The Chairman,
SANDALWOOD EXPORT COMMITTEE:

Dear Sir,

Please find attached report by Messrs. G. Hughes and P.C. Richmond on their recent visit to India.

Copy has been sent to the Chairman of the Australian Sandalwood Company Limited.

Yours faithfully,

P.C. Richmond

31 March 1980

DISTRIBUTION

Chairman - Sandalwood Export Committee.
Chairman of Directors of the Australian Sandalwood Co. Ltd.
Forests Department.
Inspector General of Forests - India.
G. Hughes.
P.C. Richmond.

REPORT ON STUDY TOUR

OF

INDIAN SANDALWOOD RESEARCH INDUSTRY 1980

G. HUGHES AND P.C. RICHMOND

THE SANDAL TREE (SANTALUM ALBUM)

C O N T E N T S

A P P E N D I C E S

INDIAN SANDALWOOD - 1980

1. RESUMÉ

This report covers a visit to India from 20 February to 5 March 1980 by G. Hughes - Director/Secretary of the Australian Sandalwood Company and P.C. Richmond - Forest Officer in charge sandalwood production of Forests Department Western Australia.

Object was to examine the growing of Indian sandalwood (Santalum album) and the feasibility and potential suitability of the plant under Western Australian conditions.

Main occurrence of Sandal is in the State of Karnataka situated in south-western India. The areas visited were, in the main, adjacent to the cities of Bangalore and Mysore.

The Sandal tree, (Santalum album), would appear to have great potential to survive and flourish in Western Australia because it grows under a wide variety of climatic conditions with great tolerance of soil types in India.

A cold climate would appear to be the only real limiting factor, and possibly the fact India does have summer rainfall. The seed has a short viability but germinates readily. When fresh, with adequate preparation should be readily propagated under correct nursery techniques (see App. 4A Page 3). With sufficient rainfall it can be sown direct in the field with success. Is termed an 'aggressive species' and colonizes readily and has, in fact, been established and thrives in many other areas of India.

Seed should be obtained and trials laid down in the various climatic and geographic conditions available in Western Australia, from the South-West to the Kimberleys.

In Karnataka the major problems with establishment of Sandal are unrestricted grazing, wild fires, "spike" disease and depredation of growing stock by smugglers.

2. BRIEF

The brief from the Sandalwood Export Committee was in essence :-

1) To ascertain whether propagation of Santalum album was being carried out in India and if so, to study the methods and determine how this information could be used to improve propagation and establishment of Santalum spicatum in Western Australia.

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2) To examine the work being carried out by the Sandal Research Centre in Bangalore.

3) To carry out a study of methods of marketing and grading in India and determine how this could affect the general market situation in the Far East.

3. INTRODUCTION

Indian sandalwood (Santalum album), 'Sandal' tree. One school of thought considers the specie indigenous to India, another favours the theory that it was introduced a couple of thousand years ago. It is of the same family as the West Australian sandalwood, (Santalum spicatum), but is a different species. Sandal is utilised mainly for the sandalwood oil content, whereas Western Australian sandalwood is used mainly for the manufacture of joss sticks.

Most of the Sandal grows within the State of Karnataka and is under the jurisdiction of the Indian Forest Service - the headquarters of which are in New Delhi and directed by the Inspector General of Forests. Within the various States the service is semi autonomous and under the control of a Chief Conservator of Forests: for Karnataka he is situated in the capital Bangalore. However, some branches of the forest service, i.e. the Sandal Research Centre and 'Tiger' projects, (establishment of game sanctuaries primary for protection of the Tiger), deal direct with headquarters in New Delhi.

Initially, contact was established with the C.C.F., Karnataka, Mr. R.R. Parvathikar, and the objects of the visit were explained (he had received notification of our visit from the Inspector General of Forests). Generally, the production of Sandal has declined over the last decade from about 2,600 tonnes to about 1,600 tonnes per annum. Two years ago two sandalwood oil factories were in production, at Mysore and Shimoga: the latter is now closed.

Some of the problems connected with the Sandal trade included the incidence of "spike" disease (a micro plasm) which was first discovered in the 1890's and research has been in progress for the past 60-70 years. The disease does not occur in all locations and at times only affects individual trees. It primarily affects the leaves which are greatly reduced in size and occurrence and eventually the affected tree dies. Research into "spike" disease continues within the wider research programme currently being carried out by the Sandal Research Centre in Bangalore.

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Sandal in acute stage of "spike" disease.

Healthy Sandal.

Other problems included large scale smuggling of the wood into adjoining States, mainly for the sandalwood oil factories in Kerela and sandalwood auctions in Tamil Nadu. Legislation is not uniform throughout the States; sandalwood can only be purchased and distributed by the Forests Department in Karnataka but this is not so in the neighbouring States.

Unrestricted grazing, lopping of crowns for fodder and fires are other problems which have to be dealt with to ensure regeneration of Sandal.

4. THE SANDAL TREE

Distribution of Santalum album

The main growing area is within Karnataka State and extends into the neighbouring States of Kerela, Tamil Nadu and Andhra Pradesh. However, it has been established in

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most other States and is surviving and even increasing in some areas at quite a rapid rate. (See Appendix II). It is a very good colonizer of disturbed bush.

The principal centre of the sandalwood industry is the city of Mysore (See App. III). Harvesting of Sandal is carried out under the supervision of the Forests Department. Supplies are obtained from stems in areas where smuggling is rife, otherwise only over-mature stems, dead or dying stems resulting from the "spike" disease are removed. Originally all Sandal trees were the property of the Government. Now from the sale of any wood obtained from individual holdings the tenant receives 50% of the value, (currently averaging $A1,150/tonne). Proposals are in hand to increase this to the full 100% and thus encourage private planting of the Sandal tree.

All Sandalwood is brought to the Government Timber and Sandal depot at Mysore where security precautions are strict and include a 24 hour guard. Here the wood is graded. Theoretically there are 18 grades but it would appear these have been reduced to about seven only :-

1. Solid logs suitable for carving.
2. Roots.
3. Stumps.
4. Heartwood.
5. Heart and sap wood.
6. Sap wood.
7. Bark.

The wood is classified into these grades at the depot after cleaning by removal of bark and sap wood. Then it can be sold to either the Government Handicraft Department, for sale to bona-fide carvers, or the Sandal Wood Oil Factory, Mysore. Production is about 1,600 tonnes per annum.

In the Sandal Wood Oil Factory, the Sandal wood, mainly all heart grades 2,3 and 4, is mechanically chipped and further ground into a fine powder and distilled in two operations then vacuum dried to remove any excess moisture. Thus the final product of pure Sandalwood oil to the required specifications is produced and packed in 10 Kg containers for export.

From one tonne of powder 40 Kg of oil is obtained with a 99% recovery rate. The residual powder containing the 1% oil is fully utilised by drying and manufacture of Agarbathies (joss sticks) for local use. For this latter use some of the mixed heart and sap wood grades are utilised. The bark is sold for extraction of tannin.

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In the field, propagation and regeneration of Sandal is effected from potted stock with seedling and host usually Cassia siamea which is raised in the central nursery either at Mysore or to a lesser degree in one of the numerous bush nurseries.

Seedling production from Mysore is mainly for distribution under the social forestry scheme, (See App. 5). In 1979, 200,000 seedlings mainly Eucalypts but including Sandal were distributed, all free of charge. There are problems with the production of Sandal in the nursery and this is the subject of research work being carried out by the Sandal Research Centre. In the Mysore nursery the plants were on the whole very healthy with good even growth. As mentioned previously the farmers are being encouraged to grow and tend any sandal trees on their holding and the payment for merchantable sandal wood will increase from 50-100% of the market value.

Within areas of land held by the Forests Department sandal is being planted or propagated. Various 'reserves' were inspected and current techniques evaluated. One area carrying sandal, the Arabithiettu reserved forest, of approximately 2,020 ha, is 30 Km west of Mysore, has a rainfall of 500 mm and free draining rocky soil.

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ARABITHIETTU RESERVED FOREST
(Good cover of young Sandal trees)

Here there is a good ground cover from which the over-mature and dead Sandal had been removed with subsequent enrichment sowing of Sandal to augment the natural regeneration. Sowing was carried out by 'dibbling' a hollow metal pointed stick which is used to penetrate the scrub cover and disturb the soil adjacent to the base of selected host, the seeds are then sown by passing down the hollow stick and covered with loosened soil. To maximize use of rainfall and hold surface water, shallow trenches are constructed on the bottom side of individual Sandal plants.

At present, limited grazing is permitted, however, it is proposed to exclude all access by fencing initially with split granite fence posts (cost Rs.12 $A1.40 each!) and wire and planting of Agave sp., which in the long term will act as a fence and fire-break.

It has been mentioned, not only that grazing is a problem but also that the lopping of Sandal trees to obtain fodder is prevalent in some areas. Photograph which appears on the following page shows the effect of such lopping.

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Other areas inspected were degraded grazing land which had been acquired by the Forests Department. The ground had been ripped and Eucalypt species planted. In the valleys on areas of deeper soils and greater ground water availability species such as Acacia Aucuriformis, Casuarina equisitifolia, Bassia latifolia, Cebia petandra, Tamarindus indica, Dalbergia sisoo, Iolanthus excelsa and Ficus branch cuttings were planted, together with Santalum album which was planted as a nuclei for colonization.

2 Year Sandal in Lavendar
(Burbra Percilata)

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This technique is being carried out on several other areas where degraded land is being put under a tree crop, usually in blocks of about 2,000 ha.

It was possible to see only a relatively small area of sandal wood growing under higher rainfall conditions. This was in the 1250 to 1750 mm rainfall areas which bordered the private coffee plantation areas. The Sandal was still very prolific and survived very well under quite a heavy overhead canopy.

Natural regeneration of sandal will occur given protection from man, grazing animals and fire. This was adequately demonstrated in two small plots adjacent to nurseries where the natural bush had been protected over a number of years. The regeneration was of all ages, and it would appear that providing fire can now be kept out the cover of Santalum album would be more than adequate.

← NATURAL REGENERATION

and medium sized Sandal tree
(Sandal Research Centre - Bangalore)

In all areas sighted the specie appeared to be very catholic in the hosts utilised.

For further information on the very varied conditions under which Sandal will grow 'A note on the uses of Sandal in Social Forestry' a paper is included in Appendix V.

5. SANDAL RESEARCH CENTRE

This was constituted in mid 1977 under the present officer in charge, C.F. Venkatesan. Originally it was intended to concentrate on the continuing study of "spike"

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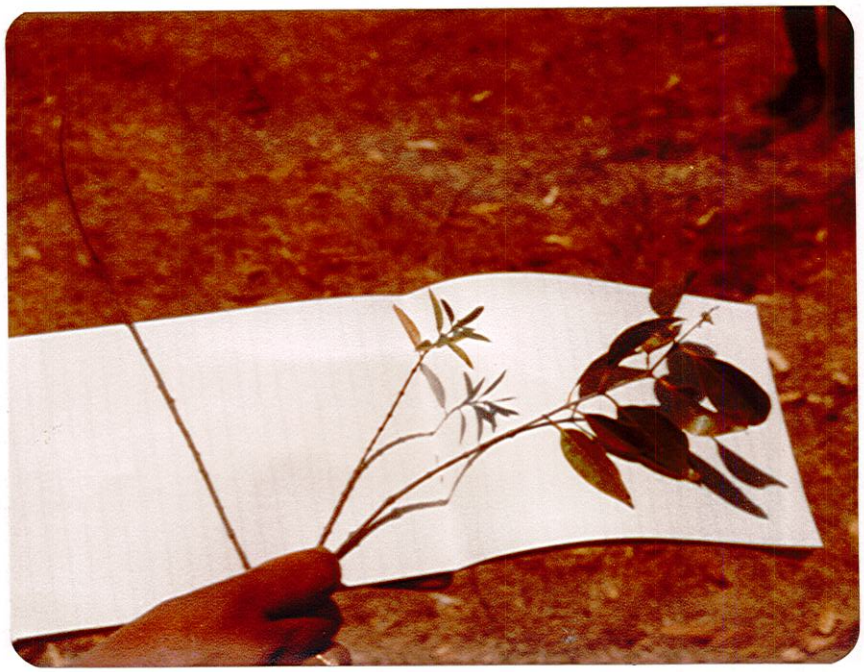
disease. However, with pressure from the officer-in-charge it took on the wider role of the study of Sandal (Santalum album). To give a more detailed outline of what has been carried out since 1977 the provisional research findings (Nos. 1 and 2) for the Sandal Research Centre are presented in Appendix IV (A and B).

Research into "spike" disease does continue: Briefly, this disease causes reduction in leaf size and thus total leaf area and there is a continued gradual leaf loss until the plant eventually dies. The disease is now stated to be caused by a micro-plasma-like organism (bacteria). It was first discovered in 1898 in the Coorg area (now part of Karnataka State). By 1917 it was estimated that it occurred over 1,000 square miles. Research into "spike" has been carried out since 1910: much has been written about it and the Research Centre is in the process of producing a monograph from all the available literature.

"Spike" is now confined to a specific area and has not progressed beyond these limits in the past several decades (App. 4 A, Page 2). In general, the impression forthcoming was that research on "spike" should not be discontinued or even diminished but much more effort must be put into other aspects of growing and protection of the Sandal tree.



"Spike" and Healthy Sandal wood Leaves.

It was stated that seed of Santalum album could only be obtained by direct application to the Inspector General of Forests.

Two very interesting and informative days were spent at the Sandal Research Centre, the Director and his staff gave freely of their time and knowledge. We were able to talk to the staff for a couple of hours on Western Australia in general and our problems with Santalum spicatum.

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The various aspects of research were looked at and discussed with the officers concerned. These aspects included :-

Tree improvement and genetics:

We were shown different geotypes, mainly leaf differences; a collection was being made of all the different Santalum species. For S. album the flowering habits being monitored, also growth rates from differing climatic and geographical regions, tolerance of soil conditions, overhead shade etc. Grafting and budding of elite material being carried out and a very important aspect, the variance in formation of heart wood, (for detailed study see App. VI).

Seed

Researchers are looking at the removal and non-removal and cracking of seed coats, scarification and soaking in sulphuric acid for differing periods. Observing characteristics of seed germination and survival in all different conditions Most important work appertaining to nursery techniques, (for further information see App. IV (B) Pages 1 and 2).

Organic Chemistry

It is considered there are four distinct varieties of Sandal, classified according to colour of heart wood, from which the quantities of santalol and sandalwood oil available can be estimated. Research has shown other uses for the Sandal tree, these include a bark extract which has an insect inhibitant, from the seed a 60% oil extract as soap substitute and from the seed coat an extract with > 1% flammability.

Bio Chemistry

Researchers are looking at methods to obtain early identification of "spike" disease, study of chlorophyll, A and B, including the varying amounts of starch, which could determine host plants capacity to absorb ions etc after parasitizm. Investigation into areas where "spike" has not spread, no difference could be observed in minerals. Looking at different forms of Sandal and the difference in the enzymes and to try and correlate any differences with the formation of heart wood. One other line of research was to determine whether the Sandal is a 100% parasite, and is parasitizm really necessary?

Wood anatomy

Researchers are looking into the spread of "spike" by birds, insects, wind or soil, including physiological causes. It was stated that it is not seed borne. Is it an accumulation of starch? It does occur on other plants

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and can be induced by grafting, leaf insertion, insects and injection. Injecting diseased Sandal trees with tetracycline can produce healthy trees but is not everlasting. Experiments continue on periodicity of injections to ascertain whether diseased plants can be kept alive.

Entomology

Since 1977 it has been shown that 25-40% of Sandal stems are affected by insect bore holes and hollow cavities in the heart wood, primarily caused by the beetle Aristobia octofasciculata which is responsible for the initial attack and holes which are often enlarged by secondary fungus. The statement made claimed that the loss on account of this borer is not less than Rs. 350 lakhs ($A4,000,000) per annum! Also being investigated is the transmission of "spike" disease by leaf hoppers. (For more information on the borer attack see App. VII).

This concluded a busy and interesting visit and the overall impression was that of a very united and dedicated research team, probably due to a large extent to Mr. Venkstesan's leadership. The overall aim came out as producing a plus Sandal tree, high yielding, quick growing and disease free. In the field, for maximum production and regeneration, plants must be protected from man, stock and fire.

There was a general discussion with the staff on the problems associated with Santalum spicatum in Western Australia. Topics included, incidence of 'dry sides' due to sun scorch, animal damage or what? Any correlation on which the incidence occurred. Incidence of hollow stems - is this due to borers, fungus? In India the long held belief that the slowest growing Sandal produces most oil has been proven wrong! As we also subscribe to the same theory in W.A. - is it also a fallacy?

The Sandal Research Centre staff are extremely keen on further dialogue on the genus Santalum and would be most appreciative of any literature available and also wood samples, seed etc and would be very willing, with a reason, to look at any specific problems we have in W.A.

6. MARKETING OF SANDAL WOOD IN INDIA

The system of marketing seems to vary from State to State according to the type of legislation applicable in the various States. In Karnataka which is apparently the largest producer, all marketing is under State control. The majority of the wood is sold to the Mysore Government Oil Factory at an agreed price according to grade, ranging from Rs. 8,000 - 12,000 per tonne ($A925 - 1,390 per tonne). Sandal wood growing on private property is also sold to the factory and now the owner receives 50% of the proceeds. Formerly all Sandal wood was the property of the State and

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consequently there was very little encouragement for the owners to protect their trees. Sandal on private property was regarded as a liability. At present there is strong agitation amongst the Forestry officers to give the owner 100% of the proceeds.

A small quantity of suitable wood is sold to the State's arts and crafts organisation for carving.

In other States such as Kerala, Tamil Nadu and Andhra Pradesh, control of Sandal wood is not as strict or as well policed. All wood is sold by public auction and prices range from Rs. 30,000 to 72,000 per tonne ($A3,468 - 8,324) with consequent encouragement to smugglers from Karnataka State in spite of heavy penalties. A small piece weighing 1 Kg may be worth Rs. 50 compared with a worker's average wage of Rs. 7 per day.

Confiscated Smuggler's Sandal wood

From these auctions buyers purchase wood for the overseas market or for the private oil factories which operate in both Kerala and Tamil Nadu.

Joss stick (or agarbathies as they are called) making in India is a large industry but only sap wood cleaned from the logs or exhausted dust from the factory is used for this purpose.

Total production of Sandal wood in all States is estimated at approximately 2,500 tonnes of which about 1,600 tonnes is produced in Mysore State.

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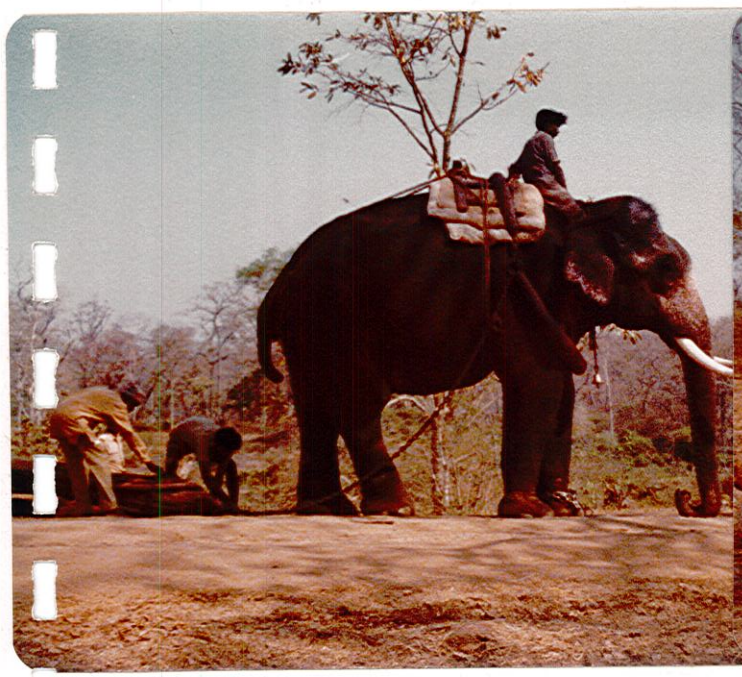
7. AFFORESTATION GENERAL AND GAME CONTROL

Some brief comments on other aspects of work being carried out by the Indian Forest Service:

In the higher rainfall areas visited (> 1500 mm rainfall) where teak, (Tectona grandis) is harvested from both the natural forest and plantations, an 80 year rotation, final crop 40-50 stems/ha and g.b.h. 1.5m. In the natural bush other commercial species were Rosewood (Dalbergia latifolia) and Pterocarpus marsupium and Terminalia tometosa. Values given included Rosewood Rs. 80,000 m^3 ($A9,250) and Teak Rs. 7,000 m^3 ($A810).

This was within the Nagerhole game sanctuary which is also administered by the Forests Department. Game look-out points have been built and areas cleared adjacent to water holes. Game sighted included bison, elephant, panther, wild boars, sambar, barking and spotted deer, langour monkeys, peacocks and jungle fowl.

In the same area the Balle working elephant camp was visited and their ability to sort out logs etc and hauling of same was demonstrated. In the camp were 22 elephants of varying ages, 8 of which had been in captivity of about 12 months and were not quite ready and trained for work in the bush.



Ready to Haul

Sorting Logs

One of the greatest problems seen in this area was the release of land for agriculture which depleted the forest resource and game sanctuary.

Mentioned briefly earlier was the 'Tiger project' in which the Forests Department is very involved. Briefly, the tiger is considered the apex of Indian wildlife and as such require protection. There are 11 such projects

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in existence, we saw one such area of 700 square km in the distance but were able to discuss the project in detail with the Conservator of Forests in charge of the Bandipur Tiger Project. This was started in 1973 with 11 tigers, there are now 33 tigers and 6 cubs. Each tiger requires 72 deer or equivalent per annum and the object is to maintain a bio-mass which will sustain sufficient game to assure the tiger population. If tigers venture out of the sanctuary and kill cattle compensation is paid immediately. The general public are permitted into the sanctuary and taken on conducted tours.

It would appear all available water is utilised by the numerous catchment dams seen in the various areas. The department has a role there in supplying trees and planting around the immediate vicinity of these water catchment dams etc. (See App. VIII) for further information on this work aspect).

This leads to social forestry for which the department supply plants (including the Sandal tree) and advice of the planting of trees on individual holdings.

The department is also involved in raising, planting, maintaining and cropping commercial trees such as cashew nut, lavendar, Euc citriodara. Another function is raising and planting trees for roadside planting which is being carried out extensively. The present techniques is to plant a permanent tree such as Tamarindus or Ficus surrounded by Prosopsis as protection and finally Euc. sp. to give initial quick growth and protection and later removed for pulpwood or fuel.

By far the biggest project is the afforestation of land classified 'C', i.e. degraded by heavy grazing, previously held by the Revenue (Lands) Department, now under jurisdiction of Forests. Two such areas visited each had an annual planting programme of 400 ha per annum, first plantings 1976. Trees were raised in the bush nursery on site as potted stock. These were mainly Eucalypts but other species, included Sandal in the better areas. Preparation, lines ripped about 1.8m apart approximately on the contour.

Russian 108 H.P. T100 M Tractor Dozer with 2 Wheel Jinker with single Line Ripper.

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Ripping

Trees were planted about 1.2m in the ripped rows. The rainfall is 500 mm per annum and the soil is rocky and friable; previous cover was generally low scrub. It is estimated that there is available approximately 20,000 ha which could be converted into mixed forest with Eucalypts for pulpwood and fuel and other species for timber and also Sandal production.

Fire, is considered to be a possible problem and 'watchers' are employed to patrol the areas.

Establishment costs given Rs. 2471/ha $A285), cost of dozer hire Rs. 110/hr per day rough going and 4-5 ha/day good going.

1979 Planting.

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General View

The Eucalypt most widely used is known as the Mysore gum and it is said to come from Eucalypt trees originally obtained by the Tippu Sultan over 300 years ago and originally planted at Nandi, (North-West of Bangalore). The specie has been identified as Euc. tereticornis. Other Eucalypts used in minor quantities include - Citriodora, camaldulensis and globulus - the latter in higher rainfall areas. There is no great enthusiasm to try other Eucalypts. It would appear they are very happy with the well tried and known Mysore gum.

8. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

Climatically Indian conditions are very different from those in W.A.

In India seed availability and suitable planting conditions are available on a regular annual basis.

S. album has a much greater colonizing ability (aggressive tendencies) than S. spicatum.

In timber form, oil content, growth rate, volume production and reproductive capacity S. album is far superior to S. spicatum.

Fire and grazing are major problems to both varieties.

Marketing. It does not appear that there would be any competition in the foreseeable future unless the price structure of S. album is changed to be more competitive with W.A. prices.

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In the short space of 2½ years the Sandal Research Centre team have covered a very large field into the characteristics of S. album including the sciences of genetics, biology, botany, chemistry, wood anatomy and entomology.

B. Recommendations

1. To initiate techniques observed in India which have possible application to the regeneration of S. spicatum. These include :-

   Soil moisture retention measures.

   Dibbling as a method of on-site establishment.

   Continue observation on occurrence and periodicity of flowering and seeding.

   Expedite and increase Silviculturist Loneragan's proposals for planting of S. spicatum with host/nurse plant in the Dryandra area.

2. Carry out an assessment of the existing Sandalwood resource in Western Australia.

3. An approach be made to the Sandal Research Centre to carry out an appraisal of S. spicatum wood quality from a variety of differing geographical localities.

4. Observations be carried out on the incidence of insect attack, fungal and other diseases contributing to possible loss of production from S. spicatum

5. A request be made to obtain sufficient seed of S. album so that trials can be established with plot plantings of S. album in a wide range of climatic and geographical conditions for the South West Wheatbelt, Goldfields and Kimberleys.

6. If a Sandalwood Research Institute is established in W.A., any research undertaken on Santalum should be carried out in conjunction with the Sandal Research Centre, Bangalore, to ensure there is no duplication of effort. Furthermore, all research findings should be freely available to both institutions.

7. Emphasis should be placed on research which it is envisaged will assist in the practical regeneration of Santalum in the field.

A C K N O W L E D G E M E N T S

The Australian Sandalwood Company Ltd., for making funds available to enable Messrs. Hughes and Richmond to visit India and study Sandalwood growing in that country.

B.J. Beggs, Conservator of Forests, Western Australia, in allowing Forest Officer Richmond, to undertake the trip.

The Director General, Indian Forest Service, New Delhi, Chief Conservator R.R. Parvathkar of Forests, State of Karnataka, (Conservator of Forests, Research and Utilization) S. Shamsundar. Conservator of Forests, K.R. Venkatesan, Sandal Research Centre and Conservator of Forests, K.A. Belliappa, Mysore Forest Division, and to include the staff of these various offices who gave of their time and knowledge in a most co-operative and generous manner.

Mr. Y.M.L. Sharma, retired I.F.S., ex C.C.F. Karnataka and Dean of Forestry School now International Forestry Consultant, Bangalore.

The General Manager, Mr. Ravadi of the Government Sandalwood Oil Factory, Mysore.

Ms. M. Lewis of the Editorial Section, Como, for help and advice.

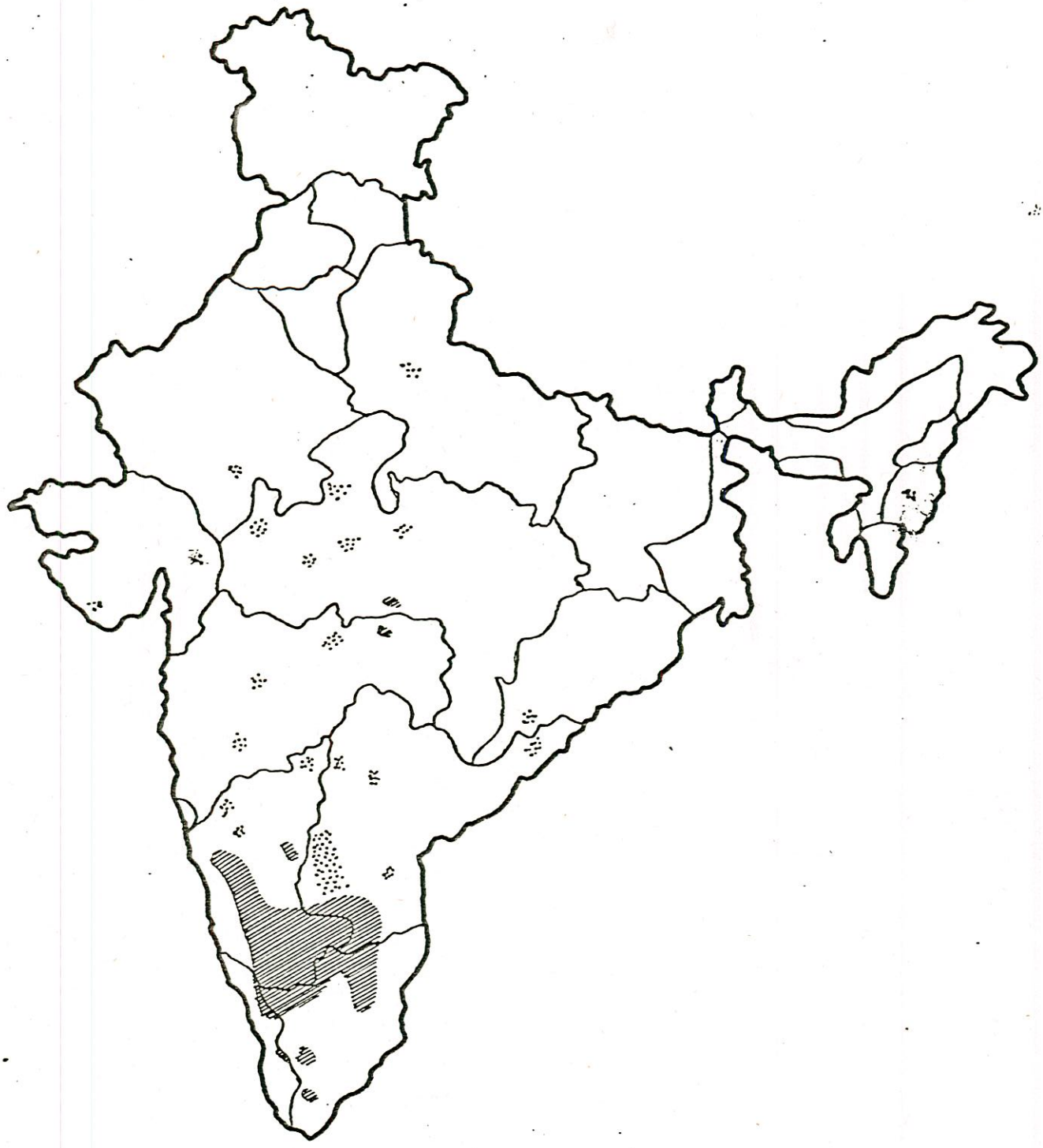
P.C. RICHMOND

G. HUGHES

A P P E N D I X I

ITINERARY OF G. HUGHES AND P.C. RICHMOND

FEBRUARY 1980			
Tuesday	19th	Depart Perth	(Air)
Wednesday	20th	Arrive Madras	(Air)
		Madras to Bangalore	(Air)
Thursday	21st	Bangalore	
		Bangalore to Mysore	(Train)
Friday	22nd	Mysore	
Saturday	23rd	Mysore - Arabithiettu - Yelawala - Brindavan - Mysore	(Road)
Sunday	24th	Mysore - Madahally - Mysore to Bangalore	(Road)
Monday	25th	Bangalore Sandal Research Centre	
Tuesday	26th	"	
Wednesday	27th	Bangalore - Gottipura - Thindalu, Nandi - Bangalore - Mysore	(Road)
Thursday	28th	Mysore - Onkara - Naganpur - Nugu - Mysore	(Road)
Friday	29th	Mysore - Hunsur - Veranahosali - Murka - Nagerhole	(Road)
MARCH 1980			
Saturday	1st	Nagerhole, Balle-Kharapur - Mysore	(Road)
Sunday	2nd	Mysore - Bangalore	(Road)
Monday	3rd	Bangalore	
Tuesday	4th	Bangalore - Madras	(Air)
Wednesday	5th	Madras - Singapore	(Air)

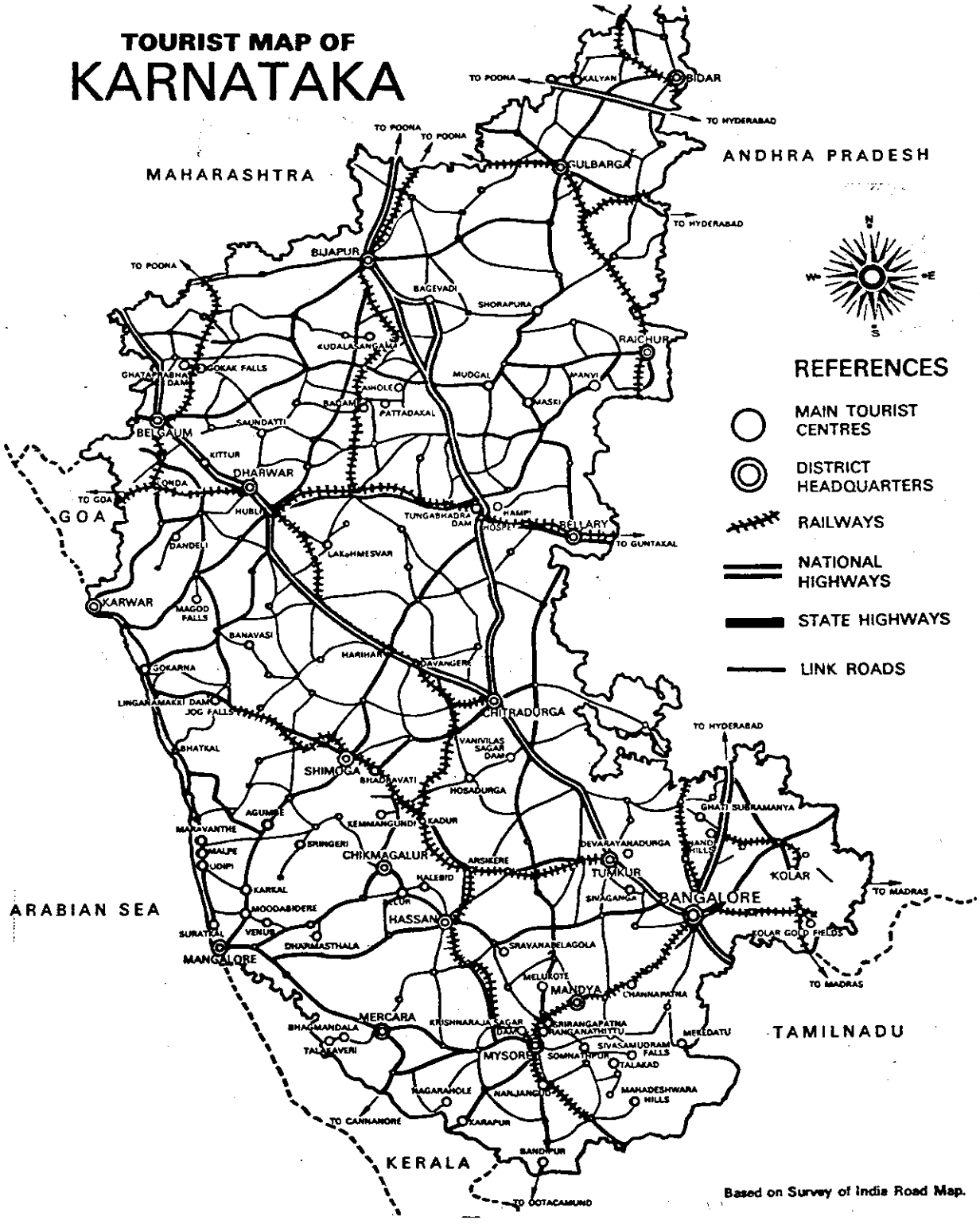


Distribution of Santalum album L.
in India.

-- Dense

-- Sparce

IV


TOURIST MAP OF
KARNATAKA
MAHARASHTRA
ANDHRA PRADESH
GOA
TAMILNADU
KERALA
ARABIAN SEA
TO POONA
TO HYDERABAD
TO GOA
TO GUNTAKAL
TO MADRAS
TO CANNANORE
TO OOTACAMUND
KALYAN
BIDAR
GULBARGA
BIJAPUR
BAGEVADI
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RAILWAYS
NATIONAL HIGHWAYS
STATE HIGHWAYS
LINK ROADS
Based on Survey of India Road Map.

No. /78-SRC
Government of India
Office of the Conservator of Forests
Sandal Research Centre
(Forest Research Laboratory Campus)
Malleswaram, Bangalore-560003.

Dated:

To

1. All the Chief Conservators of Forests
Karnataka, Tamil Nadu, Andhra Pradesh, Kerala,
Maharashtra and Madhya Pradesh.
2. All the Managing Directors of Corporations.

Sub: Sandal Research Centre - Provisional research findings - intimated.

Sir,

As you are already aware, the Sandal Research Centre is functioning since the 30th May '77 with head quarters at Bangalore. Though we have a number of findings, those which may be of direct interest to the field officers are furnished herewith. The information may please be communicated to all officers interested in sandal.

1. Sandal is capable of growing
   a. from sea level to 1800 m.
   b. from 500 mm to 3000mm rainfall
   c. in all kinds of soils like sand, black cotton soil, red soils and laterite.
2. Sandal can produce scented heartwood in all places irrespective of soil and the ability to form heartwood seems to be dependent upon genetical factors.
3. There are different varieties and strains of sandal which are under study. Superior Strains capable of producing maximum heartwood and good amount of oil are found in the following place:
   a. Chitteri in Dharmapuri Division, Tamil Nadu
   b. Thimlu - Bangalore Division Karnataka. This seems to be a separate variety of Sandal with very little sapwood (3mm) and even very small sizes (5 cm dia) have good heartwood.
   c. Yedehalli & Chennagiri of Bhadravathi Division Karnataka.
   d. Chandrakala Reserve - Shimoga Division, Karnataka.

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The concerned Divisional Forest Officers, may be addressed early for seeds. The seeding seasons are September-October and March-April.

4. In the absence of grazing and fire sandal is capable of regenerating profusely. A few trees can produce a population of thousands of pole crop within 10 to 20 years.

eg. a. Theosophical Society area in Adayar, Madras.
b. Nehru Zoological Park, Hyderabad.
c. Mudigere Experimental Garden, Karnataka.
d. Keeriparai Experimental Garden, Kanya-kumari District, Tamil Nadu
e. Forest Research Laboratory Campus, Bangalore.
f. Southern Forest Rangers College, Coimbatore.

5. Spike disease is confined to an area bounded by Chickballapur on the North, Javadi Hills on the East Nilgiris on the South and Coorg on the West. The disease has not progressed beyond these limits for the past several decades.

Even within this well defined zone the disease is fast disappearing in many places like Coorg Division Kolar Division, Salem Division and Tirupathur Division.

The disease is still in a virulent form in Hosur and Coimbatore North Divisions of Tamil Nadu, Mysore, Chamarajanagar and Kollegal Divisions of Karnataka.

6. Heartwood does deteriorate in living sandal trees and hence the presence of many hollow trees. The deterioration is brought about initially by an un-identified borer which bores a vertical hole of 1cm to 2 cm in dia. There can be as many as 20 bore holes in a single stem. Moisture and dust enter the bore holes and make a find breeding ground for some fungi. The damage to the heartwood can be as much as 90%.

The identification, life cycle and the extent of the damage by the insect and fungi are being studied.

7. Sandal is found, besides the Southern States like Tamil Nadu, Karnataka, Andhra Pradesh & Kerala, in other states like Maharashtra, Madhya Pradesh, Uttar Pradesh, Orissa, Bihar, Punjab, Manipur and even in Nepal. Trees near Nagpur, Seoni and Dehra-Dun were examined and found to contain scented heartwood.

Therefore it can be grown in all states except in very cold places. It needs strict protection from grazing for the first 5 years. Given good soil and moisture, it can grow very fast. 7 year old plants are known to attain a diameter of 15 cm at H.H. under very good conditions and form scented heartwood.

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8. Sandal seeds are viable only for a short-period. Freshly collected seeds do not germinate readily as they have a dormancy period of two months. The seeds lose their viability eight months after collection.

Soaking fresh seeds in 0.05% giberellic acid can break the dormancy and bring about 80% germination in 10 days.

9. A separate note on the use of sandal in Social Forestry is under preparation and it will be sent in due course.

This centre may be contacted for any information or advice on any aspect of sandal.

Yours faithfully,

(K.R.Venkatesan)
Conservator of Forests.

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GOVERNMENT OF INDIA

From: To:

APP. IV (B)

Sri K.R. Venkatesan, I.F.S.,
Conservator of Forests
Sandal Research Centre
BANGALORE

N.R. /79-SRC, dated:

Sub: Sandal Research Centre – Provisional Research Findings and Notes – No.2.

Sir,

This is the second instalment of the Provisional Research Findings of this Centre. Kindly treat the previous one viz. Provisional Research Findings issued during August 1978 as No.1 in the series.

We have been able to bring out two of these so far. But with your cooperation I am sure more information on sandal will be forthcoming and this centre will be in a position to issue more numbers of the Provisional Research Findings and Notes during the coming years. You are therefore requested to communicate to this Centre any interesting observation, information etc.

1. Seed:

It has been found that whenever the fruits are not properly cleaned and if some small bits of pulp adhere to the seed coat, the viability of the seed is affected on storage. While seeds with ~~x~~ seed coat take a long time for germination, the seeds in which the seed coat has been carefully removed give early and uniform germination. The effect of various pre-treatments on sandal seeds is given in the following table.

Pre-treatment of sandal seeds for quicker and uniform germination.

Treatment	Starting of germination	Completion of germination	cost
1. Untreated	50–55 days	140–150 days	No cost.
2. Acid scarification using concentrated sulphuric acid (soaking for 50 mts.)	25–30 "	65–70 "	1 kg. of seed requires 2 litres of sulphuric acid. Cost: Rs.40/- per kg.
3. Removal of seed coat	~~xx~~9–12 "	35–40 "	Using labour at the rate of 6 labourers per kg.
4. Gibberellic acid treatment (0.05%) (soaking for 16 hrs.)	10–12 "	35–40 "	Rs. 30/- per kg.

In any nursery there are two components of expenditure when it concerns germination ie. (1) the cost of pretreatment and (2) the cost of watering the nursery till germination. As per the data given above the forester may choose any one of the pretreatments according to his convenience. There are 6000 seeds per kg.

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2. Seedlings:

The sandal seedlings usually suffer from a serious disease in the nursery stage. There are two kinds of diseases; (1) seedling shedding leaves gradually, accompanied by a root decay. (2) sudden wilt of seedlings.

An examination of the soil revealed the presence of 4 species of nematodes and 3 species of fungi. Preliminary experiments using fungicide like Blitox, Bevastin, etc. by drenching the soil once a month can bring about a reasonable control of the disease.

This is a very serious disease which can bring about 100% mortality. This disease has been observed in varying degrees in many of the sandal nurseries in Karnataka, Tamil Nadu and Andhra Pradesh.

Further work on this disease is going on.

3. Flowering pattern:

Sandal usually flowers and fruits twice a year. 53 trees in the Sandal Research Centre Campus kept under observation showed the following flowering pattern.

No. of trees	Flowering
13	Throughout the year
22	Once a year
9	Twice a year
9	No flowers at all.

4. Utilisation of sandal bark:

Sandal bark which is now wasted contains 14% of tannins. In addition, this centre has isolated an insect growth inhibitor from the bark. This can act as a chemosterilant on insects.

5. Oil and santalol in relation to the heartwood colour:

Heartwoods of sandal are of different colours ranging from light yellow to dark chestnut brown. Analysis of the woods for oil indicates the following.

Colour of wood	Oil percentage	Santalol percentage
Yellow	1.3 - 3.5	90
Light brown	2.5 - 6.2	85-90
Dark brown	less than 2.5	75-85
Brown	about 2.5	less than 85

Highest oil percentage has been found in light brown woods. The yellow woods usually contain less oil, but more santalol.

6. Heartwood borer of sandal:

The heartwood borer of sandal has been identified as Aristobia octofasiculata, Aurvillius (Cerambycidae : Coleoptera). The grub attacks the heartwood and the adult eats the bark of twigs causing twig drying. The twig drying may be sometimes epidemic. Calculation of the loss by each bore hole indicates a loss of about 0.5 kg. of heartwood per bore hole. There can be as many as 20 holes in a tree.

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7. Wood decaying in sandal:

Sapwood of sandal which is also quite valuable now-a-days (Rs. 1 to 2/- kg) can be made absolutely useless in a few months when the trees are stored in the open. As many as nine species of wood decaying fungi have been found to be responsible for the decay. Heartwood is also liable to deterioration by a fungus. Several specimens of heartwood have been found to have been rendered soft by the fungus. The identification of the fungus decaying the heartwood and its damage potential are being studied. Therefore the age old practice of storing of uncleaned sandal trees in the open is not desirable.

8. Spike disease:

Inspite of virulent spike disease from 1917 onwards in the Javadi Hills of Tamil Nadu, periodic enumerations in one reserve revealed that sandal has increased in its geographical extent by 67.9% and in density by 211.6% over a period of 60 years (Working Plan by Shri Rajagopal Shetty).

9. Transmission studies:

For successful transmission of spike disease, a minimum of sixty Nephotettix virescens Distant adults, and a overnight acquisition feeding on diseased leaves and exposure period of a minimum of two days are required. Results have been published in Vol.104, No.4, pages 202-205 of the Indian Forester, 1978.

Note on the sandal in private lands

1. Araku Valley (Andhra Pradesh)

There are 7 trees planted in a row in the garden owned by Shri Ramprasad whose father was an employee of the Maharaja of Jeypore. These trees where planted approximately around 1959 by the father of Shri Ramprasad. Examination of these trees in 1979 shows that they range in girth from 60 cm to 100 cm and contain not less than 40 kgs. of heartwood each and the total yield is likely to be 400 kgs over a period of 20 years. Each tree is capable of adding not less than 2 kgs of heartwood per year. Out of the 7 trees, 6 have yellow heartwood and one has brown heartwood.

2. Turkewadi (Maharashtra)

There is a private estate owned by Shri Prabhakar Sabnis in the village Turkewadi of Chandgarh Taluk, Kolhapur District, Maharashtra, extending over 16 ha. The area is divided into four 4 ha plots leaving a 3 m. margin. His grandfather, around 1920 had planted this strip with sandal and bamboos (Oxytenanthera). The area occupied by this small strip in the entire estate measures about 1 ha. The owner had started extracting trees from 1943 onwards. So far he has extracted 4 times. The results of extraction is given below.

Year	No. of trees	Girth	Tonnage	Yield per tree
1943	50	112 cm	1.5 tonnes approx.	30 kg
1948	87	112-125cm	2 "	23 kg
1959	150	75-100	4 "	26.6 kg
1972	225	75-100	6 "	26.6 kg.
Total	512		13.5 "	

The stock of trees above 15 cm girth now is 2500 approx.

Yours faithfully,

for Conservator of Forests

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A NOTE ON THE USES OF SANDAL IN SOCIAL FORESTRY

Social Forestry as envisaged by the National Commission of Agriculture comprises of the following four aspects namely:

I. Farm Forestry or Agro-Forestry.
II. Extension Forestry.
III. Reforestation of degraded forests and
IV. Recreation Forestry.

The object of social forestry is to provide the immediate needs of the population in terms of fuel wood, small timber, fodder, green manure etc. to protect the lands against erosion and create conditions conducive to better climate and aesthetics. Though a large number of species are useful in social forestry, the silvicultural and other attributes of sandal make it an extremely important species for use in social forestry.

A. Silvicultural attributes of sandal:

1. Sandal is capable of growing at all elevations from sea level to about 1800m (except very cold places) in the south.
2. Sandal is capable of growing in different kinds of soils like sand, clay, laterite, loam, black-cotton etc. (avoiding water logged situations). Even very poor and rocky soils can support sandal.
3. Sandal is capable of thriving well in very dry and wet areas ranging from a minimum of 500mm to over 3000mm rainfall.
4. Sandal is capable of reproducing itself very profusely provided there are no unfavourable biotic factors.
5. Sandal has a dense foliage capable of stopping the wind velocity and it can even thrive under partially shaded conditions along with other tree crops.

B. Utilitarian aspects:

1. Of all the tree species known in India, sandal is the most valuable one because of the costly heartwood (present rate around Rs.40/- per kg on average, though some classes may fetch as much as Rs.70/- per kg). It is used in all religious purposes and in carving. The oil is an essential base for all high quality perfumes and is greatly in demand in the perfumery industry.
2. The sapwood, besides being a good wood for carving, is used in the agarbathi industry and the present price varies from Rs.1/- to 2½ per kg.

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3. The bark has 14% tannin and is yet to be exploited for the tanning industry. It also contains a chemical which can be used as a chemosterilant and a growth inhibitor of insects. Fresh bark is used by the villagers as a substitute for betel nut.
4. Sandal leaf is an excellent fodder and agood green manure.
5. The fruits are edible and seeds yield an oil which can be used in the varnish industry.

Here is a tree which can easily capture the imagination of the common man and tempt him to undertake planting of such a multipurpose tree.

C. Growth and Yield

Though sandal is considered to be a slow grown tree under forest conditions (1cm girth/year), it can grow at the rate of 5cm of girth and more per year under favourable soil and moisture conditions. Though the factors responsible for the quantity and quality of heartwood are not well known, the studies indicate that genetical factors must be responsible.

Under Tamil Nadu Forest conditions the following yields of heartwood can be expected on an average.

Girth	Yield in kg.
Upto 15 cm	2.4
16 - 30	6.0
31 - 45	16.5
46 - 60	39.0

An eight year old tree growing on the banks of Coleroon River (Tamil Nadu) was found to contain over 10 kg of heartwood. 20 year old trees in Araku Valley (Andhra Pradesh) were found to contain 40 kg. Taking the above facts into consideration, it can be assumed that each tree is capable of yielding atleast 1 kg per year after 20 years.

I. Use of sandal in Farm Forestry or Agro-Forestry:

This envisages the planting of trees in the private lands not only for purposes of use but also for monetary returns. Agro Forestry can be divided into three broad categories namely:

i. Block planting using sandal and host plants without agriculture, where agriculture is marginally productive, in dry lands.

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ii. Planting sandal at definite espacement in rain fed agricultural lands receiving low rainfall where the soil cannot be left to the ravages of sun and wind and where the agricultural crops are likely to thrive better under partially shaded conditions.

iii. Planting all along the bunds of cultivated fields either purely or along with other useful miscellaneous species. This could be done in dry as well as wet lands.

i. Block planting without any agriculture:

In the marginal dry lands which are not definitely profitable for agriculture, tree crops are the best alternative. As sandal is capable of thriving with very little moisture, it could be grown along with other useful tree species in such lands. The species which could be used along with sandal could be of such types which can yield annual revenue like neem, pongamia, Bélonix elata etc. The recommended spacing for sandal is 5m x 5m and the miscellaneous species in the quincunx forming an ultimate spacing of 3.5m c 3.5m. Nursery grown seedlings of not less than 8 months and of 30cm height are recommended. The miscellaneous species may either be sown or planted according to convenience.

This spacing will give 400 trees of sandal and 400 miscellaneous trees. The entire plantation can be managed under a selection system of felling after the 25th year. In addition to removing dead and dying trees, certain trees which have obtained a girth of not less than 30cm may be removed periodically.

Assuming about 250 trees are growing well, they can put on an annual increment of 1 kg per year per tree, thus giving an over all increment of 250 kg per year. This means at the present rate of Rs.40/- per kg a gross annual income of not less than Rs.10,000/- per hectare. This may be obtained by removing either 10 trees per year or 50 trees once in 5 years according to convenience.

The regeneration must be tended and well spaced to build up the future stock. Even allowing Rs.1000/- per ha for protection, extraction and tending, a net income of Rs.9000/- per ha per year can be expected. The income from the usufructs of miscellaneous species can be treated as an extra income.

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ii. Planting in low rainfall areas where agriculture is likely to be profitable mixed with tree crops.

There are many areas of 400 to 700mm rainfall, where agricultural crops do suffer on account of the effects of sun and wind. In such conditions it is not uncommon that the farmers have taken up a mixed crop ie. raising annual crops in an area where tree crops have already been established.

No definite spacing could be recommended here as this depends upon the intensity of sun and wind and according to the needs of crops. Any spacing in such conditions cannot be less than 5m from tree to tree and need not be more than 10m. Spacing can be square or rectangular. This spacing also depends upon the kind of ploughing equipment used like country plough, tractors, mechanical cultivators etc. 100 to 400 trees can be grown per hectare according to agricultural conditions. Rectangular spacing could be 6m x 4m, 8m x 3m or 10m x 2.5m.

Sandal can stand any amount of pruning and therefore the shading to the field can also be regulated. The trees, if found large in number, may be thinned out and if small in number, additional seedlings can be planted. In this kind of planting there is no need to provide any host plants as the agricultural crops themselves will act as hosts and sandal will also be benefitted due to periodical soil working, manuring etc.

iii. Planting along the field bunds:

Either by design or by chance the field bunds usually contain some tree or the other. Intelligent farmers grow purposely such useful species like neem, babul, glyricidia, delonix, pongamia, bamboo etc. as these serve not only as wind breaks but also yield green manure, fodder, small timber, firewood, fruits etc. Under such situations planting of sandal in between these miscellaneous species at a spacing of 3m to 5m will not only enhance the effectiveness of the trees as wind breaks and give fodder and manure but will be a very useful capital yielding sizeable monetary returns in due course.

The bird population will also increase as sandal fruits are mostly eaten by birds.

Assuming that the average agricultural holding is 0.2ha, the margins can hold from 35 to 60 trees. The value of each of these trees after 20 years will be on the present value Rs.800/- Eg. Sabnis Estate at Turkewadi village, Maharashtra.

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II. Extension Forestry

Extension Forestry envisages planting of (i) tree species on waste lands and village common lands, (ii) raising of shelter belts in dry and arid regions and (iii) raising of plantations on road sides, canal banks, railway lines etc.

i. While afforesting Panchayat lands, it will be useful if in addition to raising miscellaneous species, a few plants of sandal are also introduced. Introduction of sandal at a convenient spacing say 10m apart (100 trees per ha) will not only increase the usefulness of such plantations by providing better shade and soil cover but also in attracting birds and making the whole land highly valuable after a few years. Sandal may be introduced along with the miscellaneous species either by dibbling during monsoon time or by planting seedlings. As sandal is capable of growing in rocky and poor soils, it can be one of the best choices in such lands.

ii. Raising of Shelter belts:

A large number of species are used in the shelter belts, depending upon the height, crown, width and height and its density. Sandal, having a dense crown and of medium height, can be used in between the central and peripheral rows to strengthen the shelter belts as well as making the shelter belts very valuable. In due course sandal is also likely to spread all along the shelter belts thus providing a thick coverage. The ability to grow in shaded conditions makes sandal an excellent species in shelter belts.

iii. Planting on road sides, canal banks etc.:

Though sandal may not be useful as a primary avenue tree, it could be definitely used to form a second line avenue of darker colour. As it has a medium height with dense, dark and evergreen foliage, it is an excellent species for use as a second line avenue. Spacing can be 2.5m to 5m and could be planted either pure or mixed with other species like neem, pongamia, etc.

Likewise all along the river and canal banks sandal could be planted either as a pure crop or mixed with other miscellaneous species or as an under storey of teak, sissoo, bamboo etc.

III. Reforestation of degraded forests:

The usual practice is to plant species which yield firewood and small wood. Though they may be of immediate use, the value of such plantations can be made more valuable by

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m xing with sandal. It is worthwhile introducing sandal in any desirable spacing. The spacing recommended is 5m to 10m. This w ll give 100 to 400 trees per ha which could bring in a lot of revenue after a few decades. The natural r generation will cover le area and make it more productive in due course.

V. Recreation Forestry

The demand for recreational centres for the urban population is increasing day by day. It will be a good idea to introduce sandal also in any recreational forestry programme. Dense groves an be created using sandal purely under close espacement like 2 to 3m.

Sandal can also be used an occasional tree amidst lawns, as an avenue all along the footpaths and as a hedge. By a judicious use of selected types of sandal such as sandal with conical crown, round crown, spreading crown, etc. desired effects can be produced in recreational forestry.

The variation in leaves can be exploited in the landscape gardening. The sandal with narrow long leaves, sandal with large thick leaves, sandal with very small leaves, sandal with pale green leaves, sandal with dark green leaves etc. can all be used according to situations.

18-12-79

(K.R.Venkatesan)
Conservator of Forests
Sandal Research Centre
Bangalore.

rdm.
18.12.

PRELIMINARY FINDINGS ON THE HEARTWOOD FORMATION IN SANDAL (SANTALUM ALBUM L.)

Srimathi, R.A. & Harsh Kumar D.Kulkarni
Sandal Research Centre,
Bangalore.

ABSTRACT

The heartwood formation in sandal has so far not been properly understood. The traditional view is that drier situation, poor soils and medium elevations are conducive to better heartwood formation. The age at which the heartwood starts forming is also reported to be from 15 to 20 years.

Studies undertaken in Sandal Research Centre, Bangalore from 1977 onwards in the various localities in India varying in climatic and edaphic factors shows that sandal can develop heartwood under all situations. The ability to form heartwood, the age at which the heartwood starts forming and the colour of the heartwood seem to be more dependentupon genetical factors rather than on other factors.

Introduction

Factors responsible for the formation of heartwood in sandal has so far been neither understood nor well defined. Information available on this subject is meagre and varied. Even the little information available does not seem to have been based on adequate data. Time and again diverse opinions have been expressed in the literature regarding the growth of the sandal wood tree and its heartwood formation.

Moderate rainfall, stony and gravelly soil, an elevation of 750mm to 1050mm and long spells of dry weather are some of the factors reported to be conducive to the formation of heartwood containing good scented oil. Best growth of sandal is reported to be attaeined in well drained deep alluvium and in places where there is good rainfall. But in such trees the formation of heartwood was considered poor both qualitatively and quantitatively (Bhatnagar (1965), Brandis (1874), Cherry (1898), Guenther (1952), Pigott (1899), Ramarao (1908), Ricketts (1902), Sen Sarma (1977), Walker (1898).

The colour of the wood has been reported to have a direct correlation with the type of soil on which the tree was grown (Ludlow, (1869), Venkata Rao (1939).

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Soil type	Age	Colour of the wood and scent
1. Red and inferior black soil mixed with iron, stone or quartz	24	Red coloured, moderately scented wood.
2. Dry, red surface soil sub soil gravelly quartz.	20	Red coloured scented wood.
3. Black soil, free from stones	30	Yellow coloured light scented wood.
4. Garden soil	40	Yellow coloured light scented wood.
5. White stony soil	16	Pale red coloured wood.

The above reports show that the formation of heartwood, colour of the heartwood and the yield of oil are all dependent on the climatic and edaphic conditions under which sandal trees are growing.

Venkata rao (1939) reports that the scented heartwood does not form till the tree attains an age of 15 to 20 years. While Cameron (1900) reports that the tree attains commercial maturity (the age at which it pays best to fell it down) at 27 to 30 years. At this period the heartwood is well developed at a general depth of 5cm below the surface. Bhatnagar (1965) reports that the sandal trees reach full maturity at an age of 50 to 80 years or more and a tree may reach physiological maturity without forming any heartwood.

Troup (1921) and Fischer (1927) reported that the formation of heartwood and oil in sandal is yet to be studied in detail and worked out.

The Sandal Research Centre has taken up a broad based tree breeding programme with respect to fast growth, heartwood formation, oil yield and resistance to spike disease and pests. A preliminary survey of sandal for variations was conducted and the results obtained from the survey are described and discussed.

Survey:

A survey of sandal for growth, heartwood formation, colour of the heartwood and the depth at which the heartwood is found was undertaken not only in the traditional sandal areas of Karnataka and Tamil Nadu but also in places far away from sandal zone and in even aged plantations. The places surveyed included a wide range of geographical, climatic and edaphic conditions (Table I to III).

Core samples were taken at breast height (1.37m) using a Pressler's borer. The depth at which heartwood was found was measured and also the thickness of bark and sapwood. The elevation, rainfall and soil type were noted. Whenever heartwood was not found at the breast height, a second boring was done at a point as near as the ground as possible.

Observations recorded for different areas are presented in Tables.

Table I - represents data collected from plantations.
II - represents data collected from places outside the natural habitat of sandal.
III - represents data collected from natural habitat of sandal.
IV - represents data collected from Bangalore, Sandal Research Centre campus for one diameter class viz.11cm.

Results:

Plantation data (Table I)

No uniformity in growth was observed even in plantations, though the trees are growing in more or less identical situations. The growth varied from 7.2cm to 14.3cm in dia in a 8 year old plantation at Sholapuram. In a 14 year old plantation it varied from 9.7cm to 16.1cm in dia in the same locality.

Heartwood was found in small as well as bigger sized trees, though many big sized trees did not contain any heartwood. The fact that the trees in a 8 year old plantation can contain heartwood at breast height is interesting as such trees must have started forming heartwood very early in their lives, may be at the 5th or 6th year. It is also significant that one tree has a minimum of 15 kg of heartwood in the 8th year. (14.3cm dia, 8.5m tall, depth at which heartwood found 2.8cm). This has also been selected as a plus tree.

The Mudimalai plantation of Madurai North Division is situated on a sloping terrain where the soil is poor, skeletal and bouldery. The trees in the upper reaches have put on lesser diameter growth than thehtrees at the lower reaches thus showing that the growth is influenced by soil factors. Another interesting fact is that a few trees at lower reaches only have developed heartwood and none in the upper reaches, thus showing that better growth is conducive to heartwood formation.

Trees can develop heartwood even in the 5th or 6th years, however, a number of trees even in 14t and 15th year old plantations have not developed heartwood.

Data from natural and outside natural sandal: (Table II & III)

These data indicate that in all the localities, the trees which enjoy different climates and soils were found to form scented heartwood. Here again, even in the traditional sandal areas there can be all sap trees even in 11cm dia classes and heartwood can be found even in 8cm dia class in the non traditional sandal areas.

Studies in single diameter class: (Table IV)

A study of the population at the Sandal Research Centre Campus, Bangalore restricting to 11cm dia class shows that heartwood can be found at variable depths showing different quantities. The colour of the heartwood also varies from tree to tree. Some trees have not even developed heartwood.

Discussions:

Hosts, age, soils, elevation, rainfall and other factors have been reported to influence the formation of heartwood and its colour. Growth of sandal trees has also been reported to be influenced by climatic and edaphic factors. From our studies it has been found that an 8 year old tree has considerable amount of heartwood, while trees of 15 to 20 years old have not formed heartwood although other factors under which the trees are growing remain identical. It has also been found that trees of different diameter classes as well a single diameter class have scented heartwood at a depth ranging from 0.8cm to 6.0cm and the heartwood colour also varies in the same locality.

With the limited data collected from varied localities and plantations it is evident that the heartwood formation and its colour depend more on the inherent traits than on the site factors. A coordinated approach of geneticists and physiologists will help in understanding this bewildering problem of heartwood formation in sandal.

Conclusions:

The preliminary studies on the heartwood formation of sandal reveal the following:

1. Sandal can grow in all situations like 0°C to 40°C temperature 500 to 5000mm rainfall, from sea level to 1800m and in different soils. In all these places sandal can form scented heartwood.
2. The growth of sandal is not uniform, thus showing that individual traits are exhibited in growth despite similar soil and climate.
3. The ability of sandal to form heartwood seems to be dependent upon the individual characteristics of trees and not by edaphic and climatic factors.

4. The colour of heartwood also does not depend on soils but seems to be determined by individual traits of trees.
5. There is no fixed year when the heartwood starts forming. It can start as early as 5 to 6 years in some trees and as late even over 15 years.
6. Poor soil is not conducive to better heartwood formation nor better soil is inimical.
7. In general, better growth seems to be conducive to the formation of scented heartwood.

All the above facts show that the formation of heartwood in sandal is more dependent upon genetical factors than on other factors. The studies indicate that better quality of trees can be developed through a tree improvement programme which has been envisaged in the programmes of the Sandal Research Centre, Bangalore.

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REFERENCES

1. Bhatnagar, S.P.(1965). Studies in Angiospermic parasites. Santalum album L. Sandalwood tree, No.112(2). Bulletin of National Botanical Garden, Lucknow.

2. Brandis, D.(1874). Forest flora of the North West and Central India. Constable & Co., Ltd., London. p.399.

3. Cameron, J. (1900). Forest Trees. p.234-242.

4. Fischer, C.E.C. (1927). Santalum album L. Kew Bulletin No.5 p. 193-202.

5. Pigott, J.L. (1899). Indian Forester. Vol.23, p.308.

6. Ramarao, M.(1908). Indian Forester. Vol.32.

7. Sen Sarma, P.K., (1977). Cultivation and utilisation of Medicinal and Aromatic plants. ed. C.K.Attal & B.M.Kapoor, R.R.L. Jamu. p.287-298.

8. Troup, R.S. (1921). Silvicultural of Indian Trees. Clarendon Press, Oxford, Vol.III, p.799-819.

9. Venkatarao, M.G.(1939). Unpublished diary notes.

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TABLE - I

Plantation

Plantation Location	Year	Dia cm	Height m	Heartwood data: Depth at which heartwood found cm	Heartwood data: colour
Sholapuram Sandal plantation (Tamil Nadu). Alt. : 30m Rainfall: 1000mm Soil: Alluvial	1964	11.9	7.0	4.5	Brown
		9.7	6.9	3.9	Pink
		16.1	8.5	5.9	Red
		9.15	7.0	All sap	-
		10.8	8.5	2.1	Yellowish brown
		10.4	7.3	All sap	-
		9.7	6.9	3.9	Red
		14.7	7.6	All sap	-
		12.4	9.0	All sap	-
		14.8	7.4	All sap	-
	1970	14.3	8.5	2.8	Yellowish brown
		11.7	7.6	All sap	-
		12.05	7.8	5.0	Red
		11.4	7.2	All sap	-
		12.45	7.5	5.0	Red
		12.25	6.8	5.5	Red
		11.35	6.9	All sap	-
		14.2	7.9	All sap	-
		8.3	6.5	All sap	-
		7.2	6.0	All sap	-
Kudimalai Dindugal (Tamil Nadu) Alt. 300m Rainfall: 800mm Soil: Skeletal gravelly	1965	11.85	7.0	3.4	Yellowish brown
		7.2	4.5	2.5	Pink
		12.7	5.8	4.2	Brown
		11.7	5.9	All sap	-
		10.8	6.2	3.3	Brown
		7.6	4.5	All sap	-
		7.5	5.0	All sap	-

TABLE - II

Sandal Occurring outside the Natural habitat

Location	Dia cm	Height m	Heartwood data: Depth at which heartwood found cm	Heartwood colour.
Andhra Pradesh				
Nehru Zoological Park	15.15	7.7	4.0	Yellowish brown
Hyderabad	19.85	11.7	All sap	-
Alt. 510m	12.65	9.9	5.9	Pink
Rainfall:770mm	13.85	8.7	5.2	Y. [illegible]
Soil: Red gravelly	12.5	5.2	4.4	Yellow
	15.1	8.5	6.3	Grey
	14.25	10.7	4.8	Y.Brown
	13.4	8.3	2.0	Brown
	12.35	8.7	All sap	-
	9.6	6.5	All sap	-
Maharashtra				
Ajra(Kholapur)	11.8	4.6	2.3	Brown
	11.7	4.5	5.0	Brown
Alt. 660m	17.2	6.2	5.8	Y.Brown
Rainfall:3000mm	8.8	3.5	3.3	Brown
Soil: Red loam	11.85	4.5	2.5	Brown
	11.15	5.0	All sap	-
	13.25	5.8	3.2	Brown
	11.9	5.2	All sap	-
	10.2	4.9	2.8	Y.Brown
	11.05	5.3	4.3	Y.Brown
Orissa Janiguda	14.9	8.0	3.0	Yellow
(Koraput Divn.)	19.0	8.5	4.3	Y.Brown
Alt.900m	13.05	9.2	3.0	Y.brown
Rainfall:2500mm	14.35	9.3	1.9	Yellow
Soil:Red loam	20.0	10.2	3.9	yellow
	11.0	11.7	2.4	Brown
	9.5	6.4	2.8	brown
	17.25	11.0	4.0	yellow
	14.80	10.6	4.0	yellow
	15.7	9.8	6.0	Y.Brown
Kerala state	14.05	6.0	3.5	brown
Kasargode	9.3	5.5	All sap	-
Alt.60m	11.85	6.5	3.0	brown
Rainfall:5000mm	14.45	5.9	6.0	brown
Soil: laterite	13.15	5.2	All sap	-
Nyhad	38.18	14.0	6.4	Yellow
Alt: 840m	10.9	5.1	All sap	-
Rainfall:4000mm	14.6	6.0	3.5	Yellow
Soil:Clayey loam	13.6	7.0	All sap	-
	18.85	8.6	5.59	Y.Brown
Madhya Pradesh	10.3		3.6	Brown
Senni	7.0		1.7	Brown
Alt.750m	11.0		2.7	Dark brown
Rainfall:1500mm	9.7		2.0	Y.Brown
Soil: Red loam	10.6		1.6	Y.Brown
Uttar Pradesh	11.2		2.2	Brown
Dehra Dun	13.0		1.5	Light brown
	8.25		1.9	Brown
Alt: 950m	10.25		3.1	Brown
Rainfall:2000mm	10.35		1.8	Y.Brown
Soil: Red loam Alluvium				

TABLE - III

Natural sandal plantation

Location	Dia cm	Height m	Heartwood data: Depth at which heartwood found cm	Heartwood data: Heartwood colour
Karnataka				
i.Kunchanhalli Shimoga	10.9	6.8	1.5	Brown
	14.0	7.2	1.3	Brown
	11.05	7.0	2.8	brown
Alt.: 500m	11.4	7.2	2.5	Y.Brown
Rainfall: 1500mm	14.7	8.1	3.5	brown
Soil: Lateritic	12.1	8.0	2.8	Light brown
	8.05	8.7	1.3	Y.Brown
	15.3	9.0	3.7	brown
	18.6	9.5	2.9	brown
	20.0	9.6	4.6	Y.brown
ii. Kushalnagar Coorg	23.9	8.0	3.5	brownish yellow
	30.15	14.0	3.3	dark brown
	27.75	14.2	5.5	Greenish yellow
Alt.850m	21.25	9.0	3.0	brown
Rainfall:1500mm	24.45	8.0	3.5	Y.brown
Soil: Black cotton	20.7	10.0	2.0	Y.brown
	13.3	6.0	4.3	Y.brown
	12.7	6.2	5.0	Y.brown
	17.75	11.0	6.0	Yellow
	15.6	10.5	3.6	brown
iii.Chamrajnagar Mysore	16.55	6.3	4.4	Y.brown
	10.9	4.0	0.9	brown
	9.9	4.6	1.9	brown
Alt. 850m	16.25	4.5	3.2	brown
Rainfall:800mm	13.50	5.0	0.8	Y.brown
Soil: Red loam	13.9	7.5	3.4	brown
	13.7	7.0	5.8	yellow
	15.2	7.0	5.4	yellow
	11.1	5.0	All sap	-
	11.6	6.0	All sap	-
Tamil Nadu				
i. Guindy Park Madras	12.75	10.7	12.9	grey
	12.8	11.8	4.9	brown
	14.9	12.2	2.4	grey
Alt.: 0m	18.6	4.7	5.0	brown
Rainfall:700mm	15.55	9.2	2.3	Y.brown
Soil: sandy	17.4	6.7	2.4	Y.brown
	10.4	5.7	All sap	-
	13.6	7.7	All sap	-
	20.0	12.0	4.3	yellow
	13.65	7.5	3.0	Y.brown

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1	2	3	4	5
ii. Puttur (on the bank of Pudu-nanniar (Tanjavur)	14.72	8.1	2.3	brown
	12.7	8.0	1.7	Reddish brown
	7.64	7.9	3.0	brown
	13.04	8.2	2.8	brown
	11.45	7.5	2.2	grey
Alt.: 50m	8.01	5.0	1.9	Y.brown
Rainfall: 1000mm	13.04	8.5	All sap	-
Soil: Alluvium	11.13	7.3	2.2	Y.brown
	11.29	7.0	3.9	grey
	9.67	6.0	All sap	-
iii. Courtallum	13.0	6.8	All sap	-
	9.5	5.4	All sap	-
Alt. 180m	14.25	7.9	3.4	Y.brown
Rainfall: 900mm	13.25	7.5	2.4	brown
Soil: Lateritic	12.65	7.4	1.0	brown
	11.0	8.2	2.1	brown
	14.25	8.5	3.2	brown
	14.65	9.0	1.5	brown
	10.45	7.4	4.3	Y.brown
	12.85	8.9	4.5	light brown
iv. Dindugal	12.2	7.0	3.2	Y.brown
	13.3	6.4	3.3	Y.brown
Alt.330m	13.45	8.8	2.0	brown
Rainfall: 250mm	11.95	6.9	3.8	brown
Soil: Rocky gravelly	8.85	5.0	All sap	-
	10.75	6.5	All sap	-
	11.85	6.3	All sap	-
	7.2	5.4	2.5	pink
	10.1	6.0	All sap	-
	8.0	5.7	All sap	-
v. Coimbatore	9.8	6.0	1.5	brown
	12.15	7.2	3.4	brown
Alt. 450m	12.05	6.8	3.3	dark brown
Rainfall: 2270mm	10.1	6.5	1.7	pink
Soil: Black cotton	8.6	7.2	All sap	-
	8.05	6.0	All sap	-
	13.4	6.9	1.7	Y.brown
	10.95	7.1	3.5	Y.brown
	12.2	7.3	3.4	Light brown
	16.0	11.0	All sap	-
vi. Kurumbapatti Salem.	30.86	8.7	2.8	Y.brown
	21.63	7.6	1.9	light brown
	32.13	11.9	2.5	brown
Alt. 590m	25.7	8.8	5.2	Y.brown
Rainfall: 760mm	13.0	5.7	1.7	Reddish brown
Soil: Red loam	18.45	5.9	3.9	brown
	19.45	7.7	3.3	yellow
	15.9	6.8	4.2	yellow
	10.3	6.2	All sap	-
	13.4	7.0	All sap	-

PRELIMINARY INVESTIGATIONS ON THE HEARTWOOD BORER OF SANDAL

APP. VII

V.R.Sivaramakrishnan, Research-Officer
&
K.R.Venkatesan,
Conservator of Forests,
Sandal Research Centre, Bangalore.

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SUMMARY

Sandal plants are known to be affected by fire and spike disease in nature. However, in none of these cases the heartwood suffers but remains in tact.

Preliminary survey of the sandal trees in sandal depots and in the field showed bore holes and hollowness of heartwood in the living and dead conditions. 25-40% of the trees were affected.

The causal agent was identified as Aristobia octofasciaulata, Aurvillius, which emerged from the affected heartwood. The loss per year on account of this borer is estimated to be not less than Rs.350/- lakhs.

The preliminary study on the life history, nature of damage and future work proposed is presented.

Introduction

Sandalwood has been the article of national and international trade for perfumery industry. The present value of sandal is about Rs.40,000/- per tonne for all classes whereas better classes like Chatbadla can fetch about Rs.70,000/- per tonne and when the demand for good quality heartwood of sandal is on the increase, there is less of supply.

In nature sandal is reported to be dying due to many reasons like fire, spike disease and other biological agencies. However, in all these cases, the heartwood remains intact.

The dead and living sandal trees in various sandal kotis in Tamil nadu and Karnataka on examination, showed that in many cases the heartwood contained several bore holes and a number of trees were also found to be hollow. The presence of the bore holes and the hollow heartwood was found in the old trees and medium aged trees.

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Though Stebbing (1905, 1908) and Wilson (1916) have reported Stromatium sp. and Celosterna sp. attacking sandal in North Coimbatore, the Javadi and the Yellagiri Hills, none of these species seem to be responsible for the borer damage in the heartwood. Beeson, (1941), Mathur et al (1961) and Brown (1968) have recorded Aristobia octofasciculata Aurvillius (Cerambycidae: Coleoptera) broing the small branches and stem of saplings. It is therefore evident that either the hollowness and the bore holes in the heartwood escaped the notice of the concerned persons, of the heartwood borer was not found in those days. No action as to the investigation into the causal agent bringing about this damage appears to have been attempted, not to speak of any remedial measures to control the damage.

This interesting and important problem was taken up at the Sandal Research Centre in 1977. A survey of the sandal koties in Tamil Nadu and Karnataka and Andhra Pradesh was undertaken which revealed that 25-40% of the trees showed bore holes in the heartwood as well as hollows and in one lot from a locality in Vellore Division 90% of the trees were affected.

The grubs were extracted from the bore holes and were bred in the laboratory. The adults emerging during April-May were sent to the Forest Entomologist, F.R.I. & Colleges. They were identified as Aristobia octofasciculata Aurvillius (Cerambycidae, Coleoptera). Adult beetles were also collected from the double lock at Tirupathur sandal koti and Mysore.

Distribution:

The pest was recorded on sandal in the usual sandal tracts as well as from far off places where there was practically no continuity between the sandal populations and also in isolated patches of sandal trees in the following localities: several parts of Tamil Nadu like Vellore, Tirupathur, Dindigal, Tirunelvelly, Salem, Marakanam near Pondicherry; Chittoor in Andhra Pradesh; Kollegal, submersion areas of Chamarajnagar, Kolar, Shimoga, Mudigere, Bangalore in Karnataka and Ajra in Maharashtra.

Collateral hosts:

So far sandal is the only recorded host of this pest.

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Nature of attack:

In the field no signs of the borer attack are visible though a closer examination of the branches and the bark may reveal the adult feeding and site of oviposition.

The adult beetle gnaws the bark of branches of all classes of trees upto the inner cambium and girdles it. Even sandal trees with no heartwood are also attacked and the beetle successfully completes its life cycle. As a result of this feeding, the younger plants die back, the branches break in a strong wind or the top dries completely.

An examination of the dead and living sandal trees brought to the various sandal kotis in Tamil nadu and Karnataka was undertaken to study the heartwood. It was found that in many cases the heartwood contained several bore holes. Besides the borer holes, a number of trees were also found to be hollow with barely 1 to 2cm of heartwood sticking to the inner surface of the sapwood. The bore holes may be present on both the branches and the main stem, depending upon the site and the number of oviposition. The heartwood showed two kinds of hollowness (a) the central core partially hollowed having only a very thin, just 1cm or slightly more strip of heartwood all round sticking to the inner sapwood and (b) most of the tunnels getting fused in the periphery leaving a socket like heartwood core in the centre with a surrounding hollow portion.

The presence of the bore holes and the hollow heartwood was found not restricted to the old trees only but was found in younger and medium aged trees also.

Beetle:

Length 1.7cm to 2.95 cm elytra and head brick red in colour dorsally, abdomen legs and ventral portion of head black; antenna 7 segmented, black, muffed at the joints of the segments; longer in the male and brittle.

Larva 3-5cm long when full grown with a yellowish thoracic dorsal shield.

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Life history:

The beetle is on the wing immediately after the first rains during April-May and appears in numbers by day, feeding on the bark of living shoots of sandal. The attacked shoots are girdled and die later. In extreme cases the young plants are killed outright. Eggs are laid either on the branches close to the main stem or on the main stem, the female biting a crescent shaped groove where the egg is deposited. Upto 15 eggs were recorded for a single female in the laboratory conditions. The adult beetle lives upto 45 days in captivity.

On hatching, after an incubation period of 8-10 days during April-May, the larva feeds its way into the branch or main stem through the bark and sapwood and excavates long tunnels downwards from one to three metres. Some of the trees examined showed that the grub had started to feed in the branches and then bore down into the main stem downwards. However in the majority of trees the larval gallery is entirely confined to the main stem. These galleries are packed with digested wood particles which are passed out by the larva as it penetrates down the stem. In one extreme case as many as 20 grubs at varying heights of a single tree were extracted. The bore hole is about 2cm in diameter.

Pupation occurs at the end of the tunnel which goes upto the root portion in some cases, the larva, before pupating, reverses its position from its head downwards and gnaws a thin part of the sapwood very near the bark for the exit of the adult. The beetle gnaws its way out through a circular hole, The life cycle is annual.

Hollowness in sandal trees:

Though hollowness in old trees is a usual phenomena, it cannot be so in the case of medium aged trees which are at the prime of health. When this was examined closely it was found that in many cases the deterioration of heartwood was found to be taking place all around the bore holes made by the heartwood borer, where parts of the original holes was intact. This is probably brought about by the accumulation of moisture and dust inside the bore holes, which act as a breeding ground for the wood rotting fungi. Partially rotted heartwood has been collected from many places. The identification and culture of the fungus is being done separately. Therefore, the hollowness can be directly attributed to the heartwood borer.

Economic importance:

Of all the pests and diseases of sandal, the heartwood borer is likely to be the most serious because even young saplings are attacked and twig dried out, heartwood bored and finally is responsible for the hollowness of the heartwood. Therefore this may be considered to be of higher damage potential than even the spike disease as this pest attacks the most valued heartwood which is reduced in quantity and quality.

It has been calculated that a bore hole caused by Aristobia octofasciculata measuring almost about 2cm in dia and an average length of 2m can bring about a loss of about 0.5 kg. If 20 such bore holes are found a tree may lose as much as 10 kg of heartwood which at the present value will mean a loss of Rs.400/-. As the hollowness in trees are also attributed to this borer, the damage to the heartwood due to the hollowness is much more. In a rought appraisal, an average hollow tree may lose as much as 30% of its heartwood. Taking an average tree to have 20 kg. of heartwood, normally valued at Rs.800/- to lose 6 kg of heartwood valued at Rs.240/- is a considerable loss.

Even at a low estimate of 10% of the trees with one bore hole each, 10% of the trees with hollow, the estimated loss for Tamil Nadu and Karnataka which produce about 2500 tonnes of sandal per year, will not be less than Rs.350 lakhs. Here the number of trees required to produce one tonne of heartwood has been taken as 100.

Further work proposed

It is priposed to undertake a detailed study of the heartwood borer of sandal in relation to its host spectrum, enemy complex and other factors. Usually the sandal trees are associated with certain species of ants. It is proposed to study the relation of these ants in the biological control of this pest.

The Sandal Research Centre is already engaged in the breeding of sandal for better growth, heartwood content, resistance to spike disease etc. It is proposed to take up breeding of sandal against the heartwood borer also by investigating into the resistance mechanisms available in the present populations of sandal.

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REFERENCES

1 Beeson, C.F.C., 1941. Ecology and control of Forest insects of India and neighbouring countries, Vasant Press, Dehra Dun, pp.1007.

2 Brown, E.A., 1968. Pests and diseases of Forest Plantation trees. Clarendum Press, 1968.

3 Mathur, R.N., and Balwant Singh., 1961. Indian Forest Bulletin, 191 (8), (New series) Entomology: list of insect pests of plant genera - (S).

4. Stebbing, E.P., 1905. Departmental notes on Insects affecting forestry. pp.469.

5. Stebbing, E.P., 1918. Indian Forest Insects, Coleoptra, Eyre & Spottiswood, London.

6. Wilson, C.C., 1916. Working Plan for the Javadis & Yelagiri Hills.

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Tuesday, March 4, 1980 DECCAN HERALD 7

Saving tanks thro' saplings

By K. Bhanumathi

MUNIYAPPA is a farmer near the Gummareddipur tank in Srinivasapur Taluk of Kolar District. His back goes stiff with resistance when he views the 100-acre plot beside the tank where native and exotic two-year-old saplings of eucalyptus, sandal, sissoo, bage, bilwara and the manure-rich gliricidia wave their slender branches in the breeze.

To him the plot, taken up by the Forest Department represents a denial of a source of fodder and easy access to water for his cattle. He still has to wake up to the idea of social forestry and its beneficial long-term plans, which the Forest Department has adopted with earnestness in Kolar and Bijapur Districts. He is slow to grasp that the plot in five years will provide his goats with fodder, his family with fuel and timber and his land with green manure.

The Gummareddipura tank foreshore afforestation plantation is one of the 86 started in the district in 1978 to cover 1,500 hectares of tank-border area. Many of the 3,760 tanks in the district are in different stages of silting. After five years, the plantations will be thrown open to the villagers and their cattle.

The main reason for planting thousands of saplings around tanks? To prevent their silting due to soil erosion and ultimate drying up, a visiting press party from the City was told. The saplings have been chosen with care to meet different needs of the people in the future—small timber needs, fuel, manure, and fodder, according to Mr. S. M. Bhagwath, Chief Conservator of Forests (Development). Besides the koobabul, a fodder plant, a protein-rich, highly nutritive ground level variety of fodder for cattle—the Carribean legume—has been planted between the lines of saplings to enable it to procreate and spread.

At the Thimmasandra tank, also in Srinivasapur Taluk, 100 acres were planted with saplings in 1979 and 100 more will be treed this year.

ASPECT

Another aspect of social forestry is the encouragement given to farmers to take to tree-planting, as a means of augmenting agrarian income. Under the scheme, 2,000 seedlings are given free to each farmer. In Kolar District 119 lakh eucalyptus saplings—the most popular species—have been distributed to over 20,000 farmers so far. In the district, 20,000 hectares are under eucalyptus cultivation. Eucalyptus is a money-spinner. Its wood pulp yields rayon and polyester fibres. It is priced at Rs. 230 a ton, according to Mr. S. Shamsundar, Conservator, Research and Utilisation.

The Gummareddipura Tank foreshore afforestation plantation—one of 86 started in Kolar District in 1978 to combat soil erosion and prevent tanks from silting and drying up.

To provide the farmers with saplings, the Department has set up 84 nurseries for seed and sapling multiplication, according to Mr. S. K. Varadaraj, Conservator, Bangalore Circle. At the Medarahalli forest nursery, saplings like sandal and tamarind are raised in polythene bags filled with earth, while at the Khasipura Pasture Seed Nursery, fodder varieties are bred. The seed nursery which has 15 qtl. of legume seeds after using an equal amount, raised its "prize-stock" from 100 gm of seed, donated by a World Bank expert in 1978.

The social forestry norm includes under its spread avenue planting. The Department covered in 1979 535 km of road in 11 districts, including the National and State highways, at a cost of Rs. 32 lakhs, according to Mr. Bhagwath.

Social forestry in the State got Rs. 80 lakhs as its budget last year in addition to Rs. one crore for afforestation of degraded areas, another important aspect. Kolar District's share is Rs. 4.2 lakhs.

In a bid to raise the State average of forest land which is now only 15.4 per cent (15 per cent is the national average), the Department plans to take up planting of trees in revenue lands in the C (agriculture possible after heavy expenditure) and D (rocky area) classes. The land which was handed over to the Department, on paper, by a Government order last year, is yet to be received in full. Of the 14 lakh acres of C and D land in the State, only two lakhs have been handed over, according to the officials.

Another aspect of social forestry is planting of trees at public-owned industries, wholly at the department's expense. In the City, a beginning was made last year, when 100 acres at BEL were dotted with saplings. This year, 100 acres at HAL and 500 at IAF Yelahanka will be planted. The understanding is, at the time of harvest, the yield should be shared equally between the Department and the factories according to the officials.

Recreation forests like the Bannerghatta national park also come under the purview of the social forestry scheme.

The main cry of the Department is for more finance. Their other bottlenecks are non-availability of land and non-co-operation from the villagers, stemming both from apathy or hostility.

TABLE - IV

Diameter constant

Location &	Dia cm	Height m	Heartwood data: Depth at which heartwood found cm	Heartwood data: Heartwood colour
Sandal Research Centre Bangalore. Alt. :900m Rainfall:700mm Soil: Red loam	11.0	9.7	2.8	brown
	11.2	9.7	1.8	Y.brown
	11.35	14.0	2.7	brown
	11.05	11.5	3.0	P.brown
	10.5	6.2	All sap	–
	11.05	14.7	All sap	–
	11.1	11.7	2.0	brown
	10.85	5.2	2.4	yellow
	11.35	8.2	2.3	yellow
	11.25	3.6	2.5	dark brown
	11.05	10.4	2.5	brown
	11.0	15.0	1.8	Y.brown
	11.15	9.7	2.8	brown
	11.15	8.6	1.9	yellow
	11.0	9.8	2.3	yellowish brown
	11.0	8.6	1.9	brown
	11.0	3.16	3.8	Y.brown
	11.6	9.2	2.6	brown
	11.4	9.8	1.7	brown
	11.15	9.2	2.0	brown
	11.3	6.0	2.5	brown
	11.6	6.5	2.0	Reddish brown
	11.0	3.2	2.9	-do-
	11.4	6.2	4.4	Yellowish brown
	11.1	7.6	2.2	brown
	11.7	8.3	2.0	light brown
	11.4	10.0	4.4	Yellowish brown
	11.05	11.0	All sap	–
	11.4	10.5	2.2	light brown
	11.4	9.7	2.4	yellow
	11.6	10.2	5.0	brown
	11.0	8.7	2.5	brown
	11.1	7.9	2.5	yellow
	11.5	7.2	2.1	yellowish brown
	11.2	7.0	2.3	yellow
	10.65	8.0	2.4	brown
	11.1	7.2	2.8	greyish brown
	11.0	6.3	4.0	brown
	11.1	7.2	2.2	brown
	10.8	6.9	2.3	Yellowish brown
	11.0	8.1	2.4	-do-
	11.15	7.7	1.8	-do-
	11.65	6.7	3.6	brown
	11.15	5.7	2.4	yellowish brown
	10.8	8.4	3.0	dark brown
	11.0	9.0	3.0	dark brown
	11.0	9.0	3.5	yellowish brown
	11.0	8.4	0.55	brown
	11.3	8.3	1.0	brown
	11.5	8.0	4.0	brown