HAND-LENS KEY FOR THE IDENTIFICATION OF WEST AFRICAN WOODS

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WIEMANN, M.C. 1994. Hand-lens key for the identification of West African woods. Features observable with a ten-power hand-lens are the basis of a dichotomous key to the identification of woods from 114 genera of West African trees. All of the species of present commercial value plus many common and potentially important species are included. The characters used to identify the woods are defined and preparation of samples for examination is discussed.

Key words: Hand-lens key - wood identification - West Africa

WIEMANN, M.C. 1994. Kunci kanta-tangan untuk mengenalpasti kayu dari Afrika Barat. Ciri-ciri yang kelihatan dengan penggunaan kanta-tangan kuasa-10 merupakan asas kunci dikotomi untuk mengenalpasti kayu dari 114 genus pokok dari Afrika Barat. Kajian ini meliputi kesemua spesies yang mempunyai nilai komersial serta spesies yang biasa dan spesies-spesies penting yang berpotensi. Ciri-ciri yang digunakan untuk mengenalpasti kayu-kayu didefinisikan dan penyediaan sampel untuk pemeriksaan dibincangkan.

Introduction

The following dichotomous key separates 114 genera of woods native to West Africa as far as is practicable using ten-power hand-lens magnification. Usually this means separation to genus, although some woods can be separated as far as individual species or groups of species.

The use of a hand-lens key for the identification of woods has the advantage of requiring a minimum of equipment and a negligible sample preparation time. Low magnification, however, limits the number of features that can be employed in the identification of samples. Physical characteristics must be more heavily relied upon since many of the more reliable anatomical characteristics are visible only with a compound microscope. The descriptions used in the key apply to sound adult heartwood. Wood located near the pith of a tree is often quite different from the later formed adult wood, and sapwood often differs radically from heartwood in colour, odour, density and cell contents.

An advantage of a dichotomous key over a system that uses multiple entry keysort cards or computerized wood identification is that dichotomous key is easily reproduced. It can be distributed to timber inspectors for use in the field and can be used very effectively in instruction in wood identification. To use a keysort card system a user must have a complete set of properly prepared cards. Computerized wood identification requires not only the availability of a computer but also the

appropriate software including a database including all of the species to be considered.

Because of the large number of tree species found in West Africa, it is possible that a secondary species not included in the key might bear such a strong resemblance to a wood that is included as to be mistaken for it. For this reason it is advisable, when possible, to compare a sample that has been identified by means of the key to one from a reference collection of authenticated specimens. When this is not possible, the sample should be compared to a low magnification photomicrograph. Micrographs suitable for this purpose may be found in Anonymous (1953), Gottwald (1958), Normand (1950, 1955, 1960), Kribs (1968), Normand and Paquis (1976), and Ilic (1991).

Definitions of diagnostic features

There is some disagreement about the meanings of many of the terms used in wood anatomy. This section was included, therefore, to define the terms as they are used in this key. The definitions are based on those of the committees on nomenclature of the International Association of Wood Anatomists (IAWA 1964, 1989). Other sources referred to in defining the anatomical terms are Metcalfe and Chalk (1950),Gottwald (1958), Brazier and Franklin (1961), Desch(1968), Kribs (1968), Anonymous (1970), Jane *et al.* (1970), Panshin and de Zeeuw (1980), and Wheeler *et al.* (1986). Anatomical descriptions and ranges in physical properties were determined not only from inspection of wood samples but by referring to species descriptions such as those included in Spalt and Stern (1956, 1957a, 1957b, 1959), Kryn and Fobes (1959), Jay (1968), Kribs (1968), Rendle (1969), Kukachka (1970), Dechamps (1971), Titmuss (1971), Bolza and Keating (1972), and Chudnoff (1984).

Three surfaces are considered in the examination of a wood sample for identification. The cross-section is obtained by cutting the sample perpendicular to the grain direction. The tangential surface is formed by cutting the sample longitudinally in a direction perpendicular to the rays, and the radial surface is formed by cutting the sample longitudinally in a direction parallel to the rays.

A vessel element is a conduction cell with a perforated end-wall. A longitudinal series of vessel elements forms a tube-like structure of indeterminate length known as a vessel. A pore is a vessel as seen in cross-section. Pores may be solitary or in groups of two or more. Solitary pores are usually round or oval, and are either completely isolated from other pores or make only point contact with them. A group of pores that is one pore wide and two or more pores long in a direction parallel to the rays is called a radial group. The pores in such a group have flattened walls where they contact each other and sometimes appear upon casual examination to be solitary. Pores or pore groups that do not touch each other or that do not have flattened walls at their points of contact, but that fall into series parallel to the rays, are said to be in radial lines. When they fall into series that cross the rays diagonally they are said to be in oblique lines. Pores may also be arranged in

concentric, continuous tangential bands, or may be found in small irregular clusters.

Pore size is often a useful diagnostic feature. Small pores are not visible or are just barely visible without a lens, medium-sized pores are fairly distinct to the naked eye, and large pores are plainly visible to the naked eye at normal reading distance and are still visible even at arm's length. In some species the pores that are formed at the beginning of a growth ring are significantly larger than those formed later in the same growing season; such a wood is called ring-porous. If the pores are relatively uniform in diameter throughout the growth rings, the wood is diffuse-porous. Almost all West African woods are of the diffuse-porous type.

The number of pores per unit of area can be determined by drawing a small square, one to five millimeters on a side, on the cross-section of a sample, measuring its dimensions accurately, and counting the number of pores that it contains. In this key a pore group is counted as a single pore for the purpose of determining pore number per unit of area.

A number of substances may be present in heartwood vessels, among them being tyloses, gums and inorganic chalky deposits. Tyloses are outgrowths from adjacent parenchyma cells into the vessel cavities and appear as rather shiny specks when viewed with the naked eye; with a lens they appear as bubbles. Gums are secretion products of various cells and appear as droplets that plug the pores. Vessel contents can often be seen best on a split longitudinal surface.

A ray is a ribbon-like band of tissue that radiates outward from the center of a tree. In some woods the rays are large and plainly visible to the naked eye on all surfaces; in others they are small and indistinct. The visibility of rays on the cross-section depends not only on their width but also on their color and contrast with adjacent tissue. Ray visibility on the tangential surface ranges from prominent or plainly visible to the naked eye in some woods to rather difficult to distinguish from the surrounding tissue in others.

Rays may be uniform in width within a sample, or they may be of more than one size. Some woods with variable ray width show two distinct sizes of rays while others show a gradation in size. Ray height ranges from less than one millimeter in many woods to more than one centimeter in others. The height of the rays can be measured most accurately on the tangential surface. In woods whose rays are indistinct on the tangential surface, a split radial surface often gives a good estimate of the ray height.

Storied rays are rays which are arranged in regular horizontal rows. On a smooth tangential surface, storied rays produce a distinctive wave-like pattern known as ripple marks. When the rays form oblique rather than horizontal rows, they are said to be in echelon and they produce a rippled effect that is less distinct than that produced by storied rays.

Some rays are composed solely of procumbent cells, which are elongated in the radial direction. Others are composed either partially or entirely of upright cells, whose longest dimension is in the longitudinal direction. If the upright cells are relatively large they can be seen on a split radial surface with the aid of a lens, usually along the top and bottom margins but occasionally even within the body of a ray.

The number of rays per millimeter on the cross-section can be determined by drawing a line perpendicular to the rays and a few millimeters long, measuring its length accurately, and counting the number of rays that it crosses.

A cell of axial parenchyma is a thin-walled storage element. The long axis of axial parenchyma tissue (referred to simply as parenchyma in this key) runs parallel to the grain of the wood. The amount and distribution of parenchyma, as seen on the cross-section, constitute valuable diagnostic features. In some woods, parenchyma is absent or so sparse as to be indistinct even with a lens. When parenchyma is evident, its distribution as seen on the cross-section can be classified as follows.

Paratracheal parenchyma is that which is associated with the pores. It includes vasicentric parenchyma, which forms sheaths of uniform width around pores, and aliform parenchyma, which surrounds the pores and has wing-like extensions in the tangential direction. Sometimes the wings of aliform parenchyma of adjacent pores coalesce to form broken to continuous tangential or diagonal bands of confluent parenchyma. Confluent parenchyma typically joins few or several pores at the beginning of a growth ring, forming longer and more continuous bands at the outer portion of the ring. In some woods, however, continuous confluent bands are found throughout the growth rings.

Apotracheal parenchyma, which is parenchyma that is arranged independently of the pores, includes the following types. Marginal parenchyma forms continuous bands at the margins of the growth rings. Diffuse parenchyma, which consists of isolated strands scattered among the fibers, is usually indistinct even with a lens. Diffuse-in-aggregates parenchyma forms short, narrow tangential lines, often limited to the distance between two adjacent rays. Apotracheal banded parenchyma consists of narrow to broad continuous tangential bands that do not connect or generally include the pores.

It is often difficult to determine whether continuous parenchyma bands consist of paratracheal parenchyma, apotracheal parenchyma, or a mixture of both. If the bands are paratracheal they will usually be rather wavy, and pores which lie outside the bands will be surrounded by aliform parenchyma. Apotracheal bands, on the other hand, include, partially include, or exclude pores purely on the basis of chance. If the parenchyma bands are apotracheal, pores not surrounded by aliform parenchyma will frequently be found outside of the bands. The parenchyma bands in some woods consist of both apotracheal and confluent parenchyma. These bands are usually rather straight and regularly spaced throughout the growth rings, and they tend to more or less generally include the pores. Usually some pores are present which lie completely outside of the bands, but these are usually accompanied by aliform or confluent parenchyma.

Conjunctive parenchyma is associated with included phloem and forms continuous interconnected concentric bands.

A fibre is a longitudinally elongated cell whose principal function is support. Fibre bands are the concentric layers of fibres that occur between parenchyma bands, as seen on the cross-section of a wood with banded parenchyma.

Ripple marks, the distinctive wave-like pattern sometimes seen on longitudinal surfaces, are visible in some woods which lack storied rays. They are due in these

cases to storied longitudinal elements, *i.e.*, vessel elements, fibres or axial parenchyma cells. Any one type of cell or any combination of cell types may be storied. Storied longitudinal elements, like storied rays, are seen on tangential surfaces to be arranged in horizontal rows, although they are often distinct only with a lens. In many woods both longitudinal elements and rays may be storied.

Gum canals are intercellular spaces of indeterminate length which are surrounded by specialized cells that secrete gum. Longitudinal gum canals are parallel to the grain of the wood, and may be arranged in tangential lines or scattered among the fibres. Transverse gum canals are located within the rays. Traumatic gum canals, which are longitudinal canals formed as a result of injury, may sometimes be present. They are typically arranged in tangential lines and are usually larger and more irregular in outline than normal canals. They can be readily distinguished from normal canals because they do not occur in every growth ring.

Latex traces are slit-like radial channels found in some latex-bearing trees. They appear on tangential surfaces as lens-shaped openings which are several millimeter wide and often more than a centimeter high, and are arranged in horizontal rows which are spaced up to one meter apart.

Anomalous structure is characterized by the presence of included phloem (inner bark) within the wood. In anomalous structure of the concentric type, the pockets of phloem are arranged in concentric lines and are accompanied by bands of conjunctive parenchyma.

The density of a wood is the ratio of the weight of a specimen to its volume. In this key, density is based on the weight in grams and volume in cubic centimeters of air dry (8-12% moisture content) wood.

Dichotomous hand-lens key

A wood sample to be identified should be large enough to include several years' growth. It is necessary to cut clean radial, tangential and cross-sectional surfaces with a knife or razor blade. Also, a split radial surface is often desirable to observe such features as cell contents and ray composition. Beginning with number 1 in the key, determine whether the sample is best described by alternative "a" or alternative "b". Then proceed to the number indicated by the chosen alternative and repeat the process until the sample is identified.

1a. Longitudinal gum canals normally present. 2
b. Longitudinal gum canals normally absent. 7
2a. Ripple marks distinct and regular, all wood elements storied.
Gum canals smaller than the pores, scattered and often in tangential lines in marginal parenchyma. Rays visible to the naked eye on the cross-section; seven or eight rays per *mm*.
Pores rather large and sparse; solitary and in radial groups. 3
b. Ripple marks absent. Rays visible to the naked eye on the cross-section; five to seven rays per *mm*. Marginal parenchyma present usually prominent. 4

3a. Paratracheal parenchyma vasicentric or aliform with very short wings; marginal parenchyma present. Heartwood yellowish or reddish brown, usually with darker streaks.
Density 0.4 - 0.6 *g cm*$^{-3}$. *Daniellia ogea*
D. thurifera

b. Paratracheal parenchyma aliform and confluent, sometimes forming rather continuous tangential bands. Marginal parenchyma present or absent. Heartwood gray, red or reddish brown, usually with darker streaks.
Density 0.5 - 0.7 *g cm*$^{-3}$. *Daniellia oliveri*

4a. Wood rather light and soft. Longitudinal gum canals scattered more or less uniformly, appearing on the cross-section as small whitish dots. Paratracheal parenchyma vasicentric, aliform with short wings, and occasionally confluent connecting a few pores. Heartwood uniform light brown in color, sometimes with a pinkish tinge.
Density 0.4 - 0.5 *g cm*$^{-3}$. *Gossweilerodendron balsamiferum*

b. Wood moderately hard and heavy.
Density 0.6 - 0.8 *g cm*$^{-3}$. 5

5a. Paratracheal parenchyma vasicentric, aliform with short to long wings, and usually confluent forming irregular tangential bands. Longitudinal gum canals scattered more or less uniformly, usually appearing on the the cross-section as rather large yellowish dots. Traumatic gum canals sometimes present. Heartwood yellowish to pinkish or reddish brown with darker streaks.
Density 0.6 - 0.7 *g cm*$^{-3}$. *Oxystigma oxyphyllum*

b. Paratracheal parenchyma vasicentric and sometimes aliform with short wings; rarely confluent connecting a few pores. Heartwood light to dark reddish brown, often with darker streaks.
Density 0.7 - 0.8 *g cm*$^{-3}$. 6

6a. Gum canals relatively numerous; arranged in tangential lines in the marginal parenchyma. Pores medium-sized.
Copaifera mildbraedii
C. salikounda

b. Gum canals not very numerous; scattered, and in tangential lines in the marginal parenchyma. Pores rather large.
Detarium senegalense

7a. Pores almost exclusively solitary. 8

b. Pores solitary and in radial groups or predominantly in radial groups. 18

8a. Transverse gum canals present, large and distinct to the naked eye on the tangential surface as dark spots. Pores visible to the naked eye on the cross-section, often containing yellow deposits. Rays indistinct to the naked eye on the cross-section. Parenchyma diffuse-in-aggregates forming broken tangential lines between the rays; visible with a lens.
Heartwood dark red or reddish brown.
Density 0.6 - 0.9 *g cm*$^{-3}$. *Mammea africana*

b. Transverse gum canals absent. 9

9a. Parenchyma arranged in more or less continuous tangential bands which are wider than the rays. 10

b. Parenchyma bands absent or, if present, not wider than the rays. ...11

10a. Parenchyma exclusively apotracheal forming continuous, closely-spaced, wavy tangential bands. Pores large and plainly visible to the naked eye; sparse. Rays indistinct to the naked eye on the cross-section. Wood pinkish, orangish or reddish brown.
Density 0.8 - 1.1 $g\ cm^{-3}$. *Parinari* spp.

b. Parenchyma aliform with rather long wings, and apotracheal and confluent forming occasionally discontinuous bands. Pores medium-sized to rather large; not very numerous. Rays barely visible to the naked eye on the cross-section. Wood yellow, yellowish brown or dark brown.
Density 0.9 - 1.1$g\ cm^{-3}$. *Klainedoxa gabonensis*

11a. Rays large and plainly visible to the naked eye on the cross-section, occasionally as wide as or wider than the pores; several *mm* in height. Pores large and plainly visible without a lens. Paratracheal parenchyma aliform with short to rather long wings, and sometimes confluent connecting a few pores. Apotracheal parenchyma forming short tangential lines between the rays and occasionally arranged in long narrow rather continuous tangential bands. Wood uniform pink or pinkish red.
Density 0.4 - 0.5 $g\ cm^{-3}$. *Poga oleosa*

b. Rays less than one-half the width of the pores. 12

12a. Parenchyma exclusively paratracheal; aliform forming diamond-shaped patches around the pores and sometimes confluent connecting a few pores diagonally. Pores plainly visible to the naked eye. Rays distinct to the naked eye on the cross-section. Wood reddish or yellowish brown.
Density 0.8 - 1.0$g\ cm^{-3}$. *Anopyxis klaineana*

b. Paratracheal parenchyma absent or, if present, accompanied by diffuse-in-aggregates parenchyma. 13

13a. Parenchyma relatively abundant, plainly visible with a lens and often distinct to the naked eye. Rays barely visible to the naked eye on the cross-section. 14

b. Parenchyma rather sparse, usually indistinct or only barely visible even with a lens; if visible, appearing as narrow broken lines between the rays. 15

14a. Pores not numerous, generally fewer than ten per mm^2; moderately large. Diffuse-in-aggregates parenchyma forming numerous broken tangential lines between the rays; paratracheal parenchyma vasicentric, usually invisible even with a lens. Wood light to medium yellow.
Density 0.8 - 1.0 $g\ cm^{-3}$. *Ongokea gore*

b. Pores more numerous than ten per mm^2; sometimes moderately large. Parenchyma diffuse-in-aggregates forming broken to rather continuous tangential lines and sometimes aliform with long wings. Wood reddish or

yellowish brown.
Density 0.7 - 0.9 *g cm*$^{-3}$. *Cassipourea* spp.

15a. Rays commonly more numerous than three per pore diameter; usually visible to the naked eye on the cross-section. Pores rather large; fewer than six per *mm*^{2}. Heartwood distinctive orange, yellow or reddish brown, sometimes with dark red streaks.
Density 0.7 - 0.9 *g cm*$^{-3}$. *Nauclea diderrichii*

b. Rays fewer than three per pore diameter. 16

16a. Pores moderately large, visible to the naked eye, rather numerous. Rays indistinct to the naked eye on the cross-section. Wood grayish, reddish or purplish brown.
Density 0.8 - 1.0 *g cm*$^{-3}$. *Sacoglottis gabonensis*

b. Pores small, often indistinct to the naked eye. 17

17a. Pores numerous, commonly more than twenty per *mm*^{2}; not filled with gum or tyloses. Rays barely visible to the naked eye on the cross-section. Wood pale brown, pink or orangish brown.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Pausinystalia lane-poolei*

b. Pores moderately numerous to numerous, sometimes unevenly distributed on the cross-section and often containing yellowish gum. Rays indistinct to the naked eye on the cross-section. Wood dark gray, reddish or yellow, often with flame-shaped brown or black markings on longitudinal surfaces.
Density 0.9 - 1.0 *g cm*$^{-3}$. *Adina microcephala*

18a. Axial parenchyma sparse, indistinct even with a lens. 19

b. Axial parenchyma visible with a lens or to the naked eye. 36

19a. Ripple marks distinct and regular. Rays barely visible or indistinct to the naked eye on the cross-section; distinctly storied. Pores rather small and numerous. 20

b. Ripple marks absent, indistinct or irregular. 21

20a. Vessels containing red gum. Heartwood light to dark red or reddish brown.
Density 0.7 - 0.8 *g cm*$^{-3}$. *Nesogordonia papaverifera*

b. Vessels not containing gum or tyloses. Heartwood dark yellowish or grayish brown, often with a purplish cast.
Density 0.6 - 0.7 *g cm*$^{-3}$. *Mansonia altissima*

21a. Pores small, indistinct to the naked eye; more numerous than ten per *mm*^{2}. 22

b. Pores distinct to the naked eye. 24

22a. Rays small, indistinct to the naked eye on the cross-section and less than one *mm* in height. Pores often predominantly in radial groups. Heartwood dark reddish brown with a purplish tinge.
Density 0.9 - 1.0 *g cm*$^{-3}$. *Oldfieldia africana*

b. Rays distinct to the naked eye on the cross-section and commonly exceeding two *mm* in height. 23

23a. Rays variable in width, the largest plainly visible to the naked eye, the smallest distinct only with a lens on the cross-section. Wood pale yellow. Density 0.6 - 0.7 *g cm*$^{-3}$. *Scottellia chevalieri*
S. coriacea

b. Rays relatively uniform in width, usually distinct to the naked eye on the cross-section. Wood light to dark red or reddish brown. Density 0.9 - 1.1*g cm*$^{-3}$. *Rhizophora mangle*
R. racemosa

24a. Pores fewer than three per *mm*^{2}. 25

b. Pores more numerous than three per *mm*^{2}. 27

25a. Rays more numerous than ten per *mm*, indistinct to the naked eye. Vessels usually containing whitish or yellowish gum. Heartwood brown or reddish brown. Density 0.7 - 1.0*g cm*$^{-3}$. *Blighia sapida*
B. welwitschii

b. Rays fewer than ten per *mm*, distinct to the naked eye on the cross-section. 26

26a. Rays fewer than five per *mm*. Pores large, usually two or three per *mm*^{2}. Wood white or yellowish. Density 0.2 - 0.4 *g cm*$^{-3}$. *Musanga cecropioides*

b. Rays six or seven per *mm*. Pores medium-sized, usually two or three per *mm*^{2}. Wood white, gray or pinkish brown. Density 0.4 - 0.6 *g cm*$^{-3}$. *Pycnanthus angolensis*

27a. Rays commonly exceeding two *mm* in height, fewer than six per *mm*. Pores medium-sized and numerous. Heartwood light to dark red or reddish brown. Density 0.6 - 0.9 *g cm*$^{-3}$. *Uapaca* spp.

b. Rays less than two *mm* in height. 28

28a. Pores predominantly in radial groups of two to five and often tending to form oblique lines; medium-sized and rather numerous. Rays indistinct to the naked eye on the cross-section, usually more numerous than eight per *mm*; upright cells distinct with lens. Heartwood light pinkish or reddish brown. Density 0.6 - 0.7 *g cm*$^{-3}$. *Erythroxylum mannii*

b. Pores not predominantly arranged in radial groups. 29

29a. Transverse gum canals present in some rays; barely visible with a lens on tangential surfaces and occurring in rays which are wider than those lacking canals. Rays distinct to the naked eye on the cross-section, four to seven per *mm*. Pores medium-sized, mostly solitary with some groups of two or three. Heartwood grayish or reddish brown. Density 0.5 - 0.7 *g cm*$^{-3}$. *Antrocaryon micraster*

b. Transverse gum canals absent. 30

30a. Rays more numerous than ten per *mm*, commonly up to one *mm* in height; upright cells distinct with a lens. Pores medium-sized; radial pairs sometimes quite numerous. Heartwood yellowish white.
Density 0.7 - 0.9 *g cm*$^{-3}$. *Homalium* spp.
b. Rays fewer than ten per *mm*. 31
31a. Rays variable in width, the largest plainly visible to the naked eye, the smallest distinct only with a lens; prominent on tangential surfaces. Pores medium-sized to rather large. Traumatic gum canals sometimes present. Heartwood light to dark red or reddish brown, sometimes with a purplish cast.
Density 0.4 - 0.8 *g cm*$^{-3}$. *Khaya* spp.
b. Rays relatively uniform in width. 32
32a. Pores generally three to five per *mm*; medium-sized to rather large. Rays visible on the cross-section, usually rather distinct on the tangential surface; upright cells visible with a lens. Wood white, tan or yellowish brown.
Density 0.4 - 0.6 *g cm*$^{-3}$. *Canarium schweinfurthii*
b. Pores more numerous than five per *mm*^{2}; medium-sized to rather small. 33
33a. Rays commonly up to one *mm* in height; upright cells distinct with a lens, usually in several rows. Pores usually rather small and numerous. Heartwood brown or grayish brown, often with yellowish streaks.
Density 0.5 - 0.6 *g cm*$^{-3}$. *Bridelia* spp.
b. Rays less than one *mm* in height; upright cells absent or indistinct with a lens. 34
34a. Vessels containing dark brown gum; medium-sized. Rays rather prominent on tangential surfaces. Traumatic gum canals often present. Heartwood yellowish or grayish brown, or dark brown.
Density 0.4 - 0.7 *g cm*$^{-3}$. *Lovoa trichilioides*
b. Vessels not containing brown gum; yellowish gum sometimes present, not very abundant. Rays not very prominent on tangential surfaces. Heartwood yellow or yellowish white. 35
35a. Pores medium-sized, distinct to the naked eye at normal reading distance; usually five to nine per *mm*^{2}. Rays distinct to the naked eye on the cross-section.
Density 0.4 - 0.6 *g cm*$^{-3}$. *Turraeanthus africanus*
b. Pores rather small, usually more numerous than nine per *mm*^{2}. Rays sometimes not very distinct to the naked eye on the cross-section, occasionally in echelon having an irregular ripple appearance on tangential surfaces. Traumatic gum canals sometimes present.
Density 0.6 - 0.7 *g cm*$^{-3}$. *Araliopsis tabouensis*
36a. Ripple marks distinct and regular. 37
b. Ripple marks absent, indistinct or irregular. 68

37a. Pores mostly small and indistinct to the naked eye, increasing in size at the ends of the growth rings showing a tendency toward ring-porosity. Parenchyma vasicentric, aliform with short wings, diffuse-in-aggregates forming broken tangential lines between the rays, and apotracheal in continuous closely spaced wavy bands; often not visible in heartwood. Heartwood very dark brown, purplish black or black, sometimes with dark purple streaks.
Density 1.1 - 1.2 *g cm*$^{-3}$. *Dalbergia melanoxylon*

b. Wood diffuse-porous. Heartwood not black in color. Density less than 1.1 *g cm*$^{-3}$. 38

38a. Parenchyma predominantly diffuse-in-aggregates, usually forming narrow broken tangential lines between the rays. Paratracheal parenchyma absent or sparse. 39

b. Diffuse-in-aggregates parenchyma absent or sparse; non-marginal parenchyma bands, if present, usually as wide as or wider than the rays. 44

39a. All wood elements storied including the rays. 40

b. Rays not storied; ripple marks due to storied longitudinal elements. 41

40a. Vessels containing red gum. Heartwood light to dark red or reddish brown.
Density 0.7 - 0.8 *g cm*$^{-3}$. *Nesogordonia papaverifera*

b. Vessels not containing gum or tyloses. Heartwood dark yellowish or grayish brown, often with a purplish cast.
Density 0.6 - 0.7 *g cm*$^{-3}$. *Mansonia altissima*

41a. Rays more numerous than five per *mm*. 42

b. Rays fewer than five per *mm*. 43

42a. Pores large, visible even at arm's length; usually fewer than three per *mm*^{2}. Rays often not very distinct to the naked eye on the cross-section. Traumatic gum canals sometimes present. Heartwood pale reddish brown to dark brown.
Density 0.4 - 0.6 *g cm*$^{-3}$. *Rhodognaphalon brevicuspe*

b. Pores medium-sized, distinct to the naked eye at normal reading distance. Marginal parenchyma sometimes present. Wood pale yellowish brown.
Density 0.3 - 0.5 *g cm*$^{-3}$. *Triplochiton scleroxylon*

43a. Diffuse-in-aggregates parenchyma distinct with a lens as clearly defined lines which alternate regularly with the intervening fiber bands. Ray outline on the tangential surface usually well-defined. Traumatic gum canals sometimes present. Wood yellowish or pinkish brown.
Density 0.3 - 0.4 *g cm*$^{-3}$. *Bombax buonopozense*

b. Diffuse-in-aggregates parenchyma rather indistinct and irregularly arranged. Marginal parenchyma sometimes present. Ray outline on the tangential surface usually rather indistinct. Traumatic gum canals sometimes present. Wood light brown or pinkish brown.
Density 0.2 - 0.4 *g cm*$^{-3}$. *Ceiba pentandra*

44a. Marginal parenchyma prominent. 45
b. Marginal parenchyma absent or indistinct. 50

45a. Non-marginal parenchyma arranged in continuous closely-spaced tangential bands, mostly apotracheal but sometimes seemingly apotracheal and confluent; bands distinct to the naked eye and usually more numerous than five per *mm* of ray. Rays barely visible to the naked eye on the cross-section; usually nine to twelve per *mm*. All wood elements storied. Heartwood dark reddish or pinkish brown.
Density 0.8 - 1.0 *g cm*$^{-3}$. *Dialium* spp.
b. Parenchyma bands absent or, if present, fewer than five per *mm* and usually not very regularly spaced. 46

46a. Non-marginal parenchyma exclusively paratracheal. All wood elements storied. 47
b. Non-marginal parenchyma paratracheal and apotracheal. Rays rather prominent on the tangential surface. 49

47a. Rays more numerous than nine per *mm*; indistinct to the naked eye on on the cross-section. Paratracheal parenchyma aliform with short wings forming diamond-shaped patches around the pores, sometimes confluent connecting a few pores. Traumatic gum canals sometimes present. Heartwood light to dark brown or pinkish brown.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Brachystegia* spp.
b. Rays fewer than nine per *mm*; visible to the naked eye on the cross-section. 48

48a. Paratracheal parenchyma aliform with short to long wings, confluent connecting a few pores, or confluent forming long wavy tangential bands. Heartwood distinctive bright yellow or yellow brown.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Distemonanthus benthamianus*
b. Paratracheal parenchyma vasicentric, visible only with a lens. Wood often with a slight cedar-like scent. Heartwood reddish brown.
Density 0.7 - 0.8 *g cm*$^{-3}$. *Pseudocedrela kotschyi*

49a. Wood with distinctive cedar-like scent. Paratracheal and apotracheal parenchyma forming rather straight, usually broken tangential bands which are fairly conspicuous. Rays and fibers storied. Traumatic gum canals sometimes present. Heartwood pink, red or reddish brown, often with a purplish cast.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Entandrophragma cylindricum*
b. Distinctive odour absent or faint. Paratracheal and apotracheal parenchyma forming wavy broken or continuous tangential bands which are usually rather indistinct. Rays and occasionally fibres storied. Traumatic gum canals sometimes present. Heartwood light to dark reddish or purplish brown.
Density 0.5 - 0.7 *g cm*$^{-3}$. *Entandrophragma utile*

50a. Rays variable in size, the largest plainly visible to the naked eye and commonly exceeding one *mm* in height, the smallest sometimes indistinct to the naked eye; fewer than five rays per *mm*. Parenchyma arranged in broad apotracheal and confluent bands; conspicuous on all surfaces. Ripple marks not visible outside of the parenchyma bands. 51

b. Rays relatively uniform in width; more numerous than five per *mm*. 54

51a. Heartwood white, yellow or yellowish brown in color. Pores rather large and plainly visible to the naked eye. 52

b. Heartwood brown or reddish brown in color. Rays commonly exceeding two *mm* in height. 53

52a. Heartwood uniform yellow or yellowish brown, sometimes with an orange cast. Vessels often containing yellow gum. Traumatic gum canals sometimes present.
Density 0.7 - 0.8 $g\ cm^{-3}$. *Sterculia oblonga*

b. Heartwood creamy white or pale yellow. Vessels not containing gum or tyloses. Traumatic gum canals sometimes present.
Density 0.5 - 0.8 $g\ cm^{-3}$. *Pterygota bequaertii*
P. macrocarpa

53a. Rays commonly as wide as or wider than the pores. Pores small or medium-sized. Traumatic gum canals sometimes present. Heartwood light brown with an orange or reddish cast.
Density 0.4 - 0.8 $g\ cm^{-3}$. *Cola* spp.

b. Rays narrower than the pores. Pores medium-sized to rather large. Heartwood reddish brown, sometimes with darker streaks.
Density 0.6 - 0.8$g\ cm^{-3}$. *Sterculia rhinopetala*

54a. Parenchyma arranged in more or less continuous tangential or diagonal bands. 55

b. Parenchyma aliform with short to rather long wings, and confluent connecting several or many pores. All wood elements storied. 66

55a. Solitary pores and pore groups arranged in definite irregular radial or oblique lines. Rays not distinct to the naked eye on the cross-section; storied. Parenchyma bands apotracheal; usually barely visible to the naked eye; four to seven bands per *mm* of ray. Heartwood pinkish or reddish brown, or red.
Density 0.6 - 0.8 $g\ cm^{-3}$. *Tieghemella heckelii*

b. Pores not arranged in radial or oblique lines. 56

56a. Rays fewer than nine per *mm*. 57

b. Rays more numerous than nine per *mm*. 61

57a. Parenchyma bands predominantly or exclusively paratracheal; individual bands usually rather variable in width. All wood elements storied. 58

b. Parenchyma bands apotracheal and confluent, occasionally as wide as or wider than the intervening bands of fibres; continuous bands usually found throughout the growth rings. 59

58a. Continuous parenchyma bands usually not found throughout the growth rings; parenchyma aliform and confluent forming short bands in the inner portions of the rings, the confluent bands becoming more continuous in the outer portions of the rings. Rays visible to the naked eye on the cross-section. Heartwood light to dark golden yellow or yellowish brown.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Distemonanthus benthamianus*

b. Parenchyma bands usually rather continuous throughout the growth rings. Rays indistinct to the naked eye on the cross-section. Heartwood light to dark brown with light parenchyma markings and often with darker streaks.
Density 0.8 - 0.9 *g cm*$^{-3}$. *Haplormosia monophylla*

59a. Parenchyma bands very broad; distinct to the naked eye at arm's length and fewer than two bands per *mm* of ray. Pores large and sparse. Rays distinct to the naked eye on the cross-section. All wood elements storied. Heartwood light yellowish brown.
Density 0.7 - 0.8 *g cm*$^{-3}$. *Amphimas pterocarpoides*

b. Parenchyma bands usually indistinct at arm's length; four to seven bands per *mm* of ray. Pores small and moderately numerous. Longitudinal elements storied.
Density 0.9 - 1.1 *g cm*$^{-3}$. 60

60a. Rays generally indistinct to the naked eye on the cross-section; less than one *mm* in height and sometimes distinctly storied. Heartwood bright orange, orangish red or dark red. *Baphia nitida*

b. Rays usually distinct to the naked eye on the cross-section and commonly exceeding one *mm* in height; not storied. Heartwood orange, orangish red or dark red. *Baphia pubescens*

61a. Parenchyma bands rather straight and numerous, usually five or more bands per *mm* of ray; continuous bands usually found throughout the growth rings. Rays barely visible or indistinct to the naked eye on the cross-section. All wood elements storied. Heartwood dark reddish or pinkish brown.
Density 0.8 - 1.0 *g cm*$^{-3}$. *Dialium* spp.

b. Parenchyma bands fewer than five per *mm* of ray. Rays barely visible or indistinct to the naked eye on the cross-section. 62

62a. Parenchyma predominantly confluent forming very wavy bands which are rather variable in width. All wood elements storied. Heartwood light to dark brown with light parenchyma markings and often with darker streaks.
Density 0.8 - 0.9 *g cm*$^{-3}$. *Haplormosia monophylla*

b. Parenchyma bands seemingly apotracheal and confluent; relatively straight and rather uniform in width. 63

63a. Parenchyma bands commonly as wide as or wider than the bands of fibers. Pores rather sparse. All wood elements storied. Heartwood greenish yellow, sometimes with brownish streaks.
Density 0.8 - 1.0 *g cm*$^{-3}$. *Lonchocarpus sericeus*

b. Parenchyma bands narrower than the bands of fibers. 64

64a. Pores more numerous than three per mm^2; medium-sized to rather small. Ripple marks due to storied rays. Heartwood light to dark reddish brown. Density 0.8 - 1.0 $g\ cm^{-3}$. *Cynometra ananta*
C. leonensis

b. Pores usually fewer than three per mm^2. All wood elements storied. 65

65a. Pores medium-sized to large. Heartwood bright orange red, blood red or dark brown, frequently with darker streaks. Density 0.7 - 0.9 $g\ cm^{-3}$. *Pterocarpus soyauxii*

b. Pores medium-sized. Heartwood white or yellowish, occasionally with reddish streaks near wounds. Density 0.5 - 0.7 $g\ cm^{-3}$. *Pterocarpus mildbraedii*
P. santalinoides

66a. Parenchyma not very distinct to the naked eye; aliform parenchyma with narrow wings. Rays distinct to the naked eye on the cross-section. Pores medium-sized, usually containing whitish gum. Wood whitish or pale yellowish brown. Density 0.6 - 0.9 $g\ cm^{-3}$. *Holoptelea grandis*

b. Parenchyma distinct to naked eye. 67

67a. Pores fewer than seven per mm^2. Rays visible to the naked eye on the cross-section, fewer than nine per *mm*. Heartwood light to dark golden yellow or yellowish brown. Density 0.6 - 0.8 $g\ cm^{-3}$. *Distemonanthus benthamianus*

b. Pores more numerous than seven per mm^2. Rays barely visible or indistinct to the naked eye on the cross-section, sometimes more than nine per *mm*. Heartwood yellowish brown or pale brown, frequently with darker brown streaks. Density 0.6 - 0.9 $g\ cm^{-3}$. *Pericopsis elata*
P. laxiflora

68a. Wood with anomalous structure of the concentric type; strands of included phloem occurring in tangential zones and accompanied by bands of conjunctive parenchyma. Pores small, sometimes predominantly in radial groups. Paratracheal parenchyma vasicentric or aliform with short wings; often indistinct to the naked eye. Rays barely visible to the naked eye on the cross-section. Heartwood light brown or pinkish brown. Density 0.9 - 1.0 $g\ cm^{-3}$. *Avicennia africana*

b. Anomalous structure absent. 69

69a. Rays of two sizes, the larger sometimes twice the width of the pores and commonly exceeding one *cm* in height, the narrower often not distinct to the naked eye on the cross-section. Parenchyma arranged in apotracheal bands which are narrower than the rays. Pores medium-sized to large; fewer than four per mm^2. Wood grayish brown. Density 0.7 - 0.8 $g\ cm^{-3}$. *Anisophyllea laurina*
A. meniaudi

b. Largest rays less than one *cm* in height. 70
70a. Marginal parenchyma prominent. 71
b. Marginal parenchyma absent or indistinct. 98
71a. Diffuse-in-aggregates parenchyma present forming broken tangential lines. 72
b. Diffuse-in-aggregates parenchyma absent. 73
72a. Rays fewer than five per *mm*; distinct to the naked eye on all surfaces, prominent on the tangential surface. Pores medium-sized to large; not very numerous. Apotracheal parenchyma forming short to occasionally rather long irregular bands; paratracheal parenchyma vasicentric, aliform with short wings and occasionally confluent connecting a few pores. Traumatic gum canals sometimes present. Heartwood light to dark reddish brown.
Density 0.5 - 0.8 *g cm*$^{-3}$. *Heritiera utilis*
b. Rays generally more numerous than six per *mm*; barely visible to the naked eye on the cross-section, not very distinct on the tangential surface. Pores medium-sized to large; sparse to moderately numerous. Paratracheal parenchyma vasicentric and aliform with short wings. Diffuse-in-aggregates parenchyma sparse. Traumatic gum canals occasionally present. Wood yellowish white or clear yellow.
Density 0.6 - 1.0 *g cm*$^{-3}$. *Fagara* spp.
73a. Rays more numerous than nine per *mm*. Apotracheal parenchyma absent. 74
b. Rays fewer than nine per *mm*. 80
74a. Paratracheal parenchyma predominantly vasicentric, occasionally aliform with very short wings; confluent parenchyma absent. Rays not distinct to the naked eye on the cross-section. Traumatic gum canals sometimes present. Heartwood pale red or reddish brown.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Tetraberlinia tubmaniana*
b. Paratracheal parenchyma aliform or aliform and confluent. 75
75a. Paratracheal parenchyma aliform with rather narrow wings, and usually confluent connecting several to many pores. 76
b. Paratracheal parenchyma aliform with short blunt wings, forming diamond-shaped patches around the pores; often confluent joining a few or several pores. Rays not distinct to the naked eye on the cross-section. 77
76a. Rays conspicuous on the radial surface and often distinct to the naked eye on the tangential surface and cross-section. Pores medium-sized. Paratracheal parenchyma aliform with long wings and confluent connecting several pores. Wood yellowish or reddish.
Density 0.8 - 1.0 *g cm*$^{-3}$. *Cryptosepalum tetraphyllum*
b. Rays inconspicuous on the radial surface; indistinct on the tangential surface and cross-section. Pores medium-sized to large. Paratracheal parenchyma aliform with long wings, confluent connecting several pores and often confluent forming continuous tangential bands. Traumatic

gum canals sometimes present. Wood pale yellow, yellowish green or grayish, sometimes with darker streaks.
Density 0.4 - 0.7 *g cm*$^{-3}$. *Terminalia superba*

77a. Rays in echelon producing an irregular rippled effect on the tangential surface. Paratracheal parenchyma sometimes confluent connecting a few pores. Pores medium-sized. Traumatic gum canals sometimes present. Heartwood light to dark yellowish or reddish brown, sometimes with darker streaks.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Brachystegia* spp.

b. Rays not in echelon. 78

78a. Confluent parenchyma abundant, commonly connecting three or more pores. Traumatic gum canals often present. Heartwood reddish, yellowish or purplish brown, sometimes with blackish streaks.
Density 0.7-0.9 *g cm*$^{-3}$. *Anthonotha* spp.

b. Confluent parenchyma rarely connecting more than three pores. 79

79a. Heartwood pinkish or reddish brown, usually with dark brown or purple streaks forming a distinctive figure. Traumatic gum canals sometimes present.
Density 0.7 - 0.9 *g cm*$^{-3}$. *Berlinia* spp.

b. Heartwood brown or reddish brown.
Density 0.8 - 1.0 *g cm*$^{-3}$. *Gilbertiodendron* spp.

80a. Non-marginal parenchyma apotracheal and confluent, arranged in broad conspicuous bands. Rays usually visible to the naked eye on the cross-section. Pores medium-sized. Heartwood bright yellow, reddish or brown.
Density 0.7 - 0.9 *g cm*$^{-3}$. *Morus mesozygia*

b. Non-marginal parenchyma not arranged in broad conspicuous bands. 81

81a. Pores variable in size and distribution, often tending toward ring-porosity. Paratracheal parenchyma vasicentric, aliform and occasionally confluent connecting a few pores. Rays distinct to the naked eye on the cross-section. Wood white or yellowish brown.
Density 0.5 - 0.6 *g cm*$^{-3}$. *Vitex micrantha*

b. Wood diffuse-porous. 82

82a. Confluent parenchyma present. 83

b. Confluent parenchyma absent or rare. 91

83a. Non-marginal apotracheal parenchyma present in short to long tangential bands. Pores medium-sized to rather large. Rays prominent on the tangential surface. 84

b. Non-marginal apotracheal parenchyma absent. 85

84a. Wood with distinctive cedar-like scent. Paratracheal and apotracheal parenchyma forming rather straight, usually broken tangential bands which are fairly conspicuous. Rays visible to the naked eye on the cross-section. Traumatic gum canals sometimes present. Heartwood pink, red or

reddish brown, sometimes with a purplish cast.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Entandrophragma cylindricum*

b. Distinctive odour absent or faint. Paratracheal and apotracheal parenchyma forming wavy broken or continuous tangential bands which are usually rather indistinct. Rays barely visible or indistinct to the naked eye on the cross-section. Traumatic gum canals sometimes present. Heartwood light to dark red or reddish brown, often with a purplish cast.
Density 0.5 - 0.7 *g cm*$^{-3}$. *Entandrophragma utile*

85a. Wood with distinctive spicy odour. Paratracheal parenchyma vasicentric, aliform with short wings and confluent connecting few pores. Rays barely visible to the naked eye on the cross-section. Pores medium-sized. Heartwood red or reddish brown.
Density 0.6-0.7 *g cm*$^{-3}$. *Beilschmiedia mannii*

b. Distinctive odour absent. 86

86a. Rays prominent on the tangential surface; visible to the naked eye on the cross-section. Paratracheal parenchyma vasicentric, aliform with short wings and confluent connecting few pores. Pores medium-sized. Traumatic gum canals sometimes present. Heartwood light to dark red or reddish brown, often with a purplish cast.
Density 0.5 - 0.7 *g cm*$^{-3}$. *Entandrophragma angolense*

b. Rays not prominent on the tangential surface. 87

87a. Upright cells distinct with a lens. Pores more numerous than three per *mm*^{2}; medium-sized. Confluent parenchyma joining few to many pores, sometimes forming rather long wavy bands. Rays barely visible to the naked eye on the cross-section. Heartwood white or light yellow.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Celtis* spp

b. Rays without upright cells 88

88a. Wood hard and heavy. Paratracheal parenchyma abundant; vasicentric, aliform forming diamond-shaped patches around the pores and confluent connecting few to several pores. Rays barely visible or indistinct to the naked eye on the cross-section. Pores rather large. Heartwood light to dark reddish brown.
Density 0.9 - 1.1 *g cm*$^{-3}$. *Pentaclethra macrophylla*

b. Wood moderately hard and heavy.
Density 0.5 - 0.9 *g cm*$^{-3}$. 89

89a. Heartwood yellowish brown, sometimes with a greenish cast. Paratracheal parenchyma vasicentric, aliform and confluent connecting a few pores. Rays visible to the naked eye on the cross-section. Pores usually fewer than five per *mm*^{2}; rather large.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Piptadeniastrum africanum*

b. Heartwood red or reddish brown. Rays barely visible or indistinct to the naked eye on the cross-section. Pores medium-sized.
Density 0.6 - 0.9 *g cm*$^{-3}$. 90

90a. Pores fewer than four per *mm*^{2}. Paratracheal parenchyma aliform forming prominent diamond-shaped patches around the pores and confluent

connecting a few pores. Heartwood yellowish or reddishbrown or red. *Afzelia* spp.

b. Pores more numerous than four per mm^2. Paratracheal parenchyma vasicentric, aliform with short wings and often confluent joining a few pores diagonally. Heartwood dark red or reddish brown. *Burkea africana*

91a. Wood with distinctive spicy odour. Paratracheal parenchyma vasicentric and aliform with short wings. Rays barely visible to the naked eye on the cross- section. Pores medium-sized. Heartwood red or reddish brown. Density 0.6 - 0.7 $g\ cm^{-3}$. *Beilschmiedia mannii*

b. Distinctive odour absent. 92

92a. Pores fewer than two per mm^2; large. Paratracheal parenchyma vasicentric; often indistinct even with a lens. Rays distinct to the naked eye on the cross-section. Wood white or yellowish. Density 0.2 - 0.4 $g\ cm^{-3}$. *Musanga cecropioides*

b. Pores more numerous than two per mm^2. 93

93a. Widest rays commonly exceeding one-half the width of the widest pores. Paratracheal parenchyma vasicentric and aliform with short wings. Non-marginal apotracheal parenchyma sometimes present; arranged in continuous bands which are often difficult to distinguish from the marginal bands. Pores medium-sized. Traumatic gum canals occasionally present. Heartwood pink, red, reddish brown or dark brown. Density 0.6 - 0.9 $g\ cm^{-3}$. *Carapa procera*

b. Widest rays narrower than one-half the width of the widest pores. 94

94a. Rays prominent on the tangential surface; visible to the naked eye on the cross-section. Wood light to dark red or reddish brown, often with a purplish cast. 95

b. Rays not prominent on the tangential surface. 96

95a. Rays variable in width, the largest plainly visible to the naked eye, the smallest visible only with a lens. Paratracheal parenchyma vasicentric; sometimes difficult to see even with a lens. Pores medium-sized to rather large. Traumatic gum canals sometimes present. Density 0.4 - 0.8 $g\ cm^{-3}$. *Khaya* spp.

b. Rays relatively uniform in width. Paratracheal parenchyma vasicentric and aliform with short wings. Pores medium-sized. Traumatic gum canals sometimes present. Density 0.5 - 0.7 $g\ cm^{-3}$. *Entandrophragma angolense*

96a. Heartwood golden brown or dark brown, often with black streaks. Rays visible to the naked eye on the cross-section. Paratracheal parenchyma vasicentric and aliform with short wings. Density 0.7 - 0.9 $g\ cm^{-3}$. *Guibourtia ehie*

b. Heartwood yellow, yellowish white or yellowish brown, sometimes with a reddish cast. 97

97a. Rays generally fewer than six per *mm*; visible to the naked eye on the cross-section. Pores rather large. Paratracheal parenchyma vasicentric and aliform with short to rather long wings. Heartwood yellowish brown, sometimes with a greenish cast.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Piptadeniastrum africanum*

b. Rays generally more numerous than six per *mm*; barely visible to the naked eye on the cross-section. Pores medium-sized to rather large. Paratracheal parenchyma vasicentric and aliform with short wings. Traumatic gum canals occasionally present. Wood yellowish white or clear yellow.
Density 0.6 - 1.0*g cm*$^{-3}$. *Fagara* spp.

98a. Large transverse gum canals present; distinct to the naked eye on the tangential surface. 99

b. Transverse gum canals absent or, if present, not distinct even with a lens. 100

99a. Rays indistinct to the naked eye on the cross-section; eleven to fifteen rays per *mm*. Pores large and sparse. Parenchyma arranged in more or less continuous tangential bands. Wood yellowish white.
Density 0.4-0.5 *g cm*$^{-3}$. *Anthocleista* spp.

b. Rays visible to the naked eye on the cross-section; five to seven rays per *mm*. Pores rather small. Parenchyma aliform and confluent, often forming more or less continuous bands at the ends of the growth rings. Heartwood pinkish brown.
Density 0.7 - 0.9 *g cm*$^{-3}$. *Garcinia polyantha*

100a. Paratracheal parenchyma present. 101

b. Paratracheal parenchyma absent or rare. 163

101a. Diffuse-in-aggregates parenchyma present. 102

b. Diffuse-in-aggregates parenchyma absent or indistinct. 107

102a. Rays generally more numerous than six per *mm*; barely visible to the naked eye on the cross-section. 103

b. Rays fewer than six per *mm*; rather large and plainly visible to the naked eye on the cross-section. 104

103a. Upright cells distinct with a lens. Paratracheal parenchyma vasicentric, aliform with rather short wings and sometimes confluent connecting a few pores. Heartwood light to dark red or reddish brown.
Density 0.7 - 0.9 *g cm*$^{-3}$. *Petersianthus macrocarpus*

b. Rays with out upright cells. Paratracheal parenchyma vasicentric and aliform with short wings. Traumatic gum canals occasionally present. Wood yellowish white or clear yellow.
Density 0.6 - 1.0 *g cm*$^{-3}$. *Fagara* spp.

104a. Pores usually more numerous than ten per *mm*^{2}; medium-sized. Rays commonly exceeding two *mm* in height. Parenchyma rather sparse; paratracheal parenchyma vasicentric and sometimes aliform with very short wings. Heartwood light to dark red or reddish brown.
Density 0.6 - 0.9 *g cm*$^{-3}$. *Uapaca* spp.

b. Pores fewer than five per *mm*^{2}. 105

105a. Rays less than two *mm* in height. Pores rather large, sometimes unevenly distributed on the cross-section. Apotracheal parenchyma forming short to occasionally rather long irregular bands; paratracheal parenchyma vasicentric, aliform and occasionally confluent connecting a few pores. Traumatic gum canals sometimes present. Heartwood light to dark reddish brown.
Density 0.5 - 0.8 *g cm*$^{-3}$. *Heritiera utilis*

b. Rays commonly exceeding two *mm* in height. 106

106a. Apotracheal parenchyma abundant, often forming rather continuous irregular bands; paratracheal parenchyma vasicentric. Traumatic gum canals sometimes present. Heartwood yellowish white or grayish.
Density 0.4 - 0.5 *g cm*$^{-3}$. *Sterculia tragacantha*

b. Apotracheal parenchyma not abundant; arranged in short tangential lines between the rays and occasionally in long narrow rather continuous bands which, if present, are widely spaced. Paratracheal parenchyma aliform with short to rather long wings, and sometimes confluent connecting a few pores. Pores large and plainly visible to the naked eye. Wood uniform pink or pinkish red.
Density 0.4 - 0.5 *g cm*$^{-3}$. *Poga oleosa*

107a. Parenchyma arranged in more or less continuous tangential or diagonal bands. 108

b. Parenchyma not arranged in continuous lines or bands. 131

108a. Parenchyma bands exclusively apotracheal; paratracheal parenchyma vasicentric or aliform. 109

b. Parenchyma bands paratracheal and apotracheal or exclusively paratracheal. 111

109a. Widest rays commonly exceeding one-half the width of the widest pores. Paratracheal parenchyma vasicentric and aliform with apotracheal parenchyma arranged in usually rather widely spaced bands which often resemble marginal bands. Pores medium-sized. Traumatic gum canals occasionally present. Heartwood pink, red, reddish brown or dark brown.
Density 0.6 - 0.9 *g cm*$^{-3}$. *Carapa procera*

b. Widest rays narrower than one-half the width of the widest pores. Paratracheal parenchyma vasicentric. Pores usually fewer than three per *mm*^{2}. 110

110a. Rays fewer than five per *mm*; distinct to the naked eye on the cross-section and commonly exceeding one *mm* in height. Parenchyma bands generally narrower than the rays. Pores large. Wood white, yellowish or grayish.
Density 0.3 - 0.5 *g cm*$^{-3}$. *Cleistopholis patens*

b. Rays more numerous than five per *mm*; visible to the naked eye on the cross-section. Parenchyma bands wider than the rays. Pores medium-sized. Wood light yellowish or pinkish brown.
Density 0.4 - 0.5 *g cm*$^{-3}$. *Ficus* spp.

111a. Parenchyma bands exclusively paratracheal. 112

b. Parenchyma bands seemingly apotracheal and paratracheal. 115

112a. Rays commonly exceeding one *mm* in height; visible to the naked eye on the cross-section. Pores medium-sized. Confluent parenchyma in rather broad wavy tangential bands throughout the growth rings. Heartwood yellowish, orangish or greenish brown, usually with a reddish cast.
Density 0.5 - 0.8 *g cm*$^{-3}$. *Symphonia globulifera*

b. Rays less than one *mm* in height. 113

113a. Rays more numerous than ten per *mm*; indistinct to the naked eye on the cross-section. Pores medium-sized to large. Confluent parenchyma sometimes forming continuous bands throughout the growth rings, or sometimes forming continuous bands only at the ends of the growth rings. Traumatic gum canals sometimes present. Wood pale yellow, yellowish green or grayish, sometimes with darker streaks.
Density 0.4 - 0.7 *g cm*$^{-3}$. *Terminalia superba*

b. Rays fewer than ten per *mm*. 114

114a. Upright cells distinct with a lens. Pores fewer than three per *mm*^{2}; large. Rays distinct to the naked eye on the cross-section. Parenchyma bands usually variable in width and unevenly distributed within the growth rings. Heartwood light yellow, brown or greenish brown.
Density 0.5 - 0.8 *g cm*$^{-3}$. *Chlorophora excelsa*
C. regia

b. Upright cells absent. Paratracheal parenchyma aliform with long narrow wings and confluent forming rather narrow tangential bands. Rays barely visible to the naked eye on the cross-section. Pores large and rare. Traumatic gum canals occasionally present. Wood white or yellowish.
Density 0.2 - 0.4 *g cm*$^{-3}$. *Quassia undulata*

115a. Rays fewer than five per *mm*. Parenchyma bands broad and distinct. 116

b. Rays more numerous than five per *mm*. 120

116a. Rays less than one *mm* in height; prominent on the tangential surface. Pores medium-sized to large. Traumatic gum canals sometimes present. Heartwood reddish brown, usually with a purplish cast.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Entandrophragma candollei*

b. Rays variable in size, the largest plainly visible to the naked eye and commonly exceeding one *mm* in height, the smallest sometimes indistinct to the naked eye. 117

117a. Heartwood white, yellow or yellowish brown in color. Pores rather large and plainly visible to the naked eye. 118

b. Heartwood brown or reddish brown in color. Rays commonly exceeding two *mm* in height. 119

118a. Heartwood uniform yellow or yellowish brown, sometimes with an orange cast. Vessels often containing yellow gum. Traumatic gum canals some times present.
Density 0.7 - 0.8 *g cm*$^{-3}$. *Sterculia oblonga*

b. Heartwood creamy white or pale yellow. Vessels not containing gum or tyloses. Traumatic gum canals sometimes present.
Density 0.5 - 0.8 $g\ cm^{-3}$. *Pterygota bequaertii*
P. macrocarpa

119a. Rays commonly as wide as or wider than the pores. Pores small or medium-sized. Traumatic gum canals sometimes present. Heartwood light brown with an orange or reddish cast.
Density 0.4 - 0.8 $g\ cm^{-3}$. *Cola* spp.

b. Rays narrower than the pores. Pores medium-sized to rather large. Heartwood reddish brown, sometimes with darker streaks.
Density 0.6 - 0.8 $g\ cm^{-3}$. *Sterculia rhinopetala*

120a. Wood with distinctive cedar-like scent. Parenchyma arranged in irregular wavy, sometimes broken bands. Rays indistinct to the naked eye on the cross-section. Pores medium-sized. Heartwood pink, red or reddish brown.
Density 0.5 - 0.7 $g\ cm^{-3}$. *Guarea cedrata*

b. Distinctive odour absent or faint. 121

121a. Rays variable in width, the largest visible to the naked eye on the cross-section, the smallest distinct only with a lens. Parenchyma bands more or less generally including the pores; pores outside of the bands accompanied by vasicentric parenchyma. Pores medium-sized. Wood light yellowish or pinkish brown.
Density 0.4 - 0.5 $g\ cm^{-3}$. *Ficus* spp.

b. Rays relatively uniform in width. 122

122a. Parenchyma bands fewer than two per *mm* of ray; broad and distinct to the naked eye. 123

b. Parenchyma bands more numerous than two per *mm* of ray. 124

123a. Rays prominent on the tangential surface. Pores medium-sized to large. Traumatic gum canals sometimes present. Heartwood reddish brown, usually with a purplish cast.
Density 0.6 - 0.8 $g\ cm^{-3}$. *Entandrophragma candollei*

b. Rays not very prominent on the tangential surface; often in echelon producing an irregular rippled effect on the tangential surface. Parenchyma bands often as wide as or wider than the intervening bands of fibres. Pores large and sparse. Heartwood light yellowish brown.
Density 0.7 - 0.8 $g\ cm^{-3}$. *Amphimas pterocarpoides*

124a. Pores small, barely visible or indistinct to the naked eye. 125

b. Pores distinct to the naked eye. 127

125a. Upright cells distinct with a lens. Pores sparse to rather numerous. Rays barely visible to the naked eye on the cross-section. Heartwood yellow or pale brown.
Density 0.8 - 1.0 $g\ cm^{-3}$. *Garcinia epunctata*
G. kola
G. mannii

b. Upright cells absent.
Density 0.9 - 1.1 $g\ cm^{-3}$. 126

126a. Rays generally indistinct to the naked eye on the cross-section; less than one *mm* in height. Heartwood bright orange, orangish red or dark red. *Baphia nitida*

b. Rays usually distinct to the naked eye on the cross-section and commonly exceeding one *mm* in height. Heartwood orange, orangish red or dark red. *Baphia pubescens*

127a. Rays commonly up to or exceeding one *mm* in height. 128

b. Rays less than one *mm* in height. 129

128a. Pores fewer than five per mm^2. Parenchyma aliform with rather long wings, and apotracheal and confluent forming occasionally discontinuous bands; usually two or three bands per *mm* of ray. Rays barely visible to the naked eye on the cross-section. Wood yellow, yellowish brown or dark brown. Density 0.9 - 1.1 $g\ cm^{-3}$. *Klainedoxa gabonensis*

b. Pores more numerous than five per mm^2. Parenchyma in continuous apotracheal and confluent bands; usually about four bands per *mm* of ray. Rays indistinct to the naked eye on the cross-section. Wood yellowish, grayish or pinkish brown.
Density 0.8 - 1.0 $g\ cm^{-3}$. *Irvingia gabonensis*

129a. Rays more numerous than nine per mm^2; barely visible or indistinct to the naked eye on the cross-section; often in echelon producing an irregular rippled effect on the tangential surface. Pores rather small to medium-sized. Heartwood light to dark reddishbrown.
Density 0.8 - 1.0 $g\ cm^{-3}$. *Cynometra ananta*
C. leonensis

b. Rays fewer than nine per *mm*. Wood moderately hard and heavy.
Density 0.5 - 0.8 $g\ cm^{-3}$. 130

130a. Pores fewer than five per mm^2; medium-sized. Parenchyma arranged in rather straight continuous bands. Rays indistinct to the naked eye on the cross-section. Heartwood pink, red or reddish brown.
Density 0.5 - 0.8 $g\ cm^{-3}$. *Guarea thompsonii*

b. Pores more numerous than five per mm^2; medium-sized. Wood pinkish, grayish or reddish.
Density 0.6 - 0.7 $g\ cm^{-3}$. *Bosqueia angolensis*
B. phoberos

131a. Confluent parenchyma present. 132

b. Confluent parenchyma absent or rare. 144

132a. Rays more numerous than nine per *mm*. 133

b. Rays fewer than nine per *mm*. 134

133a. Rays conspicuous on the radial surface and often distinct to the naked eye on the tangential surface and the cross-section. Pores medium-sized. Parenchyma aliform with long wings and confluent connecting several pores. Wood yellowish or reddish.
Density 0.8 - 1.0 $g\ cm^{-3}$. *Cryptosepalum tetraphyllum*

b. Rays inconspicuous on the radial surface; indistinct on the tangential surface and the cross-section. Parenchyma aliform and confluent

connecting several to many pores. Pores medium-sized to large. Traumatic gum canals sometimes present. Wood pale yellow, yellowish green or grayish, sometimes with darker streaks.
Density 0.4 - 0.7 *g cm*$^{-3}$. *Terminalia superba*

134a. Heartwood vessels containing tyloses. Upright cells distinct with a lens. 135

b. Tyloses absent; gum sometimes present. Upright cells absent. 136

135a. Pores fewer than three per *mm*^{2}; large. Confluent parenchyma connecting several to many pores. Rays distinct to the naked eye on the cross-section. Heartwood light yellow, brown or greenish brown.
Density 0.5 - 0.8 *g cm*$^{-3}$. *Chlorophora excelsa*
C. regia

b. Pores more numerous than three per *mm*^{2}. Paratracheal parenchyma vasicentric, aliform with rather short wings and confluent connecting a few pores. Rays barely visible to the naked eye on the cross-section. Pores medium-sized. Heartwood light to dark red or reddish brown.
Density 0.7 - 0.9 *g cm*$^{-3}$. *Petersianthus macrocarpus*

136a. Rays commonly more numerous than three per pore diameter. Parenchyma aliform with short wings forming diamond-shaped patches around the pores and confluent connecting several pores. Rays indistinct to the naked eye on the cross-section. Pores large. Heartwood light to dark orange, red or reddish brown.
Density 0.8 - 1.1 *g cm*$^{-3}$. *Erythrophleum africanum*
E. ivorense
E. suaveolens

b. Rays fewer than three per pore diameter. 137

137a. Non-confluent parenchyma almost exclusively aliform. Rays barely visible to the naked eye on the cross-section. Pores medium-sized. Wood yellow or reddish brown.
Density 0.4 - 0.5 *g cm*$^{-3}$. *Parkia bicolor*
P. filicoidea

b. Non-confluent parenchyma vasicentric and aliform with short wings. 138

138a. Heartwood vessels containing conspicuous yellow chalky deposits. Wood often with tallow odour. Pores medium-sized to large. Rays barely visible or indistinct to the naked eye on the cross-section; generally fewer than six per *mm*. Heartwood light to dark yellowish or reddish brown.
Density 0.9 - 1.1 *g cm*$^{-3}$. *Cylicodiscus gabunensis*

b. Vessels without conspicuous chalky deposits; often containing reddish or yellowish gum. 139

139a. Wood hard and heavy; density 0.9 - 1.1 *g cm*$^{-3}$. Rays barely visible or indistinct to the naked eye on the cross-section. Pores rather large. 140

b. Wood rather light to moderately hard and heavy; density 0.4 - 0.8 *g cm*$^{-3}$. 141

140a. Heartwood light to dark reddish brown. Parenchyma abundant; vasicentric, aliform forming diamond-shaped patches around the pores and confluent connecting few to several pores. *Pentaclethra macrophylla*

b. Heartwood dark brown, sometimes with a reddish cast. Parenchyma abundant; vasicentric, aliform with short wings and confluent connecting few to many pores. *Bussea occidentalis*

141a. Rays indistinct to the naked eye on the cross-section. Parenchyma abundant; vasicentric, aliform with short wings and confluent connecting a few pores. Pores rather large. Heartwood medium to dark brown, occasionally with purplish tinges. *Albizia ferruginea*
A. gigantea

b. Rays distinct to the naked eye on the cross-section. 142

142a. Rays sparse, fewer than four per *mm* and seemingly spaced more than a pore width apart. Pores large and plainly visible to the naked eye. Heartwood yellowish, greenish or pale golden brown.
Density 0.4 - 0.5 *g cm*$^{-3}$. *Maesopsis eminii*

b. Rays four to six per *mm*. 143

143a. Parenchyma rather abundant, usually plainly visible to the naked eye; vasicentric, aliform with short wings and confluent connecting a few pores. Pores medium-sized to large. Heartwood golden yellow, greenish, or yellowish or reddish brown.
Density 0.4 - 0.7 *g cm*$^{-3}$. *Albizia adianthifolia*
A. gummifera
A. zygia

b. Parenchyma moderately abundant but often indistinct to the naked eye; vasicentric, aliform with short to rather long wings and confluent connecting a few pores. Pores rather large. Heartwood yellowish brown, sometimes with a greenish cast.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Piptadeniastrum africanum*

144a. Rays commonly exceeding two *mm* in height. Pores medium-sized; numerous. Parenchyma vasicentric and sometimes aliform with very short wings; often indistinct even with a lens. Heartwood light to dark red or reddish brown.
Density 0.6 - 0.9 *g cm*$^{-3}$. *Uapaca* spp.

b. Rays less than two *mm* in height. 145

145a. Aliform parenchyma present. 146

b. Aliform parenchyma absent or rare; paratracheal parenchyma vasicentric. 155

146a. Rays of two sizes, the widest commonly exceeding one-half of the width of of the widest pores. Pores medium-sized. Traumatic gum canals occasionally present. Heartwood pink, red, reddish brown or dark brown.
Density 0.6 - 0.9 *g cm*$^{-3}$. *Carapa procera*

b. Widest rays narrower than one-half of the width of the widest pores. 147

147a. Heartwood vessels containing tyloses. Rays barely visible to the naked eye on the cross-section; upright cells distinct with a lens. Pores medium-sized. Heartwood light to dark red or reddish brown.
Density 0.7 - 0.9 *g cm*$^{-3}$. *Petersianthus macrocarpus*
b. Tyloses absent or sparse. 148
148a. Upright cells distinct with a lens; rays distinct to the naked eye on the cross-section. Pores medium-sized to large. Wood white, yellow or yellowish brown.
Density 0.4 - 0.6 g. *Antiaris africana*
A. welwitschii
b. Upright cells absent. 149
149a. Rays commonly more numerous than three per pore diameter. Parenchyma aliform with short wings forming diamond-shaped patches around the pores. Rays indistinct to the naked eye on the cross-section. Pores large. Heartwood light to dark orange, red or reddish brown.
Density 0.8 - 1.1 *g cm*$^{-3}$. *Erythrophleum africanum*
E. ivorense
E. suaveolens
b. Rays fewer than three per pore diameter. 150
150a. Heartwood vessels containing conspicuous yellow chalky deposits. Wood often with tallow odour. Pores medium-sized to large. Rays barely visible or indistinct to the naked eye; generally fewer than six per *mm*. Heartwood light to dark yellowish or reddish brown.
Density 0.9 - 1.1 *g cm*$^{-3}$. *Cylicodiscus gabunensis*
b. Vessels without conspicuous chalky deposits; often containing reddish or yellowish gum. 151
151a. Rays barely visible or indistinct to the naked eye on the cross-section. Pores rather large. Heartwood medium to darkbrown, occasionally with purplish tinges.
Density 0.5 - 0.8 *g cm*$^{-3}$. *Albizia ferruginea*
A. gigantea
b. Rays visible to the naked eye on the cross-section. 152
152a. Rays generally more numerous than six per *mm*. Pores medium-sized to rather large. Traumatic gum canals occasionally present. Wood yellowish white or clear yellow.
Density 0.6 - 1.0 *g cm*$^{-3}$. *Fagara* spp.
b. Rays generally fewer than six per *mm*. 153
153a. Rays sparse, fewer than four per *mm* and seemingly spaced more than a pore width apart. Pores large and plainly visible to the naked eye. Heartwood yellowish, greenish or pale golden brown.
Density 0.4 - 0.5 *g cm*$^{-3}$. *Maesopsis eminii*
b. Rays four to six per *mm*. 154
154a. Parenchyma rather abundant, usually plainly visible to the naked eye. Pores medium-sized to large. Heartwood golden yellow, greenish, yel-

lowish brown or reddish brown.
Density 0.4 - 0.7 *g cm*$^{-3}$. *Albizia adianthifolia*
A. gummifera
A. zygia

b. Parenchyma moderately abundant, often indistinct to the naked eye. Pores rather large. Heartwood yellowish brown, sometimes with a greenish cast.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Piptadeniastrum africanum*

155a. Pores fewer than two per *mm*^{2}; large. Rays distinct to the naked eye on the cross-section. Wood white or yellowish.
Density 0.2 - 0.4 *g cm*$^{-3}$. *Musanga cecropioides*

b. Pores more numerous than two per *mm*^{2}. 156

156a. Rays more numerous than eight per *mm*; indistinct to the naked eye on on the cross-section. Pore small to medium-sized, numerous, predominantly in radial groups of two to five. 157

b. Rays fewer than eight per *mm*. 158

157a. Wood light pinkish or reddish brown. Pores sometimes tending to form form oblique lines.
Density 0.6 - 0.7 *g cm*$^{-3}$. *Erythroxylum mannii*

b. Wood light to dark brown or nearly black. Growth rings often visible due to zones lacking in pores.
Density 0.9 - 1.1 *g cm*$^{-3}$. *Anogeissus leiocarpus*

158a. Growth rings distinct and regular due to zones which are deficient in pores. Rays barely visible to the naked eye on the cross-section. Pores rather large. Traumatic gum canals sometimes present. Wood yellow or light greenish brown.
Density 0.5 - 0.7 *g cm*$^{-3}$. *Terminalia ivorensis*

b. Growth rings indistinct. 159

159a. Widest rays commonly exceeding one-half the width of the widest pores. Pores medium-sized. Traumatic gum canals occasionally present. Heartwood pink, red, reddish brown or dark brown.
Density 0.6 - 0.9 *g cm*$^{-3}$. *Carapa procera*

b. Widest rays narrower than one-half the width of the widest pores. 160

160a. Heartwood vessels containing reddish or brownish gum. 161

b. Vessels not containing gum or tyloses. Pores medium-sized to large. Rays distinct to the naked eye on the cross-section. Wood white, yellow or yellowish brown.
Density 0.4 - 0.6 *g cm*$^{-3}$. *Antiaris africana*
A. welwitschii

161a. Rays variable in width, the largest distinct to the naked eye on the cross-section, the smallest distinct only with a lens; prominent on the tangential surface. Pores medium-sized to large. Traumatic gum canals sometimes present. Heartwood light to dark red or reddish brown, some times with a purplish cast.
Density 0.4 - 0.8 *g cm*$^{-3}$. *Khaya* spp.

b. Rays relatively uniform in width. 162

162a. Rays distinct on the tangential surface; usually distinct on the cross-section. Pores medium-sized. Traumatic gum canals often present. Heartwood yellowish or grayish brown or dark brown.
Density 0.4 - 0.7 $g\ cm^{-3}$. *Lovoa trichilioides*

b. Rays rather indistinct on the tangential surface; barely visible or indistinct on the cross-section. Pores medium-sized to large. Heartwood reddish brown.
Density 0.6 - 0.7 $g\ cm^{-3}$. *Newtonia aubrevillei*
N. duparquetiana

163a. Parenchyma predominantly diffuse-in-aggregates forming broken tangential lines. 164

b. Parenchyma not predominantly diffuse-in-aggregates. 174

164a. Pores fewer than two per mm^2; large. Rays indistinct to the naked eye on the cross-section. Diffuse-in-aggregates parenchyma abundant. Wood white or pale yellow.
Density 0.1 - 0.3 $g\ cm^{-3}$. *Ricinodendron heudelotii*

b. Pores more numerous than two per mm^2; often arranged predominantly in radial groups. 165

165a. Pores small, indistinct to the naked eye. 166

b. Pores distinct to the naked eye. 168

166a. Wood moderately light and soft. Parenchyma abundant forming numerous tangential lines between the rays and often crossing several rays. Wood creamy white or grayish white, sometimes with narrow dark lines on the longitudinal surfaces.
Density 0.5 - 0.7 $g\ cm^{-3}$. *Holarrhena floribunda*

b. Wood hard and heavy.
Density 0.9 -1.1 $g\ cm^{-3}$. 167

167a. Rays commonly exceeding one *mm* in height; usually indistinct to the naked eye on the cross-section. Parenchyma rather abundant, forming numerous tangential lines between the rays. Heartwood pinkish or purplish brown. *Strombosia glaucescens*
S. pustulata

b. Rays rarely exceeding one *mm* in height; indistinct to the naked eye on the cross-section. Parenchyma sparse, often indistinct even with a lens. Heartwood dark reddish brown with a purplish tinge.
Oldfieldia africana

168a. Solitary pores and pore groups tending to form irregular radial or oblique lines; sometimes not very distinct. 169

b. Pores not arranged in radial or oblique lines. 170

169a. Pore groups numerous and evenly distributed throughout the cross-section. Heartwood yellowish brown, sometimes with greenish cast.
Density 0.6 - 0.7 $g\ cm^{-3}$. *Panda oleosa*

b. Pore groups rather unevenly distributed; moderately numerous. Heartwood whitish or pale brown.
Density 0.5 - 0.7 *g cm*$^{-3}$. *Chrysophyllum pruniforme*

170a. Rays fewer than nine per *mm*; barely visible or indistinct to the naked eye on the cross-section. Lines of diffuse-in-aggregates parenchyma often crossing several rays. 171
b. Rays more numerous than nine per *mm*. Pores rather small. 172

171a. Pores rather small, barely distinct to the naked eye; relatively numerous. Wood creamy white or grayish white, sometimes with narrow dark lines on the longitudinal surfaces.
Density 0.5 - 0.7 *g cm*$^{-3}$. *Holarrhena floribunda*
b. Pores medium-sized to occasionally rather small; not very numerous. Latex traces occasionally present. Heartwood yellow or yellowish white.
Density 0.4 - 0.6 *g cm*$^{-3}$g. *Funtumia* spp.

172a. Wood hard and heavy. Rays indistinct to the naked eye on the cross-section; often exceeding one *mm* in height. Diffuse-in-aggregates parenchyma abundant forming numerous tangential lines between the rays. Heartwood red or reddish brown, sometimes with brownish streaks:
Density 0.9 - 1.1 *g cm*$^{-3}$. *Coula edulis*
b. Wood rather light or moderately heavy.
Density 0.5 - 0.7 *g cm*$^{-3}$..... 173

173a. Heartwood distinctive bright sulphur yellow or yellowish orange.
Nauclea pobeguinii
b. Wood pinkish, grayish or yellowish brown.
Mitragyna ciliata
M. stipulosa

174a. Solitary pores and pore groups arranged in definite irregular radial or oblique lines; pores sometimes arranged predominantly in radial groups. Parenchyma bands apotracheal; usually barely visible to the naked eye. Rays indistinct to the naked eye on the cross-section. 175
b. Pores not arranged in radial or oblique lines. 178

175a. Pores small; barely visible or indistinct to the naked eye.
Heartwood red or reddish brown.
Density 0.9 - 1.1 *g cm*$^{-3}$. *Manilkara multinervis*
M. obovata
b. Pores medium-sized; distinct to the naked eye. 176

176a. Solitary pores and pore groups rather sparse; usually fewer that four per *mm*^{2}. Heartwood dark red or reddish brown, often with darker streaks.
Density 0.8 - 1.0 *g cm*$^{-3}$. *Autranella congolensis*
b. Solitary pores and pore groups typically more numerous than four per *mm*^{2}. 177

177a. Parenchyma bands usually as wide as or wider than the rays. Heartwood pink, red or reddish brown.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Tieghemella heckelii*

b. Parenchyma bands narrower than the rays. Heartwood pinkish brown, reddish brown or red.
Density 0.6 - 0.9 *g cm*$^{-3}$. *Baillonella toxisperma*

178a. Parenchyma bands generally wider than twice the width of the rays. 179

b. Parenchyma bands generally narrower than twice the width of the rays. 180

179a. Rays indistinct to the naked eye on the cross-section; more numerous than nine per *mm*. Pores large. Heartwood light to dark brown or reddish brown.
Density 0.9 - 1.1 *g cm*$^{-3}$. *Lophira alata*

b. Rays distinct to the naked eye on the cross-section; variable in width; fewer than nine per *mm*. Pores medium-sized. Wood light yellowish or pinkish brown.
Density 0.4 - 0.5 *g cm*$^{-3}$. *Ficus* spp.

180a. Rays commonly exceeding one *mm* in height. Apotracheal parenchyma arranged in regularly-spaced continuous tangential bands which are narrower than the rays. 181

b. Rays less than one *mm* in height. Pores often arranged predominantly in radial groups. 185

181a. Parenchyma bands fewer than four per *mm* of ray. Pores large and sparse. Wood white or gray.
Density 0.3 - 0.5 *g cm*$^{-3}$. *Cleistopholis patens*

b. Parenchyma bands more numerous than four per *mm* of ray. 182

182a. Parenchyma bands four to eight per *mm* of ray. Rays plainly visible to the naked eye on the cross-section. 183

b. Parenchyma bands more numerous than eight per *mm* of ray. 184

183a. Pores small, indistinct to the naked eye; usually more numerous than five per *mm*^{2}. Rays commonly as wide as or wider than the pores. Wood distinctive bright yellow.
Density 0.5 - 0.6 *g cm*$^{-3}$. *Enantia chlorantha*
E. polycarpa

b. Pores large, plainly visible to the naked eye; usually fewer than five per *mm*^{2}. Wood white or pale yellowish brown.
Density 0.4 - 0.7 *g cm*$^{-3}$. *Xylopia aethiopica*
X. staudtii

184a. Pores large, plainly visible to the naked eye; usually fewer than five per *mm*^{2}. Rays plainly visible to the naked eye on the cross-section. Wood reddish or yellowish brown, sometimes with a greenish cast.
Density 0.6 - 0.8 *g cm*$^{-3}$. *Pachypodanthium staudtii*

b. Pores medium-sized or small, usually more numerous than five per *mm*^{2}. Rays barely visible to the naked eye on the cross-section. Wood yellowish or greenish brown.
Density 0.8 - 1.0 *g cm*$^{-3}$. *Xylopia quintasii*

185a. Rays fewer than ten per mm^2. Pores large and sparse. Parenchyma bands distinct to the naked eye. Latex traces sometimes present. Wood white or yellowish white.
Density 0.3 - 0.5 $g\ cm^{-3}$. *Alstonia boonei*
A. congensis

b. Rays more numerous than ten per *mm*. Pores medium-sized to rather small. Parenchyma bands often indistinct to the naked eye. 186

186a. Wood hard and heavy. Rays usually narrower than the parenchyma bands. Pores small, often invisible or indistinct to the naked eye.
Density 0.9 - 1.1 $g\ cm^{-3}$..... 187

b. Wood moderately hard and heavy. Pores barely visible to the naked eye. Rays usually as wide as or wider than the paren-chyma bands.
Density 0.5 - 0.9 $g\ cm^{-3}$..... 188

187a. Heartwood black. *Diospyros crassiflora*
D. piscatoria

b. Heartwood whitish, grayish or brown, often with a reddish cast and sometimes with black streaks. Vessels containing gum and occasionally tyloses. *Diospyros abyssinica*
D. kamerunensis
D. mespiliformis
D. sanza-minika

188a. Growth rings often rather well-defined due to zones deficient in pores and parenchyma. Wood grayish brown, often with a pinkish cast.
Density 0.5 - 0.7 $g\ cm^{-3}$. *Aningeria altissima*
A. robusta

b. Growth rings usually not well-defined. Wood brown, yellow or whitish.
Density 0.6 - 0.9 $g\ cm^{-3}$. *Chrysophyllum albidum*
C. delevoyi
C. perpulchrum
C. subnudum

Species Included in the Key

Genus	Species	Family
Adina	*microcephala* (Del.) Hiern	Rubiaceae
Afzelia	*africana* Sm.	Leguminosae (Caes.)
	bella Harms	
	bipindensis Harms	
	bracteata T. Vogel ex Benth.	
	pachyloba Harms	
Albizia	*adianthifolia* (Schum.) W.F. Wight	Leguminosae (Mim.)
	ferruginea (Guill. & Perr.) Benth.	
	gigantea Chev.	
	gummifera (Gmel.) C.A. Sm.	
	zygia (DC.) J.F. Macbr.	
Alstonia	*boonei* De Wild.	Apocynaceae
	congensis Engl.	
Amphimas	*pterocarpoides* Harms	Leguminosae (Caes.)
Aningeria	*altissima* (A. Chev.) Aubrév. & Pellegr.	Sapotaceae
Aningeria	*robusta* (A. Chev.) Aubrév. & Pellegr.	
Anisophyllea	*laurina* R. Br. ex Sabine	Rhizophoraceae
Anisophyllea	*meniaudi* Aubrév. & Pellegr.	
Anogeissus	*leiocarpus* (DC.) Guill. & Perr.	Combretaceae
Anopyxis	*klaineana* (Pierre) Engl.	Rhizophoraceae
Anthocleista	spp., including	Loganiaceae
	nobilis G. Don	
	vogelii Planch.	
Anthonotha	spp., including	Leguminosae (Caes.)
	explicans (Baill.) J. Leónard	
	fragrans (Bak. f.) Exell & Hillcoat	
	macrophylla P. Beauv.	
Antiaris	*africana* Engl.	Moraceae
	welwitschii Engl.	
Antrocaryon	*micraster* A. Chev. & Guill.	Anacardiaceae
Araliopsis	*tabouensis* Aubrév. & Pellegr.	Rutaceae
Autranella	*congolensis* (De Wild.) A. Chev.	Sapotaceae
Avicennia	*africana* P. Beauv.	Verbenaceae
Baillonella	*toxisperma* Pierre	Sapotaceae
Baphia	*nitida* Lodd.	Leguminosae (Pap.)
	pubescens Hook. f.	
Beilschmiedia	*mannii* (Meisn.) Benth. & Hook. f.	Lauraceae
Berlinia	spp., including	Leguminosae (Caes.)
	bracteosa Benth.	
	confusa Hoyle	
	grandiflora (Vahl) Hutch. & Dalz.	
	occidentalis Keay	
	tomentella Keay	
Blighia	*sapida* Koenig	Sapindaceae
	welwitschii (Hiern) Radlk.	
Bombax	*buonopozense* P. Beauv.	Bombacaceae
Bosqueia	*angolensis* Ficalho	Moraceae
	phoberos Baill.	
Brachystegia	spp., including	Leguminosae (Caes.)
	eurycoma Harms	
	leonensis Hutch. & B. Davy	
	nigerica Hoyle & A.P.D. Jones	
Bridelia	spp., including	Euphorbiaceae
	atroviridis Muell. Arg.	
	grandis Pierre ex Hutch.	
	micrantha (Hochst.) Baill.	
Burkea	*africana* Hook.	Leguminosae (Caes.)

Bussea	*occidentalis* Hutch. & Dalz.	Leguminosae (Caes.)
Canarium	*schweinfurthii* Engl.	Burseraceae
Carapa	*procera* DC.	Meliaceae
Cassipourea	spp., including	Rhizophoraceae
	afzelii (Oliv.) Alston	
	firestoneana Cooper & Record	
	nialatou Aubrév. & Pellegr.	
Ceiba	*pentandra* (L.) Gaertn.	Bombacaceae
Celtis	spp., including	Ulmaceae
	adolfi-friderici Engl.	
	brownii Rendle	
	durandii Engl.	
	integrifolia Lam.	
	mildbraedii Engl.	
	zenkeri Engl.	
Chlorophora	*excelsa* (Welw.) Benth.	Moraceae
	regia A. Chev.	
Chrysophyllum	*albidum* G. Don	Sapotaceae
	delevoyi De Wild.	
	perpulchrum Mildbr. ex Hutch. & Dalz.	
	pruniforme Pierre ex Engl.	
	submudum Bak.	
Cleistopholis	*patens* (Benth.) Engl. & Diels	Annonaceae
Cola	spp., including	Sterculiaceae
	acuminata Schott & Engl.	
	buntingii Bak. f.	
	chlamydantha K. Schum.	
	lateritia K. Schum.	
	nitida (Vent.) Schott & Endl.	
	simiarum Sprague ex Brenan & Keay	
Copaifera	*mildbraedii* Harms	Leguminosae (Caes.)
	salikounda Heckel	
Coula	*edulis* Baill.	Olacaceae
Cryptosepalum	*tetraphyllum* (Hook. f.) Benth.	Leguminosae (Caes.)
Cylicodiscus	*gabunensis* Harms	Leguminosae (Mim.)
Cynometra	*ananta* Hutch. & Dalz.	Leguminosae (Caes.)
	leonensis Hutch. & Dalz.	
Dalbergia	*melanoxylon* Guill. & Perr.	Leguminosae (Pap.)
Daniellia	*ogea* (Harms) Rolfe ex Holl.	Leguminosae (Caes.)
	oliveri (Rolfe) Hutch. & Dalz.	
	thurifera Benn.	
Detarium	*senegalense* J.F. Gmel.	Leguminosae (Caes.)
Dialium	spp., including	Leguminosae (Caes.)
	aubrevillei Pellegr.	
	dinklagei Harms	
	guineense Willd.	
Diospyros	*abyssinica* (Hiern) F. White	Ebenaceae
	crassiflora Hiern	
	kamerunensis Gürke	
	mespiliformis Hochst. ex A. DC.	
	piscatoria Gürke	
	sanza-minika A. Chev.	
Distemonanthus	*benthamianus* Baill.	Leguminosae (Caes.)
Enantia	*chlorantha* Oliv.	Annonaceae
	polycarpa (DC.) Engl. & Diels	
Entandrophragma	*angolense* (Welw.) DC.	Meliaceae
	candollei Harms	
	cylindricum (Sprague) Sprague	
	utile (Dawe & Sprague) Sprague	
Erythrophleum	*africanum* (Welw. ex Benth.) Harms	Leguminosae (Caes.)
	ivorense A. Chev.	
	suaveolens (Guill. & Perr.) Brenan	

Erythroxylum	*mannii* Oliv.	Erythroxylaceae
Fagara	spp., including	Rutaceae
	leprieurii (Guill. & Perr.) Engl.	
	macrophylla (Oliv.) Engl.	
	parvifolia A. Chev. ex Keay	
	tessmannii Engl.	
Ficus	spp., including	Moraceae
	capensis Thunb.	
	exasperata Vahl	
	mucuso Welw. ex Ficalho	
	thonningii Blume	
	vogeliana (Miq.) Miq.	
Funtumia	spp., including	Apocynaceae
	africana (Benth.) Stapf	
	elastica (Preuss) Stapf	
	latifolia (Stapf) Schlecht.	
Garcinia	*epunctata* Stapf	Guttiferae
	kola Heckel	
	mannii Oliv.	
	polyantha Oliv.	
Gilbertiodendron	spp., including	Leguminosae (Caes.)
	bilineatum (Hutch. & Dalz.) J. Leónard	
	dewevrei (De Wild.) J. Leónard	
	ivorense (A. Chev.) J. Leónard	
	limba (Sc. Elliott) J. Leónard	
	preussii (Harms) J. Leónard	
	splendidum (A. Chev. ex Hutch. & Dalz.) J. Leónard	
Gossweilerodendron	*balsamiferum* (Verm.) Harms	Leguminosae (Caes.)
Guarea	*cedrata* (A. Chev.) Pellegr.	Meliaceae
	thompsonii Sprague & Hutch.	
Guibourtia	*ehie* (A. Chev.) J. Leónard	Leguminosae (Caes.)
Haplormosia	*monophylla* (Harms) Harms	Leguminosae (Pap.)
Heritiera	*utilis* (Sprague) Sprague	Sterculiaceae
Holarrhena	*floribunda* (G. Don) Dur. & Schinz	Apocynaceae
Holoptelea	*grandis* (Hutch.) Mildbr.	Ulmaceae
Homalium	spp., including	Flacourtiaceae
	africanum (Hook. f.) Benth.	
	aylmeri Hutch. & Dalz.	
	letestui Pellegr.	
	molle Stapf	
Irvingia	*gabonensis* (Aubry-Lecomte ex O'Rorke) Baill.	Irvingiaceae
Khaya	spp., including	Meliaceae
	anthotheca (Welw.) C. DC.	
	grandifoliola C. DC.	
	ivorensis A. Chev.	
	senegalensis A. Juss.	
Klainedoxa	*gabonensis* Pierre ex Engl.	Irvingiaceae
Lonchocarpus	*sericeus* (Poir.) H.B.K.	Leguminosae (Pap.)
Lophira	*alata* Banks ex Gaertn. f.	Ochnaceae
Lovoa	*trichilioides* Harms	Meliaceae
Maesopsis	*eminii* Engl.	Rhamnaceae
Mammea	*africana* Sabine	Guttiferae
Manilkara	*multinervis* (Baker) Dubard	Sapotaceae
	obovata (Sabine) J.H. Hemsley	
Mansonia	*altissima* (A. Chev.) A. Chev.	Sterculiaceae
Mitragyna	*ciliata* Aubrév. & Pellegr.	Rubiaceae
	stipulosa (DC.) Kuntze	
Morus	*mesozygia* Stapf	Moraceae
Musanga	*cecropioides* R. Br.	Moraceae
Nauclea	*diderrichii* (De Wild. & Th. Dur.) Merr.	Rubiaceae
	pobeguinii (Pobéguin ex Pellegr.) Petit	
Nesogordonia	*papaverifera* (A. Chev.) R. Capuron	Sterculiaceae

Newtonia	*aubrevillei* (Pellegr.) Keay	Leguminosae (Mim.)
	duparquetiana (Baill.) Keay	
Oldfieldia	*africana* Benth. & Hook. f.	Euphorbiaceae
Ongokea	*gore* (Hua) Pierre	Olacaceae
Oxystigma	*oxyphyllum* (Harms) J. Leonard	Leguminosae (Caes.)
Pachypodanthium	*staudtii* (Engl. & Diels) Engl. & Diels	Annonaceae
Panda	*oleosa* Pierre	Pandaceae
Parinari	spp., including	Chrysobalanaceae
	chrysophylla Oliv.	
	congensis F. Didr.	
	excelsa Sabine	
	glabra Oliv.	
	kerstingii Engl.	
	robusta Oliv.	
Parkia	*bicolor* A. Chev.	Leguminosae (Mim.)
	filicoidea Welw. ex Oliv.	
Pausinystalia	*lane-poolei* (Hutch.) Hutch. ex Lane Poole	Rubiaceae
Pentaclethra	*macrophylla* Benth.	Leguminosae (Mim.)
Pericopsis	*elata* (Harms) V. Meeuwen	Leguminosae (Pap.)
	laxiflora (Benth. ex Bak.) V. Meeuwen	
Petersianthus	*macrocarpus* (Beauv.) Liben	Lecythidaceae
Piptadeniastrum	*africanum* (Hook. f.) Brenan	Leguminosae (Mim.)
Poga	*oleosa* Pierre	Rhizophoraceae
Pseudocedrela	*kotschyi* (Schweinf.) Harms	Meliaceae
Pterocarpus	*mildbraedii* Harms	Leguminosae (Pap.)
	santalinoides L'Her. ex DC.	
	soyauxii Taub.	
Pterygota	*bequaertii* De Wild.	Sterculiaceae
	macrocarpa K. Schum.	
Pycnanthus	*angolensis* (Welw.) Warb.	Myristicaceae
Quassia	*undulata* (Guill. & Perr.) D. Dietr.	Simaroubaceae
Rhizophora	*mangle* L.	Rhizophoraceae
	racemosa G.F.W. Mey	
Rhodognaphalon	*brevicuspe* (Sprague) Roberty	Bombacaceae
Ricinodendron	*heudelotii* (Baill.) Pierre ex Pax	Euphorbiaceae
Sacoglottis	*gabonensis* (Baill.) Urb.	Humiriaceae
Scottellia	*chevalieri* Chipp	Flacourtiaceae
	coriacea A. Chev. ex Hutch. & Dalz.	
Sterculia	*oblonga* Mast.	Sterculiaceae
	rhinopetala K. Schum.	
	tragacantha Lindl.	
Strombosia	*glaucescens* Engl.	Olacaceae
	pustulata Oliv.	
Symphonia	*globulifera* L. f.	Guttiferae
Terminalia	*ivorensis* A. Chev.	Combretaceae
	superba Engl. & Diels	
Tetraberlinia	*tubmaniana* J. Leónard	Leguminosae (Caes.)
Tieghemella	*heckelii* (A. Chev.) Roberty	Sapotaceae
Triplochiton	*scleroxylon* K. Schum.	Sterculiaceae
Turraeanthus	*africanus* (Welw. ex DC.) Pellegr.	Meliaceae
Uapaca	spp., including	Euphorbiaceae
	corbisieri De Wild.	
	guineensis Muell. Arg.	
	heudelotii Baill.	
	paludosa Aubrév. & Léandri	
Vitex	*micrantha* Gürke	Verbenaceae
Xylopia	*aethiopica* (Dunal) A. Rich.	Annonaceae
	quintasii Engl. & Diels	
	staudtii Engl. & Diels	

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