Handbook of 25 timber species from Bhutan

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Introduction

Bhutan is known for its traditional houses, which are made mainly of timber. It has taken generations of experience for the craftsmen who build them to acquire their arts and skills. The techniques used in house-building depend very much on the quality and workability of the timber, and although other timber species might be able to meet the rigid demand, people confine themselves to species they know. Thus, the increase in demand for timber as living standards improve is leading to over-exploitation in certain forests.

The forest products of Bhutan have recently become available on the international market. However, since many of the timber species are unknown to the rest of the world, they have no market, or only a limited one, outside the country.

Also, all the local wood-based industries are based on imported technology, and it is difficult to determine the local equivalent of the species for which the technology was originally devised. The country also produces a lot of timber for which no industrial uses have been found.

It therefore is imperative that all the important timber species should be tested to obtain information on their physical and mechanical properties, including durability and workability. Such information would allow consumers to be certain of buying the right timber for particular uses. It would ultimately improve the utilization of timber within the country, expanding existing markets and broadening the scope of the market for Bhutanese timber. It would also help to achieve value added for an important natural resource and to promote the industrialization process in general.

The results of a literature survey of the properties of 25 species of Bhutanese timber, together with observations of samples, are brought together in this Handbook, *which will, it is hoped, add to the limited knowledge that exists in this important field. The study was carried out by Wong Wing-Chong, Ani Sulaiman and Lim Seng-Choon of the Forest Research Institute of Malaysia under the supervision of the United Nations Industrial Development Organization (UNIDO) within project BHU/80/014, executed by the Food and Agriculture Organization of the United Nations (FAO) and funded by the United Nations Development Programme (UNDP).*

I. Nomenclature

In scientific investigation, botanical names are used to avoid confusion about the identity of the timber being tested. However, a botanical name is not suitable for trade use: the people involved in the processing, trade and use of the timber require a simpler name that can easily be remembered. For important commercial timber that is widely traded internationally, each species or group of species is given a standard name for ease of marketing. The standard trade names of many species are better known and more widely used than their botanical names.

Bhutan has not so far been an important supplier of timber and timber products, and its timbers are not well known in the trade. For the purpose of preparing this *Handbook* based mainly on a bibliographic survey, standard names have had to be proposed for each of the 25 species. The authors have selected the name for a species based on the following considerations:

(a) If the same species or other species within the same genus is being marketed under a standard name by other countries, this name is preferably adopted for the Bhutanese species. For species whose properties differ from those of counterparts in other countries, the name is preceded by the word Bhutan;

(b) If a species is not being marketed under a standard name, the standard species names in Indian Standard IS:1150-1976 are considered appropriate for similar Bhutanese species, not only because Bhutan is close to India geographically but also because many of the Bhutanese timber species are also found in India;

(c) If a species is not being traded and has no standard name and if no name can be found for it in Indian Standard IS:1150-1976, a distinctive local name should be used;

(d) For *Michelia champaca*, *Michelia excelsa* and *Alcimandra cathcartii*, the Bhutanese trade names have been adopted as their standard names and separate data sheets have been prepared for each species. However, the differences among them may not be conspicuous enough to warrant marketing them separately. For most practical purposes, the people who handle, trade and use these three species cannot differentiate them readily.

For easy reference, the botanical names of 25 timbers of Bhutan are listed in alphabetical order in table 1, together with the suggested standard names and other equivalent names. The standard names are listed alphabetically in table 2, together with the botanical names.

Table 1. Botanical names and suggested standard names of Bhutanese timbers

Data sheet No.	*Botanical name*	*Suggested standard name*	*Other equivalent names*
Hardwood timbers			
1	*Acer campbellii* Hook. f. et Thoms.	Himalayan maple	Sycamore (UK) Chalam (Dz) Sermaling-shing (Sha)
2	*Alnus nepalensis* Don.	Alder/gama	Nepal alder (Nep) Alder (UK) Aulne (F) Els (N) Erle (G) Gama-shi (Dz) Gamoshing (Sha)
3	*Beilschmiedia sikkimensis* King.	Tarsing	Medang (Mal) Kanda (Af) Tarsing (Nep) Golong-shing (Sha)

Table 1. ***(continued)***

Data sheet No.	Botanical name	Suggested standard name	Other equivalent names
Hardwood timbers (continued)			
4	*Betula alnoides*	Birch/tap	Birch (a common name for the timber of *Betula* spp.) Tab (Dz) Chhar-shing (Sha)
5	*Castanopsis* spp.	Chestnut/sokay	Berangan (Mal) Philippine chestnut (P) Saninten (I) Kor (T) American chestnut (NA) Sweet chestnut (E) Sokay (Dz) Tshai-shing (Sha)
6	*Cedrela* spp.	Toon/chhun	Toon (Ind) Limpaga, surian (Mal) Kalantas (P) Yom-hom (T) Thiakado (My) Cedar (usùally qualified by the country or region of origin, e.g. Central American cedar) Chhuen (Dz) Rawa-shing (Sha)
7	*Daphniphyllum* spp.	Lal chandan/jurooshing	Lal chandan (Nep) Jurooshing (Dz) Aawa-shing
8	*Elaeocarpus varunua* Ham.	Bhadrasi/gasha-thung-shing	Sengkurat, mendong (Mal) Jenitri (I) Mun (T) Rudrak (Ind) Gasha-thung-shing (Sha)
9	*Exbucklandia populnea* R. W. Brown (Syn. *Bucklandia populnea* R. Br.)	Pipli/lemshing	Pipli (Ind and Nep) Gerok (Mal) Lemshing (Sha)
10	*Juglans regia* Linn.	Bhutan walnut	Walnut (usually named after country or region of origin, e.g. Japanese walnut, European walnut) Thitcha (My) Tashing (Dz) Khey-shing (Sha)
11	*Litsea* spp.	Bhutan medang	Medang (Mal) Nengshing (Sha)
12	*Machilus edulis* (Syn. *Persea fruti-fera*)	Kawla	Machilus (Ind) Seiknanggi (My) Kulilisiau (P) Pak hoi (C) Golee-shing (Sha)
13	*Machilus gammieana* King	Phamphal	Machilus (Ind) Kulilisiau (P) Seiknangyi (My) Pau hoi (C)
14	*Alcimandra cathcartii* Hook. f. & Th.	Tite champ	Champ (Ind) Chempaka (Mal) Kala champ, titi champ (Nep)
15	*Michelia champaca* Linn.	Aule champ	Champ, chempaka (Ind) Chempaka (Mal) Kala champ, titi champ (Nep) Kha-shi (Dz) Kar-shing or Chhampay-shing (Sha)

Table 1. ***(continued)***

Data sheet No.	*Botanical name*	*Suggested standard name*	*Other equivalent names*
16	*Michelia excelsa* Blume ex wall. (Syn. *M. doltsopa* Buck. Ham ex DC)	Rani champ	Chempaka (Mal) Champa (T) Champ, champak (Ind) Sandit (P) Bara champ, champ, safed champ, seti champ, seto champ (Nep)
17	*Nyssa javanica* (Bl.) Wang (Syn. *N. sessiliflora* Hook f. et Th.)	Nyssa	Nyssa (NA and Asia) Tupelo (NA) Blackgum (NA) Nyssa, gahori sopa (Ind)
18	*Prunus nepalensis* Hook. f.	Cherry	Nepalese cherry, arupate, likh-aru (Nep) Cherry (a well-known name for the genus *Prunus*)
19	*Quercus* spp.	Oak	Mempening (Mal) Oak (a popular name for the timber of the genus *Quercus*)
20	*Schima wallichii* Choisy	Chilauni/puyam	Chilauni (Ind) Samak (Mal) Puspa (I) Mang-tarn (T) Puyam (Dz) Zala-shing (Sha)
21	*Symplocus* spp.	Kharane	Lodh, podipari (Ind) Kharani, chamlani (Nep)
Softwood timbers			
22	*Larix griffithiana* Hook. f. and Th.	Larch	Japanese larch (J) Zashi (Dz)
23	*Picea spinulosa*	Spruce	Himalayan spruce (Ind) Ba-shi (Dz) Spruce (a popular name for the timber *Picea*)
24	*Pinus wallichiana* (Syn. *Pinus excelsa* (wall) A. B. Jack)	Blue pine	Kail (Ind) Tongphu (Dz) Chang-shing (Sha)
25	*Tsuga brunoniana* Carr. (Syn. *Tsuga dumosa* (D. Don) Eichl)	Hemlock	Hemlock (Ind) Sey-shi (Dz)

Notes:

Af	=	Africa
C	=	China
Dz	=	Dzongkhag (Bhutan)
E	=	Europe
F	=	France
G	=	Germany
I	=	Indonesia
Ind	=	India
Mal	=	Malaysia
My	=	Myanmar
N	=	Netherlands
NA	=	North America
Nep	=	Nepal
P	=	Philippines
Sha	=	Shachop (Bhutan)
T	=	Thailand
UK	=	United Kingdom

Table 2. Suggested standard names of Bhutanese timbers and corresponding botanical names

Data sheet No.	Suggested standard name	Botanical name
Hardwood		
1	Himalayan maple	*Acer campbelli*
2	Alder/gama	*Alnus nepalensis*
3	Tarsing	*Beilschmiedia sikkimensis*
4	Birch/tap	*Betula alnoides*
5	Chestnut/sokay	*Castanopsis* spp.
6	Toon/chhun	*Cedrela* spp.
Hardwood (continued)		
7	Lal Chandan/jurooshing	*Daphniphyllum* spp.
8	Bhadrasi/gashthungshing	*Elaeocarpus varunua*
9	Pipli/lemshing	*Exbucklandia populnea/Bucklandia populnea*
10	Bhutan walnut	*Juglans regia*
11	Bhutan medang/nenshing	*Litsea* spp.
12	Kawla	*Machilus edulis*
13	Phamphal	*Machilus gammieana*
14	Tite champ	*Alcimandra cathcartii*
15	Aule champ	*Michelia champaca*
16	Rani champ	*Michelia excelsa*
17	Nyssa	*Nyssa javanica/Nyssa sessiliflora*
18	Cherry	*Prunus nepalensis*
19	Oak	*Quercus* spp.
20	Chilauni/puyam	*Schima wallichii*
21	Kharane	*Symplocus* spp.
Softwood		
22	Larch	*Larix griffithiana*
23	Spruce	*Picea spinulosa*
24	Blue pine	*Pinus wallichiana/Pinus excelsa*
25	Hemlock	*Tsuga brunoniana/Tsuga dumosa*

II. Explanation of the data sheets

A data sheet has been prepared for each of the 25 species from Bhutan. Together, data sheets 1-25 form the annex to the *Handbook*. The preparation of such sheets on the basis of published information alone is a difficult task. Bhutan has not done any tests to establish the properties of these species. Moreover, only a little information is available elsewhere concerning the properties of Bhutanese timbers and it is scattered and reported in various publications. Because Bhutan is close to India, publications from India provide much of the information used in the *Handbook*.

It has to be recognized that accuracy is sacrificed when the properties of the same species or other species of the same genus from other countries are used for classifying Bhutan species. The accuracy of the data in this *Handbook* is further compromised when data from different sources have to be used for the preparation of the data sheets.

Data collected from different sources are not strictly comparable, as different institutes tend to have different testing methods or procedures. For instance, a species that has been classified as non-durable under Indian conditions might be classified as moderately durable if tested under less hazardous conditions. The sizes of the samples used also have a bearing on the results reported in different publications. This *Handbook* should be read and used with this limitation in mind. The data given should be accepted as an indication of the properties of Bhutanese timbers and not as a statement of their actual properties, which can only be determined by actual tests.

The *Handbook* brings together all available information on the 25 species and identifies data that are lacking. For a more authoritative treatise, tests to establish the properties of Bhutanese timbers would need to be carried out. The tests could be done in Bhutan if a testing laboratory were to be established, or they could be contracted out to a research organization in the region. Only by adopting standardized evaluation procedures for the 25 species could the data reported in the *Handbook* be made fully comparable to one another.

In comparison with the Malaysian experience in compiling the book *100 Malaysian Timbers* [1], the compilation of this *Handbook* was more difficult. In the case of *100 Malaysian Timbers*, data were available that had been obtained by subjecting the timbers to standard testing procedures. It then became relatively easy to place each of the timbers into the appropriate strength, durability and treatability classes, once the limits for each class had been established. Such a straightforward practice could not be adopted herein. As a consequence, many of the data sheets have several gaps. If a timber could not readily be placed in a durability or treatability class, a relevant comment from the literature was provided instead.

A standard format has been adopted for the data sheets. For each species, two coloured photographs show the tangential and radial grain patterns. A photomicrograph of the cross-section is also given, although it is not common practice to include such photomicrographs in a handbook of timber species. Since information on Bhutanese timbers is sparse, it was felt that the inclusion of photomicrographs would extend the usefulness of the *Handbook*, by facilitating the identification of the 25 species with the use of a simple hand lens.

Nomenclature and distribution

As explained in chapter I, a standard name for each species has been proposed based on certain criteria and is suggested as the trade name for the particular species. It is this name that is shown at the top of each data sheet in the annex. The Bhutanese trade name is the trade name currently used in Bhutan and may eventually change. The botanical name is the scientific name of the timber, including family, genus and species.

The entry under "distribution" lists the areas besides Bhutan where a particular species can also be found.

General description

Various types of information are given under the heading "general description". The colour of the timber, especially any difference in colour between heartwood and sapwood, is mentioned first.

The grain of the timber is then described using words such as straight, wavy or interlocked. The texture of the timber is usually described as fine, medium or coarse and even or uneven. These descriptions may be further qualified by using such words as very and moderately.

The anatomical features of the timbers are given next. The size, number and distribution of vessels, tracheids, parenchymatous tissues, rays and resin canals (if any) are described. If these rather detailed

descriptions of anatomical features are read with care and with reference to the photomicrograph, the information is sufficient to allow identification of the species.

The general descriptions are mostly the work of the authors, who prepared them after having examined the wood samples.

Physical properties

Information on air-dry density, shrinkage and seasoning are provided under the heading "physical properties". The air-dry density at 12 per cent moisture content (MC) is given in both metric and imperial units. When data on density at another moisture content are the only data available, they may be corrected to 12 per cent MC using the following example: If the density of timber A at 18 per cent MC is 1,000 kg/m^3, its density at 12 per cent MC is

$$\frac{1{,}000 \times 1.12}{1.18} = 949$$

For the few species whose air-dry densities are not reported in the literature, these densities were determined at the Forest Research Institute Malaysia, using wood samples from Bhutan.

Shrinkage values from green to air-dry in the radial and tangential directions are given if such information was available. For many species from Bhutan, however, no such information is available, and values must be established through experimentation (see chapter III for shrinkage class limits).

The ease with which a species can be seasoned is also mentioned, together with information on the presence of drying degrade. If other information on proper seasoning practice for a Bhutanese species is available, it is included.

Mechanical properties

For many species from Bhutan, no detailed mechanical properties are available. For some species, there are no data on mechanical properties at all. In such circumstances, the authors provisionally assigned a timber to an appropriate strength group, which is placed in parentheses to show that data from another species of the same genus having similar density have been used. The strength groups S1-S7 are those given in Australian Standard SAA MP45-1979, which is explained by Keating and Bolza [2]. The minimum standard strength data used for classifying timbers into strength groups are given in table 3.

Data on static bending, compression or shear are not generally available for timbers from Bhutan. However, published data for the same species of another provenance or for another species of the same genus are given in parentheses.

A species whose strength properties are not known is placed provisionally in a particular strength group based on its density, according to Australian Standard SAA MP45-1979 (table 4).

Table 3. Minimum standard strength classification, based on small clear specimens

Strength group	Moisture condition	Properties (MPa)[a]			
		Modulus of rupture	Modulus of elasticity x 10^3	Maximum crushing strength	Maximum shear strength
S1	Green	103.0	16.3	52.0	13.1
	12%[b]	158.0	18.7	81.0	18.7
S2	Green	86.0	14.2	43.0	11.0
	12%[b]	134.0	16.3	71.0	16.7
S3	Green	73.0	12.4	36.0	9.1
	12%[b]	114.0	14.2	62.0	15.0
S4	Green	62.0	10.7	31.0	7.7
	12%[b]	94.0	12.4	53.0	15.0
S5	Green	52.0	9.1	26.0	6.5
	12%	79.0	10.7	46.0	11.7
S6	Green	43.0	7.9	22.0	5.5
	12%[b]	67.0	9.1	40.0	10.3
S7	Green	36.0	6.9	18.0	4.6
	12%	57.0	7.9	34.0	9.1

Source: W. C. Keating and E. Bolza, *Characteristics, Properties and Uses of Timbers: South East Asia, Northern Australia and the Pacific* (Melbourne, Commonwealth Scientific and Industrial Research Organization, 1982).

[a] 1 megapascal = 1 N/mm^2 = 145 lbf/in^2 = 10.2 kgf/cm^2.

[b] Seasoned values estimated from corresponding green values.

Table 4. Assignment of a species to a strength group on the basis of air-dry density

Strength group	Air-dry density at 12 per cent moisture content (kg/m³)
SD1	1 200
SD2	1080
SD3	960
SD4	840
SD5	730
SD6	620
SD7	520
SD8	420

Durability

In countries where the natural durability of the timbers has been tested to determine the number of years a timber can last under established exposure conditions, it is easy to classify the timbers into various durability classes. Such information is not available for Bhutanese timbers, and their durability is only occasionally referred to in the literature. Under "durability", it is only possible to quote such observations, and until further data are generated, the 25 species from Bhutan cannot confidently be placed into durability classes.

Treatability

The rate at which a cubic metre of a timber absorbs preservative under standardized conditions serves as a measure of its treatability. In countries where the rates of preservative absorption of timbers have been established by tests, the timbers can be readily placed into appropriate treatability classes. No data on treatability are available for Bhutanese timbers. The relative ease with which a few species absorb preservative has occasionally been mentioned in the literature, and these mentions are cited on the data sheets.

Working properties

The working properties of timbers from Bhutan have not been properly assessed. In most cases, it is not possible to say whether a timber is easy or difficult to plane, to bore, to turn or to nail and whether the finish of the timber thus processed is smooth or rough. However, some information on the working properties of certain Bhutan timbers is available in the literature, although it is not comprehensive enough to enable the authors to state definitively how these timbers perform. When relevant statements on the working properties of Bhutanese timbers have been found, they are quoted.

Uses

Information on the suitability of each of the 25 Bhutanese timbers for various uses is generally available. It is assumed that they can be used more or less in the same applications as the same species found in other countries, where more information is available.

III. Summary of data on Bhutanese timbers

Detailed information on the timbers of Bhutan is given in data sheets 1-25 (annex). The sheets have been arranged as follows: within the two overall categories "hardwoods" and "softwoods", the species have been placed in the alphabetical order of their botanical names.

A summary of the important data has been prepared for ease of reference and comparison (table 5). The table is arranged in the same order as the data sheets, from which key information has been extracted.

In the table, a species is said to have low, medium, upper, high/very high or exceptionally high density depending on its density range (kg/m^3) [3]:

Low	300-500
Medium	500-650
Upper	650-725
High/very high	725-1,000
Exceptionally high	above 1,000

The 25 Bhutanese timbers are considered to have large, medium or low shrinkage from green to air-dry conditions depending on the sum of their radial and tangential shrinkage: large, >4.5 per cent; medium, 3.5-4.5 per cent; and small, < 3.5 per cent.

The suitability of each species in four areas of use has also been included in table 5, following the method adopted by Hansom in classifying the market for sawn hardwood in the United Kingdom [3]. An area of use labelled "special" has been added to indicate the suitability of the species for special uses such as match splints, toys, drawing boards, ladder stock and pencils. Each species is therefore placed in one of five use classes: decorative (D); special (Sp); lighter (low/medium density) utility (LU); heavier (upper/high density) utility (HU); and constructional (C).

For the purposes of the table, a species is said to be suitable for decorative use if it has the colour, grain, texture and ability to accept good finishes, such that it can be used for making products like furniture and joinery items, where the natural beauty of the wood will be brought out. It may be used decoratively in solid form or as sliced veneers.

A species is said to be suitable for use as a utility timber if it possesses adequate strength; ease of drying with limited degrade and shrinkage; and reasonably good woodworking properties. A higher density timber with better mechanical properties may be used as a heavier utility timber, whereas a timber with low to medium density qualifies as a lighter utility timber.

Two criteria are used to assess the suitability of a species for structural use: good strength properties and high natural durability. If the timber does not have sufficient natural durability, it must be treatable with preservative to make it last as long as structural timbers with acceptable natural durability. A species may also be considered suitable for structural use if it is generally used for construction in Bhutan or other countries that do not demand high-quality constructional timber.

Table 5. Summary of the characteristics and properties of Bhutanese timbers

Data sheet No.	Botanical name (suggested standard name)	General characteristics	Density at 12% MC (kg/m³)	Provisional strength group		Durability	Treatability	Shrinkage	Use class[a]					References
				Green	Air-dry				D	Sp	LU	HU	C	
		HARDWOOD TIMBERS												
1	*Acer campbellii* (Himalayan maple)	Sapwood white with a slight reddish brown tinge; heartwood white ageing to light greyish brown or reddish brown. Grain straight or wavy. Texture fine and even.	595		(SD5)	Moderately durable under cover	Difficult		+	+	+			[4]-[8]
2	*Alnus nepalensis* (alder/gama)	Sapwood white or almost white. Heartwood reddish white to light brownish grey. Texture medium and even with fairly straight grain.	595		(SD7)	Non-durable	Moderately permeable				+			[1], [3], [9], [10] and [11]
3	*Beilschmiedia sikkimensis* (tarsing)	Sapwood pinkish to yellowish and clearly defined from the heartwood, which is pinkish brown to reddish brown or darkish brown. Texture fine to medium and even with straight grain.	560		(SD5)	Durable			+	+	+			[12]-[15] and [21]
4	*Betula alnoides* (birch/tap)	Sapwood white and generally distinct from heartwood, which is light greyish brown or grey and often with a faint purplish cast. Irregular in contour. Lustrous on radial surface. Texture moderately fine and even with straight grain.	515-555	(S5)	(SD4)	Moderately durable under cover in India; European birch has been classified as perishable		Large	+		+			[4], [5], [7], [11] and [16]
5	*Castanopsis* spp. (chestnut/sokay)	Sapwood pale yellowish white, broad and not distinct from heartwood, which is light greyish yellow to light greyish brown; lustrous when fresh. Texture is medium to coarse and uneven with irregular and interlocked grain.	640-670	(S4)		Moderately durable	Very difficult	Large	+			+		[5], [8], [9], [11] and [15]
6	*Cedrela* spp. (toon/chhun)	Sapwood pinkish or greyish white and sharply defined from heartwood, which is light brick red to rich reddish brown, usually with darker streaks on radial surface. Texture moderately coarse and uneven with straight to wavy grain.	595		(SD7)	Non-durable	Heartwood partially treatable	Medium	+		+			[6], [8], [10] and [14]-[18]
7	*Daphniphyllum* spp. (lal chandan/jurooshing)	Sapwood white; heartwood greyish brown with occasional streaks of bright crimson. Texture fine and even with straight grain.	570		(SD7)						+			[12] and [19]

Data sheet No.	Botanical name (suggested standard name)	General characteristics	Density at 12% MC (kg/m³)	Provisional strength group		Durability	Treatability	Shrinkage	Use class[a]					References
				Green	Air-dry				D	Sp	LU	HU	C	
HARDWOOD TIMBERS *(continued)*														
8	*Elaeocarpus varunua* (bhadrasi/gashthungshing)	Sapwood white to greyish white; heartwood yellowish to greyish brown often with an olive tinge; lustrous. Texture fine and even with straight, wavy, curly or interlocked grain.	450-795	(S6)	(SD7)	Non-durable	Difficult		+	+	+			[6], [18], [21] and [24]
9	*Exbucklandia populnea*/ *Bucklandia populnea* (pipli/lemshing)	Sapwood not distinct from heartwood. Wood light reddish brown to brown or greyish brown; dull to somewhat lustrous especially on the radial surface; smooth feel. Texture very fine and even with shallowly interlocked grain.	640		(SD6)	Very durable under cover			+		+		+	[6], [12], [15], [21] and [22]
10	*Juglans regia* (Bhutan walnut)	Sapwood wide and greyish white in colour and clearly defined from the heartwood, which is greyish brown with few or no markings or with darker streaks. Texture medium and even with straight grain.	530		(SD7)	Moderately durable	Difficult	Large	+		+		+	[1], [5], [10], [11] and [14]
11	*Litsea* spp. (Bhutan medang)	Sapwood not distinct from heartwood, which is yellowish grey or olive grey to olive brown or greyish brown, generally with darker lines indicating seasonal increments; lustrous when fresh but becoming dull with age. Texture medium and quite even with fairly straight or somewhat wavy grain.	690	(S6)		Tested in India to be durable, but the Malaysian species have been found to be non-durable under exposed conditions	Difficult	Medium	+			+	+	[8], [14] and [15]
12	*Machilus edulis* (kawla)	Pale red and pinkish brown with occasional darker streaks. Grain straight to shallowly interlocked. Texture fine and even.	740	(S5)-(S6)		Expected to be durable under cover						+	+	[3], [8], [9], [11] and [15]
13	*Machilus gammieana* (phamphal)	Pale yellowish or roseate grey when fresh, ageing to light grey or pinkish grey. Core wood pale red and pinkish brown with occasional darker streaks. Texture fine and even with straight grain.	560	(S5)-(S6)		Tested in India and found to be very durable under cover			+		+		+	[3], [8], [9], [11] and [15]
14	*Alcimandra cathcartii* (tite champ)	Sapwood white to greyish white: heartwood yellowish olive green to olive brown or pale brown. Texture fine and even with straight grain.	480		(SD5)	No data available; probably durable under cover	Difficult		+	+	+		+	[3], [8], [9], [11], [15], [17], [20] and [21]

Table 5. (*continued*)

Data sheet No.	Botanical name (suggested standard name)	General characteristics	Density at 12% MC (kg/m³)	Provisional strength group		Durability	Treatability	Shrinkage	Use class[a]					References
				Green	Air-dry				D	Sp	LU	HU	C	
15	*Michelia champaca* (aule champ)	Sapwood not distinct from heartwood. Wood light reddish brown to brown or greyish brown; dull to somewhat lustrous, especially on the radial surface; smooth feel. Texture very fine and even with shallowly interlocked grain.	640		(SD6)	Very durable under cover			+		+		+	[3], [8], [9], [11], [15], [17], [20] and [21]
16	*Michelia excelsa* (rani champ)	Sapwood white or greyish white; heartwood greenish yellow to olive brown. Texture medium and even with straight grain.	560-590		(SD5)	Durable under cover; the chempaka of Malaysia is only moderately durable		Large	+	+	+		+	[3], [8], [9], [11], [15], [17] and [20]
17	*Nyssa javanica/ Nyssa sessiliflora* (nyssa)	Sapwood pale yellow white ageing to light yellow brown; greyish brown or light brown; heartwood not distinct; surface somewhat lustrous. Texture moderately fine and even with straight or shallowly interlocked grain.	625		(SD6)	Durable under cover in India; however, the nyssa in Malaysia and North America are reported to be susceptible to fungi and insect attack				+	+			[1], [10], [11] and [23]
18	*Prunus nepalensis* (cherry)	Sapwood white to pale pinkish white; heartwood pale red to deep red, reddish or greyish brown or brown. Texture fine to medium coarse and even with straight or wavy grain.	544-720 (av. 630)		(SD6)	Durable in India; however, the cherry elsewhere has been reported to be only moderately durable		Large	+	+	+			[4], [5], [10], [11], [21] and [22]
19	*Quercus* spp. (oak)	Sapwood not differentiated from heartwood; ranges from yellowish grey, grey to light pinkish brown or reddish brown, becoming appreciably darker with age. Texture medium fine and uneven with straight, interlocked, irregular or wavy grain.	865	(S1)	(SD2)	Moderately durable to durable depending on species		Large	+			+	+	[4], [8], [11], [17], [18] and [22]
20	*Schima wallichii* (chilauni/puyam)	Sapwood dirty white to greyish white; heartwood light red to light reddish brown, sometimes with broad and straight darker bands. Texture moderately fine and even with straight or irregular grain.	735	(S4)	(SD4)	Durable under cover; reported to be non-durable in Malaysia	Difficult	Large				+	+	[9], [11], [15], [16] and [18]
21	*Symplocus* spp. (kharane)	Sapwood and heartwood not differentiated. Wood white when fresh, turning uniform pale yellow or pale yellowish brown or reddish grey on ageing. Texture fine and even with straight or interlocked grain.	512-784		(SD7)-(SD5)				+	+	+			[3], [21] and [23]

Data sheet No.	Botanical name (suggested standard name)	General characteristics	Density at 12% MC (kg/m³)	Provisional strength group		Durability	Treatability	Shrinkage	Use class[a]					References
				Green	Air-dry				D	Sp	LU	HU	C	
			SOFTWOOD TIMBERS											
22	*Larix griffithiana* (larch)	Sapwood light-coloured and sharply defined from the heartwood, although sapwood not observed in the sample provided. Heartwood pale reddish brown to brick red.	490	(S5)	(SD5)				+		+		+	[1], [7], [10], [21] and [24]-[28]
23	*Picea spinulosa* (spruce)	No distinction between sapwood and heartwood except in large trees, where the core wood and the butt may be dull red in colour. The timber is white when first exposed, turning greyish brown with age; no characteristic odour or taste. Texture medium fine and even with straight grain.	464		(SD6)	Non-durable	Difficult	Large	+	+	+			[9], [11], [14] and [17]
24	*Pinus wallichiana/Pinus excelsa* (blue pine)	Sapwood whitish and heartwood light pinkish red to light red and fairly lustrous. Texture medium fine with fairly straight grain.	515		(SD7)	Non-durable	Easy		+		+		+	[11], [14], [17] and [28]
25	*Tsuga brunoniana/Tsuga dumosa* (hemlock)	Light-coloured wood with a pinkish tinge; soft and light in weight. Texture medium fine and even with generally straight grain.	464	(S5)		Moderately durable	Medium		+		+			[9], [12] and [21]

[a]D= Decorative; Sp = special (match splints, toys, drawing boards, ladder stock, pencils etc.); LU = light utilities; HU = heavy utilities; C = construction.

Annex

Data sheets for 25 species of timber from Bhutan

Data sheet 1

HIMALAYAN MAPLE

BHUTANESE TRADE NAME

Kapasi

BOTANICAL NAME

Aceraceae
Acer campbellii, Hook. f. and Thoms.

DISTRIBUTION

Sikkim and the eastern Himalayas, including Bhutan, at 2,100-3,000 m.

GENERAL DESCRIPTION

Sapwood wide, white with a slight reddish brown tinge; heartwood white, ageing to light greyish brown or reddish brown.

Grain straight or wavy. Texture fine and even.

Growth rings distinct, delimited by sharp, narrow, brown lines.

Vessels small to very small and not visible to the naked eye. Solitary or in radial rows of 2-6.

Wood parenchyma consists of terminal bands; scanty paratracheal parenchyma cells and diffuse strands of apotracheal parenchyma cells.

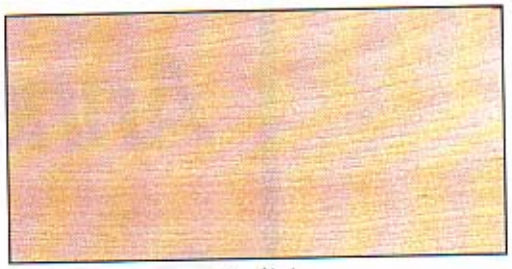
Rays not visible to the naked eye; fine, straight and variable in width, with the wider separated by narrower rays, 4-12 per mm. Conspicuous on radial surface as attractive flecks.

PHYSICAL PROPERTIES

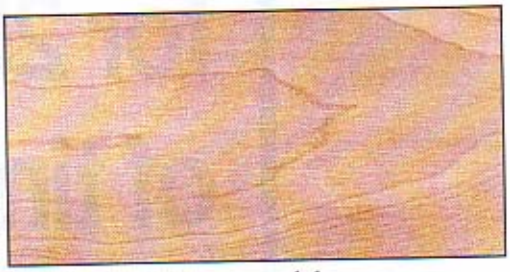
Air-dry density: 595 kg/m^3 (37 lb/ft^3) at 12% MC.
Shrinkage*
Radial: 2.5%
Tangential: 5.2%
Seasoning: Not refractory to season. The best results are by green conversion in which cracking, splitting and twisting are minimal.

MECHANICAL PROPERTIES (AIR-DRY)

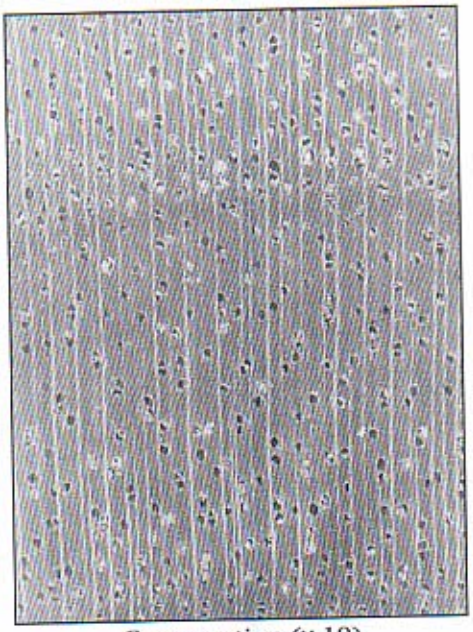
Strength group: (SD5)**
Static bending, MPa
MOE: (10.1 x 10^3)
MOR: (108)



Radial



Tangential



Cross-section (x 10)

*Data for *Acer pseudoplatanus*.

***Acer pseudoplatanus* from Europe, which has similar density (673 kg/m^3), is not quite as strong as European beech. The assignment of the Himalayan maple to this strength group is based on this similarity to beech.

Compression strength, MPa

Perpendicular to grain: (9.41)
Parallel to grain: (51.8)

Shear strength, MPa (16.2)

Durability

Moderately durable under cover.

Treatability

Difficult.

Working properties

Planing: good	Finish: good
Turning: good	Finish: good

The timber saws and machines well. In a lathe it cuts with great ease, coming off in long shavings, and it can be classed as a fine turnery wood of the softer kind.

Uses

Suitable for planking and tea chests, turnery articles (e.g. cotton reels, toys, wooden egg cups and bread rollers), wooden platters, decorative panelling and flooring.

Equivalent wood

Sycamore (*Acer pseudoplatanus*)	United Kingdom
Himalayan maple	India

References

[4]-[8].

Data sheet 2

ALDER

BHUTANESE TRADE NAME

Utish (alder)

BOTANICAL NAME

Betulaceae
Alnus nepalensis Don

DISTRIBUTION

From Sutlej eastwards to Bengal, Khasia hills, Shan states and Kachin hills of Myanmar. Also found in Kashmir.

GENERAL DESCRIPTION

Sapwood white or almost white. Heartwood reddish white to light brownish grey.

Grain fairly straight. Texture medium and even.

Growth rings present but relatively inconspicuous.

Vessels quite evenly distributed; medium sized to small or very small; occasionally solitary, radial rows of 2-5; tyloses wanting.

Wood parenchyma consists of both the paratracheal and apotracheal types.

Paratracheal parenchyma restricted to occasional cells and apotracheal parenchyma as scattered cells in the fibres and rarely forming short tangential lines; terminal parenchyma fairly abundant.

Rays are of two types, simple and aggregate. Simple rays not conspicuous whereas aggregate rays plainly visible to the naked eye.

PHYSICAL PROPERTIES

Air-dry density: 595 kg/m^3 (37 lb/ft^3) at 12% MC.
Shrinkage*

Radial: green to oven dry (2.1-4.0%)
green to 12% MC (1.1-3.0%)

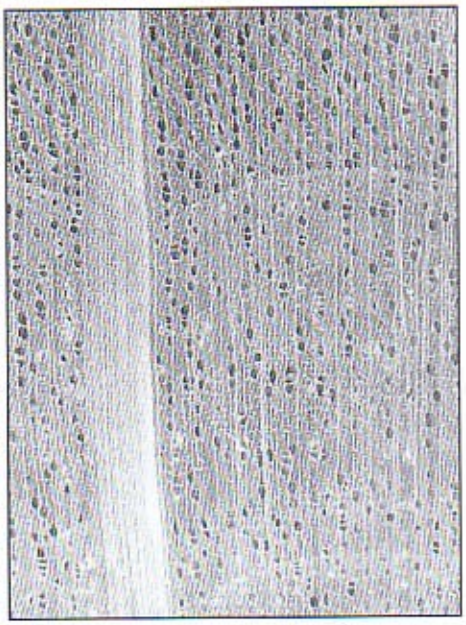
Tangential: green to oven dry (3.6-6.5%)
green to 12% MC (2.6-5.5%)

Seasoning: Seasons fairly well and not liable to warp but has a tendency to develop stain if care is not taken.

*Data for *A. formosana*.

Radial

Tangential



Cross-section (x 10)

Mechanical properties (air-dry)

Strength group: (SD7)*
Static bending, MPa

MOE: N.A.
MOR: (35.6)

Compression strength, MPa

Perpendicular to grain: N.A.
Parallel to grain: (17.0)

Shear strength: N.A

Durability

Not durable if exposed to weather but fairly so under cover.

Treatability

Tests on Formosan alder indicate that sapwood is permeable whereas heartwood is only moderately permeable.

Working properties

Easy to saw and finish by hand or on machines to a smooth, shiny surface. It is said not to hold nails well.

Uses

Suitable for tea chests, carpentry, core veneer, match boxes, panelling and building construction.

Equivalent wood

Nepal alder	Nepal
Alder	United Kingdom and India
Aulne	France
Els	Netherlands
Erle	Germany

References

[1], [3], [9], [10] and [11].

*Based on data from the same timber tested elsewhere, alder has no reputation for strength, being comparable to poplar in general strength properties, although a little harder and rather more resistant in shear. It is classed here as SD7 based on the strength values of *Alnus nepalensis* from Nepal as reported in *Journal of the Timber Development Association* (India).

Data sheet 3

TARSING

BHUTANESE TRADE NAME

Tarsing

BOTANICAL NAME

Lauraceae
Beilschmiedia sikkimensis King.

DISTRIBUTION

Hills of Sikkim and Bhutan, at 1,900-2,400 m. Darjeeling forests and extending probably to Oudh and Kumaon.

GENERAL DESCRIPTION

Sapwood pinkish to yellowish and clearly different from the heartwood, which is pinkish brown to reddish brown or darkish brown.

Grain straight. Texture fine to medium and even.

Growth ring markings appear on plain sawn surfaces as rather subdued, brighter lines.

Vessels moderate to large, very few, single or in small groups.

Wood parenchyma in both apotracheal and paratracheal types; paratracheal type as vasicentric to aliform parenchyma; apotracheal parenchyma as irregularly spaced terminal bands.

Rays very fine, irregularly spaced and rather conspicuous on radial section as small flecks.

PHYSICAL PROPERTIES

Air-dry density: 560 kg/m^3 (35 lb/ft^3) at 12% MC.
Shrinkage*

Radial: (1.8%)
Tangential: (4.1%)

Seasoning: Difficult and slow to dry, with a definite tendency to check seriously and for case hardening to develop. Requires care and protection from hot sun during air drying, followed by carefully controlled kiln drying.

MECHANICAL PROPERTIES (AIR-DRY)

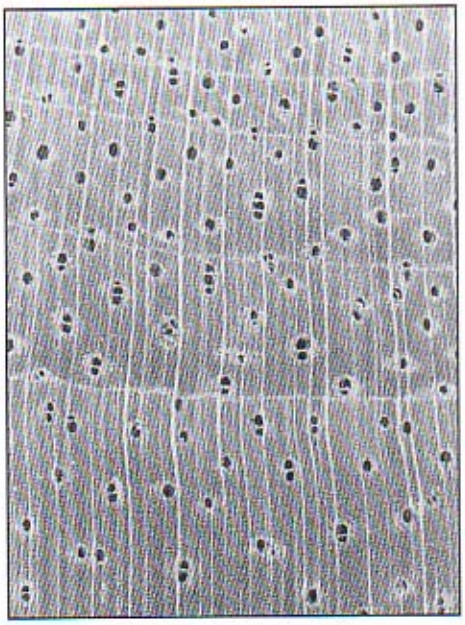
Strength group: (SD5)
Static bending, MPa

MOE: (9.1 x 10^3)
MOR: (52.0)

*Value for *Beilschmiedia kweo* of density between 545 and 735 kg/m^3 and averaging of 655 kg/m^3.

Radial

Tangential



Cross-section (x 10)

Compression strength, MPa

Perpendicular to grain: N.A.
Parallel to grain: (26.0)

Shear strength, MPa: (6.5)

Reported to have good strength properties.

Durability

Durable under cover.

Treatability

No data available.

Working properties

Planing: good	Finish: good
Turning: good	Finish: N.A.
Nailing: good	

Difficult to saw and has a severe blunting effect on cutting edges due to the presence of silica in the wood. It planes, turns and moulds well and is capable of giving a good finish. It has good nailing properties. It is said to peel and slice satisfactorily for veneer.

Uses

Suitable for building purposes, tea chests, joinery, plywood, cabinet work, carving, picture framing and sculpture.

Equivalent wood

Medang	Malaysia
Kanda	Africa
Tarsing	Nepal
Mfimbo	United Republic of Tanzania

References

[12]-[15] and [21].

Data sheet 4

BIRCH

BHUTANESE TRADE NAME

Birch

BOTANICAL NAME

Betulaceae
Betula alnoides D. Don

DISTRIBUTION

From Ravi eastwards through United Provinces, Nepal and Bengal to the Khasia Hills in Assam, at 900-1,500 m elevation and at 1,500-1,800 m in the the Kailin and Shan hills of Myanmar.

GENERAL DESCRIPTION

Sapwood white or almost so, wide and generally distinct from heartwood, which is light greyish red to pinkish grey, ageing to light greyish brown or grey and often with a faint purplish cast, irregular in contour, lustrous on radial surface.

Grain straight. Texture moderately fine and even.

Growth rings distinct, delimited by fine, sharply delineated, light line of terminal parenchyma.

Vessels medium-sized to small and very small; solitary and in radial rows of 2-4 (mostly 2-3) but mostly solitary; perforation scalariform; tyloses wanting.

Wood parenchyma indistinct to the naked eye, diffuse; terminal parenchyma bands distinct to the naked eye on all surfaces.

Rays fine, somewhat darker than the background, forming a fine, inconspicuous fleck on the radial surface.

PHYSICAL PROPERTIES

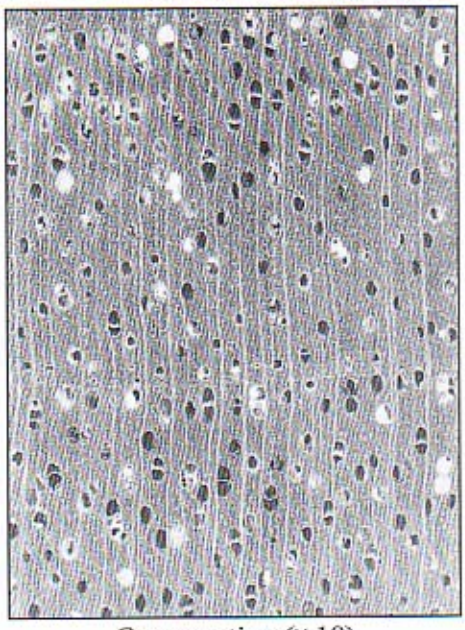
Air-dry density: 515-655 kg/m^3 (32-41 lb/ft^3) at 12% MC.
Shrinkage

Radial: 5.0%
Tangential: 8.0%

Seasoning: Dries easily except slight end splitting; however, European birch tends to warp and is prone to fungal infection.

Radial

Tangential



Cross-section (x 10)

MECHANICAL PROPERTIES

	Green	*Air-dry*
Strength group:	(S5)*	(SD4)*
Static bending, MPa		
MOE:	(9.9×10^3)	(13.3×10^3)
MOR:	(63.0)	(123)
Compression strength, MPa		
Perpendicular to grain:	N.A.	N.A.
Parallel to grain:	(26.3)	(59.9)
Shear strength, MPa	(7.7)	(16.2)

DURABILITY

Moderately durable under cover. However, the European birch has been classified as perishable and susceptible to furniture beetle and pinhole borer attack; it is probably immune to lyctus infestation.

TREATABILITY

Betula verrucosa and B. pubescens have been noted to be amenable to preservative treatment.

WORKING PROPERTIES

The timber is said to be difficult to saw, but with careful handling it gives a very good finish. European birch, however, is said to work relatively easily in most hand and machine operations and it planes and moulds to a good finish; it turns and feels well; it takes all finishes well and glues satisfactorily.

USES

Suitable for construction, cabinets, plywood, high-class furniture and flooring.

EQUIVALENT WOOD

Birch	A common name for the timber *Betula* spp. in the United Kingdom and many other countries.

REFERENCES

[4], [5], [7], [11] and [16].

*Since the strength of *B. alnoides* is not known, the strength values of European birch (*Betula* spp.) tested in the United Kingdom (density at 12% MC = 673 kg/m^3) has been provided here as a guide.

Data sheet 5

CHESTNUT

BHUTANESE TRADE NAME

Katush

BOTANICAL NAME

Fagaceae
Castanopsis spp.

DISTRIBUTION

From Nepal eastwards, in Bengal, Assam, the Khasia Hills, Chittagong Hills and in upper Myanmar; common in the ruby mines, eastern Himalaya of Sikkim.

GENERAL DESCRIPTION

Sapwood pale yellowish white, broad and not distinct from heartwood, which is light greyish yellow to light greyish brown; lustrous when fresh.

Grain irregular and interlocked. Texture medium to coarse and uneven.

Growth rings distinct, delineated by a darker band of denser fibrous tissue.

Vessels few to moderately numerous; medium-sized to large; solitary but arranged in radial or oblique groups; perforation simple; tyloses abundant in some species; deposits absent.

Wood parenchyma abundant mainly as apotracheal bands.

Rays very fine and visible to the naked eye. Not conspicuous on the radial surfaces.

PHYSICAL PROPERTIES

Air-dry density: 640-670 kg/m^3 (40-42 lb/ft^3) at 12% MC.

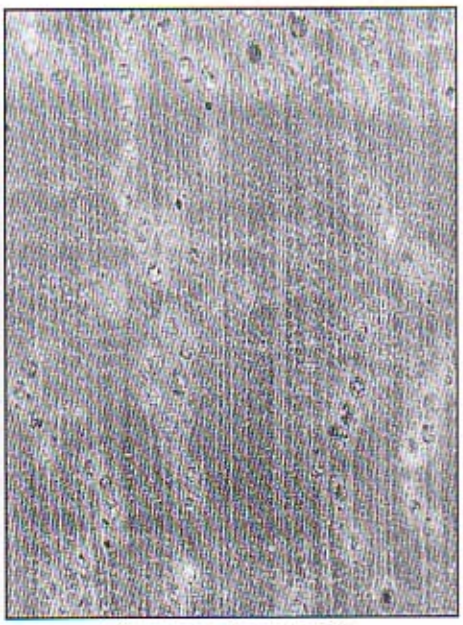
Shrinkage

Radial: 2.3%
Tangential: 4.5%

Seasoning: The timber seasons fairly well, although it is liable to end splitting if left in the log. Surface checking is negligible. The timber seasons fairly slowly without any defects, except for some staining. In Malaysia, 25 mm boards take five months to air dry.

Radial

Tangential



Cross-section (x 10)

MECHANICAL PROPERTIES (AIR-DRY)*

Strength group: (SD4)
Static bending, MPa

MOE: (12.0×10^3)
MOR: (58)

Compression strength, MPa
Perpendicular to grain: (4.94)
Parallel to grain: (31.5)

Shear strength, MPa: (8.2)

DURABILITY

Moderately durable.

TREATABILITY

Very difficult. However, in tests in India chestnut sleepers took up 160 kg/m³ (10 lb/ft³ creosote) without any difficulty.

WORKING PROPERTIES

Planing: easy	Finish: smooth
Boring: easy	Finish: smooth

Tests in India indicate that the timber is easy to saw and very easy to split. It requires a little care in planing and to bring it to a good finish.

USES

Regarded as the main construction timber in the hills of Bengal and commonly used for shingles; other uses include cart shafts, axles, naves, poles and felloes of wheels, agriculture implements, furniture and interior finishing.

EQUIVALENT WOOD

Berangan	Malaysia
Philippine chestnut	Philippines
Saninten	Indonesia
Kor	Thailand
American chestnut	North America
Sweet chestnut	Europe

REFERENCES

[5], [8], [9], [11] and [15].

*Based on the strength values of *Castanopsis hystrix*.

Data sheet 6

BHUTANESE TRADE NAME

Toon

BOTANICAL NAME

Meliaceae
Cedrela spp.

DISTRIBUTION

From Rawalpindi eastwards, Kangra district, sub-Himalayan tracks and valleys up to 1,200 m, Bengal, Bhutan, Assam, Chittagong, Myanmar, the valleys of Singhbum, the Santal Parganahs, Hasaribagh, Balaghat, Bilaspur, the higher plateau of S. Mandla, Hoshingabad Districts in the Central provinces, Akrani in Kandesh, Konkan and N. Kanara, Eastern Ghats, Deccan Hills, Sandur and Mysore, Western Ghats of Madras.

GENERAL DESCRIPTION

Sapwood pinkish or greyish white, rather sharply defined from the heartwood, which is light brick red to rich reddish brown, usually with darker streaks on radial surface.

Grain straight to wavy. Texture moderately coarse and somewhat uneven.

Growth rings distinct, delimited by large and more numerous earlywood.

Vessels mostly isolated; ring porous; large vessels aligned concentrically; without tyloses; often plugged with dark brown gum; transition to latewood zone rather gradual; extreme latewood zone with pores single or in radial pairs of 2-3.

Wood parenchyma vasicentric and terminal; the vasicentric parenchyma inconspicuous; the terminal parenchyma distinct.

Rays fine to medium-sized; distinct to the naked eye.

PHYSICAL PROPERTIES*

Air-dry density: 595 kg/m^3 (37 lb/ft^3) at 12% MC.

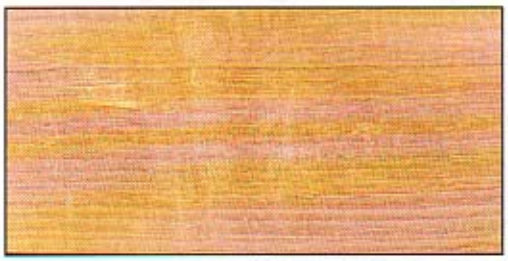
Shrinkage

Radial: 1.1%
Tangential: 2.7%

Seasoning: The wood seasons fairly rapidly without any degrade, except for some slight warping.

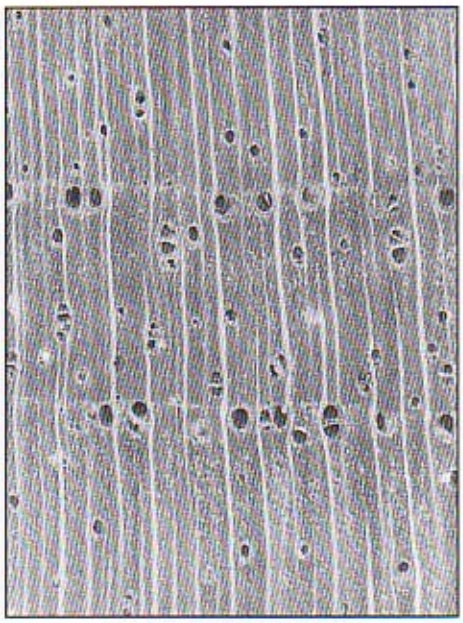
*Results for samples tested in Malaysia.

TOON



Radial

Tangential



Cross-section (x 10)

MECHANICAL PROPERTIES (GREEN)*

Strength group: (S7)

Static bending, MPa

MOE: (6.6×10^3)
MOR: (29)

Compression strength, MPa

Perpendicular to grain: (1.65)
Parallel to grain: (14.6)

Shear strength, MPa: (4.4)

DURABILITY

Not durable.

TREATABILITY

Heartwood partially treatable.

WORKING PROPERTIES

Planing: easy Finish: smooth

The timber saws and works easily; if quarter sawn, it is ornamental, taking a fine finish and polish. Tests in Malaysia indicate that the timber is easy to resaw and cross-cut. Planing is easy and the planed surface is smooth.

USES

Suitable for furniture; in house construction for boarding, doors, panels, frames, windows, foot boards and roofs; tea chests, louvre blinds, cigar boxes, ceilings, boats, masts, oars, toys, carving and musical instruments.

EQUIVALENT WOOD

Limpaga, surian	Malaysia
Toon	India
Kalantas	Philippines
Yom-hom	Thailand
Thiakado	Myanmar
Cedar	Usually qualified by the country of origin, e.g. Central American, Honduran or Spanish cedar

REFERENCES

[6], [8], [10] and [14]-[18].

*Results for the species *Cedrela surent* tested in Malaysia in the green condition.

Data sheet 7

LAL CHANDAN

BHUTANESE TRADE NAME

Lal chandan

BOTANICAL NAME

Daphniphyllaceae
Daphniphyllum spp.

DISTRIBUTION

Himalayas, from Shimla eastwards, in valleys along streams at 1,200-1,800 m, rising to 3,000 m in Sikkim; Khasia Hills.

GENERAL DESCRIPTION

Sapwood white; heartwood greyish brown with occasional streaks of bright crimson.

Grain straight. Texture fine and even.

Growth rings indistinct.

Vessels very small or moderately small; angular; very numerous; solitary; scalariform perforation present but difficult to discern with a hand lens.

Wood parenchyma not visible to the naked eye or with a hand lens.

Rays extremely fine or very fine; very numerous, causing a shining satiny silver grain on radial section.

PHYSICAL PROPERTIES

Air-dry density: 570 kg/m^3 (35 lb/ft^3) at 12% MC.
Shrinkage

Radial: N.A.
Tangential: N.A.

Seasoning: Splits lightly during drying.

MECHANICAL PROPERTIES (AIR-DRY)

Strength group: (SD7)
Static bending, MPa

MOE: N.A.
MOR: N.A.

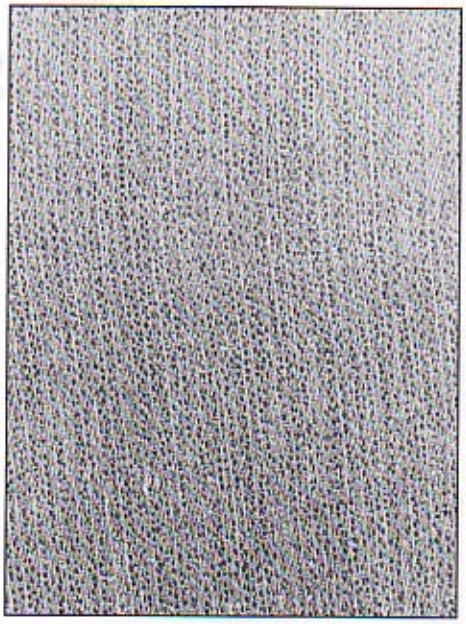
Compression strength, MPa

Perpendicular to grain: N.A.
Parallel to grain: N.A.

Shear strength, MPa: N.A.

Radial

Tangential



Cross-section (x 10)

Durability

No data available.

Treatability

No data available.

Working properties

No data available.

Uses

Suitable for veneer and as poles and rafters in native houses.

Equivalent wood

Lal chandan	Nepal

References

[12] and [19].

Data sheet 8

BHADRASI

BHUTANESE TRADE NAME

Bhadrasi

BOTANICAL NAME

Elaeocarpaceae
Elaeocarpus varunua Ham.

DISTRIBUTION

In the sub-Himalayan tract from Nepal eastwards up to 1,200 m and also in Bhutan, Assam and Chittagong.

GENERAL DESCRIPTION

Sapwood white to greyish white; heartwood yellowish to greyish brown, often with an olive tinge; lustrous, light to medium heavy, moderately hard to hard.

Grain straight, wavy, curly or interlocked. Texture fine and even.

Growth rings well defined to indistinct.

Vessels fine with majority in radial arrangement and rarely solitary; moderately few to moderately numerous; perforation simple; tyloses sparse; deposit absent.

Wood parenchyma sparse; visible with a hand lens as faint terminal bands at infrequent intervals.

Rays fine and of two distinct sizes; the wider separated by several fine rays; the wider rays are of medium-size and visible to the naked eye.

PHYSICAL PROPERTIES

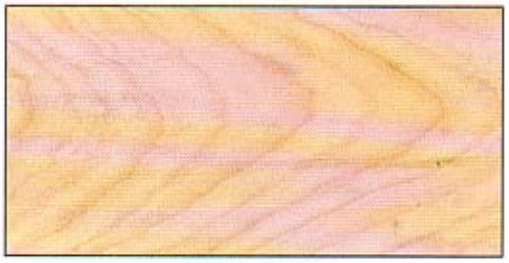
Air-dry density: 450-795 kg/m^3 (28-49 lb/ft^3) at 12% MC.

Shrinkage

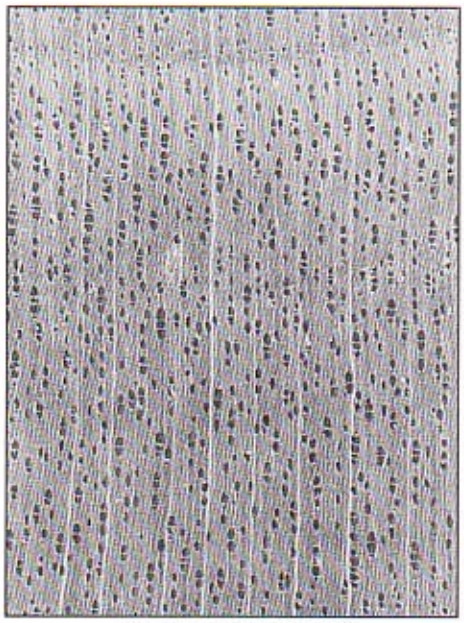
Radial: N.A.
Tangential: N.A.

Seasoning: Generally not a refractory timber to season, although it is somewhat liable to develop fine, straight, deep end splits and honeycombed at the end in some cases; it is liable to bad discolouration and stain. The logs should be converted green to prevent unnecessary deterioration.

Radial



Tangential



Cross-section (x 10)

MECHANICAL PROPERTIES

	Green	*Air-dry*
Strength group:	(S6)*	(SD7)*
Static bending, MPa		
MOE:	(9.1 x 10^3)	(10.3 x 10^3)
MOR:	(47)	(61)
Compression strength, MPa		
Perpendicular to grain:	N.A	N.A
Parallel to grain:	(24.7)	(34.1)
Shear strength, MPa:	(6.8)	(7.2)

DURABILITY

Not durable in exposed situation but fairly so under cover.

TREATABILITY

Difficult.

WORKING PROPERTIES

Planing: easy	Finish: moderately smooth
Boring: easy	Finish: moderately smooth
Turning: easy	Finish: moderately smooth
Nailing: good	

Malaysian *Elaeocarpus* is easy to resaw and cross-cut. Planing is easy and the planed surface is moderately smooth. Nailing property is rated as good. However, tests in India on other species of *Elaeocarpus* indicate that the timber is easy to moderately difficult to saw but works both by hand and on a machine to a good finish and takes a good polish.

USES

Suitable for many general carpentry purposes and, to a limited extent, for boarding, wood boxes and dugout canoes. It has also been tested for matchboxes and splints and found to be fairly suitable.

The timber is listed under use class LU but there are other *Elaeocarpus* spp. with higher density qualified for use class HU.

EQUIVALENT WOOD

Sengkurat	Malaysia
Jenitri	Indonesia
Mun	Thailand
Rudrak	India
Quandong	Papua New Guinea, Solomon Islands, Australia

REFERENCES

[6], [18], [21] and [24].

*The strength values are those of *E. sphaericus* tested in Malaysia.

Data sheet 9

PIPLI

BHUTANESE TRADE NAME

Pipli

BOTANICAL NAME

Hamamelidaceae
Exbucklandia populnea R. W. Brown
(Syn. *Bucklandia populnea* R. Br.)

DISTRIBUTION

Eastern Himalayas, in Bhutan and the Darjeeling and Kurseong divisions, the Khasia Hills of Assam and the Martaban Hills of lower Myanmar. Also occurs in the Naga Hills at elevations of 1,000-2,500 m in Malaya, Sumatra and Java.

GENERAL DESCRIPTION

Sapwood not distinct from heartwood. Wood light reddish brown to brown or greyish brown; dull to somewhat lustrous especially on the radial surface; with smooth feel, without characteristic odour or taste.

Grain shallowly interlocked. Texture very fine and even.

Growth rings wanting or scarcely distinct; when present, delimited by a narrow, poorly defined band of denser fibrous tissues containing smaller vessels.

Vessels very small; indistinct to the naked eye; very numerous (50 per mm²); solitary; sometimes in pairs; evenly distributed; tyloses fairly abundant.

Wood parenchyma consists of both paratracheal and apotracheal types. Paratracheal type as scanty parenchyma surrounding the vessels whereas the apotracheal type as sparse, diffuse strands.

Rays fine and not visible to the naked eye.

PHYSICAL PROPERTIES

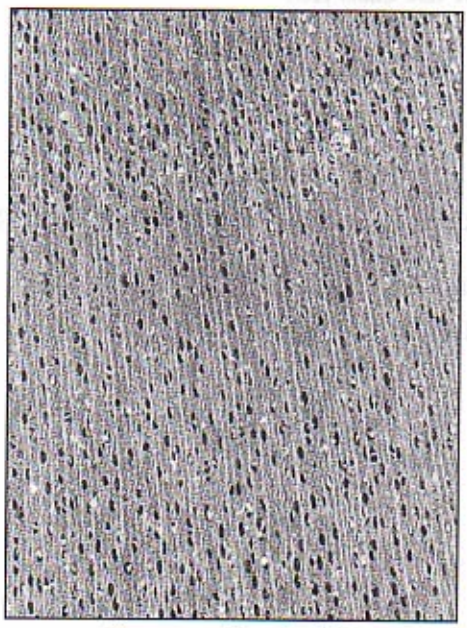
Air-dry density: 640 kg/m³ (40 lb/ft³) at 12% MC.
Shrinkage

Radial: N.A.
Tangential: N.A.

Seasoning: Not a really refractory timber to season, though liable to end splitting if left in the log. It should be converted green and should not season too rapidly as long, fine, wavy cracks are liable to develop.

Radial

Tangential



Cross-section (x 10)

Mechanical properties (air-dry)

Strength group: (SD6)*

Static bending, MPa

MOE: (9.5×10^3)
MOR: (70.7)

Compression strength, MPa

Perpendicular to grain: N.A.
Parallel to grain: (39.2)

Shear strength: N.A.

Durability

Very durable under cover and fairly durable in exposed conditions.

Treatability

No data available.

Working properties

The timber is easy to saw and plane. On a lathe it turns up easily and finishes to an exceptionally smooth surface, taking a good polish. It also turns and peels well.

Uses

Suitable for planking, beams and rafters, door and window framing, general carpentry works, heavy packing cases, furniture and cabinet-making, gun butts and second-grade general utility plywood.

Equivalent wood

Pipli, dingdah, singliang	India
Gerok	Malaysia
Pipli	Nepal

References

[6], [12], [15], [21] and [22].

*The timber is moderately strong and elastic and moderately hard. It has been tested air-dried in India; results indicate that it is 29 and 32 %, respectively, below Myanmar teak in transverse strength and in compression parallel to grain.

Data sheet 10

BHUTAN WALNUT

BHUTANESE TRADE NAME

Okhar (walnut)

BOTANICAL NAME

Juglandaceae
Juglans regia Linn.

DISTRIBUTION

In the Himalayas at elevations of 900-1,300 m, from Afghanistan to Bhutan and in the hills of northern Myanmar. It is also extensively cultivated. The same species is found in Iran and cultivated in Europe.

GENERAL DESCRIPTION

Sapwood wide and greyish white in colour and clearly defined from the heartwood, which is greyish brown with few or no markings or with darker streaks. The wood is variable in intensity of colour and markings, but beautiful mottled wood can be obtained by selection.

Grain generally straight. Texture medium and even.

Growth rings generally distinct and delimited by bands of parenchyma.

Vessels moderately large in the early wood and progressively decreasing in size across the growth ring to medium and small size in the late wood; majority solitary, others in radial groups of 2-5 (mostly 2 or 3) and some in a radially aligned cluster; perforation simple; tyloses fairly abundant; deposits absent.

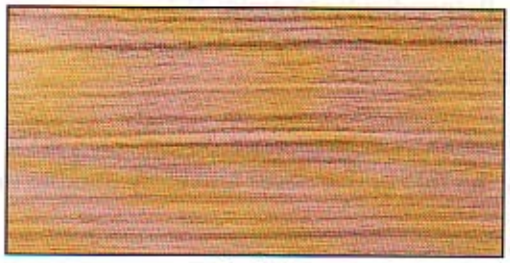
Wood parenchyma consists of apotracheal and paratracheal types; apotracheal types extend across several rays whereas paratracheal types are relatively sparse and form a narrow uniseriate sheath around the pores; terminal parenchyma form more or less continuous, uniseriate lines terminating the growth rings.

Rays medium fine to fine, appearing as fine, light brown lines with a hand lens.

PHYSICAL PROPERTIES

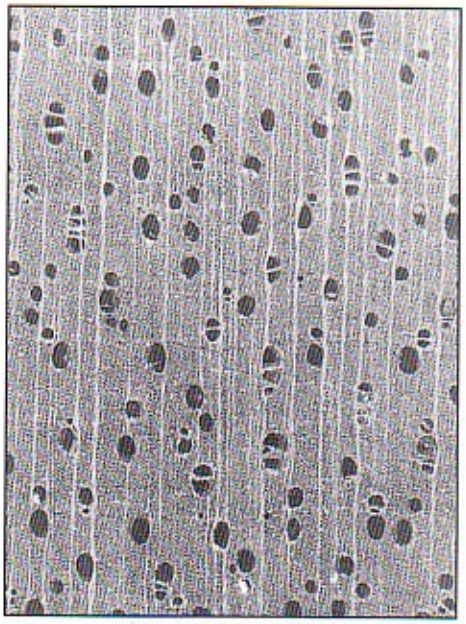
Air-dry density: 530 kg/m³ (33 lb/ft³) at 12% MC.*

*It has been reported that similar species of walnut grown elsewhere (Europe and Asia Minor) are generally heavier, e.g. European walnut weighs 640 kg/m³.



Radial

Tangential



Cross-section (x 10)

Shrinkage

Radial: 3%
Tangential: 5.5%

Seasoning: Dries well though rather slowly; tendency for honeycombing in thick boards. Medium movement.

MECHANICAL PROPERTIES (AIR-DRY, 15 %)

Strength group: (SD7)
Static bending, MPa

MOE: (7.0×10^3)
MOR: (62.0)

Compression strength, MPa

Perpendicular to grain: N.A.
Parallel to grain: (35.7)

Shear strength: N.A.

DURABILITY

Moderately durable.

TREATABILITY

Other species of *Juglans* are reported to be very low in permeability.

WORKING PROPERTIES

It is reported to saw easily and finishes to a smooth surface and takes a high polish. It peels well on a rotary veneer cutter, finishing to a smooth, lustrous surface after the logs have been pretreated with heated water.

USES

Suitable for furniture, gun and rifle stocks, carving, panelling, decorative veneer and interior finishing.

EQUIVALENT WOOD

European walnut	Europe
Walnut	Usually is named after the country of origin, e.g. Japanese or American walnut.
Thitcha	Myanmar

REFERENCES

[1], [5], [10], [11] and [14].

BHUTAN MEDANG

Data sheet 11

BHUTANESE TRADE NAME

Pahale

BOTANICAL NAME

Lauraceae
Litsea spp.

DISTRIBUTION

From Rawalpindi Division in the Punjab to the east of Bengal, sub-Himalayan tracts and adjacent plains, including Bhutan, throughout the dry forests of India in the central provinces, Chota Nagpur, Konkan, N. Kanara forests, South India and Myanmar.

GENERAL DESCRIPTION

Sapwood not distinct from heartwood, which is yellowish grey or olive grey to olive brown or greyish brown, generally with darker lines traceable to seasonal increments; lustrous when first exposed but becoming dull with age; fairly smooth feel and no characteristic odour or taste.

Grain fairly straight or somewhat wavy in the radial plane. Texture medium and quite even.

Growth rings distinct and relatively conspicuous.

Vessels medium small or very small; not visible to the naked eye; open or occasionally plugged with tyloses; arranged in radial rows of 2-6 (mostly 2-3); rarely solitary or in clusters; perforation simple; reddish or yellowish brown deposits sometimes present.

Wood parenchyma is paratracheal, relatively sparse in forming a narrow, ragged, 1-2 seriate sheath around the vessels; slightly aliform.

Rays scarcely visible with the naked eye; medium to fine.

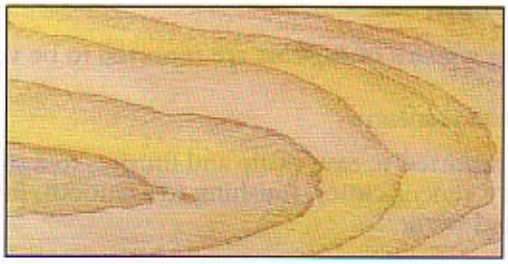
PHYSICAL PROPERTIES

Air-dry density: 690 kg/m³ (43 lb/ft³) at 12% MC.
Shrinkage

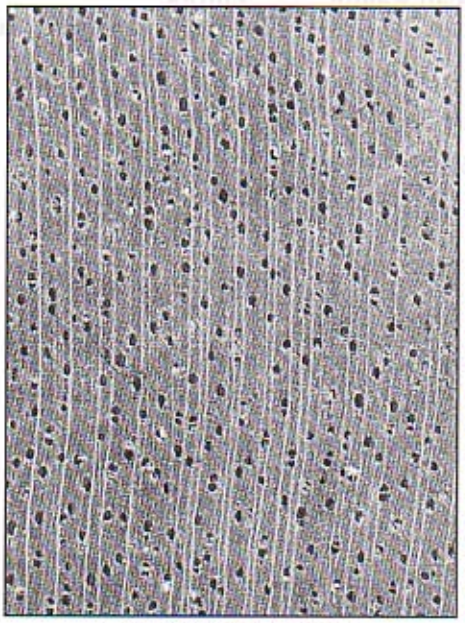
Radial: 1.2%
Tangential: 2.7%

Seasoning: Reputed to dry without degrade and with very low shrinkage. The timber is likely to stain during seasoning. *Litsea* of Malaysia is found to shrink 1.2% and 2.7% in the radial and tangential positions respectively.

Radial



Tangential



Cross-section (x 10)

Mechanical properties (green)

Strength group: (S6)*

Static bending, MPa

MOE: (7900)
MOR: (51)

Compression strength, MPa

Perpendicular to grain: (2.46)
Parallel to grain: (25.2)

Shear strength, MPa: (6.2)

Durability

Variable with species, for example *L. sebifera* of India is rated as durable and to a certain extent immune to insect attack. However, the *Litsea* of Malaysia has been found to be not durable under exposed conditions.

Treatability

The heartwood is difficult to treat, while the sapwood absorbs preservatives readily.

Working properties

Planing: easy	Finish: smooth
Boring: easy	Finish: smooth
Turning: easy	Finish: smooth
Nailing: excellent	

The timber is easy to saw and takes a good polish. Darkens on exposure.

Uses

Suitable for house-building, panelling, furniture, oars, agricultural implements and cabinet work etc.

Equivalent wood

Medang	Malaysia
Boi loi	Viet Nam
Batikuling	Philippines
Ondon	Myanmar
Bollywood	Australia

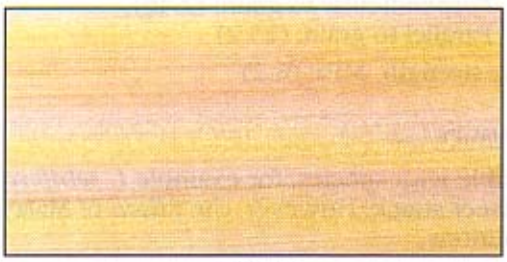
References

[8], [14] and [15].

Based on mechanical tests carried out in Malaysia on the Malaysian species of *Litsea*.

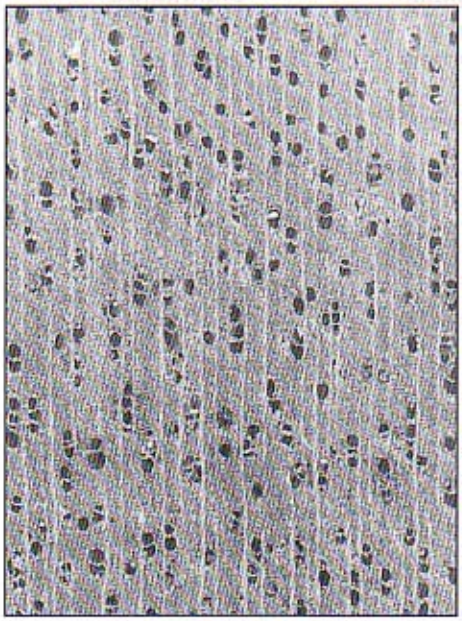
Data sheet 12

KAWLA



Radial

Tangential



Cross-section (x 10)

BHUTANESE TRADE NAME

Kawla

BOTANICAL NAME

Lauraceae
Machilus edulis

DISTRIBUTION

Forests around Bhutan.

GENERAL DESCRIPTION

Pale red and pinkish brown with occasional darker streaks.

Grain straight to shallowly interlocked. Texture fine and even.

Growth rings present but indistinct, delimited by narrow zones of denser fibrous tissue.

Vessels small to very small, solitary and in radial rows of 2-4 (mostly 2-3) or more.

Wood parenchyma paratracheal, relatively abundant forming a thin sheath around the vessel and occasionally extending laterally uniting adjacent vessels.

Rays visible to the naked eye.

PHYSICAL PROPERTIES

Air-dry density: 740 kg/m^3 (46 lb/ft^3) at 12% MC.
Shrinkage

Radial: N.A.
Tangential: N.A.

Seasoning: Expected to season well. The *Machilus* of Japan and Taiwan Province of China have been reported to season well except that the timber tends to warp. Some species of *Machilus* are also liable to blue stain and insect attack during seasoning.

MECHANICAL PROPERTIES (GREEN)

Strength group: (S5-S6)*
Static bending

MOE: N.A.
MOR: N.A.

*Other species of *Machilus* from Taiwan Province and Japan were tested and could generally be classified under strength group S5 or S6 depending on the species.

Compression strength

Perpendicular to grain: N.A.
Parallel to grain: N.A.

Shear strength: N.A.

Durability

Other species of *Machilus* have been found to be durable under cover or moderately durable in exposed conditions.

Treatability

No data available.

Working properties

No data available. However, other species of *Machilus* have been found to be easy to saw and to work well to a fine finish.

Uses

Suitable for building construction, tea chests, furniture, internal fittings, flooring, ceiling boards, boats, packing cases, veneer and plywood.

Equivalent wood

Machilus	Taiwan Province, Japan and India
Kulilisiau	Philippines
Seiknanggi	Myanmar
Pau hoi	China

References

[3], [8], [9], [11] and [15].

Data sheet 13

PHAMPHAL

BHUTANESE TRADE NAME

Phamphal

BOTANICAL NAME

Lauraceae
Machilus gammieana King

DISTRIBUTION

Sikkim and the forests around Darjeeling and Bhutan.

GENERAL DESCRIPTION

Pale yellowish or roseate grey when fresh and ageing to light grey or pinkish grey. Towards the centre of the tree, the wood is pale red and pinkish brown with occasional darker streaks.

Grain straight. Texture fine and even.

Growth rings distinct but inconspicuous, delimited by a narrow zone of denser fibrous tissue.

Vessels small to very small or extremely small, solitary and in radial rows of 2-4 (mostly 2-3); scalariform perforation plates present.

Wood parenchyma abundant and paratracheal, arranged in rows and often interrupted by rays and occasionally by fibres.

Rays not visible to the naked eye. Conspicuous on radial surface as fine, close silvery flecks.

PHYSICAL PROPERTIES

Air-dry density: 560 kg/m^3 (35 lb/ft^3) at 12% MC.
Shrinkage
Radial: N.A.
Tangential: N.A.
Seasoning: Seasons well with little defect.

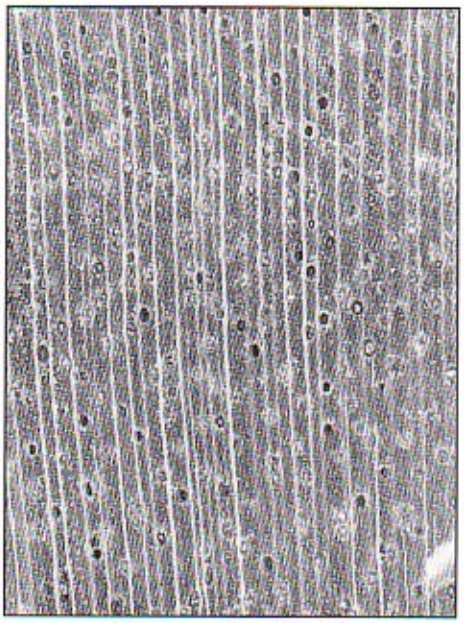
MECHANICAL PROPERTIES (GREEN)

Strength group: (S5-S6)*
Static bending
MOE: N.A.
MOR: N.A.

*Tests on other species of *Machilus* from Taiwan Province and Japan indicate that the timber can generally be classified under strength group S5 or S6 depending on the species.

Radial

Tangential



Cross-section (x 10)

Compression strength

Perpendicular to grain: N.A.
Parallel to grain: N.A.

Shear strength: N.A.

Durability

Very durable under cover. Other species of *Machilus* have been reported to be only moderately durable in exposed positions.

Treatability

No data available.

Working properties

Easy to saw and works well to a fine finish.

Uses

Suitable for building construction, tea chests, furniture, internal fittings, flooring, ceiling boards, boats, packing cases and veneer and plywood.

Equivalent wood

Machilus	Taiwan Province, Japan and India
Kulilisiau	Philippines
Seiknanggi	Myanmar
Pau hoi	China

References

[3], [8], [9], [11] and [15].

Data sheet 14

TITE CHAMP

BHUTANESE TRADE NAME

Tite champ

BOTANICAL NAME

Magnoliaceae
Alcimandra cathcartii Hk. f. & Th.

DISTRIBUTION

Sikkim Himalayas and Bhutan at 1,500-2,100 m, Khasia and Naga hills of Assam.

GENERAL DESCRIPTION

Sapwood white to greyish white and heartwood yellowish olive green to olive brown or pale brown.

Grain straight. Texture fine to medium and even.

Growth rings distinct, delimited by concentric bands of soft tissue.

Vessels small to moderately large; evenly distributed; few to very numerous (7-72 per mm²); solitary or in radial multiples of 2-3; round or oval; scalariform perforation plates usually visible on the radial surface; occasionally filled with tyloses and whitish deposits.

Wood parenchyma in narrow concentric bands delimiting growth rings and forming false growth marks.

Rays fine, fairly closely spaced, evenly distributed.

PHYSICAL PROPERTIES

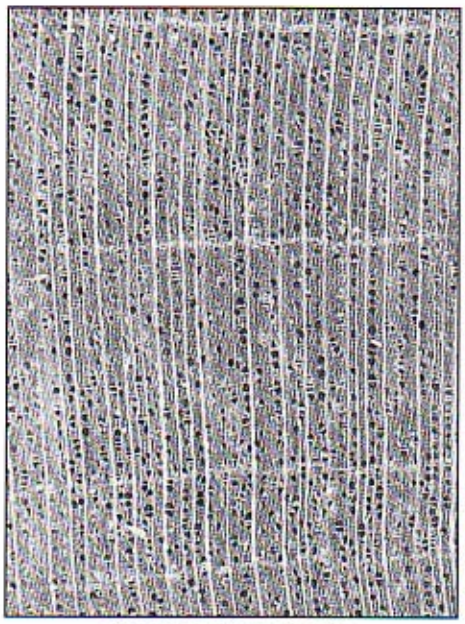
Air-dry density: 655 kg/m³ (41 lb/ft³) at 12% MC.
Shrinkage

Radial: N.A.
Tangential: N.A.

Seasoning: Can be seasoned without difficulty or degrade if handled properly. The logs should be converted green and then stacked in plank and scantling form in a sheltered, well-ventilated shed. The timber can be kiln-dried well except there may be some slight discolouration. It is liable to crack if not handled properly.

Radial

Tangential



Cross-section (x 10)

Mechanical properties (air-dry)

Strength group: (SD5)*

Static bending

MOE: N.A.
MOR: N.A.

Compression strength

Perpendicular to grain: N.A.
Parallel to grain: N.A.

Shear strength: N.A.

Durability

Timbers lasted not more than five years in the open.

Treatability

Heartwood refractory to treatment.

Working properties

Planing: Good Finish: smooth

The timber is easy to saw, works well with tools and finishes to a smooth, glossy surface that stains and polishes well. It peels easily and economically.

Uses

Excellent for light furniture and plywood and suitable for all indoor works. Locally used for constructional purposes and for planking. The finer textured samples are suitable for the manufacture of turnery articles.

Equivalent wood

Chempaka	Malaysia
Champ	India
Kala champ, titi champ	Nepal

References

[3], [8], [9], [11], [15], [17], [20] and [21].

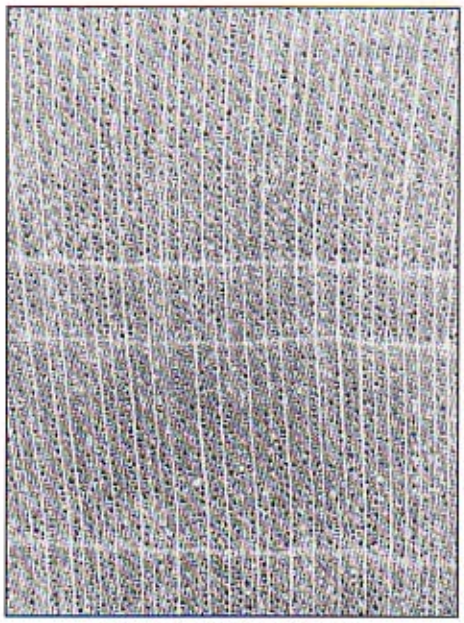
*Its strength properties are expected to be similar to other *Michelia* spp. and since this timber has higher density, it can be placed in strength group SD5.

Data sheet 15

AULE CHAMP

Radial

Tangential



Cross-section (x 10)

BHUTANESE TRADE NAME

Aule Champ

BOTANICAL NAME

Magnoliaceae
Michelia champaca Linn.

DISTRIBUTION

From Nepal eastwards, including Bhutan up to 900 m, Assam, Chittagong Hill tracts, southern Myanmar and on west coast from Kanara southwards.

GENERAL DESCRIPTION

Sapwood white and heartwood light yellowish brown to olive brown; somewhat lustrous; no characteristic odour or taste; light and soft.

Grain straight. Texture medium and even.

Growth rings distinct, delimited by light lines of terminal parenchyma.

Vessels quite evenly distributed and less abundant in the outer portion of the ring; small to very small; solitary and in radial groups of 2-4; tyloses sparse.

Wood parenchyma consists of both paratracheal and apotracheal types; very sparse and difficult to distinguish from the fibres in the transverse section.

Rays fine to moderately broad and just visible to the naked eye. Conspicuous on the radial surface as flecks.

PHYSICAL PROPERTIES

Air-dry density: 500-545 kg/m^3 (31-34 lb/ft^3) at 12% MC.
Shrinkage

Radial: 3.2%
Tangential: 5.2%

Seasoning: If properly handled, the timber can be dried with little difficulty.

MECHANICAL PROPERTIES (AIR-DRY)

Strength group: (SD6)

Static bending, MPa

MOE: (9.6 x 10^3)
MOR: (64)

Compression strength, MPa

Perpendicular to grain: (6.7)
Parallel to grain: (44)

Shear strength, MPa: (7.9)

Durability

Durable under cover. Liable, however, to attack by fungus and termites.

Treatability

Heartwood difficult to treat.

Working properties

The timber is straight-grained, easy to saw and works to a smooth surface, taking a good polish. It is not suitable for turnery work. It has been tried for plywood and has proved suitable, although not decorative.

Uses

Suitable for posts, boards, scantlings, general joinery work, light furniture, boat-building, bentwood ribs, dugout canoes, carriage-building, veneer and plywood.

Equivalent wood

Chempaka	Malaysia
Champa	Thailand
Champ, champak	India
Sandit	Philippines

References

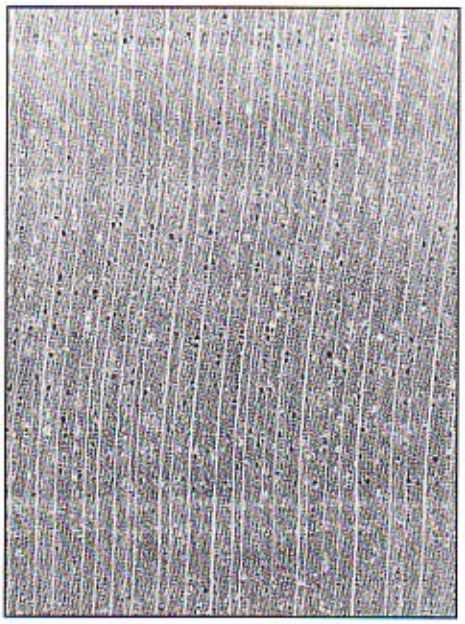
[3], [8], [9], [11], [15], [17] and [20].

Data sheet 16

RANI CHAMP

Radial

Tangential



Cross-section (x 10)

BHUTANESE TRADE NAME

Rani champ

BOTANICAL NAME

Magnoliaceae
Michelia excelsa, Blume ex wall.

DISTRIBUTION

Eastern Himalayas, including Bhutan up to 1,800-2,400 m and scattered in the Khasia hills and upper Darjeeling forests.

GENERAL DESCRIPTION

Sapwood white or greyish white; heartwood greenish yellow to olive brown.

Grain straight. Texture medium and even.

Growth rings distinct; delimited by lines of terminal parenchyma.

Vessels are quite evenly distributed, very small and less abundant in the outer portion of the ring, solitary and in single or double rows of 2-4; scalariform perforation plates; tyloses scanty.

Wood parenchyma is in terminal bands; paratracheal and apotracheal types are very sparse and difficult to distinguish from the fibres in the transverse section.

Rays are fine and not distinct to the naked eye. Conspicuous on the radial surface as flecks.

PHYSICAL PROPERTIES

Air-dry density: 560-590 kg/m^3 (32-35 lb/ft^3) at 12% MC.

Shrinkage

Radial: 3.9%
Tangential: 7.6%

Seasoning: The timber seasons well with few cracks. A *Michelia* species tested in Malaysia gives shrinkage values of 1.2% and 1.4% radially and tangentially, respectively. The timber seasons fairly slowly without any serious degrades except some insect attacks.

MECHANICAL PROPERTIES (AIR-DRY)

Strength group: (SD5)*

*Based on tests in India.

Static bending, MPa

MOE: (11.4 x 10^3)
MOR: (79)

Compression strength, MPa

Perpendicular to grain: (5.2)
Parallel to grain: (41)

Shear strength, MPa: (5.6)

Durability

Durable under cover. However, the chempaka of Malaysia is reputed to be only moderately durable.

Treatability

No data available.

Working properties

The timber is easy to saw and works to a smooth, glossy surface. It polishes well.

Uses

Suitable for door and window frames, furniture, ceiling boards, rafters, tea chests.

Equivalent wood

Chempaka	Malaysia
Champ, champak	India
Sandit	Philippines
Champa	Thailand
Bara champ, champ, safed champ, seti champ, seto champ	Nepal

References

[3], [8], [9], [11], [15], [17] and [20].

Data sheet 17

NYSSA

BHUTANESE TRADE NAME

Lek chilauni

BOTANICAL NAME

Nyssaceae
Nyssa javanica (Bl.) Wang
(Syn. *N. sessiliflora* Hook. f. et Th.)

DISTRIBUTION

Eastern Himalayas in Sikkim and Bhutan, at over 1,500 m; in Assam, especially in the Cachar Hill tracts; Khasia Hills and in some of the hills of Myanmar, at elevations over 1,200 m.

GENERAL DESCRIPTION

Sapwood pale yellow-white when first exposed, ageing to light yellow-brown, greyish brown or light brown; heartwood not distinct; surface somewhat lustrous.

Grain straight or shallowly interlocked. Texture moderately fine and even.

Growth rings distinct, delimited by darker-coloured fibres.

Vessels moderately numerous to numerous, small to very small; majority solitary and in radial groups of 2-5 (mostly 2) and rarely in clusters; perforation scalariform and difficult to discern with a lens.

Wood parenchyma moderately abundant but indistinct even with a lens; consisting of diffuse parenchyma but sometimes forming short tangential layers; paratracheal parenchyma consisting of a few cells surrounding the vessels.

Rays consisting of two types moderately fine in their broadest part; barely to just visible to the naked eye on end and tangential surfaces, conspicuous on radial surface.

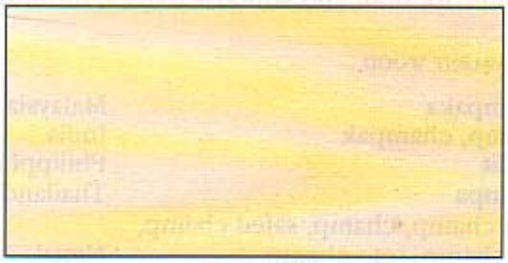
PHYSICAL PROPERTIES

Air-dry density: 625 kg/m^3 (39 lb/ft^3) at 12% MC.
Shrinkage

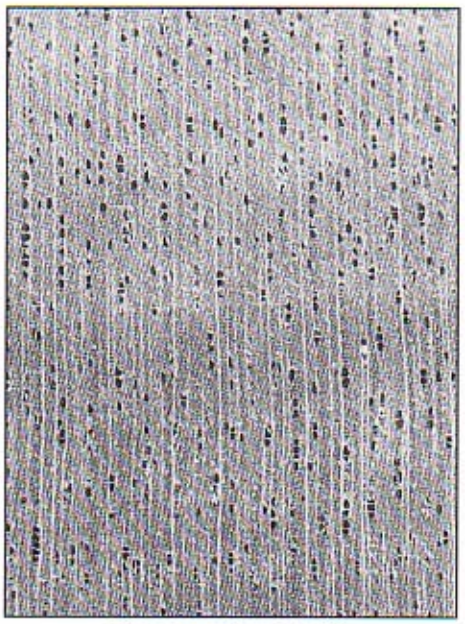
Radial: N.A.
Tangential: N.A.

Seasoning: Not a difficult timber to season but somewhat liable to stain. Sawn stock should therefore be open-stacked in a well-ventilated situation.

Radial



Tangential



Cross-section (x 10)

MECHANICAL PROPERTIES (AIR DRY)

Strength group: (SD6)*

Static bending

MOE: N.A.
MOR: N.A.

Compression strength

Perpendicular to grain: N.A.
Parallel to grain: N.A.

DURABILITY

Durable under cover but liable to attack from insects. The specimen in the Kepong Wood Collection has been rather heavily attacked by powder post beetles, dry wood termites and slightly discoloured by a sap stain fungus. The American tupelo is not resistant to decay and should be treated with preservative when used in an exposed situation.

TREATABILITY

No data available.

WORKING PROPERTIES

It has been described as a very easy wood to saw and works to a bright, smooth surface; it peels well. The American tupelo is said to work well with all tools and is an excellent timber for mouldings, as a perfect finish is readily obtained. The timber stains well and takes paint and enamel better than most timbers.

USES

Commonly used for building and tea chests in the eastern Himalayas. Suitable for backing boards of cupboards, bottoms and sides of drawers, small tables and similar purposes. Similar timber in North America has been used for boxes and crates, built-in fitments, shelves, interior joinery, furniture, dock flooring, wagon and bridge planking, plywood, barrels, cigar boxes, toys etc.

EQUIVALENT WOOD

Nyssa	North America and Asia
Tupelo	North America
Black gum	North America

REFERENCES

[1], [10], [11] and [23].

*The timber has not been tested for strength. However, it is said to be moderately hard and strong. The tupelo (*Nyssa* spp.) of North America has been found to be of moderate strength and has similar strength properties to Canary whitewood (*Liriodendron tulipiferae* L.). Based on its density, the timber is provisionally placed in strength group SD6.

Data sheet 18

CHERRY

BHUTANESE TRADE NAME

Arupatey

BOTANICAL NAME

Rosaceae
Prunus nepalensis Hook. f.

DISTRIBUTION

From Kumaon to Bhutan at 1,800-3,000 m elevation and in the Khasi Hills at 1,200-1,800 m elevation; also in the hills of upper Myanmar. It is often cultivated for its fruit.

GENERAL DESCRIPTION

Sapwood white to pale pinkish white; heartwood pale red to deep red, reddish or greyish brown or brown.

Grain straight or wavy. Texture fine to medium coarse and even.

Growth rings distinct, usually demarcated by slightly larger tangentially aligned early wood vessels and denser latewood fibres.

Vessels small to very small, mostly solitary and in radial rows of 2-6 or more; simple perforation; gum-like deposit present.

Wood parenchyma sparse and not readily visible even with a lens.

Rays of two distinct sizes; larger rays distinct to the naked eye and wider than the pores.

PHYSICAL PROPERTIES

Air-dry density: 544-720 kg/m^3 (34-45 lb/ft^3) at 12% MC (av. 630 kg/m^3).

Shrinkage

Radial: (3.5%)
Tangential: (6.5%)

Seasoning: Seasons fairly readily but with a pronounced tendency to warp; medium movement.

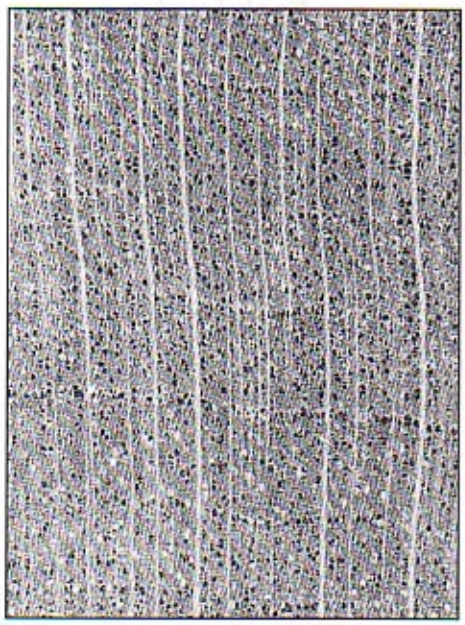
MECHANICAL PROPERTIES (AIR-DRY)

Strength group: (SD6)*

*Other species of Prunus, like European cherry (P. avium), have been described as a tough timber, being as tough as ash in the unseasoned state but some 30% less tough than the timber when seasoned; otherwise less strong than European beech. Based on its density, the timber is provisionally placed in strength group SD6.

Radial

Tangential



Cross-section (x 10)

Static bending

MOE: N.A.
MOR: N.A.

Compression strength

Perpendicular to grain: N.A.
Parallel to grain: N.A.

Shear strength: N.A.

Durability

It has been reported to be durable. However, European cherry (*P. avium*) has been reported to be moderately durable and almost immune from powder post beetle attack but liable to attack by the common furniture beetle.

Treatability

No data available.

Working properties

No information available; however, tests carried out on other species of *Prunus* in India indicate that when green it can be sawn easily, but when seasoned, less easily. It works to a good finish with a fine lustre.

Uses

Suitable for walking sticks, ornamental items, furniture, handles of sickles, rafters, turnery for toys, and the manufacture of small articles like rulers and small tabletops. It is placed in use class LU, but there are other species that have higher density and are qualified to be placed in use class HU.

Equivalent wood

Nepalese cherry, arupate, likh-aru	Nepal
Cherry	A well-known name for the genus *Prunus*

References

[4], [5], [10], [11], [21] and [22].

Data sheet 19

OAK

BHUTANESE TRADE NAME

Oak

BOTANICAL NAME

Fagaceae
Quercus spp.

DISTRIBUTION

From Afghanistan to Bhutan in the inner Himalayas, between 915 and 3,600 m elevation.

GENERAL DESCRIPTION

Sapwood not differentiated from the heartwood; heartwood ranging from yellowish grey or grey to light pinkish brown or reddish brown; becoming appreciably darker with age.

Grain straight, interlocked, irregular or wavy. Texture medium fine and uneven.

Growth rings usually indistinct.

Vessels very large to medium-sized, small or very small; solitary and irregularly distributed in radial and oblique rows or in flame-like clusters; perforation simple; tyloses present. Wood parenchyma predominantly apotracheal, occurring in fine lines between rays.

Rays of two distinct sizes, extremely broad and very fine; the former very few, widely spaced and prominent to the eye on all three surfaces, producing silver figure on the radial surface.

PHYSICAL PROPERTIES

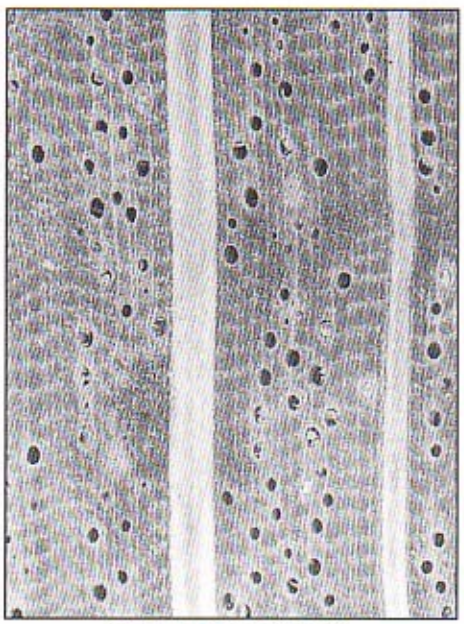
Air-dry density: 865 kg/m^3 (54 lb/ft^3) at 12% MC.
Shrinkage

Radial: 1.9%
Tangential: 4.2%

Seasoning: Tests on Indian *Quercus* indicate that the timber is refractory to season. Sawn material is liable to collapse if seasoned too fast. Some species, if left in the log, can split so severely as to cause complete rejection. It has been suggested that to minimize the drying defects, the logs should be converted green and the sawn materials close-piled and well protected from the sun and hot winds. The close piling of the sawn materials is to retard seasoning during the initial and most difficult period.

Radial

Tangential



Cross-section (x 10)

MECHANICAL PROPERTIES

	Green	*Air-dry*
Strength group:	(S1)*	(SD2)*
Static bending, MPa		
MOE:	(16.3 x 10^3)	(18.1 x 10^3)
MOR:	(101)	(120)
Compression strength, MPa		
Perpendicular to grain:	(9.72)	(11.92)
Parallel to grain:	(49.1)	(62.3)
Shear strength, MPa:	(13.1)	(16.2)

DURABILITY

Moderately durable to durable depending on the species.

TREATABILITY

No data available.

WORKING PROPERTIES

Planing: easy	Finish: smooth
Boring: easy	Finish: moderately smooth
Turning: difficult	Finish: rough
Nailing: poor	

Tests carried out in Malaysia indicate that the timber is easy to saw when green but slightly difficult to work when dried. The planed surface produced is smooth but the quality of finish when turned is rough. Nailability is poor. Various Indian *Quercus* have been evaluated for their working properties and in most cases the timber has been found to be difficult to saw, especially when well seasoned. The timber, however, can be finished to a smooth surface if correctly worked.

USES

An important building timber used for beams, door and window frames, shingles, agriculture implements, tool handles, flooring and furniture manufacture.

EQUIVALENT WOOD

Mempening	Malaysia
Oak	Americas, Europe, Asia

REFERENCES

[4], [8], [11], [17], [18] and [22].

*Judging from the oak specimens provided by the Bhutanese authorities, Bhutanese oak is definitely harder and heavier than European oak (*Quercus* spp.) and red oak (*Quercus rubra*). It is probably closer to the Malaysian mempening (*Lithocarpus* and *Quercus* spp.) and Indian oak (*Quercus* spp.). The above strength values are based on test results of *Quercus argentata* (air-dry density 930 kg/m³) tested in Malaysia.

Static bending, MPa		
MOE:	(10.3 x 10^3)	(12.0 x 10^3)
MOR:	(88)	(60)
Compression strength, MPa		
Perpendicular to grain:	(5.45)	(2.93)
Parallel to grain:	(46.3)	(32.3)
Shear strength, MPa:	(12.3)	(8.0)

Durability

Durable under cover. However, fungus can get into the timber rapidly if it is not stored under cover. Similar species tested in Malaysia indicate that it is not durable when exposed to weather.

Treatability

Heartwood difficult to treat.

Working properties

Planing: slightly difficult	Finish: smooth
Boring: slightly difficult	Finish: smooth
Turning: N.A.	Finish: N.A.
Nailing: excellent	

In India, the timber saws and works easily to a smooth surface. It takes a fair polish, although it absorbs the polishing solution rather readily. It is, however, likely to cause irritation to wood workers due to the presence of sharp crystalline needles from the bark. Tests in Malaysia indicate that the timber is fairly easy to resaw and cross-cut and is easy to slightly difficult to plane. The finish, however, is smooth.

Uses

Suitable for construction, ploughshares, planking, scantling, joinery work, handles for tools such as hand-saws, plywood manufacture, wooden pallets, door and window frames.

Equivalent wood

Samak	Malaysia
Puspa	Indonesia
Mang-tarn	Thailand
Chilauni	India

References

[9], [11], [15], [16] and [18].

Data sheet 21

KHARANE

BHUTANESE TRADE NAME

Kharane

BOTANICAL NAME

Symplocaceae
Symplocus spp.

DISTRIBUTION

Warmer parts of Asia, Australia and America but absent from Africa. There are more than 35 species of mostly shrubs and a few trees found in Bhutan, eastern Himalayas, mainly in Assam, and in the Western Ghats and adjoining hills except for one species, which extends to the western Himalayas.

GENERAL DESCRIPTION

Sapwood and heartwood not differentiated. Wood white when fresh, turning uniform pale yellow or pale yellowish brown or reddish grey on ageing.

Grain straight or interlocked. Texture fine and even.

Growth rings indistinct, often faintly demarcated due to denser bands of latewood fibres.

Vessels very small to moderately small; numerous or very numerous; solitary and in radial pairs, but mostly solitary; scalariform perforation plates present.

Wood parenchyma moderately abundant, in narrow apotracheal layers from ray to ray.

Rays of two distinct sizes; medium-sized rays distinct to the naked eye on end and tangential surfaces and fine rays visible only with a lens on end and tangential surfaces; rays not prominent on radial surface.

PHYSICAL PROPERTIES

Air-dry density: 512-784 kg/m^3 (32-49 lb/ft^3) at 12% MC.

Shrinkage

Radial: N.A.
Tangential: N.A.

Seasoning: Seasons slowly without serious degrade.

Radial

Tangential

Cross-section (x 10)

Printed in Austria
V.93-90296—October 1994—870

Mechanical properties (air-dry)

Strength group: (SD7-SD5)*

Static bending

MOE: N.A.
MOR: N.A.

Compression strength

Perpendicular to grain: N.A.
Parallel to grain: N.A.

Shear strength: N.A.

Durability

No data available.

Treatability

No data available.

Working properties

Timber saws fairly easily, giving a fibrous and rough surface when rip-sawing. Easy to work in machine and hand operations. Little tendency to split in nailing.

Uses

It is one of the approved timbers for match splints. Similar timber is reported to be sold in Bhutan under the name "white horn" and is used by some firms in the Punjab for making compressed shuttle blocks.

Equivalent wood

Lodh, podipari	India
Kharani, chamlani	Nepal

References

[3], [21] and [23].

*Based on its density, the timber is provisionally placed in strength group SD7-SD5.

MECHANICAL PROPERTIES

	Green	*Air-dry*
Strength group:	(S5)*	(SD5)*
Static bending, MPa		
MOE:	(7.9×10^3)	(9.9×10^3)
MOR:	(53)	(92)
Compression strength, MPa		
Perpendicular to grain:	(24.3)	(46.7)
Parallel to grain:	(6.9)	(12.2)
Shear strength, MPa:	(12.3)	(8.0)

DURABILITY

Reported to be durable. However, other species of *Larix*-like European and Japanese larch have been reported to be only moderately durable.

TREATABILITY

Another species of larch (*Larix decidua*) has been reported to offer very high resistance to the penetration of preservatives, even under pressure. Sapwood has also been reported to be fairly difficult to impregnate.

WORKING PROPERTIES

Tests on *Larix decidua* in the United Kingdom indicate that the timber is sometimes a little difficult to convert, owing to its resinous nature and its tendency to bend on the saw. When dried, larch saws and machines fairly rapidly and to a good finish. It has good nailing properties.

USES

It is suitable for use in the construction of farm buildings, gates and fences. In other building construction, larch is used mainly for exterior work such as cladding, gates and sills. It has also been a traditional timber for boat building and is used for floors of motor lorries and for vats in the chemical industry. A large volume of larch is used in the form of poles.

EQUIVALENT WOOD

Japanese larch (Red larch) Japan

REFERENCES

[1], [7], [10], [21] and [24]-[28].

*No data for *L. griffithiana* are available. However, the species *L. decidua*, tested in the United Kingdom, is used as a guide since its density is very close to that of *L. griffithiana*.

Data sheet 23

SPRUCE

BHUTANESE TRADE NAME

Spruce

BOTANICAL NAME

Pinaceae
Picea spinulosa

DISTRIBUTION

Widely distributed in the cooler and temperate regions of the northern hemisphere. Found from Afghanistan eastwards at elevations of 1,800-3,000 m. It is also found in the inner valleys of Sikkim and Bhutan.

GENERAL DESCRIPTION

No distinction between sapwood and heartwood except in large trees, where the core wood and the butt may be dull red; the timber is white when first exposed, turning greyish brown with age; without characteristic odour or taste.

Grain straight. Texture medium fine and even.

Growth rings distinct, delineated by a somewhat darker band of denser summer wood.

Tracheids medium fine and arranged in definite radial rows; spring wood tracheids variable in size in the transverse section, squarish to somewhat hexagonal or occasionally rectangular; transition from spring wood to summer wood gradual.

Parenchyma absent.

Rays not distinct with the naked eye.

Resin canals present, longitudinal and transverse, with thick-walled epithelium; longitudinal canals very irregular in their distribution and confined mainly to the middle and outer portion of the ring; solitary or occasionally two or more; transverse canals are smaller then the longitudinal canals, solitary and are found inside the ray.

PHYSICAL PROPERTIES

Air-dry density: 464 kg/m^3 (29 lb/ft^3) at 12% MC.

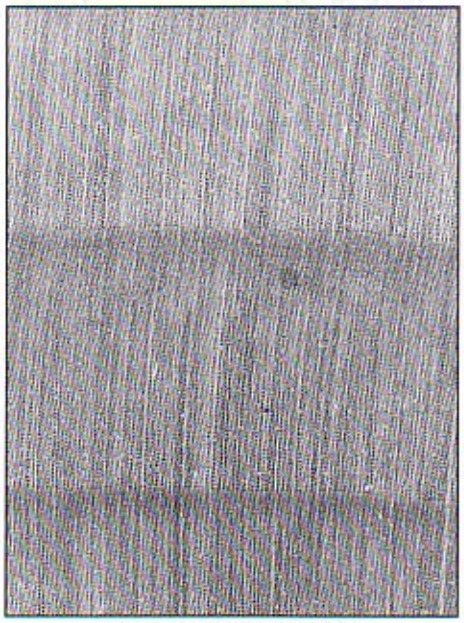
Shrinkage

Radial: 4.3%
Tangential: 7.4%

Seasoning: The timber seasons well and does not warp or twist to any extent; however, long and

Radial

Tangential



Cross-section (x 10)

fine splits may develop if exposed to direct sunlight. It is advisable to convert the logs as soon as possible after felling to prevent fungi infestation and decay.

Mechanical properties (air-dry)

Strength group: (SD6)*

Static bending, MPa

MOE: (10.8×10^3)
MOR: (68.5)

Compression strength, MPa

Perpendicular to grain: (6.1)
Parallel to grain: (40.4)

Shear strength: N.A.

Durability

Non-durable.

Treatability

Difficult to treat with preservative.

Working properties

It has been reported that spruce is easy to saw and machine; in this respect, it is very similar to European spruce. However, some difficulties may be encountered in the presence of numerous large knots. It takes varnish well but darkens considerably on exposure.

Uses

Suitable in house-building as planks, ceiling and floor and for packing cases, tea chests and water troughs. It is said to be suitable for matchboxes but unsuitable for match splints.

Equivalent wood

Himalayan spruce	India
Spruce	A popular name for the timber *Picea*

References

[9], [11], [14] and [17].

*Based on the strength values of *Picea morinda* in India.

Data sheet 24

BLUE PINE

BHUTANESE TRADE NAME

Blue pine

BOTANICAL NAME

Pinaceae
Pinus wallichiana
[Syn. *Pinus excelsa* (wall) A. B. Jack]

DISTRIBUTION

From Afghanistan to Sikkim and Bhutan, at 1,800-3,800 m, but usually above 2,400 m, sometimes in pure stands, sometimes in association with deodar and other species.

GENERAL DESCRIPTION

Sapwood whitish and heartwood light pinkish red to light red and fairly lustrous.

Grain fairly straight. Texture medium fine.

Growth rings distinct, formed by darker bands of dense summer wood.

Tracheids medium fine and arranged in definite radial rows; spring wood tracheids squarish to rectangular or somewhat hexagonal in the transverse section, without intercellular spaces; transition from the spring wood to summer wood gradual.

Parenchyma absent.

Rays not distinct with naked eye.

Resin canals present; irregularly distributed and confined for the most part to the middle and outer portion of the ring; solitary or rarely two, contiguous in the tangential plane.

PHYSICAL PROPERTIES

Air-dry density: 515 kg/m^3 (32 lb/ft^3) at 12% MC.

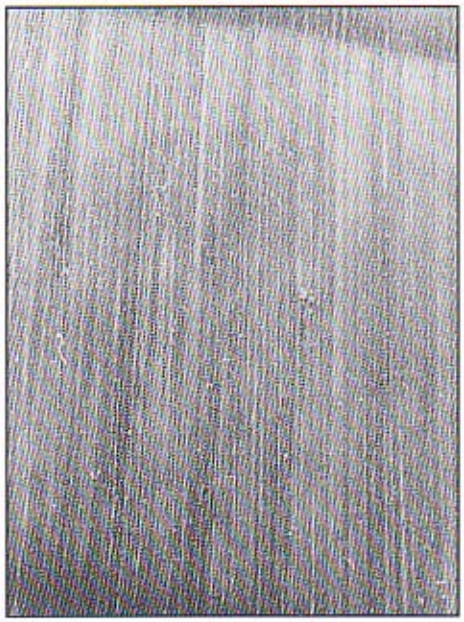
Shrinkage

Radial: N.A.
Tangential: N.A.

Seasoning: The timber seasons well and considerably better than other Indian pines. It has been reported that it is easy to kiln-dry and that boards with moisture content of 25% could be dried in six days to 7%, with no degrade whatsoever. It shows little tendency to warp or twist, nor does it shrink appreciably.

Radial

Tangential



Cross-section (x 10)

Mechanical properties (air-dry)

Strength group: (SD7)*

Static bending, MPa

MOE: (6.8×10^3)
MOR: (47)

Compression strength, MPa

Perpendicular to grain: N.A.
Parallel to grain: (36)

Shear strength, MPa: (8.0)

Durability

Non-durable.

Treatability

Can easily be treated with preservative by pressure impregnation.

Working properties

Turning: good Finish: good

It has been reported that the timber is one of the easiest timbers to saw, machine and bring to a good finish, particularly if free of knots. The timber turns very cleanly and can be machine-finished to a good surface across the grain.

Uses

Suitable for construction, joinery, flooring, decking for boats and, when selected, for drawing boards.

Equivalent wood

Blue pine, kail India

References

[11], [14], [17] and [28].

*The strength value is based on the test results of *P. excelsa* from India, which is a synonym to the Bhutanese *P. wallichiana*.

Data sheet 25

HEMLOCK

BHUTANESE TRADE NAME

Hemlock

BOTANICAL NAME

Pinaceae
Tsuga brunoniana Carr.
(Syn. *Tsuga dumosa* (D. Don) Eichl)

DISTRIBUTION

Central and eastern Himalayas from Kumaon to Bhutan at 2,500-3,200 m.

GENERAL DESCRIPTION

Light-coloured wood with a pinkish tinge, soft and light in weight.

Grain generally straight. Texture medium fine and even.

Growth rings distinct.

Tracheids fine and difficult to see, even with a hand lens; transition from early wood to late wood gradual.

Parenchyma absent.

Rays fine and not distinct with naked eye. Resin ducts scanty.

PHYSICAL PROPERTIES

Air-dry density: 464 kg/m^3 (29 lb/ft^3) at 12% MC.
Shrinkage

Radial: 1.1%
Tangential: 2.7%

Seasoning: Seasons well with care.

MECHANICAL PROPERTIES (AIR-DRY)

Strength group: (SD7)*

Static bending

MOE: N.A.
MOR: N.A.

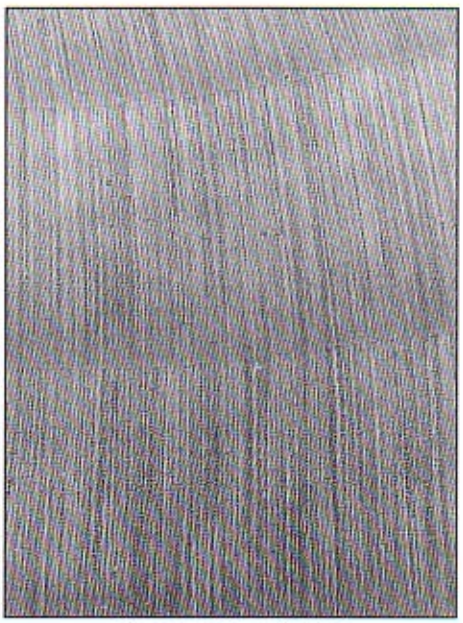
Compression strength

Perpendicular to grain: N.A.
Parallel to grain: N.A.

Shear strength: N.A.

Radial

Tangential



Cross-section (x 10)

*Based on its density, the timber is provisionally placed in strength group SD7.

Durability

Moderately durable.

Treatability

No data available.

Working properties

Easy to work and finishes smoothly.

Uses

Suitable for all kinds of tool handles, construction work, beams, rafters, agriculture implements, wheel works, turnery. Also used for shingles of roofs.

Equivalent wood

Indian hemlock spruce	India
Hemlock	A popular name for the timber *Tsuga* in many countries

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[9], [12] and [21].

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