

PHYSICAL AND ANATOMICAL CHARACTERISTIC OF WOOD OF SOME LESS-KNOWN TREE SPECIES OF KERALA

K.V. Bhat



KERALA FOREST RESEARCH INSTITUTE
PEECHI, THRISSUR

December 1994

Pages: 25

CONTENTS

	Page	File
Summary		r.96.2
1 Introduction	1	r.96.3
2 Materials and Methods	2	r.96.4
3 Results	4	r.96.5
4 Discussion	21	r.96.6
5 Conclusion	23	r.96.7
6 Literature cited	24	r.96.8
7 Figures		r.96.9

SUMMARY

Wood characteristics of 21 lesser-known tree species of Kerala forests were examined in the present study. The properties investigated include physical features of wood like colour, grain, texture, heartwood content, basic density and shrinkage in addition to the anatomical structure of the wood. Majority of the timbers examined have density value comparable to commonly used structural and joinery timbers. However, only a few species like *Aglaia barberi*, *Aporusa lindleyana*, *Ormosia travancorica* and *Pterospermum rubiginosum* possess a distinct, wide heartwood. Rest of the species which have a narrow or indistinct heartwood are not likely to be durable unless treated with preservative chemicals. Except for a few species like *Euodia lunu-ankenda*, *Aporusa lindleyana*, *Ormosia travancorica* and *Syzygium chavaran* the majority of timbers have high shrinkage. A number of species are likely to be useful for furniture-making or turnery due to their decorative figure and fine texture. However, a few like *Garcinia morella*, *Madhuca bourdillonii*, *Mastixia arborea* and *Polyalthia coffeoides* were found to be less suitable for the above purposes. On the whole, the study suggests that a good proportion of the native, less-known hardwoods possess timber value which can be exploited for achieving optimum use of the resource.

INTRODUCTION

Situated between 8° 18' and 12° 48' N latitude and 74° 52' and 77° 22' E longitude, Kerala State forms a small portion of the richly forested tropical belt of the world. The State which encompasses the southern third of the Western Ghats, once known to possess luxuriant humid tropical vegetation comparable to similar vegetation of the world, is one of the botanically rich forest areas of the country. Although the species diversity in tropical forests of Asia Pacific Region is, in general, not comparable in magnitude to that in Latin American forests, the wide geographic and climatic variations within this region have led to occurrence of diverse vegetation types of differing species composition. Out of the total of about 4000 species of flowering plants known to occur in Western Ghats (Nair and Daniel, 1986) over 3000 species occur in Kerala forests. Of these, roughly 600 are trees and more than 350 of them are medium to large trees of exploitable size.

Kerala State has a long tradition in forestry, forest-based industries and timber trade. Forest exploitation in this part of the country dates back to early 19th Century (Karunakaran, 1986). However, the trend of forest utilization, as elsewhere in the country, has been a selective exploitation of commoner tree species of known timber value for various purposes like construction, railway sleepers, boat and shipbuilding. There has been hardly any change in this tendency over the years although a few more species have gained entry into the list of commercially important timbers because of their acceptability for plywood and panel products. Presently just over a hundred timbers of Kerala can be grouped under commercial timbers or, at least, known in timber trade and manufacture. Technical properties and utilisation technology of such timbers is rather well established due to tests carried out at FRI, Dehra Dun and elsewhere in the country. Comprehensive publications on wood structure, properties and utilisation of important Indian commercial timbers are already available based on these earlier investigations (eg. Pearson and Brown, 1932; Trotter, 1960). A more extensive coverage of timber species of the country including popular and lesser known ones, is available from the works of Brandis (1906) and Gamble (1922) and particularly of Kerala region from Bourdillon (1908). However, these monumental works, although most valuable from botanical point of view, provide only a preliminary account of the wood characteristics. Similarly more recent series of "Indian Woods" (Choudhury and Ghosh, 1958; Anonymous, 1963; Rao and Purkayastha, 1972; Purkayastha, 1982; 1985) provide only brief descriptions of several native timber species.

It is obvious that a large number of potentially useful tree species (roughly 2/3 of the total) that occur in the forests of Kerala are under-used and go as 'miscellaneous species'. Their wood quality or possible uses remain less known except locally in certain cases. Very often these timbers are regarded as inferior due to various reasons and this widely prevalent notion

prevents their acceptability for better purposes other than packing case manufacture, temporary construction etc. Further limitations are their localised distribution and limited availability. However, it is worthwhile to note that such miscellaneous species together constitute a significant component of the total forest wealth and improved utilization of such timbers will be a partial solution to the shortage of traditionally used timbers. There is evidence to show that some of the less known hardwoods have the potential as effective substitutes for reputed timbers and cases are known of a few timbers, less known at one time which later gained much popularity in the international market (Tamolang *et al*, 1982). Therefore screening various under-utilised native tree species for their timber value has great relevance in the present context not only to accomplish the optimum use of our finite resources, but also to adopt a more balanced approach in wood utilisation. Although many promising species have limited export potential due to their inadequate supply there is ample scope for intensifying their use at the local level. With the use of modern processing techniques it is no longer a difficult task to improve the quality of wood in terms of its service life, drying behaviour or manufacturing qualities whereby each timber can be put to a better use than what it used to be earlier.

Besides utilisation, study of wood properties of native species has got both academic and informative value. From conservation point of view it helps in proper appraisal of different forest trees and to build up a comprehensive data base on various aspects of different forest trees and to identify promising species for experimental trials. Such studies are warranted particularly in the Indian context since practically very little is known about wood properties of many indigenous forest trees.

Considering the importance of data on native forest trees to facilitate a sustainable use of the resources this study is undertaken to look into basic properties of some less known tree species of Kerala forests (Table 1).

MATERIALS AND METHODS

Wood samples of different tree species (Table 1) for the study were obtained from mature standing trees from natural forests. Depending on availability, 2 to 4 trees were sampled per species. The tree girth, sapwood width, thickness of bark, wood colour, odour, etc. were recorded during the collection. Leafy twigs were also collected from the trees for subsequent authentic identification of species. Using a 0.4 cm dia. increment borer, core samples were extracted from breast height level of each tree and were properly covered and transferred to the laboratory without appreciable moisture loss. Each increment core was subdivided in such a way as to obtain representative samples for outer, middle and inner portions of the stem radius (computed from field measurements) and were precisely end-trimmed to facilitate accurate length measurement. The length and diameter (along tangential direction

Table 1. Details of timber species investigated and the localities of collection

Species	Local name	Locality of collection
<i>Aglaia barberi</i> Gamble	Not known	Palappilly, Achenkovil
<i>Aporusa lindleyana</i> (Wt.) Baill.	Vetti	Pothumala, Thirunelli
<i>Dimocarpus longan</i> Lour.	Chempoovam	Peechi, Pothumala
<i>Diospyros buxifolia</i> (Bl.) Hiern	Elichuzhi	Achenkovil, Peechi
<i>Diospyros crumenata</i> Thw.	Karimaram	Peechi, Pothumala
<i>Drypetes oblongifolia</i> (Bedd.) Airy shaw	Malampayin	Pothumala, Vellanimala
<i>Dysoxylum beddomei</i> Hiern	Akil	Peechi
<i>Euodia lunu-ankenda</i> (Gaertn.) Merr.	Kambili	Pothumala, Chimmini, Achenkovil
<i>Garcinia morella</i> (Gaertn.) Desr.	Chigiri	Pothumala
<i>Heritiera papilio</i> Bedd.	Chocklamaram	Thirunelli, Peechi
<i>Litsea floribunda</i> (Bl.) Gamble	Not known	Pothumala, Thirunelli
<i>Madhuca bourdillonii</i> (Gamble) H.J.Lam	Thandidiyan	Vellanimala
<i>Mastixia arborea</i> (Wt.) Bedd. ssp <i>metziana</i> (Wang) Mathew	Vella adambu	Peechi
<i>Ormosia travancorica</i> Bedd.	Malamanchadi	Vellanimala
<i>Palaquium ravii</i>	Not known	Peechi
<i>Polyalthia coffeoides</i> (Thw.) Benth.ex HK. f. &Thoms	Nedunaru	Achenkovil, Palappilly
<i>Pterospennum rubiginosum</i> Heyne ex Wt. & Arn.	Chittilaplavu	Palappilly, Peechi
<i>Strombosia ceylanida</i> Gardn.	Kal kadambu	Achenkovil, Vellanimala
<i>Syzygium chavaran</i> (Bourd.) Gamble	Chavaran	Vellanimala, Achenkovil
<i>Terminalia travancorensis</i> Wt. & Arn.	Peikkadukka	Pothumala, Achenkovil
<i>Vepris bilocularis</i> (Wt. & Am) Engl.	Moothassari	Achenkovil, Peechi

of wood) measurements of the core samples were done with a screw gauge of 0.01 mm accuracy and the readings were used to calculate volume as well as shrinkage percentage subsequently. After the measurement, the samples were oven-dried for 48 hours at 110° C, cooled in a desiccator and weighed. The radial and tangential dimensions were also measured again. The basic density and shrinkage percentages were calculated using standard formulas. The values for outer, middle and inner portions of the stems for different trees were computed separately to find out the range and to calculate average breast height values for density and shrinkage.

The increment core samples were subsequently used for anatomical studies. For microtomy, the samples were mounted with proper orientation on end grain surface of wood blocks of appropriate size using 'Araldite' adhesive. After waterlogging the blocks by boiling them, transverse, radial and tangential sections of 25µ m thickness were cut on a Reichert sliding microtome. The sections were stained in Safranin-Fast Green (Johansen, 1940), dehydrated and mounted on slides for microscopic observation. The cell dimensions were measured from sections and maceration preparations and for each dimension 50 cell elements were measured microscopically at random.

RESULTS

The data gathered on tree characteristics, wood properties and structure are presented species-wise. The details include botanical name(s), synonym(s) and common name(s) if any, family, tree height and diameter and other bole characteristics; wood physical characteristics like colour, texture, grain, heartwood extent, basic density and shrinkage; and wood anatomical details such as type and arrangement of cells, their dimensions, special structural features etc. The range of values given for describing certain properties are based on observed minimum and maximum values rounded off to the nearest multiple of ten. Characteristics such as heartwood extent are described in relative terms such as broad or narrow based on measurements since the features are highly variable depending on tree age and size.

Aglaia barberi Gamble
Meliaceae

Local names: Not known

Medium to large sized tree found in evergreen and semi-evergreen forests, with over 20 m height and 60 cm diameter. Bark up to a cm thick, exfoliating in flakes, surface rather rough, dark brown.

Physical characteristics and structure of wood

Medium fine textured, heavy wood with a narrow pinkish white sapwood and a pinkish brown or reddish brown heartwood. With fine tangential markings of soft tissue. Grain straight to more commonly interlocked. A faint odour present when fresh. Basic density in the range of 670-730kg/m³. Average basic density 710kg/m³. Meantangentialshrinkage 8.6% and radial shrinkage 3.6%.

Diffuse porous wood with no distinct growth rings. Vessels solitary or in short radial multiples and evenly distributed. Vessel diameter ranging from 60to 150µ m. Perforation simple. Pits minute, numerous and alternate. Deposits abundant in heartwood vessels occluding the lumen. Parenchyma predominantly in straight or wavy tangential bands. Rarely scanty paratracheal to thin sheaths around vessels and with narrow wing like extensions connecting nearby vessels. Individual cells ranging from 120to 260µ m in length and 15 to 30µ m in diameter. Cells containing abundant extractives in heartwood. Crystals rarely found, in chambered cells. Fibres septate and thin-walled. Lumens without appreciable infiltration contents. Rays 1 to 3 seriate, more commonly biseriate. Ranging from 100to 450µ m in height and 10to 35 µm in width. Closely spaced and heterogeneous with usually a single marginal row of square cells. Ray heterogeneity sometimes less pronounced.

Aporusa lindleyana (wt.) Baill.

Syn: *Scepa lindleyana* Wt.

Euphorbiaceae

Local name: Vetti

Medium sized tree found in evergreen and semievergreen forests, with a branched or forked stem attaining a height of 12-15 m and diameter of 40cm. Bole rather crooked. Bark 0.5 to 1.0 cm thick, vertically striated, surface rough, greyish brown.

Physical characteristics and structure of wood

A hard, medium textured wood. Sapwood pinkish white, narrow, heartwood pinkish brown to pale brown. Grain usually interlocked to wavy. Basic density in the range of 620 - 680 kg/m³. Average basic density 650 kg/m³. Meantangential and radial shrinkage values 5.6% and 2.6% respectively.

Growth rings not distinct. Wood diffuseporous with vessels occurring in singles or short radial multiples. Pore clusters fairly common. Rather unevenly distributed. Often a tendency of grouping in tangential lines evident. Vessel diameter ranging from 70 to 150 μ m Perforation simple. Deposits rarely present. Tracheids present in addition to vessels either in association with the latter or as independent strands. Parenchyma predominantly paratracheal, scanty paratracheal to inconspicuously vasicentric, occasionally connecting adjacent vessels or forming short inconspicuous lines. Diffuse parenchyma present. Cells ranging from 70 to 160 μ m in length and 15 to 25 μ m in diameter, containing abundant extractives in the heartwood. Crystals not found. Fibres non-septate and thin walled with a tendency of arrangement in radial rows, without appreciable amount of extractives in the lumen. Rays 1 to 5 seriate, commonly 2 to 4 seriate. Height ranging from 220 to 600 μ m rarely up to 850 μ m and width 20 to 60 μ m, closely spaced. Heterogeneous with one or occasionally more rows of square or upright cells. Uniseriate rays composed of upright and square cells. Organic deposits abundant, crystals not found.

Dimocarpus longan Lour.

Syn: *Euphoria longan* Lamk., *Nephelium longana* (Lamk.) Gamble
Sapindaceae

Local names: Chempoovam, Poripunna, Chempunna

Medium sized tree of evergreen and semi-evergreen forests, with a height of 20 m and a diameter of 40-50 cm. Bole nearly straight. Bark less than a cm thick, surface smooth, greyish brown.

Physical characteristics and structure of wood

A medium textured, hard, usually interlocked grained wood with a pinkish white sapwood progressively darkening and merging with an inner core of pinkish brown or light reddish brown heartwood. With scarcely distinct growth markings. Basic density in the range of 650 · 770 kg/m³ with an average of 710 kg/m³. Mean tangential and radial shrinkage values 9.5% and 4.8% respectively.

Growth rings distinguishable due to apparent difference in wall thickness of latewood and earlywood fibres. Wood diffuse porous. Vessels solitary and in short radial multiples. Long radial multiples occasional. Vessel diameter ranging from 50 to 130 μ m. Perforation simple. Inter-vessel pits very minute and alternate. Gummy deposits frequent in vessels of heartwood. Tyloses not found. Tracheids occur in addition to vessels. Parenchyma very scanty. Predominantly paratracheal forming incomplete to thin sheath around vessels.

Cells 70 to 160 mm in length and 10 to 30 mm wide. Organic deposits present in cells. Crystals not found. Fibres thin walled and septate. Infiltration abundant in fibre lumen. Rays exclusively uniseriate and homogeneous. Ranging from 150 to 450mm in height and 15 to 25 mm in diameter, closely spaced. Copious organic deposits present in ray cells. Crystals rarely found in few cells.

Diospyros buxifolia (Bl.) Hiern

Syn: *Leucoxylon buxifolium* Bl., *Diospyros microphylla* Bedd.

Ebenaceae

Local name : Elichuzhi, Malamuringa

Large evergreen tree with a nearly straight buttressed bole of 20 to 25 m length and 50 to 75 cm diameter. Bark about 0.5 cm thick, with a black rather smooth surface mottled with whitish patches.

Physical characteristics and structure of wood

A medium textured, rather hard and heavy wood with a pinkishgrey sapwood progressively merging with a darker, reddish grey or reddish brown heartwood. Grain straight to interlocked. Basic density ranging between 570 and 670 kg/m³ with an average of 630 kg/m³. Mean shrinkage values for tangential and radial directions 8.2% and 5.3% respectively.

Growth rings indistinct. Wood diffuse porous. Vessels solitary or in short or long radial multiples, clusters rarely present. Diameter ranging from 70 to 200 μ m Perforation simple. Inter-vessel pits minute and alternate. Deposits fairly common in heartwood vessels. Tyloses not found. Parenchyma apotracheal, diffuse in aggregates or in fine tangential lines. Cells ranging from 70 to 160 μ m in length and 20-30 μ m in width. Organic deposits abundant in heartwood cells. Crystals present in chambered cells. Fibres non-septate and thin walled, arranged in less distinct radial rows. Infiltration scanty. Rays exclusively uniseriate and closely spaced. Height ranging from 250 to 850 μ m or more. Heterogeneous with square and upright cells.

Diospyros crumenata Thw.
Ebenaceae

Local name : Karimaram

Medium sized evergreen tree with a height of up to 20 m and a diameter of 30 to 45 cm. Bole buttressed. Bark less than a cm thick, surface blackish grey and smooth.

Physical characteristics and structure of wood

A medium textured, hard and heavy wood with a yellowish or creamy white sapwood gradually merging with a light reddish brown or orange brown heartwood. Usually straight grained. Basic density in range of 650 to 740 kg/m³. Average basic density 690 kg/m³. Mean tangential and radial shrinkage values 8.4% and 4.3% respectively.

Growth rings not distinct. A diffuseporous wood with vessels distributed in singles or radial multiples. Both short and long radial multiples present but the latter less common. Pore clusters occasional. Vessel diameter ranging from 70 to 200 μ m. Vessel perforation simple. Intervascular pits minute and alternate. Deposits present in heartwood vessels. Tyloses not found. Parenchyma apotracheal, diffuse in aggregates forming fine tangential lines. Cells ranging from 80 to 150 μ m in length and 15 to 25 μ m in width. Globular organic deposits fairly common in heartwood cells. Crystals not found. Fibres thin walled and non-septate, arranged in radial rows. Infiltrations scanty, restricted to some fibres only. Rays exclusively uniseriate and heterogeneous with many rows of square and upright cells. Closely spaced, height ranging from 150 to 750 μ m and width 20 to 30 μ m. Crystals present in majority of upright and square cells.

Drypetes oblongifolia (Bedd.) Airy Shaw
Syn : *Laneasagum oblongifolium* Bedd.
Cyclostemon macrophyllus Bl. var. *sessiliflora* Bedd.
Euphorbiaceae

Local name : Malampayin

Large tree of evergreen and semievergreen forests growing up to 25 m in height and 70 cm in diameter. Bole straight but fluted. Bark slightly over a cm thick, surface smooth and grey often mottled with greenish patches.

Physical Characteristics and structure of wood

A fine textured, hard, rather heavy timber with a greyish white sapwood gradually merging with a core of greyish brown heartwood. Grain straight to interlocked. Basic density in the range of 600-680 kg/m³ with an average of 640 kg/m³. Mean radial and tangential shrinkage percentages 5.4 and 11.3 respectively.

Diffuse porous wood with indistinct growth rings. Vessels solitary or in radial multiples. The latter usually predominate. Radial multiples short or long. Pore clusters occasional. Diameter ranging between 50 and 100 μm Perforation ranging from simple to scalariform with occasional intergrading forms. Inter-vessel pits alternate and minute. Deposits rarely present in vessels. Tyloses absent. Tracheids present. Parenchyma apotracheal, diffuse. Scattered as individual cells or sometimes in aggregates. Cells ranging in length from 60 to 180 μm and, width from 20 to 35 μm Organic deposits abundant in the cells. Fibres non-septate and thick walled. Lumens without infiltration Rays 1 to 3 seriate, heterogeneous and closely spaced. Multiseriate rays with long tails composed of upright and square cells. Uniseriate rays composed of upright and square cells only. Multiseriate portions of rays not appreciably wider than uniseriate parts, 15 to 60 μm wide and up to or more than 1 mm in height, especially when vertically fused with other rays. Organic deposits present. Crystals found in some ray cells.

Dysoxylum beddomei Hiem Meliaceae

Local name : Akil

Large evergreen tree of over 30 m height and diameter of 100cm. Bark 0.5 to 1.0cm thick, surface rough, yellowish grey and lenticellate.

Physical characteristics and structure of wood

Medium fine textured wood with a faint odour when fresh. Colour yellowish white to yellowish grey. Heartwood not sharply demarcated. With closely spaced straight or wavy tangential markings of soft tissue demarcating growth rings. Straight to wavy grained. Basic density in the range of 590-650 kg/m³. Average basic density 630 kg/m³. Mean tangential shrinkage 8.1% and radial shrinkage 4.4%.

A diffuse porous wood with distinct growth rings. Vessels distributed in singles or in short radial multiples. Pore clusters occasional. Vessel diameter ranging from 70 to 180 μm.

Perforation simple. Intervascular pits very minute, numerous and alternate. Organic deposits limited to some vessels. Parenchyma predominantly in bands delimiting the growth rings, bands 2 to 4 seriate. Paratracheal parenchyma scanty forming an incomplete or a thin sheath around vessels or vasicentric. Cells ranging from 60 to 180 μ m in length and 20 to 45 μ m wide. Organic deposits scanty and crystals absent. Fibres thin walled, commonly non-septate. Infiltration scarce in the lumen. Rays 1 to 3 seriate, more commonly uni- and biseriate. Heterogeneous with one or occasionally 2 rows of marginal square cells. Rarely with a longer tail at one end or fused vertically with other rays. Ray height ranging from 140 to 530 μ m and width 20 to 50 μ m. Scanty organic deposits present. Crystals not found.

Euodia lunu-ankenda (Gaertn.) Merr.

Syn: *Fagara lunu-ankenda* Gaertn., *Euodia roxburghiana* Benth.

Rutaceae

Local names: Kambili, Nasakam, Kanala

Medium sized tree found in evergreen, semievergreen and secondary forests, with a height of up to 15 m and a diameter of 45 cm. Bark 0.5 to 1.0 cm thick, yellowish grey. Surface rather smooth, lenticels present.

Physical characteristics and structure of wood

Soft, light, straight-grained wood with a uniform creamy white or yellowish white colour. Growth markings distinct. Timber showing no indications of a heartwood. Texture medium fine. Basic density in the range of 350-400 kg/m³ with an average value of 380 kg/m³. Mean tangential shrinkage 5.2% and radial shrinkage 3.0%.

Growth rings readily distinguishable by the difference in wall thickness of earlywood and latewood fibres. Wood diffuse porous. Vessels solitary or in short radial multiples. Evenly distributed. Vessel walls thin. Diameter ranging from 80 to 250 μ m. Perforation simple. Inter-vessel pits small and alternate. Gummy deposits occur in a few vessels. Tyloses absent. Parenchyma ranging from scanty paratracheal forming incomplete sheaths around vessels to narrow complete sheaths, occasionally the narrow wing-like extensions connecting adjacent pores. Individual cells ranging from 60 to 150 μ m in length and 20 to 40 μ m in width. Infiltration scarce. Crystals absent. Fibres non-septate and very thin walled. Latewood fibre more radially flattened and possessing thicker walls than earlywood fibres. Infiltration scarce. Rays 1 to 4 seriate, commonly bi- to triseriate, homogeneous or with a tendency to heterogeneity. Height ranging from 150 to 500 μ m. Width 10 to 35 μ m. Organic deposits rare. Silica bodies present in few rows of ray cells.

Garcinia morella (Gaertn.) Desr.
Syn: *Mangostana* morella Gaertn.
Clusiaceae

Local name : Chigiri

Medium sized tree found in evergreen forests, with a height of 12 to 15 m and a diameter of 30 cm. Bark over 0.5 cm thick, surface smooth, brown.

Physical characteristics and structure of wood

A moderately hard, medium fine textured wood with a bright yellow colour when fresh fading to yellowish or olive grey on exposure. Without a distinct heartwood. Generally interlocked grained. Basic density in the range of 510- 600 kg/m³. Average basic density 560 kg/m³. Mean tangential shrinkage percentage 9.0 and radial shrinkage 4.6%.

Diffuse porous wood showing no distinct growth rings. Vessels occurring as solitary pores or in short radial multiples. Solitary vessels predominant. Vessel diameter ranging from 70 to 130 μ m Perforation simple and inter-vessel pitting alternate. Extractives present in vessel lumen. Tyloses absent. Parenchyma generally diffuse in aggregates or forming fine lines. Paratracheal parenchyma scanty in the form of few cells contiguous to vessels and not forming a complete sheath around. Individual cells varying in length from 70 to 150 μ m and in width from 15 to 30 μ m. Infiltration as droplets common in cells. Crystals not found. Fibres thin walled and non-septate, arranged in distinct radial rows. Infiltration present in few fibres occluding the lumen. Rays exclusively uniseriate and closely spaced. Heterogeneous with procumbent, square and upright cells. organic deposits present but scanty. Crystals present in a few cells only.

Heretiera papilio Bedd.
Sterculiaceae

Local name: Chocklamaram, Cholachadachi

Large tree occasionally found in semievergreen forests, with a height of up to 30 m and diameter of 60 cm. Bark greyish brown, over 1 cm thick and longitudinally furrowed.

Physical characteristics and structure of wood

Heavy, hard, rather coarse textured wood with a narrow greyish or pinkish white sapwood and a wide pinkish or reddish brown heartwood. Straight to interlocked grained. Growth rings scarcely distinct. Basic density ranging from 680 kg/m³ to 800 kg/m³. Average basic density 740 kg/m³. Mean tangential shrinkage 10.2% and radial shrinkage 3.4%.

Growth rings not distinct but distinguishable by the relative abundance of parenchyma and difference in fibre wall thickness. Wood diffuse porous. Vessels solitary or in radial multiples. The latter more commonly short, rarely long. Vessel diameter ranging from 120 to 250 μm. Perforation simple. Inter-vessel pitting alternate. Heartwood vessels blocked by extractives. Tyloses absent. Parenchyma generally diffuse, in aggregates or fine tangential lines. With appreciable difference in abundance in early and latewoods. Individual cell 60 to 200 μm long and 15 to 35 μm wide. Organic deposits abundant. Crystals rare. Fibres non-septate, rather thick walled. Infiltration present in lumens. Rays 1 to 4 seriate, heterogeneous. Divisible on the basis of size into 2 types: Smaller (uni- or biseriate) 150 to 480 μm tall, larger (3 to 4 seriate) up to or more than 1 mm in height (300-1250 μm). Organic deposits abundant, crystals absent.

Litsea floribunda (Bl.) Gamble
Syn: *Cylicodaphne floribunda* Bl.
Lauraceae

Local name: Not known

Medium to large sized evergreen tree with a height of over 15 m and diameter 50 cm. Bole straight. Bark nearly a cm thick, surface rather smooth, brown and lenticellate.

Physical characteristics and structure of wood

A moderately hard, yellowish or olive brown wood with medium coarse texture. Having no well defined heartwood. Grain straight to wavy. Having fine tangential lines of soft tissue. Basic density range 570-640 kg/m³ with an average of 600 kg/m³. Mean shrinkage percentages 8.3 (tangential) and 4.1 (radial).

Growth rings indistinct. Wood diffuse porous. Vessels solitary or in short radial multiples. Pore clusters rare. Vessel diameter ranging from 120 to 250 μm. Perforation simple. Inter-vessel pitting alternate. Pits appreciably large. Pits to rays slightly larger, elliptical or

fusiform-shaped. Tyloses present. Parenchyma predominantly banded occasionally connecting nearby vessels. Paratracheal parenchyma limited to few cells adjacent to vessels rarely forming a thin sheath around them. Individual cell 150 to 350 μ m long and 20-35 μ m wide. Infiltration scanty. Crystals not found. Fibres thin walled and non-septate. Infiltration scanty in the lumen. Rays 1 to 4 seriate. Distinguishable into two types based on size: smaller, uniseriate, rarely with paired cells 150 to 900 μ m in height and 15 to 35 μ m wide and composed of upright and square cells only and larger 3 to 4 seriate, 300 μ m to 1000 μ m in height and 40 to 65 μ m wide. Heterogeneous with 1 or 2 rows of marginal square cells, rarely with longer tails at one or both ends. Organic deposits present in cells. Crystals absent.

Madhuca bourdillonii (Gamble) H.J. Lam

Syn: *Bassia bourdillonii* Gamble

Sapotaceae

Local name : Thandidiyan

Large tree found in evergreen forests, with a height of 30 m and a diameter reaching 100 cm. Bole straight and buttressed at the base. Bark more than a cm thick, fissured. Surface greyish brown.

Physical characteristics and structure of wood

A coarse textured, light timber with a broad yellowish white sapwood and pale reddish brown heartwood. Straight grained. Basic density ranging from 530 to 610 kg/m^3 with an average of 570 kg/m^3 . Mean tangential shrinkage 7.3% and radial shrinkage 3.6%.

Diffuse porous wood having no distinct growth rings. Vessels solitary or in short radial multiples with equal predominance of both. Radial multiples short or long. Radial or oblique pore chains occasional. Vessel diameter ranging from 120 to 230 μ m. Perforation simple. Inter-vessel pitting alternate. Pits to ray cells appreciably larger and oval, gash-like or almost round. Tracheids present. Parenchyma diffuse or in aggregates forming fine tangential lines. Cells ranging in length from 60 to 140 μ m and 25 to 50 μ m in width. Organic deposits scanty. Crystals rare. Fibres non-septate, moderately thick walled. Extractives scanty. Rays 1 to 3 seriate, commonly biseriate. Uniseriate rays very rare. Ranging in height from 240 to 650 μ m or up to 900 μ m when vertically fused. 30 to 70 μ m wide. Heterogeneous and closely spaced. Silicalike bodies present in most marginal and procumbent cells. Extractives present.

Mastixia arborea (Wt.) Bedd. ssp. *metziana* (Wang.) Mathew

Syn : *Mastixia metziana* Wang.

Cornaceae

Local names : Vella adambu, Neerkurunnu

Large evergreen tree with a height of over 30 m and diameter 60 cm. Bark 1 to 1.2 cm thick, surface fairly smooth, lenticellate, light brown mottled with darker patches.

Physical characteristics and structure of wood

A soft, light, straight grained wood with a uniform yellowish white colour. Texture medium coarse. Heartwood not distinct. Basic density ranging from 360 to 440 kg/m³. Average basic density 395 kg/m³. Mean shrinkage percentage for tangential direction 9.9 and along radial direction 3.1.

Growth rings indistinct. Wood diffuse porous with solitary pores and multiples. The latter usually more predominant. Multiples radial or oblique. Tangential clusters occasional. Vessel walls thin and margins appearing angular in outline. Numerous and closely spaced. Diameter ranging from 80 to 140 μ m. Perforation scalariform with numerous bars. Inter-vessel pits scalariform or opposite. Pits to rays opposite. Tyloses not found. Parenchyma abundant, diffuse or in aggregates. Scanty paratracheal limited to few cells in the vicinity of vessels. 150 to 350 μ m in length and 20 to 50 μ m in width. Organic deposits scanty. Crystals not found. Fibres non-septate, rather thick walled. Without appreciable infiltration. Rays distinctly of two types based on size and seriation, uniseriate and multiseriate, widely spaced. Up to 2 mm or more in height. Uniseriate rays 20 to 30 μ m wide and multiseriate, 50 to 120 μ m. Heterogeneous with long or short tail composed of square and upright cells. Sheath cells common in multiseriate rays. Extractives present in cell lumen.

Ormosia travancorica Bedd.

Fabaceae

Local name : Malamanchadi

Large tree of evergreen and semi evergreen forests, with a height of over 25 m and a diameter of 75 cm. Fairly straight bole. Bark 1 to 1.5 cm thick, surface smooth, colour brown mottled with lighter greyish patches.

Physical characteristics and structure of wood

A hard, coarse textured wood with straight or interlocked grain. Sapwood narrow, yellowish white and heartwood yellowish or olive brown. Having fine straight to wavy tangential markings of soft tissue. Basic density ranging from 580 to 690 kg/m³. Average density 630 kg/m³. Mean tangential shrinkage 6.2% and radial shrinkage 2.5%.

Growth rings not distinct. Wood diffuse porous with vessels distributed in singles or radial multiples. The latter commonly short or rarely up to 7 pores in length. Pore clusters occasional. Vessel diameter ranging between 60 and 250 μ m. Perforation simple, inter-vessel pits alternate, small. Deposits common in heartwood vessels. Tyloses absent. Parenchyma abundant. paratracheal, predominantly in the form of broad straight or wavy bands connecting adjacent pores tangentially or obliquely. Rarely, aliform confluent. Cells ranging from 70 to 160 μ m in length and 20 to 50 μ m in width. Organic deposits present. Crystals rarely found in chambered cells. Fibres non septate, thin to moderately thick walled. Infiltration common in heartwood fibres. Rays 1 to 4 seriate more commonly 3 to 4 seriate. 280 to 600 μ m in height and 20 to 70 μ m wide. closely spaced and homogeneous. Indistinctly storied. Organic deposits present. Crystals not found.

Palaquium ravii Sasi & Vink Sapotaceae

Local name : Not known

Large evergreen tree with a height of about 30 m and diameter reaching 75 cm. Bole straight and cylindrical. Bark more than 1 cm thick, surface smooth, brown with patches of white.

Physical characteristics and structure of wood

A moderately hard, straight grained and medium coarse textured wood with pinkish white sapwood progressively darkening inwards and merging with a reddish brown heartwood. With fine tangential closely spaced markings of soft tissue. Basic density in the range of 500-590 kg/m³. Average density 540 kg/m³. Mean tangential and radial shrinkage 7.5% and 3.4% respectively.

Growth rings indistinct. Wood diffuse porous with vessels arranged in singles or long radial multiples or chains. Radial or oblique grouping of vessels fairly common. Vessel diameter ranging from 100 to 300 μ m. Perforation simple. Vessel to vessel pitting alternate. Tyloses

abundant in the heartwood. Tracheids present in association with vessels. Parenchyma predominantly in 2-5 cells wide tangential bands connecting vessels. Paratracheal parenchyma very rare, limited to few cells contiguous to vessels. Cells 80 to 240µ m long and 20 to 40µ m wide. Organic deposits common, crystals absent. Fibres non septate and thin walled. Arranged in distinct radial rows. Pits with narrow border. Organic deposits scanty. Crystals present in some fibres in locules. Rays uni- to biseriate, heterogeneous and closely spaced. Biseriate portions not appreciably wider than uniseriate parts. Ranging from 300 to 700µ m in height and 15 to 35mm in width. Scanty organic deposits present, crystals absent.

Polyalthia coffeoides (Thw.) Benth ex Hk f & Thonis
Syn *Guatteria coffeoides* Thw
Annonaceae

Local names : Nedunaru. Villa

Medium sized tree growing in evergreen and semi-evergreen forests, reaching a height of about 25 m and diameter of 30 cm Bole straight with epicormic tubercles Bark nearly a cm thick. surface smooth. greenish brown mottled with light grey patches

Physical characteristics and structure of wood

Straight grained. medium coarse textured wood with an yellowish white colour when fresh turning yellowish grey after exposure. Rather soft, without the evidence of a heartwood Basic density ranging from 460 to 590 kg/m³. Average density 530 kg/m³ Mean tangential and radial shnkage 7.6% and 3.1% respectively.

Growth rings not distinct. Wood diffuse porous. Vessels solitary or in short radial multiples with the predominance of solitary vessels. Pore clusters occasional. Ranging from 90 to 220 µ m in diameter. Vessel perforation simple and pitting alternate. Deposits rarely present. Tyloses absent. Parenchyma apotracheal. Diffuse or in aggregates forming fine tangential lines. Cell length ranging between 70 and 150 µ m and width ranging from 15 to 35µ m. Organic deposits rare and crystals not found. Fibres non-septate and thin walled, with scanty infiltration. Rays 1 to 10 seriate. Distinguishable into two sizes although the demarcation less pronounced. Smaller rays 1 to 3 seriate and larger, 5 to 10 seriate. Widely spaced. Composed of procumbent and square cells the rows of which occurring intermingled with each other. Height of smaller rays ranging from 200 to 800mm, larger from 1 to 3

Pterospermum rubiginosum Heyne ex Wt. & Arn.
Sterculiaceae

Local name : Chittilaplavu

Large evergreen tree growing to a height over 25 m and a diameter 60 cm with a fairly straight trunk. Bark over 0.5 cm thick. surface brown.

Physical characteristics and structure of wood

A medium fine textured. soft. light wood with a straight to interlocked grain Sapwood narrow, creamy white and heartwood dull pinkish brown to reddish brown Basic density ranging from 480 to 570 kg/m³ Average density 520 kg/m³ Mean shrinkage percentages 6.9 (tangential) and 3.4 (radial)

Growth rings without sharp boundaries. Wood diffuse porous. Vessels solitary or in short radial multiples. Rarely in tangential groups and clusters. Vessel diameter ranging from 80 to 200 μ m. Perforation simple. Inter-vessel pits small and alternate. Tyloses present in heartwood vessels, deposits scant. Parenchyma abundant. diffuse in aggregates intermingled with fibres and forming discrete strands. Cells 60 to 150 μ m long and 15 to 40 μ m wide. Extractives occur in few isolated cells. Crystals very rare. Fibres non-septate and very thin walled. Lumens without infiltration. Radially flattened in latewood. Rays 1 to 4 seriate. equally, common and closely spaced. Ranging in height from 250 to 900 μ m and 20 to 80 mm in width. Heterogeneous. Individual cells appearing polygonal or axially elongated in tangential view. Intermediate rows of upright or square cells present. Organic deposits abundant in procumbent cells. Crystals rarely present in square cells.

Strombosia ceylanica Gardn.
Olacaceae

Local name : Kal kadambu

Large tree reaching a height over 30 m with a straight clear bole of up to 20 m height and 45 cm diameter and found in evergreen and semievergreen forests. Bark thin, surface smooth, yellowish grey mottled with green patches.

Physical characteristics and structure of wood

A hard, fine textured wood having a yellowish white sapwood and a pale brown heartwood. Sapwood rather wide. Grain straight to wavy. Basic density in the range of 650 - 720 kg/m³, the average being 700 kg/m³. Mean shrinkage along tangential direction 8.6% and along radial direction 4.5%.

Growth rings indistinct. Diffuse porous wood with vessels occurring as solitary pores or as short radial multiples. Rarely multiples of up to 5 vessels present. Pores appearing rather angular in cross section. Vessel diameter ranging from 60 to 110 μm. Vessel perforation scalariform with 12 to 20 bars. Inter-vessel pits scalariform or opposite. Pits to upright ray cells and parenchyma cells appreciably larger. Round or scalariform. Extractives scanty. Parenchyma diffuse in aggregates forming fine tangential lines. Cells ranging in length from 80 to 150 μm and 30 to 50 μm wide. Extractives present, crystals not found. Fibres non-septate, thick-walled, without infiltration in the lumen. Rays 1 to 4 seriate, heterogeneous and closely spaced. Multiseriate rays having long uniseriate tails composed of upright and square cells as is the case of uniseriate rays. Some rays fused vertically. Ray height ranging from 330 to 1200 μm or more and width 20 to 60 μm. Organic deposits present, crystals present mostly in square or upright cells, occasionally in procumbent cells.

Syzygium chavaran (Bourd.) Gamble

Syn: *Eugenia chavaran* Bourd.

Myrtaceae

Local name : Chavaran

Large evergreen trees of up to 30 m in height and 90 cm diameter. Stem often crooked, forked or branched at a lower height level. Bark up to a cm thick. Surface smooth. Light grey

Physical characteristics and structure of wood

A rather hard, medium fine textured wood. Grain commonly interlocked. Wood pinkish white and not sharply distinguishable into sapwood and heartwood. Basic density in the range of 590 to 630 kg/m³. Average basic density 610 kg/m³. Mean tangential shrinkage 6.6% and radial shrinkage 3.4%.

Growth rings not distinct. Diffuse porous wood with vessels distributed as solitary pores or in short radial multiples. Tangential groups or pore clusters occasionally present.

Diameter ranging from 100 to 180 μ m. Perforation simple and inter-vessel pits very minute and alternate. Pits to ray cells appreciably larger and window-like. Deposits and tyloses occasionally present, Parenchyma predominantly paratracheal. more commonly banded (3 to 5 cells wide) to confluent. Sometimes forming only a narrow sheath around vessels with narrow tangential wing-like extensions. Cells ranging from 50 to 150 μ m in length and 20 to 40 μ m wide. Fibres non-septate, thin walled, arranged in rather distinct radial rows. Without appreciable infiltration. Rays distinguishable into two types : uniseriate and multiseriate. The latter usually 3 to 5 seriate. Heterogeneous with usually short tails of 1 row of marginal cells rarely longer tails present at one end. Ray height 220 to 750 μ m and width 40 to 90 μ m (multiseriate) while uniseriate rays 15 to 25 mm wide. Extractives abundant in ray cells. Crystals not found

Terminalia travancorensis Wt. & Arn
Combretaceae

Local names : Peikkadukka. Kattu kadukka

Large tree found in evergreen forests and reaching up to 30 m height and 75 cm diameter. Bole rarely straight, buttressed and having irregular bumpy outgrowths. Bark slightly over 0.5 cm thick, surface smooth, yellowish brown to greyish brown

Physical characteristics and structure of wood

Hard, heavy, fine textured wood with a olive grey or yellowish grey sapwood and a olive brown or dark brown heartwood. Sapwood usually wide. Grain commonly interlocked. Basic density in the range of 670 to 750 kg/m^3 with an average of 710 kg/m^3 . Mean tangential shrinkage 7.6% and radial shrinkage 5.0%

Growth rings scarcely distinguishable. Wood diffuse porous with vessels occurring as solitary pores or in short radial multiples. Solitary vessels predominant. Earlywood vessels slightly larger than those in latewood. Vessel diameter ranging from 50 to 200 μ m. Perforation simple and inter-vessel pits alternate. Deposits frequent in heartwood vessels. Tyloses absent. Parenchyma predominantly paratracheal forming incomplete or thin sheath around vessels and having narrow wing-like extensions. Diffuse parenchyma present. Narrow terminal bands of parenchyma present but not readily distinguishable. Cells 60 to 150 μ m long and 20 to 35 μ m wide. Extractives abundant. Large crystals occur in some cells. Fibres non-septate and thin walled. Heartwood fibres containing deposits. Rays exclusively uniseriate and closely spaced. Heterogeneous with square and upright cell rows

which are not necessarily marginal Ray height ranging from 180 to 750 μ m and width from 15 to 30 μ m Extractives abundant in ray cells Square and upright cells occasionally enclose large crystals.

Vepris bilocularis (Wt. & Arn.) Engl

Syn: *Toddalia bilocularis* Wt. & Arn.

Rutaceae

Local name: Moothassari

Large evergreen tree growing over 25 m in height and 60 cm in diameter. Bole straight but branched. Bark 0.3 to 1.0 cm thick. Surface warty, yellowish or greyish brown.

Physical characteristics and structure of wood

A hard, heavy, fine textured wood with a uniform yellowish white or creamy white colour. and fine tangential markings of soft tissue representing growth ring boundaries Distinct heartwood not found Grain commonly wavy or interlocked Basic density in the range of 710 to 790 kg/m³ Average basic density 740 kg/m³ Mean tangential shrinkage 8.2% and radial shrinkage 4.2%

Growth rings distinguishable by the difference in wall thickness of earlywood and late wood fibres and band of parenchyma delimiting the rings. Diffuseporous wood. Vessels solitary or in radial multiples or chains with the predominance of chains which are short or rarely long. Diameter ranging from 40 to 150 μ m. Perforation simple. Vessel pits minute, alternate. Deposits rarely present in vessels. Tyloses absent. Parenchyma commonly in 4-5 cells wide tangential bands delimiting growth rings. Paratracheal parenchyma scanty in the form of few cells contiguous to vessels. Individual cells ranging from 80 to 140 μ m in length and 15 to 25 μ m in width. Organic deposits occasional, crystals not found. Fibres non-septate, thin to moderately thick-walled from early to latewood. Arranged in rather distinct radial rows. Crystal-containing idioblasts with larger lumen occasional among fibres. Infiltration scanty. Rays 1 to 5 seriate, commonly 3 to 5 seriate. Homogeneous with height ranging from 120 to 320 μ m and width of 15 to 30 μ m Scanty organic deposits present in cells. Crystals not found.

DISCUSSION

Native timbers that have gained acceptance for various end-uses are rather limited as compared to the large number of tree species found in the forests. Probably one major factor which prevents wider utilization of many potential species is the user's bias with regard to the quality of these woods. The present study indicates that such a bias is unfounded and a good proportion of secondary tree species have got the potential to become reasonably good substitutes for common commercial timbers for purposes like joinery, furniture, turnery and structural applications. The basic density of wood of majority of timbers covered here ranges between 600 kg/m³ and 750 kg/m³ (Table 2) suggesting strength properties comparable to many medium density structural and joinery timbers listed in IS:3629 (ISI, 1966) and IS:1003 (ISI, 1966). There is also a mention in the literature (Gamble, 1922; Anonymous, 1963; Rao and Purkayastha, 1972; Purkayastha, 1982; 1985) regarding suitability of some of these timbers for various solid wood uses. For example, *Aporusa lindleyana*, *Dimocarpus longan*, *Diospyros buxifolia*, *Heretiera papilio*, *Pterospermum rubiginosum* and *Terminalia travancorensis* are reported to be used, to a limited extent for structural purposes. *Dimocarpus longan* is said to be suitable for furniture, carriage and wagon building. The tough wood of *Diospyros* sp. and *Vepris bilocularis* is found to be appropriate for tool handles, cart wheels etc. Timber from *Ormosia travancorica* is mentioned as remarkably good; however, no specific end-uses have been suggested. Similarly very little is known regarding the quality and end-uses of some timbers examined here (eg: *Dysoxylum beddomei*, *Madhuca bourdillonii*, *Polyalthia coffeoides*, *Palaquium ravii*, *Strombosia ceylanica* and *Syzygium chavaran*). At least some medium density woods among them like *D. beddomei*, *Strombosia ceylanica* and *Syzygium chavaran* are worth examining for structural strength.

Among different species that have been examined in this study only a few like *Aglaia barberi*, *Aporusa lindleyana*, *Heretiera papilio*, *Ormosia travancorica* and *Pterospermum rubiginosum* have got a distinct, broad heartwood. Rest of the species possess a narrow or less distinct heartwood. Although the durability of various timbers cannot be precisely judged from the present study, it can be said that most timbers, especially those with narrow or indistinct heartwood would require preservative treatment for an improved service life as recommended in IS:3629 for structural timber (ISI, 1966). Except for a few species like *Litsea floribunda*, *Palaquium ravii* and *Pterospermum rubiginosum* which have got tyloses in the vessels, rest of the timbers have open vessels which is again a positive point from the view of penetration of preservative chemicals during treatment.

The shrinkage values recorded for majority of the species in this study are higher than average for common structural timbers. This is particularly true for heavier woods and is in accordance with a common observation that heavier woods tend to shrink more than the

Table 2. Comparison of wood characteristics of different tree species investigated.

Species	Texture	Grain	Heartwood extent	Decorative features	Basic density	Radial shrinkage kg/m ³	Tangential shrinkage %
<i>Aglaia barberi</i>	MF	S-I	Br	Pg,Pa	710	3.6	8.6
<i>Aporosa lindleyana</i>	M	I-w	Br	-	650	2.6	5.6
<i>Dimocarpus longan</i>	M	I	GT	GR	710	4.8	9.5
<i>Diospyros buxifolia</i>	M	S	GT	-	630	5.3	8.2
<i>Diospyros crumenata</i>	M	S	GT	-	690	4.3	8.4
<i>Drypetes oblongifolia</i>	F	S-I	GT	SG	640	5.4	11.3
<i>Dysoxylum beddomei</i>	MF	S-W	ND	Pa	630	4.4	8.1
<i>Euodia lunu-ankenda</i>	MF	I	A	GR	380	3.0	5.2
<i>Garcinia morella</i>	MF	I	A	-	560	4.6	9.0
<i>Heretiera papilio</i>	C	S-I	Br	GR,SG	740	3.4	10.2
<i>Litsea floribunda</i>	MC	S-W	A	-	600	4.1	8.3
<i>Madhuca bourdillonii</i>	C	S	Na	-	570	3.6	7.3
<i>Mastixia arborea</i>	MC	S	A	SG	395	3.1	9.9
<i>Ormosia travancorica</i>	C	S-I	B	Pg	630	2.5	6.2
<i>Palaquium ravii</i>	MC	S	GT	Pa	540	3.4	7.5
<i>Polyalthia coffeoides</i>	MC	S	A	SG	530	3.1	7.6
<i>Pterospermum rubiginosum</i>	MF	S-I	Br	-	520	3.4	6.9
<i>Strombosia ceylanica</i>	F	S-W	Na	Pg	700	4.5	8.6
<i>Syzygium chavaran</i>	F	I	ND	-	610	3.4	6.6
<i>Terminalia travancorensis</i>	F	I	Na	Pg	710	5.0	7.6
<i>Vepris bilocularis</i>	F	I-W	A	Pa	740	4.2	8.2

Texture : F - fine, M - medium, C - coarse, MF - medium fine, MC - medium coarse

Grain : S - straight, I - interlocked, W - wavy

Heartwood : Br - broad, GT - gradual transition, ND - not distinct, A - absent, Na - narrow

Decorative features : Pg - pigment figure, Pa - parenchyma, GR - growth ring, SG - silver grain

lighter woods do. Further, woods such as *Drypetes oblongifolia*, *Mastixia arborea* and *Polyalthia coffeoides* sp. have large rays and thus a likelihood of developing splits if not carefully dried. However, lighter woods like *Euodia lunu-ankenda* have low shrinkage. Among medium density woods *Aporosa lindleyana*, *Ormosia travancorica* and *Syzygium chavaran* are found to have fairly low shrinkage.

Physical appearance of a timber including its colour, decorative features and texture are other major wood quality considerations, apart from strength and durability, for furniture timber. In this respect the following timbers deserve a mention. Wood of *Aglaia barberi*, *Ormosia travancorica*, *Strombosia ceylanica* and *Terminalia travancorensis* have pigment figure resulting from uneven distribution of extractives in the heartwood. *Dimocarpus longan* and *Heretiera papilio* have growth ring figure. *Drypetes oblongifolia*, *Heretiera papilio*, *Mastixia arborea* and *Polyalthia coffeoides* are likely to show silver grain on radial face when quarter-sawn. The conspicuous bands of parenchyma in *Dysoxylum beddomei*, *Palaquium ravii* and *Vepris bilocularis* can also be of appreciable decorative value in furniture making. Besides the figure, fine textured woods of *Drypetes oblongifolia*, *Dysoxylum beddomei*, *Strombosia ceylanica*, *Syzygium chavaran*, *Terminalia travancorensis* and *Vepris bilocularis* can also offer the possibility of making turned furniture components, tool handles and other turnery items.

Timbers that can be used for wooden packaging, boxes and crates have only minimum quality requirements to meet. Indian Standards IS:3071 (ISI, 1965) and IS:6662 (ISI, 1972) specify the requirements for crates and packing cases respectively and provide lists of species that are suitable for the purpose. Out of the timber species covered in this study, only *Euodia lunu-ankenda* has been recommended for packing cases. However, other lighter woods which lack heartwood and which are not worthy for better purposes like joinery or furniture are worth considering for packing case manufacture. For example, *Garcinia morella*, *Madhuca bourdillonii*, *Mastixia arborea* and *Polyalthia coffeoides* are a few such species.

CONCLUSION

It is evident that many less-known tree species have untapped timber value which is not fully recognised. For proper appraisal of this potential extensive screening of native tree species is necessary. Data on wood quality will also be useful in evaluating the relative merit of each forest species for conservation and domestication. Although a number of less-known tree species produce timber having an acceptable range of properties, their wider utilization has not gained momentum. This has been mainly due to the user's preference for timbers of known wood quality. However, the currently prevailing shortage of reputed timbers has necessitated a search for alternative timber species. The present study shortlists a few

promising species based on preliminary wood quality assessment and for further testing depending on their proposed end-uses.

LITERATURE CITED

- Anonymous (1963). Indian Woods: Their Identification, Properties and Uses. Vol. II. Manager of Publications, Delhi.
- Bourdillon, T.F. (1908). The Forest Trees of Travancore. Govt. Press, Trivandrum.
- Brandis, D. (1906). Indian Trees. Bishen Singh and Mahendra Pal Singh. Dehra Dun.
- Choudhury, K.A. and Ghosh, S.S. (1958). Indian Woods Vol. I. Manager of Publications, Delhi.
- Gamble, J.S. (1922). A Manual of Indian Timbers. Bishen Singh and Mahendra Pal Singh, Dehra Dun.
- ISI (1965). Specification for wooden crates. IS: 3071: 17p.
- ISI (1966). Specification for timber panelled and glazed shutters. Part I. Door shutters. IS: 1003 (Part I) 17p.
- ISI (1966). Specification for structural timber in building. IS:3629:22p.
- ISI (1972). Specification for timber species suitable for wooden packaging. IS: 6662: 10p.
- Johansen, D.A. (1940). Plant Microtechnique McGraw-Hill, New York.

Karunakaran, C.K. (1986). Ecodegradation of Kerala forest: Historical facts Proc. Seminar on Ecodevelopment of Western Ghats, KFRI, Peechi, India. pp 104-109.

Nair, N.C. and Daniel, P. (1986). The floristic diversity of Western Ghats and its conservation. A review. Proc. Indian Acad. Sci. Suppl. 127-163.

Pearson, R.S. and Brown, H.P. (1932). Commercial Timbers of India. Govt. of India. Calcutta.

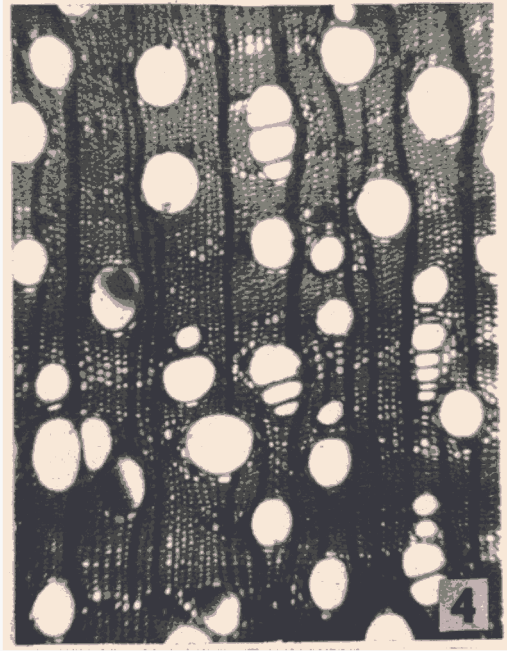
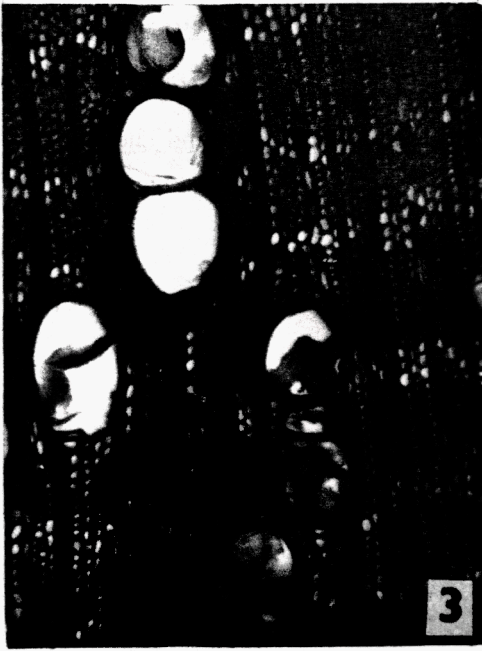
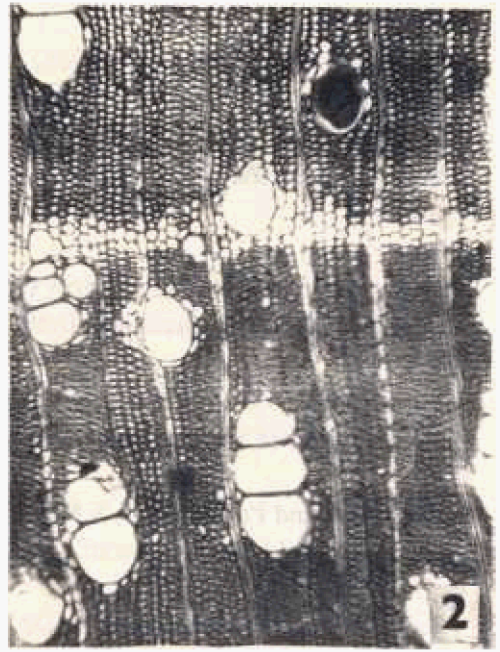
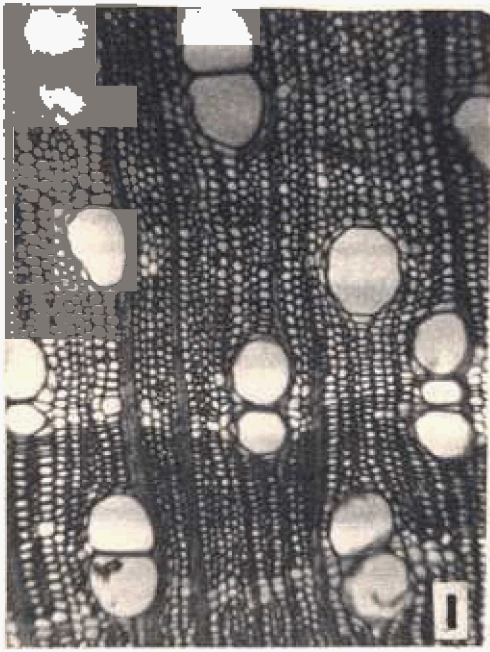
Purkayastha, S.K. (1982). Indian Woods: Their Identification, Properties and Uses. Vol. IV. Controller of Publications, Delhi.

Purkayastha, S.K. (1985). Indian Woods: Their Identification, Properties and Uses Vol. V. Controller of Publications, Delhi.

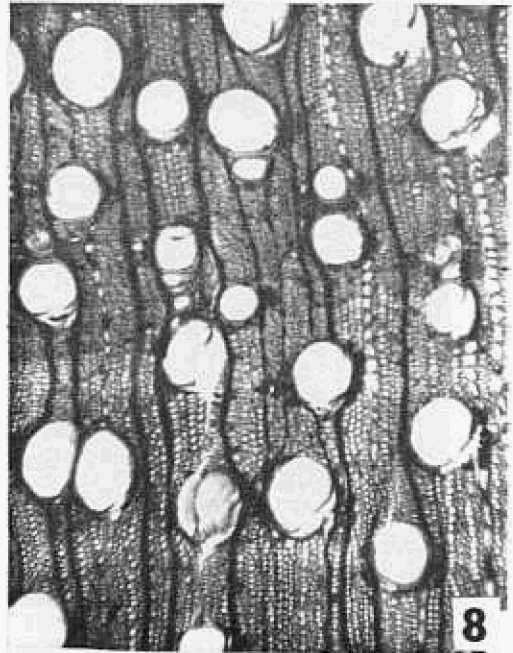
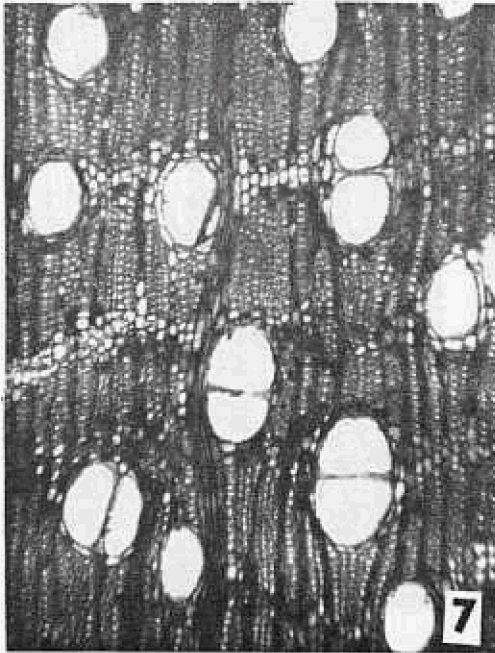
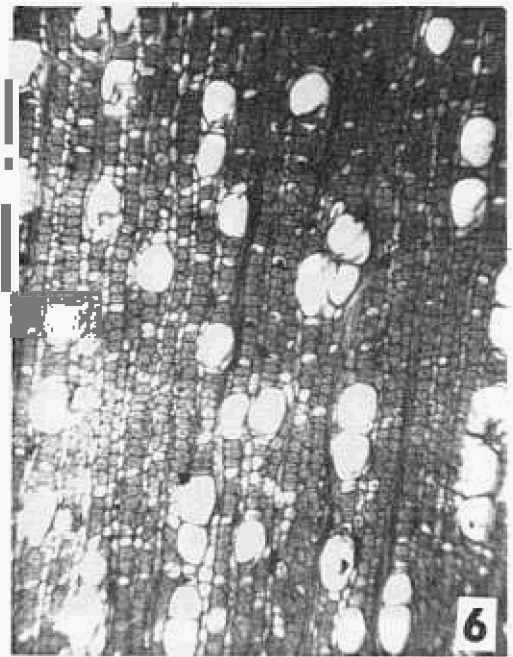
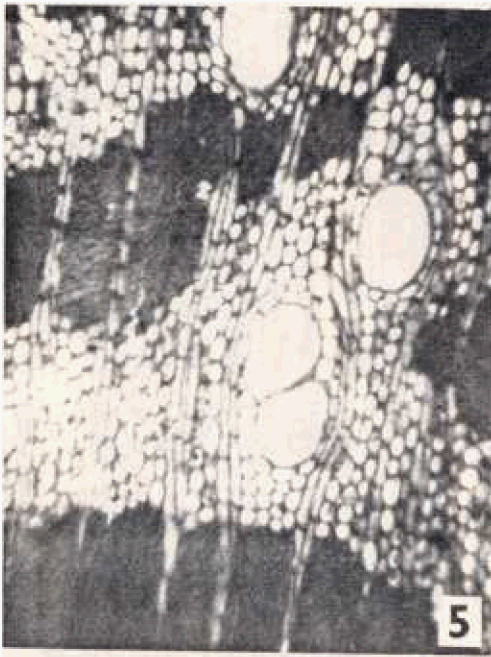
Rao, K.R. and Purkayastha, S.K. (1972). Indian Woods: Their Identification, Properties and Uses. Vol III. Manager of Publications, Delhi.

Tamolang, F.N. Meniado, J.A., De Vela, B.C. and Lopez, F.R. (1982). Prospects of plantation and lesser-known tropical hardwood species for commercial utilization. In Roelof A.A. Oldeman (ed.) Tropical Hardwood Utilization: Practice and Prospects Martinus Nijhoff/Dr. W. Junk Publishers, The Hague.

Trotter, H. (1960). The Common Commercial Timbers of India and Their Uses. Manager of Publications, Delhi.



Figs. 1-4, Transverse sections. 1. *Euodia lunu-ankenda* showing distinct rings due to difference in fibre wall thickness between earlywood and latewood. x60. 2. *Dysoxylum beddomei* in which rings are delimited by bands of parenchyma. x60. 3. *Palaquium ravii* with radial or oblique grouping of vessels and banded parenchyma. x60. 4. *Aglaia barberi* showing evenly distributed vessels and parenchyma arrangement. x60.



Figs. 5-8, Transverse sections. 5. *Ormosia travancorica* showing abundant parenchyma as wide paratracheal patches and bands. x60. 6. *Strombosia ceylanica* with small vessels, diffuse parenchyma and thick walled fibres. x 60. 7. *Syzygium chavaran* showing banded parenchyma and fibres aligned in nearly distinct radial rows. x60. 8. *Terminalia travancorensis* with scanty paratracheal and diffuse parenchyma. x60.

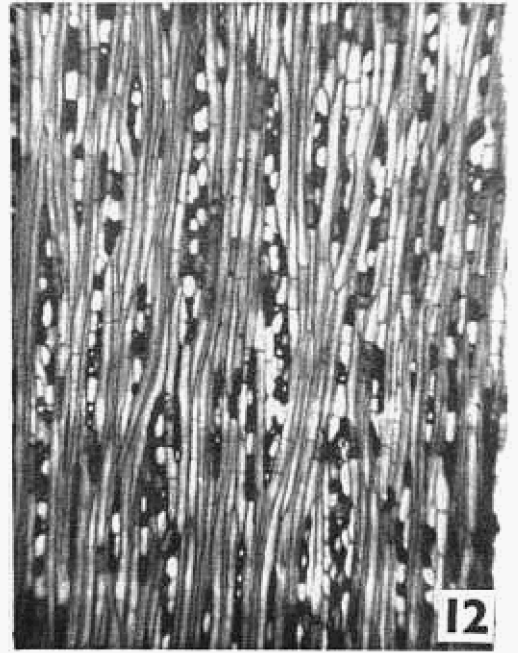
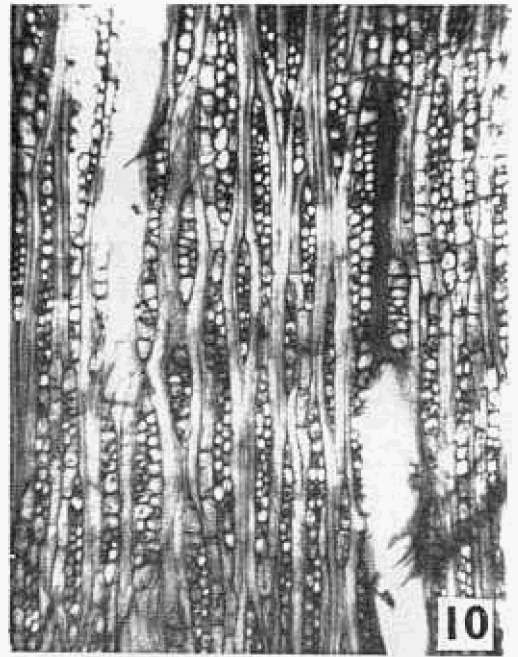
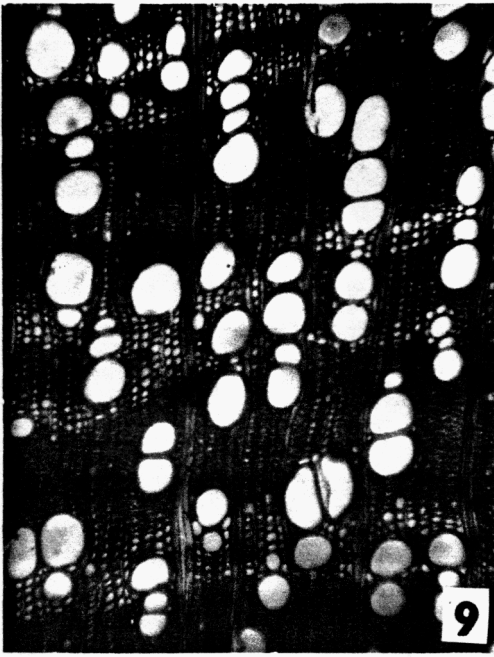


Fig. 9. Transverse section; 10-12, Tangential sections. 9. *Vepris bilocularis* having small vessels arranged in multiples and chains and parenchyma delimiting rings. x60. 10. *Madhuca bourdillonii* showing tracheids (arrows) and predominantly biseriate rays. x60. 11. *Drypetes oblongifolia* with closely spaced rays composed of multiseriate and uniseriate portions with almost similar width, x60. 12. *Pterospermum rubiginosum* with ray cells appearing polygonal or vertically elongated in TLS. x60.

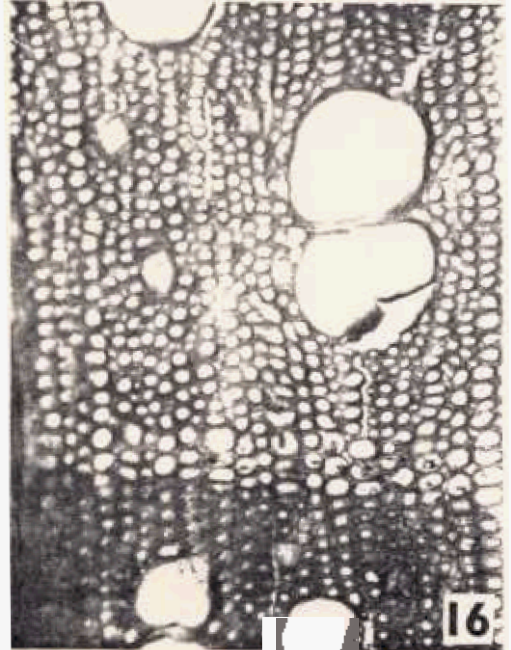
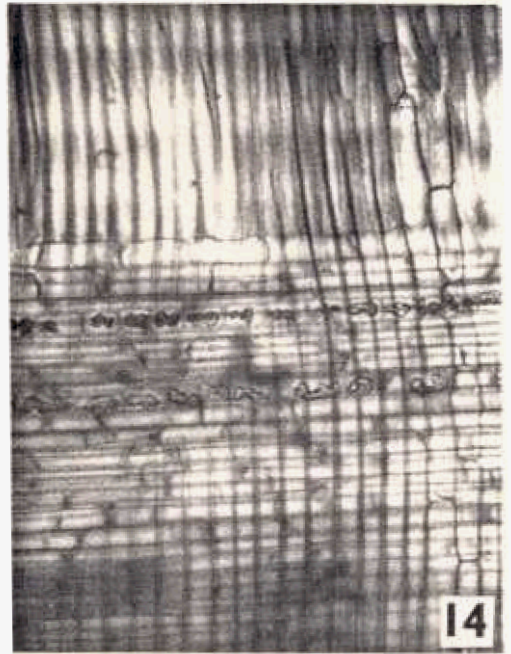


Fig. 13. *Syzygium chavaran*, TLS showing two distinct types of rays. x60. 14. *Euodia lunu-ankenda*, RLS showing crystalline bodies in ray cells, x60. 15. *Palaquium ravii*, TLS showing crystals in fibres. x60. 16. *Vepris bilocularis*, TS showing crystal containing idioblasts (arrows) among fibres