TROPICAL FORESTRY PAPERS 28

"PROSPECT" for Improved Use of Tropical Timbers

by

J.P. Smith

R.A. Plumptre

J.D. Brazier

V.T. Burclaff

C.E. Dorey

OXFORD FORESTRY INSTITUTE
DEPARTMENT OF PLANT SCIENCES
UNIVERSITY OF OXFORD
1994

TEP28 "PROSPECT" for Improved Use of Tropical Timbers Smith et al. OFI

PHOTOGRAPHS

Front cover

Making a dugout canoe from *Cordia millennii* (Mujuganjoma), Semiliki Forest, Uganda.
Photograph: R.A. Plumptre.

Back cover

Natural moist forest in Colombia River Reserve, Belize.
Photograph: R.A. Plumptre.

Flood plain forest with *Acacia albida*, *Kigelia africana* and *Riclilia emetica*, Mina Pools, Zambesi Valley, Zimbabwe.
Photograph: R.D. Barnes.

Logging truck on Bia River Bridge, Ghana.
Photograph: R.A. Plumptre.

The PROSPECT database in use at the Oxford Forestry Institute.
Photograph: J. Baker.

Chest, Wez Waring "Woodfellows".
Photograph: A. Brown.

Boat building, Guyana.
Photograph: R.A. Plumptre.

Oxford Forestry Institute
South Parks Road
Oxford OX1 3RB

Telephone: (0865) 275000
Fax: (0865) 275074
Telex: 73147 VIAOR G ATTN FOROX

TROPICAL FORESTRY PAPERS
No. 28

"PROSPECT" for Improved Use of Tropical Timbers

A Guide to the Use of Lesser Known Timbers

by
J.P. Smith, R.A. Plumptre, J.D. Brazier[1],
V.T. Burclaff and C.E. Dorey

[1] Wood technology consultant,
formerly at B.R.E., Princes Risborough

Oxford Forestry Institute,
Department of Plant Sciences,
University of Oxford
1994

ISBN 0 85074 129 7
ISSN 0141-9668

Printed and bound in Great Britain by Oxuniprint, Oxford University Press, Walton Street, Oxford

Foreword

This monograph has been written to record the work carried out by the Oxford Forestry Institute over the last ten to twelve years on compiling a database of wood properties and end-uses. The name given to the database is PROSPECT, which stands for the "*P*rogrammed *R*etrieval *O*f *S*pecies by the *P*roperty and *E*nd-use *C*lassification of their *T*imbers". One of the main objectives of the project, has been to allow a wide range of people to access the vast amount of scattered information on this subject, in a format that is comprehensive yet easy to use. It is hoped that it will enable wood users to select and utilise efficiently a wider range of the many attractive tropical timbers, which are at present virtually unknown or inappropriately used. The database is, therefore, primarily intended as a guide, not only to the timbers and their properties, but also on how to use them to best advantage. It contains information from some sixteen hundred references, and, besides being of considerable use to those who work in wood research, it is confidently hoped that timber specifiers, such as architects and engineers, as well as builders, joiners, furniture makers, and those involved in the timber retail trade, will also realise its value and full potential. The database is primarily designed to be useful to those who live and use wood in tropical countries, and only secondarily for those who live in countries which import tropical timbers. This publication takes pains to explain why using more tropical forest species should make the sustainable management of the forest resource easier rather than more difficult to accomplish. It is hoped therefore, that this monograph will encourage many to make use of PROSPECT.

Acknowledgements

The development of the PROSPECT database has been financed since its inception by the Overseas Development Administration of the British Government, whose support is gratefully acknowledged. The authors would also like to record their thanks to all staff who have contributed by entering data into the database, especially to Mr. Moray Isles and Mr. Bernard Lobo.

Contents

Page

FOREWORD iii

ACKNOWLEDGEMENTS iii

PART 1: THE NEED FOR PROSPECT 1

1. INTRODUCTION 3

2. WHY USE MORE SPECIES? 4
   - 2.1 Forest Degradation and Destruction 4
   - 2.2 Management and Species Use 4
     - The Results of Poor Management 4
     - Effects of Creaming 5
     - Methods of Avoiding Creaming 5
     - Disadvantages of Mixed Tropical Forest as a Resource Base 6
     - Implications of Removing More Species 6
     - Advantages to Management of Being Able to Utilise More Species 7

3. MARKETS FOR TROPICAL TIMBERS 8
   - 3.1 Local Markets 8
     - Durability and Preservation 10
     - Seasoning 10
     - Timber Grouping 10
   - 3.2 Export Markets 11
   - 3.3 Further Manufacture in Country of Origin 11

4. USING PROSPECT TO PROMOTE THE UTILISATION OF MORE SPECIES 12
   - 4.1 Information of Individual Species 12
   - 4.2 Species suitable for a Specified End-use 12
   - 4.3 End-uses for a Given Species 12

5. POTENTIAL USERS OF PROSPECT 13

6. THE FUTURE OF PROSPECT 14

7. CONCLUSION 14

REFERENCES 15

PART 2: GUIDE TO THE PROSPECT DATABASE 17

Tables

Table 1: Details of Production & Export of Tropical Wood Products 1989 9

Part 1

The Need for PROSPECT

1. Introduction

PROSPECT (*P*rogrammed *R*etrieval *O*f *S*pecies by the *P*roperty and *E*nd-use *C*lassification of their *T*imbers) is a database containing the wood properties of tropical timbers; a recommendation was made by the 11th Commonwealth Conference in 1980 that the Oxford Forestry Institute should develop a computer operated database drawing information from its extensive library records. Following this a three year project from 1981 till 1984 was funded by the Overseas Development Administration (ODA) of the British Government. The project employed a team of three people, headed by Dr. C. Goodwin-Bailey, who wrote a computer database program to operate on the Department's mini-computer which was the only machine at the time capable of running it. Data were abstracted from the literature and by the end of the project the information for some 1300 species had been recorded on cards; 900 of these had been entered into the database. At that stage no further funds were available to promote the use of the system although it was used internally and a limited number of enquiries were answered using information from it. Subsequently, in 1989, a decision was made to convert the package for use by IBM-compatible machines, which by then had developed sufficiently in processing power to be able to manage such large volumes of data. By this time there were similar but smaller databases operated by France and the Netherlands which are described in the literature (ITTO, 1989 & Wageningen, 1991).

Besides these databases of wood properties and uses, further databases recording wood anatomy information for wood identification have been developed by Drs. Elizabeth Wheeler and Regis Miller in the United States, and Drs. David Cutler and Peter Gasson at the Jodrell Laboratory at Kew in Britain. Other complementary databases include INSPIRE, developed at the Oxford Forestry Institute, which records information on the preferred environmental conditions and known uses of 173 species, and uses these data to assess their potential performance in tropical and sub-tropical plantations (Webb et al., 1984).

A new two year ODA project was approved in 1990 under the general direction of the second author, employing the first author to adapt the PROSPECT program and using the services of the third author as a consultant to reorganize the system. The database has been largely rewritten using FoxPro, a commercial database package which was ideally suited to fulfil the requirements of PROSPECT. After critical evaluation of the properties with a view to developing end-use classifications, the methods of recording timber data have been altered considerably, in order to make it possible to devise logical and reliable classifications for different timber uses. This has required considerable modification of the original system. It has meant that the whole of the 1990/92 project has been taken up with re-organizing the system and re-entering existing information rather than adding new information. Essentially, the database has now been improved and made suitable for use by anyone with access to a medium capacity PC. It provides easily accessible information relating to the properties and potential uses of a wide range of species, many of which are seldom if ever used.

Part 2 of this paper comprises a comprehensive user's guide to PROSPECT, with appendices providing the technical details of how the system operates, the timber characteristics and uses it records, and the current list of species it covers. The guide enables a beginner to use the system with minimal assistance. The priority now is to add more species to the system and test its value to potential users.

2. Why Use More Species?

PROSPECT is designed expressly to encourage the use of more tropical timbers; one may, however, ask whether it is not dangerous to use more species if a major priority is to prevent the destruction of the forest; will it not merely speed up the demise of the forest? Paradoxically, this point of view is wrong for a number of very good reasons; these are explained in the following sections of the paper before methods of operating PROSPECT are described in detail.

2.1 Forest Degradation and Destruction

A distinction needs to be made between these two terms. Degradation is the impoverishment of the forest in terms of numbers of species or their relative quantities; it also indicates a reduction in the capacity of the forest to provide the goods and services that it was formerly capable of providing. Destruction is a much stronger term; it involves complete removal of tree cover and the elimination of most or all of the associated flora and fauna in that location. Recovery from this state may take several hundred years, assuming no human interference, whereas recovery from degradation may be relatively rapid.

Although the destruction of tropical forest by man has been taking place for many centuries, the situation is now particularly serious, and a matter of concern not only to a small minority, but to a large number of people intuitively aware of the consequences of forest loss. The reasons for the relatively recent much wider public awareness of this problem are not difficult to find: the speed of destruction and degradation continues to accelerate, human population is increasing more rapidly, and the ability of mankind to measure these effects has greatly increased. Furthermore, communications have improved immensely, allowing millions to see the effects of this destruction of the environment on their television screens. The problem now centres, not on whether the destruction is taking place, but on how it can be halted or minimised.

Forest degradation and destruction and possible methods of combating them have been well documented in Lanly (1982) Brundtland et al. (1987), Poore et al. (1989), Repetto and Gillis (1988) and the World Resources Institute (1992). Total destruction almost always results from clearance of forest for agriculture, sometimes accelerated by access provided by logging roads, while degradation can result from overlogging or a variety of other factors such as fuel cutting, charcoal burning or grazing. Ultimately, the prevention of these processes can only be achieved by determined and effective management. This requires a decision not only from governments but also from wood users and the population as a whole, that these destructive processes must be controlled. It is essential that these forest management practices provide for the needs of the people by securing both forest and agricultural products, this can be best achieved when an integrated approach to land use management is adopted.

2.2 Management and Species Use

The Results of Poor Management

The attempts that have been made to devise methods of reducing or halting these destructive processes are equally well documented, both in the books mentioned above and in numerous International Tropical Timber Organization (ITTO) reports including ITTO (1990), Plumptre et al. (1991) and Cranbrook et al. (1990). All ITTO member countries have now pledged themselves to manage their forests sustainably by the year 2000 under the "Sustainability 2000" agreement. This is a good start, but only a start. Well meaning

declarations of intent do not put management in place. Further examination of the factors involved may shed some light on the difficulties which hinder the implementation of effective management.

Destruction results from people cutting down the forest and turning the land over to some other use. This can be the result of a planned process where there may be good reasons for removing the forest. It is, for instance, unrealistic to expect a country which is 80% covered by forest not to clear some of it to make way for agriculture to cater for a growing population. Frequently, however, destruction results from inadequate planning, or sometimes inability or a lack of determination to implement plans. Once destruction of natural forest occurs, only plantations will re-instate forest in a reasonable length of time and the full biological diversity of the forest is lost for a very long time. Shifting cultivation may not completely remove this diversity but it severely reduces it.

Degradation usually results from poor management. It frequently starts with "creaming" of the forest for the best species: – the mahoganies, afrormosia and iroko in Africa; mahoganies, rosewoods and cedar in South and Central America; rosewood, sandalwood and teak in India and Burma and the blackwoods throughout the tropics. Creaming usually occurs because net revenue per cubic metre utilised of a valuable species is greater, often very much greater, than for the less valuable trees; the market is assured, methods of handling the timber are known, export markets for the wood (and therefore access to foreign exchange) may be available; the timber is usually durable, frequently stable, and consequently tolerant of misuse such as inadequate seasoning. When the best species have been depleted the next best come into use and, in the absence of alternative supplies, the worst will eventually be used. There are very few woods that will not find a use if there is an acute shortage of timber. The final product will not be as good but "beggars cannot be choosers"; throughout most of the world there are few economically feasible alternatives to timber for most of its uses. The rule of the marketplace, therefore, is: "take the best and the most profitable first and the less good only when you are forced to do so".

Effects of Creaming

The creaming of forest is an insidious, wasteful and destructive process. It removes the best species, usually reducing their capability to regenerate and compete with other species; it may also reduce the genetic quality of these species because there is often selection against the best individuals in the population. Many high value tropical species are of medium density and strength; they are neither the very fast growing, low density light demanders nor the very high density, slow growing shade tolerant "ironwoods". They are, therefore, often moderately light demanding and regenerate best under some, but not too much shade. In Africa and South America, where the number of species marketed is relatively small in comparison with the total number available, creaming does not usually open the canopy sufficiently to favour regeneration of these species, whether naturally or artificially. In South East Asia however, the large proportion of medium density species with similar properties tends to lead to more intensive use of the forest which may be too intensive in some places. Here creaming is often less of a danger than the failure to control the size of trees taken and the total volume of timber removed per hectare at any given felling. Whitmore (1991) describes in detail the results of recent research into the ecological requirements of different species and types of forest.

Methods of Avoiding Creaming

There are three main methods which can be used to reduce the incentive to cream forests. One is to set "royalties" or forest fees for standing timber at such a rate that it is equally profitable to cut, process and market valuable as well as non-valuable species. In many tropical countries this would be a difficult to establish, mainly because a detailed knowledge

of production costs for different species, as well as the likely revenue obtainable from the different end products, would be very hard to quantify. There is also, likely to be strong resistance from the local timber trade, to such an idea, which relies on the valuable species to produce the major part of its revenue; high fees on valuable species may have to be balanced by very low fees on the low value trees. A second way is to improve the technology used to process the wood so as to add value to low value timbers. Finally the third way, is to improve the marketing of the products and identify "niche" uses for previously low value timbers in order to obtain a higher value for them.

Disadvantages of Mixed Tropical Forest as a Resource Base

The large number of intimately mixed species in this forest result in low quantities of any one in a given area. If markets are demanding in their requirements, particularly in terms of appearance of the wood, which is common for many export markets, then it is difficult to market timbers except as individual species; this in turn makes it difficult to supply enough of any one species to supply a large market demand.

The result over most of the tropics, except in parts of South and South East Asia, has been low percentage utilisation of the resource both in terms of available species and of yield per hectare which, historically, has varied between 0.3 and 2.0 m^3 ha^{-1} yr^{-1}. In addition, the percentage utilisation of the individual tree has been low with only prime logs from the bole being used and branchwood discarded.

Implications of Removing More Species

However, if the commercially profitable use of a larger number of species is achieved there will be less incentive to cream the forest and trees will tend to be removed in proportion to their natural occurrence in the forest. Even without any management this might merely result in the removal of all trees in the forest over the diameter which can economically be processed; the result would be a very open and immature canopy but it would probably still leave small trees on the ground roughly in the proportions in which they originally occurred. Subsequent regeneration, because of the openness of the canopy, would favour light demanders over shade tolerant trees but the forest would only be set back a few stages in its natural succession and most of the natural diversity would probably be retained. Very heavy fellings, however, cause a large amount of damage to the saplings and regeneration on the forest floor even though the destruction is often less than might be expected. (Whitmore, 1991). This type of situation is by no means desirable but probably better than uncontrolled creaming. Lack of effective tropical forest harvesting and silvicultural management is, therefore, bad for the forest if many species are taken, but not necessarily any worse, than if the forest is creamed for just a few. From the short term point of view of utilising the existing resource, it is far better to remove and make useful products from a large volume per hectare of many species, than a small volume per hectare of a few. In this way, a smaller area of forest is degraded to supply a given demand for timber. The case for using more species is, therefore, good even if management is poor.

In the worst case scenario it is possible that the indiscriminate removal of a large number of species is worse than creaming for a few. However, it should be noted that in the latter case the temptation to re-enter the forest is often too great and further removals usually result. Consequently, regardless of the number of species initially harvested, there is no real alternative to some form of management, for without it, the forest will eventually be destroyed.

Advantages to Management of Being Able to Utilise More Species

The exact silvicultural requirements for species and volume removal by harvesting will vary according to the type of forest and the objectives of management. These objectives can vary from retaining forest composition as close as possible to the natural state of the forest at one extreme, to optimising the growth of the valuable species without unduly affecting the diversity of the forest. It is assumed that the conversion of the forest to a monoculture or semi-monoculture is not desired.

Mahogany (*Swietenia macrophylla*) in Central America is a good example; the species regenerates naturally after hurricanes and fires but does not do so easily under a closed canopy. In order to ensure that there is mahogany in the future, fairly drastic opening of the canopy will be required. The same is true of the African mahoganies, iroko and some of the South East Asian dipterocarps but the actual conditions required will vary from one ecological community to another. There is a danger of removing too much, but there is also a danger of removing too little once management is in place and providing some protection from the natural hazards to which the forest has been exposed in the past. Complete protection would eventually result in forest composed of mainly shade tolerant climax species, almost certainly less biodiversity and a set of hard heavy timbers which are difficult to utilise. Conversely, overcutting can result in almost pure crops of extreme light demanders, climber tangles and a reduction of the populations of the shade tolerant species; this again may result in lower biodiversity. Good inventories of forest composition provide essential information required before sizable management decisions can be taken.

When effective management is established, the great advantages of being able to harvest and use profitably a large number of species become fully apparent. If all species can be used, management merely consists of specifying which trees should not be felled because they must be kept for silvicultural or environmental reasons. Minimum diameter limits can be set below which trees of any given species must not be felled and these will not be the same for all species. Trees with sapwood that is different from the (valuable) heartwood will often be grown to a larger size than trees whose sapwood and heartwood can both be used for the same purpose. Trees which only grow to a small size, for instance some of the understorey trees, which often inhibit the growth of regeneration of the valuable species, can be felled at lower diameters than the large trees; many grow to sizes that are quite large enough to be used in sawmills equipped to cut logs down to 20-30cm in diameter. Equipping a sawmill to cut this size of log is not usually costly if it is already capable of cutting larger logs. Trees that need to be kept to provide seed, or to give shade, can be left to grow larger than others. Trees that provide food for wildlife or non-timber products, valuable to man, can be grown to large sizes. The facility to use all or most species provides silviculturalists with the options they need, so that a more flexible approach to forest management can be adopted, while allowing forest managers to supply the forest industry with sufficiently large volumes of timber per hectare to make it profitable to operate. A thorough knowledge of the properties and potential uses of as many species as possible is, therefore, extremely valuable to any forest manager; without this knowledge effective management is very difficult.

3. Markets for Tropical Timbers

What are the main markets for timbers from multispecific tropical natural forest? Table 1 gives information about production and export of hardwood logs, sawnwood and panel products from 35 of the main tropical producer countries in 1989 (FAO, 1991).

The following facts emerge from the table:

- 18.3% of log production was exported but exports from Malaysia alone accounted for 77.3% of all exports; if Malaysia is omitted only 5.7% of the production of the other 34 countries was exported.

- 17.6% of sawnwood and sleeper production was exported but exports from Malaysia and Indonesia alone accounted for 79.9% of this; if these countries are omitted only 5.3% of production was exported.

- 62.8% of wood based panels were exported but exports from Malaysia and Indonesia accounted for 88.4% and if they are ignored only 19.4% of production was exported.

It can be seen, therefore, that, for all the main tropical wood products exported, the export market is dominated by these two countries, and for the great majority of the rest, the volume of wood products exported is very small compared with the amount consumed by the local markets.

Locally marketed timber is, therefore, vital to the housing, furnishing, tooling, and the general standard of living of the vast majority of people in the producer countries. Unfortunately, its importance, compared to the export trade, often receives little attention from Governments, environmentalists, and the international community, who also fail to recognise the fact, that failure to supply local demand often results in uncontrollable pressure on the forest which no amount of prohibition will control. It is essential, therefore, that governments and foresters in both their short and long term planning, give serious attention to local timber requirements. This is likely to not only stimulate demand for a greater range of species, but also helps to substantiate and foster the perception that the forest should be a sustainable asset to the local community.

The methods required to market timber locally, in tropical countries, may be quite different from export marketing and the following are some of the differences in the conditions which prevail:

3.1 Local Markets

The great majority of sawnwood used in tropical countries is used in building, while smaller quantities of better quality timber are used to make furniture; other uses include household tools, vehicle bodies, bridges, boats and a host of other, relatively minor uses in terms of quantity of wood used.

The quality requirements for many of these uses are often not very exacting. Most buildings have only one storey, they are of small size and do not require timber of great strength; but the one essential requirement for timbers used in construction, is that they should be **durable.**

Table 1: Details of Production & Export of Tropical Wood Products 1989

COUNTRY	HARDWOOD LOGS PROD		HARDWOOD SAWNWOOD PROD	EXPORT	HARDWOOD PANELS PROD	EXPORT
Cameroon	1969	457	1136	132	160	36
Central African Rep.	154	28	104	48	8	2
Congo	808	443	92	48	108	58
Ivory Coast	2650	550	1550	920	532	196
Gabon	1222	913	212	2	456	104
Ghana	720	201	944	308	106	32
Equatorial Guinea	160	120	84	36	20	0
Liberia	1008	701	622	50	10	6
Madagascar	468	534	462	0	10	0
Nigeria	5589	16	5400	2	466	0
Zaire	380	117	242	46	106	8
TOTAL AFRICA	**15128**	**4080**	**10848**	**1592**	**1982**	**442**
Costa Rica	941	4	1006	6	116	40
Mexico	426	0	338	0	1290	30
Nicaragua	485	0	254	2	6	6
Panama	279	0	36	0	24	2
TOTAL CENTRAL AMERICA	**2131**	**4**	**1634**	**8**	**1436**	**78**
Brazil	18964	46	19590	1066	5784	1366
Bolivia	243	0	182	0	8	4
Colombia	1900	0	1360	2	226	14
Ecuador	2701	0	2980	36	290	64
French Guiana	179	2	38	24	0	0
Guyana	188	18	114	18	0	0
Peru	1019	0	1068	6	72	0
Surinam	189	1	144	2	20	10
Venezuela	716	0	650	0	320	0
TOTAL SOUTH AMERICA	**26099**	**67**	**26126**	**1154**	**6720**	**1458**
Bangladesh	467	0	146	0	16	0
India	15812	61	29668	4	884	34
Indonesia	36226	3	20742	5418	17676	16186
Malaysia	41000	21110	16366	10270	3260	2420
Myanmar (Burma)	3657	360	06	146	30	0
Philippines	2702	101	1900	876	850	376
Thailand	2048	0	2518	160	514	34
Vietnam	1382	0	614	0	80	0
TOTAL ASIA	**103294**	**21635**	**72860**	**16874**	**23310**	**19050**
Fiji	169	0	106	0	32	14
Papua New Guinea	2416	1255	148	6	38	0
Solomon Islands	311	261	42	8	0	0
TOTAL OCEANIA	**2896**	**1516**	**296**	**14**	**70**	**14**
TOTAL TROPICS	**149548**	**27302**	**111764**	**19642**	**33518**	**21042**

Note:
1) Volumes are in thousands of cubic metres and have been doubled for manufactured products to allow for recovery during processing and enable comparison with log volume. Totals for manufactured products exceed log production in some instances where recovery is higher than 50%.
2) Volume totals are only for listed countries and not all countries in each region
3) Panel products include conifers as well as hardwoods.

Durability and Preservation

Many species are not used for the sole reason that they lack durability and, in many countries, people will go to great expense to obtain a high grade, durable wood to build their house rather than accepting a lower cost timber treated with preservative. The predilection for iroko (*Milicia*, formerly *Chlorophora, excelsa*) in Ghana for building is an example; elsewhere it is used only as a high value furniture and joinery timber. The cost of pressure treatment with a Copper-chrome-arsenate preservative is seldom more than 20-25% of the price of the cheaper timbers and, therefore, the total price of these, plus treatment, is normally considerably lower than that of the more valuable durable wood. Treatment is very effective; CCA-treated fence stakes of non-durable species have lasted for more than 30 years in tropical conditions (USDA, 1990). Few tropical countries, however, have adequate treatment facilities. A priority requirement for the use of more species is therefore the provision of adequate preservation facilities. This would add significantly to their ability to use more species. Research in Uganda on 50 species (Plumptre and Kasirye, 1968) showed that only two of these were non-durable as well as being resistant to treatment; all the rest could be used, provided that all sapwood and the heartwood of the non-durable ones were treated. The chances are good therefore, that by using relatively simple methods of timber preservation, most non-durable woods could be easily and effectively treated.

Seasoning

The second major cause of the failure to use tropical timbers successfully in their countries of origin is inadequate drying; consequently the products made from them are of poor quality and of low value. In most locations where the timbers grow, the climate is humid, and air drying cannot dry the timber below a moisture content of 16-20%, even during dry seasons. The equilibrium moisture content of wood within closed buildings in these climates is in the region of 12%. Shrinkage between 16%mc and 12%mc can be very considerable, particularly if wide boards are used to make such things as a table top. If a quality product is to be obtained, it is, therefore, essential to kiln dry timber to be used for furniture and joinery manufacture, even in tropical countries. This is by no means universally understood, and results in widespread misuse of timber which is most apparent when the less stable woods are used. It is no accident that the most valuable timbers are not only durable but stable. Their value derives from their ability to tolerate misuse.

The use of kiln drying, or solar kiln drying techniques, are therefore considered essential if the range of utilisable species is to be increased. Either method provides a degree of control over the drying process that minimises both drying degrade and subsequent movement in service.

Timber Grouping

Provided the requirements for preservation and seasoning are met, and where appearance and colour are not considered essential attributes, the opportunities for grouping timbers for different uses in local markets are considerable. Prime examples would be in construction and timber framing. As well as selecting individual species for a particular use, PROSPECT enables timbers with similar properties to be grouped together. This helps to offer economies of scale as far as marketing and distribution is concerned, and a degree of buffering should any one species timber temporarily fall in short supply.

3.2 Export Markets

The introduction of new species to export markets is more difficult than to local ones. The range of possible uses is normally smaller, large quantities of a uniform product are normally required and quality specifications are high. Grouping of species is not normally easy because colour is often important in selecting the wood. Nevertheless, one outstanding exception to this rule is the grouping of Malaysian Dipterocarps into the light red, dark red and yellow merantis which sell in huge quantities around the world; it is clear, therefore, that where grouping for international trade is agreed there are large benefits in terms of the morew species to be obtained. Closer links improve communications between producers and users, making the introduction of unknown species or groups of species more likely, often in small trial quantities in the first instance. Knowledge of timber properties and potential uses is essential in creating these links.

3.3 Further Manufacture in Country of Origin

The further processing of sawnwood and panel products into such items such as furniture, furniture components, mouldings, doors, windows, flooring and other similar commodities, frequently make it possible to mix different timbers into the product without detracting from its quality and acceptability. This can add appreciably to the number of species that can be marketed.

It is planned during the current project to provide a facility to compare new species with well known "benchmark" species so that substitutes can be found for known, valuable timbers.

4. Using PROSPECT to Promote the Utilisation of More Species

PROSPECT, not only offers an information base on individual species properties and uses, it also provides the enquirer with several different ways of looking at the information. The following are brief summaries of what is offered; a more detailed description of how the system works and how to use these options appears in later sections.

4.1 Information on Individual Species

The database currently contains information on over 90 properties and more than 160 recorded uses for individual species. The references from which the information comes are recorded so that any data can be traced back to source. Up to twenty references are recorded for any one property. Species can be searched for either by botanical or local name and by region or country. The system is, therefore, versatile in obtaining information on an individual species.

4.2 Species Suitable for a Specified End-use

The properties required for a particular end-use can be specified either by using a "system" specification built into the system by the suppliers of PROSPECT or by users making up their own specification. The program then compares the properties of timbers in the database with the specified requirements and lists species in order of their degree of compliance with the specifications. This enables selection of the most suitable species for the use.

4.3 End-uses for a Given Species

Similarly, it is possible to use the system to find the suitable end-uses for a given species. This facility can be useful to identify what is the most suitable use for a species.

5. Potential Users of PROSPECT

PROSPECT is currently one of the largest and most comprehensive available databases of wood properties and uses.

- It covers some 90 properties and over 160 uses. A list of properties and uses is given in the appendices of part 2.
- It contains detailed information on size of tree, location of occurrence and local, trade and botanical names.
- It allows great flexibility in searching the system and tracing information back to its original source.
- It offers two methods of using end-use classifications firstly, by searching for species for an end-use and secondly, by searching for end-uses for a species.

It differs from other databases in being strongly oriented towards the use of tropical timber in local as well as export markets.

The following are seen as potential users:

In Producer Countries:

1. Forest services and research institutions: to give them comprehensive information, often not available in local libraries, on timber properties and uses in an easily accessible form; to identify where further research into timber properties is required (and avoid unnecessary duplication of such work); and to provide a basis for the promotion of timbers and the better utilisation of the forest. The database can form the basis for systems of grouping timbers for particular uses so that species can be marketed by groups. This benefits forest management in giving more flexibility to management and more revenue per hectare.

2. Promotional organisations, exporters and traders in timber: to find substitutes for currently used timbers, to facilitate grouping of timbers and to prepare promotional literature.

3. Wood processors, sawmillers, plymillers and other primary users of wood: to improve knowledge and utilisation of woods they already use, to find substitutes for these timbers by identifying other species with similar properties, to thus increase yield per hectare and consequently reduce logging costs.

4. Users of timber including engineers, architects and secondary wood using industries: to increase knowledge of how to improve the use of known timbers, to give information which promotes better methods of design of timber products and to indicate possible substitute timbers.

5. Educators: universities working in timber research and education.

In Consumer Countries:

1. Timber importers, agents and distributers: to promote and market under-utilised species.

2. Those concerned with developments in design, production of codes, standards and specifications.

3. Users of all kinds, architects, engineers, manufacturers, etc.

4. Wood research organisations and teaching establishments.

6. The Future of PROSPECT

PROSPECT is currently operational and almost 950 species can be readily accessed. The main system is virtually complete except for the possible addition of a graphical method of comparing the properties of one timber with another "standard" one. As many more species and additional data continue to complement the system, users of PROSPECT will need to be provided with a service that can update the database at regular intervals. This can and should be done in co-operation with organizations operating other systems, possibly offering joint packages of several databases which give complementary information.

7. Conclusion

PROSPECT can only be a means to an end. It is designed to gather and focus information, often only to be found in hundreds of inaccessible publications, into a single "user friendly" database, that not only provides a wealth of information on timber properties, but also uses that same information to suggest specific end-uses where maybe none existed before.

There is no doubt that the opportunities for tropical countries to secure greater value from their natural tropical forests, (both from products used locally and from exports), are immense. The value of the forest can be increased by extending and improving the range and quality of forest products, thus stimulating investment, employment, and conservation. This is one of the most important contributing factors motivating sustainable forest management policies. Strategies need to be developed for using more species and a greater proportion of each tree so that the available resource is used to provide maximum value. These strategies need to be tailored differently for local and export markets.

It is hoped that PROSPECT will be used as a tool to achieve these ends.

References

Brundtland, G.H. et. al. (1987) Our common future: The World Commission on Environment and Development. Oxford University Press. 383p.

Cranbrook (Chairman) et. al., (1990) The promotion of sustainable forest management: a case study in Sarawak, Malaysia. Report to ITTC No. ITTC(VIII)/17. 206p.

Echenique-Manrique, R. and Plumptre, R.A. (1990) A guide to the use of Mexican and Belizean timbers. Tropical Forestry Papers No. 20, Oxford Forestry Institute, U.K. 175p.

FAO, (1991) Forest products yearbook, 1989. FAO, Rome. 336p.

ITTO, (1989) Lesser known tropical wood species database software (Version 1.0), User's guide, CTFT, Paris. 9p.

ITTO, (1990) Selection and introduction of lesser known and lesser used species for specific end-uses. Final report of ITTO project PD 18/87 Rev 1(1). 15p.

Lanly, J.P., (1982) Tropical forest resources. Tropical Forestry Papers No. 30., Oxford Forestry Institute, U.K. 106p.

OFI, (1992) Annual report for 1991. Oxford Forestry Institute, U.K. 37p.

Plumptre, R.A. and Kasirye, B., 1968, The resistance of Some Ugandan Timbers to Vacuum-Pressure Impregnation with Copper-Chrome-Arsenate Wood Preservatives, Uganda Forest Department, Bulletin No. 10, 17p.

Plumptre, R.A., Jayanetti, L., Fraser, A.I., Fawcett, T., Elliott, G.K. and Gane M., (1991) Incentives in producer and consumer countries to promote sustainable development of tropical forests. OFI & TRADA report to ITTO. 71p.

Poore, D., Burgess, P., Palmer, J., Rietbergen, S. and Synnott, T. (1989) No timber without trees. Earthscan Publications, London. 252p.

Repetto, R. and Gillis, M., Eds. (1998) Public policies and the misuse of forest resources. Cambridge University Press. 432p.

USDA, (1989) Comparison of wood preservatives in stake tests. 1987 progress report, US Forest Products Laboratory, Madison. 98p.

Wageningen, (1991) MoreLKS, Manual for the computer program concerning lesser known species and end-use requirements. Pub. Wageningen Agricultural University, Netherlands, 65p.

Webb, D.B., Wood, P.J., Smith, J.P. and Henman, G.S. (1984) A Guide to Species Selection for Tropical and Sub-Tropical Plantations. Tropical Forestry Papers No. 15, (2nd edition, revised), Oxford Forestry Institute, U.K. 256p.

Webster, C. (1978) Timber selection by properties - The species for the job. Windows, Doors, Cladding and Flooring. Report, Building Research Establishment, HMSO, London, Part 1, 125p.

Webster, C., Taylor, V. and Brazier, J.D. (1984) Timber selection by properties - The species for the job. Furniture. Report, Building Research Establishment, HMSO, London, Part 2, 88p.

Whitmore, T.C. (1991) An introduction to tropical rainforests. Oxford University Press. 226p.

World Resources Institute, (1992) World Resources. A report by WRI, UNEP and UNDP, Oxford University Press. 385p.

Part 2

Guide to the PROSPECT Database

Contents

1. INTRODUCTION 1

2. DATABASE CONTENTS 2
   2.1 Species Taxonomy 2
   2.2 Species Distribution 2
   2.3 Timber Properties 2
   2.4 End-Uses 2
   2.5 References 2

3. DATABASE OPERATION 3
   3.1 Navigating the Menus 3
   3.2 Operating Hints 3
   3.3 Contributor Information 4
   3.4 Manager Privilege 4

4. A PROSPECT SESSION 5
   4.1 Timber Characteristics Data 6
   4.2 Database Details 13
   4.3 References 22
   4.4 Species Evaluation for a Given End-use 25
   4.5 End-use Evaluation for a Given Species 32
   4.6 System Configuration 36
   4.7 Directory of Contributors 37

5. APPENDICES 39
   Appendix 1. Technical Aspects of PROSPECT 39
   Appendix 2. List of Timber Properties 42
   Appendix 3. List of End-uses 55
   Appendix 4. List of countries/geographical regions 56
   Appendix 5. List of species 57

1. Introduction

This guide is designed to show how the PROSPECT system operates, how the data it records can be presented to the user, and how the relationship between a timber's properties and its possible uses can be used to survey that information.

An outline of the structure and content of the database is given and general guidelines are provided on operating the program, understanding user input requests and accessing on-line help. The main part of this guide takes the form of a PROSPECT session, examining the functions of each section of the program.

The PROSPECT database currently contains some information for almost 950 species. Of these, there are approximately 40% Asian, 30% African and 30% Central and South American species.

2. Database Contents

PROSPECT records a wide range of information for each species, covering the following areas:-

General information
Taxonomy: botanical names and synonyms/misapplied names
Vernacular names: trade/commercial and common/local names
Distribution: occurrence by country or geographical region

Timber information
Timber properties
Known end-uses

References
Publications used in the data extraction

2.1 Species Taxonomy

Species names are recorded in terms of family, genus, specific name and authority. A list of the species currently included in PROSPECT is shown in Appendix 5. Vernacular names are registered as either a trade/commercial name, or a common/local name. Each common name is recorded with a link to its associated literature source.

2.2 Species Distribution

The distribution of each species is described in terms of its known occurrence in a country or general geographical region selected from predefined lists of countries and regions (Appendix 4).

2.3 Timber Properties

The features of the timber are based on a predefined list and are also grouped into 12 sections. Each property is defined by a list of possible descriptions. Data of a numerical nature are entered into predefined size classes. The system has the capability to record up to 20 different data sources for each timber property and any relevant conditions under which the data were evaluated. These multiple data entries can be displayed to illustrate any variation of opinion in the published literature and allows the user to make his own interpretation of the data. Each data item is coupled with the reference source from which it was extracted. General comments or observations relating to any property of a given species and also the technical definition and related information can be displayed. Detailed descriptions of the recorded characteristics are shown in Appendix 2.

2.4 End-Uses

Recognised end-uses are based on a predefined list and are recorded within the same data structure as the timber properties, but with three fixed categories denoting the known degree of use. Details of the list of end-uses and descriptors are shown in Appendix 3.

2.5 References

References are recorded by author(s), date of publication, title, journal and, for the benefit of users at the O.F.I., the library in which the publication was located and its actual location (shelf mark) within the library. Each publication is given a unique code number by which it is referred to in the database.

3. Database Operation

3.1 Navigating the Menus

PROSPECT operates by means of menus and data entry screens. Menus are used to direct the user through the different areas of the program by offering a choice of options from a list. In general, these can be selected by moving the cursor to the desired choice and pressing RETURN. The ESC(ape) key will cause the program to return to the previous menu stage.

Some options may invoke further menus or prompt the user for more information. Menu choices can also be selected by pressing the first letter of the chosen option.

3.2 Operating Hints

Help
At all stages of the program a status line is shown at the bottom of the screen to advise the user of the next possible action to be taken. At any time on-line help is also available by pressing function key F1.

Useful Keys
Most keys have their expected functions, but there are some additional key operations which may be useful for deleting text in data entry fields:

Ins	= toggle between insert and overwrite modes
BackSpace	= backspace i.e. delete preceding character
Del	= delete current character
Ctrl+Y	= delete from current character to the end of the line

deleting a string of characters:
mark block of text

Shift+→	= highlight character(s) to the right of the cursor
Shift+←	= highlight character(s) to the left of the cursor

then

Del or BkSp	= delete block

Case Sensitivity
The program is insensitive to upper and lower case characters. It will convert text where it needs to and will always make matches with database data without regard to case.

Data Matching
When entering requests for information from the system, it is not always necessary to enter the whole text. For example, the first few letters of a species name or country may be enough to identify it uniquely. In many cases it will also check if any records *contain* the chosen string. If more than one matching record is found, the user will be prompted with a list of choices.

Data Entry Fields
Moving between entry fields is performed by using the RETURN or cursor keys. In general, the user will complete fields in sequence down the screen. On completion of the last field, the program performs the request. However, moving the cursor **up** at the top field will also complete the entry screen.

Prompting
The user will generally be told how to enter their requirements by means of the status line or specific messages. In many places, a list of the possible choices can be evoked by putting a "?" as the first character of the field.

Printing
Most output produced on the screen can also be reproduced on a printer. The option to print will be indicated on the status line, and can be invoked by pressing the F2 function key. The user will then be asked for confirmation and then can choose to send their results directly to a printer or to a file named RESULTS (set by the program).

Output from PROSPECT will not exceed 80 characters in width. If a specific typeface or line spacing is desired on the printout, this will need to be set manually before starting to print. However, if output is directed to RESULTS, the resulting text file can be imported into any preferred word processor.

The printed output may not be identical to the screen displays, but this is most commonly because screen colours must be represented by symbols.

3.3 Contributor Information

As PROSPECT has developed it has become apparent that many users have data of their own which they would like to include in the database. This information could also be useful to other users of the system.

PROSPECT records the "originator" or "contributor" of each item of information together with the date on which it was entered or last edited. This means that data provided by a user can be identified when added to the master copy held at the OFI.

Each item of information in the database is labelled with a unique three-letter code denoting the contributor and the month and year entry. Any user may see this information by pressing function key F9 which switches the display on or off. Alternatively the setting may be fixed using the "System configuration" option of the main menu. A directory of contributors with their identity codes is available from the main menu.

When this option is enabled, the contributor details will be included in all displays of species names, vernacular names, distribution details, property data and comments, end-use data and references.

3.4 Manager Privilege

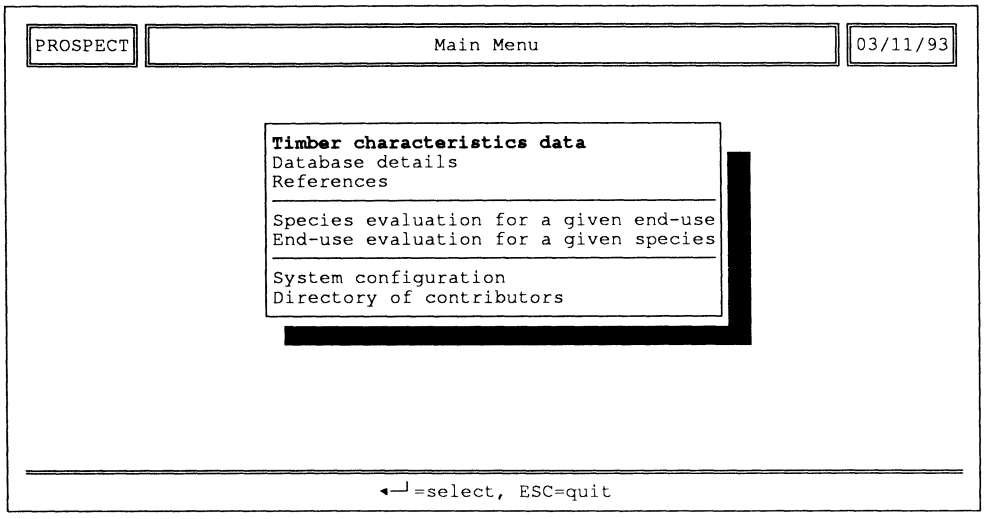
The system will normally operate in "read-only" mode. This means an inexperienced or non-technical user can view any part of the data but is not able to edit or delete the data. Only the OFI will have the privilege to "manage" the database. Sites wishing to add data to the system (contributors) will need to apply for special authorisation from the OFI, and will then be given a unique contributor's identity code.

4. A PROSPECT Session

Throughout this part of the program guide each menu stage is displayed and described. Most menu choices are self-explanatory, but each item will be briefly outlined. Menu options requiring supplementary input are described but the resulting screen displays are not always shown.

Not all input field entries are shown, but the data requested are usually self-explanatory. Where names are requested, for example genus, only a few letters of the name need be given although identification time will be minimised by entering the whole name. Where there is a need to identify a data item uniquely, a "?" may be entered as the first character of the input field to display the list of possible choices from the database. The program will automatically do this if it cannot uniquely identify the entry.

At the bottom of each screen the choices are shown for the next action that may be taken. This action usually entails pressing a function key, the ESC key, or any other key to continue the run. The function key F1 may be used to get help at any time, either to clarify the input required or to interpret the output. For certain output screens, function keys can initiate further displays to explain how the output was obtained, or to display additional relevant information.



The program begins with a "Main Menu" which gives access to the main sections of the program.

Timber characteristics data
- any subset of the data recorded for each species

Database details
- characteristic list
  (characteristics/characteristic groups/end-uses)
- distribution details
  (countries/regions/species distribution)
- taxonomy
  (families/genera/species/synonyms/misapplied names/vernacular names)

References
- any subset of the recorded references

Species evaluation for a given end-use
- Evaluates species which exhibit properties which make it potentially suitable for a given end-use

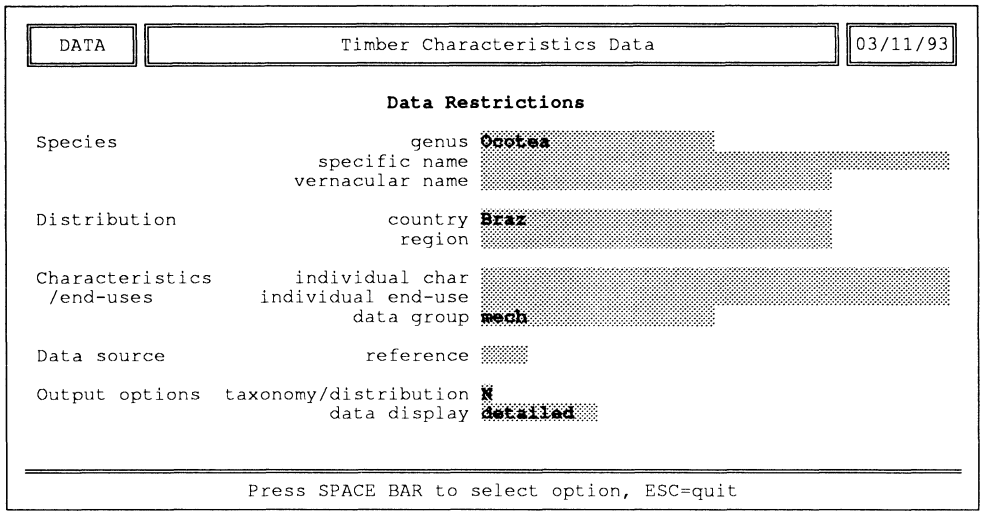
End-use evaluation for a given species
- Evaluates possible products which might be made from a given timber

System configuration
- Sets default assignments for cursor shape, data display options and reference display order.

Directory of contributors
- ID codes and names/addresses of contributors

4.1 Timber characteristics data

A major function of the PROSPECT program is concerned with showing any selection of species information stored in the database. The first item on the main menu provides the facility to browse selected areas of data.



Choosing "Timber characteristics data" from the main menu enables the user to display any subset of the timber data. Limitations on the range of data can be specified by filling in the relevant fields for any combination of the following:

Species	species (by botanical or vernacular name) or genus
Distribution	country or geographical region
Characteristics/end-uses	property, end-use, property group or all end-uses (enter "end-uses")
Data source	individual reference from which property/end-use data originates
Output options	the last two input fields enable the user to control the level of data output for each species.

taxonomy/distribution
this information is optional, enter Y for yes, N for no

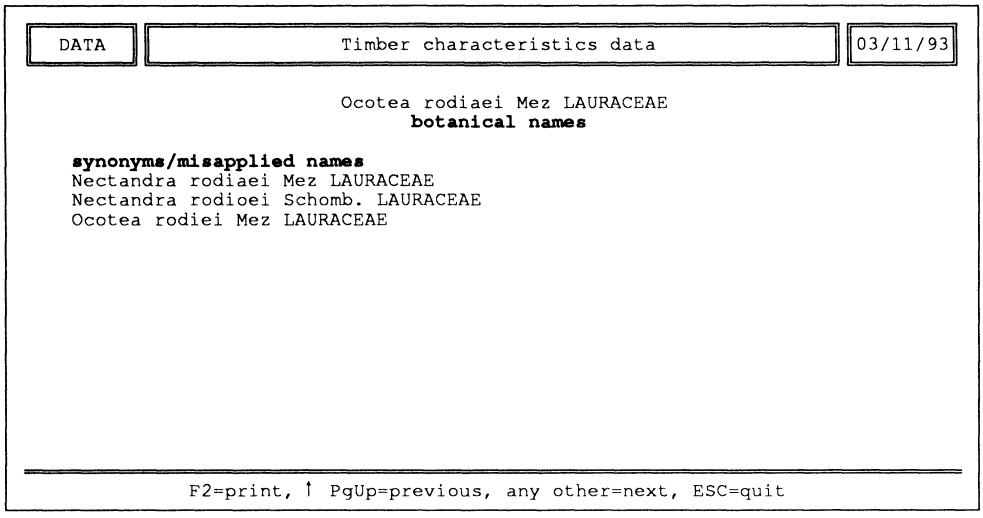
data display
sets the level of data displayed for each timber property or end-use to:

detailed	includes each item of information with reference to its literature source
summarised	shows number of literature sources recording each descriptor under each condition (if any)
none	no property data displayed (only possible if taxonomy/distribution requested)

If no restrictions are given on the range of characteristics/end-uses then all characteristics are output followed by the recorded end-uses. If a single characteristic or end-use is requested for all species or a particular genus, the descriptors of interest may also be selected.

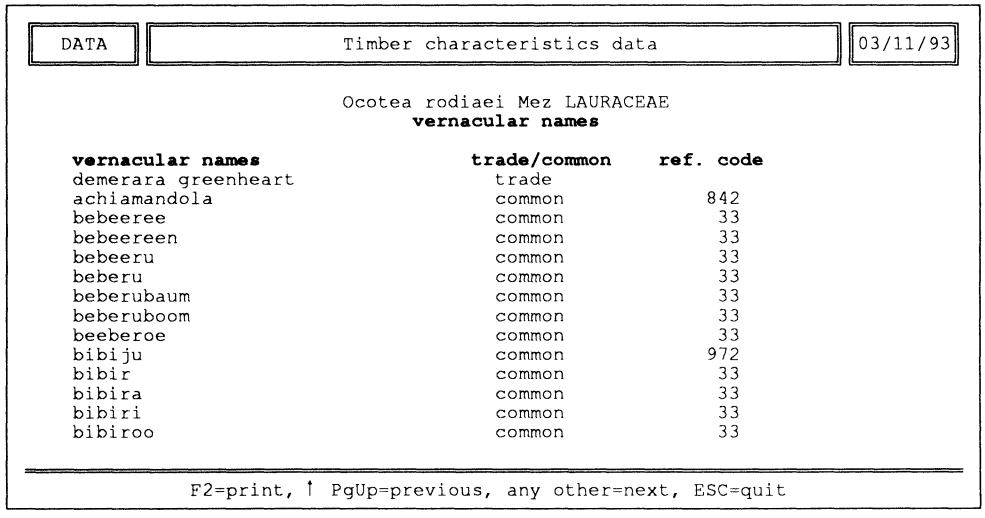
If there are data for more than one species within the requested range, a list of these species will be shown before output continues. All of these species may be viewed in alphabetical order or an individual species may be selected. At any stage during the following displays the complete sequence of requested data can be printed by pressing the F2 function key.

If "Y" is entered for the "taxonomy/distribution" option, the following three screens of data will be shown for each species:



If taxonomy/distribution output is requested, the current name of the current species, and a list of its synonyms/misapplied names is displayed.

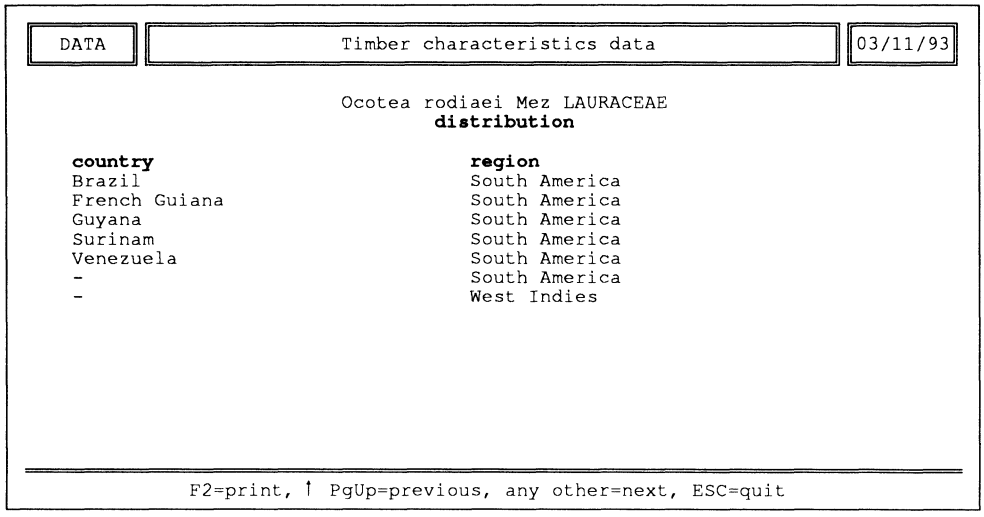
If the contributor display is enabled (function key F9), an extra column will be displayed, showing the contributor of each species name and the date of entry.



If the taxonomy/distribution output if requested, vernacular names for the current species are displayed. This includes information on whether each name is a commercial/trade name or local/common name for the timber. If it is a common name, it will also show the code number for the reference in which that name was cited.

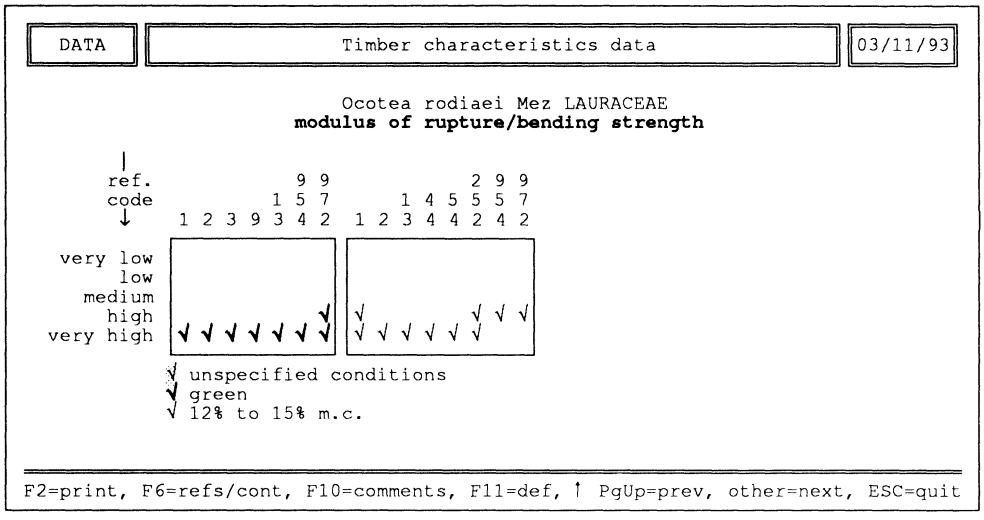
This list can be extensive and will continue onto subsequent screens if necessary. The above example is the first display screen of four.

If the contributor display is enabled (function key F9), an extra column will be displayed, showing the contributor of each vernacular name and the date of entry.



If taxonomy/distribution output is requested, the distribution of the current species is displayed, showing the country and region where the species is known to grow. A specific country may not have been given in the literature, so distribution may be recorded as a general geographical region only.

If the contributor display is enabled (function key F9), an extra column will be displayed, showing the contributor of each country or region and the date of entry.



detailed data format - property data

The above display is an example of a typical screen of timber characteristic data in detailed format, in this case showing the bending strength of *Ocotea rodiaei*.

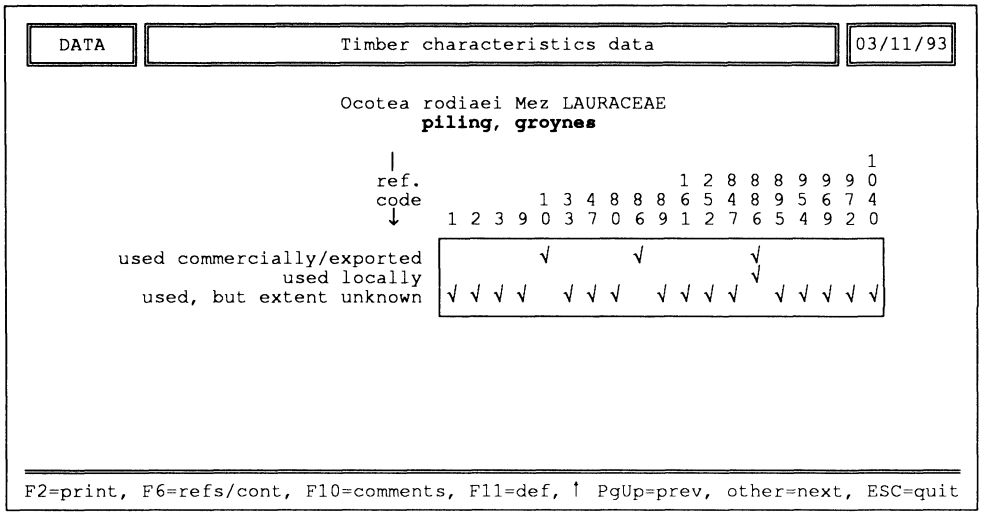
The detailed form of the timber data gives a comprehensive display of the information stored for each property of each selected species. The data are presented in a tabular format with the descriptors listed down the side and each reference source, denoted by its code number, arranged in a vertical manner above the entries which stemmed from it. There may be more than one √ entered for any one reference source. For example, in the display shown above, reference number 972 stated that the bending strength of *Ocotea rodiaei* is high to very high when the timber is green.

Where characteristics have provision to record the conditions or qualifiers relating to the data values (as for bending strength, above), the entries are displayed in colour-coded groups so that data recorded under the same conditions can be compared.

The relevant publications can also be checked by pressing the F6 function key. A red arrow can then be guided to point to the required reference code, and pressing the RETURN key will display that reference, then return to the data display. If the contributor display is enabled (function key F9), the contributor and date of entry will be shown at this point.

There is also provision at this point to view "comments" by pressing function key F10. These are general comments or observations about this property of this particular species, which may be entered by any contributor to the database. This comprises any textual information, which may be of special significance to the contributor or of general interest to other users. If the contributor display is enabled (function key F9), each comment will be identified by its contributor and the date of entry. The option "F10=comments" at the bottom of the screen will be dimly displayed to indicate the absence of information.

Pressing function key F11 will also display the technical definition and any related information concerning the currently displayed property.



detailed data format - end-use data

The above display is an example of a typical screen of end-use data in detailed format, in this case showing the known recorded use of *Ocotea rodiaei* for piling and groynes.

The data are presented in the same tabular format as the property data, with the same options to display references and contributors, except that the same list of three descriptors applies to all recorded end-uses. These descriptors relate to the level at which the species has been used for the relevant purpose. The species will be recorded as being exported as suitable for this purpose, or being sold and used locally, or recorded as used, but where the extent of use is unknown or not specified.

Pressing function key F11 will also display the technical description and any related information concerning the currently displayed end-use.

```
DATA          Timber characteristics data                    03/11/93

                        Ocotea rodiaei Mez LAURACEAE
                             summarised data

 modulus of rupture/bending strength
                              green:  7/ 8  very high
                                      1/ 8  high
                      12% to 15% m.c.:  6/10  very high
                                        4/10  high

modulus of elasticity/bending stiffness
                              green:  7/ 7  very high
                      12% to 15% m.c.:  8/ 9  very high
                                        1/ 9  high

hardness (Janka side grain)
                              green:  5/ 7  very hard
                                      2/ 7  hard
                      12% to 15% m.c.:  1/ 1  very hard

                F2=print, ↑ PgUp=prev, other=next, ESC=quit
```

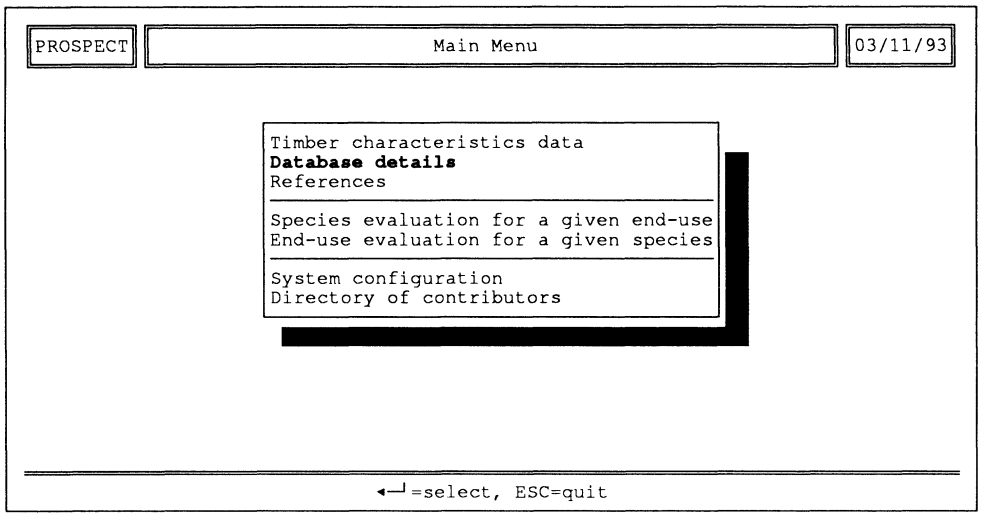
summarised data format

The above display is an example of a typical screen of output in summarised format, in this case some of the timber features in the mechanical section of the data for *Ocotea rodiaei.*

The summarised form of the timber data gives an overall summary of the data stored for each property. For each characteristic for which there are data registered, the number of data items recorded for each descriptor is shown in relation to the total number of data items recorded for that property.

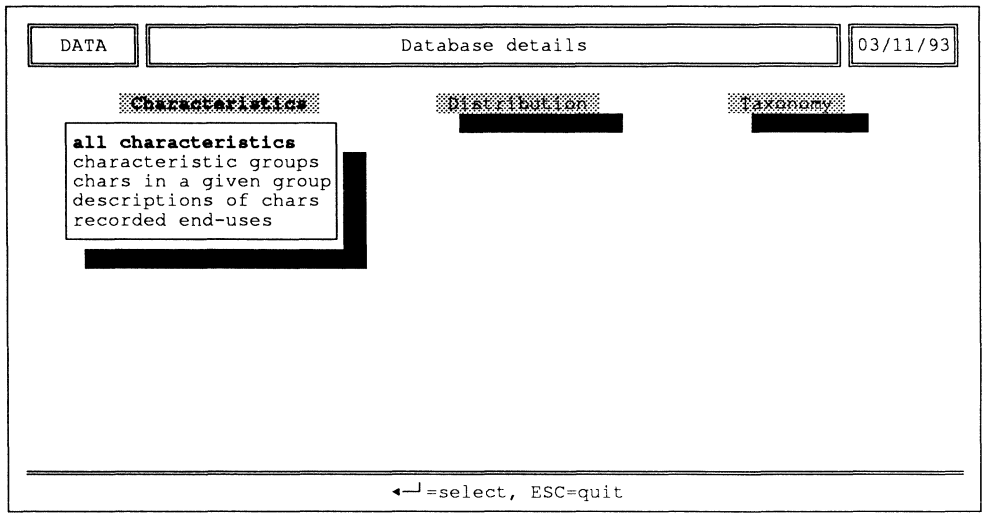
In the above display, 7/8 means that 7 out of a total of 8 data items recorded the green bending strength as very high, and 1/8 means 1 out of the 8 said it was high. For bending stiffness (green) the 7 data sources agreed unanimously that it was very high.

For characteristics such as those shown above, where the conditions under which the data are measured are also recorded, the ratios are shown separately for each specific condition.



4.2 Database Details

From the main menu, the second option will examine the general content of the database in terms of predefined static lists, species distribution and taxonomic material. In general, this section gives lists of the basic elements of the database, i.e. characteristics, end-uses, species etc., but does not show any timber information.



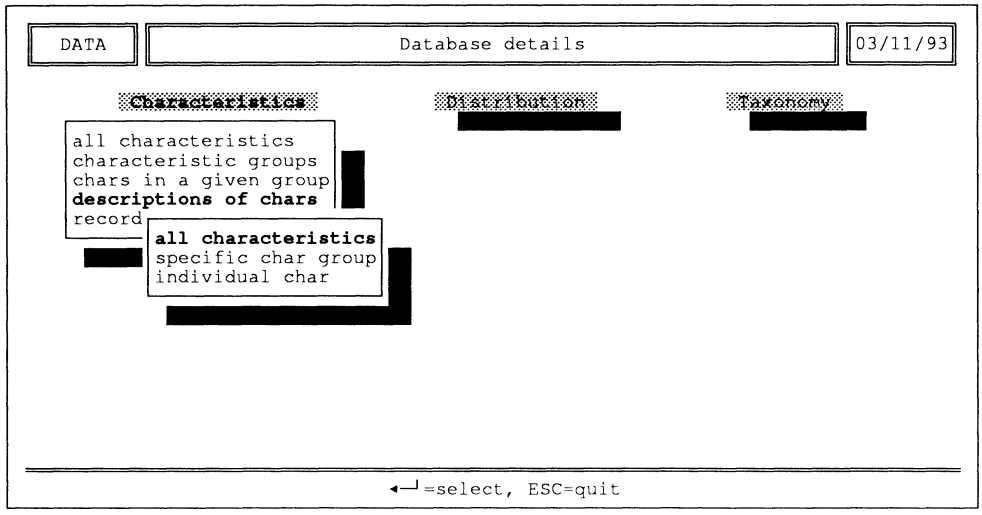
This display takes the form of a bar menu with three sections of information, namely characteristics/end-uses, distribution and taxonomy. Only one of these sub-menus can be active at any one time. Each sub-menu screen shown will be described in turn. No output will be shown as it would be too voluminous.

Characteristics

The first sub-menu describes in detail the list of timber characteristics and end-uses.

all characteristics	simple list of characteristics with relevant groups
characteristic groups	simple list of groups
chars in a given group	simple list of characteristics - requests characteristic group of interest
descriptions of chars	detailed descriptions of characteristics (see next section) - requests characteristics range or group of interest
recorded end-uses	simple list of end-uses, also indicating whether criteria for species/end-use evaluation have been defined.

Selecting "descriptions of chars" invokes a further menu.

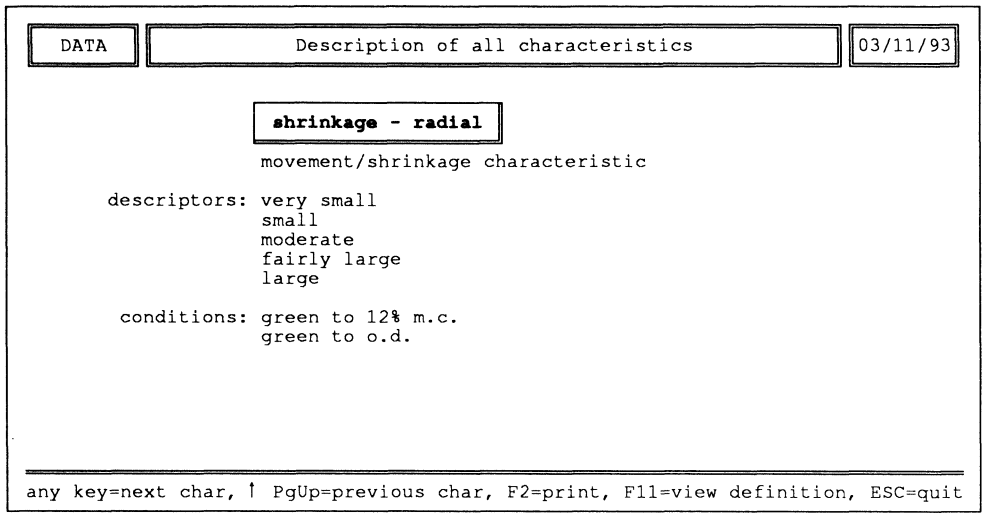


Descriptions of chars

The detail of how each characteristic is recorded within the database can be shown by choosing "descriptions of chars".

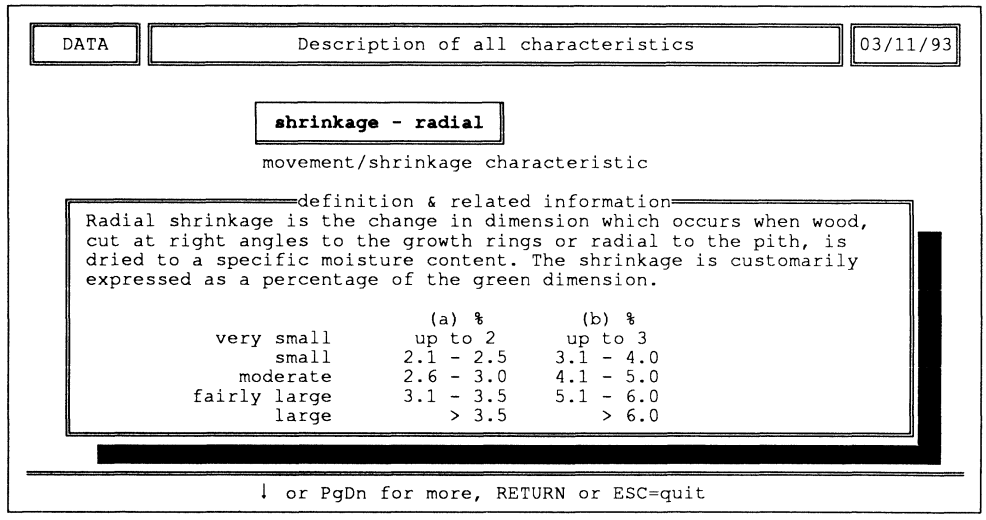
The user will be given the choice of displaying details for any subset of the characteristic list:

all characteristics	describes all timber characteristics
specific char group	describes characteristics in a given group - requests group of interest
individual char	describes a specific characteristic - requests characteristic of interest

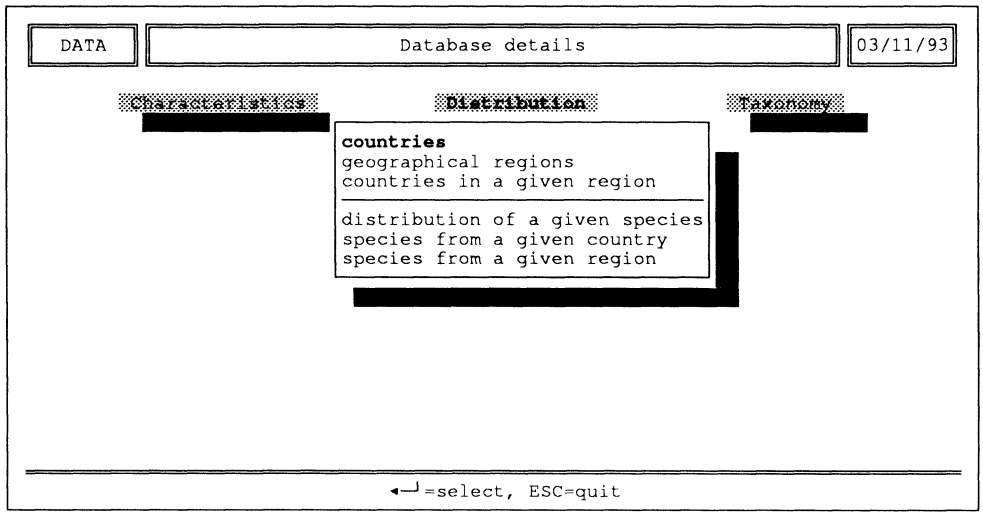


In general, qualitative data are described by a list of possible descriptions and quantitative data by a range of size classes.

The display shows the descriptors/classes used to depict the characteristic, and if relevant, the possible conditions under which the data were collected. The screen display above shows a typical characteristic with conditions. The technical definition of the property and any related information can be viewed by pressing function key F11. The user can browse through their selection and also print these details.



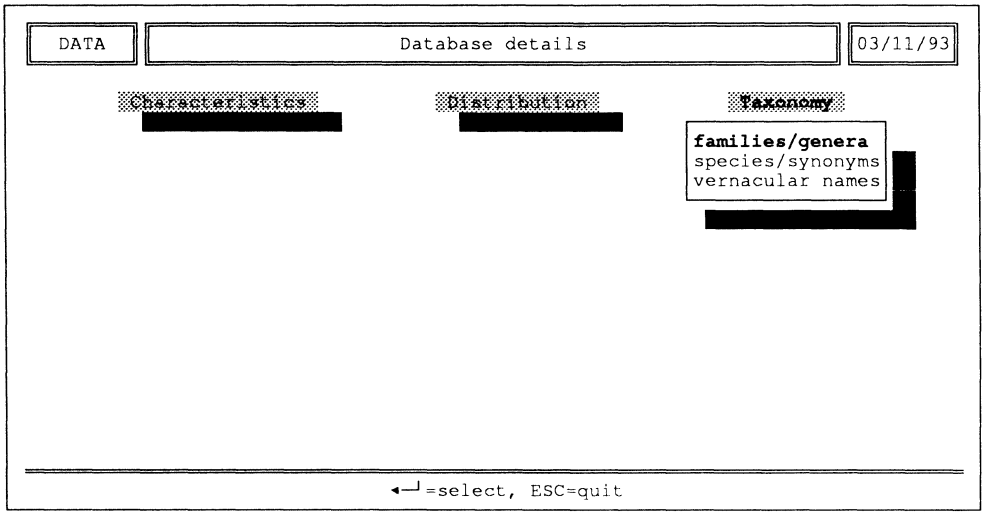
Function key F11 produces this optional output describing the technical definition of the characteristic and, if a quantitative property, the exact values for the descriptive classes. Not all the description may be visible (as in the example above) so the user can scroll through the display. This output is available on key F11 wherever detailed property data are presented.



Distribution

The second sub-menu describes the static list of countries and geographical regions used in the database and can also show the distribution of each species.

countries	list of countries, with corresponding regions
geographical regions	list of geographical regions
countries in a given region	list of countries in a specific region - requests region of interest
distribution of a given species	list of countries, with corresponding regions, where the species grows - requests species of interest
species from a given country	list of species which grow in a specific country - requests country of interest
species from a given region	list of species which grow in a specific region - requests region of interest



Taxonomy

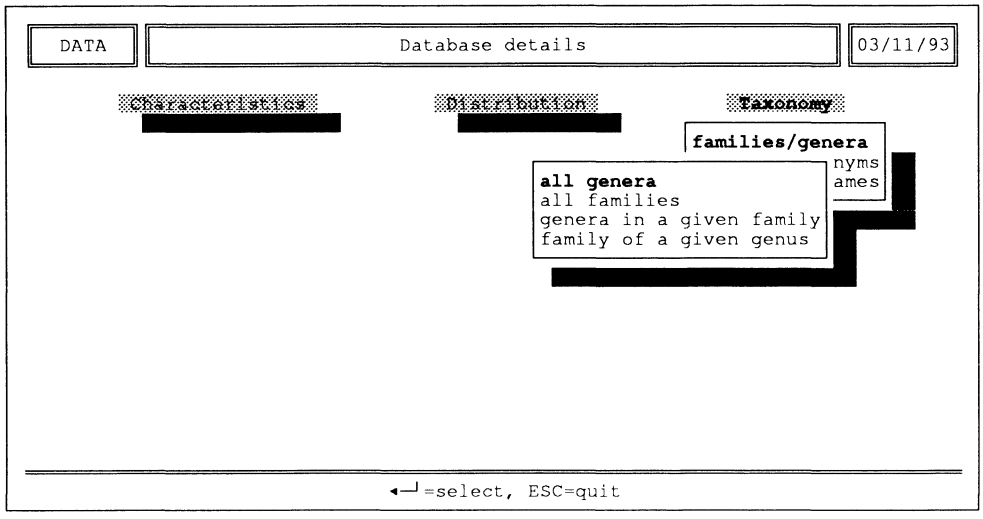
The final sub-menu describes the taxonomic details of the species in the database.

families/genera displays all details of the family/genus hierarchy

species/synonyms displays all or any subset of the recorded species names including any synonyms or misapplied names

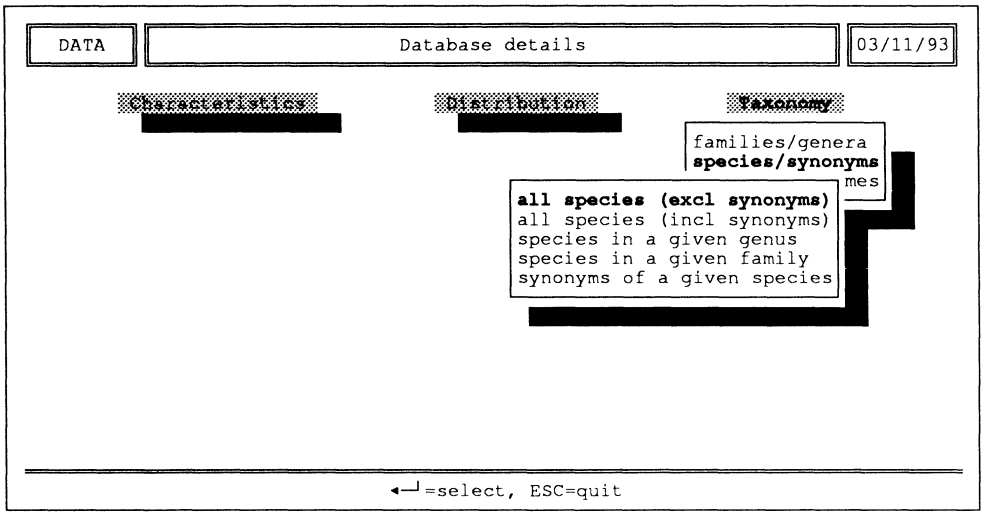
vernacular names displays all or any subset of the trade/commercial names and common/local names together with the botanical names of the species

Selecting each of these invokes further menus.



Families/genera

all genera	displays all genus names with corresponding family
all families	displays all family names
genera in a given family	displays all genera belonging to a specific family - requests family of interest
family of a given genus	displays the family name of a specific genus - requests genus of interest



Species/synonyms

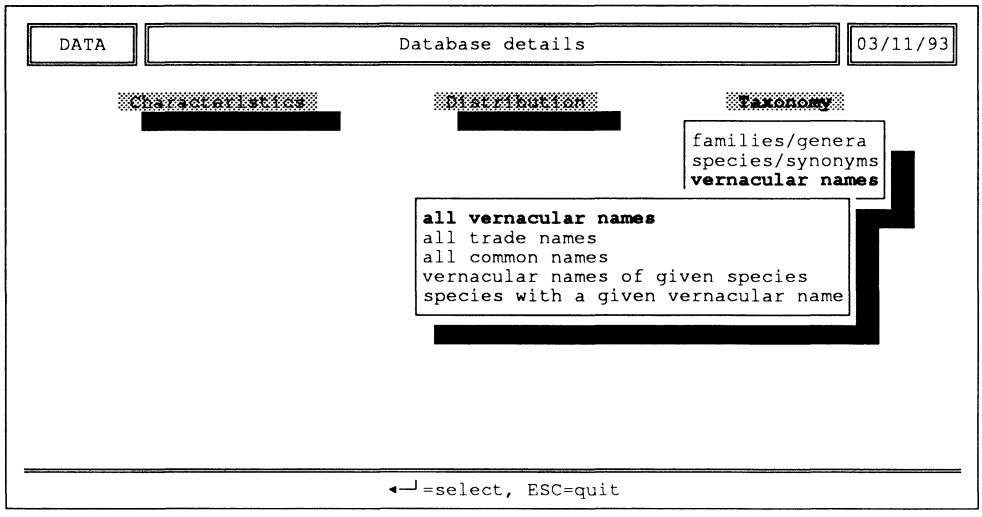
all species (excl synonyms) displays all primary species names stored in the database, with appropriate family, excluding those which are synonyms or misapplied names

all species (incl synonyms) displays all recorded species names, with appropriate family, names including synonyms/misapplied names

species in a given genus displays recorded species names (including synonyms/misapplied names) belonging to a specific genus - requests genus of interest

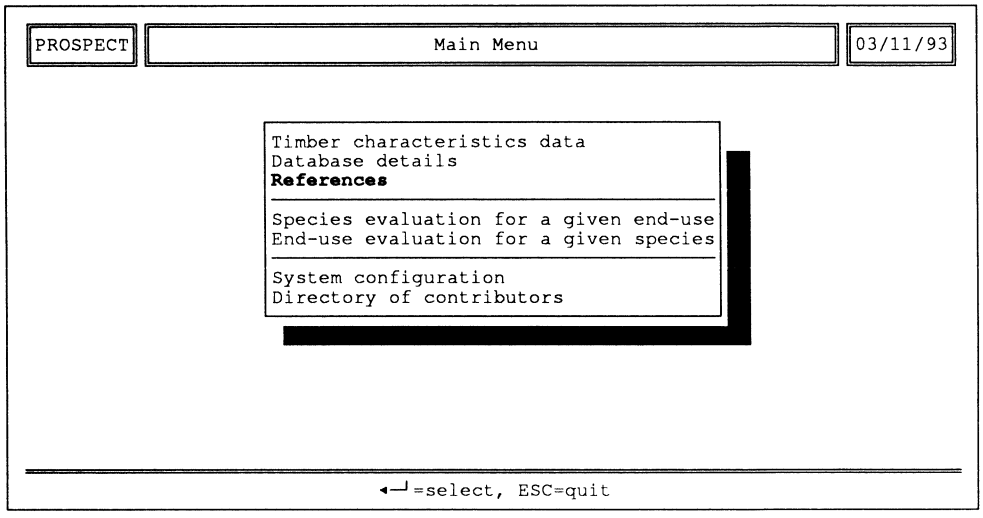
species in a given family displays recorded species names (including synonyms/misapplied names) belonging to a specific family - requests family of interest

synonyms of a given species displays synonyms and misapplied names, with appropriate family) of a specific species - requests species of interest



Vernacular names

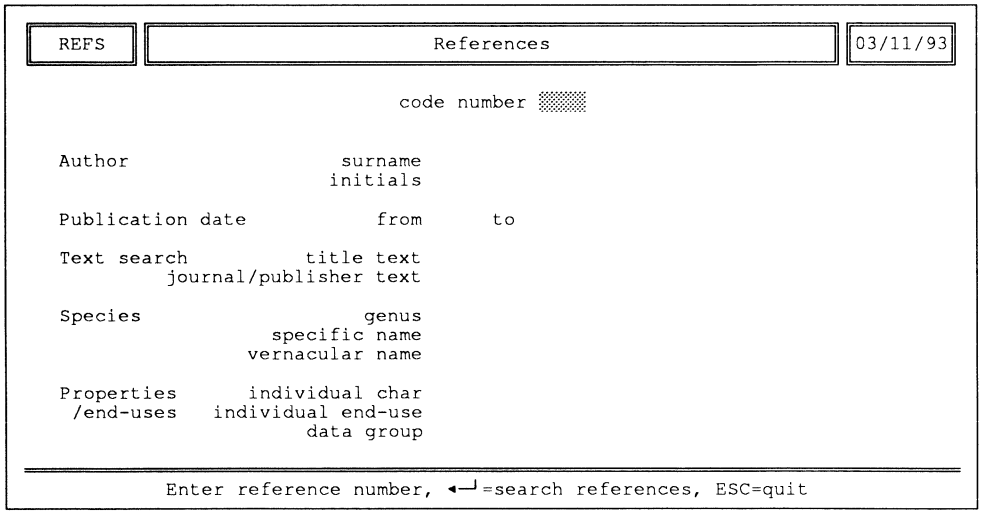
all vernacular names	displays all vernacular names recorded in the database, and the botanical names of the species to which they relate
all trade names	displays all trade/commercial names recorded, and the associated botanical names
all common names	displays all common/local names recorded, and the associated botanical names
vernacular names of a given species	displays the trade and common names of a specific species - requests species of interest
species with a given vernacular name	displays species with a trade or common name containing a given name - requests vernacular name of interest (either whole or part of the name may be given)



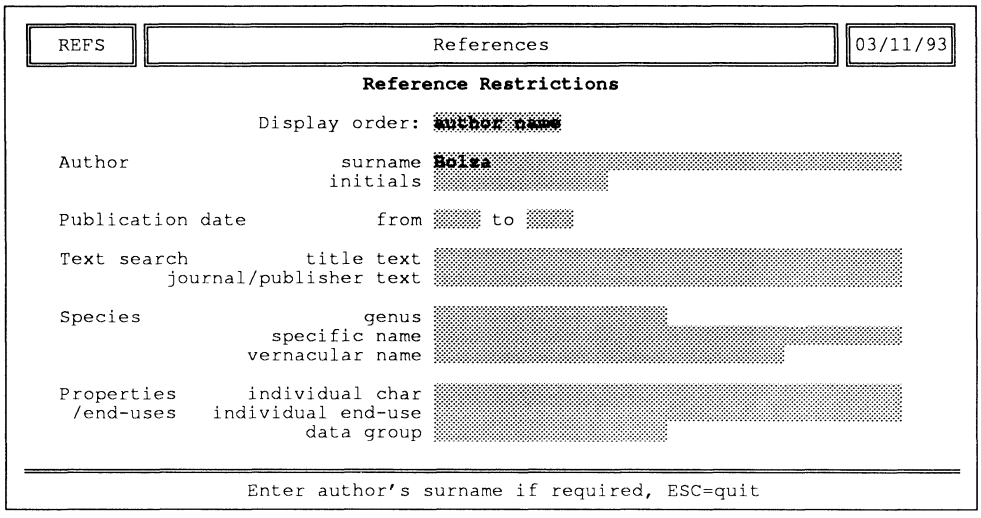
4.3 References

From the main menu, we will now look at the "References" option.

This section allows the user to peruse the publication list. It can also show references relating to specific species and/or characteristics.



A specific reference may be displayed by entering only its code number at this stage. If the code number field is not completed (e.g. RETURN is pressed) the data fields shown for the other items will become active and require completion.



The user is first requested to specify whether the references are to be displayed alphabetically by author's surname, or in numerical order by code number.

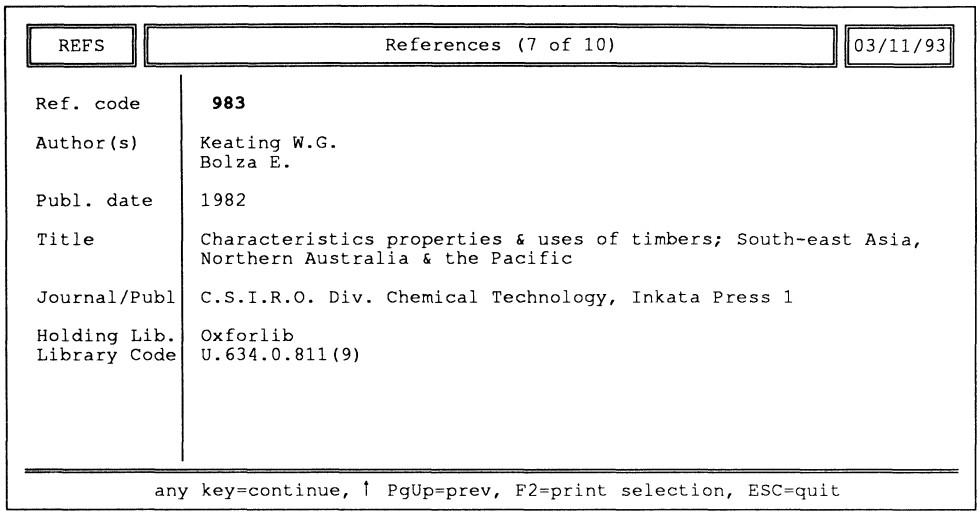
Any subset of the publication list may then be selected by filling in the relevant fields of interest for any combination of the following:

author's name	surname or the first letter(s) of the surname, and/or initials (full stops not required)
range of publication dates	inclusive years (for a single year, put same date twice)
text	any text occurring in the publication's title or in the journal/publisher's name
species range	genus or individual species by botanical or vernacular name
property/end-use range	individual characteristic, end-use, characteristic group or all end-uses (enter "end-uses")

Where any section of the restriction options is not completed, the program will assume that all possible entries should be included.

Note that if the author's name is entered, the program will display *all* references by authors whose names contain those letters. For example, entering surname "smith" will display all references by authors whose names *contain* the string "smith" (case insensitive). This ensures the inclusion of double-barrelled names such as Wyatt-Smith.

At any stage during the displays the complete sequence of requested references can be printed by pressing the F2 function key.



Output from the reference selection procedure includes:

code number

author(s)

publication date

publication title

journal/publisher

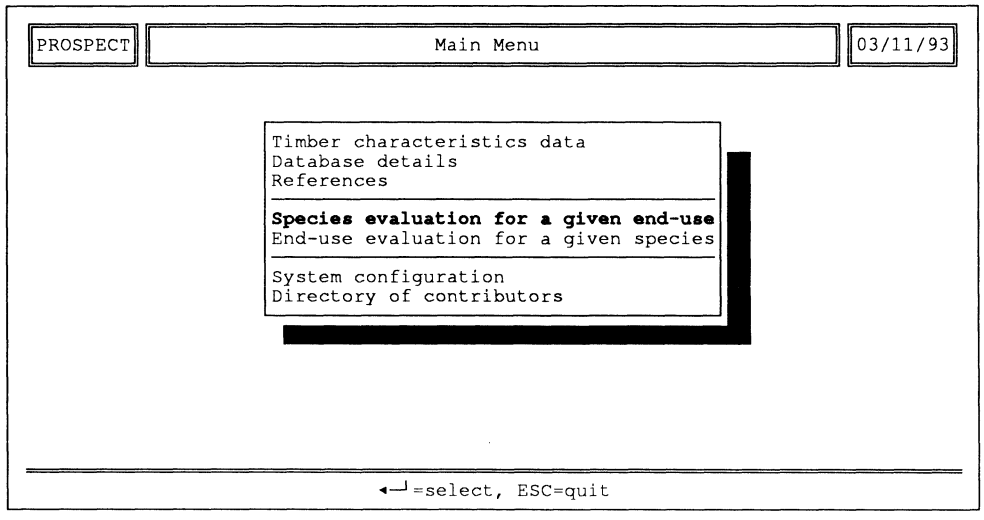
For users of PROSPECT at the OFI, the display will also include (for references entered by the OFI):

the library holding the publication

the library location code (shelf mark) to facilitate quicker retrieval of the relevant document.

The above example shows the 7th of 10 publications by author Bolza.

If the contributor display is enabled (function key F9), the contributor of the reference and the date of entry will be shown next to the code number.



4.4 Species Evaluation for a Given End-use

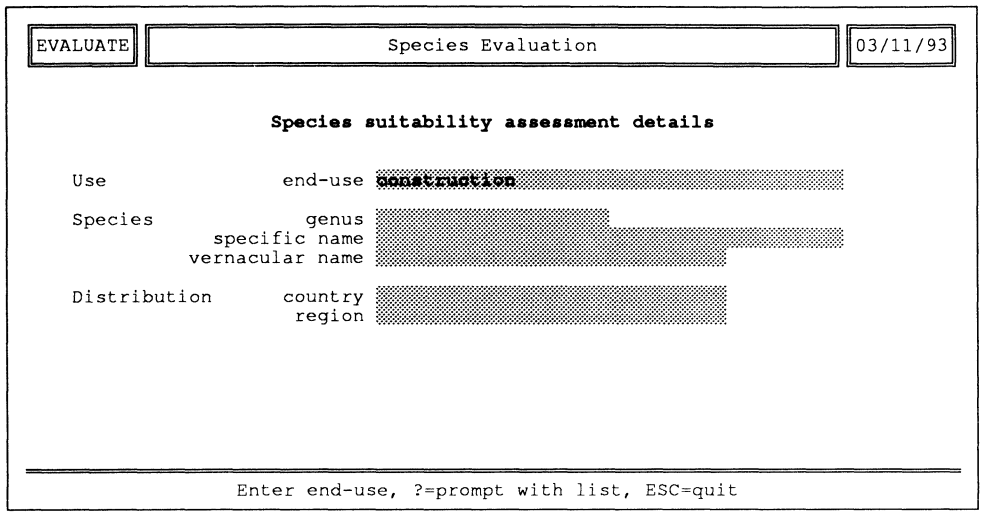
From the main menu, there are two options concerning the use of the information in the database to examine the possible relationships between the properties of any given timber and its potential uses.

This can be approached either by considering one specific end-use and assessing which species in the system might best make that product, or by looking at the potential products which might be made from one particular species.

For both of these assessments to be made, the program requires a list of required timber features to be defined which form the basic criteria upon which the species-use relationship can be evaluated.

For many end-uses, the program has pre-assigned the features of a timber which are important for making that product. These are referred to as the "system" assessment criteria. As these property selections may not be necessarily appropriate or relevant for some applications, the program makes provision for a user with the technical knowledge to define their own set of criteria in addition to the system settings. These are referred to as the "user" criteria.

We now look at the option "Species evaluation for a given end-use" from the main menu. The subsequent example shows the procedure for evaluating all species in the database, to assess which might be suitable for heavy construction.



Species evaluation details

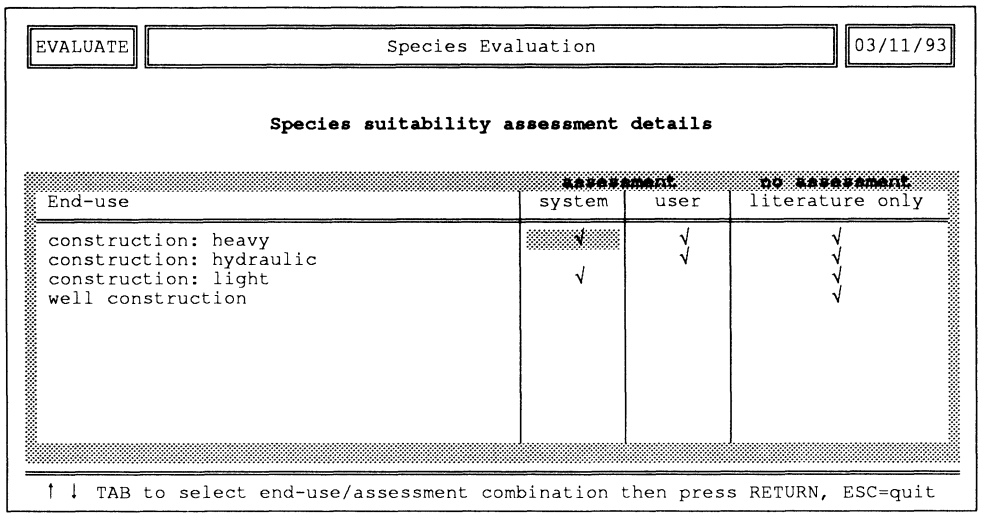
This section of the program evaluates all or any subset of the species in the database for their possible potential for producing a specific product and compares this assessment with the uses recorded in the literature.

The user is first invited to choose an end-use. The range of species searched may be restricted, if desired, by specifying a genus or individual species and/or a country or geographical region of interest in the appropriate entry fields.

When the end-use is entered, the program tries to identify the product from the existing list. The user will always be prompted with a list for confirmation of their choice. If an end-use name ends with a "→" symbol, it means that it is recorded under another category, either broader or more specific. For example, "door thresholds" would come under the category "joinery (external): ground contact", whereas "beams" might relate to agricultural, industrial or domestic structures. Selecting a use ending with "→" will therefore revise the list to show the possible end-uses under which it may be recorded.

It is also possible for the user to define requirements for a completely new end-use which will be added to the existing list, although at first there will not be any literature recorded for comparison purposes.

In this example we will look at timbers suitable for heavy construction. Entering simply "construction" in the end-use field will prompt the user to be more precise.

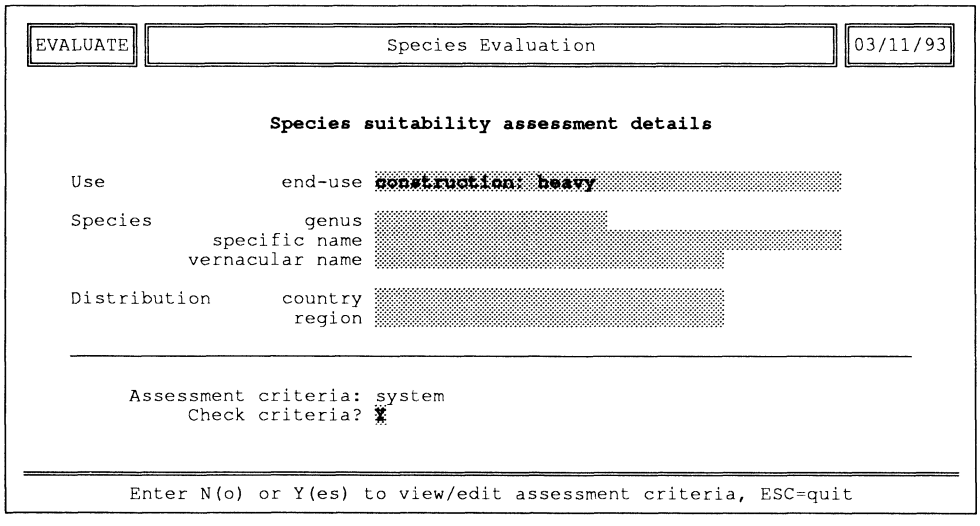


In the above example, further clarification is necessary to determine which type of "construction" is required, so we are prompted with the possible categories of timber construction.

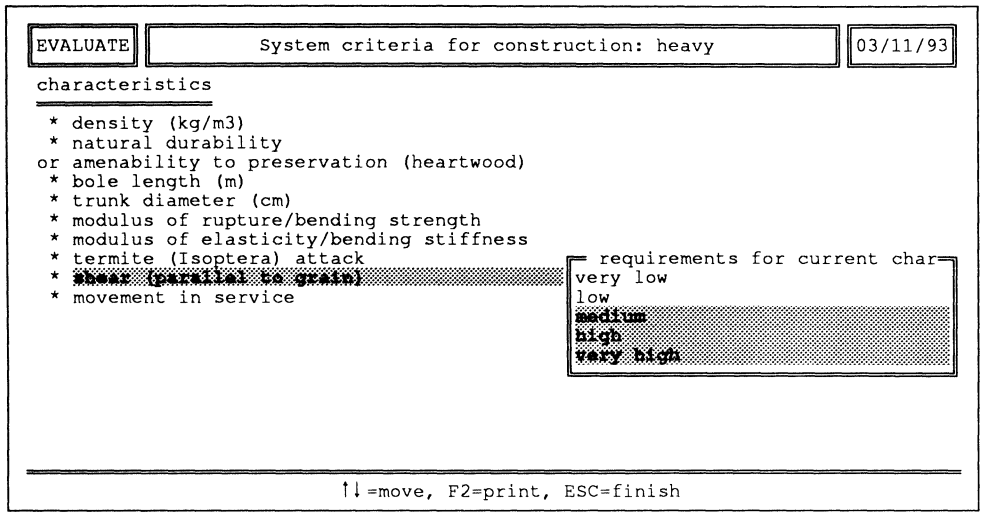
After selecting the desired use, the user must also specify which set of assessment criteria to apply. The "system" criteria are those set by the program and cannot be altered by the user. The "user" criteria are those defined at a user's site. If the user does not want a property assessment to be made, they can just view the species which have been recorded as used for this purpose in the literature by selecting the "literature only" option.

For the assessment options, a √ indicates where criteria have already been defined. Where there is no √ in the "user" column, the user will be able to define criteria specific to their site's needs. A √ in the "literature only" column indicates whether there is information recorded.

To select the desired end-use/criteria combination, move the cursor to the required cell in the table using the cursor and TAB keys, then press RETURN.



Having selected the end-use and assessment criteria the user can choose to view the requirements defined for the appropriate assessment (and also modify the user definitions) by specifying "Y" for the "Check criteria?" option before the evaluation is performed.



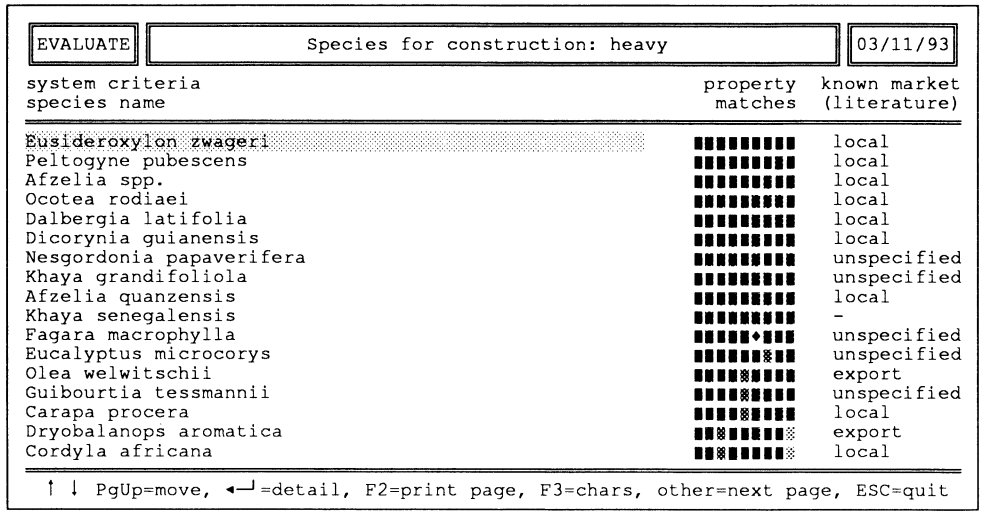
Checking evaluation criteria

Answering "Y" to the "Check criteria?" question allows the user to view and possibly edit the criteria used in the evaluation. The minimum criteria for determining whether a timber could be suitable for making a specific product are defined here. The features which are considered important are given as a list of appropriate characteristics, the acceptable measures of which are selected from the associated list of descriptors shown in the box to the right of the screen.

The characteristics are entered in descending order of importance. Those marked with an asterisk (*) are key requirements; in addition, alternative characteristics may be defined which may substitute or compensate for a key feature should data be lacking or unsatisfactory. Such property names are preceded with the word "or" and relate to the first key feature above it. For example, if a key requirement is that the timber is naturally durable, or if not, treatable with preservative, then the key characteristic could be "natural durability: very durable or durable" and an alternative ("or") property could be "amenability to preservation: permeable or moderately resistant".

If the system definitions are being viewed, these settings cannot be changed. However, user definitions can be created or altered. The list of required characteristics can be revised by deleting, inserting or appending properties or by modifying any necessary descriptors.

When leaving this screen, the program will ask for confirmation that the evaluation model is correct before commencing the assessment.



Species evaluation results

The program will display all species in the database for which it has some data (approximately in order of suitability). The column headed "property matches" shows how each of the species fulfilled the timber property requirements. For every species, each selected property is represented by a coloured square or diamond (shown shaded in this guide) denoting how that feature satisfied the minimum requirements, as follows:

- ▮ (light green) this property met the necessary requirements (all published opinion unanimous)
- ▮ (dark green) this property met the necessary requirements (some variation in published opinion)
- ▮ (red) this property failed to meet the necessary requirements (all published data show unsuitable)
- ▮ (white) there were no data recorded for this property

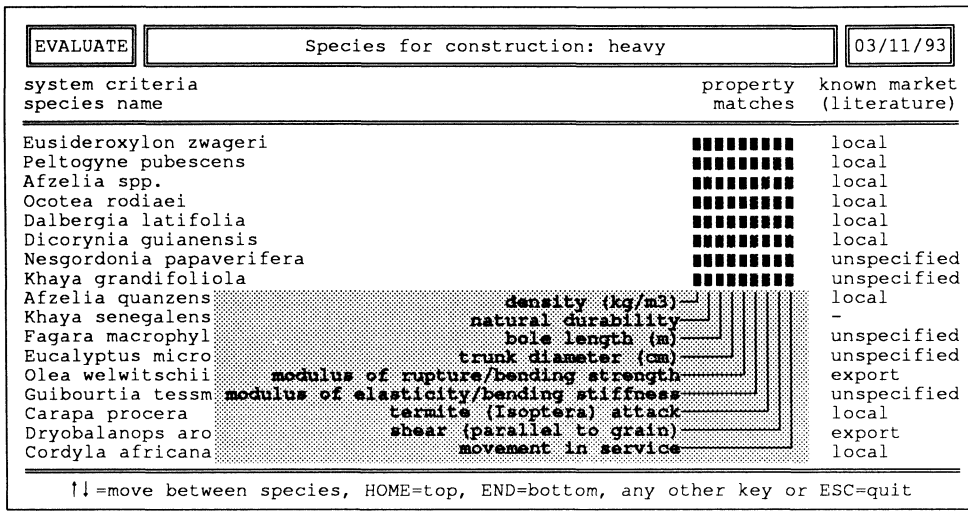
A ♦ symbol is used instead of ▮ to show where a key characteristic was unsuitable or no data were recorded, and an alternative property was considered instead.

The column headed "known market" shows the highest known level of use recorded in the literature, as follows:

export	- known to be sold on commercial markets, i.e. exported
local	- known to be sold in local markets
unknown	- reported used, but extent of use unknown
-	- no record of use

This enables the user to assess the importance of each timber property in the evaluation process and also to compare the assessment of each species with the known degree of its use as recorded in the literature.

Further display options are available here, which are described on the following page.



Species evaluation results - supplementary display

To assist the interpretation of the evaluation output, additional output can be shown by highlighting the species of interest using the vertical cursor keys, then pressing these keys:

F3 - overlays the names of the characteristics used in the evaluation. This helps to identify the features represented by the coloured symbols and indicates their levels of acceptance. This is shown in the screen example above (colours not represented).

<RETURN> - shows each assessed characteristic in turn showing in detail how each property met or failed to meet the required acceptable levels, and allowing access to relevant references. The display of this matching process is very similar in format to the presentation of the "detailed" data in the "Timber characteristics data" section and so will not be shown again here.

The results of all evaluations can be printed. The output shows:

- the requested properties and their desired minimum levels
- the actual evaluation results with the colour-coded symbols represented by printable characters, preceded by the interpretation of those characters.

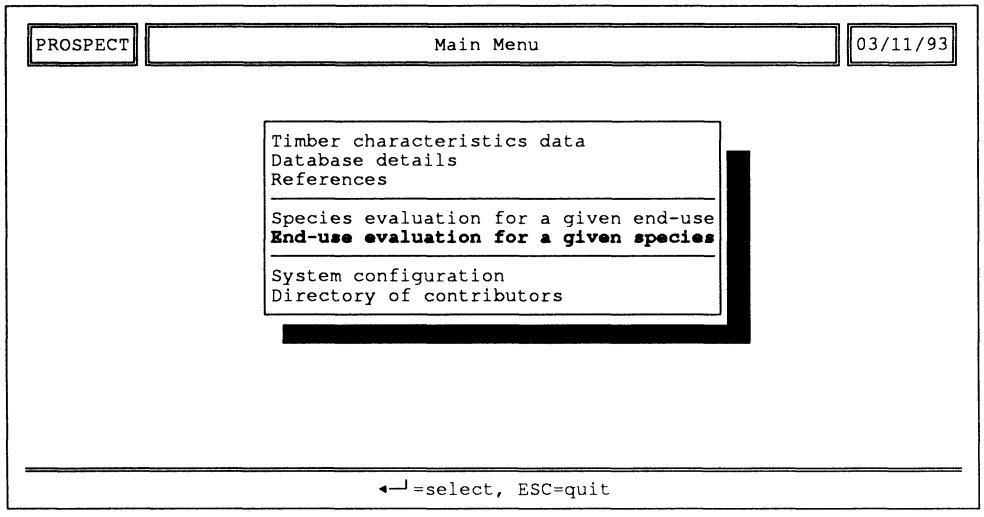
Each screen of species displayed can be printed separately, with subsequent screens concatenated on the page. The first page of output produced by applying the system-defined criteria for heavy construction are shown here:

Species for construction: heavy
(system criteria)

* density (kg/m3)	600-699 basic 720- 839 air-dry or 700-799 basic 840- 959 air-dry or 800-899 basic 960-1079 air-dry or 900-999 basic 1080-1199 air-dry or ≥1000 basic ≥1200 air-dry
* natural durability	very durable or durable
or amenability to preservation (heartwood)	permeable or moderately resistant
* bole length (m)	10 - <20 or 20 - <30 or 30 - <40 or 40 - <50 or 50 and above
* trunk diameter (cm)	50 - <100 or 100 - <150 or 150 - <200 or 200 - <250 or 250 - <300 or 300 - <350 or 350 and above
* modulus of rupture/bending strength	medium or high or very high
* modulus of elasticity/bending stiffness	medium or high or very high
* termite (Isoptera) attack	resistant or moderately resistant
* shear (parallel to grain)	medium or high or very high
* movement in service	small or medium

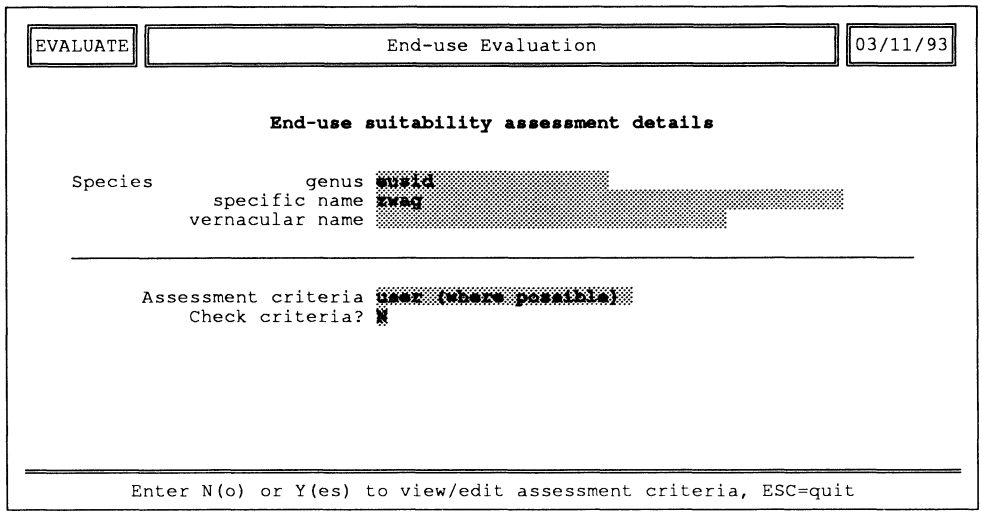
property assessment indicators:
- ■ property met the necessary requirements with unanimous opinion
- ≡ property met the necessary requirements, but variation in opinion
- x property failed to meet necessary requirements
- · there were no data for this property

system criteria species name	property matches	known market (literature)
Eusideroxylon zwageri	■≡≡■■■■■■	local
Peltogyne pubescens	■≡≡■■■■≡■	local
Afzelia spp.	■≡■■■■≡■≡	local
Ocotea rodiaei	■≡≡■■≡≡≡■	local
Dalbergia latifolia	■≡■≡■≡≡≡≡	local
Dicorynia guianensis	■≡≡≡■≡■■≡	local
Nesgordonia papaverifera	■≡≡≡■≡■■≡	unspecified
Khaya grandifoliola	■■■≡≡≡≡■≡	unspecified
Afzelia quanzensis	■≡≡≡■≡≡■≡	local
Khaya senegalensis	■≡■≡≡≡≡■≡	-
Fagara macrophylla	■≡■≡≡≡≡■≡	unspecified
Eucalyptus microcorys	■≡≡≡■■x■≡	unspecified
Olea welwitschii	■≡■≡x≡■■≡	export
Guibourtia tessmannii	■■■■x≡≡■■	unspecified
Carapa procera	■■≡■x≡■≡≡	local
Dryobalanops aromatica	■≡x■■≡■■·	export
Cordyla africana	■≡x≡■■■■·	local



4.5 End-use Evaluation for a Given Species

The option "End-use evaluation for a given species" on the main menu, deals with performing an end-use evaluation for an individual species. Just as it is possible to relate timber characteristics to an end-use to make an assessment of species which have the potential to produce a given product (see 4.4), it is also possible to evaluate the potential uses for a specific timber.



End-use evaluation details

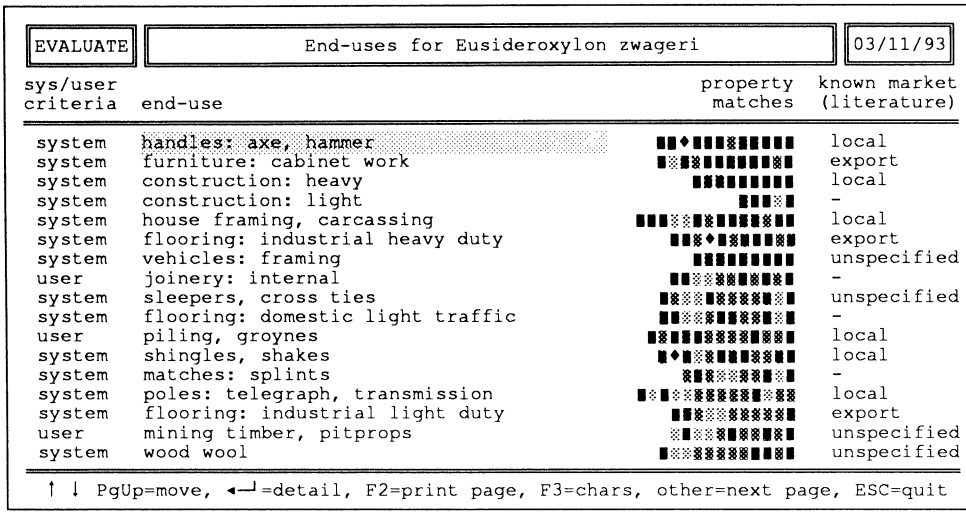
The user is first invited to specify a species of interest. The species may be entered either by genus and specific name or vernacular name.

The program will consider all end-uses for which the characteristic requirements have been defined. At the question "Assessment criteria?" the choices are:

system	the assessment criteria predefined in the system
user (where possible)	the assessment criteria defined at the user's site
none (literature only)	no assessment - literature search only

If the "user" criteria are chosen, the program will use all user-defined criteria where possible, otherwise system criteria will be used. The actual criteria used will be indicated in the left column of the results screen (see next example).

The user can view (and print) the requirements defined for the appropriate assessment for any end-use (and also modify the user definitions) by specifying "Y" for the "Check criteria?" option before the evaluation is performed. The end-use of interest will be requested. The procedure for defining characteristic requirements is described in the previous section.



End-use evaluation results

The program will display all end-uses in the database for which it has data and either a system- or user-defined set of property criteria.

The form of the output is the same as in the species evaluation section of the program with the addition of the column headed "sys/user criteria". This shows which criteria were used in the assessment. If "user" criteria had been requested, as in the example above, for each end-use the program will try to use the "user-defined" property requirements, otherwise the system definition will be used and vice versa.

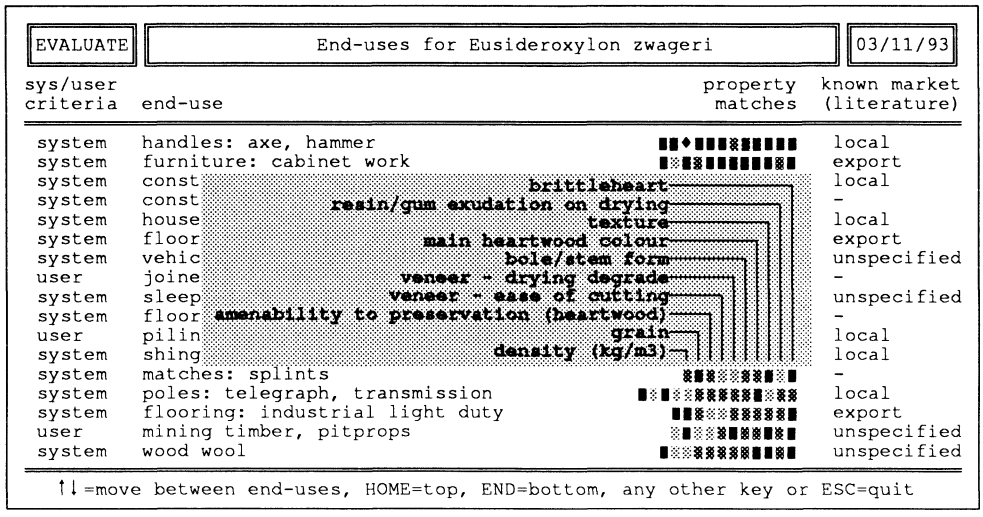
The column headed "property matches" shows how each of the species fulfilled the timber property requirements. For every end-use each property considered is represented by a coloured square or diamond (shown shaded in this guide) denoting how that feature satisfied the minimum requirements, as follows:

- ▮ (light green) this property met the necessary requirements (all published opinion unanimous)
- ▮ (dark green) this property met the necessary requirements (some variation in published opinion)
- ▮ (red) this property failed to meet the necessary requirements (all published data shows unsuitable)
- ▮ (white) there were no data recorded for this property

A ♦ symbol is used instead of ▮ to show where a key characteristic was unsuitable or no data were recorded, and an alternative property was considered instead.

The column headed "known market" shows the highest known level of use recorded in the literature, and enables a comparison to be made between the assessment and the known degree of use. The possible entries are:

export - known to be sold on commercial markets, i.e. exported
local - known to be sold in local markets
unknown - reported used, but extent of use unknown
\- - no record of use



End-use evaluation results - supplementary display

For each of the end-uses evaluated, a different set of timber property requirements will have been assessed. The main evaluation display indicates the number of properties considered for each end-use, but for more detail further displays are necessary.

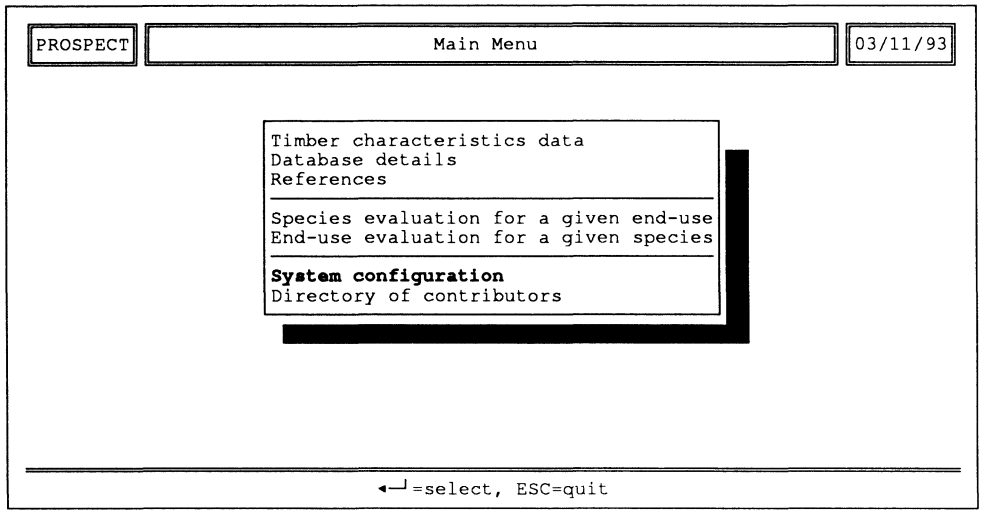
To assist the interpretation of the evaluation, additional output can be shown by highlighting the end-use of interest using the vertical cursor keys, then pressing these keys:

F3 - overlays the names of the characteristics used in the evaluation. This helps to identify the features represented by the coloured symbols and indicates their levels of acceptance. This is shown in the screen example above (colours not represented).

<RETURN> - shows each assessed characteristic in turn showing in detail how each property met or failed to meet the required acceptable levels, and allowing access to relevant references. The display of this matching process is very similar in format to the presentation of the "detailed" data in the "Timber characteristics data" section and so will not be shown again here.

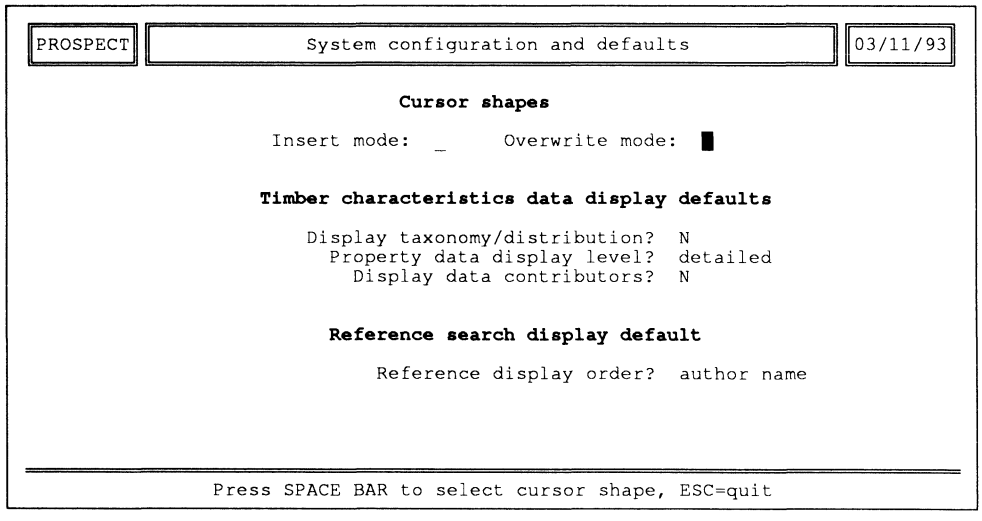
The display generated by pressing function key F3 is shown in the above example and indicates the system-defined timber properties involved in the assessment for match splints. Note that in this example the overlayed list is presented *above* the relevant end-use, as the orientation is dependent on the space available on the screen.

The results of all evaluations can be printed. Each screen of end-uses displayed can be printed separately, with subsequent screens concatenated on the page. Output is not shown here as it is similar to that for the species evaluation (see 4.4), with the exception that the property requirements for each end-use are not shown due to the quantity involved. Note that the property requirements for a specific end-use can be viewed and printed through the "Check criteria?" option previously described.



4.6 System Configuration

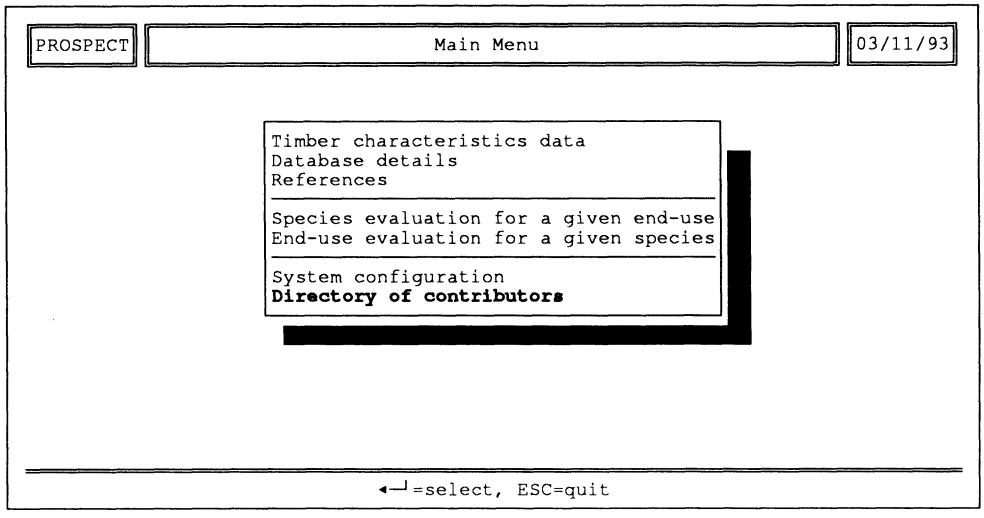
From the main menu, we will now look at the "System configuration" option.



This option allows the user to set system defaults. These options are then remembered after the session is closed, so that these settings will automatically be in force when PROSPECT is next run.

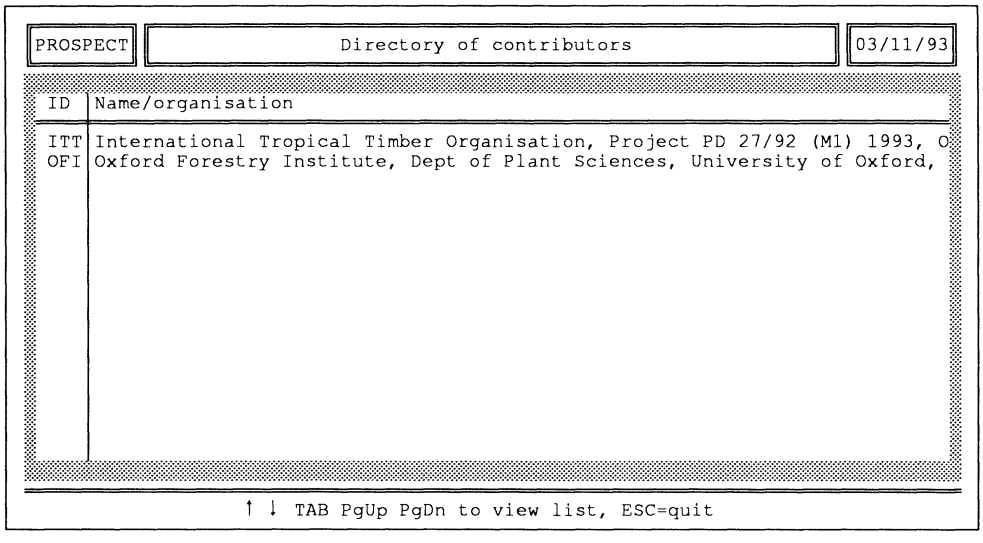
The shape of the cursor may be set to one of _ ▄ or ■ for both inserting and overwriting/typeover modes. The possible shapes can be selected by pressing the space bar on the appropriate entry fields until the desired shape appears, then press return.

Default settings may be assigned for the "output options" in the timber property/end-use data section of the program, the option to display contributor information, and the preferred order of publication display in the reference section.



4.7 Directory of Contributors

From the main menu, select the item "Directory of contributors".



This option enables the user to identify sites which have contributed information to the database.

Each item of PROSPECT data has a label comprising a three-letter ID code and date, which identifies the contributor of that information and when it was entered. This list shows the names of the contributors represented by those ID codes.

At present the contributors are OFI (data entered at the OFI during earlier projects) and ITT (data entered during the current ITTO project). Users contributing information to the database will be allocated a unique identity code and included in the list.

5. Appendices

Appendix 1 : Technical Aspects of PROSPECT

Hardware

A new version of PROSPECT was developed to make timber information accessible to a wide range of users by making a portable and user-friendly package for use on affordable computer equipment. The database has been designed to operate on IBM-compatible microcomputers and requires a minimum configuration of:

- 386 processor running MS-DOS 3.0
- 2Mb RAM
- 10Mb of hard disk storage (maximum for full dataset)
- colour VGA monitor
- dot matrix printer, 80-column (optional)

Software

The FoxPro package was chosen as the database management system to handle the information for PROSPECT for several reasons:

1. It is compatible with dBASE, a well-proven and familiar product to many database programmers. This meant minimum re-training for the programmer on the project, and enables support and exchange of ideas with other dBASE-based programmers, working on similar projects.

2. It has flexible facilities for data presentation, file handling and menu control, together with a capacity to store and manage large amounts of data, which is vital to the future expansion prospects of the database. It is also fast; with the vast wealth of information that PROSPECT could ultimately record, speed of operation was an essential consideration.

3. It provides powerful facilities for the programmer to aid program development; it can display multiple operating "windows" on the screen, so that several files can be examined simultaneously, and the progress of the program can be monitored as it runs.

Distribution Considerations

Using the FoxPro Distribution Kit, run-time version of the PROSPECT program can be produced so that is can be easily distributed to users at other sites without incurring copyright problems or royalty charges.

The program, FoxPro system files, and all data files, which form a fully operational version of the PROSPECT package, currently occupy almost 10 megabytes of hard disk storage. They can be compressed onto three high density 3½" floppy diskettes for distribution.

Program Design

The first consideration when developing the microcomputer-based version of PROSPECT was to ensure that it was easy and pleasant to use. For those unfamiliar with computers a menu structure provided a clear and logical way to steer the user around the system.

The program was designed to guide the user by showing a permanent display (at the bottom of the screen) of the possible options for their next action. This was supplemented by more detailed assistance which was also provided at all stages at the press of a key, both to help with the response expected from the user and to clarify the output shown on the screen.

Where input from the user is required, it was felt to be important that all possible assistance should be given, to remove the necessity to remember or guess what information is recorded in the system. For example, in most places where text is requested, the user need only enter part of the text, or put ? to give the whole list of possible entries.

It was decided to use colours for the screen displays to clarify and emphasize results, especially the presentation of assessment results.

The main purpose of the database was to store timber information and enable rapid and easy access by the user. Care was taken to ensure that any part of the information can easily be extracted and displayed in a clear and simple way, and that access to the literature source is available whenever possible. The information can further be used to make a judgement on the possible uses for that timber. The operation of the program was therefore divided into two distinct areas.

The methods of achieving the assessment sections of the program are described in more detail next.

End-use Classifications

In order to make some assessment of the potential uses of a timber, it is necessary to decide which qualities of the timber are most desirable, or indeed essential, for that product. The consultant on the project has had many years of experience in this field, and with his expert advice it has been possible to implement these judgements for end-uses recorded in PROSPECT.

Based on the recorded timber characteristics and their descriptions, a list of required properties and their minimum acceptable levels has been built up for several end-uses. This involves simply indicating which descriptors are acceptable for each required property. The program makes provision for alternative or compensating properties to be specified. For example, where a timber is not naturally durable it may be acceptable if it was amenable to preservation treatment.

The program attempts to display the species/use matches very approximately in descending order of suitability so that the user need only scan the first few screens of results. To do this it uses a very basic "scoring" system.

Each characteristic in the list of required features is examined in turn. Should there be no satisfactory data for a "key" characteristic (i.e. either there are no data recorded or all data entries show it is an unacceptable feature) it will consider, in turn, data for any alternative properties if they have been specified. If an alternative property is satisfactory, it will be shown in the results but these will be scored slightly lower than a key feature.

To perform this assessment, the program examines the "summarised" form of the data. For any given end-use and species, the program looks at the total number of recorded data entries (i.e. $\sqrt{s}$) for each descriptor. There are four possible situations which may arise, each of which is given a score as follows:

Situation	Meaning	Score (key property)	Score (alternative property)
All data entries (√) are in the range of required descriptors	Complete data match - all reference sources show property completely satisfactory	10	8
Some of the data entries (√) are in the range of required descriptors	Partial data match - some reference sources show property satisfactory, but others indicate contradictory opinion	9	7
There are no recorded data	No information to form an opinion	0	0
None of the data entries (√) are in the range of required descriptors	Failed data match - all reference sources show property unsuitable	-30	-30

For each species, the scores for each characteristic are totalled and recorded. In addition to this, each characteristic is given a weighting according to its position in the property requirements list. The properties should be specified in order of importance; the weighting is allocated linearly with the first property given a high weighting and the last a low. This is so that the most essential features are stressed.

As a final stage, a score is also given for the level of known use recorded in the published sources. This is only a small addition, mainly to provide distinction where only literature data are displayed. Scores are given as follows:

Recorded level of use	Score
Available on commercial markets (i.e. exported)	3
Available on local markets	2
Used, but degree of use unknown	1
No information recorded	0

The species or uses are then displayed in descending order of score. When potential end-uses for a given species are being assessed, the distinction between the most and least suitable is complicated by the fact that for each end-use a different set of property requirements is being considered. To overcome this, the score for each use is divided by the number of features being considered, i.e. the mean score per feature is used.

Appendix 2: List of Timber Properties

Characteristic	Descriptors	Details/Conditions	Definition
tree features			
tree height (m)	0 - <10 10 - <20 20 - <30 30 - <40 40 - <50 50 - <60 60 - <70 70 and above		The total height of the tree from the ground to the topmost branch.
bole length (m)	0 - <10 10 - <20 20 - <30 30 - <40 40 - <50 50 and above		The length of the bole from the ground to the first large branch.
trunk diameter (cm)	0 - <50 50 - <100 100 - <150 150 - <200 200 - <250 250 - <300 300 - <350 350 and above		Trunk diameter measured at breast height (1.3m above the ground, or 1.3m above any buttress).
bole/stem form	straight misshapen cylindrical fluted buttressed not buttressed other		The general shape of the bole/stem.
end splitting on felling	very susceptible may occur rare/absent		The susceptibility of the bole/stem to splitting when the tree is felled.
bark width (mm)	0 - <5 5 - <10 10 - <15 15 - <20 20 - <25 25 - <30 30 - <40 40 - <50 50 and above		The width (thickness) of the bark or tree tissue outside of the cambium, including the inner (living) and outer (dead) bark.

Characteristic	Descriptors	Details/Conditions	Definition
sapwood width (cm)	0 - <5 5 - <10 10 - <15 15 - <20 20 - <25 25 and above		The width (thickness) of the sapwood (alburnum), where it is visibly distinct from the heartwood.
brittleheart	frequent/extensive rare or absent/sparse in amount		The extent of the occurrence of brittleheart (brittleness) found in the heartwood of certain species.
appearance/physical characteristics			
main heartwood colour	white / cream yellow / golden-yellow / orange pale brown brown dark brown pale red / pink red dark red reddish brown greenish / greyish purple black		The predominant colour of the heartwood after drying.
other heartwood colour	white / cream yellow / golden-yellow / orange pale brown brown dark brown pale red / pink red dark red reddish brown greenish / greyish purple black		Secondary or other heartwood colour after drying, including streaks, bands, etc.
sapwood colour	same as heartwood paler than heartwood well defined white / yellow pinkish other colour		Sapwood characteristics after drying.
light-induced colour change (interior)	darker lighter none		The change in colour of heartwood caused by light during internal (indoor) use.

Characteristic	Descriptors	Details/Conditions	Definition
deposits	whitish deposits in vessels yellowish deposits in vessels stone/gum aggregates gum/resin exudation		The character of deposits found in various wood tissues.
growth features of the wood	gum/resin streaks latex or other ducts included phloem		The occurrence of generally undesirable growth features of the wood.
silica present	slight moderate severe	<0.1% wt/od wt wood 0.1-0.5% >0.5%	The extent of silica deposits in the heartwood.
grain	straight wavy spiralinterlocked other		The alignment of cells relative to the axis of the tree or the longitudinal edge of a piece of sawn timber.
figure	growth ring stripe ripple mottle dimple burr ray irregular colour other		The ornamental markings on the longitudinal surface of wood as a result of the arrangement of its constituent tissues and the nature of the grain.
figure (occurrence)	very fine & distinct distinct weak variable		The intrinsic quality of the figure.
texture	fine fine/medium medium medium/coarse coarse		Structural characteristics of wood as revealed by touch or reaction to cutting tools. (Largely determined by distribution and size of the various cells).
lustre	pronounced lustrous slightly lustrous dull		The reflective properties of wood.
toxicity	non-toxic respiratory effects dermatitic effects poisonous unspecified toxicity		A characteristic that provides an indication of the reactive effects which may arise when handling or working a wood.

Characteristic	Descriptors	Details/Conditions	Definition
staining properties	non-staining coloured water-soluble extract reacts with Fe to discolour wood other staining characteristics		Extractives in wood which react, usually in the presence of water, to cause discolouration of the wood or adjacent materials.
corrosive properties	non-corrosive reacts with metals		The corrosive action when a timber comes into contact with metal, such as screws, nails, bolts and plates.
density (kg/m^3)	0-199 basic 0- 239 air-dry 200-299 basic 240- 359 air-dry 300-399 basic 360- 479 air-dry 400-499 basic 480- 599 air-dry 500-599 basic 600- 719 air-dry 600-699 basic 720- 839 air-dry 700-799 basic 840- 959 air-dry 800-899 basic 960-1079 air-dry 900-999 basic 1080-1199 air-dry $\geq$1000 basic $\geq$1200 air-dry		The air dry density of wood at 12-15% moisture content (kg/m^3) related to basic density (oven-dry weight, green volume)
movement/shrinkage characteristics			
movement in service	small medium large stable not stable/prone to move	<3% 3-4.5% >4.5% *conditions: experiment* *reputation*	Movement is dimensional stability subsequent to drying. It is determined by measuring the dimensional change in both tangential and radial directions when wood is conditioned, first at 90% r.h. and then at 60% r.h. at a constant temperature of 25°C. It is expressed as the sum of the radial and tangential dimensional changes expressed as percentages of the dimension at 60% r.h.
shrinkage - radial	very small small moderate fairly large large	*(a)* *(b)* up to 2% up to 3% 2.1-2.5% 3.1-4.0% 2.6-3.0% 4.1-5.0% 3.1-3.5% 5.1-6.0% >3.5% >6.0% *conditions: green to 12% m.c. (a)* *green to o.d. (b)*	Radial shrinkage is the change in dimension which occurs when wood, cut at right angles to the growth rings or radial to the pith, is dried to a specific moisture content. The shrinkage is customarily expressed as a percentage of the green dimension.

Characteristic	Descriptors	Details/Conditions	Definition
shrinkage - tangential	very small small moderate fairly large large	*(a)* / *(b)* up to 3% / up to 5% 3.1-4.0% / 5.1-6.5% 4.1-5.0% / 6.6-8.0% 5.1-6.0% / 8.1-9.5% >6.0% / >9.5% *conditions: green to 12% m.c. (a)* *green to o.d. (b)*	Tangential shrinkage is the change in dimension which occurs when wood, cut parallel to the growth rings or tangential to the pith, is dried to a specific moisture content. The shrinkage is customarily expressed as a percentage of the green dimension.
shrinkage - volumetric	very small small moderate fairly large large	*(a)* / *(b)* up to 5% / up to 8% 5.1-6.5% / 8.1-10.5% 6.6-8.0% / 10.6-13.0% 8.1-9.5% / 13.1-15.5% >9.5% / >15.5% *conditions: green to 12% m.c. (a)* *green to o.d. (b)*	The change in volume that occurs because of shrinkage as a result of moisture loss. It is slightly less than the sum of axial, radial and tangential shrinkage.
mechanical characteristics			
maximum crushing strength (parallel to grain)	very low low medium high very high	*(a)* / *(b)* ≤10 N/mm² / ≤20 N/mm² 11-20 / 21-35 21-35 / 36-55 36-62 / 56-85 >62 / >85 *conditions: green (a)* *12% to 15% m.c. (b)*	The load per unit area sustained by timber on its end grain.
modulus of rupture/ bending strength	very low low medium high very high	*(a)* / *(b)* ≤32 N/mm² / ≤50 N/mm² 32-54 / 50-85 55-77 / 86-120 78-114 / 121-175 >114 / >175 *conditions: green (a)* *12% to 15% m.c. (b)*	The stress of the extreme fibres at the point of failure.
modulus of elasticity/ bending stiffness	very low low medium high very high	*(a)* / *(b)* ≤8.6 kN/mm² / ≤10 kN/mm² 8.7-10.4 / 10.1-12.0 10.5-13.0 / 12.1-15.0 13.1-17.5 / 15.1-20.0 >17.5 / >20.0 *conditions: green (a)* *12% to 15% m.c. (b)*	The ratio of stress to strain in bending within the elastic range of the wood perpendicular to the grain. Stiffness is a measure of deflection under load.

Characteristic	Descriptors	Details/Conditions	Definition
toughness - total work	very low low medium high very high	≤0.130 mmN/mm³ 0.131-0.210 0.211-0.300 0.301-0.440 >0.440	The energy required to cause complete failure in a beam when the load is applied rapidly.
toughness - work to maximum load	very low low medium high very high	(a) ≤0.070 mmN/mm³ 0.071-0.100 0.101-0.130 0.131-0.180 >0.180 (b) ≤0.085 mmN/mm³ 0.086-0.140 0.141-0.180 0.181-0.220 >0.220 *conditions: green (a)* *12% to 15% m.c. (b)*	Work to maximum load represents the ability of the specimen to absorb shock with some permanent deformation.
toughness - hammer drop	very low low medium high very high	≤0.60 m 0.61-0.90 0.91-1.20 1.21-1.60 >1.60	A constant weight is dropped perpendicularly from increasing heights onto the test sample until it fractures. Results are expressed as the height from which the weight is dropped to effect failure.
toughness - pendulum	very low low medium high very high	≤20.3 J 20.4-37.3 37.4-54.2 54.3-71.2 >71.2	A pendulum weight is progressively raised and released until it causes failure.
hardness (Janka side grain)	very soft soft medium hard very hard	(a) ≤2500 N 2510-5000 5010-7500 7510-10000 >10000 (b) ≤3000 N 3010-6000 6010-9000 9010-12000 >12000 *conditions: green (a)* *12% to 15% m.c. (b)*	The load required to imbed a 11.3mm diameter hardened steel ball into the sample surface to one half the diameter of the ball.
shear (parallel to grain)	very low low medium high very high	(a) ≤6.0 N/mm² 6.1- 8.5 8.6-12.0 12.1-14.5 >14.5 (b) ≤9.0 N/mm² 9.1-13.0 13.1-18.0 18.1-22.0 >22.0 *conditions: green (a)* *12% to 15% m.c. (b)*	A condition of stress and resulting strain, acting to cause portions of the sample to move or slide in parallel, but opposite directions to each other.

Characteristic	Descriptors	Details/Conditions	Definition
durability characteristics			
natural durability	very durable durable moderately durable non durable perishable	*(a)* years: ≥25; 15-<25; 10-<15; 5-<10; <5 *(b)* years: ≥10; 5-<10; 2-<5; 1-<2; <1 *(c)* av. dry wt. loss %: nil or negligible; <5; 5-<10; 10-<30; ≥30 *conditions: temperate (a), tropical (b), laboratory test (c), observation*	The resistance of heartwood to biodegrade (fungal and insect attack) under adverse conditions, such as ground contact.
wood staining fungal attack	resistant sapwood susceptible heartwood susceptible		The resistance or susceptibility of sapwood and heartwood to the staining effects of fungal attack.
Pinworm attack (ambrosia beetle)	unusual or absent commonly present present in standing tree attack of felled log occurrence in heartwood		Damage caused by one of a group of beetle belonging to the Family Platypodidae and some genera of Scolytidae.
Powder post attack (Lyctid & Bostrychid)	resistant susceptible		Damage to hardwood and softwood by beetles of the Families Lyctidae and Bostrychidae.
termite attack (Isoptera)	resistant moderately resistant susceptible	*conditions: field test, laboratory test, observation/reputation*	Damage caused by insects of the Order Isoptera.
Marine borer attack	resistant moderately resistant susceptible	*conditions: salt water test, observation/reputation, tropical waters, temperate waters*	Damage caused in marine or brackish water by marine molluscs and marine crustaceans.
permeability characteristics			
amenability to preservation (heartwood)	permeable moderately resistant resistant extremely resistant	complete penetration by preservative lateral penetration 6-18mm lateral penetration 3-6mm effectively untreatable	The extent to which heartwood timber can be impregnated with a preservative under pressure.

Characteristic	Descriptors	Details/Conditions	Definition
amenability to preservation (sapwood)	permeable moderately resistant resistant extremely resistant	complete penetration by preservative lateral penetration 6-18mm lateral penetration 3-6mm effectively untreatable	The extent to which sapwood can be impregnated with a preservative under pressure.
drying characteristics			
drying (rate)	fast moderate slow	*conditions: air drying* *kiln drying*	The rate at which timber dries from a green condition.
drying (ease)	easy moderate difficult variable	*conditions: air drying* *kiln drying*	The ease with which timber can be dried from a green condition.
kiln drying rate (green to 12% m.c.)	rapid fairly rapid rather slow slow	*(a)* ≤10 days; 11-17; 18-28; >28 *(b)* ≤20 days; 21-34; 35-56; >56 *(c)* ≤30 days; 31-51; 52-84; >84 *conditions: up to 32mm thickness (a)* *33 to 63mm thickness (b)* *>63mm thickness (c)*	The time in days to kiln dry timber from green to 12% moisture content.
kiln schedule	UK=A US=T2D4/T2D3 Fr=1 UK=B US=T2C2/T2C1 Fr=2 UK=C US=T3C2/T3C1 Fr=3 UK=D US=T3D2/T3C1 - UK=E US=T6D2/T3D1 Fr=5 UK=F US=T6D4/T3D3 Fr=6 UK=G US=T8B3/T5B1 - UK=H US=T10D4S/T8D3S Fr=7 UK=J US=T10D5S/T8D4S Fr=4 UK=K US=T13C4S/T11D3S - UK=L US=T14C6S/T12C5S - UK=M - -		Equivalent kiln schedules used in the U.K. (United Kingdom), U.S. (United States of America), and Fr (France).
drying degrade - surface checking	none slight moderate severe		Separation of wood fibres along the grain forming a crack or fissure that does not penetrate through the timber from one surface to the other.

Characteristic	Descriptors	Details/Conditions	Definition
drying degrade - end splitting	none slight moderate severe		Split at the end of a log or piece.
drying degrade - collapse/honeycomb	none slight moderate severe		Collapse is flattening or buckling of cells during drying which become manifest in excessive or uneven shrinkage. Honeycomb is separation of the fibres in the interior of a piece induced by drying stresses.
drying degrade - cup	none slight moderate severe		Curvature of a piece of timber across the width of the face.
drying degrade - spring/bow	none slight moderate severe		Bow: curvature of a piece of timber lengthwise in a plane normal to the edge, Spring: curvature of a piece of timber lengthwise in a plane normal to the face.
drying degrade - twist/warp	none slight moderate severe		Spiral distortion of a piece of timber lengthwise.
resin/gum exudation on drying	absent present		Movement of mobile extractives (gums and resins) which occur when timber is dried as ambient temperatures increase.
sawing characteristics			
sawing - general (green)	easy moderate difficult variable		The ease or difficulty with which a timber can be sawn when green.
sawing - general (dry)	easy moderate difficult variable		The ease or difficulty with which a timber can be sawn when air dry (12-15% moisture content).
sawing - blunting effect (green)	mild moderate severe		The effect of a timber on the performance of a saw when the timber is green.

Characteristic	Descriptors	Details/Conditions	Definition
sawing - blunting effect (dry)	mild moderate severe		The effect of a timber on the performance of a saw when the timber is dry.
machining characteristics			
machining - general	easy moderate difficult variable		The ease or difficulty with which a timber can be machined.
machining - blunting effect	slight moderate fairly severe severe variable		The effect of a timber on the performance of a machine when the timber is processed.
planing (ease)	easy moderate difficult		The ease of planing a timber.
planing (finish)	good satisfactory poor		The quality of finish when the timber is planed.
mortising (ease)	easy moderate difficult		The ease with which a mortise can be cut in a timber either by hand or with a machine.
mortising (finish)	good satisfactory poor		The quality of finish when a timber is mortised.
moulding (ease)	easy moderate difficult		The ease with which a timber can be shaped.
moulding (finish)	good satisfactory poor		The quality of finish when a timber is moulded.
turning (ease)	easy moderate difficult		The ease with which a timber can be machined on a lathe.

Characteristic	Descriptors	Details/Conditions	Definition
turning (finish)	good satisfactory poor		The quality of finish when a timber is machined on a lathe.
boring	easy moderate difficult		The ease with which a timber can be bored perpendicular to the grain.
recessing & routing (ease)	easy moderate difficult		The ease with which a timber can be slotted, rebated or routed.
recessing & routing (finish)	good satisfactory poor		The finish achieved when a timber is slotted, rebated, or routed.
steam bending	very good good moderate poor very poor	<150 mm 150-250 260-500 510-750 ≥750 *conditions:* *radius of curvature supported* *radius of curvature not supported*	The curvature to which a 1 inch (25mm) thick sample may be steam bent with an expectation of a 5% failure rate.
fastening characteristics			
nailing (ease)	easy difficult possible if prebored		The ease or difficulty of nailing a timber.
nailing (hold)	good satisfactory poor		The tenacity with which a timber holds a nail.
screwing (ease)	easy difficult possible if prebored		The ease or difficulty of screwing a timber.
screwing (hold)	good satisfactory poor		The tenacity with which a timber holds a screw.
resistance to splitting (nail & screw)	excellent good fair poor very poor		The resistance of a timber to splitting when nailed or screwed.

Characteristic	Descriptors	Details/Conditions	Definition
gluing (solid wood)	easy moderate difficult		The ease with which a timber can be glued.
surfacing characteristics			
finishing - general	good satisfactory poor		The general quality of the finished surface.
sanding (ease)	easy moderate difficult		The ease or difficulty with which a timber can be finished using a paper or cloth backed abrasive.
sanding (finish)	good satisfactory poor		The quality of the surface finish obtained when using a paper or cloth backed abrasive.
staining	good satisfactory poor	*conditions: requires filling*	The ease with which a timber can be uniformly stained, using either a water or spirit based stain, and the quality of the resulting stained surface.
painting	good satisfactory poor	*conditions: requires filling*	The ease with which a timber can be painted and the quality of the finished surface.
varnishing	good satisfactory poor	*conditions: requires filling*	The ease with which a timber can be varnished and the quality of the finished surface.
polishing	good satisfactory poor	*conditions: requires filling*	The ease with which a timber can be polished, e.g. French polished, and the quality of the finished surface.
veneer production characteristics			
veneer - bolt preparation	steaming required no steaming needed		Treatment of a timber in order for it to produce an acceptable veneer.

Characteristic	Descriptors	Details/Conditions	Definition
veneer - ease of cutting	easy moderately easy difficult	*conditions: rotary cutting* *slicing*	Ease with which a bolt or flitch of timber can be peeled or sliced.
veneer - drying degrade	no degrade - dries flat/no split slight/moderate - buckles/splits moderate/severe - collapse + b/s		The degrade, typically splits and distortion, of a veneer on drying.
veneer - gluing	good variable difficult	*conditions: uf resin* *pf resin* *other resin*	The ease with which a veneer of a timber can be glued and the resulting tenacity of the bond.

Appendix 3: List of End-uses

agricultural implements
artificial limbs
axles
bakers items
baskets
battery separators
bearings, cogs, pulley & brake blocks
beehives
boats: building (general)
boats: decking
boats: fittings
boats: framing
boats: masts / flag masts
boxes, crates, pallets, packing cases
bridges: decking
bridges: structures (freshwater)
bridges: structures (marine)
bridges: unspecified
brushbacks
bungs, stoppers, plugs
canoes
carriages
carts
carving
charcoal
chemical derivatives
cladding (external): agri./industrial
cladding (external): domestic
cladding (external): unspecified
cladding (internal): panelling
coffins
combs
compressed wood
construction: heavy
construction: hydraulic
construction: light
cooperage: slack
cooperage: tight
cooperage: unspecified
decking
draining boards
drawing boards
fencing: paling
fencing: posts/stakes
fencing: rails
fencing: unspecified
fibre building board/hardboard
floats & lifebelts
flooring (general)
flooring: commercial heavy traffic
flooring: commercial normal traffic
flooring: domestic light traffic
flooring: industrial heavy duty
flooring: industrial light duty
food containers
footwear
fuelwood/briquettes
furniture: general
furniture: cabinet work
furniture: chairs
furniture: laboratory/other bench tops
furniture: table/counter tops
furniture: upholstered furniture
gates
gums, resins, tannins, oils
handles: axe, hammer
handles: broom, brush
handles: cutlery/knife
handles: wood working tools
handles: unspecified
house framing, carcassing
insulation
joinery (external): ground contact
joinery (external): non-ground contact
joinery (general): internal and external
joinery (internal)
ladders: rungs
ladders: stiles
ladders: unspecified
laminated products/beams
liquid fuel
matches: boxes
matches: splints
mathematical instruments, rulers
millwork
mining timber, pitprops
model making & toys
mouldings, picture frames, etc.
musical instruments: percussion
musical instruments: piano/organ parts
musical instruments: strings
musical instruments: unspecified
musical instruments: woodwind
oars, paddles
panelling
particleboard/chipboard
patterns
pencils
picking sticks
piling, groynes
plywood (general)
plywood corestock
plywood: core (lamin/blockboard)
plywood: veneer (exterior)
plywood: veneer (interior)
plywood: veneer (marine)
poles: scaffolding
poles: shunting
poles: telegraph, transmission
printers blocks
pulp/paper
rifle furniture
rollers, mangles
roof trusses: agric/industrial
roof trusses: domestic
roof trusses: unspecified
ropes & fibres
scaffold boards
shingles, shakes
shuttering (concrete)
sleepers, cross tiessports items:
baseball bats
sports items: billiard cues
sports items: cricket bats
sports items: golf club heads
sports items: golf club shafts
sports items: hockey sticks
sports items: lacrosse sticks
sports items: polo sticks
sports items: skis
sports items: tennis rackets
sports items: unspecified
steps (sides and treads)
structural beams: unspecified
structures: agricultural
structures: domestic
structures: freshwater
structures: industrial
structures: marine
textile bobbins, shuttles, cotton reels
textile machinery
tobacco pipes
tool handles: unspecified
tools: mallets
tools: planes
tools: spirit levels
toothpicks
turnery: ornamental
turnery: dairy & kitchen utensils
turnery: unspecified
vats, tanks
vehicles: decking/flooring
vehicles: framing
vehicles: sidings, cab timber, etc.
veneer: decorative
veneer: general purpose
waferboard
walking sticks
water cooling towers
well construction
wharves unspecified
wheels: rims
wheels: spokes
wood flour
wood wool

descriptors:

used commercially/exported	(known to be used and exported for this application)
used locally	(known to be used locally for this application but not exported)
used, but extent unknown	(known to have been used for this application, but extent of use unknown)

Appendix 4: List of countries/geographical regions

Australasia
- Australia
- New Zealand
- Papua New Guinea
- West Irian

Central America
- Belize
- Costa Rica
- El Salvador
- Guatemala
- Honduras
- Mexico
- Nicaragua
- Panama

Central Asia
- U.S.S.R.

Central Southern Africa
- Angola
- Malawi
- Mozambique
- Zambia
- Zimbabwe

East Africa
- Djibouti
- Ethiopia
- Kenya
- Somalia
- Tanzania
- Uganda

East Asia
- China
- Japan
- Taiwan

Equatorial Africa
- Burundi
- Cameroon
- Central African Republic
- Chad
- Congo
- Equatorial Guinea
- Gabon
- Rwanda
- Zaire

Indian Ocean
- Comoro Islands
- Madagascar
- Maldives
- Mauritius
- Reunion
- Seychelles

North Africa
- Algeria
- Libya
- Morocco
- Spanish Sahara
- Tunisia

North America
- U.S.A.

North Atlantic
- Azores
- Bermuda
- Canary Islands
- Cape Verde Islands
- Madeira

North East Africa
- Egypt
- Sudan

Pacific
- Fiji
- French Polynesia
- Hawaii
- New Caledonia
- Norfolk Island
- Samoa
- Solomon Islands
- Tonga
- Vanuatu

South America
- Argentina
- Bolivia
- Brazil
- Chile
- Colombia
- Ecuador
- French Guiana
- Guyana
- Paraguay
- Peru
- Surinam
- Uraguay
- Venezuela

South Atlantic
- Ascension Island
- St. Helena

South East Asia
- Andaman Islands
- Borneo
- Brunei
- Burma
- Indonesia
- Kampuchea
- Laos
- Malaysia
- Philippines
- Sabah
- Sarawak
- Singapore
- Sumatra
- Thailand
- Vietnam

South West Asia
- Bahrain
- Iran
- Iraq
- Israel
- Jordan
- Kuwait
- Lebanon
- Muscat & Oman

South West Asia (cont.)
- Qatar
- Saudi Arabia
- Syria
- Turkey
- United Arab Emirates
- Yemen - Peoples Dem. Rep.
- Yemen Arab Rep.

Southern Africa
- Botswana
- Lesotho
- Namibia
- South Africa
- Swaziland

Southern Asia
- Afghanistan
- Bangladesh
- Bhutan
- India
- Nepal
- Pakistan
- Sri Lanka

Southern Europe

West Africa
- Benin
- Dahomey
- Gambia
- Ghana
- Guinea
- Guinea-Bissau
- Ivory Coast
- Liberia
- Mali
- Mauritiana
- Niger
- Nigeria
- Sao Tomé & Principe
- Senegal
- Sierra Leone
- Togo
- Upper Volta

West Indies
- Antigua
- Bahamas
- Barbados
- Cuba
- Dominica
- Dominican Rep.
- Grenada
- Guadeloupe
- Haiti
- Jamaica
- Martinique
- Montserrat
- Netherlands Antilles
- Puerto Rico
- St. Kitts, Nevis & Anguilla
- St. Lucia
- St. Vincent
- Trinidad & Tobago
- Virgin Islands

Appendix 5 : PROSPECT Species List

Abelia triflora Br.
Acacia albida Del.
Acacia aneura F.v.M.
Acacia arabica Willd.
Acacia catechu Willd.
Acacia confusa Merr.
Acacia mearnsii De Wild.
Acacia melanoxylon R.Brown
Acacia polyacantha Willd.
Acanthosyris falcata Griseb.
Acer catalpifolium Rehd.
Acer cultratum Wall.
Achras zapota
Ackama paniculata Engl.
Acrocarpus fraxinifolius Wight
Acronychia porteri Hook. f.
Adansonia digitata L.
Adenanthera pavonina L.
Adinandra lamponga Miq.
Aegiceras floridum Roem. & Schult.
Aegiceras majus Gaertn.
Aegle marmelos Correa
Aesculus turbinata Bl.
Aextoxicon punctatum Ruiz & Pav.
Afrormosia angolensis (Baker) De Wild.
Afrormosia spp.
Afzelia africana Persoon
Afzelia quanzensis Welw.
Afzelia spp.
Aglaia odoratissima Bl.
Agonandra brasiliensis Benth. & Hook. f.
Agrostistachys borneensis Becc.
Ailanthus altissima Saingle
Ailanthus excelsa Roxb.
Alangium chinense (Lour.) Harms
Albizia adianthifolia (Schum.) W.F.Wight
Albizia antunesiana Harms
Albizia ferruginea (Guill. & Perr.) Benth.
Albizia gummifera (Gmel.) C.A.Sm.
Albizia lebbeck (L.) Benth.
Albizia odoratissima Benth.
Albizia spp.
Albizia zygia (DC.) Macbride
Aleurites fordii Hemsl.
Aleurites moluccana (L.) Willd.
Alexa imperatricis (Schomb.) Baill.
Alibertia edulis A.Rich.
Allanblackia parviflora A.Chev.
Alphitonia philippinensis Braid.
Alseis yucatanensis
Alseodaphne semecarpifolia Nees
Alstonia congensis Engl.
Alstonia scholaris (L.) R.Br.
Altingia excelsa Nor.
Alvaradoa amorphoides Liebm.
Amaioua corymbosa H.B.K.
Amanoa grandiflora Muell.Arg.
Amblygonocarpus andongensis (Welw.ex Oliv.)Excell&Torrey
Amblygonocarpus obtusangulus Harms
Amburana cearensis (Fr.Allem.) A.C.Smith.
Amoora cucullata Roxb.
Amoora wallichii King
Ampelocera hottlei (Standl.) Standl.
Amphimas ferrugineus Pierre ex Pellegr.
Amphimas pterocarpoides Harms
Amyris balsamifera L.
Amyris elemifera L.
Amyris simplicifolia Karst.
Anacardium excelsum (Bert & Balb) Skeels
Anacardium occidentale L.
Anadenanthera macrocarpa (Benth.) Brenan
Andira inermis (H.B.K.) (W. Wright) D.C.
Androstachys johnsonii Prain
Angelesia splendens Korth.
Aniba ovalifolia Mez
Aningeria altissima (A.Chev.) Aubr. & Pellegr.
Anisophyllea laurina R.Br.
Anisoptera curtisii Dyer ex King
Anogeissus acuminata Wall.
Anogeissus leiocarpus (DC.) Guill. & Perr.
Anona glabra L.
Anona squamosa L.
Anthocephalus chinensis (Lam.) A.Rich. ex Walp.
Antiaris africana Engl.
Antiaris spp.
Antidesma ghaesembilla Gaertn.
Antrocaryon micraster A.Chev. & Guill.
Apeiba aspera Aubl.
Aphanamixis rohituka Pierre
Aphananthe philippinensis Planch.
Apodytes dimidiata E.Mey ex Bernh.
Aporosa aurea Hook. f.
Aporosa maingayi Hook. f.
Aporosa nigricans Hook. f.
Apuleia leiocarpa (Vog.) Macbride
Aquilaria malaccensis Lam.
Aralidium pinnatifidum Miq.
Ardisia lanceolata Roxb.
Aromadendron elegans Bl.
Arthrophyllum diversifolium Blume
Artocarpus altilis (Parkinson) Fosberg
Artocarpus bracteata Hook. f
Artocarpus gomeziana Wall.
Aspidosperma megalocarpon Mull. Arg
Aspidosperma megalocarpum
Aspidosperma peroba S.da Gama.
Aspidosperma quebracho-blanco Schl.
Asteriastigma macrocarpa Bedd.
Asteropeia rhopaloides Bak.
Astronium le-cointei Ducke
Atamisquea emarginata Miers
Atherosperma moschatum Labill.
Aucoumea klaineana Pierre
Autranella congolensis (De Wild.) A.Chev.
Averrhoa bilimbi L.
Averrhoa carambola L.
Azadirachta indica A.Juss.
Baccaurea motleyana Muell.Arg.
Bagassa guianensis Aubl.
Baikiaea plurijuga Harms
Baillonella toxisperma Pierre
Balanites aegyptiaca (L.) Del.
Balanocarpus heimii King
Balfourodendron riedelianum Engl.
Balsamodendron mukul Hook. ex Stocks
Banara guianensis Aubl.
Baphia nitida Lodd.
Baphia pubescens Hook. f.
Barringtonia acutangula Gaertn.
Barringtonia scortechinii King
Barringtonia speciosa Forst.
Bastardiopsis densiflora Hassl.
Beilschmiedia mannii (Meissn.) Benth. & Hook. f.
Beilschmiedia spp.
Beilschmiedia tawa (A.Cunn.) Kirk
Bellucia costaricensis
Belotia panamensis Pitt.
Berlinia auriculata Benth.
Berlinia bracteosa Benth.
Berlinia grandiflora (Vahl) Hutch. & Dalz.
Berrya cordifolia (Willd.) Burret
Bersama paullinioides (Planch.) Bak.
Bertiera guianensis Aubl.
Betula alnoides Ham.
Billia columbiana Planch. & Lind.
Bischofia javanica Blume
Bixa orellana L.
Blastemanthus grandiflorus Spruce
Blighia sapida Koenig
Blighia unijugata Bak.
Boehmeria rugulosa Wedd.
Bombacopsis quinata (Jacq.) Dugand

Appendix 5 : continued

Bombacopsis sepium Pitt.
Bombax ceiba L.
Bonyunia aquatica Ducke
Boschia griffithii Mast.
Bosqueia angolensis (Welw.) Ficalho
Bouea burmanica Griff.
Bouea macrophylla Griff.
Bourreria ovata Miers
Bowdichia nitida Spruce ex Benth.§
Brachylaena hutchinsii Hutch. §
Brachystegia cynometroides Harms §
Brachystegia eurycoma Harms
Brachystegia mildbraedii Harms
Brachystegia spiciformis Benth.
Brassaiopsis hainla Seem.
Bravaisia integerrima Standl.
Brosimum alicastrum
Brosimum caloxylon Standl.
Brosimum costaricanum Liebm.
Brosimum paraense Hub.
Broussonetia papyrifera Vent.
Brya ebenus DC.
Buchanania lancifolia Roxb.
Buchanania lanzan Spreng.
Buchenavia capitata (Vahl) Eichl.
Bucida buceras L.
Bucklandia populnea R.Br.
Bulnesia arborea Engl.
Bumelia obtusifolia R.& Sch.
Burkea africana Hook.
Bursera simaruba (L.) Sarg.
Bussea occidentalis Hutch.
Butea monosperma (Lamk.) Taub.
Butea superba Roxb.
Byrsonima coriacea (Sw.) DC.
Byrsonima crassifolia (L.) H.B.K.
Byrsonima spicata (Cav.) DC.
Cabralea cangerana Sald.
Cabralea oblongifoliola C.DC.
Cadaba trifoliata W.& A.
Caesalpinia coriaria Willd.
Caesalpinia granadillo Pittier
Caesalpinia sappan L.
Calatola costaricensis Standl.
Caldcluvia paniculata Don
Calliandra guildingii Benth.
Callicarpa arborea Roxb.
Calodendrum capense (L.f.) Thunb.
Caloncoba brevipes Gilg
Calophyllum brasiliense Camb.
Calophyllum costatum F.M.Bail.
Calpocalyx brevibracteatus Harms
Calycolpus glaber (Benth.) Berg
Calycophyllum candidissimum (Vahl) DC.
Calyptranthes pallens Griseb.
Calyptranthes zuzygium (L.) Sw.
Calyptrella cucullata Triana
Campnosperma auriculata (Bl.) Hook. f.
Camptostemon philippinense (Vidal) Beccari
Canangium odoratum (Lam.) Baill.
Canarium euphyllum Kurz
Canarium schweinfurthii Engl.
Canella winterana (L.) Gaertn.
Canotia holacantha Torr.
Capparis cynophallophora L.
Carallia calycina Thw.
Carapa guianensis Aubl.
Carapa procera DC.
Carapa slateri Standl.
Cardwellia sublimis F.Muell.
Careya arborea Roxb.
Cariniana excelsa Casar.
Cariniana legalis (Mart.) Kuntze
Carissa spp.
Carpodiptera cubensis Griseb.
Caryocar costaricense Donn.Sm.
Casearia dinklagei Gilg
Cassia nodosa Buch. Ham. ex Roxb.
Cassia siamea Lamk.
Cassia timoriensis DC.
Cassine crocea O.Ktze
Cassipourea afzelii (Oliv.) Alston
Cassipourea elliptica Poir.
Cassipourea malosana (Bak.) Alston
Cassipourea verticillata N.E.Br.
Castanopsis cuspidata Schott
Castanopsis junghuhnii (Miq.) Hayata
Castanopsis kawakamii Hayata
Castanopsis sumatrana A.DC.
Castanospermum australe A.Cunn.
Castela coccinea Griseb.
Castilla fallax Cook
Casuarina litorea L.
Casuarina torulosa Dryand. ex Ait.
Catalpa longissima Jacq.
Cavanillesia platanifolia H.B.K.
Cecropia juranyana A.Rich.
Cecropia obtusifolia Bertol.
Cedrela odorata (MELIACEAE)
Ceiba pentandra (L.) Gaertn.
Celtis adolfi-friderici Engl.
Celtis africana Burm. f.
Celtis australis L.
Celtis durandii Engl.
Celtis mildbraedii Engl.
Celtis philippensis Blanco
Celtis prantlii Priemer ex Engl.
Celtis zenkeri Engl.
Centrolobium paraense Tul.
Centrolobium patinense Pittier
Centronia excelsa (Bonpl.) Triana
Cephalosphaera usambarensis (Warb.) Warb.
Ceratonia siliqua L.
Ceratopetalum apetalum D.Don
Cerbera odollam Gaertn.
Cercidiphyllum japonicum S.& Z.
Cercidium praecox (R. & P.) Harms
Cercis canadensis L.
Ceriops tagal C.B.Rob.
Cervantesia colombiana A.C.Smith
Cestrum panamense Standl.
Chaetocarpus castanocarpus Thw.
Chilopsis linearis P.DC.
Chlorophora excelsa (Welw.) Benth.
Chlorophora tinctoria (L.) Gaud.
Christiania africana DC.
Chrysochlamys membranacea Tr. & Pl.
Chrysophyllum cainito L.
Chrysophyllum oliviforme L.
Chrysophyllum sanguinolentum (Pierre) Monach.
Chukrasia tabularis A.Juss.
Chytroma idatimon Miers
Cinchona ledgeriana Moens ex Trimen
Cinnamomum camphora Nees. & Eberm.
Cinnamomum iners Reinw.
Cinnamomum parthenoxylon Meissn.
Cipadessa fruticosa Bl.
Citharexylum caudatum L.
Citharexylum fruticosum L.
Citharexylum macradenium Greenm.
Citrus aurantium L.
Citrus medica L.
Clarisia racemosa R.& P.
Cleistanthus collinus Benth.
Cleistanthus myrianthus Kurz
Cleistopholis glauca Pierre ex Engl. & Diels
Cleistopholis patens (Benth.) Engl. & Diels.
Clerodendron disparifolium Bl.
Clethra lanata Mart. & Gal.
Clidemia naevula (Naud.) Triana

Appendix 5 : continued

Cneorum trimerum (Urb.) Chod.
Cochlospermum orinoccense Steud.
Coelocaryon oxycarpum Stapf
Coelostegia griffithii Benth.
Cola acuminata (P.Beauv.) Schott & Endl.
Cola spp.
Colophospermum mopane (J.Kirk ex Benth.) J.Leonard
Colubrina arborescens (Mill.) Sarg.
Colubrina cubensis (Jacq.) Brongn.
Colubrina reclinata (L'Her.) Brongn.
Columbia floribunda Kurz
Combretodendron macrocarpum (P.Beauv.) Keay
Combretum binderianum Kotschy
Combretum lamprocarpum Diels
Compsoneura sprucei (A.DC.) Warb.
Condalia lineata A.Gray
Condalia obovata Hook.
Conocarpus erectus L.
Conopharyngia durissima Stapf
Conostegia xalapensis (Bonpl.) D.Don
Copaifera mildbraedii Harms
Copaifera panamensis (Britton) Standley
Cordia caffra Sond.
Cordia dichotoma Forst. f.
Cordia dodecandra DC.
Cordia gerascanthus L.
Cordia goeldiana Hub.
Cordia obliqua Willd.
Cordia spp. (African)
Cordia trichotoma Vell. ex Steud.
Cordyla africana Lour.
Cornus macrophylla Wall.
Cornus peruviana Macbride
Cosmocalyx spectabilis Standley
Cotylelobium malayanum V.Sl.
Coula edulis Baill.
Coumarouna oleifera (Benth.) Taub.
Couratari panamensis Standley
Couroupita darienensis Pittier
Couroupita odoratissima Seem.
Coutarea hexandra K.Schum.
Craibiodendron shanicum W.W.Smith
Crataegus oxyacantha L.
Craterogyne kamerunana (Engl.) Lanjouw
Cratoxylon arborescens (Vahl) Bl.§
Crinodendron tucumanum Lillo
Croton argyratus Bl.
Croton megalocarpus Hutch.
Croton oblongifolius Roxb.
Crudia obliqua Griseb.
Crypteronia paniculata Blume.
Cryptocarya chinensis Hemsl.
Ctenolophon englerianus Mildbr.
Ctenolophon grandifolius Oliv.
Cuervea kappleriana (Miq.) A.C.Smith
Cullenia exarillata A.Robyns
Cunonia capensis L.
Curtisia faginea Ait.
Cussonia arborea Hochst. ex A.Rich.
Cyclobalanopsis gilva Oerst.
Cyclobalanopsis morii (Hayata) Hayata
Cylicodiscus gabunensis (Taub.) Harms
Cynometra alexandri C.H.Wright
Cynometra megalophylla Harms
Cynometra polyandra Roxb.
Cynometra ramiflora L.
Cyrilla racemiflora L.
Dacryodes buettneri (Engl.) J.H.Lam.
Dacryodes edulis (G.Don) H.J.Lam
Dactylocladus stenostachys Oliv.
Dalbergia cearensis Ducke
Dalbergia frutescens Britton
Dalbergia latifolia Roxb.
Dalbergia melanoxylon Guill. & Perr.
Dalbergia nigra Fr.Allem.
Dalbergia oliveri Gamble
Dalbergia retusa Hemsl.
Dalbergia sissoo Roxb.
Dalbergia stevensonii Standl.
Daniellia klainei Pierre ex De Wild
Daniellia ogea (Harms) Rolfe ex Holl.
Daniellia oliveri (Rolfe) Hutch. & Dalz.
Daniellia thurifera Benn.
Daphnandra micrantha Benth.
Daphniphyllum lancifolium Hook.
Daphnopsis macrophylla Gilg
Daphnopsis philippiana Krug & Urban
Dehaasia curtisii Gamble
Delonix regia (Bojer) Raf.
Deplanchea bancana V.Steenis
Dermatocalyx parviflora Oerst.
Desbordesia glaucescens (Engl.) Van Tiegh.
Desmostachys vogelii Stapf
Detarium senegalense J.F.Gmel.
Dialium guianense (Aubl.) Sandw.
Dialium spp.
Dialyanthera otoba Warb.
Dichrostachys glomerata (Forsk.) Chiov.
Dicorynia guianensis Amsh.
Dillenia reticulata King
Dimorphocalyx malayanus Hook.
Dinizia excelsa Ducke
Diospyros abyssinica (Hiern.) F.White
Diospyros atropurpurea Gurke
Diospyros burmanica Kurz
Diospyros crassiflora Hiern.
Diospyros ehretioides Wall.
Diospyros ferrea (Willd.) Bakh.
Diospyros gabunensis Gurke
Diospyros kaki L. f.
Diospyros kamerunensis Gurke
Diospyros mannii Hiern
Diospyros mespiliformis (Hochst.) ex A.DC.
Diospyros thomasii Hutch. & Dalz.
Diospyros xanthochlamys Gurke
Diphysa robinioides Benth.
Diplodiscus paniculatus Turczaninow
Diplorhynchus condylocarpon (Muell. Arg.) Pichon
Diplotropis purpurea (Rich.) Amsh.
Dipterocarpus rotundifolius Foxworthy
Dipterodendron costaricense Radlk.
Discoglypremna caloneura (Pax) Prain
Discophora panamensis Standley
Distemonanthus benthamianus Baill.
Distylium racemosum S. & Z.
Doerpfeldia cubensis Urb.
Drimys granatensis L. f.
Dryobalanops aromatica Gaertn. f.
Drypetes brownii
Drypetes diversifolia Krug & Urb.
Drypetes lateriflora (Sw.) Krug & Urb.
Drypetes principum (Muell.Arg.) Hutch.
Duabanga grandiflora (Roxb. ex DC.) Walp.
Duboisia myoporoides R.Br.
Dyera costulata Hook. f.
Dysoxylum fraseranum Benth.
Ehretia acuminata R.Br.
Ehretia anacuna (Berl.) Johnston
Ehretia cymosa Thonn.
Ehretia tinifolia L.
Ekebergia capensis Sparrm.
Ekmanianthe actinophylla (Gris.) Urb.
Elaeocarpus floribundus Bl.
Elateriospermum tapos Bl.
Embothrium coccineum Forst.
Enallagma latifolia (Mill.) Sm.
Enantia chlorantha Oliv.
Endiandra palmerstonii (F.M.Bail.) C.T.White
Endospermum malaccense Muell.Arg.
Engelhardtia formosana Hayata

Appendix 5 : continued

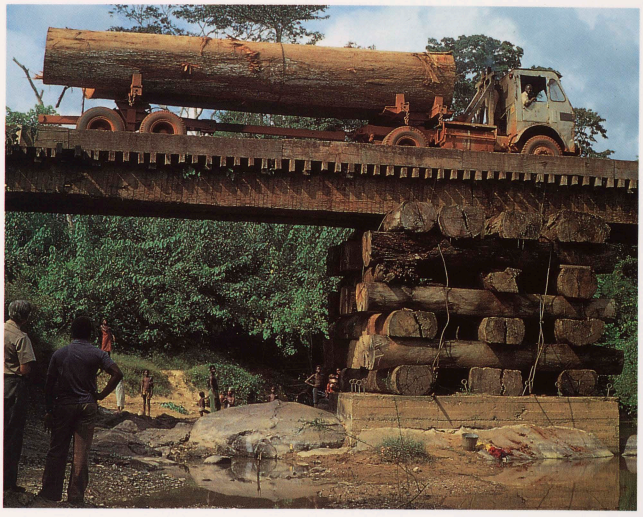
Engelhardtia nudiflora Hook.
Engelhardtia pterocarpa (Oerst.) Standl.
Engelhardtia roxburghiana Lindl.
Engelhardtia spicata Bl.
Entada abyssinica Steud. ex A.Rich.
Entandrophragma angolense (Welw.) C.DC.
Entandrophragma candollei Harms
Entandrophragma cylindricum Sprague
Entandrophragma utile (Dawe & Sprague) Sprague
Enterolobium cyclocarpum (Jacq.) Gris.
Eperua falcata Aubl.
Erblichia odorata Seem.
Eremophila mitchellii Benth.
Erinocarpus nimmoanus Grah.
Eriobotrya bengalensis Hook. f.
Eriolaena candollei Wall.
Eriolaena quinquelocularis Wight
Eriolaena spectabilis Planch.
Erithalis fruticosa L.
Ervatamia corymbosa King & Gamble
Erythrina berteroana Urb.
Erythrina mildbraedii Harms
Erythrophleum africanum (Benth.) Harms
Erythrophleum guineense G.Don
Erythrophleum ivorense A.Chev.
Erythroxylum mannii Oliv.
Escallonia myrtillioides L.
Eschweilera amara (Aubl.) Ndz.
Esenbeckia alata (Karst. & Tr.) Tr. & Pl.
Esenbeckia atata Pitt.
Esenbeckia pilocarpoides H.B.K.
Esenbeckia spp.
Eucalyptus calophylla R.Br.
Eucalyptus globulus Labill.
Eucalyptus melliodora A.Cunn.
Eucalyptus microcarpa Maiden
Eucalyptus microcorys F.Muell.
Eucalyptus pilularis Smith
Eucalyptus saligna Smith
Eucalyptus wandoo Blakely
Euclea lanceolata E.Mey.
Eucryphia lucida Druce
Eugenia axillaris (Sw.) Willd.
Eugenia confusa DC.
Euphorbia tirucalli L.
Euroschinus falcatus Hook. f.
Eusideroxylon zwageri T. & B.
Euxylophora paraensis Hub.
Evodia glabra Blume
Excoecaria agallocha L.
Exocarpos latifolius R.Br.Prod.356
Exostema caribaeum (Jacq.) R. & S.
Fagara brieyi Vermoesen & Gilbert
Fagara flava Krug & Urb.
Fagara heitzii Aubrev. & Pellegr.
Fagara leprieurii Engl.
Fagara macrophylla Engl.
Fagaropsis angolensis (Engl.) Dale
Fagraea fragrans Roxb.
Fagraea gigantea Ridl.
Faramea occidentalis (L.) A.Rich.
Faurea macnaughtonii Phill.
Ficalhoa laurifolia Hiern.
Ficus aurea Nutt.
Ficus glabrata
Ficus glaucescens Miq.
Ficus laevigata Vahl
Fillaeopsis discophora Harms
Flacourtia cataphracta Roxb.
Flindersia brayleyana F.Muell.
Forestiera acuminata Poir.
Funtumia africana (Benth.) Stapf
Gallesia scorododendrum Casar.
Gambeya lacourtiana (De Wild.) Aubr. & Pell.
Gamblea ciliata Clarke
Ganua motleyana Pierre
Garcinia cowa Roxb.
Garcinia kola Heckel
Gardenia coronaria Ham.
Gardenia latifolia Ait.
Gavarretia terminalis Baill.
Geissois benthami F.Muell.
Genipa americana L.
Gironniera nervosa Planch.
Gironniera reticulata Thw.
Glandonia macrocarpa Gris.
Gliricidia sepium (Jacq.) Steud.
Gluta elegans (Wall.) Hook. f.
Gmelina arborea Roxb.
Goethalsia meiantha (D.Sm.) Burret
Gomidesia lindeniana Berg.
Gonioma kamassi (Eckl.) E.Mey.
Goniothalamus griffithii Hook. f. & Th.
Gonocaryum calleryanum (Baill.) Becc.
Gonystylus bancanus (Miq.) Kurz
Gonystylus macrophyllus (Miq.) A.Shaw.
Gordonia papuana Kobuski
Gossweilerodendron balsamiferum (Verm.) Harms
Gossypiospermum praecox (Gris.) P.Wils.
Goupia glabra Aubl.
Grewia microcos L.
Grias fendleri Seem.
Grislea secunda Loefl.
Guarea cedrata (A.Chev.) Pell.
Guarea glabra
Guarea thompsonii Sprague & Hutch.
Guazuma ulmifolia Lam.
Guettarda combsii
Guevina avellana Mol.
Guibourtia arnoldiana (De Wild.& Th.Dur.) J.Leonard
Guibourtia coleosperma (Benth.) J.Leonard
Guibourtia demeusei (Harms) J.Leonard
Guibourtia pelligriniana J.Leonard
Guibourtia spp.
Guibourtia tessmannii (Harms) J.Leonard
Guilandina echinata (Lam.) Spreng.
Gymnacranthera farquhariana Warb.
Gymnanthes lucida Sw.
Gynocardia odorata R.Br.
Gynotroches axillaris Bl.
Haematoxylon campechianum L.
Hagenia abyssinica (Bruce) J.F.Gmel.
Haldina cordifolia (Roxb.) Ridsd.
Halfordia scleroxyloa F.Muell.
Halleria lucida L.
Haloxylon ammodendron Boiss.
Hannoa klaineana Pierre & Engl.
Haplormosia monophylla (Harms) Harms
Hardwickia binata Roxb.
Harungana madagascarensis Lam. ex Poir.
Hasseltiopsis dioica (Benth.) Sleumer
Heinsia crinata (Afzel.) G.Taylor
Heisteria macrophylla Oerst.
Heisteria parvifolia Smith
Helicostylis latifolia Pittier
Helietta cuspidata (Engl.) Chod. & Hassl.
Heliocarpus popayanensis H.B.K.
Heritiera littoralis (Dryand.) Ait.
Heritiera macrophylla Wall.
Hernandia ovigera L.
Hernandia sonora L.
Heterophragma adenophyllum Seem.
Heterotrichum cymosum (Wendl.) Urb.
Hevea guyanensis Aubl.
Heynea trijuga Roxb.
Hibiscus elatus Sw.
Hibiscus floccosus Mast.
Hibiscus macrophyllus Roxb.
Himatanthus articulata (Vahl) Woodson
Hippomane mancinella L.

Appendix 5 : continued

Hippophae rhamnoides L.
Hippophae salicifolia Don
Holigarna helferi Hook. f.
Holoptelea grandis (Hutch.) Mildbr.
Holoptelea integrifolia (Roxb.) Planch.
Homalium angustistipulatum Keay
Homalium aylmeri Hutch. & Dalz.
Homalium letestui Pellegr.
Homalium longifolium Benth.
Homalium tomentosum Benth.
Homalium zeylanicum Benth.
Hopea beccariana Burck.
Hopea ferrea Lanessan
Hopea odorata Roxb.
Humboldtia bourdilloni Prain
Humiria balsamifera (Aubl.) St. Hil.
Humiria floribunda Mart.
Humiria procera Little
Hunteria corymbosa Roxb.
Ichthyomethia piscipula (L.) Hitchcock
Ilex belizensis
Ilex casiquiarensis Loes.
Ilex cymosa Bl.
Ilex mitis (L.) Radlk.
Ilex panamensis Standley
Ilex paraguensis St. Hil.
Ilex sideroxyloides Griseb.
Inga edulis Mart.
Jacaranda copaia (Aubl.) D.Don
Jacaranda rhombifolia G.F.W. Mey.
Jackia ornata Wall.
Jacquinia keyensis Mez
Joannesia heveoides Ducke.
Jodina rhombifolia Hook. & Arn.
Juglans mandshurica Maxim.
Juglans sieboldiana Maxim.
Julbernardia pellegriniana Troupin§
Kalopanax pictus Nakai
Kandelia rheedii W. & A.
Khaya anthotheca (Welw.) C.DC.
Khaya grandifoliola C.DC.
Khaya ivorensis A.Chev.
Khaya senegalensis (Desr.) A.Juss.
Khaya spp.
Kigelia pinnata (Jacq.) DC.
Kiggelaria africana L.
Kirkia acuminata Oliv.
Klainedoxa gabonensis Pierre ex Engl.
Kleinhovia hospita L.
Knema furfuracea Warb.
Lachnopylis floribunda (Benth.) C.A.Sm.
Lacistema aggregatum (Berg) Rusby
Laetia procera (Poepp & Endl.) Eichl.
Lagerstroemia calyculata Kurz
Lagerstroemia hypoleuca Kurz
Lagerstroemia speciosa (L.) Pers.
Lagerstroemia subcostata Loehne
Lagerstroemia tomentosa Presl.
Laguncularia racemosa (L.) Gaertn.
Lannea coromandelica (Houtt.) Merrill
Lannea kerstingii Engl. & Krause
Lannea welwitschii (Hiern.) Engl.
Lansium domesticum Jack
Laplacea fruticosa (Schrad.) Kobuski
Laurelia sempervirens (R. & P.) Tul.
Laurelia serrata Bert.
Licania platypus
Lonchocarpus castilloi
Maba cooperi Hutchinson & Dalziel
Macaranga puncticulata Gage
Macoubea guianensis Aubl.
Macropanax oreophilum Miq.
Madhuca latifolia (Roxb.) McBride
Madhuca malaccensis H.J.Lam
Madhuca tomentosa H.J.Lam
Madhuca utilis (Ridl.) H.J.Lam
Maesa ramentacea A.DC.
Maesopsis eminii Engl.
Malacantha alnifolia (Baker) Pierre.
Malache scabra B.Vog.
Mallotus macrostachyus Muell.Arg.
Mallotus muticus (Muell. Arg.) Airy Shaw
Mallotus penangensis Muell.Arg.
Mallotus philippinensis Muell. Arg.
Mansonia altissima A. Chev.
Mansonia gagei J.R.Drumm.
Melaleuca quinquenervia (Cav.) S.T.Blake
Metopium brownii
Millettia laurentii de Wild
Napoleonaea leonensis Hutch. & Dalz.
Nauclea diderrichii (De Wild. ex Th. Dur.) Merr.
Nauclea junghuhnii (Miq.) Merr.
Nauclea maingayi Hook. f.
Nauclea pobeguinii (Pellegr.) Petit
Naucleopsis macrophylla Miq.
Necepsia afzelii Prain
Neesia synandra Mast.
Neonauclea peduncularis Merrill
Nephelium longana Camb.
Nesgordonia papaverifera (A.Chev.) R.Capuron §
Newtonia buchananii (Bak.) Gilb. & Bout.
Niemeyera prunifera F.Muell.
Norrisia malaccensis Gardn.
Nothofagus dombeyi Blume
Nothofagus moorei (F.Muell.) Krasser
Nothofagus truncata (Colenso) Cockayne
Nothopegia colebrookiana Bl.
Nuxia floribunda Benth.
Nyctanthes arbor-tristis Linn.
Nycticalanthus speciosus Ducke
Ochanostachys amentacea Masters
Ochna arborea Burch. ex DC.
Ochna wallichii Planch.
Ochroma lagopus Sw. §
Ochthocosmus africanus Hook. f.
Ocotea barcellensis Mez
Ocotea bullata E.Mey.
Ocotea coriacea (Sw.) Britt.
Ocotea porosa L. Barroso §
Ocotea rodiaei Mez §
Ocotea rubra Mez§
Ocotea usambarensis Engl.§
Octoknema borealis Hutch. & Dalz.
Octomeles sumatrana Miq.
Oldfieldia africana Benth. & Hook. f.
Olea capensis L.
Olea hochstetteri (A.Chev.) Bak.
Olea welwitschii (Knobl.) Gilg & Schell.
Pachira aquatica Aubl.
Pachira insignis Sw.
Pachyanthus cubensis A. Rich.
Pachypodanthium staudtii (Engl. & Diels) Engl.
Pahudia cochinchinensis Pierre ex Laness.
Pajanelia rheedii D.C.
Pangium edule Reinw.
Parahancornea amapa (Huber) Ducke
Paramacherium schomburgkii (Benth.) Ducke
Parartocarpus triandrus J.J.Smith
Parartocarpus venenosus (Zoll.& Mor.) Becc.
Parashorea lucida (Miq.) Kurz
Parashorea plicata Brandis
Parashorea stellata Kurz
Parastemon urophyllus A.DC.
Paratecoma peroba (Record) Kuhlm.
Paratrophis glabra (Merrill) v.Steenis
Parinari excelsa Sabine
Parishia insignis Hook. f.
Parkia bicolor A.Chev.
Parkia javanica (Lam.) Merr.
Parkinsonia aculeata L.

Appendix 5 : continued

Paropsia vareciformis Mast.
Patagonula americana L.
Paulownia tomentosa (Thunb.) Steud.
Pausinystalia lane-poolei Hutch.
Payena lucida A.DC.
Pelliciera rhizophorae Planch. & Triana
Peltogyne porphyrocardia Griseb.
Peltogyne pubescens Benth.§
Peltophorum dasyrachis Kurz ex Bak.
Pentace burmanica Kurz
Pentace triptera Mast.
Pentaclethra macroloba (Willd.) Kuntze
Pentaclethra macrophylla Benth.
Pentadesma butyracea Sabine
Pentaphylax arborea Ridley
Pentaspadon motleyi Hook. f.
Perebea laevigata Standl.
Pericopsis elata (Harms) Van Meeuwen §
Pericopsis mooniana Thw.
Peronema canescens Jack
Pithecolobium arboreum
Prosopis juliflora (Sw.) DC.
Pterocarpus dalbergioides Roxb.
Pterocarpus soyauxii
Qualea rosea Aubl.
Quararibea asterolepis Pittier
Quassia amara L.
Quassia indica (Gaertn.) Nooteboom
Quercus dentata Thunb.
Quercus ilex L.
Randia cochinchinensis (Lour.) Merrill
Randia exaltata Griff.
Randia scortechinii King & Gamble
Rapanea guianensis Aubl.
Rapanea laetevirens Mez
Rapanea melanophleos Mez
Raputia magnifica Engl.
Recordoxylon amazonicum Ducke
Reynosia septentrionalis Urb.
Rhabdodendron macrophyllum (Spruce) Huber
Rheedia edulus Planch. & Triana
Rhizophora apiculata Bl.
Rhodamnia cinerea Jack
Rhodamnia trinervia Blume
Rhodoleia teysmannii Miq.
Rhus cotinus L.
Rhus semialata Murray
Rhus succedanea L.
Rhus typhina Torn.
Rhus wallichii Hook. f.
Ribes glaciale Wall.
Sabinea florida (Vahl) DC.
Saccopetalum unguiculatum C.E.C. Fischer
Sacoglottis gabonensis (Baill.) Urb.
Sacoglottis obovata Urb.
Sageraea ellptica Hook. f. & Thomas
Sageretia oppositifolia Brongn.
Sagotia racemosa Baill.
Samanea saman (Jacq.) Merrill.
Sandoricum indicum Cav.
Santalum album L.
Sapindus detergens Roxb.
Sapindus drummondii Hook. & Arn.
Sapindus saponaria L.
Sapium baccatum Roxb.
Sapium insigne Benth.
Schizolobium parahybum
Simarouba amara Aubl.§
Simarouba glauca DC.
Siphonodon australis Benth.
Siphonodon celastrineus Griff.
Spondias mombin
Swietenia macrophylla
Symphonia globulifera
Tabebuia Donnell-Smithii J.N.Rose
Tabebuia insignis (Miq.) Sandw.
Tabebuia rosea (Bertol.) DC.
Tabernaemontana arborea Rose
Tabernaemontana citrifolia L.
Talauma sambuensis Pittier
Tamarindus indica L.
Tambourissa thouvenotii P.Dang.
Tapirira guianensis Aubl.
Terminalia amazonia (Gmel) Ecell.
Terminalia amazonica
Terminalia ivorensis A. Chev.
Terminalia paniculata W.& A.
Terminalia superba Engl. and Diels.
Tieghemelia heckelii Hutch. et Dalz
Trachylobium verrucosum. Oliv
Turraeanthus africanus (Welw. ex C.DC.) Pelergry
Uapaca guineensis (Don) Muell.Arg.
Uapaca kirkana Muell.Arg.
Ulmus mexicana Planch.
Ungnadia speciosa Endl.
Unona latifolia Hook. f. & Th.
Urophyllum corymbosum Korth.
Vaccinium leschenaultii Wight
Vallesia glabra (Cav.) Link
Vangueriopsis discolor Robyns
Vatairea lundellii
Vataireopsis araroba (Aguiar) Ducke
Vateria indica L.
Vatica cinerea King
Vatica heteroptera Symington
Vatica stapfiana (King) V.Sl.
Vepris lanceolata (Lam.) G.Don
Veronia arborea Ham.
Villebrunea integrifolia Gaud.
Virgilia capensis Lam.
Virola koschnyi
Virola koschnyi Warb
Vitex gaumeri
Vochysia Hondurensis
Wallaceodendron celebicum Koord.
Wallenia laurifolia (Jacq.) Sw.
Walsura villosa Wall.
Waltheria americana L.
Warburgia ugandensis Sprague
Warscewiczia coccinea (Vahl) Klotsch
Weinmannia trichosperma Cav.
Wendlandia tinctoria DC.
Wercklea insignis Pitt. & Stand.
Wightia gigantea Wall.
Wormia pulchella Jack
Wrightia tinctoria R.Br.
Wrightia tomentosa R. & Sch.
Xanthophyllum flavescens Roxb.
Ximenia americana L
Xylia xylocarpa Taub.
Xylopia parviflora (A.Rich.) Benth.
Xylopia parvifolia Hook. f. & Th.
Xylopia quintasii Engl. & Diels
Xymalos monaspora (Harv.) Baill.
Zanthoxylum elephantiasis McFad.
Zanthoxylum fagara (L) Sarg.
Zanthoxylum martinicense (Lam.) DC.
Zelkova formosana Hayata
Zelkova serrata Makino
Zinowiewia integerrima Turcz.
Ziziphus jujuba Lamk.
Zollernia paraensis Hub.
Zuelania guidonia (Sw.) Britt. & Millsp.




PROSPECT