The Identification of Important Indian Sleeper Woods.

By

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PREFACE.

This Bulletin is the first of its kind to be published by the Forest Research Institute at Dehra Dun, and aims at supplying Forest officers, Railway Passing officers, and others with sufficient information to enable them to identify some of the more common Indian sleeper woods, in the field.

It is the intention to publish similar bulletins from time to time, dealing with the timbers of individual Provinces.

Railway sleepers have, however, always formed a very large proportion of the total production of timber from Indian forests, and as officers have for some time past been pressing the Forest Research Institute to produce a simple key for the identification of Indian sleeper woods, it was felt that a start could well be made by dealing with these woods first.

In subsequent Bulletins, it is the intention to deal with timbers according to localities rather than uses.

Dehra Dun;
December 1st, 1931.

H. Trotter,
Forest Economist.
INTRODUCTION.

For the efficient utilization of timbers, it is necessary not only to know their strength, durability and working qualities, but also to be able to identify the various kinds that are sold in the market. In the past, the use of timber of unknown identity has often caused heavy financial losses to the users. In India, little information is available for the proper identification of commercial timbers. This bulletin attempts partly to meet this shortage by showing, as far as possible in non-technical manner, the structural differences of Indian sleeper woods and the way to identify them in the field.

Considerable research has been done at the Forest Research Institute to find out the suitability or otherwise of various Indian timbers for railway sleepers. As a result, it has been possible to include more than fifty species in this bulletin as possible sleeper woods. The work done so far shows that some of these are naturally durable, while others are not so and require treatment with preservatives. To lengthen the life of railway sleepers, it is also imperative that they should undergo proper seasoning previous to use. This seasoning merely involves the open piling of the sleepers under cover for a few months.

Full details regarding the treatment of sleepers with preservatives, as well as the proper seasoning of various species, can be obtained from the Forest Research Institute, Dehra Dun.

In conclusion, I wish to express my sincere thanks to Capt. H. Trotter, Forest Economist, and Mr. F. D. Ardagh, Officer in Charge, Minor Forest Products Section, for their encouragement and assistance during the progress of this work. I am also indebted to the Officers in Charge, Timber Testing Section (Mr. L. N. Seaman), Wood Preservation Section (Mr. F. J. Popham) and Seasoning Section (Dr. S. N. Kapur), for supplying me with information concerning their sphere of work, and to the Officiating Silviculturist (Mr. M. V. Laurie) for allowing me to use his photographic laboratory.

Dehra Dun; November 1931.

K. A. CHOWDHURY,
Wood Technologist.
NON-POROUS

CHIR
(Pinus longifolia.)

RING-POROUS

DIFFUSE-POROUS

TEAK
(Tectona grandis.)

SAL
(Shorea robusta.)

A. End surface.
B. Tangential surface.
C. Radial surface.
D. Wood ray.
E. Early wood.

F. Late wood.
G. Resin canal.
H. Tracheid.
I. Pore.
J. Fibre.
The Identification of Important Indian Sleeper Woods.

1. THE GROSS STRUCTURE OF WOOD.

(a) Sapwood and heartwood. Usually, the dark coloured central portion of a log is called heartwood and the light coloured outer portion, sapwood. The colour distinction, however, is not always present; for instance, Himalayan silver fir and spruce show no difference in colour between sapwood and heartwood, although physiologically a certain amount of heartwood is always present in mature wood of any species.

Experience has shown that under similar conditions heartwood is more durable than sapwood. There is no explanation for this from a structural point of view, for there is very little difference in structure between heartwood and sapwood. The durability of heartwood has sometimes been attributed to the presence of chemical deposits, such as resins, gums and oils, which may serve as natural preservatives of the wood.

Due to the greater durability of heartwood, its proportion in a log is of great commercial importance. But the factors governing the formation of heartwood are many and often uncontrollable, hence it is not possible to state the specific percentage of heartwood for any one species.

When logs are left in the open for some time, they are often subjected to what is called “sap stain”. When this happens, although the sapwood is discoloured and looks defective, yet the strength of the timber is not materially affected. The various fungi, which are responsible for bringing about this discolouration effect, live, for the most part, on carbohydrates and starch deposits in the green sapwood, and do not damage the timber as a whole.

(b) Spring wood and summer wood. Originally these two terms were applied to the wood of temperate climates, where there are two distinct growth periods, namely spring and summer. But in India, trees grow, at least in some localities, throughout the whole
year, and the terms spring wood and summer wood can not, therefore, always be used with accuracy. On the other hand, in some trees variable intensity of growth is very prominent—a rapid growth in the form of open wood followed by a layer of dense wood. The former may be called early wood and the latter, late wood. The early wood is usually light in colour while the late wood is dark in appearance.

The greater the difference between the spring wood or early wood and the summer wood or late wood, the more prominent is the growth ring, often also called the annual ring.\(^*\) The rate of growth depends on many factors such as species, position in the tree, locality and condition of the soil in which the tree grows. The rate of growth and strength of the timber are inter-related to some extent but that is a subject by itself and cannot be discussed here.

(c) **Grain and texture.** The indiscriminate use of these two terms has caused much confusion in the past. For the sake of clearness it seems advisable to define them. **Grain** applies to the alignment of cells, *i.e.*, whether it is straight or cross, spiral or interlocked, curly or wavy. On the other hand, **texture** applies to the size of the cells and their proportion in unit volume. The modifying adjectives used to indicate types of texture are fine and coarse. One of the finest textured woods included in this bulletin is *Mitragyna parvifolia*, and one of coarse texture is *Parashorea stellata*.

The width of the growth ring has often been included in the description of grain, but it seems more accurate to describe this character as wide-ringed or narrow-ringed rather than coarse-grained or fine-grained, thus avoiding confusion.

(d) **Pores and tracheids.** Wood is composed of minute tube-like cells of different size and structure, which perform various functions, both physiological and mechanical, necessary for the life activities of a tree. In conifers, tracheids are the main longitudinal elements, and their function is to conduct liquids (sap) and also to give rigidity to the tree. In broad-leaved trees, there is a division of labour, that is, there are pores for conduction and fibres

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\(^*\) As the ring shows the difference in the growth activities of a tree from season to season, which may not be in the climate of this country one full year, it seems judicious to use the word 'growth ring' instead of 'annual ring'.

---
for strength. Structurally, pores are short cells with wide openings and are usually visible to the naked eye (see frontispiece). The wood of broad-leaved trees is, therefore, called porous, and that of conifers, non-porous.

Ring-porous and diffuse-porous. The wood of broad-leaved trees is classified as ring-porous and diffuse-porous, according as to whether the pores form a sort of band at the early part of the ring or are distributed more or less uniformly throughout the ring (see frontispiece). Again, the pores of some woods often show a tendency towards radial arrangement, and this character is taken into consideration for classification and identification of timbers (plate XIV).

Tyloses and their importance in the utilization of wood. Tyloses are in-growths found in the pores of certain species. With a hand lens they appear as a foam-like structure, often filling the entire pore cavity. Experience has shown that when tyloses are present in any species they are a constant feature of the heartwood, and occasionally of the inner sapwood.

The greater durability of heartwood has often been attributed to its tyloses, which control, at least to some extent, the moisture and temperature of the wood inside, and thus serve as a protection against fungal attack. But the presence of tyloses is not without a drawback, for impregnation with creosote or other preservatives is rendered more difficult in the heartwood of tylosed species.

(c) Fibres. Structurally, fibres are similar to the tracheids of conifers. They are present only in broad-leaved trees and are responsible for the strength of the wood. Individually, they are too minute to be visible with a hand lens, although collectively they show different arrangement and distribution, which is of some value in the identification of woods.

(f) Parenchyma cells or soft tissues. Parenchyma cells or soft tissues, as they are often called, are short, minute, thin-walled cells; like fibres they are not individually visible with a hand lens, but collectively their distribution and arrangement are of importance in the classification and identification of timbers.

There are various types or patterns of parenchyma arrangement, of which the more important are as follows:—Parenchyma is called terminal when it occurs more or less in a band on the outer
Zone of the growth rings, e.g., *Michelia excelsa*. In other species like *Albizia lebbek*, it forms a sort of halo or eyelet round the pores. A type like that of *Xydia dolabriformis*, where the parenchyma cells are arranged in a thin band round the pores, is also often met with. The fourth type is called diffused. In this type, distribution is more or less irregular throughout the wood, e.g. *Shorea obtusa*.

It may be noted here that parenchyma arrangements are not limited definitely to the four types mentioned above, nor does each distinct type occur in different species. In practice all kinds of gradations and combinations may be observed.

*Pith flecks.* As a result of injury by insects, certain trees develop groups of parenchyma cells called pith flecks. These show rather conspicuously against the natural colour of the wood, and on a board face may be mistaken for resin canals. Although little importance is given to pith flecks in the identification of timbers, yet their presence is of diagnostic value, for some species are more liable to form pith flecks than others.

*(g) Resin canals.* Certain timbers of both coniferous and broad-leaved trees contain cavities of resin, called resin canals. These run vertically along the grain, and are responsible for the dark streaks often seen on boards of pine and spruce. In some species they are also present in the wood rays, but are too minute to be visible to the naked eye or with a hand lens, and therefore cannot be considered in this bulletin, which deals only with hand lens identification.

The arrangements of resin canals are usually of two types. In pines, spruces, and *Dipterocarpus* species, they are more or less evenly distributed throughout the growth rings, while in others like deodar (*Cedrus deodara*), toon (*Cedrela toona*) and sal (*Shorea robusta*) they are often found in lines of variable length at irregular intervals.

For identification purposes the colour of the resin-deposit that is present in a wood is of importance. For instance, members of the *Dipterocarpaceae* have resins of a whitish colour, which is seldom found in timbers of any other family.

*(h) Wood rays or medullary rays.* Wood rays or rays, as they are often called, are groups of cells arranged radially from the
bark towards the centre of a tree. Their function is storage and conduction, at any rate radial conduction, of food materials. On the end surface they appear as straight radial lines, often too minute to be visible to the naked eye. On the tangential surface even, they are not always visible to the eye, but with the help of a hand lens their spindle-shaped structures are easily discerned. On the radial surface they are not conspicuous, except in the case of unusual height when they appear as small plates and produce the effect known as "silver grain".

Their size and distribution are, therefore, of importance, not only for identification but also from a utility point of view. In addition, rays are, to a certain extent, also responsible for the texture of wood.

Ripple marks. In certain timbers, rays are so arranged as to bring about, on the tangential surface, the effect of fine, equidistant wavy lines at right angles to the grain. These are called ripple marks. Andaman padauk (Pterocarpus dalbergioides) is a typical example of this.

II. THE GENERAL FEATURES OF WOOD.

(a) Colour. Differences in colour do not necessarily imply differences in wood-structure. In fact, a great deal of variation in colour is found in wood of the same species. Colour has, however, some diagnostic value, especially when timbers are very similar in structure, but show a marked difference in colour. As an example, Andaman padauk (Pterocarpus dalbergioides) and Burma padauk (Pterocarpus macrocarpus) can often be separated by their colour though they are structurally similar.

Usually timber ages to a darker colour than when it is freshly cut. This is due to the oxidization of chemical deposits under atmospheric conditions and light. In the case of Michelia excelsa, for example, the oxidization on a freshly cut surface is so fast that one can sometimes see the colour turning, within a few minutes, from yellow green to brownish grey.

(b) Lustre. The special property of the cell walls of certain timbers to reflect light, known as lustre, is of importance for identi-
Lustre is usually present on longitudinal, and more often on the radial-longitudinal surfaces. Among conifers, spruce has a characteristic pearly lustre. Quarter-sawn timbers of some species also reflect light from their rays and give a figure to the plank.

(c) Odour. Odour is another characteristic which can sometimes be used for identification purposes. It is not, however, always easy to describe verbally. The odour of deodar, for example, is so characteristic that it can hardly be mistaken for that of anything else, yet it is impossible to describe it. The customary method of describing the odour of any wood is to compare it with that of something else very familiar to us, e.g. teak is said to have a leathery odour. Due to abundance of chemical deposits in the heartwood, odour is usually more pronounced there than in the sapwood. Sometimes, on an exposed surface, odour may become very faint but can be recovered by making a fresh cut and moistening it with water.

(d) Weight. The weight of wood varies not only in different species but also in the same species, and is dependent on a number of factors. For the sake of brevity, we shall consider here the most important factor from the utilization point of view, namely the moisture content. Timber when first felled has a very high percentage of moisture, but, on exposure, it gradually loses the free water in the cell cavities and later the water that was absorbed in the cell walls. Again, wood can be dried under artificial conditions, such as in a seasoning kiln, or even in an electric oven, till it attains a constant weight. Therefore, in giving the weight of any wood it should be stated whether the timber was green, air-dry, kiln-dry or oven-dry. The moisture content of green timber may be any thing from 50 per cent upwards, and may be as high as 200 per cent. Air-dry timber usually has a moisture content of from about 8-15 per cent depending on the climate, while kiln-dry timber may be less or more according to requirements. Oven-dry is a term usually used to describe timber from which all moisture has been removed. By “moisture content” is meant the amount of moisture in the wood, shown as a percentage of the oven-dry weight of the wood.
The classification given below is based on air-dry (12-15 per cent moisture) weight and volume determined at the Forest Research Institute, Dehra Dun:—

<table>
<thead>
<tr>
<th>Weight per cubic ft.</th>
<th>Very light</th>
<th>Light</th>
<th>Moderately light</th>
<th>Heavy</th>
<th>Very heavy</th>
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<td></td>
<td>18-22 lbs.</td>
<td>22-27</td>
<td>27-32</td>
<td>32-39</td>
<td>39-49</td>
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(c) **Hardness.** The customary physical laboratory test for hardness consists of finding the resistance which wood offers to indentations. But this is not a practical method which can be carried out in the field. For the purposes of this bulletin, therefore, the test for hardness has been confined to the resistance which wood offers when subjected to the action of a sharp knife across the grain.

**III. DECAY IN WOOD.**

It is well known that under identical conditions heartwood is more durable than sapwood. The reason for this is that, structurally or otherwise, sapwood is more likely to create the favourable conditions necessary for the germination of fungal spores than heartwood. Moreover, the presence of chemical deposits in the heartwood often serves as a natural preservative against wood destroying agencies. But this drawback on the part of the sapwood can be overcome by treatment with different preservatives suitable for the purpose for which the timber is used.

The fungi that are usually found on or in the wood may be classified under two groups:—

(1) Sap-stain fungi.
(2) Wood destroying fungi.

The fungi belonging to the sap-stain group usually live on the food materials present in the wood—only in rare cases penetrating the cell walls. They do not, therefore, do any material damage to the timber other than discolouring it.
A warm humid atmosphere is the most favourable condition for the spread of sap-stain fungi. As a preventive measure against the attack of such fungi, it is advisable to have logs converted and piled in a well ventilated place so that the sap may dry quickly, thus preventing the germination of fungi.

The species comprising the wood destroying group of fungi, which are the cause of decay or rot in wood, have the ability to destroy the cell wall substance of the wood, ultimately reducing it to a powdery state. The difficulty about this group is that they are not easily detectable. When they are far advanced, signs of deterioration or rot are visible, and then it is often too late to adopt any preventive measure. Early conversion and quick seasoning after conversion are the two essentials to prevent fungus attack in the initial stages, and subsequent treatment with a preservative is usually sufficient to ward off attack for a number of years even in the case of non-durable species.

IV. PROCEDURE FOR THE IDENTIFICATION OF TIMBERS IN THE FIELD.

With some experience in handling timbers, one may be able to identify some of them by their general features. But this is possible only in a few cases, and even then, too much importance may be given to variable features like colour and weight, and mistakes made thereby. The best way of identifying timbers is by the structure exhibited on the end surface. The structure of wood is its most conservative characteristic, and it seldom varies to the extent of causing confusion in identification. With a little systematic practice anyone should easily be able to identify all the timbers included in this bulletin.

For field identification work two things are required; a good steel knife which must be kept very sharp, and a hand lens, magnifying 10-12 times, which can be obtained from any scientific instrument dealer.

The method of procedure in identification work is as follows:— Make a sharp cut on the end surface. Hold the lens close to the eye and gradually bring the object near enough for the structure to be distinctly visible. Sometimes a drop of water on the cut surface
brings out the structure in detail, but there are cases like *Bischofia javanica* in which the structure becomes rather blurred on the application of water. Both ways should, therefore, be tried in order to obtain the best definition.

The wood should be held in such a way as to get a good light on the cut surface. The portion to be examined need not be large (half an inch square will be sufficient), but it must not be taken from the portion nearest to the pith. In most cases a single cut will be sufficient for satisfactory identification. In some cases, however, a number of cuts may be required, to ensure correct observation of important characteristics, such as the type of distribution of resin canals. A little experience will enable one to judge when such extra checks are necessary.

**V. HOW TO USE THE KEY.**

In the key which follows chapter six, timbers have been grouped according to the structural features that are visible to the naked eye or with a hand lens. Every group has duplicate numbers on the left hand side, each showing contradictory characteristics. The numbers on the right hand side indicate where the further divisional characteristics are to be looked for. In this way, each group is taken up separately and divided into further groups until the species are ultimately separated off. The following example of tracing a species through the key will help to make the procedure quite clear. On examination a piece of wood is found to be porous. This leads us to number 6; which is divided into two parts, ring-porous and diffuse-porous. Our specimen is found to be diffuse-porous which takes us to number 13. Number 13 again has two divisions, ripple marks or no ripple marks. If ripple marks are present, the specimen is one of those under number 14. If no ripple marks are present we must refer to number 16 in the key, and continue in this fashion until the timber has been traced. It will be observed that in certain cases 2 or 3 species have been grouped together. This is unavoidable, for these species cannot be separated with the help of a hand lens.

It should be remembered that a key is only a means for identification and cannot be made to give a full description of the wood.
Only those features which are of distinguishing value have been mentioned in it. With practice in identification one acquires, after a time, mental pictures of the timbers one knows, and the necessity of a key is no longer felt.

Lastly, a key will offer the best help for identification, only when the important features are clearly seen. Examination of an unevenly cut surface is often confusing, and may even lead to wrong identification. It is, therefore, of primary importance that the surface to be examined should be clean cut with a very sharp knife.

VI. MAP SHOWING THE DISTRIBUTION OF SPECIES.

At the end of this bulletin a map, showing the various species of sleeper woods that grow in the areas with which different Railway Groups are concerned, is given. For the sake of convenience, the Central Group and Terai Group have been lumped together, and Burma has been separated from the Eastern Group. The map is intended to serve two purposes. Firstly, it shows at a glance the species that can be obtained from a given locality and secondly, it will help in identification, as one can easily eliminate a species that does not occur in any particular locality. For example, a freshly cut sleeper in Madras may appear at first sight to be Pterocarpus macrocarpus, but a glance at the map will at once show that this cannot be so as this species occurs only in the Burma area.

Conclusion.

In conclusion, a word of warning not to be discouraged at the first attempts at identification is given. Quick and accurate identification of timbers can only be achieved after much practice. It is a fascinating pastime, and when one becomes expert, it is a most valuable asset. Should any difficulties be encountered a reference to the Forest Research Institute at Dehra Dun will always be treated with sympathy, and a visit from anyone interested in identification of timbers will always be welcomed.
VII. A KEY FOR THE IDENTIFICATION OF IMPORTANT INDIAN SLEEPER WOODS.

(Roman numerals on the right hand side refer to the plate numbers of photomicrographs.)

1. Wood non-porous ........................................... 2
1. Wood porous .................................................. 6
2. Resin canals present, mostly scattered ...................... 3
2. Resin canals usually absent, if present grouped in short tangential bands ....................... 5
3. Resin canals fairly large, distinctly visible to the naked eye, rather numerous. Wood moderately heavy. .......... 4
3. Resin canals minute, not visible to the naked eye, scanty. Wood moderately light, lustrous. HIMALAYAN SPRUCE, Picea morinda ............ (I)
4. Wood yellow to pale reddish brown, uneven grained. Transition from spring to summer wood abrupt. CHIR, Pinus longifolia ......................... (I)
4. Wood with a pinkish tinge, even-grained. Transition from spring to summer wood gradual. BLUE PINE, Pinus excelsa ................. (II)
5. Wood with characteristic odour, bitter taste. Resin canals occasionally in short tangential bands. DEODAR, Cedrus deodara .......... (II)
5. Wood without any odour or characteristic taste. Resin canals absent. HIMALAYAN SILVER FIR, Abies pindrow ................. (III)
6. Wood ring-porous or semi-ring-porous .................. 7
6. Wood diffuse-porous ........................................... 13
7. Ripple marks present, very distinct on the tangential surface ..................................................... 8
7. Ripple marks absent ........................................... 10
8. Heartwood golden yellow to golden brown, often streaked with darker bands. BIJASAL, Pterocarpus marsupium. ANDAMAN PADAUK, Pterocarpus dalbergioides (off colour) .................. (III & IV)
8. Heartwood reddish brown to dark red .................. 9
9. Heartwood bright red, often streaked with black. ANDAMAN PADAUK, Pterocarpus dalbergioides ........... (IV)
9. Heartwood brick red, rather dull in appearance. BURMA PADAUK, Pterocarpus macrocarpus ............... (IV)
10. Rays fairly broad, distinctly visible with the naked eye. Late pores seldom connected by parenchymatous bands. Wood yellow to golden brown. TEAK, Tectona grandis ................... (V)
10. Rays not visible to the naked eye. Parenchyma round the late pores, often forming wavy tangential bands .... 11
11. Wood moderately hard, light red to bright reddish brown. **JARUL, Lagerstroemia flos-reginae** (V)

11. Wood hard to very hard, greyish brown to reddish brown. 12

12. Late wood pores mostly surrounded by thick layer of parenchyma, often extending in wavy tangential bands. **LENDI, Lagerstroemia parviflora** (VI)

12. Late pores mostly surrounded by thin layer of parenchyma. **BENTEAK, Lagerstroemia lanceolata** (VI)

13. Ripple marks present, very distinct on the tangential surface 14

13. Ripple marks absent 16

14. Heartwood golden yellow to golden brown, often streaked with darker bands. **BIJASAL, Pterocarpus marsupium. ANDAMAN PADAUK, Pterocarpus dalbergioides** (off colour) (III & IV)

14. Heartwood reddish brown to dark red 15

15. Heartwood bright red, often streaked with black. **ANDAMAN PADAUK, Pterocarpus dalbergioides** (IV)

15. Heartwood brick red, rather dull in appearance. **BURMA PADAUK, Pterocarpus macrocarpus** (IV)

16. Resin canals present, often containing whitish substance 17

16. Resin canals absent 25

17. Resin canals scattered, single, often filled with white deposits, rarely surrounded by parenchyma. Wood moderately soft, whitish grey to brownish grey. **VEL-LAPINEY, Vateria indica** (VII)

17. Resin canals mostly in groups or bands, rarely single, often surrounded by whitish parenchymatous band 18

18. Resin canals often in long tangential bands, extending more than an inch, the rest rather irregularly distributed 19

18. Resin canals mostly in short tangential bands (2-15 canals per band), the rest uniformly distributed 23

19. Pores large, distinctly visible to the naked eye. Rays rather broad, visible to the naked eye 20

19. Pores small, just visible to the naked eye. Rays rather fine, indistinct to the naked eye; wood very hard to extremely hard. **HOPEA, Hopea parviflora** (VII)

20. Wood moderately heavy, rather soft, light greyish brown. Tyloses absent. **MAKAI, Shorea assamica** (VII)

20. Wood heavy to very heavy, hard. Tyloses present 21

21. Wood heavy 22

21. Wood very heavy. Tyloses completely filling up the pores of the heartwood. **SAL, Shorea robusta. BURMA SAL, Shorea obtusa. Pentacme suavis** (VIII & IX)

22. Wood coarse textured. Parenchyma forming distinct eyelets round the pores. **TAVOY WOOD, Parashorea stellata** (X)
22. Wood rather fine textured. Parenchyma mostly diffuse. **THINGAN, Hopea odorata**


23. Resin canals mostly in rows of more than 2, rarely single

24. Wood hard to very hard, even textured. **ENG, Dipterocarpus tuberculatus**

24. Wood moderately hard to hard, somewhat coarse textured. **GURJUN, Dipterocarpus alatus**. **BLACK DAMMAR, Dipterocarpus indicus**. **GURJUN, Dipterocarpus turbinatus**.

25. Pores fairly large, individually distinct to the naked eye

25. Pores minute, indistinct to the naked eye

26. Pores in radial or obliquely radial groups

26. Pores rather irregularly arranged

27. Tangential bands of parenchyma broad. Wood brick red, very heavy, extremely hard. **MESUA, Mesua ferrea**

27. Tangential bands of parenchyma fine

28. Wood very heavy, very hard. **MAHWA, Bassia latifolia**

28. Wood moderately heavy to heavy, moderately hard

29. Rays very fine, just visible with a hand lens. Tyloses scarce. **INDIAN SWEET CHESTNUT, Castanopsis hystrix**

29. Rays fairly broad, distinctly visible with hand lens. Tyloses abundant. **PALL, Dichopsis elliptica**

30. Rays visible to the naked eye

30. Rays indistinct to the naked eye

31. Rays prominent, conspicuous to the naked eye

31. Rays inconspicuous, just visible to the naked eye

32. Wood medium textured. Parenchyma diffuse. **CHALTA, Dillenia indica**

32. Wood coarse textured. Parenchyma forming distinct eyelet round the pores. **CHAPLASH, Artocarpus chaplasha**

33. Parenchyma distinctly visible with a hand lens

33. Parenchyma scarcely visible with a hand lens. Pores in the heartwood densely filled with tyloses. **GARUGA, Garuga pinnata**

34. Parenchyma forming tangential wavy bands. Wood yellowish grey. **PADRI WOOD, Stereospermum cheilonoides**

34. Parenchyma diffuse or in straight tangential bands

* Natural hybrids are known to exist among the different species of *Dipterocarpus*. As the wood of a hybrid usually shows characteristic structures of both the parents, it is often difficult to identify it. In such cases timbers should be identified as *Dipterocarpus* spp. and this will serve for practical purposes.
35. Wood light brown, moderately light to moderately heavy, soft. Parenchyma in fine tangential bands. **KARANI, Cullenia excelsa**. (XVII)

35. Wood deep brown, often with a pinkish tinge, very heavy, very hard. Parenchyma diffuse. **SUNDRI, Heritiera minor**. (XVIII)

36. Rays fairly broad (with a hand lens), irregularly spaced. 37

36. Rays fine, equidistant. 40

37. Wood blackish red, often streaked with purplish tinge, very heavy, very hard to extremely hard. **ANJAN, Hardwickia binata**. (XVIII)

37. Wood whitish yellow to dark brown, moderately heavy to heavy, moderately hard to hard. 38

38. Tangential bands of parenchyma often present. 39

38. Tangential bands of parenchyma not distinguishable with a hand lens. Wood brick red, coarse textured. **BISHOP WOOD, Bischofia javanica**. (XIX)

39. Parenchyma bands thick, ending abruptly. Eyelets round the pores rather inconspicuous. Wood whitish yellow to brownish grey. **MANGO, Mangifera indica**. (XIX)

39. Parenchyma bands always in fine lines, continuous. Eyelets round the pores conspicuous. Wood dark brown with black and grey streak. **KOKKO, Albizia lebbek. WHITE SIRIS, Albizia procera**. (XX)

40. Parenchyma not in tangential bands. 41

40. Tangential bands of parenchyma present, at least in the outer part of the growth ring. 43

41. Pores filled with tyloses. Wood moderately hard. **INDIAN RED PEAR, Bursera serrata**. (XXI)

41. Pores for the most part open. Wood very hard to extremely hard. 42

42. Parenchyma forming a distinct whitish band round the pores. Wood sometimes with an oily appearance. **PYINKADO, Xylocopa dolabriformis. IRUL, Xylocopa xylocarpa**. (XXI & XXII)

42. Parenchyma not distinguishable with a hand lens. Wood rather dull looking. **KUSUM, Schleichera trijuga**. (XXII)

43. Terminal bands of parenchyma distinctly visible with a hand lens. 44

43. Terminal bands of parenchyma if present, not distinguishable with a hand lens. 46

44. Tangential bands of parenchyma mostly confined to the late pores. 45

44. Tangential bands of parenchyma present both in early and late wood, connecting the pores and alternating with fibrous bands. **BAHERA, Terminalia belerica. LEIN, Terminalia pyrifolia**. (XXIII)

45. Wood greyish brown with yellowish tinge, moderately hard. **HOLLÖCK, Terminalia myricarpa**. (XXIV)
45. Wood greyish brown to dark brown, hard to very hard.
   **LAUREL, Terminalia tomentosa.** **ARJAN, Terminalia arjuna**
   (XXIV & XXV)

46. Growth marks distinct, delimited by fibrous band, which
    is almost without pores  
   47

46. Growth marks indistinct  
   48

47. Pores rather conspicuous on the face of the board. **KINDAL, Terminalia paniculata**
   (XXV)

47. Pores inconspicuous on the face of the board. **YON, Anogeissus acuminata**
   (XXVI)

   **PING, Cynometra polyandra**
   (XXVI)

48. Wood moderately hard to very hard. Parenchyma bands rather fine  
   49

49. Wood very heavy, very hard. Pores often filled with whitish gum. **JAMAN, Eugenia gardneri**
   (XXVII)

49. Wood moderately heavy to heavy. Pores mostly open. **JAMAN, Eugenia jambolana**
   (XXVIII)

50. Wood very hard to extremely hard, very heavy. Yellowish grey. Parenchyma round the pores. **THAN, Terminalia oliveri**
   (XXVIII)

50. Wood soft to hard  
   51

51. Growth rings conspicuous on the longitudinal surface  
   52

51. Growth rings inconspicuous on the longitudinal surface  
   53

52. Wood rather soft, green when freshly cut, gradually
    turning to brownish grey. Parenchyma forming
    distinct terminal bands. **CHAMP, Michelia excelsa**
   (XXVIII)

52. Wood rather hard. Terminal parenchyma absent. **JUTILI, Altingia excelsa**
   (XXIX)

53. Wood moderately hard. Parenchyma diffuse. **KAIM, Mitragyna parvifolia**
   (XXIX)

53. Wood hard to very hard. Parenchyma not distinguishable
    with a hand lens. **NEEDLE WOOD, Schima wallichii**
   (XXX)

**VIII. SCIENTIFIC NAMES, TRADE NAMES AND OTHER NAMES.**

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Trade Name</th>
<th>Other Common Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>Abies pindrow</em></td>
<td>Himalayan silver fir.</td>
<td></td>
</tr>
<tr>
<td>2. <em>Albizzia lebbek</em></td>
<td>kokko</td>
<td><em>siris,</em> East Indian walnut.</td>
</tr>
<tr>
<td>3. <em>Albizzia procera</em></td>
<td>white siris</td>
<td><em>safed siris,</em> <em>sit,</em> <em>thitpya.</em></td>
</tr>
<tr>
<td>4. <em>Altingia excelsa</em></td>
<td>jutili</td>
<td><em>nanlayok</em> (Burma).</td>
</tr>
<tr>
<td>5. <em>Anogeissus acuminata</em></td>
<td>yon.</td>
<td></td>
</tr>
<tr>
<td>6. <em>Artocarpus chaplasha</em></td>
<td>chaplash</td>
<td><em>chaplish,</em> <em>cham.</em></td>
</tr>
<tr>
<td>7. <em>Bassia latifolia</em></td>
<td>mahwa.</td>
<td></td>
</tr>
<tr>
<td>8. <em>Bischofia javanica</em></td>
<td>bishopwood.</td>
<td></td>
</tr>
<tr>
<td>Scientific name</td>
<td>Trade name</td>
<td>Other common names</td>
</tr>
<tr>
<td>-----------------</td>
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<td>--------------------</td>
</tr>
<tr>
<td>9. Bursera serrata</td>
<td>Indian red pear</td>
<td>thadi (Burma).</td>
</tr>
<tr>
<td>10. Cuscuta hystrix</td>
<td>Indian sweet chestnut.</td>
<td></td>
</tr>
<tr>
<td>12. Cullenia excelsa</td>
<td>karani</td>
<td></td>
</tr>
<tr>
<td>13. Cynometra polyandra</td>
<td>ping</td>
<td></td>
</tr>
<tr>
<td>14. Dichopsis elliptica</td>
<td>pali</td>
<td></td>
</tr>
<tr>
<td>15. Dillenia indica</td>
<td>chalta</td>
<td>ramphal</td>
</tr>
<tr>
<td>16. Dipterocarpus alatus</td>
<td>gurjun</td>
<td>kanyin (Burma).</td>
</tr>
<tr>
<td>17. Dipterocarpus indicus</td>
<td>black dammar.</td>
<td></td>
</tr>
<tr>
<td>18. Dipterocarpus macrocarpus</td>
<td>hollong</td>
<td></td>
</tr>
<tr>
<td>19. Dipterocarpus tuberculatus</td>
<td>eng</td>
<td>in, maiyang</td>
</tr>
<tr>
<td>20. Dipterocarpus turbinatus</td>
<td>gurjun</td>
<td>kanyin (Burma).</td>
</tr>
<tr>
<td>21. Eugenia gardneri</td>
<td>jaman</td>
<td></td>
</tr>
<tr>
<td>22. Eugenia jambolana</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Garuga pinnata</td>
<td>garuga</td>
<td></td>
</tr>
<tr>
<td>24. Hardwickia binata</td>
<td>anjan</td>
<td></td>
</tr>
<tr>
<td>25. Heritiera minor</td>
<td>sundri</td>
<td>pinle-kanazo</td>
</tr>
<tr>
<td>26. Hopea odorata</td>
<td>thingan</td>
<td></td>
</tr>
<tr>
<td>27. Hopea parviflora</td>
<td>hopea</td>
<td>kongu, irubogam</td>
</tr>
<tr>
<td>28. Lagerstroemia flos-reginae</td>
<td>jarul</td>
<td>pyinma (Burma)</td>
</tr>
<tr>
<td>29. Lagerstroemia lanceolata</td>
<td>benteak</td>
<td>nana</td>
</tr>
<tr>
<td>30. Lagerstroemia parviflora</td>
<td>lendi</td>
<td>nandi, bakli</td>
</tr>
<tr>
<td>31. Mangifera indica</td>
<td>mango</td>
<td>am, ambia</td>
</tr>
<tr>
<td>32. Mesua ferrea</td>
<td>mesua</td>
<td>nagesar, penage, gangaw, nangal</td>
</tr>
<tr>
<td>33. Michelia excelsa</td>
<td>champ</td>
<td>bara champ, safed champ</td>
</tr>
<tr>
<td>34. Mitragyna parvifolia</td>
<td>kaim</td>
<td></td>
</tr>
<tr>
<td>35. Parashorea stellata</td>
<td>Tavoy wood</td>
<td>thingadu (Burma)</td>
</tr>
<tr>
<td>36. Pentacme suavis</td>
<td>Burma sal</td>
<td>ingyin. (usually mixed with Shorea obtusa under the name of thitya- ingyin)</td>
</tr>
<tr>
<td>37. Picea morinda</td>
<td>Himalayan spruce</td>
<td>rai</td>
</tr>
<tr>
<td>38. Pinus excelsa</td>
<td>blue pine</td>
<td>kail</td>
</tr>
<tr>
<td>39. Pinus longifolia</td>
<td>chir</td>
<td>chil, long-leaved pine</td>
</tr>
<tr>
<td>40. Pterocarpus dalbergioides</td>
<td>Andaman padauk</td>
<td>padauk</td>
</tr>
<tr>
<td>Scientific name.</td>
<td>Trade name.</td>
<td>Other common names.</td>
</tr>
<tr>
<td>------------------</td>
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<td>---------------------</td>
</tr>
<tr>
<td>42. Pterocarpus marsupium</td>
<td>bijasal.</td>
<td></td>
</tr>
<tr>
<td>43. Schima wallichii</td>
<td>needle wood.</td>
<td></td>
</tr>
<tr>
<td>44. Schleicheria trijuga</td>
<td>kusum</td>
<td>gyo (Burma).</td>
</tr>
<tr>
<td>45. Shorea assamica</td>
<td>makai.</td>
<td></td>
</tr>
<tr>
<td>46. Shorea obtusa</td>
<td>Burma sal</td>
<td>thitya (usually mixed with Pentacme suavis under the name of thitya-ingyin).</td>
</tr>
<tr>
<td>47. Shorea robusta</td>
<td>sal.</td>
<td></td>
</tr>
<tr>
<td>48. Stereospermum chelono-ides</td>
<td>padri wood</td>
<td>pader, padri.</td>
</tr>
<tr>
<td>49. Tectona grandis</td>
<td>teak</td>
<td>sajun.</td>
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<tr>
<td>50. Terminalia arjuna</td>
<td>arjan</td>
<td>arjuna.</td>
</tr>
<tr>
<td>51. Terminalia beberica</td>
<td>bahera.</td>
<td></td>
</tr>
<tr>
<td>52. T. myriocarpa</td>
<td>hollock</td>
<td>panisaj.</td>
</tr>
<tr>
<td>53. T. oliveri</td>
<td>than.</td>
<td></td>
</tr>
<tr>
<td>54. T. paniculata</td>
<td>kindal</td>
<td>kinjal.</td>
</tr>
<tr>
<td>55. T. pyrifolia</td>
<td>lein.</td>
<td></td>
</tr>
<tr>
<td>56. T. tomentosa</td>
<td>laurel</td>
<td>asna, sain, asan, mutt, taukkyan, karimaradu.</td>
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<tr>
<td>57. Vateria indica</td>
<td>vellapiney</td>
<td>dhup.</td>
</tr>
<tr>
<td>58. Xylia dolabriformis</td>
<td>pyinkado.</td>
<td></td>
</tr>
<tr>
<td>59. Xylia xylocarpa</td>
<td>irul</td>
<td>jambu.</td>
</tr>
</tbody>
</table>
Photomicrographs of the woods mentioned in the key.

All photomicrographs were taken at 10 diameters.
HIMALAYAN SPRUCE
Picea morinda.

CHIR.
Pinus longifolia.
BLUE PINE.
Pinus excelsa.

DEODAR.
Cedrus deodara.
Plate III.

HIMALAYAN SILVER FIR.
Abies pindrow.

BIJASAL.
Pterocarpus marsupium.
Plate IV.

ANDAMAN PADAUK.
Pterocarpus dalbergioides.

BURMA PADAUK.
Pterocarpus macrocarpus.
Plate V.

TEAK.
Tectona grandis.

JARUL.
Lagerstroemia flos-regime.
LENDI.
Lagerstroemia parviflora.

BENTEAK.
Lagerstroemia lanceolata.
VELLAPINEY.
Vateria indica.

HOPEA.
Hopea parviflora.
Plate VIII.

MAKAI.
Shorea assamica.

SAL.
Shorea robusta.
Plate IX.

BURMA SAL.
Shorea obtusa.

BURMA SAL.
Pentacme suavis.
TAVOY WOOD.
Parashorea stellata.

THINGAN.
Hopea odorata.
HOLLONG.
Dipterocarpus macrocarpas.

ENG.
Dipterocarpus tuberculatus.
GURJUN.
Dipterocarpus alatus.

BLACK DAMMAR.
Dipterocarpus indicus.
GURJUN.
Dipterocarpus turbinatus.

MESUA.
Mesua ferrea.
INDIAN SWEET CHESTNUT.
Castanopsis hystrix.

MAHWA.
Bassia latifolia.
PALI.
Dichopsis elliptica.

CHALTA.
Dillenia indica.
CHAPLASH.
Artocarpus chaplasha.

GARUGA.
Garuga pinnata.
PADRI WOOD.

Stereospermum chelonoides.

KARANI.

Cullenia excelsa.
Plate XVIII.

SUN DRI.

Heritiera minor.

ANJAN.

Hardwickia binata.
BISHOP WOOD.
Bischofia javanica.

MANGO.
Mangifera indica.
Plate XX.

KOKKO.
Albizzia lebbek.

WHITE SIRIS.
Albizzia procera.
Plate XXI.

INDIAN RED PEAR.
Bursera serrata.

PYINKADO.
Xyliu dolabriformis.
IRUL.
Xylica xylocarpa.

KUSUM.
Schleicheria trijuga.
BAHERA.
Terminalia bekerja.

LEIN.
Terminalia pyrifolia.
Plate XXIV.

HOLLOCK.
Terminalia myriocarpa.

LAUREL.
Terminalia tomentosa.
Plate XXV.

ARJAN.
Terminalia arjuna.

KINDAL.
Terminalia paniculata.
YON.

*Anogeissus acuminata.*

PING.

*Cynometra polyandra.*
Plate XXVII.

JAMAN.
Eugenia gardneri.

JAMAN.
Eugenia jambolana.
THAN.
Terminalia oliveri.

CHAMP.
Mehelia excelsa.
Plate X:IX.

JUTILI.
Altingia excelsa.

KAIM.
Mitragyna parvifolia.
Plate XXX.

NEEDLE WOOD.
Schima wallichii.
INDIA

MAP SHOWING SLEEPER WOODS
IN DIFFERENT SLEEPER GROUPS.

Scale 1" = 400 Miles.

REFERENCES

NORTHERN GROUP
CENTRAL & TERAI GROUP
EASTERN GROUP
SOUTHERN GROUP
BURMA

ABIES PINOW
CEDRUS DEODARA
PICEA MONTANA
PINUS EXCELSA
PINUS LONGIFOLIA

ALBIZIA LEBBEK
ALBIZIA PROCERA
ALTINGIA EXCELSA
ANGELIUS ACUMINATA
BASSIA LATIFOLIA
BISCHOPIA JAVANICA
BURSERA SERIATA
CASTANOPSIS Hystrix
CYMOGLEA POLYANDRA
DILLENIA INDICA
DIPTEROCARPUS MACRACARPUS
DIPTEROCARPUS TURBINATUS
EUGENIA GARDNERI
EUGENIA JAMBOLENA
GARUGA PINNATA
LAGERSTROMIA FLORE-REGIA
LAGERSTROMIA PARDIFLORA
MESUA FERREA
MICHJELIA EXCELSA
PTEROCARPUS MARSUPIUM
SCHLEICHEN HUANQUA
SCHLEICHEN TRIGUSA
SNOREA ASSAMICA
SNOREA ROBUSTA
MITRAGYNA PARVIFOLIA

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