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All correspondence regarding contributions, subscriptions, &c., should be addressed to—

The Hony. Editor,
The Ceylon Forester,
Forest Department,
9, Kew Road,
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Hony. Editor .. L. C. A. WIJESINGHE

Editorial Office .. FOREST DEPARTMENT

9, KEW ROAD

COLOMBO 2

"The forest is a peculiar organism of unlimited kindness and benevolence that makes no demands for its sustenance and extends generously the products of its life activity; it affords protection to all beings, offering shade even to the axeman who destroys it."—Gautama Buddha.

EDITORIAL

DEVELOPMENT OF FOREST INDUSTRIES IN CEYLON

THE types of industrial goods produced from timber are many and varied. The simplest to produce is sawn timber. Other products include plywood, fibre board, particle board and paper. The industrial process can be said to start at the point when the forest trees are harvested. Felling, logging and extraction of timber from the forest are skilled operations, which are highly mechanised in advanced countries. Once the timber is extracted it is sent to saw mills for the production of sawn timber, or to other factories where the timber is broken down and re-made into products like plywood, particle board and paper.

Despite the fact that over 40 per cent. of our land area is covered by forest, a large proportion of which is owned by the State, the annual production of timber from Crown Forests is only about 4 million cu. ft. As the demand is more than the supply, almost an equal volume of timber has to be imported. The imports consist mainly of tea chests, the plywood mill at Gintota being able to supply barely a fifth of our requirements. The annual expenditure on the import of tea chests is about Rs. 16 million.

In regard to paper, the mill at Valaichchenai is able to produce only a fraction of our requirements and annually Rs. 32 million is spent on the import of paper and paper products. Even at Valaichchenai no local forest produce goes into the manufacturing process, the raw material consisting of straw and imported wood pulp. At present there are no particle board or fibre board factories in Ceylon, and in 1963 Rs. 1.3 million was spent on the import of these products.

The reason for the retarded development of our forest industries is the lack of sufficient investment in this field. The raw material is available in our forests only waiting to be harvested. According to the inventory carried out on the basis of aerial surveys, it was estimated that the forests in the Island could yield an annual outturn of 30 million cu. ft. Of course much of this is in the form of inferior timber which perhaps will be not of much use for industry. But in that case, when any species have been tested and found unsatisfactory, capital must be invested to replace these species with useful ones which could serve as raw materials for industry.

We do not propose to deal at length with the subject of investment in Forest Industry as it has been fully covered by Mr. A. E. K. Tisseverasinghe in the 1964 presidential address to Section B (Agriculture and Forestry) of the Ceylon Association for the Advancement of Science which we publish in this issue. However, we should like to emphasise that investment in Forest Industry should not be confined to the actual manufacturing process but should cover the whole field from forest to mill. This seems most obvious, for how can an industry function adequately unless there is a steady supply of the raw material delivered at the mill at an economical rate? Nevertheless we often find that sufficient attention has not been paid to ensuring a steady and continuous supply of the raw materials.

Now let us consider the plans made by the Plywoods Corporation to expand the mill to increase the capacity thrice in the 1st stage and to double it again later. The present consumption of the mill is 2,000 cu. ft. of timber per day, and the Forest Department experiences difficulty in providing a sustained supply at this rate. How then do we propose to supply 6,000 cu. ft., and later 12,000 cu. ft. per day? The timber is there in the vast tracts of virgin jungle in Sinharaja and other reserves, but extraction by the present out-dated method of elephant haulage alone is well nigh impossible because of the difficult terrain. What is worse, the forests are very inaccessible and even if mechanised equipment is used for logging and haulage it would still be necessary to construct forest roads. Investment on mechanised equipment and road construction is urgently needed if we are to ensure a sustained supply of plywood timber at the rate it would be required. It is not necessary to go into detail about the economic feasibility of such investments to seek justification for them when we consider that annually Rs. 16 million is spent on the import of tea chests.

In this issue we publish a report which gives an account of the timber industry of Singapore. We see that this Island has made vast strides in the development of its sawn timber industry and that too by the use of imported timber. We should be able to emulate her example and do even better on account of the large natural resources of timber available in our Island.

We are glad that a start has been made to study the possibilities of forest industrial development in the Island. We refer to the agreement signed between the Ceylon Government and the United Nations Special Fund for carrying out a pre-investment survey of forest industries development in the Island. Work on this project has already started. The testing of indigenous species for various industrial processes, the possibility of growing exotic species suitable for industries like paper, and the possibility of using different types of mechanised equipment for logging and extraction are some of the problems which would be carefully studied by the team of F. A. O. officers who are working on this project. We feel sure that once concrete proposals have been made there will be no hesitation in investing in suitable forest industrial projects, for not only would we be able to produce all our requirements of wood based industrial products but we should also be able to find a ready market for them in other eastern countries.

U. N. S. F. PROJECT

We welcome to the Island Mr. K. K. Lund, Project Manager and Logging Expert, Mr. J. Huuhtanen, Forest Industries Expert, Mr. Vasilij D. Scherbachenko, Logging Consultant and Mr. J. Zimmerman, Associate Expert, who arrived in the Island in the course of this year and have started work on this project. We wish them all success.

DOUBLE ISSUES OF THE CEYLON FORESTER

We apologize to our readers for publishing yet another double issue of our journal. It seems that this is becoming more the rule than the exception! In recent years we have been finding it increasingly difficult to obtain contributions from the officers of the Department. This is not due to any lethargy on the part of our officers—for they are now more hard worked than ever before—but due to the fact that year by year our

work has been increasing in leaps and bounds without there being a proportionate increase in the staff. For example, teak reforestation has increased from 300 acres to 6,000 acres and mahogany line planting from 300 acres to 3,000 acres during the last decade, while the increase in staff has been very small over the same period. However, we sincerely hope that our officers, despite their onerous duties, will still find time to pursue scientific investigations and report the results of their work in our journal.

Tannins from Our Wattles (*Acacia* spp.) for the Leather Industry

By W. G. WEERARATNA

(*Senior Assistant Conservator of Forests*)

SUMMARY

THIS is a note dealing with the availability of Wattles locally with a view to establishing the extent of plantations required for self-sufficiency in wattles. 2,400 acres of pure wattle plantations of Indian Quality III are required for sustained yield. 1,700 acres of mixed Wattle-Eucalyptus plantations capable of conversion into pure wattle are presently available. Locally grown wattles have produced tannin of acceptable standards. 500 tons of extract are annually imported at a cost of $\frac{1}{2}$ a million rupees—the projected annual demand is 600 tons. Cost of collection of local bark is favourable. The feasibility of using dried bark by the 'contact process' as against extraction of tannin from the wattle needs further investigation.

AVAILABILITY OF LOCAL HIDES

Based on slaughter figures about 375,000 hides are annually available in Ceylon. 60 per cent. of this comprises cattle hide, 34 per cent. goat hide and 6 per cent. buffalo hide. Of the total quantity of cattle hide locally produced about 30 per cent. is exported to the U. K. as tanned cow hide earning foreign exchange upto about 3 million rupees annually. The rest of the locally produced hide is used in the manufacture of leather footwear, suit cases, and other leather goods including volley balls, straps, machine belting, gloves, fancy bags, washers, musical instruments, strap-hangers for buses and the Railway. The bulk of the leather however is used in foot-wear including shoes, boots, slippers, etc. Over 2 million pairs of shoes have been produced in 1963 as against 0.8 million in 1960. Besides shoes there has been a significant increase in the production of all other leather goods in the last few years.

TANNINS

For careful preservation of raw hide and its use thereafter the hide has to be tanned—for this purpose tannins from various vegetable products are used. Tannins are organic substances obtained from various fruits, herbs, leaves, etc., which have the property of combining with albumen and gelatine to form an insoluble compound which will resist decay. Raw animal hide treated with tannin is converted into the decay resisting material known as leather.

The principal materials which have produced tannin of commercial value throughout the world are as follows:—

Wattle bark—obtained from species of *Acacia*. Produced extensively in South and East Africa and Australia. This is one of the chief export products of South Africa. Also grown in India and Ceylon.

Mallet bark—obtained from *Eucalyptus occidentalis* in Australia.

Hamcock bark—obtained from species of *Tsuga* in Canada and the U.S.

Oak and Larch bark—obtained from the *Oak* and *Larch* in the U.K.

Mangrove bark—obtained from a number of trees belonging to the Rhizophoraceae. Mangrove tannins (Kadol) are extracted in East Africa, Borneo, Malaya, India and Ceylon.

Avaram bark—obtained from *Cassia auriculata* (*Ranawara*) in South India and Ceylon.

Babul bark—obtained from *Acacia arabica* in North India.

Myrobalams—These are astringent fruits of several species of *Terminalia* extensively distributed in the Tropics—most important being the gall-nut (*Aralu*). India exports large quantities of Myrobalams.

Divi Divi—obtained from pods of *Caesalpinia coriaria* cultivated in Jamaica, India, etc.

Gambier—solid extract from leafy twig of *Uncaria gambier* in Malaya.

Sumach—from leaves of *Rhus coriaria* in Cyprus.

Cutch—from wood of *Acacia arabica* in India.

Besides this, several other species are used locally in various parts of the world, e.g., *Callitris* sp., *Carissa* (*Karamba*) *Cassia fistula* (*Ehela*), *Anaphrennium*, *Anogeissus latifolia* (*Dawu*), *Pinus* sp., *Eucalyptus* sp., *Shorea*, etc.

WATTLE BARK IN THE TANNIN INDUSTRY

Of the several vegetable tannin materials used throughout the world, extract from the Wattle bark has been found to be the most satisfactory. Wattles are species of *Acacia* found abundantly in Australia and grown extensively in South Africa. These were first introduced into India in 1840 for cheap fuel and to Ceylon in 1900. Of the three species *Acacia dealbata* (Silver wattle), *Acacia mollissima* (black wattle) and *Acacia decurrens* (green wattle), the black wattle is considered most suitable. Although the silver wattle grows fastest the tannin content of its bark is only 8 per cent. to 12 per cent. as compared with the other two wattles where the tannin content ranges from 30 per cent. to 35 per cent. Although the green wattle contains a satisfactory percentage of tannin it has a higher percentage of undesirable red and yellow colouring matter, resulting in leather of poor colour and reduced value. Hence all wattle producing countries today prefer to plant *Acacia mollissima*, the Black wattle.

GROWTH OF THE WATTLE INDUSTRY

Although wattles are indigenous to Australia these have been extensively cultivated outside their home.

South Africa particularly has specialised in the growth of wattles since the beginning of this century, and large quantities of bark were exported to the Indian tanneries. India realised the economic importance of growing wattles in 1934 when it was found that about 30,000 tons of South African bark were imported annually, and the cost per ton had increased to Rs. 700 in 1948, i.e., over Rs. 21 million was spent in 1948 in the importation of wattle bark. Since 1934 rapid strides have been made in India in the cultivation of the wattles as a source of tannin. Considerable research has also been carried out in evolving suitable planting techniques, tending, determining optimum period for harvesting and the utilisation of the final product.

Although wattle has been cultivated in Ceylon for over half a century it has only been used as a fuel and no serious effort has been made for the utilisation of its tannin. In 1957 with the collaboration of the C. I. S. I. R. and the Leather Corporation an attempt was made to investigate the tannin contents of our local wattles, and the results of this preliminary investigation have been most promising.

INTRODUCTION AND CULTIVATION OF WATTLES IN CEYLON

The wattles were first introduced to Ceylon in the Up-country tea plantations in 1900 as wind belts and shade trees and they became popular due to their rapid growth, suitability as a fuel and easy regeneration. Subsequently the Forest Department cultivated these at elevations between 5000'-6000' in Kandapola, Pattipola and Ohiya and later even at lower altitudes (3500'-5000') in Erebedde, Kinigama, and Ettalapitiya in association with other exotic species.

At the time that wattles were introduced to Ceylon their economic importance as a source of tannin was not considered. They were primarily grown as shade trees and as subsidiary species for fuel for the Up-country. With the admirable performance of other introduced species, particularly *Eucalyptus*, both in the drier and wetter areas of the Up-country, wattles occupied only a secondary place in the Departmental plantation programme. It must also be admitted that the silviculture of wattles has not been properly appreciated by local foresters, as all wattles in the Up-country even upto recent times, have been grown under the shade of *Eucalyptus*, although wattle is a pronounced light demander.

The technique of raising wattles was by sowing hot water treated seeds along contour bunds formed in areas prepared for *Eucalyptus* basket planting at 10' x 10' espacement in prepared holes. With this technique the *Eucalyptus* has an initial faster rate of growth keeping well above the wattle seedlings. Hence, as is to be expected, most of these wattles are today malformed due to suppression and show very poor growth both in diameter and height, particularly those under a heavy *Eucalyptus* overwood. In patches where the *Eucalyptus* have failed there is abundant growth of wattles. Due to prolific seeding of this species and good seed viability there is a considerable amount of natural regeneration in established plantations. Where fires have occurred naturally in patches of older plantations, dormant wattle seeds have shown remarkable growth ousting all other species, indicating a technique for future management.

In the very wet patanas of Pattipola where mechanised ploughing was carried out prior to planting of *Eucalyptus* (and sowing of wattle seed) wattles show comparatively satisfactory progress—this is also partly due to the generally poor performance of *Eucalyptus* in this tract.

If wattles are to be given their correct place, the present technique of raising these species will have to be reconsidered. They will have to be raised in the open either by direct planting or sowing, preferably the former. Experiments in the Nilgiris indicate that transplanting is significantly the best method of raising wattles in South India. This will apply to new extents required in wattles.

Some of the recent trials at Kandapola and Pattipola are significant in that they indicate the possibility of conversion of the older mixed plantations into pure wattle areas. In the older plantations where wattles have been existing as an understory, removal of all trees either for timber or firewood followed by an artificial light fire promotes intensive natural regeneration of wattles. This is abundantly clear in Kandapola Compartment 1B, where this technique in 1962 has given a pure extent of prolific wattle regeneration. Sample counts in 1/16 square chain blocks showed approximately 12,800 plants per acre in 1964 with an average top height of about 10'-12'.

Similar results are observed when mixed *Eucalyptus*—Wattle plantations are felled for second rotation planting of *Eucalyptus* or *Cupressus*. The new plants of *Eucalyptus* and *Cupressus* planted at a spacing of 10' × 10' are almost smothered by wattle regeneration, e.g., in Compartment 4 Pattipola (1962 plantation). These observations clearly indicate the possibility of converting with ease and without much expenditure any mixed suppressed wattle plantation into a healthy pure wattle stand.

IMPORTS OF WATTLE EXTRACT

Since 1955 there has been a progressive increase in the import of wattle extract from South and East Africa. 540 tons of extract worth $\frac{1}{2}$ million rupees have been imported in 1963. With the diversification of our industries and higher standards of living the consumption of leather goods will increase in the future and larger quantities of tannin will be required. Following are the figures of wattle extract imported since 1955:—

			Tons		Value in Rs.
1955	..	..	372.8	..	360,745
1956	..	..	298.5	..	302,202
1957	..	..	260.7	..	233,431
1958	..	..	270.8	..	229,758
1959	..	..	328.9	..	281,579
1960	..	..	422.8	..	341,540
1961	..	..	319.4	..	219,736
1962	..	..	431.4	..	334,143
1963	..	..	540.7	..	452,327

With the pattern of imports in the last 10 years it would be reasonable to assess the total annual requirement at about 600 tons of wattle extract in the next few years. Hence, if these imports are to be restricted or totally banned in the years to come a progressive building up of our wattle plantations is imperative.

EXTENT OF WATTLE PLANTATIONS IN CEYLON AS AT 1964

A survey of the wattle plantations in the Up-country Division shows a total of about 1,700 acres approximately distributed as follows :—

		<i>Acres</i>
Ambawela	}	500
Pattipola		
Kandapola ..	..	200
Dixons Corner	..	400
Ohiya ..	..	400
Ettalapitiya	..	200
		1,700

All these are, however, mostly mixed wattle areas with the wattle heavily suppressed in most places. The plantations in Ohiya and Kandapola contain wattle ranging in age from 10-25 years. Those in Ettalapitiya, Dixons Corner, Ambawela and Pattipola are about 10 years old. Counts taken in 1/10 acre sample plots in the older Kandapola plantations show an average of about 2,000 plants per acre with an average girth of about 7" whilst the pure converted areas have over 10,000 plants per acre.

ROTATION, GROWTH AND YIELD DATA OF WATTLES

No data are available locally of the growth and yield statistics of our wattles. Hence, until such time as this information is obtained it would be necessary to accept data available for the plantations of the Nilgiris in South India if immediate headway is to be made in the utilisation of our wattles.

Since bark from the old trees yield tannin of poor value, harvesting has to be done at an optimum age. The age fixed for harvesting Indian wattles is 8-10 years. 8 years may tentatively be accepted as the felling age for our wattles.

Raghavan has prepared tentative yield tables for *Acacia mollissima* of the Nilgiris. On the basis of these data the yield of dry bark at 8 years is as follows:—

1st site quality	... 7 tons dry bark per acre
2nd site quality	.. 5.8 tons dry bark per acre
3rd site quality	... 4 tons dry bark per acre

TOTAL EXTENT OF WATTLE PLANTATIONS REQUIRED FOR SELF-SUFFICIENCY IN TANNINS

Assuming an average annual requirement of 600 tons of wattle extract, 1,200 tons of dry wattle bark is required.

(1 ton wattle extract is obtained from 2 tons of dry bark).

According to data available for the Nilgiris (South India) a third quality plantation at 8 years should yield 4 tons of dry bark per acre. As a safety factor even if all our wattle plantations are classed as 3rd quality, 300 acres would be required annually to yield the estimated quantity of dry bark.

Hence with a 8-year rotation, the total extent of pure wattle plantation that is required is only 2,400 acres for sustained yield.

As indicated earlier about 1,700 acres of mixed wattle plantations are already available, and it would be necessary to draw up a working plan to determine which areas would need conversion into pure wattle and also the rate of this conversion taking into consideration the possible exploitation of *Eucalyptus* for other industrial uses such as newsprint manufacture which will commence shortly at Ambawela. The balance extent to make up the total of 2,400 acres will have to be selected early and progressively planted up as pure wattle.

TRIALS CARRIED OUT ON WATTLE EXTRACT IN THE C. I. S. I. R.

In 1961-62 a set of trials was carried out by the Ceylon Institute of Scientific and Industrial Research on the quality of tannin extract from locally grown wattles. The solid extracts obtained in the pilot plant trials compared well with the imported extract in regard to their composition. The tanning property of five samples of wattle extract prepared in the C. I. S. I. R. has been reported as satisfactory and comparable with that of the imported one.

			Imported Extract		C. I. S. I. R. Extract from Local Wattle
% tannin	..	..	68.65	..	67.6
% non-tannin	..	..	25.12	..	27.5
% insolubles	..	..	2.64	..	2.5
% moisture	..	..	3.59	..	2.4
Tannin to non-tannin ratio	..	..	2.74	..	2.5

'CONTACT' PROCESS vs. EXTRACTION UNIT

PRIOR to the imports of wattle extract large quantities of wattle bark have been imported from South Africa. The table given below indicates the extent of the imports.

Year		Weight of Bark imported in Cwts.		Value in Rs.
1955	..	300	..	15,217
1956	..	237	..	13,803
1957	..	1,074	..	41,269
1958	..	1,730	..	81,418
1959	..	2,494	..	106,394

In the local tanneries although the tendency now is to use the imported wattle extract, bark has been used direct in large quantities by adopting the 'contact' process. In this process the dried bark is directly placed in water containing the cleaned hide. This is a wasteful process as about 50% of the tannin is not leached out, and the time taken to tan the hide is considerable. Besides this there are several other disadvantages in the direct use of the dried bark and the modern trends are to use the extract, having centralised the extraction unit and locating it close to the source of supply of the raw material.

As against this it is significant to note that although India requires about one lakh of tons of wattle bark annually, and sufficient plantations are raised to meet this requirement in full without resorting to imports, the 'contact process' is still followed. As the total requirement of wattle bark in Ceylon is only 1,200 tons per year it would be necessary to determine whether an extraction unit is desirable.

UTILIZATION OF BARK FROM AVAILABLE TREES IN THE PROCESS OF CONVERSION

AS indicated earlier 1,700 acres of mixed wattle plantations of varying ages up to 20 years are presently available, and even if a part of these plantations are to be converted into pure wattle a significant quantity of bark would be available. Even at present in the course of firewood exploitation in the Up-country large quantities of wattle bark annually go waste. Hence it would be imperative to find an immediate use for this bark.

The Indian technique of drying the bark could be followed locally. The question of storage of dried bark would not arise if the use of dried bark is popularised. However it is necessary to determine the effect of this technique on the quality of the leather produced—particularly those

exported. Hence if the Leather Corporation or the local tanners are induced to use the 'contact' system, suitable modification would be necessary in the process, for greater efficiency and better quality.

COST OF BARK COLLECTION

THE wattle bark imported in the past has cost approximately Rs. 900 per ton. For purposes of experimentation local bark has been collected in situ at 8 cents per pound (i.e. Rs. 179.20 per ton). This leaves a big margin even for transport of the bark to Colombo.

The Economics of Forestry in Developing Countries*

By A. E. K. TISSEVERASINGHE

(*Acting Senior Assistant Conservator of Forests*)

INTRODUCTION

THE title of my address needs some explanation. I did not select this title merely to be in the fashion and beat the economic development drum nor because I am a Specialist in the field of forest economics but because this is a most important subject for us in all developing countries and because it has been grossly neglected in the past.

There are two reasons for this neglect. The first reason is that Forest Economics began, and continued to be studied in, developed countries, and in the field of forestry at least, the problems facing developing countries are very, very different. In developed countries much stress is placed on the financial yield from forestry as compared with the rate at which money can be borrowed. Other factors are of little importance. I will give just one instance to illustrate this. In a scheme of reforestation, if the financial yield is 8% and the rate at which money can be borrowed, or the interest rate, is 6%, then the investment is considered to be a desirable one. The time taken for the investment to mature or what planners call the gestation period is of little account. This attitude is quite sound in the developed countries of the West where a large proportion of the forests are privately owned and where forest owners operate under conditions of more or less perfect competition and where investment capital is freely available. In developing countries the position is totally different. In most of these countries State Forestry is so predominant as to make conditions monopolistic. Very often the rest of the economy is also to some extent or other controlled by the State. Further, investment capital is not freely available and the little that is available has to be allotted according to a system of priorities. This position does not in any way invalidate the argument that the investment must be profitable in terms of financial yield, but this is merely one of the factors which are taken into account. In Ceylon for instance, retail prices of timber sold at Government Depots are fixed by the State. The price is not fixed according to supply and demand or according to the capacity or willingness of the consumer to pay, but in such a way that timber is made available to all sections of the population at reasonable prices. The effect which factors of this kind will have on forest economics has not been studied.

* Text of the Presidential address delivered before Section 'B' (Agriculture & Forestry) of the Ceylon Association for the Advancement of Science at its 20th Annual Session, reproduced here by kind permission of the Council of the Ceylon Association for the Advancement of Science.

The second reason for the neglect of the subject of forest economics in developing countries is that planners generally lump forestry together with agriculture. In developing countries generally, agriculture is an extremely important sector of the economy and tends to overshadow forestry. Man must eat to live, hence from the dawn of civilisation agriculture has been the most important and widespread human activity. The position today is no different. One of the reasons for the relative stagnation in Ceylon's economy is the fact that so much money has to be sent out of the country to purchase food. Planners therefore tend to give agriculture the highest priority and forestry suffers as a result. Planners also find that in terms of money yield per acre, forestry in developing countries is relatively inefficient and thus does not merit attention. For instance studies made in India show that forestry which uses 22% of the land contributes 0.6% to the National Income while the 40% of the land devoted to agriculture contributes 50% of the National Income—(Von Monroy 1960). In Nigeria, a country which even exports timber, the value of total timber production (excluding firewood) was less than 1% of the Gross Domestic Product, (Prest & Stewart 1953 quoted by Macgregor 1959). I am not aware how these calculations were made and hence cannot comment on their validity. However, in addition to the bare National income calculation if output per person employed were taken into account or income in relation to expenditure, forestry may score over agriculture. In any case, in developing countries where the people live at subsistence level, most of the domestic product must necessarily be agricultural in origin. To take a simple case: If Ceylon produced sufficient rice to feed 10 million people at the rate of one pound per person per day, the value of the annual production of rice alone on the basis of the present guaranteed price would be in the region of Rs. 1,400,000,000! Forestry can never hope to produce anything like this value if considered purely as a primary product. If however, industries based on these primary products are taken into account, the picture will be very different. Since such industries do not play a very significant part in the economies of developing countries, forestry has tended to be neglected!

I have taken some time to indicate why forestry in developing countries has been relatively neglected but the time has not been wasted because what has been said so far is relevant to the main theme of my address.

In developing countries generally, land is the most important factor of production. Leaving aside other minor forms of land use, agriculture and forestry are the two main uses to which land is put. For various reasons which it is not necessary to go into now, a certain proportion of the land must be left in forest. In the words of a previous President of this section, "forests, like the poor, must always be with us"! In Ceylon, the latest inventory based on aerial photographs of 1956 revealed that 44% of the land was under forest (Andrews 1960). The position has of course, changed since 1956 and will continue to go on changing but yet one can assume that a fairly substantial proportion of the land is going to remain as forest. Several questions now arise, are we to let the forest remain as it is, harvesting only the meagre increment which we are able to remove and use or are we to spend money to build roads into inaccessible forests, or invest in various types of equipment which will help to make unusable species usable, or create factories to convert timber into other products such as particle board, fibre board, pulp or artificial fibres; should we convert the natural forest into high yielding plantations and so on.

Investment Criteria in Relation to Forestry

There are several criteria to be used in deciding whether to invest money in forest development in preference to, or as complementary to, other forms of investment. Some of these criteria are rather simple and are mentioned here only for the sake of completeness.

Since forestry is a form of land use one of the first criteria which will come to mind is the comparative income per acre of forestry as against other types of land use. I have already said that studies in India and Nigeria show that the income from Forestry is very small in contrast to the income from agriculture.

However even without going into these two cases individually it is possible to say that such statements have to be considered in relation to several other factors and not in isolation. For instance, it is generally true to say that Agriculture is practised on the most fertile land and forestry on the least fertile. The annual expenditure on Agriculture per acre is generally very much higher than on forestry. The reason for this again, is that in a subsistence economy all other activities are subordinated to food production. Relatively long term projects such as forest development got much less attention. If comparable amounts of money are spent on forestry, the results may be quite startling. The annual increment in the forests of Ceylon, taking all species into consideration, has been calculated at 4-16 cubic feet per acre for the Dry Zone and 16-95 cubic feet per acre for the Wet Zone (Andrews (1960)). A good Eucalyptus plantation on the other hand can produce more than 300 cubic feet/acre/year on a 10-year rotation. The expenditure for this would have been about Rs. 30 per acre per year. Thus, a relatively small sum of money spent on plantations in a good site can produce yields per acre comparable with the annual value of some agricultural crops and also produce a very high income in relation to expenditure.

Another criterion which is used in deciding investment priorities is the extent to which the product can substitute for imports. Ceylon imports a very high proportion of her annual food requirements and hence much money is spent every year on encouraging local production of this food e.g., the relatively high proportion of the total investment which is spent on providing irrigation facilities, the high guaranteed price paid for rice produced in the country, subsidised fertilisers, agricultural extension services and so on. However, the extent of import substitution as a means of assessing the value of industrial projects has fallen into disfavour recently. With a tight foreign exchange situation other criteria have become more important. Every imported product need not necessarily be substituted for by a locally manufactured product—instead one can learn to do without. Mr. Maithripala Senanayake, Minister of Rural and Industrial Development addressing a meeting of technical personnel recently said: "We have now come to the stage of thinking in terms of a strict priority of industries rather than an earlier policy of import substitute industries. You will find gentlemen, that in at least 60% of our industries the major portion is imported in the form of industrial raw materials. While there is a foreign exchange saving, yet with increasing demand and increasing population, the foreign exchange saving resulting from industrial manufacture had disappeared."

The extent of possible import substitution in the forestry field is not high in terms of value compared to agriculture but it is much easier to achieve a break-through in this field e.g., 18 million rupees were spent in 1962 on the import of timber and timber products such as Tea Chests and 25.5 million rupees were spent on the import of paper and paper

products. One should bear in mind that 1962 was a year when import restrictions operated very severely and hence these imports should be considered as being absolutely essential. In the case of agriculture, increased production involves land tenure reforms, the use of new methods of cultivation, the opening up of new land and a host of other factors which tend to make the process slow. In forestry, as Ceylon's short-term implementation plan has recognised, the position is quite different. "Forests provide an existing resource which only awaits exploitation. The investment required to bring this resource into a condition where it could be used is relatively small. The Capital/output ratio is also low while its gestation period is comparatively short (except in the case of reforestation). Priority should therefore be given to investment in forestry, and every effort should be made to increase the rate of exploitation. In conjunction with a more rational utilization of local timbers based on the processing of a wide range of species." I will not labour the point about the comparative advantages of forestry as against Agriculture—the key to economic development in Ceylon is more productivity from the land and this includes both Agriculture and Forestry.

As far as industrial projects are concerned a whole host of criteria are now used in deciding priorities. These have been stated by the Minister of Rural and Industrial Development in the same address quoted above, in the following terms: "The Planning Secretariat in consultation with the Ministry, is also planning a set of criteria on which future approvals for industry will be based. Such factors as the gestation period, capital output ratio, capital labour ratio, capital foreign exchange ratio and capital profit ratio will receive increasing attention. But one fact has clearly become evident. Unless an industry makes use of a large percentage of our local raw materials, the chances of it being approved are slim." The reasons for this are obvious. In a period of extreme difficulty, imports of manufactured products can be stopped at the cost of temporary inconvenience, but if raw material imports have to be stopped the effect on the economy may be serious. Hence the stress on using local raw materials and hence also the importance of forest industries using local forest products as raw material.

One highly important criterion to be taken into account when deciding on the priorities for investment is the influence of particular types of investment on economic growth. This tends to be forgotten if planners and industrialists concentrate on the purely book keeping aspects of investment but for a developing country this should be the all important criterion.

The Indian 5-year plans have been severely criticised by some economists on the ground that excessive stress is placed on heavy industry at the expense of agriculture, education, &c. This kind of imbalance can happen only if the broad aims of development policy are lost sight of in the maze of immediate priorities. Reddaway (1962) commenting on the Indian economy says:

"Long range strategy must have one overriding objective: to secure a progressive rise in the level of consumption per head, by methods which will make possible an indefinite continuance of the process and which also satisfy certain social and political ideals Other economic objectives such as increased capital formation and industrialisation, or a viable balance of payments—are essentially dealing with means and not ends." Again Friedman (1955) (quoted by Bauer (1961) says about India: "There is a tendency not only in India but in most of the literature on economic development to regard the ratio of investment to National Income as almost the only key to the rate of development, to take it for granted that there is a rigid and mechanical ratio between the amount of investment and additions to output. This seems to me a serious mistake. There are two reasons why the amount of investment and the increase in output can be, and empirically are only loosely connected: first the form and distribution of investment are at least as important as its sheer magnitude. Second, what we call capital investment is only part of the total expenditure on increasing the productivity of the economy.

"The first reason needs little additional comment. The second is perhaps less clear. In any economy, the major source of productivity is not machinery, equipment, buildings, and other physical capital, it is the productive capacity of the human beings who compose the society. Yet what we call investment refers only to investment on physical capital; expenditure that improve the productive capacity of human beings are generally left entirely out of account."

Galbraith (1958) expressed this same idea much more pungently when he lamented that education was considered unproductive but the provision of a toilet to a School lavatory was productive !

You might wonder where forestry fits into all this. I have quoted these economists to show that purely mechanical criteria are not sufficient for deciding investment priorities. Merely because other criteria are difficult to assess it does not make them less important. The Indian 5-year Plans have been criticised on these grounds also. Two Indian economists—Vakil and Brahmanand (1956) posed these questions: "Is the industrial structure that is emerging, evenly balanced both in relation to each of the industries included within the structure and also in relation to the other sectors of the economy. Should not the plans of expansion take into account the needs and requirements in specific fields? Is it true to say that that industries, once they are started, find that the problems of adequate markets and of effective utilization of their capacity are automatically solved? These are somewhat inconvenient questions, but no one can deny that they are important." Investment in forest industries is desirable whether looked at from the point of view of using an existing raw material as an industrial base or from the point of view of substituting for imported manufactured products.

Thus the type of economic development proposed should fit naturally into the social and economic circumstances of the country—it is only then that development can take place on all fronts. Merely transporting western factories into developing countries will not solve the problems of economic growth. Excessive investment in one or two fields to the neglect of others will only produce a lop sided result. One example of this can be seen in the oil rich Arab States where Cadillacs and Camels are parallel means of transportation.

In developing countries a high proportion of the work force is engaged in Agriculture and this cannot be changed overnight. Planned national development should therefore start with this base and from there extend to other fields. In fact it seems necessary at different stages of economic growth to concentrate on different areas of investment. According to Rostow (1960) at the early stages of growth it is necessary to "apply quick-yielding changes in productivity to the most accessible and naturally productive resources In a generalised sense, modernization takes a lot of working capital and a good part of this working capital must come from rapid increases in output achieved by higher productivity in agriculture and the extractive industries," and again: "It is therefore an essential condition for a successful transition that investment be increased and—even more important—that the hitherto unexploited backlog of innovations be brought to bear on a society's land and other natural resources, where quick increases in output are possible." Since a large proportion of the work force is engaged in Agriculture (in which I include forestry), small increases in productivity will have a substantial total value. The amount of investment necessary to achieve increases in productivity need not be high—this is specially true of forestry.

Developing countries usually want a return for the money invested to be obtained very fast. In forestry, investment can be in several different fields. It may be in the field of timber extraction where provision of mechanised methods or new roads will increase output or in the field of timber utilization, where the installation of seasoning kilns and pressure impregnation plant will help to use timber which might otherwise not be used, or the installation of more efficient sawing machinery which will help to reduce waste in sawing, or in the field of reforestation. Finally investment could be in factories whose raw material requirements are supplied by forestry say, Paper mills, Plywood, hardboard or particle board factories and so on. In none of these things is the gestation period unduly long except perhaps in reforestation. Even here, an acquaintance with the economics of plantation forestry in Ceylon will show that in some cases returns can be expected after as little as seven years—this first return may even repay the cost of planting. Also in the case of fast growing species such as *Lunumidella* (*Melia dubia*), *Albizzia moluccana*, or *Eucalyptus* the final crop might be harvested even before 10 years. The idea that forest plantations only pay for themselves after very long periods of time is a misconception that must be abandoned.

Considering all the criteria I have mentioned above, it will be seen that investment in forestry is desirable in developing countries. The investment should be in the direction of firstly exploiting existing resources and secondly in making the resource more productive.

A Forestry Survey of Developing Countries

Before I discuss the possible lines of forestry investment in developing countries it is necessary to take a quick look at the position of forestry in these countries. The table below gives some basic statistics of a selection of developing countries of America, Africa and Asia together with similar statistics for some developed countries.

TABLE

<i>Country</i>	<i>Total Forest Area '000 ha.</i>	<i>Forests in use</i>	<i>Total Forest as % of land</i>	<i>Removal of in- dustrial wood per ha. of total Forest</i>
Fed. Rep. of Germany	7,038	7,038	29	3.5
Denmark	444	436	10	3.2
Switzerland	976	897	24	3.0
Japan	23,040	12,411	63	2.1
Finland	21,874	21,874	72	1.7
Philippines	13,173	5,001	44	0.5
Uganda	1,607	117	77	0.47
Br. N. Borneo	6,306	355	83	0.44
Malaya	9,518	220	72	0.24
Pakistan	2,552	2,462	3	0.20
Ghana	14,103	1,724	39	0.13
Br. Honduras	1,813	1,378	80	0.06
India	72,752	37,273	22	0.06
Indonesia	90,177	61,268	61	0.06
Burma	45,274	24,087	67	0.04
Ceylon	3,546	1,045	56	0.04
Nigeria	31,960	1,078	33	0.04
Br. Guiana	18,130	260	84	0.01
Tanganyika	51,282	27,195	58	0.01

Figures computed from "Year Book of Forest Products Statistics" (1963) and "World Forest Inventory" (1958) both published by F. A. O. Rome.

Much variation can be seen in the basic picture that is shown in the table. For instance, variation in size ranging from Indonesia with 90,177,000 hectares of forest land to Uganda with 1,607,000 hectares; also in the forest area as a percentage of total land area, ranging from British Guiana with 84 per cent. to Pakistan with 3 per cent. However in one feature there is not much variation and this is in the depressingly low production per unit area, computed on the basis of total forest area, as compared with the developed countries. Just to take an example, the production of industrial wood per hectare in West Germany was 350 times the production in Tanganyika or British Guiana. There could be several reasons for these low production figures but it is rather curious that the developing countries most of whom enjoy climatic and soil conditions which are very favourable for forest growth should exhibit this common factor of low production. It seems to suggest that all the different reasons

for low production can be reduced to a single basic cause. The cause is of course, insufficient investment in forestry and by investment I mean not only capital investment in machinery or plantations but also investment in research and education.

This, to an economist will seem a truism. He might contend, with some truth, that if any field of economic activity in developing countries is selected, insufficient investment will be found to be a basic problem. However, not all forms of investment are equally attractive; forestry is a unique field of investment in that firstly it is a naturally occurring resource only awaiting exploitation, secondly because planned exploitation does not reduce it, but will in fact, increase its productivity, thirdly because it provides a basic raw material on which other industries are built, and fourthly because the gap between potential and actual productivity is very wide.

It must be remembered that except for one or two countries such as Britain, high productivity in Agriculture and forestry preceded economic growth. This is not entirely a coincidence. In Sweden and Finland economic development was based on forestry and its allied industries. In the early years of the U. S. S. R. foreign exchange was earned by vigorous exploitation of its vast forest resources and sale on the world market. To such an extent was this done that world prices were depressed and the U. S. S. R. was accused of 'dumping'.

Many of the developing countries also have rich forest resources which can be developed in this way. It may perhaps surprise many of you to know that the growing stock of timber in Ceylon's forests has been estimated at about 4,500,000,000 cubic feet! Of course, included in this figure are species which are not used today and also species like Wira (*Drypetes sepiaria*) which cannot be used in its natural form in the foreseeable future. Yet it gives an idea of the vast potential of forestry which only awaits planned exploitation and development.

Lines of Investment in Forestry

I shall now deal with the type of investment that can be made in forestry in developing countries.

(1) Rendering more forest areas accessible. I have placed this first because in Ceylon at least this will be the quickest yielding investment. Also this is a type of investment that can be labour intensive or capital intensive at will. If we consider road building for instance, it can be done using labourers with pickaxes and shovels or using bulldozers and other heavy equipment. The other circumstances in the country will determine the method to be used. In Ceylon the richest forests are found in the Wet Zone in the South Western part of the island. The type of country in which the forest occurs is very rugged and quite a proportion of it is not served by roads. Thus, some of these forests are, as near as may be, virgin forests awaiting exploitation. Most of these areas have been mapped out and typed using aerial survey methods and the location of rich forests is known. One such Compartment in Kanneliya Reserve of 267 acres was enumerated last year prior to felling and was found to contain 250,000 cubic feet of timber in the form of trees over 5 feet in girth. Exploitation of this Compartment only became possible because a forest track 9 miles long had already been cut over the previous few years. If the exploitable timber in this one compartment is valued at only Re. 1 per cubic

foot, the production from this Compartment alone would pay for the whole road! Of course, the road has, in the course of its 9 miles advance into the forest, already paid for itself several times over.

I quote this example to show how under certain circumstances road building into forests can be extremely profitable—it may not apply to other countries where the growing stock per acre or the level of utilisation is much lower than in Ceylon.

(2) Mechanisation of logging. This is a field where Ceylon is particularly backward due to historical reasons. In the Western countries a high proportion of the forests are privately owned and have supplied timber for industrial use for several centuries. Hence investment in forestry grew together with production. In most of the tropical countries timber exploitation was on the concession system where private firms assured of long—tenure leases invested heavily. In Ceylon, most of the forests are State owned and have never been exploited on the concession system. This may be a good thing because this system tends to promote local over-exploitation but one of the disadvantages was that investment becomes the responsibility of the State. In the last few years Government has invested in road building, impregnation plant, seasoning kilns and modern saw milling machinery but the field of logging and extraction is difficult for the Government to enter and has thus been relatively neglected.

At the present time, with very few exceptions, private contractors use only elephants or sling carts for extraction of logs from the forest. The daily output of elephants and sling carts is very small compared to that of crawler tractors with logging arches or winches, and since the availability of elephants it not unlimited haulage costs tend to rise. This tends not only to restrict the radius of economic exploitation from a consuming centre and thus leave productive forests unexploited but also to prevent the speedy exploitation of forest areas released for development. I will not say anything more about this because such difficulties only arise in countries where forest policies and organisation do not encourage investment in this field and this is a problem which we will have to solve ourselves.

(3) The third field of investment is in ways of rendering utilisable, species of timber which have not so far been used. I would like to stress this because this is one problem which is common to all developing countries. I have in an earlier paper (Tisseverasinghe 1963) tried to show that this is a field in which most developing countries can increase production per acre without a great deal of investment and effort. Very few species of timber need be considered as completely useless, yet due to traditional and other reasons many species remain unused in the developing countries. To take a few examples: in British Guiana in 1959 two thirds of the total timber production comprised of a single species—Greenheart (*Ocotea rodiaei*), and nearly one fourth by 5 other species. In Uganda according to Swabey (1954) of 200 species growing to timber size, 72 per cent. of the production from Reserved Forests came from 20 species, five of these species contributing 70 per cent. of total production. In British Honduras 4 species constituted 90 per cent. of the total production. The extent to which production can be increased by better utilization is seen from the statement of Dawkins (1954) that in Budongo (in Uganda),

sustained yield can be increased by 400 per cent. if only four additional species viz. *Celtis*, *Chrysophyllum*, *Alstonia* and *Cynometra* were saleable. Species which are not in general use can be conveniently classified into three groups :

- (a) Timbers which are inherently durable but are not used due to lack of knowledge of their properties.
- (b) Timbers which are not inherently durable under certain conditions but whose durability can be improved by proper seasoning or preservative treatment.
- (c) Timbers which are not suitable for use in their natural form but which will have to be converted into some other product before they can be used, e.g., as Plywood, particle board, hard board or pulp.

One might imagine that timbers in the first class i.e. those which are inherently durable, will present no problems in an effort to make them used. In actual fact the solution is not at all easy. Firstly, long experience or research is needed before one can definitely specify the purposes for which a timber is suitable or to what extent it is inherently durable. This does not suffice—it is also necessary to convince the consumer of timber that particular timbers which had not been used in the past are in fact, suitable for various purposes. Whatever the difficulties of this are, yet it cannot even be attempted unless research on timber utilization is done. Hence this is an essential part of the forestry programme in any developing country.

The second class of unused timbers are those which are not inherently durable *under certain conditions*. I stress this qualification because durability is such a relative term. There are many timbers which are not durable under extreme conditions such as constant exposure to sun and rain or in contact with the ground but which are quite durable when used indoors. Certain others are not used because if used unseasoned they will warp and shrink even when used indoors.

Even in countries with advanced technologies the ordinary consumer of timber will not normally wish to be burdened with the problem of having to season it before use. The problem will naturally be more difficult in developing countries. Again, in the case of timbers which cannot be used unless they are treated with preservatives it would not normally be possible to pass this burden on to the consumer. The reason for this is that the only effective and practicable method of preservative treatment is pressure impregnation and this treatment needs expensive plant which is not usually accessible to a consumer.

In these cases therefore, it is incumbent on the seller of timber to sell seasoned or pressure impregnated timber. To do this investment in seasoning kilns and pressure impregnation plant is necessary. I had earlier examined (Tisseverasinghe, 1963) the economics of pressure impregnation and shown that the capital/output ratio of the impregnation plant operated by the Forest Department was 1.43 as compared with the average capital output ratio for the various industrial enterprises in Ceylon of 3.5. The ratio of 1.43 was derived by calculating output as the value added to the raw timber by the treatment process. If the value of the final product based on selling price is considered as output, the capital output ratio would come down to 0.5. The gestation period of this investment is also very short. On all these counts therefore this type of investment is eminently desirable.

Industries Based on Forestry Products

The third class of timbers which remain unused comprise those which cannot be used in their natural state and which have to be converted into other products before they can be used.

The first industry which I mentioned was Plywood. One of the disadvantages of timber in its natural state is the fact that its strength along the grain is several times its strength at right angles to the grain. As you will be aware, this difficulty is overcome in plywood by combining veneers in such a way that the grain in one veneer is at right angles to the grain in the succeeding veneer. Also, timbers with an unattractive appearance can be used as core veneer while figured woods can be used as face veneer. Many species which may not be used in their natural form can be used as Plywood. Even if no Plywood is manufactured, a veneering machine is always a useful investment because many of the developing countries export veneer quality logs which are processed by other countries. Veneering these logs in the country of origin and exporting the veneer will definitely be more profitable. Ceylon exports, for instance, a certain quantity of Satin logs which are used in veneer form by the importing country. Timber is a bulky commodity and hence freight charges account for a high proportion of the cost of the timber. If instead of transporting logs with the attendant waste, only the veneer were transported a much better price could be obtained for the product. Further, the work involved in veneering will be done in the country of origin and not in the importing country.

Ceylon imports a large number of Plywood Tea Chests in which export tea is packed. The Ceylon Plywood Factory at present produces only 20 per cent. of the annual requirement of Tea Chests. However, plans are now under consideration to increase production at the factory and it is hoped to produce all the requirements of the country without building new factories. This will mean that the factory will be using 5 times as much timber as it is doing at present. This order of increase of production of timber from the forests can only be achieved if more money is invested in roads, mechanised logging equipment and so on. The investment will be worthwhile because of the ready made market that exists.

The manufacture of Particle Board is only in its nascent stage in developing countries. Koelmeyer (1959) in his Presidential address before this Section gave figures to show that with a capital investment of 3 million rupees a Chipboard factory producing 10 million square feet per year could be established. At a price of 50 cents per square foot this represents an annual production in value of Rs. 5,000,000—thus making the capital/output ratio a little more than 0.5. Under present day conditions this figure may have to be revised but even if the capital cost goes up to 5 million rupees the capital/output ratio will still be only 1. Particle Board manufacture usually started off in Western countries—as an ancillary to saw mills and other wood using industries in order to make use of waste wood. Today it is an industry in its own right competing with other industries for timber. Particle Board is not very choosy about species of timber and is hence particularly suitable for tropical countries which have a large number of species in their forests—many of which are not used at all. Particle board has certain advantages over timber in its natural form. For one thing it does not warp or shrink and for another its strength is uniform in all directions. It can be given a very pleasing appearance by the addition of a veneer surface.

Fibre board manufacture is the next stage in forest industries development. The technology is more complicated than in particle board since timber has to be reduced to its fibres instead of being cut up into chips, however a much bigger variety of products can be manufactured to any required density. The consumption of fibre board which includes soft board and hard board is still rising very rapidly and although fears of possible market saturation were expressed at the early stages of the industry, that level has still not been reached. In Ceylon there have been suggestions that hard board be manufactured from Rubber wood and a hard board corporation has been set up, but so far work has not started on it. Although rubber wood is not strictly a forest product it deserves a lot of attention because it is a comparatively uniform raw material available in known quantities generally in areas well served by roads.

Paper pulp manufacture using mixed tropical woods has not yet been shown to be a feasible proposition. Pulp mills in the temperate countries depend mostly on conifers for pulp. Recently, the timber of broad leaved species has been used to an increasing extent but yet no mill has used arbitrarily mixed species.

In the newer countries the tendency has been to raise forest plantations for pulping. Australia, South Africa and Brazil to name three widely scattered countries produce large quantities of pulp from species of *Eucalyptus*. In India and Pakistan Bamboo and grasses are used, and in Ceylon, Paddy straw. Feasibility reports on the use of Rubber wood and *Eucalyptus grandis* (wrongly termed *Eucalyptus saligna* in the past) have been prepared by the Eastern Paper Mills Corporation and it is likely that a newsprint mill will be set up soon. Unfortunately *Eucalyptus* has a relatively short fibre in the region of 1mm. and will thus have to be mixed with coniferous pulp, which of course will have to continue to be imported. However, the future need not be bleak—experiments are under way to grow various species of Pine in Ceylon and if this is successful, Pine plantations may contribute the coniferous pulp required. Bamboo can also substitute to some extent for long fibred pulp. Studies in India by Lundquist (1964) suggest that *Pinus insignis*, *Pinus insularis* and *Pinus merkusii* can be successfully grown and *Pinus insularis* has a very long fibre—more than 3 m.m. Past experiments with Pine planting in the Up-Country in Ceylon have not been very successful—perhaps due to lack of suitable mycorrhiza and perhaps because planting was confined to high elevations. Continuous experiment by the Forest Department is going on in this connection.

One of the difficulties facing developing countries in their effort to start forest industries is that machinery has been designed in Western countries to make use of processes based on raw materials available in those countries. Thus paper mills are generally designed for very large scale operations using coniferous wood as raw material. Such large scale operation does not suit developing countries and in any case the coniferous raw material is not always available in quantity. Special processes and machinery may have to be designed to make use of local raw materials and to be able to do this the industry must make a start, learn from mistakes and then perhaps improve the process. I will mention two examples of how new processes have helped developing countries. The first is the attrition process for pulping hardwoods which is now being used in many parts of the world. A new mill has been established in Pakistan based on a local

hardwood. Similarly dissolving pulps for the artificial fibre industry used to be made only from Spruce-type timbers. The recently developed "prehydrolysis sulphate" process has made it possible to use a wide range of other raw materials. A mill producing artificial fibre is under erection in India using Bamboo as raw material. (Greitz 1963).

The next stage of forest industries development is the use of the Cellulose in timber as artificial fibre. This has not even been attempted in Ceylon and hence it may appear to be a strange idea. However, timber is a very important fibre producer. It may surprise you to learn that a mature forest contains as much fibre as six hundred cotton crops can produce from the same acreage. Looked at in another way, an acre of forest will produce annually as much fibre as 5 acres of good cotton land. (Glesinger—1950). In countries like ours which have to spend large sums of money annually on the import of textiles, there is much scope for the establishment of an artificial fibre industry. At present private industrialists have started a rayon weaving industry using imported fibre. The time may not be far off when the fibre itself is produced within the country.

Plantation Forestry

I have not given this subject its customarily important place because I feel that in underdeveloped countries the stress should be on using what is available rather than on replacing natural forest with plantations. Of course, planting must go together with exploitation in cases where the net return from natural forests is low or if industries are established which require special, uniform varieties of timber. The subject of plantations is usually quite adequately covered in the literature of forestry and this was another reason why I did not expand on it. There has been a tendency in some developing countries to embark on ambitious planting programmes purely on the ground that the percentage net yield was higher than the rate at which money could be borrowed. I think I have said enough to show that this narrow view of forest economics is unsuitable for developing countries. In such countries, when planting programmes are organised stress should also be placed on planting high increment, short rotation species. In Ceylon we have recently increased our softwood planting programme to cope with the growing demand for match wood, packing case wood and so on.

Minor Forest Produce

This is an aspect of forestry which has tended to be neglected. Some countries like India set much store by their minor forest produce such as canes, bamboos, grasses, medicinal plants, seeds, herbs and so on. These items contribute substantial sums to forest revenue in India. In Ceylon however, this subject was neglected in the past and we have been content to import the various kinds of produce. This was taken to such an extent that in one year even cow dung was imported! Even at the present time Aralu (*Terminalia chebula*) and Bulu (*Terminalia belerica*) seeds are imported although these occur in abundance in this country and in fact were once exported from Ceylon. I do not have the time to expand on this subject but I am glad to say that we have now woken from our apathy and are making every effort not only to collect all our requirements but even to build up an export market.

We are now organising the collection of Beedi leaves (*Diospyros melanoxylon*) locally and are making investigations on Gammalu (*Pterocarpus marsupium*) resin and Weniwelgeta (*Coscinium fenestratum*) for which there is an export market. The male Bamboo (*Dendrocalamus strictus*) is now being propagated with a view to using it for paper pulp in the future.

It has been possible within the time at my disposal only to touch on some of the important fields of forestry investment, but I hope this will suffice to show you to what extent forestry can stimulate economic development. I must warn you that because foresters are a relatively neglected community, we tend to make exaggerated statements about the value of forestry. In this particular instance however, being faced with an audience comprising the scientific elite of the country, I have studiously avoided exaggeration—if I have erred in any way, it is in the direction of conservatism.

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Report on Afforestation with Eucalyptus in Ceylon

By L. D. PRYOR
(FAO Forestry Officer)

SUMMARY OF RECOMMENDATIONS FOR ANY FUTURE USE OF EUCALYPTUS IN CEYLON

EUCALYPTUS is filling a useful place in timber production in the highland zone and the best species in the main are being used namely *E. grandis*, *E. microcorys* and *E. robusta*.

2. In the more extreme dry Patana of this zone as at Medawalagama the more drought-resistant species should be used such as *E. citriodora*. A few other species should be tried such as *E. punctata* and *E. nova-anglica*.

3. Everywhere but especially in grasslands, attention must be given to initial cultivation (site preparation and surface cultivation in the first two years), if satisfactory growth of Eucalyptus is to be obtained. Some of this work can be done only with heavy mechanical equipment. In such sites also the use of fertilizer, especially, N. and P., immediately (three weeks) after planting should be tested.

4. The future place of Eucalyptus planting depends on many economic and policy decisions but if these require it Eucalyptus can be successfully planted on the lowlands for either charcoal or pulp or other industrial use.

5. In the wet zone, by the conversion of rain forest using techniques rather like those for the establishment of rubber or tea, *E. robusta* can be planted for the production of charcoal and also *E. decaisneana* (known in Brazil as *E. alba*). The latter species and *E. deglupta* can be planted for industrial timber.

6. In the dry zone where the rainfall is more than 60" the Savannah forest can be converted to *E. grandis* or *E. citriodora*. Here also *E. torelliana* should be tried and trials with *E. camaldulensis* and *E. umbellata* (*tereticornis*) extended.

7. Successful establishment in the Savannah zone will require deep ripping with heavy tractors; pushing over, heaping and burning (after any possible utilization); fertilising, and surface cultivation for two years.

8. In the very dry zone with heavy soil as near Hambantota *E. microtheca* should grow successfully for firewood and small pole production.

9. In the future when saw logs are used from existing highland plantations improved methods of conversion, particularly to minimize splitting of logs, should be introduced especially by affording a local forest officer an opportunity to examine such work in a suitable overseas country.

* The account of an assignment carried out in Ceylon from 8-20 May, 1964, within the framework of the UN Special Fund Project "Pre-Investment Study on Forest Industries Development."

10. Similar study should be made before dry zone large scale afforestation is extended substantially.

11. Good size working trials are needed at once in the wet zone as well as the dry zone in Eucalyptus afforestation to evaluate performance of species and to establish precise methods and assess costs. Some mechanical equipment—especially a D6 or better bulldozer will be necessary for this.

12. Eucalyptus can be expected to perform satisfactorily for industrial use on a 10-15 year rotation. Increments exceeding 200 cubic ft. per acre per annum (M. A. I.) can be expected.

NOTES ON AFFORESTATION WITH EUCALYPTUS IN CEYLON

There has been a long history of Eucalyptus planting in Ceylon as is seen from old well grown specimens of quite a wide range of species in different parts of the country. The following species were positively identified :

<i>Eucalyptus grandis</i>	<i>E. sideroxylon</i>
<i>E. saligna</i>	<i>E. paniculata</i>
<i>E. deglupta</i>	<i>E. macarthuri</i>
<i>E. microcorys</i>	<i>E. baueriana</i>
<i>E. citriodora</i>	<i>E. nova-anglica</i>
<i>E. robusta</i>	<i>E. pilularis</i>
<i>E. alba</i>	<i>E. botryoides</i>
<i>E. maculata</i>	<i>E. andreana</i>
<i>E. globulus</i>	<i>E. fastigata</i>
<i>E. Camaldulensis</i>	and the close relative of
<i>E. viminalis</i>	<i>Eucalyptus, Angophora intermedia.</i>

In addition, specimens were seen which from the material available were provisionally identified as :

<i>E. scabra</i> (= <i>eugenioides</i>)	<i>E. acmenioides</i>
<i>E. urceolaris</i>	<i>E. calophylla</i>
<i>E. sparsifolia</i>	<i>E. punctata</i>
<i>E. wilkinsoniana</i>	

In a few cases an incorrect name has become attached to a species, the most important of which is the consistent use of the name *E. saligna* for *E. grandis*. This is widely planted and in all plantations on which a check was made *E. grandis* only was seen. There were a few fine old specimens of *E. saligna* in the park at Nuwara Eliya and these were the only trees positively identified as this species. It is quite possible that there is some true *E. saligna* in some of the plantations since it is evidently an introduction of long standing but it is equally evident that if this is so it is quite uncommon. There is a good deal of variation in the fruit size and shape—rather more than is found in any one single stand of *E. grandis* in Australia—which makes identification more complicated than would otherwise be the case.

In a number of instances too, hybrids were found in plantations as at Dixon's corner between *E. grandis* and *E. robusta*. This combination is quite common under natural conditions in Australia also. Since the wood qualities of *E. grandis* differ somewhat from *E. saligna* it is important to make this correction in naming especially when information about the species is taken from published work. It should be mentioned here that the same error has been made in South Africa where likewise all the material in Natal referred to as *E. saligna* in the literature is in fact *E. grandis* and published material from that country which is of particular value in utilization relates to *E. grandis* though the name "*saligna*" is often used—and always so in the older papers.

Another important change to be made is in the so called "*E. regnans*" plot at Pattipola which is in fact the closely related but distinct species *E. fastigata*.

SPECIES PERFORMANCE

Apart from species introduced in collections as in the botanical garden at Hakgalla the species which have been used mainly are *E. globulus*, *E. robusta*, *E. citriodora*, *E. grandis*, *E. microcorys*, *E. pilularis* and *E. camaldulensis*. A good deal of planting has been done privately on the tea estates or by arrangement on adjoining land to provide firewood; *E. robusta* has been widely used for this purpose but its form and growth are inferior to *E. grandis* and the tendency is in new planting to switch over to the latter species in spite of the fact that the wood is of lower density, and therefore rather less satisfactory for fuel.

E. globulus has been widely tried in small areas and is without exception of very poor form and unthrifty growth although at times reaching substantial dimensions. It has wisely largely been dropped from cultivation. This performance is however interesting in view of the excellent growth of this species in the Nilgiris Hills in India. Since the climate is rather similar there to that in the Ceylon highlands and since low latitude has little effect on this species in spite of the fact that it occurs naturally from about Lat. S. 39-42° in Australia, one reason for the difference is the soil dissimilarity between Ceylon and the Nilgiris—but there may be a genetic difference.

E. grandis has been planted widely in stands for more than 30 years and is the main species now in use in the central highlands. It shows its characteristically good form and fast growth rate and is suitable for quite diverse conditions from Dry Patana to Wet Patana as at Pattipola. Several stands about 30 years old have dominants well over 150 ft. tall and it is apparent that increments of up to about 300 cubic ft. per acre per annum (mai) are obtained on the better sites.

E. microcorys is often mixed with *E. grandis* and, though a little slower than *E. grandis*, makes fine stems. *E. citriodora* is planted mainly on drier sites where growth is good and *E. pilularis* has produced some small patches of well formed trees but again with a volume less than that of *E. grandis*.

E. camaldulensis is found here and there and in some new low level trials. At higher elevations it is of very unusual appearance especially because of the persistence of the bark and it does not look thrifty. At lower

elevations as in the small trial near Puttalam, establishment technique has not been sufficiently good to judge performance yet. The trial plot is very irregular and in any case it is still young.

It will be seen that most of the *Eucalyptus* planting has been carried out in the wet zone in the central highlands above about 3,000 ft. The main object in the initial planting has largely been achieved in supplying firewood and small round building timber in this area. In the highlands, growth is fast and it is clear that *Eucalyptus grandis* and *E. microcorys* in particular are important species for future afforestation.

FUTURE PLANTING IN THE HIGHLANDS

In view of the fact that *E. grandis* is used successfully as a sawlog from plantations from about 20-30 years of age in South Africa, it is clear that there is every prospect that with suitable techniques it can be used likewise in Ceylon. The main point to overcome is the severe splitting that is always associated with very quick growth in planted stands. This diminishes with age and can be ameliorated by careful felling and suitable sawing techniques. When utilization of this species as a sawlog commences, improvements along these lines should be made. No doubt the best means of securing this information would be for one of the officers of the forestry department to visit a suitable country where such techniques are in vogue—probably Brazil or Spain.

Future planting in the highlands might well continue with the two species *E. grandis* and *E. microcorys* as at present wherever suitable land becomes available. One or two other species can be added to provide a little diversity, especially *E. pilularis* and if planting is carried out at very high elevations as at Pattipola, *E. fastigata*. In the dry Patana areas a few more species are worth adding such as *E. punctata*, *E. citriodora* and *E. nova anglica* in case the site is too dry for the successful growth of *E. grandis* or *E. robusta*. However, some of the difficulty on the drier sites at present is due to techniques and until this deficiency is removed by the provision of more mechanical cultivation it is premature to say whether there should be more use of species other than *E. grandis*, *E. robusta* and *E. citriodora*.

It is clear that future planting in the highlands is limited in scope. Pressure for land for agriculture is likely to increase rather than to decline and it would be unwise to clear more of the natural or semi-natural montane rain forest in view of the great importance of this area as water catchment or for extensive irrigation works at lower elevations. In this area therefore it seems that planting will continue to fill a useful place in conjunction with agriculture to meet local timber needs. The fast growth and good quality of *Eucalyptus* species which thrive in this zone will make them one of the main groups of species for planting, in the future as at present. Some conifers such as *Pinus elliottii* and perhaps *Cupressus macrocarpa* and *C. lusitanica* can also be grown here if local needs warrant it and it is an ideal location for the cultivation of *Acacia mollissima* for tan bark production which is said to be a pressing need in Ceylon. If planting of *Acacia* is to proceed it is especially important that the techniques used in Africa be studied by sending a forester from Ceylon

to a suitable area such as Kenya or Uganda before the work proceeds far. Seed supply could be arranged at the same time—an important matter since it is likely that much of the *Acacia mollissima* at present in Ceylon is hybridized in some degree with the less satisfactory *Acacia decurrens*.

PROSPECTS FOR PLANTING IN THE LOWLANDS

Eucalyptus planting has been largely confined to the highlands and almost no planted trees are to be seen at low elevations. It seems likely that this area, both in the dry zone (a relative term since rainfall is often 70-80 inches and spread over about 8 months) and the wet zone, will have a special place in future afforestation—especially if timber is wanted for industrial purposes such as pulp. It is apparent that land suitable for afforestation is available in substantial areas as for example on either side of Batticaloa. The present yield is low and planting would involve conversion to plantation either in conjunction with or independently of teak. There would be a recovery in firewood possible, if found to be economically sound at the same time. In such areas the topography is easy and there is little pressure for agricultural use once that part which can be converted to paddy with irrigation has been withdrawn.

Future needs might well include a substantial area for the production of pulpwood and timber for charcoal for use in the projected steel mill near Colombo. Even under present conditions there is a need for additional species to consolidate the plantation areas where teak is planted since the exacting requirements of this species lead to it being confined to the well drained sites which are at present being connected by planting *Berrya* and *Terminalia arjuna* both of which are quite slow growing and the latter of moderate value only.

There is no doubt that *E. robusta* would succeed under such conditions and probably *E. grandis* too, since both and especially the former occupy periodically inundated sites in their natural habitat. They are in fact known in Australia as Swamp Mahogany and Flooded Gum respectively. At the same time *E. umbellata* from a suitable provenance should also be tried here—the species occurs naturally in New Guinea in similar latitudes and also not far removed from this in Cape York Peninsula. All three species regularly endure a climate with a distinct dry period, and the total annual rainfall is often rather less than 70 inches.

In the wet lowland zone *E. robusta* will grow satisfactorily, and since the timber is rather denser than the other species it could be safely used to initiate planting for charcoal for the steel mill in the nearest available wet lowland zone from Colombo.

E. deglupta is also well suited to the lowland zone but is suited for pulp and sawlogs rather than charcoal. It should be tried at the same time and seed could be obtained from Peradeniya where there are three large trees fruiting well. The seed of this species unlike most other Eucalypts stores poorly and remains viable only for a short time so that a local source is important.

ESTABLISHMENT TECHNIQUE AND SPECIAL TRIALS

The main need in technique is thorough preparation of the soil by deep tractor ripping and then clean cultivation in the first two years of the plantation. Fertilizer application may be important on some sites. It is important to emphasise that mechanical preparation of the site is essential in pushing over the existing secondary savannah trees and in the following ripping. Hand labour cannot accomplish this. Unless such technique is used, the main benefit of Eucalyptus planting, that is quick growth, is lost.

A decision to proceed with planting of this kind will depend on many factors which it is beyond the scope of this report to set out. However, to allow future evaluation of costs, growth and species, a working trial of a hundred acres or so is very desirable at this stage. It could commence immediately with *E. grandis* and *E. robusta* to which *E. umbellata* could soon be added. Other species which are worth a trial are *E. Torelliana* which has shown promise in Nigeria and *E. tetrodonta* and *E. nesophila* from near Darwin, Australia.

It is also important to introduce *E. decaisneana* (incorrectly known as *E. alba* in Brazil) which is indigenous to Portuguese Timor. This is a splendid tree and will certainly grow in the highlands and may succeed in the lowlands.

Since no planting has been carried out in the lowlands there is a need for some caution, and working trials are necessary at once to test the species. There is every prospect that quick growth and industrial timber will be obtained in a short time if proper techniques of establishment are used.

For industrial use, long-fibred pulp will no doubt be of importance and no doubt trials at the same time should include tropical Pines such as *P. merkusii*, *P. insularis*, *P. khaysia*, *P. hondurensis* and *P. elliottii* and any others which may be suited to the Ceylon climate. However, the slower growth in comparison with Eucalypts will make them a matter for complementary planting and not an alternative.

A Study of the Fibre Lengths of *Eucalyptus grandis* Grown in Ceylon*

By M. S. RANATUNGA

Divisional Forest Officer (Timber Supplies)

SUMMARY

MEASUREMENT of vessel element and fibre length was made in four even aged (34 years) plantation grown *Eucalyptus grandis* trees.

Both vessel elements and fibres increased in length outwards from the pith reaching a constant length at about 25 per cent of the radial distance from the pith to the periphery (about 8-9 years).

Fibre lengths at comparable distance from the pith were less at the bottom of the tree.

Intrusive growth of fibres was least near the pith. Rapid growth is accompanied by greater intrusive growth of the fibres.

Sampling for the selection of plus trees should be from trees more than 9 years of age and is safe at not lower than 10 per cent stem height, though this may be higher than necessary.

Introduction

Growing trees for pulp is a major objective in forestry. In doing so, continuous attempts are being made to grow species and strains better suited for the purpose. In the case of conifers it has been known for a long time that amongst other factors, a high percentage of thin walled tracheids is most desirable. As opposed to conifers, hardwoods are complex, with more variation, both in the type of elements and their dimensions. This poses the question whether fibre length in hardwoods is as important as in conifers in determining quality of pulp. For hardwoods, in addition to fibre length, the general cell arrangement, such as the proportion of various types of cells, is important. (Frey-Wyssling and Aeberli, 1942). Using a method given by Frey-Wyssling and Aeberli, Dadswell and Wadrop (1960) found that amongst various hardwoods the genus *Eucalyptus* ranks high as regards fibrous cell content. This genus has been used successfully for pulping purposes in Australia, its country

* This work was undertaken as a part of the Post-graduate course at the Commonwealth Forestry Institute, Oxford, during 1962-63. The species *E. grandis*, grown in Ceylon was erroneously identified as *E. saligna* till recently.

of origin, and attempts are being made to do so in a number of other countries where it has been introduced, such as India (Sageriya and Waheed Khan, 1962) and Ceylon. In Ceylon there are over 8,000 acres of *Eucalyptus* grown on a 40 year rotation mainly as fuel wood. Of the total acreage over half the extent is *Eucalyptus grandis* and all new plantations added each year are of the same species in mixture with *Eucalyptus microcorys*.

In the selection of "plus" trees for seed for future plantation work, external form alone is inadequate. Selection of trees with long fibres is considered important. Although results are by no means conclusive (Zobel, 1961), fibre length is considered to be one of the anatomical characteristics with a high degree of heritability (Dadswell, Fielding, Nicholls and Brown, 1961).

The general pattern of the variation of tracheid length radially and vertically in the stem originally observed by Sanio (1872) and later by others (Chalk, 1930), appears to hold good for *Eucalyptus* (Bisset and Dadswell, 1949). Apart from these radial and vertical variations, it is known that fibre length at the base of the tree is affected by rooting and associated buttressing. These variations make it difficult for a representative sample to be selected from a "plus" tree.

In species such as *Eucalyptus* grown on short rotations, information regarding the occurrence of juvenile wood is of importance. The term juvenile wood has not been fully defined, but it is generally considered to be that region in the centre of the tree where anatomical characters have not yet reached their full development. Most of the characteristics of juvenile wood make it less attractive to the user. In the pulp industry it is unpopular and the demand is for longer and stronger fibres with their accompanying higher binding power and greater tensile strength. To the forester growing timber whether for pulp or for structural purposes, the extent and location of the juvenile core is useful information.

This study was undertaken to find out—

- (a) the variation of fibre length in *Eucalyptus grandis* grown in Ceylon ;
- (b) the position on the tree likely to give the most representative sample of fibre ;
- (c) the extent and location of juvenile wood.

Materials and Methods

The four trees used in this study were 34 year old plantation grown *Eucalyptus grandis* from Ceylon. The plantation is situated at 4,700 feet elevation receiving 80-90 inches rain with no conspicuous dry periods. At the time of initiation of the plantation in 1929, the original grassland cum natural forest was clear felled, burnt and planted with *Eucalyptus* species including *Eucalyptus grandis* along with *Cedrella toona* Roxb, at an

espacement of 6' $\times$ 6'. From the size of the trees and the present espacement it appears that the trees are slow grown and under-thinned. The trees were selected so that there was a wide range of dimensions as shown in Table I.

Table showing girth measurements and heights of trees from which samples were removed

TABLE I

Tree No.	<i>Girth at Breast Height (4' 6") over bark</i>		<i>Girth at Breast Height (4' 6") under bark</i>		<i>10% Timber Height</i>	<i>25% Timber Height</i>	<i>50% Timber Height</i>
A ..	..	4' 9"	..	4' 4"	.. 15'	.. 38'	.. 75'
E ..	..	4' 2"	..	3' 9"	.. 10'	.. 25'	.. 50'
F ..	..	3' 2"	..	2' 11"	.. 9'	.. 23'	.. 45'
H ..	..	2' 10"	..	2' 8"	.. 7'	.. 18'	.. 35'

The trees were felled and discs three inches thick were removed at ten per cent, twenty-five per cent, fifty per cent and seventy-five per cent of the timber height. The East-West diameter strip chosen for the study was sawn off through the pith to give a narrow strip two centimetres wide and two and half cm. deep. This strip was split at the pith and the western radial strip was used for studying fibre length within the ring, from the pith outwards and at different heights in the tree.

METHOD A

Variation of Fibre Length within a Growth Ring

Growth rings in the specimens were vague, narrow and irregular. After cutting and polishing radial strips the most conspicuous growth ring was chosen (Tree E at ten per cent height). The ring boundary was carefully marked and the specimen was boiled for two hours and cut on the microtome into sections 50 μ thick. All sections were placed in labelled tubes and every twentieth section was used for maceration.

METHOD B

Variation of Fibre Length from Pith Outwards

It was not possible to distinguish growth rings or internodes for comparative purposes and samples were removed from percentage distance along the radius. The four strips at ten per cent timber height were measured from the centre of the pith to the periphery and the following six points were marked: the centre of the pith, ten per cent, twenty-five per cent, fifty per cent, seventy-five per cent of the radial measurements and the periphery. The strip was split at right angles to the radius at these positions and a small chip of material was removed and placed in labelled tubes for maceration.

Variation of Fibre Length from Pith Outwards at Higher Levels in the Same Trees

Method B was repeated at twenty-five per cent and fifty per cent timber height.

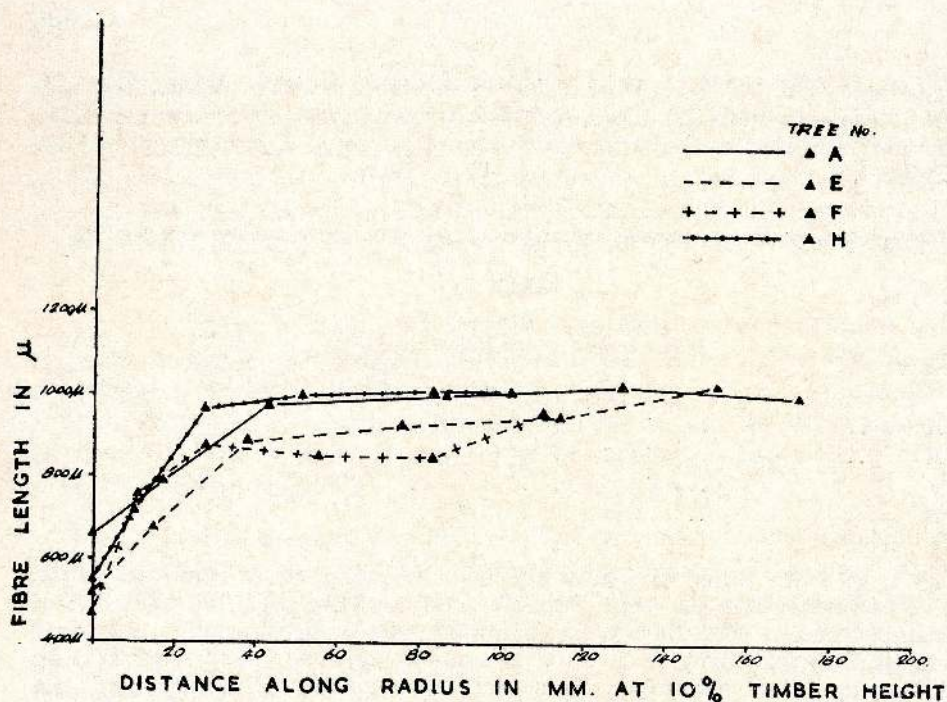


FIG. 1

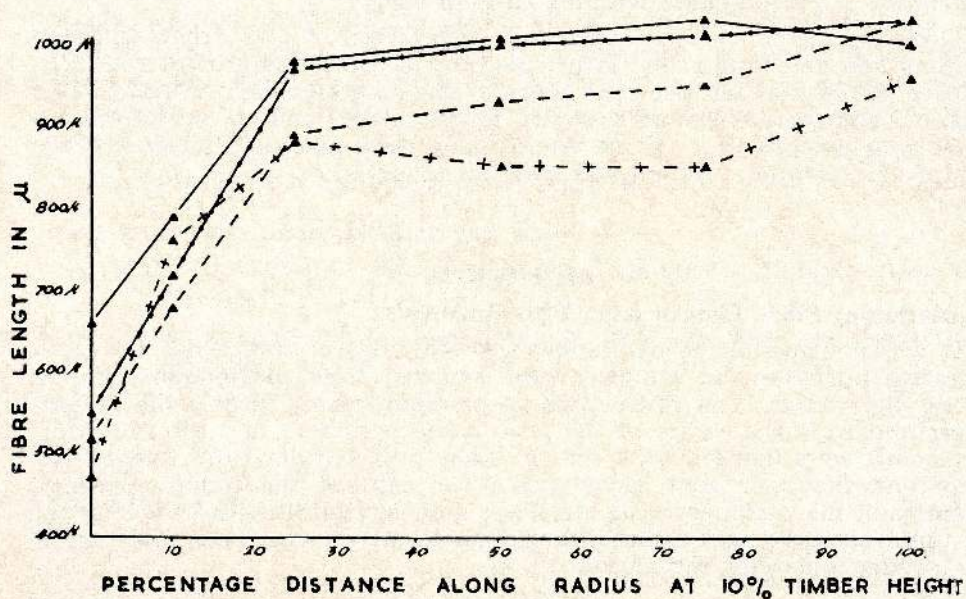


FIG. 2

Macerations

The wood sections and chips from known positions placed in labelled tubes were covered with fifty per cent glacial acetic acid and fifty per cent hydrogen peroxide and maintained at a temperature of 60°C for thirty-six hours. After this period maceration was found to be complete.

Measurements

Slides were prepared from the washed macerations by staining in Safranin and mounting in glycerine jelly. Using a projection microscope fifty fibres were measured from each slide. Vessel members were measured direct from water mounts with the aid of a callibrated eye piece. Twenty-five measurements were taken from each position.

RESULTS

Variation in Fibre Length within a Growth Ring

The results of the present study are given in Table II.

TABLE II

Table showing variation in length within the growth ring

<i>Distance from the ring boundary</i>			<i>Fibre length in μ</i>
- 2 mm.	..	..	937
- 1 mm.	..	..	961
0	..	..	1,042
+ 1 mm.	..	..	1,015
+ 2 mm.	..	..	995
+ 3 mm.	..	..	913
+ 4 mm.	..	..	990
<i>Next Ring Boundary</i>			
+ 5 mm.	..	..	935

The fibres were longest at the ring boundary (0) and decreased away from it but increased again just before the end of the ring. These changes were small in amount.

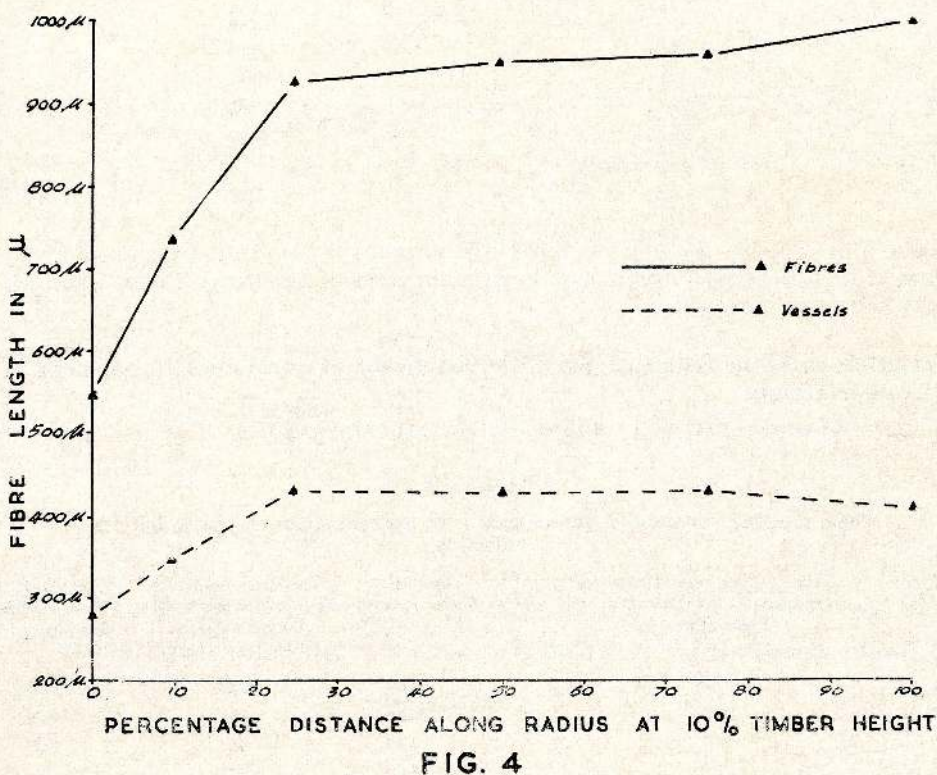
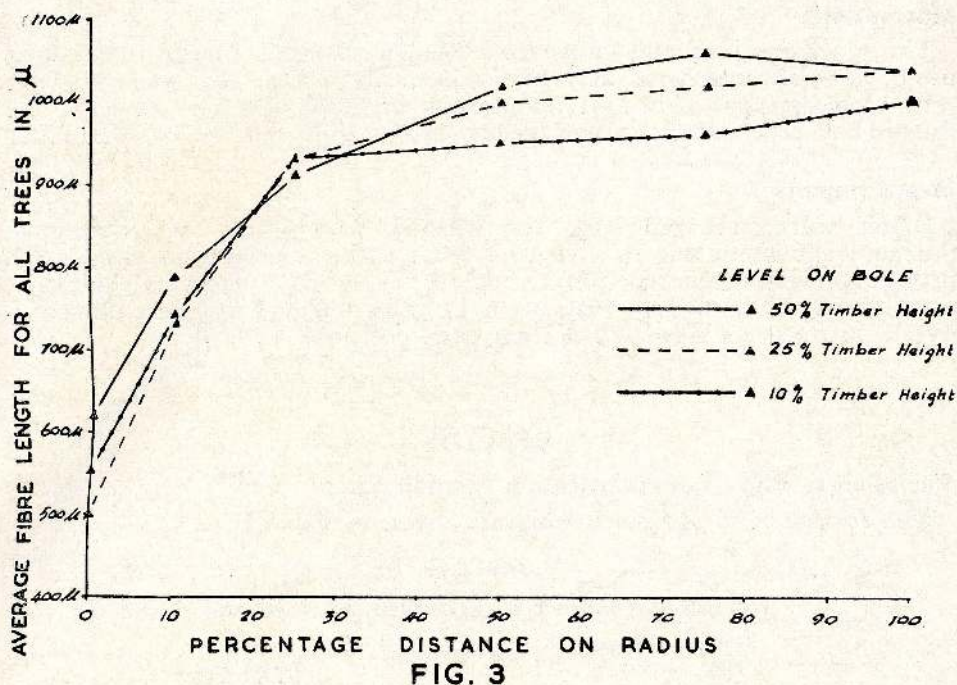
Variation of Fibre Length from Pith Outwards, at one Level 10 per cent of Timber Height

Table III and figures (1) and (2) illustrate the results.

TABLE III

Table showing variation of fibre length at 10 per cent timber height from pith outwards

<i>Tree No.</i>	<i>Size of Tree represented by radius in mm. at 10% Timber height</i>	<i>Initial Fibre Length in μ</i>	<i>Distance from the Pith at which Fibre length ceases to increase in mm.</i>	<i>Constant Fibre length level in μ</i>
A ..	172	.. 660 ..	43	.. 1,000
E ..	152	.. 520 ..	38	.. 950
F ..	110	.. 470 ..	28	.. 890
H ..	102	.. 550 ..	27	.. 1,000



The fibre length at the pith was low and increased rapidly outwards soon attaining a relatively constant length. The fibre length settled down to a constant length immediately the period of rapid increase was completed. Variations in fibre length after reaching a constant level were of small magnitude only and not consistent for different trees.

Variation of Fibre Length from Pith Outwards at Different Levels

The variations of fibre length at 25 per cent and 50 per cent timber height are given in Tables IV and V.

TABLE IV

Table showing variation of fibre lengths at 25 per cent timber height along percentage distances of radius

Tree No.	Size of tree as represented by radius in mm at 10 per cent timber height	Fibre length at percentage distance along the radius in μ					
		At pith					At periphery
		0	10	25	50	75	100
A ..	155	540	830	910	1,140	1,130	1,120
E ..	136	510	680	860	850	930	940
F ..	107	430	610	850	930	980	1,030
H ..	98	510	800	1,080	1,090	1,060	1,100

TABLE V

Table showing variation of fibre length at 50 per cent timber height along percentage distances of radius

Tree No.	Size of tree as represented by radius in mm at 10 per cent timber height	Fibre length at percentage distance along the radius in μ					
		At pith					At periphery
		0	10	25	50	75	100
A ..	140	655	860	980	1,030	1,000	940
E ..	102	570	800	960	980	1,070	1,060
F ..	81	620	690	830	980	1,070	1,020
H ..	85	640	800	880	1,120	1,130	1,120

The pattern of variation at 25 per cent and 50 per cent timber height was similar to that at the 10 per cent timber height level already described. Fibre length at different levels in the same tree from 10 per cent timber height did not reveal significant results. Averaging the values for all trees at three different levels (figure 3) shows that the maximum fibre length was higher at the two upper levels (25 per cent and 50 per cent timber height) than at the lowest level 10 per cent timber height.

Variation in Measurements of Vessel Elements at 10 per cent Timber Height

The results are shown in Table VI. The vessel elements at the pith had smaller dimensions and increased outwards reaching a uniform level, which was about fifty per cent higher than the initial length. The vessel elements are considered to lengthen very little (Bailey 1920) after they were differentiated from the cambial initials. Using this as a guide it is possible to obtain the dimensions of the cambial cells and the extent to which they vary outwardly.

TABLE VI

Table showing variation of vessel element lengths at 10 per cent timber height along percentage distance of radius

Tree No.	Size of tree as represented by radius in mm at 10 per cent. timber height	Vessel element length at percentage distance along the radius in μ .					
		At pith 0	10	25	50	75	At periphery 100
A ..	172	290	370	430	440	420	420
E ..	152	270	330	410	410	430	390
F ..	110	270	330	400	410	370	420
H ..	102	286	360	460	470	480	470

Relation of length of Fibres to Length of Vessels at Various Levels

Comparison of the length of the cambial initials (as indicated by vessel element dimension) and fibre lengths at the same points yields information on the amount of fibre elongation. This comparison is given in Table VII in which the length of fibre is shown in relation to that of the cambial initial and the average values for all trees are shown in figure 4.

TABLE VII

Table showing relationship of fibres to vessels

Tree No.	Size of tree as represented by radius in mm at 10 per cent. timber height	Fibre/Vessel at percentage distance along the radius					Average fibre/vessel
		At pith 0	10	25	50	75 At periphery 100	
A ..	172	2.27..	2.12..	2.10..	2.27..	2.50..	2.29
E ..	152	1.92..	2.06..	2.17..	2.26..	2.20..	2.21
F ..	110	1.72..	2.30..	2.20..	2.07..	2.27..	2.14
H ..	102	1.92..	2.00..	2.06..	2.06..	2.08..	2.06

DISCUSSION

Variation in fibre length within a growth ring has been investigated by many workers, but most of the work has been confined to Conifers. Bisset and Dadswell (1950) who studied this aspect in twenty-eight angiosperms with distinct growth rings observed a definite increase in fibre length from first formed early wood to last formed late wood, whilst in species without definite growth rings, there was little or no variation in fibre length over radial distances covering growth over several years. The results of this experiment at Table II shows that fibre length was longest at the ring boundary and decreased from there onwards with slight fluctuation. This is in accordance with results of Bisset and Dadswell (1950).

Since the original work of Sanio (1872) other workers have confirmed the initial increase in length of tracheids and fibres from the centre onwards. But not all are in agreement that fibres or tracheids maintain a constant length after the initial increase. Hartig (1885) reported an actual decrease after reaching a maximum for Beech [*Fagus sylvatica* L.] Similar observations were made by Shepard and Bailey (1914) for *Pinus palustris* Mill and by Lee and Smith (1916) for *Pseudotsuga taxifolia* (Lamb) Britt. Desch (1932) reported that fibre length gradually increased after 129 years in *Fagus sylvatica*, 102 years in *Populus serotina* Hartig, 56 years in *Acer pseudoplatanus* L. and *Betula pubescens* Ehrh. Bisset and Dadswell (1949) found that in 50 year old *Eucalyptus regnans* F. v. M. fibres increased their length up to ten growth rings from the pith, after

which a more or less constant value was reached. Arulchelvam (1962) found that a constant fibre length was reached between 3 and 9 years for *Eucalyptus robusta* Sm.

The rate of growth did not appear to be related to the initial fibre length, rate of increase of fibre length, or the final fibre length level reached. Figure I indicates that specimen H the slowest growing tree, initially had a shorter fibre than the fastest growing tree A but in course of time both reached the same fibre length. Similar lack of consistent relationship was noted in trees E and F.

It has been observed by Lee and Smith (1916), Bisset, Dadswell and Wadrop (1951) and Murray (1961) that faster growth produced shorter average length in fibres in conifers. This has also been found to be so for *Eucalyptus gigantea* by Bisset, Amos and Dadswell (1949). On the other hand Kennedy (1957) working on Black Cotton, *Populus trichocarpa* Torr and Gray, have shown that faster grown trees produced longer fibres.

Since, as indicated by Figure I there is no consistent difference in fibre length between trees with different growth rates, it seems likely that other factors play an important part in determining final fibre length besides the length of the cambial initial and the extent of elongation to form the fibre. From Table III it appears that the maximum fibre length was reached for all trees at about twenty-five per cent of the radial distance. This is better illustrated when fibre length is plotted against fractions of the radius than at fixed distances as in Figure 2. Minor variations at constant level can be ignored when the rotation is short.

Evidence on whether fibre length is related to distance from the pith or to age is conflicting. Bisset and Dadswell (1949) found that fibre length is related to age in *Eucalyptus regnans*. Others, Anderson (1951), Hejnowicz and Hejnowicz (1958), hold the opposite view namely that fibre length is a function of cambial age represented by distance from the pith. Most recent work, for example that of Dinwoodie (1963) tends to combine both views and state that in the early life of a tree closer relationship is shown to age than to distance, whilst in the later life relationship is closer to distance from the pith. In the mid-age of the tree the relationship is transitional.

The results of the present work indicate that fibre length is related to age rather than to distance from the pith, in that all trees irrespective of size or rate of growth reached uniform fibre length level to one quarter of their present radius. On the assumption of uniform growth the age at which this would occur would be at 8 to 9 years.

Studies of this nature have all been made in stems showing growth rings, either by following upwards a single ring or, rings at fixed number of years from the pith. With regard to variation of fibre length up the tree within one growth ring, the observations by Sanio (1872), Bisset and Dadswell (1949), Hejnowicz and Hejnowicz (1959) show that fibre length increased up the stem to a certain point before decreasing progressively to the top of the tree. The position of maximum tracheid length in each ring is located at higher levels as successive rings are formed.

In the studies of fibre length at a point a fixed number of rings from the pith but at different heights in the stem Lee and Smith (1916), Anderson (1951) it was found that with the exception of the first ring

tracheid length increased up to some point in the stem after which it remained constant. Working on hardwoods Bisset and Dadswell (1949) found that there is a slight decrease to the top of the tree.

In both studies higher levels had been taken at fixed heights from the ground and criticism has been made, that comparison of different trees yield better results if the sampling is done at the same number of internodes or at least at the same percentage heights of different trees.

In the present study owing to the lack of distinct growth rings, it was not possible to take samples corresponding to the number of internodes, as has been suggested by Dinwoodie (1961). An approximation to this technique was however possible by assuming a uniform rate of height and diameter growth, in each tree and selecting samples at fixed proportions of the height or of the radius. Thus a sheath of tissue could be distinguished similar to that of a growth ring. Comparison of the results of individual trees may not have been possible due to variation within these larger sheaths. However, the average for all trees as shown in figure 3 does indicate that up to fifty per cent timber height the tendency is for fibre length to increase. For *Eucalyptus regnans* Bisset and Dadswell (1949) the fibre length increase terminated at one third the height when a single tree was studied.

Fibre Elongation

The measurement of vessel elements at ten per cent timber height at the identical points along the radius at which fibre length was measured are shown in Table VI. The vessel elements are considered to lengthen very little (Bailey, 1920) after they are differentiated from the cambial initials. Using this as a guide it is possible to obtain the dimensions of the cambial cells and the extent to which they vary outwards. In this study the vessel elements at the pith had smaller dimensions and increased outwards reaching a uniform level which was about fifty per cent higher than the initial length.

Comparison of the cambial initial lengths and fibre lengths at the same points yields information on the amount of fibre elongation. Increase of fibre lengths outwards from the pith is usually attributed to increase in length of cambial initials and elongation by intrusive growth. In conifers it is entirely due to variation in the length of cambial initial. In some storeyed hardwoods there is considerable elongation after being cut off from the cambium and the effect of the cambium is negligible (Chalk, Marstrand, Walsh, 1955). In a non-storeyed hardwood it has been shown that intrusive growth remains uniform through the tree and the outward variation of fibre length is governed primarily by the variation in the length of cambial initials (Hejnowicz and Hejnowicz, 1958). In other storeyed hardwoods where there was an increase in fibre length accompanied by increase in cambial cell length the accompanying increase in cambial cell length was insufficient to account for the increase in fibre length. (Hejnowicz and Hejnowicz, 1959; Mynt Aung, 1960).

In this study which is based on a non-storeyed hardwood, it is seen that cambial initial length, as represented by vessel element length, increased outwards, to a uniform level. The fibres too showed a similar pattern. Comparison of the two is given in Table VII in which length of fibre is shown in relation to that of the cambial initial, and average values for all trees in Figure 4.

It appears that during the initial phase fibres increase in length much faster than the pace set by increase of cambial initials. Both cambial initials and fibres settle down to a uniform length at about the same time and after that the percentage of elongation remains the same. This indicates that during the initial phase fibres increased more by intrusive growth than as the result of elongation of the cambial initials, whereas later the amount of intrusive growth settles down to a definite proportion.

The ratio of fibre to vessel length can be considered an indicator of intrusive growth. The results in Table VII show that the ratio was largest in the fastest grown tree and was progressively smaller in the smaller trees. This would tend to show that other things being equal, faster growth will produce longer fibres. In fact, however, the fastest grown trees may have a genetic tendency to produce short fibres. This emphasizes the importance of selecting "plus" trees with an inherently long fibre and suggests that having selected the right strain, length will probably be increased, rather than diminished by rapid growth.

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A Preliminary Study on the Distribution Growth and Propagation of Weniwelgata (*Coscinium fenestratum*)

By S. MUTTIAH

(Junior Assistant Conservator of Forests)

SUMMARY

WENIWELGATA (*Coscinium fenestratum*) is used in the Ayurvedic System of Medicine chiefly as an anti-tetanus measure. Its specificity in the treatment of other diseases as well as its mode of action afford an interesting study for medical research. Since it is widely used and because of a ready foreign market, it is necessary to have sufficient data on its distribution, growth and regeneration to ensure a sustained yield. An attempt has been made in this direction. Plots have been laid to study growth. As regards propagation, results of experiments carried out indicate that seedlings and stumps can be planted out but the trials carried out so far have been in the open. Best results of germination have been obtained with seeds which were collected from the forest floor 1 to 2 months after seed fall.

There is an urgent necessity to protect forests where this species is richly distributed particularly from large scale excisions and encroachments. Where such forests are to be enriched with timber species, it is best to line plant with suitable species like Mahogany instead of adopting the clearfelling system.

INTRODUCTION

"WENIWELGATA" or "Ban" is the Sinhalese name, (Tamil—Maramanehal, Manjalkodi; English—False Calumba, Tree turmeric) for a liane (woody climber) which is widely used in the Ayurvedic system of medicine chiefly as an anti-tetanus measure. Other therapeutic powers have been attributed to this plant such as in the treatment of certain back-aches, as a blood purifier and for malarial fever. It is also said to possess antiseptic properties and is used for dressing wounds and ulcers. Though this plant is used in the treatment of such a wide spectrum of ailments, its specificity remains to be worked out and this affords an interesting study for medical research. Because of its wide usage in Ayurveda, increasing attention has been focussed recently on the export of these plants to foreign pharmaceutical firms in countries like Japan and Germany.

It is of interest to note that this plant is widely used in Central and South India where it is well distributed while the related *Berberis* species ("Calumba") which is said to possess even greater medicinal properties is solely used in North India where this can be readily procured.

No data are available on the total requirement of this plant product per annum in Ceylon but an attempt is being made by the Board of Ayurveda to collect the required statistics. In the event of an increased demand, particularly in view of a ready foreign market, it is very essential to gather more information on the distribution, growth and regeneration of this species to ensure a sustained yield.

Apart from its medicinal use, the plant has a number of minor uses. Because of its tough fibres and antiseptic properties the stems are used to tether cattle and as harnesses. Larger sizes are used as tow ropes for hauling logs by elephants as well as in the construction of primitive suspension bridges. The stems on boiling with water yield a deep, yellow dye used for dyeing the robes of Buddhist monks.

COLLECTION AND MODE OF TREATMENT

THE plant has hitherto not been cultivated. The stems and branches are collected from the forest and when air-dried can be kept for considerable periods. It is reported that storage does not result in the loss of medicinal values. Pieces of the stem appear to be unaffected by insects. In preparing the stems for use, they are scraped to remove the outer corky rind and then boiled with water, sometimes with coriander, to yield a deep yellow and bitter decoction which is administered to the patient with copious amounts of sugar. It is also not uncommon for fresh stems to be used in place of dried ones. It has not been possible to find out the amount of stem that is used in the treatment of different ailments but excess is stated to be harmful and even dangerous. The decoction is supposed to lower the rate of respiration.

CONSTITUENTS

THE stem of the plant is reported to contain ceryl alcohol, hentriacontane, sitosterol, palmitic and oleic sitosterol glucoside, saponins and berberin (1.6 per cent. in the dry basis) (1).

DISTRIBUTION

THIS species is distributed in the intermediate and wet evergreen forests of Ceylon where the rainfall varies from 75"-200" per annum. It is found in abundance in cool, humid pockets on well drained humus soils and

thrives best in dense shade. It is found in and around Deniyaya, Matara, Kamburupitiya, Akuressa in the Southern Province ; in Waga, Agalawatte, Matugama, Ingiriya in the Western Province ; in Kuliyaipitiya in the North-Western Province ; and in Kegalle, Kitulgala, Rakwana, and Ratnapura in the Sabaragamuwa Province. There is no marked association with any particular 'host' tree, there being a wide variety, e.g., Milla, Godapara, Del, Etamba, Gonna, Munamal, Netaw, Malaboda, Kekuna, Hedawake, etc. It frequently climbs on other lianes. Various stages of growth ranging from seedlings to parent stems varying in diameter from 1"-4" at root collar can be found in the same locality. The species can climb to heights of 50-60' and it ramifies in the crowns of host trees to form tangled nests.

TAXONOMY AND MORPHOLOGY

THIS species belongs to the family Menispermaceae (Trimen). The plant is either rooted in the immediate vicinity of the host or a few feet away from it, in which case, the stem trails along the ground rooting at intervals till it has reached the host. Then it normally climbs straight upwards, but it is sometimes seen to twine intimately round the host. The stem is usually cylindrical, rarely curved or twisted, with knotty surfaces at irregular intervals. According to observations made, the stem varies in diameter from 1"-6" at the root collar. The bark is relatively thin, pale green in the young stems turning to greyish white in the older stems due to heavy lichen growth. It is lightly furrowed longitudinally and when scraped or blazed reveals the underlying dark yellow wood. This is a very characteristic feature and is often employed in the field to recognize it from other lianes. A cross section of the stem shows a diffuse porous wood with large pores intercalated by prominent broad bands of medullary rays radiating from the central pith to the outer cortex. Greater histological details are given in (I).

Leaves are simple, petiolate, alternate, cordate or peltate with palmate venation. They are glabrous green on the upper surface and greyish white below with a felt like lining of tomentose hairs. Veins and veinlets are prominent on the under surface. There is no regular branching habit. A well developed tap root is present.

LEAF SHEDDING, FLOWERING AND FRUITING

THE plant sheds it's old leaves during the South-West and North-East monsoonal rains and reflushes towards the end of the rains.

Flowers occur in aggregates of umbelled heads or capitules and each aggregate is borne at the end of a downy peduncle, about 1" long, several of which may arise from the same node either on the main stem or on the older branches. They are unisexual and dioecious. They are greyish in colour and appear in April and May.

Fruits appear in June and ripen in August and seem to appear every year. However, observations on the periodicity of flowering and fruiting are in progress. The fruits are light brown in colour, and appear as aggregates of one seeded drupes resembling "bunches of grapes". Each drupelet has a thin fleshy mesocarp with a woody, oblong stone convolute round a condyliform process, and contains a fleshy endosperm. The mature fruits fall to the ground and can be freely collected from the forest floor underneath the parent plant. For propagation purposes, fresh fruits can be collected either from the parent plant or from the forest floor and dried in light shade for a few days prior to sowing. Fruits are very bitter and hence unattacked by large animals. No visible sign of either insect or fungal attack has been noticed on the fruits and seeds. The same is true of the parent plant as well; this is not surprising since the plants have been observed only in biologically well balanced environments.

There are 95-130 seeds to the lb. or roughly 6-8 seeds per ounce. Viability tests have been initiated at Kankaniyamulla Nursery.

NATURAL REGENERATION

AFTER the mature fruits fall to the ground, the mesocarp decays and this is followed by germination of the seeds. Experiments in the Nursery indicate that the germination percentage is low (below 20 per cent.). Nevertheless fairly abundant natural regeneration can be observed as a result of profuse seed fall. Seedlings are robust and firmly rooted in the soil with well developed tap roots. For instance, seedlings with an average 6" shoot have tap roots 4-5" long. It is proposed to carry out regeneration counts and to observe the effect of transplanting these seedlings under different habitats, i.e., in the open, in light and dense shades. Seedlings are singularly free from any animal damage. No fungal attack has been observed either. The species is found to coppice well.

EXPERIMENTS ON ARTIFICIAL PROPAGATION

TRIALS were initiated at Kankaniyamulla Nursery to determine the best method of propagation from the following: seeds, shoot and root cuttings, stumps and seedlings from the Natural forest. Seeds were sown direct and after pretreatment with lime water for different periods. Planting materials were all obtained from Kankaniyamulla Reserve adjoining the nursery. It must be pointed out that these trials have not been statistically designed in any way but merely restricted to single bed plots, 10' x 4', since the object of this study was to gain some idea to serve as a starting point for more detailed experiments later on, if found necessary. All the

beds were laid contiguously on a flat site and watered once daily except on rainy days when no watering was done. The trials are briefly enumerated below together with the results :

OBSERVATIONS

A.—Seeds (in fact, the fruits, 400 were used per plot)

	Germination period	Germination percentage	Plant percentage (as at April 1964)	Average height (as at April 1964)
1. Fresh, mature seeds plucked from parent climber July '63 and sown direct. (85% sound as shown by cutting test) ..	1½ months ..	8 ..	97.5 ..	4.5"
2. Fresh seeds collected from the forest floor in first month of seed fall (August '63) and sown direct. (84% sound) ..	1½ ..	6 ..	96.0 ..	4.7"
3. Seeds collected from the forest floor in the second month of seed fall (September '63) and sown direct. (92% sound) ..	1½ ..	18.5 ..	95.0 ..	4.2"
4. Seeds obtained from source (3) pretreated with lime water for 6 hours. ..	1½ ..	19.5 ..	97.4 ..	4.0"
5. Seeds obtained from source (3) pretreated with lime water for 12 hours. 1½	..	15.0 ..	98.3 ..	4.1"
6. Seeds obtained from source (3) pretreated with lime water for 24 hours. 1½	..	11.0 ..	100.0 ..	4.1"

B.—Cuttings

7. 25 root cuttings 6" long taken below the root collars and buried slantwise 3" below soil level.	No sprouting noticed up to end of April 1964. Partially decayed.
8. 25 stem cuttings (average diameter 1½") taken up to first 6" above the root collars and buried <i>slantwise</i> as at (7).	do.
9. 25 stem cuttings (average diameter 1") taken from the second 6" part of the stems used at (8) and buried <i>slantwise</i> as at (8).	One sprouted after 2½ months, another two at the end of the 3rd month. Plants delicate but were dead soon afterwards.
10. 25 stem cuttings (average diameter ½") taken from the 3rd : 6" part of the stems used at (8) and buried <i>slantwise</i> as at (7).	Two sprouted after two months, another 2 after 3 months but three were dead soon afterwards. A solitary plant remained in April, 1964.
11. 25 stem cuttings taken from the first 6" and buried <i>horizontally</i> just beneath the soil surface.	None sprouted up to April 1964. Partially decayed.

C.—Stumps

12. 25 stumps 3/16" in diameter obtained from natural regeneration.	21 sprouted after one month but due to heavy mortality only 5 remained in April 1964. Average height 3".
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D.—Seedlings

13. 25 seedlings 6" high from the Natural Forest.	Heavy casualties. Only one survivor in April 1964. Average height 4".
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DISCUSSION OF RESULTS

AN examination of the results, subject to the limitation stated at the outset, indicates that propagation is best achieved using seeds. It would appear that seeds collected from the forest floor in the second month of seed fall gave higher values of germination percentages, in fact double the figures, than those obtained by direct sowing of fresh seeds collected either from the parent climbers direct or from the forest floor. This can be probably attributed to the stony endocarp undergoing some form of weathering and being easily capable of dehiscing along the condyliform process with the passage of time.

One striking feature is that seedlings obtained by methods 1-6 were the healthiest as is also apparent from the high values of plant percentages. Germination is hypogeal and the fleshy endosperms serve as a rich store house of nutrients to see the plants through their formative stages.

Based on these observations, seeds pretreated with lime water for 6 hours are being dibbled round the trunks of trees both in Natural Forest and plantations as a means of spreading this species.

Propagation by cuttings, both shoot and root, had also been tried out but the results were disappointing. Root cuttings had been a complete failure while stem cuttings had been a near failure. Even the few survivors from stem cuttings were feeble with ill-developed root systems. It is interesting to note that the regenerative capacity of the stem cuttings appears to improve the higher they were taken from the main stem.

Planting out stumps and seedlings obtained from the Natural Forest has not been successful. Perhaps mortality has been heavy due to planting out in the open.

GROWTH AND YIELD

TRIAL plots have been opened at three centres to study the distribution, densities and growth increments under different climatic conditions. The number of stems (over 1" girth at root collars) were as follows :

	<i>Kankaniyamulla Reserve</i>	<i>Beraliya Reserve</i>	<i>Diyadawa Reserve</i>
Distribution Density :	.. 112 per acre	.. 40 per acre	.. 164 per acre
Province :	.. North-Western	.. Southern	.. Southern
Range of girths :	.. 1"-4"	.. 1"-6"	.. 1"-5.5"

It was also decided to get an idea of the total yield of exploitable sizes in a forest. For this purpose a representative one acre plot was selected by the writer at Kankaniyamulla Reserve as denoting the occurrence of

this species through out this Reserve. 112 climbers were harvested here, these were then weighed and the wet weight amounted to 6 $\frac{3}{4}$ cwts. Every attempt was made to gather as much of the climbers as possible but inevitably a certain proportion could not be pulled down from the great heights. It was eye-estimated that a third remained uncollected but for practical purposes the figure quoted represents the maximum collectable material, unless improved methods, such as climbing, are resorted to for maximum utilisation. Working on this figure, the total yield is estimated at about 900 tons from this Reserve alone where, no doubt, it is well distributed.

It is proposed to carry out increment studies on the regrowth from the 112 climbers till they reach commercially exploitable sizes again. Since this is a long term experiment, an adjacent plot has also been opened to study growth increments on stems of different sizes. This is, of course, based on the fair assumption that the growth rates would be uniform on the same site. Similar growth observations are being made at the other two centres ; these data would be used in working out a rotation age.

COSTS

THE cost of collection as worked out in the yield plot at Kankaniyamulla amounts to 10 cts. per lb. This is based on the fact that 20 man days were expended, working an 8 hour day, in collecting the 6 $\frac{3}{4}$ cwts.

The cost of a lb. in the local market is 40 cts. so that, an acre of the best Weniwelgata area such as at Kankaniyamulla carries a potential money yield of Rs. 225, exclusive of the cost of collection.

ACKNOWLEDGMENT

THE WENIWELGATA trials were initiated at the instance of the Silvicultural Research Branch. Thanks are due to the field officers, in particular, Messrs. S. K. Cumarasingham and K. H. S. Fernando who assisted in the collection of data at Kankaniyamulla. I am also obliged to Mr. W. G. Weeraratne, Senior Assistant Conservator of Forests, and Dr. Ponniah of the Ayurveda College of Medicine for the valuable points given by them and which have been incorporated in this article.

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Notes on a Reconnaissance Survey for the Integrated Development of the Walawe Basin of Ceylon

By S. SRIDAS

(Assistant Superintendent of Surveys—Resources)

SUMMARY

THIS paper attempts a study of a reconnaissance survey, executed by a team of Canadian experts, of the resources of the Walawe Basin of Ceylon. Besides indicating, in general outline, the nature of the different investigations with aerial photographs as the starting point, certain aspects of integrated resources surveys in development planning are discussed.

NATURAL FEATURES OF THE AREA

Physiography

The survey area is about 1200 sq. miles in extent (with a maximum length of 52 miles and a maximum width of 32 miles), situated in the south-east quarter of Ceylon. The Basin exhibits great contrasts and abrupt changes in physiographic pattern. Slightly more than half the area is comprised of the lowland plain with elevations to 500 ft., about a third of the area, constituting the upland regions of the Basin, lies between 500 and 2,000 ft., the rest being the mountainous area with elevations of over 2,000 ft. The latter area includes a steep escarpment marking the south edge of the central highlands of Ceylon and extending across the north of the Basin. The crest of this escarpment forms the watershed of the Walawe system and lies 3,500 to 4,500 ft. above the tract of hills and ridges at its base.

Climate

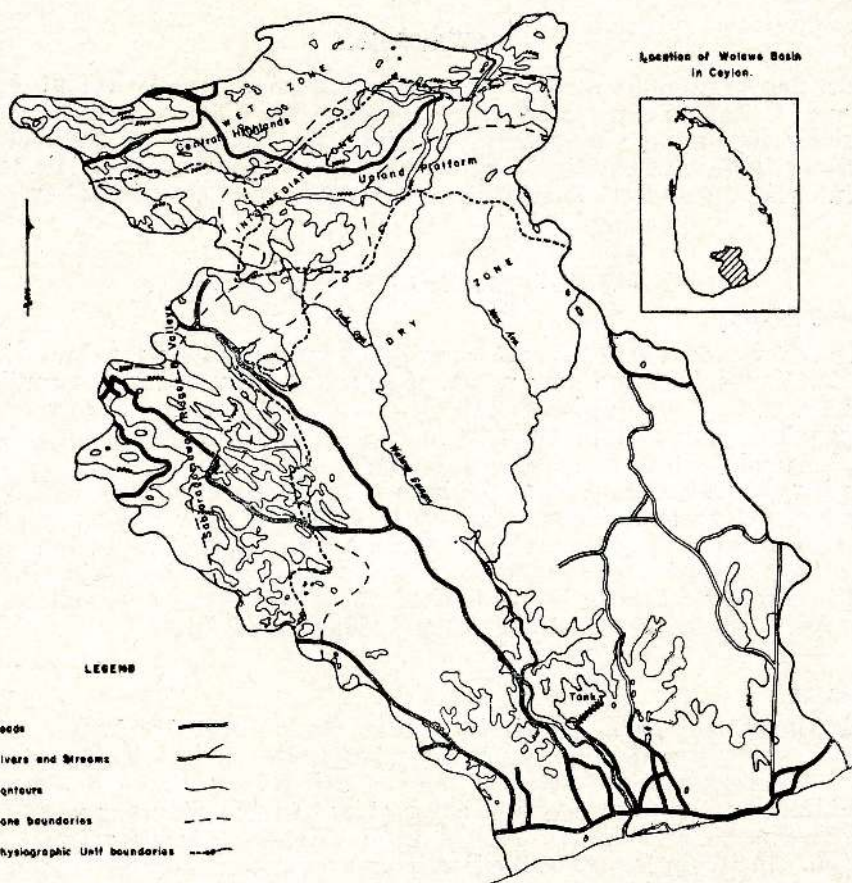
The important factor which determines the current development of the area is, apart from the physiography and soils, the climate. Though temperature differences in the different regions, due principally to elevation, are significant to the nature of the crops grown in the different regions, the chief climatic factor which determines development is the rainfall distribution. The higher parts of the Basin have an annual rainfall of more than 100 inches, the north and west portions of the lowland plain receive about 75 inches and less than 40 inches fall on the drier parts in the south and east. The Basin is divided into three climatic zones—Wet, Intermediate and Dry based, chiefly, on rainfall but taking, in addition, such factors as relief, soil drainage, agricultural land-use and forest cover.

PRE-SURVEY CONSIDERATIONS

Scope of the Survey

The scope of the survey includes the preparation of a development plan for the Basin. The criteria of development would be the optimum utilization of the resources in the area. This could be achieved by a more intensive management of the existing resources and by the exploitation of new areas

THE WALAWE GANGA BASIN



and resources. The emphasis, however, is on integrated development, by considering the area as one unit, so that, if successfully managed, the area will contribute the maximum benefit to the community.

Preliminary Study

A preliminary study of the economic structure and general conditions, in and around the survey area, indicated the nature of the development that could be contemplated. This basic knowledge is essential for the planning of the survey itself. Indications were that the chief potential lay in the field of agriculture and the survey procedure was evolved with this in view though mineral and other resources too received adequate consideration. The preliminary study also indicated that inadequate water supply had been the limiting factor for agricultural development over a large part of the lowland plain despite the plentiful supply in the Basin as a whole. The solution does not consist in the mere building of various structures for water-storage and control of flow but calls for a co-ordinated study of the related problems of flood control and erosion and proper management of the land-use and vegetation of the whole Basin.

Photo-scale

The scale of photography chosen had to satisfy the requirements of the different fields of study. Small-scale photography is particularly useful in landform and geological studies where an overall picture, of as large an area as possible, is often advantageous. Too small a scale may not, however, permit a reasonable assessment of timber potential of the natural woodlands, an assessment necessary for the vegetation management planning. In the light of these considerations, the 1 : 40,000 photography for the photo-interpretation and the 1 : 31,680 mosaics as the base for the detail representation proved very satisfactory. A common scale in such integrated survey projects is of particular significance as, in addition to controlling the scale of detail representation, it defines, as it were, the 'level' of the survey just as in topographic surveys the selected scale defines the significant contour interval.

THE SURVEY

The Survey Unit

Physiographic units, accepted basic geographic units in geological and pedological studies, were further broken up into 'Landform types' based on repetitive landscape elements. Comprehensive landform studies were conducted in the Basin and thirteen landform types were mapped. Of these thirteen types, certain highland and upland types were further subdivided on the basis of general configuration and relief and certain lowland types on the basis of the thickness of soil profile, relief and the presence of incised drainage. It may be noted that no attempt was made to study the landform of the physiographic unit 'Mountain' owing to its very low potential for development and the impossibility of mapping on the scale adopted for the survey. The landform type, the unit of compilation of resources inventories was recognised as the smallest practical unit for adequate investigation which, at the same time, permitted an overall appraisal of the resource potential in the area as a whole. The significance and efficiency of this approach rests, however, on the fact that landform types can, in most cases, be delineated by photo-interpretation.

Land Use

The development of an area entails a modification of the present land-use. The nature of this modification and the extent to be affected are important factors incorporated in the integrated plan evolved on the basis of the Resources inventory. Information for the various inventories was elicited by photo-interpretation and supplemented by fieldwork, the magnitude of the field work varying with the field of study. The land use studies indicated the fair development of the highland and upland regions, mainly with plantation agriculture (Tea and Rubber). The poor utilization of the lowlands prompted more careful investigations in these areas.

Geology

Geological investigations were aimed chiefly at providing the minimum data on the lithology and structural geology of the Basin to assist in further engineering and hydrological studies. The investigations, conducted by a combination of photo-interpretation and field-checking, were limited to a broad delineation of 'Rock-type groups' in the lithological studies, adequate at the reconnaissance stage.

Soils

The object of the soil investigations was to determine the suitability on a broad landform basis. The studies were directed first towards the recognition of the major and minor soil categories in the residual and alluvial soils of the 'promising' lowland landforms. The broad landform-soil associations were then established by soil profile studies along traverses, in areas selected with the aid of aerial photographs. What is gathered by reference to the landform map is, therefore, a general impression of the soil pattern but an adequate framework for the subsequent, detail soil surveys of selected areas.

Forestry

Forest cover is an important aspect of land-use and vegetation management. Sufficient forest has to be retained to prevent erosion, especially in the higher regions; to secure maximum rainfall absorption, leading to better regulation of stream flow; to prevent floods and silting. The extent to be preserved has to be decided after suitable study of the alternative land uses. The existing forest cover was studied on a climatic (ecological) basis rather than on a physiographic basis, the climatic forest having distinct specific composition more indicative of the nature of stocking. No detail inventories were prepared but with minimum field work, adequate data on timber stocking and distribution was obtained through photo-interpretation involving the classification of the complex forests into yield classes. The correlation of the forest cover categories with the physiographic features of the basin (Landforms) was also shown and statistical summaries of their distribution provided. The studies revealed that only a small proportion of the forest in the wet zone merited a sustained yield management as a timber producing forest, the major forest cover in the area being of no commercial value. Consolidation of a few isolated forest areas into new reserves was suggested, other recommendations being the abandonment of certain existing poor reserves and the afforestation of areas requiring protection.

Hydrology

The existing land-use in the higher regions of the Basin where there is an adequate supply of water through an evenly distributed rainfall, needs no qualitative modification though certain areas may be more intensively

developed and some marginal areas reserved for forests. The development of the lower regions of the Basin, however, has been handicapped by deficiency of water attributable to low total rainfall, uneven distribution of rainfall and absence of facilities to utilize the surplus water of the upper reaches of the Basin. The hydrological studies were directed towards assessing the potentialities of the Walawe river system for harnessing the water-flow for hydro-electric power development in the Upper Walawe Ganga and for providing water for irrigation development of a large part of the low-land plains. No adequate hydrological data was available for the necessary analysis of annual, seasonal and monthly flows nor for the determination of the frequency, intensity and duration of flood and drought flows. However, the analysis of rainfall runoff relationships from the available rainfall and run-off data provided sufficient information on flows and long term variations in flow. The hydrological studies established the general, physical feasibility of the dual, hydro-power and irrigation, development in the Walawe Basin, while the aerial photographs indicated the possible alternative water storage and dam sites.

The Development Plan

Besides furnishing an inventory of the natural resources and other basic factual information required for undertaking further physical feasibility studies, a tentative plan for the integrated development of the entire Basin was also submitted. Such a plan is essential for a preliminary study of the economic feasibility of the development project, to be followed by further, more detailed physical and engineering feasibility studies before costs and benefits can be worked out in detail.

GENERAL OBSERVATIONS

A survey has to be evaluated by its approach, accuracy, speed and cost. The approach with aerial photographs as the starting point, is the most efficient for rapid large scale development planning, involving the appraisal of the present utilization of the land, an independent simultaneous analysis of the various aspects of the terrain and the evolution of an integrated plan for the development of the area. With regard to accuracy, a reconnaissance survey, involving only a general qualitative analysis of rather extensive tracts of land, has its limitations and the water resources analyses have been based entirely on figures made available by government departments. The survey was completed in less than three years and the cost of the survey will have significance only when it is related as a percentage to the total development costs which will be available only after detailed physical and engineering feasibility studies have been concluded.

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An Investigation of the Nature and Extent of Insect Attack on Sixteen Species of Ceylon Timber

By K. VIVEKANANDAN

(Research Assistant, Forest Department)

SUMMARY

The nature and extent of insect attack on 16 species of Ceylon Timbers were studied to assess the suitability of these timbers for general utility purposes.

Iriya (*Horsfieldia iriya*) was very severely attacked even after seasoning and the strength of the timber was impaired. Dorana (*Dipterocarpus glandulosus*) and Polhunna (*Axinandra zeylanica*) were severely attacked when unseasoned but were resistant after seasoning. The others, Pelen (*Kurrimia zeylanica*), Etamba (*Mangifera zeylanica*), Aridda (*Camposperma zeylanica*), Godakirilla (*Holoptelea integrifolia*), Kolon (*Adina cordifolia*), Helamba (*Mitragyna parvifolia*), Timbiri (*Diospyros malabarica*), Panakka (*Pleurostylia opposita*), Welang (*Pterospermum canescens*), Kataboda (*Cullenia ceylanica*), Waljambu (*Syzygium species*), Madol (*Garcinia echinocarpa*) and Mora (*Euphoria longana*) were only slightly attacked even in the unseasoned state.

The organisms causing the attack were larvae of *Heterobostrychus* (on Etamba) and *Lyctus* (on the other 15 species).

INTRODUCTION

The total extent of Forests in Ceylon is about 44 per cent. of the land area and is distributed unevenly. The composition of the forest is varied there being some three hundred tree species. Of these species, only a few are used for constructional and other purposes. The reason for this is twofold—firstly it is because people in Ceylon have accustomed themselves to the use of timber such as Teak, Satin, Halmilla, Milla, Jak and Nedun and as a result there is a lot of conservatism in using new species of timber. Secondly, the lack of information on the species other than the traditional types prevents the use of these because there is a misconception that the “non-traditional” timbers are non-durable.

From the point of view of timber utilization the term durability is a relative term. Thus, a timber may be durable when used for a particular purpose, but non-durable under different conditions. In assessing the suitability of a particular kind of timber for a specific purpose, in addition to its durability several other factors are taken into consideration. For convenience these have been classified into structural, physical and Biological (Cartwright and Findlay, 1951). Structurally the timber should

be free from defects such as end splits, checks, knots, cracks, cupping, shakes, honeycombs, etc. physically, factors such as hardness, shape-retention, shock resistance, weight, ability to withstand compression and cleavage to an appreciable degree should be considered. Biologically it should be resistant to insect attack and fungal decay. These three factors require separate investigation and are considered to be of equal importance when assessing the suitability of a timber for a particular purpose. In this investigation one aspect of the Biological factor, namely, the nature and extent of insect attack on sixteen species was studied to assess the suitability of these species for general utility purposes.

MATERIALS AND METHODS

The following Sixteen Species of Ceylon timbers were tested :—

1. Iriya	..	<i>Horsfieldia iriya</i> (Guertn) Warb.
2. Polen	..	<i>Kurrimia zeylanica</i> Arn.
3. Etamba	..	<i>Mangifera zeylanica</i> (B1) Hook. f.
4. Aridda	..	<i>Campnosperma zeylanica</i> , Thw.
5. Godakirilla	..	<i>Holoptelea integrifolia</i> , (Roxb) Planch.
6. Kolon	..	<i>Adina cordifolia</i> (Roxb) Brandis.
7. Helamba	..	<i>Mitragyna parvifolia</i> (Roxb) korth.
8. Timbiri	..	<i>Diospyros malabarica</i> (Lam) Kostel.
9. Panakka	..	<i>Pleurostylia opposita</i> (Wall) Alst.
10. Welang	..	<i>Pterospermum canescens</i> (Roxb)
11. Dorana	..	<i>Dipterocarpus glandulosus</i> , Thw.
12. Kataboda	..	<i>Cullenia ceylanica</i> , (Gardn.) K. Schum.
13. Waljambu	..	<i>Syzygium</i> Species
14. Polhunna	..	<i>Axinandra zeylanica</i> , Thw.
15. Madol	..	<i>Garcinia echinocarpa</i> , Thw.
16. Mora	..	<i>Euphoria longana</i> , Lam.

Planks of 1 in. thickness and including the bark were sawn and stacked for seasoning. Observations on insect attack were made for a period of 5 to 7 months from the date of conversion. After this period the planks were sawn into scantlings of cross sectional area 1" X 1". Those parts of the planks which had been attacked were excluded when conversion into scantlings was carried out. Observations were continued on the scantlings for a further period of about 6 months.

RESULTS

The following observations were made :—

1. Insect attack was observed in all the species in the unseasoned state but the attack on Iriya, Dorana and Polhunna was severe in comparison with the others. (See Figs. 1 & 2.)
2. Attack was more severe in the peripheral regions of the planks.
3. The incidence of attack was greater on the shaded sides.

4. The tunnels were circular in cross-section and were filled with powdery frass except in Dorana where lumps of wood dust were present in the tunnels.
5. The tunnels had both entrance and exit holes.
6. After air seasoning for 7 months, no further insect attack was observed in 12 out of the 16 species. Of the other 4 species, 3 were attacked only to a small extent while one (Iriya) was extensively attacked. Further particulars are given in the table.
7. The causative organisms were members of the family Bostrychidae and were identified by reference to Beeson (1941) and the Forest Products Research Laboratory Leaflet No. 3 as *Heterobostrychus aequalis* and *Lyctus* species (See Figs. 3 & 4). The former attacked only Etamba and the latter was responsible for the attack in the others.

Table—Further Particulars of Insect Attack

No.	Species	Date of conversion of logs into planks	Date of Conversion of planks into scantlings	No. of Scantlings attacked as against the number tested (3. 1. 64)	No. of Scantlings attacked as against the number tested (15. 5. 64)
1.	Iriya	11. 4. 63	20.11.63	16/132	} .. 41/132 as on 3.1.64
2.	Pelen	do.	do.	5/210	
3.	Etamba	do.	do.	0/156	
4.	Aridda	do.	do.	0/201	
5.	Godakirilla	6.5.63	25.11.63	1/161	
6.	Kolon	do.	do.	0/152	
7.	Helamba	4.5.63	do.	1/223	
8.	Timbiri	3.5.63	11.12.63	0/154	
9.	Panakka	do.	do.	0/159	
10.	Welang	do.	do.	0/145	
11.	Dorana	17.7.63	13.12.63	0/154	
12.	Katuboda	22.7.63	do.	0/159	
13.	Waljambu	18.7.63	16.12.63	0/171	
14.	Polhunna	16.7.63	18.12.63	0/153	
15.	Madol	17.7.63	18.12.63	0/177	
16.	Mora	—	19.12.63	0/176	

DISCUSSION

The members of the family Bostrychidae are classified into (a) Cylindrical powder post beetles, e.g., *Heterobostrychus* and (b) Flattened powder post beetles, e.g., *Lyctus*. The larvae of these insects bore tunnels in wood containing large quantities of starch. They devour the wood containing starch and the unwanted residue is extruded in the form of a powder which fills the tunnels.

Heterobostrychus.—These are cylindrical and black. The prothorax is rough and hooded. The hind end of the insect has curved hooks. The body length is 6 to 15 mm. Eggs are laid on the rough surface or in the pores of the wood. The larva develops from the egg and bores its way into the wood devouring the wood containing starch and extruding the unwanted residue in the form of a powdery frass.

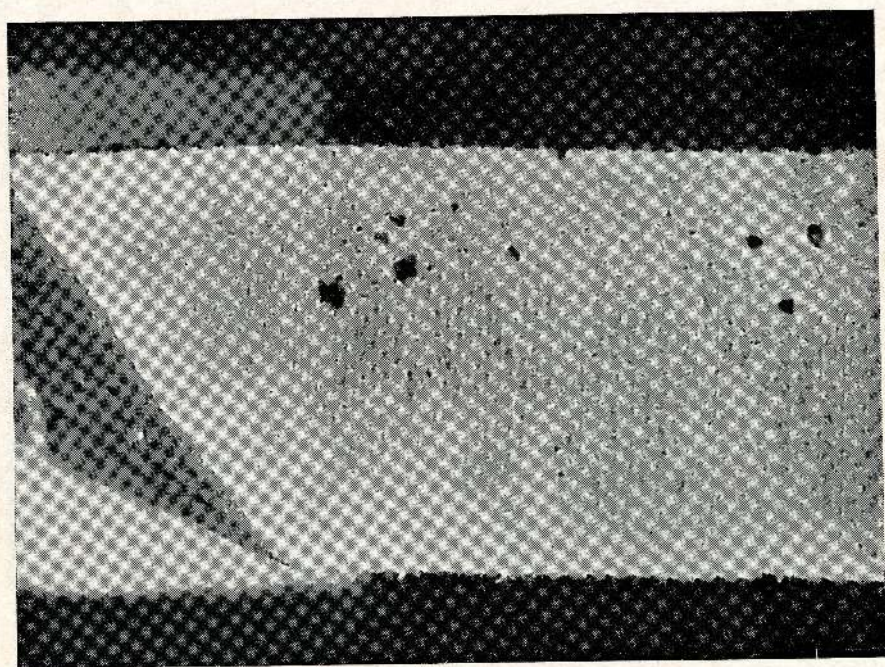


Fig. 1. Scantlings of Iriya attacked by *Lyctus* species — $\times 15$.

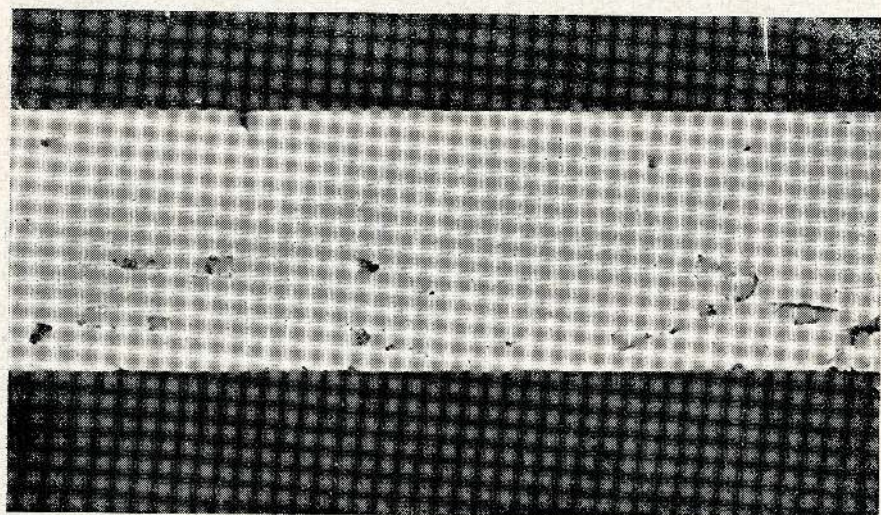


Fig. 2 Scantlings of Dorona attacked by *Lyctus* species — $\times 15$.

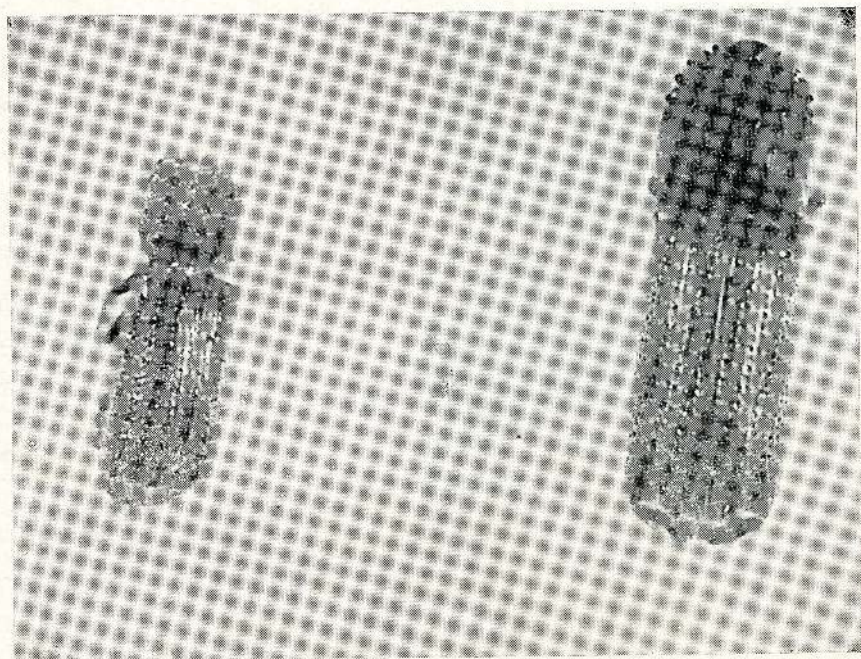


Fig. 3. *Heterobostrychus aequalis* — $\times 12$.

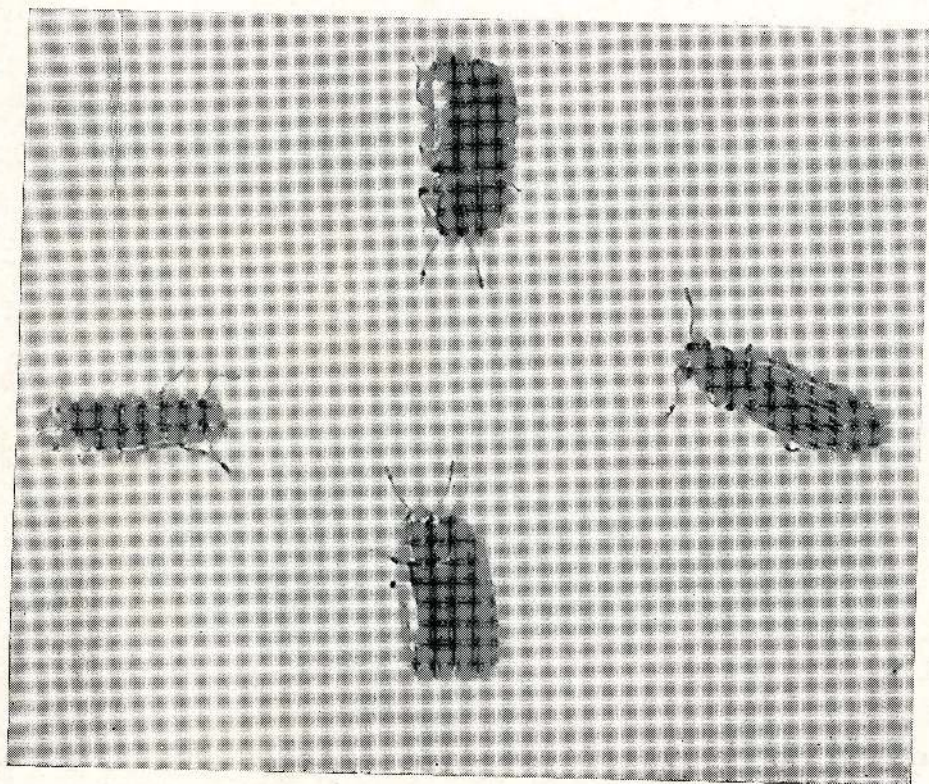


Fig. 4. *Lyteus* species. — $\times 12$.

Lyctus.—The beetles are flattened and smaller than *Heterobostrychus*. They are brownish black and the life history is similar to *Heterobostrychus*. The body length is about 2 to 8 mm.

From the observations made it is evident that all the species of timber investigated were susceptible to insect attack. The extent of attack varied from species to species and sample to sample. The principal food on which the members of the family Bostrychidae thrive is starch and the variation in attack may be related to the amount of starch present in the various species, Beeson (1941). Generally starch is found in large quantities in the sapwood and the concentrated attack observed in the peripheral regions of the plank may be due to this. The severe attack observed in Iriya even in the seasoned material may also be due to the presence of more starch in this species than the others.

Although attack was severe in Iriya, Dorana and Polhunna, the most affected was Iriya and only in this species did the strength of the timber appear to have been impaired. The other fifteen species can therefore be considered as being reasonably resistant to insect attack, especially after seasoning. Their utility value can be greatly increased by treating them with preservatives so as to make them resistant to fungal decay and insect attack. However, if these timbers are to be used for special purposes such as manufacture of tea chest battens or tea boxes preservatives cannot be used because they may alter the flavour of the tea. In such cases it might be possible to reduce the incidence of insect attack by the following 2 methods. Firstly, the timber can be depleted of its starch content by allowing the timber to be in the green state for a long period before sawing so that the starch is utilized by living cells in respiration. Secondly, the wood after conversion can be steam sterilized so that the egg, larva and adult of the insect present in the wood are killed (Beeson, 1941).

ACKNOWLEDGMENTS

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Some Observations on raising *Dendrocalamus strictus* in the Nursery

By S. N. U. FERNANDO

(Principal, Ceylon Forest College)

Dendrocalamus strictus is a species of green bamboo with solid culms which is very widely distributed in India, its homeland. Since it is an economically important species, efforts are being made to raise it in the Dry Zone of Ceylon using imported seeds from India. For this purpose seeds from two different sources, (Forest Department, Madras, and Pratap Nursery and Seed Store, Premnagar, Dehra Dun), were experimented with in the Ceylon Forest College nursery at China Bay, in the Dry Zone (rainfall 50-75 inches per annum).

The soil in the nursery is a rich sandy loam. The nursery beds are of standard size, 40 ft. $\times$ 4 ft.

The bamboo seeds used numbered 692 to the ounce.

Germination and the Effect of Presowing Treatment

In order to determine a suitable nursery technique it was decided to (a) try out presowing treatment by soaking the seed for different periods in water, and (b) experiment with different quantities of seed in drill holes. This was first done with the seed obtained from Dehra Dun.

Firstly, two beds were chosen at random from a group of eight beds, and they were drilled with one inch deep holes at a spacing of 9 in. $\times$ 9 in., giving 270 holes per bed. In both these beds dry untreated seeds of *Dendrocalamus* were sown, but in one bed 5 seeds were sown per drill hole (1,350 seeds per bed), and in the other bed 15 seeds were sown per drill hole (4,050 seeds per bed). Therefore, altogether there were 5,400 seeds drill sown in the two beds untreated.

Two other nursery beds were also selected at random from the group, and the same procedure described in the previous paragraph was repeated, but in this case the seeds were pretreated by soaking in cold water for

one day, immediately prior to drill sowing. As before one bed was sown with 5 seeds per drill hole and the other with 15 seeds per drill hole. Of the remaining four beds, two beds were again chosen at random and the former procedure was repeated, but in this case the seeds were soaked in water for exactly two days before sowing. The remaining two beds were sown as before, but with the seeds soaked for three days in water.

All the beds were well watered, morning and evening.

In all eight beds germination commenced in 5 days and was complete within three weeks, irrespective of the type of pretreatment.

The results tabulated below indicate that this type of pretreatment has no significant effect on the percentage germination, although seeds soaked for one day in cold water gave a slightly higher germination percentage than those treated differently.

Table—Germination obtained with different Methods of presowing treatment (Dehra Dun Seed)

<i>Pretreatment</i>	<i>No. of seeds sown (in two beds)</i>	<i>No. germinated (in three weeks)</i>	<i>Percentage Germination</i>
Dry untreated seeds ..	5400	3096	57.3
Seeds soaked for one day (24 hours)	5400	3165	58.6
Seeds soaked for 2 days (48 hours) ..	5400	2992	55.4
Seeds soaked for 4 days (96 hours)	5400	3068	56.8
Total: ..	21,600	12,321	57.0

The identical series of experiments that were conducted with the seeds obtained from Dehra Dun was repeated with the seeds supplied by the Forest Department, Madras.

In the case of seeds from Dehra Dun, a total of 21,600 seeds sown (treated and untreated) yielded 12,321 plants, giving an average germination percentage of 57 (see Table). But in the case of the 21,600 seeds obtained from Madras, the same treatment yielded only 778 plants, giving an extremely low germination percentage of 3.6. Thus it follows that the

figures for the effect of pretreatment on the germination percentage was also extremely low, in fact too low for any useful conclusion to be drawn from them.

However, it can be definitely concluded that the seeds from the Pratap Nursery, Dehra Dun, were definitely superior to those supplied by the Forest Department, Madras.

Method of Sowing

As mentioned earlier a pair of randomly selected nursery beds was chosen for each experiment on pretreatment, in which one bed was sown with 5 seeds per drill hole and the other with 15 seeds per drill hole.

Where the germination percentage was high, as was the case with the seeds from Dehra Dun, 15 seeds per drill hole often yielded over 10 plants per hole, which led to cover-crowding: in this case 5 seeds per drill hole yielded a more tolerable number of plants at each hole.

But with seeds having a very low germination percentage, as was the case with seeds from Madras, 15 seeds per drill hole was the ideal number to obtain a reasonable stocking per bed.

Protection

Some of the beds containing the *Dedrocalamus* seedlings were heavily attacked by Cockchafer larvae after about a month. The larvae clip the root of the seedlings decapitating the plant. The larvae operate in groups about one foot below ground level, quite immune to superficial applications of any insecticide; and in any case their presence could be detected only after the damage was done. To prevent further damage the undamaged seedlings in these beds were transplanted into 6-inch long polythene tubes. No further damage occurred to these transplants from this source of danger.

The plants were also liable to sun scorch in the very early stages of their life, and this is not surprising because of the hot climate of the Dry Zone (Temp. 80°F.) The damage is indicated by a whitening of the leaves followed by withering. A light overhead shade made of coconut leaves minimized this type of damage.

The bamboo beds were protected against vermin and bigger mammals by means of a wire-netting fence round the perimeter of the group of bamboo beds, and a circumscribing barbed-wire fence. However, these frail fences do not afford any protection against elephants. The elephants nip off all the tender shoots of the bamboo plants, after tearing down these fences. Fortunately, they do not uproot the rhizomes, from which fresh shoots spring up after a time. So far the elephants have left all the plants in polythene tubes undamaged, probably because the bags come up with the plants when the elephants try to nip off the shoots. However, repeated defoliation of this nature is bound to kill the plants.

Timber Grading in Singapore*

By D. A. L. WARNAKULA

(Instructor, Ceylon Forest College)

A TRAINING COURSE in Timber Grading was offered under the Colombo Plan Technical Aid Scheme by the Timber Department of Singapore. There were two participants, an Officer of the Forest Produce Research Division of the Forestry Department in Thailand and myself. The training period was limited to three months, July to September 1964, and during this period it was possible for the writer to acquire the knowledge essential for grading sawn hardwood timber according to the methods employed by the Grading Authority in Singapore. The system of grading adopted which is highly technical and based on the grading rules specially compiled for Malayan conditions was found to be very efficient and universally recognised.

Island of Singapore

Singapore is a small island situated at the southernmost tip of the Malay Peninsula with an area of 225 square miles. The Straits of Johore separates the mainland of Malaya from Singapore, but a road and rail causeway—about three quarter mile in length—connects the two territories.

The climate of Singapore is similar to that of the South-Western coastal sector of Ceylon with maximum and minimum temperatures of 87° F and 75° F respectively. The annual rainfall is 95 inches. The island lies at latitude 1° 17' North and longitude 103° 50' East and is located 85 miles north of the Equator.

The city of Singapore is at the southern sector of the island and the water front comprises her harbour which is reputed to be 2nd largest in Asia and 5th largest in the world, 2nd only to London in the Commonwealth as measured by the tonnage of shipping using the port.

The terrain is undulating with few low ranging hills. The vegetation is evergreen and the tropical rain forests that once covered the island have been cleared making way for industrial and agricultural development to serve the needs of the 1,700,000 inhabitants. There are no productive forests except for several acres of bush or secondary jungle on the summits of the low ranging hills and these are protected as Nature Reserves to serve as water catchments for the reservoirs.

Timber Industry

The absence of productive forests from the island did not prevent either the establishment or the progress of her timber industry. Her neighbouring countries rich in tropical hardwoods readily conceded to the requirements of her trade conscious people. Before the conflict with Indonesia,

* A Report on a training course in Timber Grading followed by the writer under a Colombo Plan Award.

Sumatra supplied the bulk of the raw material in round timber, while in the present day it comes from the vast stretches of rain forests situated in the mainland of Malaya. Singapore taking full advantage of her free port, imports round timber and processes it into sawn hardwood timber and re-exports the products. Sawn timber of heavy hardwoods are graded, the lighter hardwoods being treated with preservatives before grading and finally these reach the world market bringing revenue to the Government. According to statistics, trade in lumber is ranked the third highest. Her success in this field of international trade in timber can be attributed mainly to—

- (1) Her natural harbour with immense import and export facilities.
- (2) The business acumen of her people.
- (3) The rigid enforcement of her grading rules by the Timber Department on exported lumber.

The timber industry had its beginning at the time of the British Rule. It developed further when the Crown Colony became a State in 1959. Presently, with Singapore as a member state of the Federation of Malaysia the timber industry continues to flourish. The first saw mill was established in 1900, and today there are 56 large saw mills in operation processing timber for the export trade. There are many smaller mills that cater to her domestic needs. The logs that are sawn and ripped into lumber in Singapore come within the purview of the Malayan Grading Rules. The rules stipulate that sawn timber exported to countries specified from time to time by the Timber Department be restricted only to those that have been graded under the Malayan Grading Rules (referred to as M. G. R.). All high grade markets overseas have been specified under these rules.

Malayan Grading Rules

Prior to the introduction of the first edition of 'the Malayan Grading Rules for Sawn Hardwood Timber' in 1949 all lumber exported were graded under the Empire Grading Rules. However, the rapid expansion of the trade warranted the compilation of rules applicable to Malayan conditions. Mr. C. O. Flemmich, Forest Officer, Singapore, with the assistance of a select committee comprising officers with experience and first hand knowledge of timber grading and the export trade, compiled a set of draft rules. These rules were subjected to many alterations and amendments through criticism of saw millers, shippers, importers, etc, and emerged in 1949 as 'the Malayan Grading Rules for Sawn Hardwood Timber'. This skilled and highly technical volume replaced the Empire Grading Rules. All timber grading after 1949 was done under the M. G. R. These rules were revised in 1955 and in 1960. In fact it was recommended that the first edition of the M. G. R. be taken as a basis for drafting Regional Rules for grading Tropical Hardwood Lumber (other than Teak) at the inaugural session of the F. A. O. Forestry and Forest Products Commission for Asia and the Pacific held in Bangkok in October 1950. Mr. C. O. Flemmich, Forest Officer, Singapore, and the author of the M. G. R., was the Chairman of the F. A. O. Sub-committee which drafted the Regional Rules, which were accepted by the Fourth Session of the Commission held at Bandung, Indonesia, in July 1957.

The Malayan Grading Rules contain all the relevant information concerning the timber trade required by saw millers, graders, shippers, and buyers. The rules are designed for the grading of all hardwoods (other

than Teak) of Malaysia and adjoining countries. It embodies instructions, for the manufacture of lumber and includes separate appendices for the definition of common defects referred to in the rules and the description of the commercial timbers of Malaya.

Classification of Hardwoods and other Timbers

The forests in Malaya and the adjoining regions are Tropical Rain Forests containing a large variety of tree species, some of which are of little or no commercial value at present. Yet there are a number of exceptionally good species which are of proven commercial importance. These timbers have been classified under the M. G. R. as (i) Heavy Hardwoods, (ii) Medium Hardwoods, (iii) Light Hardwoods and (iv) Softwoods.

- (i) Heavy Hardwoods.—Heavy to very heavy constructional timbers ranging in weight from about 50 to 70 lb. per cubic foot at 15 per cent moisture content. They are naturally durable and could be used without preservative treatment. Sapwood is not durable. There are ten standard timbers in this category.
- (ii) Medium Hardwoods.—Moderately heavy to heavy constructional timbers ranging in weight from about 45 to 55 lb. per cubic foot at 15 per cent moisture content. Some of these timbers are heavy and strong enough to be classed as 'Heavy Hardwoods' but under tropical conditions they lack sufficient natural durability. Most of them, however, are naturally durable in temperate countries where climatic conditions are less conducive to the activity of the wood destroying agents. There are 14 different standard timbers under this category.
- (iii) Light Hardwoods.—25 different timbers are included in this division. They are relatively light in weight and are soft. Their weight ranges from about 25 to 45 lb. per cubic foot at 15 per cent moisture content. They are the general utility timbers of Malaya. These timbers are excellent for high class joinery work, cabinet making, furniture, decorative panelling, etc. They are not naturally durable in tropical climates but some are quite durable in temperate regions. In tropical climates if proper precautions are taken against wood destroying agents the light hardwoods make very satisfactory timbers for general construction.
- (iv) Softwoods.—(Conifers). There is only one species of commercial significance known as Malayan Kauri (*Agathis alba*). Although the M. G. R. are designed primarily to grade hardwoods they have been used for grading Kauri in which knots are relatively scarce.

In all documentation and commercial undertakings connected with the export of timber the grading rules urge that producers in Singapore and the consumers overseas should refer to a timber only by one name. For this purpose a particular species or a group of species where the timber produced is very similar in texture and appearance is called by a special name. For example, the name KERUING is used for Dipterocarp species and MEMPISANG for all species of the family Anonaceae. Only the standard name is shown in schedules of timber shipped and on Inspection and Grading certificates.

Grading Systems

In all grading rules the grades are determined by the defects present in the timber, the highest grade having the least number of defects. The rules have been formulated to grade timber limiting the defects according to the purpose for which the timber is to be used, based on the fact that wood being a natural product will yield only a small proportion of lumber that is entirely free from all defects or imperfections. The appendix in the M. G. R. which defines the common defects of Malayan timber is not merely for the convenience of the Grader, but is to guide the user so that he buys the correct grade and kind of timber to suit his requirements.

There are two basic systems of grading under the M. G. R. (1) The Defect System, and (2) The Cutting System. To these can be added a third system, the Stress System, which is only a modification of the Defect system where the effect of various defects on the strength of the piece of timber is taken into account. As there are no simple testing devices available to test each piece of sawn timber at the conversion site, up to a given working load, the stress system is not applied.

The Defect System is employed to grade timber intended for special purposes and for timber normally utilised in the exact sizes in which it is supplied by the saw mill, e.g., railway sleepers, cross arms and telegraph poles. Permissible defects are defined for each grade. If a piece of timber contains more defects than are allowed by the grading rules for that particular category, then the piece is rejected. With the exception of timber graded under this system where the products are used for special purposes the vast majority of timber bought from saw mills come in common sizes and are in practice re-sawn to smaller sizes before they are finally utilized. They are either re-sawn to shorter lengths or ripped to narrow widths or thicknesses. Such timber is graded on the Cutting System.

Before describing the cutting system of grading it will be desirable to acquaint ourself with some of the terms used in that system under the Malayan Rules, such as 'face', 'cutting', 'clear face cutting' and 'sound face cutting.'

Faces.—Applied to the two wider surfaces of a piece of sawn timber. The smaller or thinner surfaces are termed the edges. A square has four surfaces. The term better Face means the face with the least number of defects on it, and the worse Face means the face with the most number of defects.

A cutting.—Is a rectangular portion of a piece of sawn timber that could be obtained, if so desired, by cross cutting ripping or both. A cutting must be flat enough (without warps, etc.) to surface two sides to standard surface thickness should it be removed from the piece. The minimum size measured to the full half foot and the full half inch, is defined under the respective grades in this grading system.

A clear face cutting.—Is a cutting that is clear of all defects in the face graded other than bright sapwood when allowed in specific rules for any grade. The reverse face of such cutting must not be worse than defined under the sound face cutting.

A sound face cutting.—Is a cutting that is free on both faces from certain major defects such as decay, heart or wane, shakes, splits, brittle heart, but admits certain minor defects such as sound sapwood, sound knots, stain,

latex traces, latex shakes, included phloem, resin pockets of defined dimensions, seasoning checks, which do not materially affect the strength of the cutting. Pin and shot holes are also admitted without defined numerical limits provided that they are neither so numerous nor so grouped as to materially affect the strength and also if they do not appear to have been caused by Powder Post (*Lyctus*) beetles.

The Cutting System as employed under the Malayan Rules is for grading lumber that is usually reconverted to smaller sizes before use. The grade is determined from the worse face unless otherwise specified by the buyers in their agreements. The percentage of the total surface area that can be included in a limited number of cuttings (clear face or sound face) determines the grade. The best grade yields the highest percentage of clear face cuttings.

This system of grading and the meaning of the terms used appears at first glance very complicated and also as almost all lumber exported is graded under this system the major part of the training course was spent on theoretical and practical aspects of grading sawn timber under the cutting system and determining the various grades.

The Grading Authority in Singapore

The Timber Officer, Singapore, who is empowered to employ Timber Inspectors and issue Grading and Inspection certificates is the Grading Authority in Singapore under the Malayan Grading Rules. The function of the Grading Authority as given in the Rules 'is not to provide individual buyers with a guarantee of quality (and no such guarantee is either given or implied), but to protect the interests of the Malayan timber export trade as a whole by ensuring, so far as is practicable, that no timber is shipped to high grade markets, that is likely to bring the name of Malayan timber into disrepute'. The rules provide only for the export of graded timber and the overseas markets are specified in the M. G. R. Timber cannot be exported from Malaya or Singapore without the prior permission of the Grading Authority. When timber is to be exported they must be covered by a Grading Certificate issued by the Grading Authority who will cause the timber that had been graded by a certified grader to be checked (at least 10 per cent. of the parcel) by a certified Timber Inspector before such certificate is granted.

The Grading Service

The Timber Department of the Singapore State maintains a staff of Timber Inspectors who have qualified by passing strict written and practical tests, and obtaining certificates of competency to grade and check timber under the M. G. R. The Timber Officer is assisted by these Timber Inspectors in enforcing the M. G. R. and protecting the interests of the timber trade.

The Timber Graders are not employed by the Timber Department as there are no state-owned saw mills in Singapore. All timber Graders who have been trained and tested by the Timber Department before they are granted the requisite certificates of competency to grade timber are employed by either the saw millers or by the timber importers. Their work

is rigidly supervised by the Grading Authority. Should the work and conduct of a certified grader be unsatisfactory the Grading Authority under the Rules is empowered to withdraw the certificate for such time as he sees fit.

The Method of Grading

Grading is done at the supplying saw mill. The Timber Grader first studies the order or contract calling for the consignment of sawn timber intended to be issued to the consumer (usually the buyer from overseas). Having obtained the necessary information as to the kind of timber, quantity, grade, sawing instructions, dimensions, period of seasoning and any other specifications, he examines the parcel of timber and checks the date of the stack. When he is satisfied that the timber has been seasoned for the period specified in the contract and in accordance with the rules to avoid degrade in transit, the Grader breaks down the stack and examines it piece by piece. He first checks the widths and thicknesses, brushes away any saw dust that conceals the surfaces, selects the worse face of the piece (unless the purchaser specifies that grading should be done on the better face) and marks any defects. He then accepts or rejects the piece in accordance with the requirements of the contract.

An experienced Grader can generally sum up by eye, whether or not a piece is within the grade specified. If the face on which he is grading is acceptable, he turns over the piece and checks whether the reverse face does not contain more defects than are allowed in the definition of clear face or sound face cutting, and whether the portion outside the cuttings does not contain more defects than are permitted by specific rules for that required grade.

If he is in doubt as to the grade the Malayan Rules are very clear as to the procedure the Grader should adopt. 'If in doubt', states the Rules, 'mark the clear or sound face cuttings on the piece with chalk, measure the length and breadth of each cutting to the full half foot and to the full half inch, calculate the number of units in each and add all these together. If this total is less than that allowed by a particular grade specification for a piece of that surface area, or if the size of any cutting is smaller than allowed for a particular grade, or if the number of cuttings exceeds what is allowed, the piece will be below that particular grade.'

If the grader is accepting the piece, the length is measured and marked for end trimming as may be necessary. Then the piece is marked with the dimensions with marking crayon, giving the length, width and thickness, and is stencilled with the grade of the piece, standard name of the timber, the mark of origin, personal number of the timber Grader and the buyers own marks, such as the destination, trade mark, etc. All graded timber bears the personal number of the Grader so that in the event of any complaint about the grading it is possible to trace the Grader responsible.

As each piece is accepted its dimensions are entered in a Tally Book from which a grading summary is prepared. The Grader has to certify in the summary that the period of seasoning has expired while the timber

was stacked on stickers according to the rules and also that the parcel of timber is free from borer holes caused by Powder Post (*Lyctus*) beetle, in order that the Grading Authority may grant the required documents to export the parcel of timber.

Standard Grades

There are five grades under the rules for grading boards and planks. They are—

Grade	Grade marks	Percentage of the surface area that should be clear
1. PRIME	.. F D	.. 11/12 to 10/12 or 91 $\frac{1}{3}$ % to 83 1/3%
2. SELECT	.. F D SEL	
3. STANDARD	.. F D A	.. 8/12 or 66 2/3%
4. SOUND	.. F D C	.. do.
5. SERVICEABLE	F D S	.. do.

The defects allowed are specified in the rules for various grades. The specifications for Sound Grade are the same as for Prime, Select and Standard Grades except that pin and unstained shot holes are admitted in the cutting provided they do not affect the strength of the piece of timber. The Serviceable Grade is as for Standard Grade except that the cuttings are sound face cuttings.

In some timbers such as *Balanocarpus Spp.* or *Dryobalanops Spp.* pin and needle holes are so very common that a clear face cutting cannot be obtained without these pin holes being included in them. In such instances they are graded as Prime, Select or Standard and the letters 'P. H. N. D.' (Pin Holes No Defect) are stencilled after the grade mark to indicate that pin holes are included as no defect in the cuttings. Similarly there are timbers where latex traces and leaf traces are found as structural features which are characteristic of their species. They appear as pock-marks or flecks on the longitudinal surface and consist of lens-shaped slit like passages containing shrivelled up tissue running radially through the wood. They both resemble borer holes and can easily be confused with them. When these latex or leaf traces cannot be avoided in the cuttings they are graded as Prime, Select, or Standard but letters 'L. T. N. D.' (Latex Traces or Leaf Traces No Defect) are stencilled along with the grade mark to indicate that these latex traces or leaf traces have not been considered as a defect in the grades under the Rules.

A parcel of timber that contains sawn timber comprising of Prime, Select, Standard, Sound and Serviceable grades can be graded into groups.

For such grading the full product of the log down to the lowest grade mentioned must be available in the parcel. The following groupings are recognised :—

<i>Groups</i>	<i>Marking</i>	
1. SELECT AND BETTER	.. F D ..	Consists of Prime and Select grades.
	Sel & Up	
2. STANDARD AND BETTER	.. F D ..	Consists of Prime, Select and Standard grades.
	A & Up	
3. SOUND AND BETTER	.. F D ..	Consists of Prime, Select, standard and Sound grades.
	C & Up	
4. MERCHANTABLE	.. F D ..	Consists of Prime, Select, Standard Sound and Serviceable grades
	MERCH	

The percentages of various grades within any of the above 'and better' groups are likely to vary with each species and also from mill to mill.

If a buyer requires that the parcel should contain the different grades in a definite proportion, then grading under these groups is not permitted, but, instead, the proportions of the different grades contained in the parcel are given.

Export Possibilities of Ceylon Timbers

SINGAPORE alone exported in 1963 sawn hardwood lumber to the value of 29.2 million Malayan Dollars. This is a great achievement for a country without any remaining productive forests of her own. Her export figures given below indicate that the demand for Timber is increasing, although there is no appreciable difference as to the number of countries to which it is exported.

	<i>Year</i>	<i>No. of countries</i>	<i>Value in Malayan dollars</i>
(Singapore only) ..	1958 ..	37 ..	10,336,556
(do.) ..	1959 ..	36 ..	9,934,234
(do.) ..	1960 ..	39 ..	18,050,944
(Malaysia-Singapore and Malaya only)	1961 ..	— ..	37,468,689
(do.) ..	1962 ..	46 ..	47,674,457
(do.) ..	1963 ..	41 ..	62,323,169

The quantity of sawn timber exported from Malaysia (Singapore and Malaya) during the last two years given below shows the current consumption of Malayan timbers in other countries.

<i>Year</i>	<i>Graded Tons</i>	<i>Ungraded Tons</i>	<i>Total Tons</i>
1962 ..	236,405 ..	66,716 ..	303,121
1963 ..	290,011 ..	81,938 ..	371,949

The leading countries to which graded timber was exported from Malaysia in 1963 were :

Australia	..	78,378 tons
United Kingdom	..	68,355 ,,
South Africa	..	52,784 ,,
Belgium	..	16,965 ,,
France	..	16,125 ,,

The other countries were :

Aden, Algiers, Bahrein, Canada, Cyprus, Denmark, Eire, Greece, Hongkong, Holland, India, Italy, Northern Ireland, Japan, Kuwait—Cocos—Dubai, Lebanon, Mauritius, Norway, New Zealand, Pakistan, Portuguese East Africa, Rhodesia, Somalia and Sweden.

The countries that imported ungraded timber were :

Aden, Arabia, Bahrein, Brunei—Sarawak—North Borneo, French and Portuguese possessions in Africa, Indonesia, Iran, Iraq, Jordan, Mauritius, Kuwait—Cocos—Dubai, Pakistan and Somalia.

Of these the leading countries were :

Bahrein ..	..	13,380 tons
Aden	..	13,329 ,,
French possessions		
in Africa	..	13,239 ,,
Arabia	..	10,472 ,,

The above data indicate that there are ready buyers all over the world for hardwood sawn timber. Of the different kinds of graded timber exported in 1963, the following species were found to be very popular: BALAU (*Shorea* spp.), KERUING (*Dipterocarpus* spp.), KAPUR (*Dryobalanops* spp.), MENEKULANG (*Heritiera* spp.), KEMPAS (*Koompassia malaccensis*), MERANTI (*Shorea* spp.), JELUTONG (*Dyera costulata*), NYATOH (*Palaquium* spp.), GERONGANG (*Cratoxylon arborescens*), MERSAWA (*Anisoptera* spp.) and TERENTANG (*Campnosperma* spp.)

During the last 2 years 55,985 cu. ft. of graded heavy hardwoods were exported and most of this consisted of *Shorea* spp. (BALAU) which are very similar in colour and texture to the red coloured hardwood Duns of Ceylon.

Of the total of 4,623,011 cu. ft. of Medium Hardwood exported as much as 4,149,520 cu. ft. were of Keruing *Dipterocarpus* species which is similar almost in all respects to Hora.

Of the total of 9,539,668 cu. ft. of light hardwood exported as much as 8,479,044 cu. ft. were of different varieties of Meranti—*Shorea* spp. These are similar to *Shorea stipularis*—Hulan idda and *Doona congestiflora*—thiniya dun of Ceylon. Nyatoh and Terentang which are species of *Palaquium* and *Campnosperma* respectively are represented in Ceylon by *Palaquium petiolare*—Kirihibiliya and *Palaquium grande*—Kiripedda, and *Campnosperma zeylanica*—Arida.

It is worthwhile investigating the possibilities of exporting sawn timber from Ceylon to meet the increasing demands of the world market. As the trade data from Singapore (Malaysia) indicate the Dipterocarps have a ready market whether they be Heavy, Medium or Light Hardwoods. Ceylon Forests are rich in Dipterocarps the timber of which can compare favourably with that of Malayan species. Further, there are many more hitherto little used species such as Kataboda, Kekuna, Kinas, etc., which are not much favoured locally but could be exported to countries where timber is much in demand.

At a time when the country is in need of exchange, the commencement of an export trade in Ceylon Timbers is bound to contribute in no uncertain measure towards an improvement in the foreign exchange position. Saw mills for the conversion of logs into lumber are available in both the Government and the private sector. If satisfactory methods of supply could be found, most of our hitherto little utilised timbers would contribute towards higher production. It is advisable to set up machinery to promote the export of sawn timber after making trade inquiries to find markets for our light hardwoods which are suitable for constructional and joinery work in temperate countries where the wood destroying agencies are not as virulent as in the tropics. Test parcels of a few species could be graded under the M. G. R. and exported. The cost of the parcel will have to be borne by the initiators. If species such as Hora, Hulan idda and Thiniya dun are sent to markets that clamour for Keruing and Light Hardwood Meranti, the possibilities of success in establishing trade in the export of sawn hardwood timbers of Ceylon are certain.

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Appropriate Technology Services
121, POINT-PETCHO ROAD
NALLUR, JAFFNA
No. ~~1111~~