, well beyond the area indicated. Secondly, it was felt that the coding for 'Compute-a-Euc' should be over-inclusive rather than the reverse; that it was more in keeping with the function of 'Compute-a-Euc' to include all possible species for consideration than to inappropriately exclude species that could in fact be present. Failure of the programme to list all species it is possible to encounter in a given region would be very disruptive to correct identification, and much more so than the occasional inaccurate inclusion. A similar approach lay behind coding for the other 'Compute-a-Euc' variables.

However two steps were taken to minimise the occurrence-exaggerating impact of these borderline cases. One was the drawing of province boundaries so that in as many cases as possible only three lines met at a single point. If a mapped occurrence should happen to cross this point, the number of provinces recorded is three and not four as would be the case if the basic province pattern were a square grid.

The second step involved development of an intermediate coding category between 'present' and 'absent' to cope with 'shades of grey' situations. This category could be characterised as an 'uncommon' or 'uncharacteristic' indicator. Thus where the extension of the range of a eucalypt species into a particular province is marginal, or where the area concerned is much less than the area of the province itself, such species are coded as 'present but uncommon'. Species which are coded in this way do appear in lists for the provinces in which they are uncommon, but their relative rarity is indicated by a letter in brackets that follows the name of the species. The actual letter in the brackets indicates in respect of which operator-selected variables the species is uncommon. Thus if a species is relatively rare in the Sydney area, a listing for this area - province 1 - will include it, but its name will be followed by the notation '(A)', indicating that it is in respect of area that this species is uncommon. A '(B)' would indicate that it is the bark

type specified for the listing that is uncharacteristic of the species; an '(F)' that the listed form is uncharacteristic; an '(H)' indicates the same for the habitat variable selected and a '(V)' relates to the vegetation or forest type. When such species appear in the list it suggests that a specimen to be identified is relatively unlikely to be the species so indicated, but that it should not be totally excluded. A number of eucalypts with a very restricted occurrence are coded in this way. Similarly questionable records of occurrence or implied occurrences are coded as 'uncommon'. Should a species fall into this category in a number of respects in a listing, more than one bracketed letter will appear.

The provinces are coded by numbers from 1 to 77, and in the programme are requested by entry of the numbers assigned them. The numbering of the provinces is shown on the outline map (Fig. 2.1) and instructions for using 'Compute-a-Euc' in Appendix I .

2.3 Tree form

The first of the sections relating to the appearance of the trees in the field is that of 'form'. In this section there are three categories.

2.3.1 Tall trees, Code 78.

'Tall' trees are those over 30 metres (m) in height. They are usually straight trees found in good quality forests, with the first branches a long way above ground level and a high canopy. However a number of well-developed and more heavily-branched trees of open forests and woodlands also reach this size. Because this variable involves a considerable amount of estimation in the field, trees which in fact only approach this height are also included, often as 'uncommon' to indicate that such sizes are at the extreme end of the range for the species.

2.3.2 Medium trees, Code 79.

The next category is of 'medium-sized trees', which are erect, single-trunked plants which range in height from approximately 8 m to 30 m. This would be the most common range for eucalypt species. A similar procedure was followed in coding heights close to the boundary values of this category as was mentioned for the 'tall' trees. In the case of species which are characteristically in the 'tall' range when mature, the medium-sized feature is coded, but as 'uncharacteristic', as there will always be younger and less well-grown specimens in this range.

2.3.3 Stunted trees, Code 80.

The third category is that of 'stunted trees', or trees which are less than 8 m in height when mature and generally of shrubby, straggly or twisted appearance. They are often branched from or close to ground level. It includes the true mallees. A 'mallee' eucalypt is one displaying a specialised growth form that assists survival in adverse conditions, either of extreme heat or cold. The above-ground portion of these plants consists of a number of separate stems, usually relatively thin compared with the trunks of non-mallee plants. These stems emerge from an underground rootstock; a woody storage organ that can send up new stems if those above ground are damaged, for example by fire. A limited number of species occur as mallees, but sometimes stunted non-mallee eucalypts - that is, those without rootstocks - can resemble them so closely in form above ground that they are described as 'mallee-like' in the literature. As it is intended that 'Compute-a-Euc' be of use to those without specialised botanical knowledge, true mallees were not differentiated from stunted forms in coding in this category.
Most eucalypt species will become stunted if occurring on adverse sites. However to attempt to record all these, even as 'uncharacteristic', would dull the selectivity of this category. Consequently the only species to be coded as 'stunted' were those for which this form was mentioned as characteristic; those in which the typical height range extended to less than 8 m; and those in which stunting was indicated in the references to be frequent or distinctive of certain populations.

2.4 Bark

The bark of eucalypts, a feature that can be readily observed in every specimen, is one of the most useful characters for identification. With experience some species can be identified virtually by bark and area of occurrence alone. For example Eucalyptus sideroxylon, the red ironbark, is the only species with this distinctive bark type in Victoria. A number of keys to eucalypts and classifications of species are based on bark type. Eucalypts in bark-based groups, for example the ironbarks or stringbarks, while not always related botanically, do show consistent bark characters. Thus 'boxes', 'peppermints', 'mahoganies' and 'gums' all tend to display barks regarded as chracteristic of their group. Many common names of species refer to these groups, as in the case of the red ironbark mentioned above. In the 'Compute-a-Euc' bark

classification these distinctions are largely preserved. Nine categories are defined.

2.4.1 Smooth bark, Code 81.

The first is for smooth-barked trees. In these so-called 'gum-barked' species the bark is smooth throughout, and decorticates or sheds annually to ground level in scales, flakes or strips. The strips from some species occasionally hang in the branch forks, and these trees are sometimes mistakenly thought to be 'stringybarks'. The smooth bark is most often pale, with colours ranging from white to grey and pale brown. However in some species, and in others at certain times of the year, the smooth bark assumes quite striking colours including shades of red, olive green, pink and slate blue. Such colours may be uniform on the trunk or retained in irregular patches.

2.4.2 Smooth bark with stocking, Code 82.

Species in this category have the 'smooth' bark on most of the trunk, but near the ground retain a basal 'stocking' of rough, persistent bark. This extends to less than a quarter of trunk height.

2.4.3 Half-barked trees, Code 83.

In 'half-barks' this rough bark extends further than a quarter of the way up the trunk, changing to smooth bark before the major branches are reached. Sometimes the transition from rough to smooth is very abrupt; such trees have a striking appearance in the field. Trees coded as 'half-barks' are also listed under categories describing the type of the rough bark.

2.4.4 Stringybark, Code 84.

'Stringybarks' are species in which the bark is furrowed, rather thick, fibrous and fairly easily pulled off the tree in strips. Such strips tend to 'run' up the trunk and consist of very coarse, matted fibres. The overall appearance of the trunk is 'woolly' with the fissured, fibrous bark making quite prominent vertical or slightly spiral furrows on the trunk. It is usually brown or reddish brown to grey in colour.

2.4.5 Peppermint and Box bark, Code 85.

Peppermints and Boxes, grouped together as their barks are described in similar terms, have their own distinctive type. It is thinner and more finely textured than stringybark; less fibrous and more flaky, tending to crumble when rubbed or pulled off. The trunk has the appearance of being covered by a finely interlaced network of shallow fissures. Colour varies from dark grey through brown and the usual medium grey to a mealy white.

2.4.6 Rough bark, Code 86.

The sixth category covers the bark type of a wide range of eucalypt species in which the bark is rough, but does not conform to the 'typical' patterns of the other categories. The bark of the 'mahogany' group is a generally representative example of this reasonably consistent type. It is thick, quite prominently and coarsely fissured - more so than the bark of peppermints or boxes - but more crumbly and not so fibrous or stringy as typical stringybark, and softer than ironbark. It does not include thin barks such as those that are thinly scaly or papery in texture.

2.4.7 Tessellated bark, Code 87.

Tessellated bark is distinguished by being cracked into a more or less regular block-like pattern. When this pattern is well-developed the trunk looks as though it has been tiled with approximately square blocks of corky or flaky bark. This pattern, while occurring in some other species, is mainly a characteristic of the 'bloodwood' group of eucalypts, and is with some experience easily recognised even when less regular or 'sub-tessellated'. Another distinctive feature of the bloodwoods, from which they derive their name, is the red kino that is often found seeping from wounds on the trunk.

2.4.8 Ironbark, Code 88.

The ironbarks have, as the name implies, very hard bark which is either difficult or impossible to pull off the trunk with the fingers. It is usually dark, often almost black but sometimes grey, and may also be stained with red kino. Ironbark is rugged, deeply fissured and strongly ridged, making it a very distinctive type.

2.4.9 Other bark type, Code 89.

The final category is for trees with bark which does not fit readily into any of the above groups, such as the thin, papery types mentioned above. This section has also been used for coding very distinctive and unusual barks. Thus where the bark is of a kind that sets a species apart, that species is coded here (as well as in any other appropriate categories). Examples are the distinctively olive green trunk of Eucalyptus stellulata and the striking, sudden transition from tessellated to smooth bark in E. tessellaris and several related species.

To assist users who may be unfamiliar with these bark classifications, photographs representative of these and some other 'Compute-a-Euc' features will be kept with the province map at the Centre for Resource and Environmental Studies when they become available.

2.5 Habitat

The 'habitat' section allows for differentiation between species on the basis of the topographical sites in which they are typically found. It was included in 'Compute-a-Euc' as this is a useful way of distinguishing between many species in the one area, and it not only provides for the operator an impression of the sort of country in which particular species are characteristically found, but also complements the initial segregation of species according to occurrence on which 'Compute-a-Euc' is based. The inclusion of habitat information in a system where distributional and forest-type variables are also employed is in itself an interesting exercise because of the potential for generating lists of species with some relation to natural associational patterns.

However devising useful categories in which to code the various habitats in which eucalypts are found involved a number of difficulties. The most prominent and most persistent of these arose from the nature of the descriptions in the reference material itself. These varied from precise accounts of fairly specific sites, especially when the species were of restricted occurrence, to the occasional omission of any reference to habitat at all. Also it was not uncommon for the use of two different references to the one species to result in

a different set of habitat variables from each. Thus the categories had to be sufficiently broad to cover a large number of rather general descriptions, and at the same time sufficiently well-defined to be usefully selective.

In consequence of these difficulties, the coded information relating to habitat is perhaps less precise than that relating to form and bark characters. A certain amount of coding was more by implication than actual description, as too strong a reliance on key words for coding often resulted in a patchy and partial picture of a species habitat. It was a paramount objective to capture on code as true a record as possible of the actual range of sites characteristic of each species, without being unnecessarily over-inclusive. This was not an easy task, and involved co-ordinating as many references to each species as could conveniently be located, that were at the same time acceptably up-to-date. Field trips would assist greatly in this respect, but were unfortunately not possible within the scope of this project.

However within the context of available information, 'Compute-a-Euc' lists have been made as accurate as could be achieved by coding habitat differently for species occurrences in different provinces or groups of provinces, when this was appropriate. The need for this arose when coding habitat information for species with an extensive range, as preferred site often changes with location. This is especially prominent with those species having an extensive north-south distribution; while often occurring close to sea-level in the south, the northern occurrences are in many instances restricted to the higher altitudes. The problem in such circumstances is that coding the species as one of 'lowlands' because of its low-altitude occurrence in the south allows it to appear, inappropriately, in lists of the northern 'lowlands' species.

This difficulty has been avoided by making a number of entries onto the data file for the one species, each entry in respect of a particular group of provinces. For each of these entries the field characters, including habitat, are coded to match the conditions found specifically in those provinces listed in the entry. For example species with both mainland and Tasmanian occurrences very often are entered twice

on the data file; once in respect of the Tasmanian provinces, with Tasmanian habitat details, and again to cover the mainland provinces and mainland field characteristics. A similar technique is used to ensure that the code for coastal occurrence is resticted to provinces for which it is appropriate. However this is only done for those provinces in which confusion is possible. Entries for species were not split to avoid combinations with no actual possibility of occurrence.

After a certain amount of trial and error, the following categories were adopted.

2.5.1 Coastal areas, Code 90.

A species was coded as having a coastal occurrence if this was mentioned, or if the shading on the distribution map extended to the sea. Coastal occurrence was coded as 'uncharacteristic' if this extension to the sea occurred only to a very small extent in the province in question, or if the altitude of typical occurrence was greater than 300 m. If the minimum altitude was 600 m or greater a species was not coded as 'coastal'.

2.5.2 Island occurrence, Code 91.

This classification was not used for species on Tasmania or Kangaroo Island, as these areas are distinguished by their own province numbers. A species is listed as having an 'island occurrence' in a given province if there was any reference to this in the sources. However this information was very patchy even for the big islands like King, Flinders, Fraser, Bathurst and Melville Islands and Groote Eylandt, and shading of these or the lack of it on the distribution maps was not always consistent with the descriptions either in the same or other references. It is recognised that there is room for improving the accuracy of information in this particular category (as in a number of others) by field work. The provinces in which the larger islands are included are indicated by lines on the province outline map (Fig. 2.1)

2.5.3 Altitude-based categories.

2.5.3.1 Lowlands, Code 92. Areas of altitude less than 300 m above sea-level.

2.5.3.2 Rising country, Code 93. Areas in the transitional zone between lowlands and elevated country at 300 m to 600 m altitude.

2.5.3.3 Uplands, Code 94. Areas at altitudes of 600 m to 900 m.

2.5.3.4 Elevated country, Code 95. Where the altitude is greater than 900 m.

Most species descriptions included an altitude range; however altitude codes were inferred when this was not the case. If the described extent of a species range coincided with the 'boundary' altitudes above, the species was given a 'rare' coding in the adjacent altitude bracket, as it was considered unlikely that the described range would represent a sharp cut-off. This is in line with the bias towards over-inclusive listing mentioned previously.

2.5.4 Topographical categories.

These groups were conceived as lying more or less on a continuum from flat to rugged terrain. However as 'mountains' generally connote high altitude as well as rugged topography, species were in general not coded as occurring in 'mountains' unless their altitude was greater than 600 m above sea level. Another general policy employed in coding was that if two non-adjacent categories were mentioned in the description, then all those in between were regarded as implied, and included.

2.5.4.1 Plains and country of low relief, Code 96. This category was regarded as an extreme, and generally reserved for extensive flat areas. The 'coastal plain' of New South Wales is certainly flat by comparison with the Dividing Range immediately inland of it, but it was felt to be more accurately described as 'gently undulating' than as a true plain. Consequently species occurring on the 'coastal plain' of New South Wales are not included in this category.

2.5.4.2 Gentle slopes, gently undulating terrain, Code 97. This category includes low rises and sand dunes on plains.

2.5.4.3 Rolling, undulating and hilly terrain, Code 98. Self explanatory.

2.5.4.4 Ranges and ridges, Code 99. This category includes occurrences in valleys and on moderate slopes or ridges. If a species was described as occurring on 'low ridges', this was indicated with the 'uncharacteristic' notation. A considerable number of species were described in location lists as occurring in named ranges in various parts of the country, but their descriptions made no mention of a 'range or ridge' habitat. This was particularly common with Western Australian species, a number of these being listed as occurring in the Stirling Ranges, and with some South Australian species listed as found in the Flinders Ranges. To a lesser extent the same problem occurred with species in the Musgrave and Hamersley Ranges. As a coding of 'ranges and ridges' is largely by implication in these cases, the policy adopted was

to use the 'uncharacteristic' code. This ensures that the species names appear in respect of 'range' selections in the relevent provinces, but that they are also tagged by the bracketed letter 'markers' to suggest care in assuming them to be commonly present.

2.5.4.5 Mountains, rugged and broken topography, Code 100. This coding was implied in a number of species described as extending from the New South Wales coastal plain onto the tablelands, as this range includes the coastal escarpment.

2.5.5 Flats and banks of watercourses, Code 101.

Species which typically occur on alluvial flats, stream banks, swamps, poorly-drained areas, saline flats and intermittent drainage channels, or beside coastal and estuarine lagoons all appear under this heading. If they are described as occurring on flats, but these are 'dry' or 'skeletal' rather than alluvial, or the species is mentioned as avoiding poorly-drained locations, this is indicated by the 'uncharacteristic' notation. If a species has a marked preference for riverine sites, and is found in 'hilly', 'range' and 'mountainous' country almost entirely along watercourses, it will appear in lists under the headings of 'hills', 'ranges' and 'mountains', but these will be indicated to be 'uncharacter-istic' to distinguish such species from those on the higher slopes in such areas.

2.5.6 Plateaux, Code 102.

This feature indicates those species which occur on generally level sites but in elevated or broken country, and includes occurrences on broad flat-topped ridges. This category overlaps that of 'gentle slopes' to some extent, especially when the flat area of a plateau is extensive. Thus many species described as occurring on plateaux were also coded by implication as occurring on gently undulating terrain, and as 'uncharacteristic' of gentle slopes when classification under this heading was of uncertain validity. Conversely the named tablelands, for example those of New South Wales, present more extensive tracts of elevated, gently sloping land than is commonly indicated by the description of an occurrence on 'plateaux'. Thus species mentioned as occurring on such tablelands are coded as occurring on, but 'uncharacteristic' of, plateaux.

2.5.7 West of Divide, (N.S.W. & S.E. Qld.), Code 110.

This category was included, after the initial allotment of code numbers, to differentiate species with a 'lowland' occurrence on the inland side of the Dividing Range from those with a 'lowland' occurrence on the coastal side. These two groups of species are quite distinct and it was felt

necessary to include a variable by which the 'inland' group could be specified to the exclusion of the coastal group. In the inverse situation this is done by the coastal variable, no. 90. The 'west of Divide' variable thus excludes from listing coastal species occurring in the same province, and is coded for application to all New South Wales provinces and provinces 21 and 23 of south-east Queensland only. Its use in other areas is not intended and may produce inconsistent or inaccurate lists.

A similar 'caveat' applies to the use of a number of other 'Compute-a-Euc' variables. Because of the very large number of possible combinations and the difficulty of including editing segments in the programme, the operator is relied upon to request 'sensible' combinations. Entry of the coastal variable for an inland province, for example, or the 'greater altitude than 900 m' variable for the Nullarbor Plain province, will not provoke an admonitory response from the computer and will result in misleading lists. In all cases requests for variables should be in their correct sections and should match the topography and forest types likely to be found in the nominated provinces.

2.6 Forest Type

The final set of variables relates to the form of the natural vegetation in which eucalypt species may be found. This category, which is confined to relatively undisturbed stands of trees and excludes land altered for agriculture, was included in view of the tendency of many species to prefer particular forest types.

The major reference for this information was Specht et al. (1974). In this volume a number of the categories of vegetation type are defined by the density of the forest canopy. In this system a forest in which the canopy covers from 70 to 100 percent of the ground area is called a 'closed-forest'; if 30 to 70 percent of ground area is covered it is an 'open-forest'; 10 to 30 percent cover defines a 'woodland', and 'open-woodland' is characterised by less than 10 percent cover. These definitions form the basis of the 'Compute-a-Euc' classification.

When information from other references was compared with that of Specht, it was found that these sources most often mentioned just one vegetation type as typical of a given species. However it was common

for a wider range of types to be described in Specht. The policy eventually adopted was that all types mentioned were coded, but that those in Specht that did not coincide with the 'typical' pattern mentioned in other references were tagged as 'uncharacteristic'. This preserves the range of types recorded in Specht and at the same time gives an indication of the most usual formation in which a species is found.

Nine categories were employed.

2.6.1 Rainforest, Code 103.

Eucalypt species are not commonly found in the closed rainforests. A number however do have the distinctive ability to compete with rain-forest vegetation, and are often found in or at the edges of such forests. In Tasmania a number of eucalypts are recorded as occurring with a rainforest understorey. In all these cases the eucalypts are coded in the 'rainforest' category.

2.6.2 Wet sclerophyll forest, Code 104.

Sclerophyll forests are those dominated by eucalypts. In areas of annual rainfall greater than approximately 875 mm (35") such forests consist of generally tall trees above a "dense and luxurious growth of moisture-loving shrubs and herbs" (Hall, Johnston and Chippendale, 1970, p4) with ferns, palms and other species often forming a second layer or understorey. Such forests are described as 'wet' sclerophyll.

2.6.3 Dry sclerophyll forest, Code 105.

In drier situations with annual rainfall less than about 875 mm, or on less fertile sites, the dominant eucalypts are not usually of such good form as those in wet sclerophyll forests, and the associated shrubs are adapted to withstand more adverse conditions, showing such features as small, spiny or leathery leaves. The 'blackboys' or grass trees are an example of this type, which indicates a 'dry' sclerophyll forest.

2.6.4 Tropical forest, Code 106.

The distinction between dry and wet sclerophyll forests seems to be best maintained in the southern part of the continent, and accounts of northern vegetation rarely use these terms; rather the forest is in general referred to as 'tropical open-forest'. For this reason the wet and dry sclerophyll categories were used only in relation to provinces in the States of New South Wales, South Australia, Victoria, Tasmania and Western Australia south of 26 degrees south latitude (the continuation westward of the South Australia - Northern Territory border). In the

provinces of the remaining northern States and in Western Australia north of 26° S the distinction was not maintained, and all forest types indicated by classification as 'tropical forest'.

2.6.5 Woodland, Code 107.

Woodland, as described previously, is a more open plant community than a forest. The understorey may be mainly grassy or consist of small shrubs. As these vegetation categories are more or less arbitrary subdivisions of a continuous spectrum of forest density, there are many situations in which 'forests' as here defined grade into 'woodlands'. Thus although the woodlands in general characterise the drier areas between the humid forests and the arid interior, or alternatively the high altitude areas made adverse for plant life by cold conditions, there are few forest species that do not in some part of their range thin out into a woodland density as a result of some environmental factor. This is reflected in the coding for 'Compute-a-Euc'.

2.6.6 Mallee scrub, Code 108.

Mallee eucalypts, described in the section on form, often dominate large tracts of country. This vegetation type is coded separately in 'Compute-a-Euc' as it is a distinctive type. All species that were considered possible constituents of areas of low scrubby or mallee-like vegetation of approximately woodland density, but ranging from denser thickets to sparser occurrences, were included in this section. However to allow separation of the 'true' mallees from stunted forms of non-mallee species, the non-mallee species are coded as 'uncharacteristic' of mallee scrub. Where mallee-type plants were indicated to be found mixed with taller trees of woodland formation, though this mixture does not often occur, the 'mallee' species were also coded as being found in 'woodland'.

2.6.7 Isolated individuals, Code 109.

This category represents the extreme 'open' end of the forest spectrum. It indicates a canopy cover of less than ten percent of ground area, and includes the sparse occurrences characteristic of the inland arid zone of Australia, as well as the open-woodland density found in more humid areas on very adverse sites. In view of this latter situation a number of species which have a sparse occurrence on the poor and broken sandstones of the Central Coast and Blue Mountains regions of New South Wales are included in this category, as are a number of the snow gums and species of very high altitudes.

CHAPTER 3

THE "COMPUTE - A - EUC" PROGRAMME.

The 'Compute - a - Euc' programme has been developed on a 'Tektronix' mini - computer in the BASIC language. However in its operation no detailed knowledge of BASIC is necessary, and instructions on the use of the programme are included in Appendix I.

The initial part of the programme is interactive; that is to say it prompts the operator to key in the numbers that represent the variables required for species selection. The coded information on the species is stored on a magnetic tape cartridge, and this is loaded into the machine after loading of the programme itself and before the start of scanning. When the entry of variables is complete, the programme prints out on a line printer a heading showing the categories selected, and then scans the data file. When a species is found that fits the requested pattern of variables its name is printed on the line printer under the heading. This continues until all the data has been scanned. The list is then complete and may be used as a basis for identification from more detailed references as mentioned in Chapter 1.

The species have been placed on file in the sequence set out in the classification of Pryor and Johnson (1970). The list includes species of the genus Angophora. This genus is considered by Pryor and Johnson to be as closely related to certain groups of the genus Eucalyptus as are the various groups within Eucalyptus to each other (Pryor and Johnson, 1970, pp 18 & 19), and it is included for completeness. Angophora species are preceded by the letter 'A' instead of 'E' in the list. The sequence in Pryor and Johnson places species with close affinities together; thus this will also be a feature of the lists from 'Compute - a - Euc', though at certain points there will be unmarked jumps to the next major group.

The names of taxa are based on those found in the 'Classification' (Pryor and Johnson, op. cit.). A number of these, as mentioned by the authors, await formal description, and in the 'Compute - a - Euc' lists such names appear in square brackets. A small number of the taxa coded in 'Compute - a - Euc' have no published name. These are referred to as Eucalyptus species with affinity to a described

and related taxon, and the Pryor and Johnson code, if known, is included to indicate its position in their classification. Thus 'E. sp. aff. aspera (BAA:J)' refers to an unnamed eucalypt which is closely related to E. aspera and has the code BAA:J. The printing of an asterisk '*' before a species name indicates that the information available concerning this species is minimal, and that the coding may be inaccurate.

In 'Eucalyptus nomenclature' (G.M. Chippendale, 1976) a number of modifications to the taxonomy of Pryor and Johnson are proposed. A large number of these relate to whether or not certain populations of plants represent distinct species or subspecies. In general it was decided to maintain the majority of these distinctions in 'Compute-a-Euc'. This was done to preserve the maximum amount of detail in the coding of these taxa. Should it become apparent that separate identity as species or subspecies is not warranted, this can quite easily be allowed for in reading the list. However should two such taxa have been 'lumped' together during coding and then subsequently be shown to be distinct, the user cannot determine which is referred to without going back to the references for distributional information it is intended should be covered by 'Compute-a-Euc'. Combinations which differ from those in the 'Classification' (Pryor and Johnson, op. cit.) are listed in Appendix II.

3.1 Multi-variable selection.

A feature of 'Compute-a-Euc' which increases its flexibility is the provision for selection of more than one variable in each of the province, form, bark, habitat and vegetation sections. Thus two or more provinces may be specified, or a number of habitats, and so on. There are two relationships allowed for between such multiple selections.

3.1.1 The 'OR' relation.

When variables are entered in the sections of the programme connected with the 'OR' relation, a species is listed as soon as it is found to be described by one of these specified variables. Thus the list of species in 'province 1 OR province 2' will include those occurring in 1, or 2, or both. This request has the effect of aggregating smaller provinces into bigger ones for listing. Requesting all the province numbers in a State in this way will furnish a list of all

the species (subject to other variables selected) in that State.

3.1.2 The 'AND' relation.

When variables are entered in the 'AND' programme sections, species are listed that are described by all of these variables. To continue the previous example, if 'provinces 1 AND 2' are selected, only those species are listed that occur in both these provinces. Similarly, entering the variables for 'elevated' occurrence, 'undulating' terrain and 'riverine' sites will select those species for which all of these features are coded. In this way the specificity of lists may be increased or tailored to match the variety of situations met with in the field.

The details of operating these aspects of the programme are to be found in Appendix I.

CONCLUSION

The major objective of 'Compute-a-Euc' is to facilitate access to the many descriptions of eucalypt species. As most of these references are indexed by species name, using them to identify species with which one is unfamiliar requires much manual scanning and sorting. 'Compute-a-Euc' provides a means whereby this task may be done more rapidly on a computer. Its output is as a list of species names, which can then be used for access to the published descriptions.

Because 'Compute-a-Euc' includes habitat and forest type information along with details of occurrences, it has the potential to mirror in the listings a number of the natural eucalypt associations in various regions. In its present form such patterns of association implied by print-outs are of variable accuracy. It is recognised that the present compilation of coded information, on which the programme's performance and accuracy rests, is in many ways a 'first approximation'. A number of developments, to both the programme and the coding of information, can be built on to the basic framework already established. The upgrading and field testing of habitat information, and the honing of the listings into closer and closer representations of the natural plant associations, is one way in which 'Compute-a-Euc' might be developed.

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APPENDIX I

"HOW TO GET THE BEST OUT OF 'COMPUTE-A-EUC'", COMPLETE OPERATING INSTRUCTIONS.

The 'Compute-a-Euc' package operates on the mini-computer of the Centre for Resource and Environmental Studies in the BASIC language. In the event of any difficulties with it C.R.E.S. computing staff should be consulted.

The programme itself is stored on the indicated magnetic tape, and the data on a separate 'Binary File' tape. Both are required.

1. The mini-computer should be 'ON' with the line printer 'ON' and 'ON LINE', and the programme tape inserted. It should be operating as a mini-computer and not as a University system terminal.

2. Type FIND 5 on the keyboard and press 'RETURN' key. All keyboard entries must be returned to the machine with this key before they can be acted upon.

3. Type OLD. This loads the programme into the machine's memory. When the 'BUSY' light on the console goes out, press 'REWIND', remove the tape and insert the Data File tape.

4. Type RUN. This activates the programme.

The initial section of the programme requests entry of the codes you wish to make the basis of your list. The codes are as follows:

Codes 1-77 These are the province codes. For the areas to which they refer see the province map.

Code 78 Tall trees greater than 30 m in height.
Code 79 Medium trees 8 to 30 m in height.
Code 80 Stunted trees less than 8 m in height, mallees or shrubs.

Code 81 Smooth bark; decorticating in ribbons, strips or scales to ground level, 'gum-type' bark.

Code 82 Basal stocking of rough bark, rest of trunk as in 81.

Code 83 Half-bark; rough bark extends to more than a quarter of trunk height, with a line of decortication on the trunk.

Code 84 Stringybark; fibrous, long-fibred, stringy.

Code 85 Peppermint & Box; sub-fibrous, fine network of shallow fissures.

Code 86 Rough; sub-fibrous, flaky-fibrous, coarse and deeply furrowed.

Code 87 Tessellated; includes sub-tessellated, cracked into blocks, corky.

Code 88 Ironbark; thick, deeply fissured, ridged, hard and usually dark.

Code 89 Other type not as above, or unusual, distinctive.

Code 90 Coastal areas.

Code 91 Island occurrence, excluding Tasmania and Kangaroo Is.

Code 92 Lowlands; altitude less than 300 m.

Code 93 Rising country; altitude 300 m - 600 m.

Code 94 Uplands; altitude 600 m - 900 m.

Code 95 Elevated country; altitude greater than 900 m.

Code 96 Plains, country of low relief.

Code 97 Gentle slopes, gently undulating country; includes low rises and sand-dunes on plains.

Code 98 Rolling, undulating and hilly country.

Code 99 Ranges, ridges and valleys.

Code 100 Mountainous country, rugged topography.

Code 101 Lower sites; alluvial flats, adjacent lower slopes, stream banks, swamps and poorly-drained areas, flats. Includes coastal lagoons, also saline flats and intremittent drainage channels in arid areas.

Code 102 Plateaux; broad, flat-topped ridges.

Code 110 West of Divide in N.S.W. and provinces 21 & 23 of Qld.

Code 103 In or at edges of rainforest.

Code 104 Wet Sclerophyll Forest.

Code 105 Dry Sclerophyll Forest.

Code 106 Northern open-forest; Qld, N.T. and W.A. north of 26 S.

Code 107 Woodlands; alpine, shrub, savanna and tropical.

Code 108 Areas dominated by mallee and shrub eucalypts.

Code 109 Isolated individuals; very open, sparse vegetation.

Before these codes are entered, the programme asks for entry of either an 'A' or an 'O'. As mentioned in the 'Compute-a-Euc' full description (pp 21 & 22) the programme allows for the entry of variables between which either an 'AND' or 'OR' relation holds. These sets of variables are dealt with by different segments of the programme, and are thus stored in the programme as separate lists or 'arrays'. When both 'OR' and 'AND' relations are required in respect of the one field characteristic (that is; bark, form etc.) the relation between these two groups of variables can itself be specified as 'AND' or 'OR'. If the 'AND' relation is desired, enter 'A'; for the 'OR' relation enter 'O'. If only one variable is required in any section, or if only 'AND' or 'OR' type variables are required in any one section and not a combination of both, this entry is not of practical importance. If there is any doubt, entry of 'A' is recommended.

For example; it is wished to obtain a list of all species which occur at 600-900 m elevation and along watercourses. However the topography in which such riverine locations occur varies from 'undulating' to 'mountainous'. The first two variables - 94 & 101 - are thus connected by an 'AND' relation; all species listed should be those coded for both these variables. On the other hand the topographical variables 98, 99 & 100 are connected by an 'OR' relation, as they are alternatives. It is the relation between these two sets of variables that is selected at this initial entry point of the programme. In this case it is 'AND'; in other words the list required is of species coded for 600-900 m AND creeks AND hills OR ridges OR mountains.

As a second example, a list of species with any one of three bark types is required; those which have smooth bark to ground level, those with a rough 'stocking' or those that are 'half-barked' with the rough bark of the tessellated type. Species coded as either 81 OR 82 are acceptable, so these two variables are entered in the section of the programme asking for 'bark codes; 'OR' relation'. However the half-barks must be of the tessellated type, thus codes 83 and 87 should be entered in the section 'bark codes, 'AND' relation'. All that remains is to specify the relation between these two sets of bark variables, that is, between 81 OR 82, and 83 AND 87. The appropriate selection here is 'OR', thus an 'O' is entered.

As can be seen, the flexibility conferred by this arrangement also brings a degree of complexity. It is recommended that the required combinations and relations be thought out in advance of operating the programme.

On entry of 'A' or 'O' above, the programme awaits entry of province variables connected by an 'OR' relation. Enter the code numbers, following each one by pressing the 'RETURN' key. If none are required, or when entry is complete, enter a zero.

5. The programme now prompts entry of province codes with 'AND' relation. Entry of these is as above.

6. This sequence is continued for Form, Bark, Habitat and Forest Type variables.

7. When the last entry has been made, the programme prints out the selection of variables made, and scans the data file. Appropriate species names are printed out. If it is wished to stop the programme completely at any time, for example if an error has been made, press the 'BREAK' key on the keyboard twice. To start the programme again from the beginning, type 'RUN'. For the scanning section of the programme make sure it is the data file that is loaded, and that the line printer is 'ON' and 'ON LINE'.

8. At the end of listing, another run is initiated by entering RUN.

9. When finished with the programme remove tape, and turn machine and line printer off.

APPENDIX II.

"COMPUTE-A-EUC" TAXONOMIC COMBINATIONS NOT AS IN PRYOR & JOHNSON (1971

Species names are followed by an explanation of the difference between the 'Compute-a-Euc' combination and that in Pryor and Johnson's 'Classification'. As a number of these appear many times, they are abbreviated into the following codes:

1. The species has been described in the literature since publication of the 'Classification'.
2. A taxon regarded by Pryor and Johnson as a minor variant, a hybrid or a subspecies is included in 'Compute-a-Euc' as a species.
3. A taxon not previously so distinguished is included as a distinct subspecies.
4. A taxon in Pryor and Johnson has been omitted as insufficient information has been found to allow coding.

Each of these codes is followed by one of the next list to indicate the reference which was the source of the modification:

5. CHIPPENDALE G.M. (1976)
6. HALL, BROOKER et al. (1977-78)
7. HALL et al. (1970-75)

Eucalyptus acies - 1; 6.

E. angulosa - 2; 5 and Chippendale (1973) p 172.

E. aquilina - 1; 7.

E. balladoniensis - 1; 6.

E. barberi - 1; 7.

E. brachycorys - 2 and transferred to Series Dundasianae; 5.

E. brachyphylla - 2; 5 and Chippendale (1973) p 84.

E. brassiana - 1; 6.

E. brevistylis - 1; 7.

E. burgessiana - 1; 5.

E. calcicola - 1; 7.

E. cyanophylla - 1; 6

E. cylindrocarpa - 2; 5 and Chippendale (1973) p 180.

E. deflexa - 1; 6.

E. dichromophloia subspecies - 4.

E. effusa - 1; 6.

E. eremicola - 1; 5 and Boomsma (1975).

E. exilis - 1; 7.

E. forrestiana ssp. forrestiana - 3; 5 and Brooker (1974).

E. forrestiana ssp. dolichorhyncha - 1; 5 and Brooker (1974).

E. fraseri - 1; 5.

E. ["glauca"] - 4.

E. goniantha ssp. goniantha - 3; 5 and Brooker (1976b).

E. goniantha ssp. semiglobosa - 1; 5 and Brooker (1976b).

E. gregsoniana - 1 (previously E. pauciflora var nana); 5, 7.

E. hallii - 1; 7 and Brooker (1975).

E. henryana - 1; 5 and Blake (1976).

Angophora hispida - 1 (previously A. cordifolia); Blaxell (1976).

Eucalyptus huberana - 2; 5, 7.

E. incrassata form 'ceratocorys' - included as a distinct form of E. incrassata; Chippendale (1973) p 172.

E. incurva - 1; 5 and Boomsma (1975).

E. insularis - 1; 7.

E. kartzoffiana - 1; 7.

E. lansdowneana ssp. albopurpurea - 1; 5 and Boomsma (1974).

E. lansdowneana ssp. lansdowneana - 3; 5 and Boomsma (1974).

E. leucophloia - 1; 6.

E. leucoxylon ssp. pauperita-not distinguished from ssp. pruinosa; 7.

E. leucoxylon ssp. found on Eyre Peninsula included as distinct ssp; 7.

E. ligulata - 1; 7.

E. loxophleba ssp. gratiae - 1; 5 and Brooker (1972).

E. loxophleba ssp. loxophleba - 3; 5.

E. melanoleuca - 1; 5 and Blake (1976).

E. paliformis - 1; 6.

E. parramattensis ssp. parramattensis - 3; 5.

E. parramattensis ssp. sphaerocalyx - included as distinct subspecies; 5.

E. pendens - 1; 7.

E. platypus ssp. heterophylla - included as distinct subspecies; 5 and Chippendale (1973) p 58.

E. platypus ssp. platypus - 3; 5 and Chippendale (1973) p 58.

E. plenissima - 1; 5 and Brooker (1976a).

E. prominens - 1; 6.

E. pyrocarpa - previously E. pilularis ssp. [pyriformis]; 6.

E. redunca ssp.[melanophloia] - 4.

E. rhodantha - 2; 5 and Chippendale (1973) p 124.

E. rupicola - 1; 7.

E. saxatilis - 1; Kirkpatrick and Brooker (1977).

E. sphaerocarpa - 1; 7.

E. stenostoma - 1; 7.

E. sturgissiana - 1; 7.

E. urophylla - 1; 6.

E. yalatensis - 1; 5 and Boomsma (1975).

Alterations to the sequence of Pryor and Johnson (1971).

1. Species of the original series Preissianae, Diversifoliae, Marginatae, Jacksonianae and Acmenioideae are reorganised to include new Western Australian species (see list above) and according to Johnson (1976).

2. Sections Equatoria and Howittaria are removed from Subgenus Symphyomyrtus and placed in a new Subgenus Telocalyptus (Johnson, 1976).

3. Eucalyptus umbrawarrensis is transferred to Section Exsertaria (Chippendale, 1976).

APPENDIX III

TECHNICAL NOTES ON THE "COMPUTE-A-EUC" PROGRAMME.

The 'Compute-a-Euc' programme operates upon the numerical codes assigned a range of distributional and field characteristics of eucalypt species, listed in Appendix I (pp 26 & 27).

The data file has stored on it in binary form the name of each species, a number indicating the size of the one-dimensional array following, and an array of code numbers which indicate the features present in that species. 'Uncharacteristic' features are entered as negative values of the feature code number.

The programme, in lines 190 to 1096, stores the information entered by the operator. This information comes in as code numbers which represent his selection of variables. These codes are stored in ten arrays; 'A' and 'R' for area or province codes, 'F' and 'O' for form, 'B' and 'K' for bark, 'H' and 'T' for habitat and 'V' and 'G' for vegetation. Variables C0 to C9 inclusive are 'flags' indicating the number of elements in these arrays. The first-named of the above arrays (that is, A, F, B, H & V) store variables connected by the 'OR' relation, the second-named (R, O, K, T & V) store 'AND' relation variables.

Lines 1100 to 2770 generate the heading, translating the information entered in the first section of the programme into a description. It also acts as a cross-check on whether the operator has obtained his desired combination.

Lines 2775 to 4010 scan the data file for species whose codes match the requested variables. The names and one-dimensional arrays are read from the tape one at a time and scanned by sections of the programme relating to each of the ten arrays of operator-selected variables. These steps are skipped if the 'flag' indicates the array is empty or undefined. Selection of species in the patterns corresponding to 'AND' or 'OR' relations between variables is achieved by the actual structure of these sections and the conditions of transfer of programme control between them.

When an entry on the data file whose sequence of code numbers matches those requested passes through this section of the programme, control is directed to the output section beginning at line 4Ø3Ø. The species name associated with this array is printed first. Depending on the state of the 'flags' MØ to M9 - designed to signal the passage through the selection sections of negative values of the requested variables - the indicators of a feature 'uncharacteristic' of the species are added to its name if appropriate. Control is then returned to the scanning section, which reads in the next entry. This cycle continues until the end of the data file is reached.

Other programmes connected with 'Compute-a-Euc'.

These programmes are on the same tape as the main 'Compute-a-Euc' programme, which is at file 5.

The most useful of these is located at file 7. This programme enables the contents of any portion of the data file to be listed on the line printer. Each entry on the data file is assigned a sequence number, which appears on the listing. Beginning and ending with any specified sequence number, the programme lists the species name and all its code numbers. It should be remembered in reading the output from this programme that many species are coded in more than one entry in order that the habitat information be kept appropriate to specific provinces.

A complete list of the contents of the data file will be available at the Centre for Resource and Environmental Studies.

The other programmes on the tape, at files 3 and 6, were written to put onto magnetic tape the codes and species names in the form required by the main programme.

Modifications to existing programmes and new developments will be described in additional notes kept with the other 'Compute-a-Euc' maps and lists when and if they are incorporated into the system.