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INDIAN WOODS

INDIAN WOODS

Their identification, properties and uses

VOLUME II

Linaceae to Moringaceae



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PREFACE

As stated in the preface to the first volume, it was planned to bring out the book "Indian Woods" in six volumes, each dealing with about 250 to 300 species. The first volume was published in 1958 and dealt with 280 species.

The present volume which is the second in the series deals with the structure, identification, properties and uses of a further 263 species. Bringing out a comprehensive work of this type within such a short period would not have been possible but for the willing co-operation of all those who were entrusted with the task, particularly the members of the staff of the Wood Anatomy Branch.

The main task of writing and editing fell on the senior officers of the Wood Anatomy Branch especially S. S. Ghosh, K. Ramesh Rao and S. K. Purkayastha. The names of other members of the staff who participated in the preparation of the manuscript are given at the end of each family. All technical and laboratory work like section cutting, preparation of permanent slides and photomicrographs, collection of anatomical data, and determination of density of the authentic timber specimens was carried out entirely by R. Shahi, P. N. Nigam, B. S. Negi, D. N. Badola, M. S. Rawat, S. K. Gupta, M. H. Kazmi, D. N. Chaturvedi and Krishna Lal of the Wood Anatomy Branch. Considerable help in the preparation of the indices was given by Kumari K. K. Taneja, while the typing work has been executed by Shri Satya Bhushan.

Dr. K. A. Chowdhury, Professor of Botany, Aligarh Muslim University and formerly Officer-in-Charge, Wood Anatomy Branch, Forest Research Institute Dehra Dun, who was kind enough to go through the preliminary drafts of about 20 families has suggested some alterations and corrections. He has also helped in the selection of 57 photomicrographs out of 198 included in this volume.

The Officers-in-Charge, Composite Wood Branch (D. Narayanamurti), Wood Seasoning Branch (M. A. Rehman), Forest Entomology Branch (R. N. Mathur), Wood Preservation Branch (A. Purushotham), Timber Mechanics Branch (A. C. Sekhar) and Forest Pathology Branch (B. K. Bakshi) very kindly gave all co-operation by supplying available information on the properties and uses of timbers, pertaining to their respective fields. The Officer-in-Charge, Botany Branch (M. B. Raizada) has checked up the nomenclature of all the species included in this volume.

Besides the above, grateful thanks are also due to the Director, Forest Products Research Laboratory, Princes Risborough, England, for information given on Indian grown mahogany, the Chief Botanist, Botanical Survey of

India, for checking the nomenclature and the Chief Editor, Council of Scientific and Industrial Research, for permission to consult their ledger files.

The Baptist Mission Press, Calcutta, have taken great care in the preparation of the half-tone blocks and printing of the plates.

It is hoped that the information recorded in this volume will not only be of use to the timber industry but also to Wood Technologists. various government departments, universities and other organizations, both in India and abroad, who are interested in the study and applications of wood.

Dehra Dun,
4th October, 1960.

D. NARAYANAMURTI,
President,
Forest Research Institute and Colleges.

CONTENTS

	Page
PREFACE	1
LINACEAE	1
ERYTHROXYLACEAE	4
ZYGOPHYLLACEAE	7
OXALIDACEAE	10
RUTACEAE	13
SIMARUBACEAE	50
OCHNACEAE	62
BURSERACEAE	64
MELIACEAE	81
DICHAPETALACEAE	160
OLACACEAE	162
ICACINACEAE	170
AQUIFOLIACEAE	175
CELASTRACEAE	180
RHAMNACEAE	195
SAPINDACEAE	207
ACERACEAE	240
HIPPOCASTANACEAE	250
STAPHYLEACEAE	255
SABIACEAE	259
ANACARDIACEAE	264
CORIARIACEAE	324
MORINGACEAE	326
APPENDIX I. Mechanical properties	330
APPENDIX II. Classification of woods according to anatomical structure	334
APPENDIX III. Classification of woods according to uses	339
APPENDIX IV. Latest changes in nomenclature	348
INDEX I. Scientific names	351
INDEX II. Trade and common names	359

LIST OF ILLUSTRATIONS

End grain photomicrographs of timbers (10)

PLATE 31	Figure
Erythroxylon burmanicum Griff. [E. cuneatum (Wall.) Kurz]	181
E. kunthianum (Wall.) Kurz	182
E. monogynum Roxb.	183
Ixonanthes khasiana Hk. f.	184
Balanites roxburghii (L.) Dehle [B. aegyptiaca (L.) Delile]	185
Averrhoa carambola L.	186
PLATE 32	
Acronychia laurifolia Blume [A. pedunculata (L.) Miq.]	187
Aegle marmelos (L.) Correa	188
Atalantia missionis Oliver [Pamburus missionis (Wt.) Swingle]	189
A. monophylla DC.	190
Chloroxylon swietenia DC.	191
Citrus aurantium L.	192
PLATE 33	
Citrus medica L.	193
Clausena excavata Burm. f.	194
Evodia fraxinifolia Hk. f.	195
E. meliaefolia Benth.	196
E. roxburghiana Benth. [E. lunu-ankenda (Gaertn.) Merr.]	197
Feronia elephantum Correa [F. limonia (L.) Swingle]	198
PLATE 34	
Glycosmis pentaphylla (Retz.) Correa	199
Limonia acidissima Auct. (non Linn.) [Hesperethusa crenulata (Roxb.) Roem.]	200
Micromelum pubescens Blume [M. integerrimum (Buch.-Ham.) Roem.]	201
Murraya exotica L. [M. paniculata (L.) Jack.]	202
M. koenigii (L.) Spr.	203
Skimmia laureola Sieb. & Zucc.	204

PLATE 35

Vepris bilocularis Engl. 205
Zanthoxylum budrunga Wall. 206
Z. ovalifolium Wight 207
Z. rhetsa DC. 208
Ailanthus excelsa Roxb. 209
A. excelsa Roxb. 210

PLATE 36

Ailanthus grandis Prain 211
A. malabarica DC. 212
Harrisonia bennettii Hk. f. 213
Irvingia malayana Oliver 214
Picrasma javanica Blume 215
P. quassioides Bennett 216

PLATE 37

Samadera indica Gaertn. 217
Ochna wallichii Planchon 218
Balsamodendron mukul Hk. [Commiphora mukul (Hk. ex-Stocks) Engl.] 219
Boswellia serrata Roxb. 220
B. serrata Roxb. 221
Bursera serrata Wall. ex Colebr. 222

PLATE 38

Bursera serrata Wall. ex Colebr. 223
Canarium bengalense Roxb. 224
C. euphyllum Kurz 225
C. sikkimense King 226
C. strictum Roxb. 227
Garuga gamblei King 228

PLATE 39

Garuga pinnata Roxb. 229
G. pinnata Roxb. 230
Aglaia andamanica Hiern 231
A. edulis A. Gray 232
A. odoratissima Blume 233
A. odoratissima Blume 234

	Figure
PLATE 40	
Amoora cucullata Roxb.	235
A. rohituka W. & A. [Aphanamixis polystachya (Wall.) Parker] ..	236
A. wallichii King	237
A. wallichii King	238
A. wallichii King	239
Azadirachta indica A. Juss.	240
PLATE 41	
Carapa moluccensis Lam.	241
C. obovata Blume	242
Cedrela microcarpa C. DC.	243
C. serrata Royle	244
C. toona Roxb.	245
C. toona Roxb.	246
PLATE 42	
Chisocheton grandiflorus Kurz	247
C. paniculatus Hiern	248
Chukrasia tabularis A. Juss.	249
C. tabularis A. Juss.	250
C. velutina Roemer	251
Cipadessa fruticosa Blume	252
PLATE 43	
Dysoxylum binectariferum Hk. f.	253
D. hamiltonii Hiern	254
D. malabaricum Bedd.	255
D. malabaricum Bedd.	256
D. malabaricum Bedd.	257
D. procerum Hiern	258
PLATE 44	
Heynea trijuga Roxb.	259
H. trijuga Roxb.	260
Lansium anamalayanum Bedd.	261
L. decandrum King	262
Melia azedarach L.	263
M. birmanica Kurz	264

PLATE 45

	Figure
Melia composita Willd.	265
Sandoricum indicum Cav.	266
Soymida febrifuga A. Juss.	267
Swietenia macrophylla King	268
S. mahagoni Jacq.	269
S. mahagoni Jacq.	270

PLATE 46

Walsura glauca C. E. C. Fischer	271
W. piscidia Roxb.	272
W. robusta Roxb.	273
W. villosa Wall.	274
Chailletia gelonioides Hk. f. (Dichapetalum gelonioides Engl.) ..	275
Anacolosa densiflora Bedd.	276

PLATE 47

Olax scandens Roxb.	277
Phlebocalymna griffithiana Mast.	278
Schoepfia fragrans Wall.	279
Strombosia ceylanica Gardner	280
S. javanica Blume	281
Ximenia americana L.	282

PLATE 48

Apodytes cambodiana Pierre	283
Gomphandra polymorpha Wight	284
Mappia foetida Miers	285
Ilex denticulata Wall.	286
I. dipyrena Wall.	287
I. godajam Colebr.	288

PLATE 49

Ilex hookeri King	289
I. insignis Hk. f.	290
I. odorata Buch.-Ham.	291
I. venulosa Hk. f.	292
Elaedendron glaucum Pers.	293
E. hamiltonianus Wall.	294

	Figure
PLATE 50	
Euonymus javanicus Blume	295
Gymnosporia montana Lawson	296
Kokoona filiformis C. E. C. Fischer	297
K. littoralis Lawson	298
Kurrimia paniculata Wall.	299
K. pulcherrima Wall. (K. robusta Kurz)	300
PLATE 51	
Lophopetalum fimbriatum Wight	301
L. wightianum Arn.	302
Microtropis microcarpa Wight	303
M. ovalifolia Wight	304
Pleurostylia wightii W. & A.	305
Siphonodon celastrineus Griff.	306
PLATE 52	
Gouania leptostachya DC.	307
Rhamnus nepalensis Wall.	308
R. purpureus Edgew.	309
R. virgatus Roxb.	310
Sageretia brandrethiana Aitchison	311
Scutia indica Brongn.	312
PLATE 53	
Zizyphus jujuba Lam.	313
Z. jujuba Lam.	314
Z. nummularia W. & A.	315
Z. xylopyrus Willd.	316
Z. xylopyrus Willd.	317
Allophyllus cobbe Blume	318
PLATE 54	
Arytera littoralis Blume..	319
Dodonea viscosa (L.) Jacq.	320
Erioglossum rubiginosum Blume	321
Filicium decipiens Thw.	322
Harpullia cupanioides Roxb.	323
Lepisanthes tetraphylla Radlk.	324

PLATE 55

	Figure
Mischocarpus fuscescens Blume	325
Nephelium longana Cambess	326
Paranephelium hystrix W. W. Smith	327
Pometia pinnata Forst.	328
Sapindus laurifolius Vahl	329
S. mukorossi Gaertn.	330

PLATE 56

Schleichera trijuga Willd.	331
Xerospermum glabratum C. E. C. Fischer	332
Acer campbellii Hk. f. & Th.	333
A. oblongum Wall.	334
A. thomsoni Miq.	335
Aesculus indica Colebr.	336

PLATE 57

Aesculus indica Colebr.	337
Staphylea emodi Wall.	338
Turpinia pomifera DC.	339
Meliosma arnottiana Wight	340
M. dilleniaefolia Blume	341
M. pungens Walpers	342

PLATE 58

Meliosma simplicifolia Roxb.	343
M. thomsoni King	344
M. wallichii Planchon	345
Anacardium occidentale L.	346
Bouea burmanica Griff.	347
Buchanania lancifolia Roxb.	348

PLATE 59

Buchanania latifolia Roxb. (B. lanzan Spreng.)	349
Dracontomelum mangiferum Blume	350
Drimycarpus racemosus Hk. f.	351
Gluta tavoyana Hk. f.	352
G. travancorica Bedd.	353
Holigarna grahamii Hk. f.	354

PLATE 60

	Figure
Holigarna helferi Hk. f.	355
H. longifolia Roxb.	356
Lannea grandis Engl.	357
Mangifera indica L.	358
M. indica L.	359
M. longipes Griff.	360

PLATE 61

Mangifera sylvatica Roxb.	361
Melanorrhoea glabra Wall.	362
M. usitata Wall.	363
Nothopegia colebrookiana Blume	364
Parishia insignis Hk. f.	365
Pistacia integerrima Stewart	366

PLATE 62

Pistacia terebinthus L.	367
Rhus continus L.	368
R. parviflora Roxb.	369
R. punjabensis J. L. Stewart	370
R. succedanea L.	371
Semecarpus auriculata Bedd.	372

PLATE 63

Spondias mangifera Willd. [S. pinnata (L. f.) Kurz]	373
Swintonia floribunda Griff.	374
S. floribunda Griff.	375
S. schwenckii Kurz	376
Coriaria nepalensis Wall.	377
Moringa pterygosperma Gaertn. (M. oleifera Lam.)	378

LIST OF TABLES

		Page
Table I.	Mechanical and Physical Properties of Mahogany in the green condition grown in India and in Central America	150
Table II.	Comparative Anatomy of the Sapindaceae and their Allies	207
Table III.	Comparative Strength Figures of Indian and Foreign Maples	246

LINACEAE

The family consists of about 17 genera and 300 species distributed in tropical, sub-tropical and temperate regions. From the point of view of timber, the family is not of any importance as only a few attain tree size, the rest being shrubs, herbs or climbers. Economically, however, the family is of great value on account of the fibre and oil obtained from *Linum usitatissimum* Linn., the well known flax plant. Flax is reported to be the earliest vegetable fibre employed by man for textile purposes even before cotton. The "Mummy cloths" of ancient Egyptians, which are over 4,500 years old, are said to be made of this fibre(8). From very early times the cultivation of flax has been practised in Europe and other countries. The most ancient species is considered to be the biennial type *L. angustifolium* Huds., which is said to have been cultivated by Swiss lake-dwellers as well as people of northern Italy. On the other hand the species cultivated in Mesopotamia, Assyria and Egypt in olden times(4) is regarded to be *L. usitatissimum* which is an annual type. Flax is now cultivated all over the world for fibre and oil. It yields a very long bast fibre, 25 to 30 mm. in length(3) and about 6 to 7 times that of jute – *Corchorus* spp.(9), which constitutes an important raw material for the textile industry. It is used for linen, and better grades of twine, sewing, binding and other types of thread. Mixed with jute it is used in the manufacture of clothing and furnishing materials. It is also used for the manufacture of high grade writing and printing paper as well as for currency notes and permanent records.

Though grown mostly for its fibre in the temperate regions of Europe and America, it is cultivated in several parts of India – particularly Madhya Pradesh, Uttar Pradesh, Andhra Pradesh and Bihar mainly as an oil seed crop. Linseed oil is extensively used in paints and varnishes and is exported in large quantities. The oil cake left after crushing the seeds is very good as a cattle food. The bark, leaves and flowers are of medicinal value, the dried seeds being commonly used as a poultice in rheumatism and for boils.

Woods of this family are characterised by diffuse-porous structure except in *Linum* Linn. where certain species exhibit a ring-porous structure(5). Growth rings are usually wanting. Vessels are mostly solitary and moderately large. Tyloses are absent from most of the species. Parenchyma is very variable ranging from banded to scanty paratracheal. Rays are fine to moderately broad.

In India, there are three genera which may be considered woody, of which two are dealt with here. *Reinwardtia trigyna* Planch. a small shrub occurring in the hilly regions throughout India was not available for study.

The two woods described here are easily distinguishable. *Hugonia* Linn. is characterised by very small, and numerous vessels, and scanty parenchyma, which is hardly visible even under the lens, whereas in *Ixonanthes* Jack., the vessels are mostly solitary, moderately large, and rather scanty and the parenchyma is distinctly visible to the eye in fairly thick wavy tangential bands.

1. HUGONIA LINN.

A genus of climbing shrubs occurring in the tropical regions of Africa, Asia and Australia. The only species found in India is described here.

H. mystax Linn.—*Mullankode* (Kan.), *modirakanni* (Mal.), *motirakodi, kodivirai* (Tam.), *kakibira, ungaralapedmi* (Tel.). A rambling or climbing shrub. *Bark* yellowish, corky.

It is found in coastal Bombay and Mysore from Konkan southwards, and in the dry districts of the Eastern Ghats.

Description of the wood

General properties—Wood greyish-white turning yellow-brown with age ; moderately hard ; moderately heavy ; somewhat lustrous ; straight-grained and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* apparently distinct, delimited by a narrow layer of thick-walled fibres with scanty vessels, 9–14 per cm. *Vessels* very small, visible only under hand lens, very numerous (over 100 per mm.^{2}), solitary or in radial multiples of 2–3, often crowded giving the impression of clusters, round to oval in shape, open ; vessel lines not distinct. *Parenchyma* scanty and just visible under hand lens in the vicinity of the vessels as vasicentric to inconspicuously aliform. *Rays* fine to very fine, barely visible to the eye, closely spaced.

It is a straight-grained, fine-textured and fairly hard wood. The sample examined did not show any major seasoning defects. It was also free from any damage by insect or fungus. The wood appears to be suitable for making small turnery articles.

Material—

4167 Velagalapalle, Andhra Pradesh.

2. IXONANTHES JACK.

A small genus of trees occurring in tropical Asia, chiefly the Malay Peninsula. The only species growing in India is dealt with here.

I. khasiana Hook. f.—*Selbal* (Garo), *thing-buphai* (Kuki), *theibar* (Tipp.). A fairly large tree fluted at the base attaining up to 37 m. in height and 75 cm. in diameter. *Bark* greyish, rough and thin.

It grows in Assam in the Garo and Khasi Hills and Cachar. It also occurs in Sylhet.

Description of the wood

[Pl. **31**, 184]

General properties—Wood light yellowish-grey, moderately hard to hard ; moderately heavy (sp. gr. 0·72 air-dry) ; straight to somewhat interlocked-grained ; medium and rather uneven-textured ; often showing a pleasant figure on the plain sawn surface due to wavy parenchyma bands.

Gross structure—A diffuse-porous wood. *Growth rings* apparently distinct, demarcated by dense fibrous bands devoid of vessels, 2-5 per cm. *Vessels* moderately large, just visible to the eye, moderately few (5 10 per mm.^{2}), mostly solitary, showing a tendency towards oblique radial arrangement, round to oval in outline, open , vessel lines distinct on longitudinal surfaces. *Parenchyma* rather conspicuous to the eye as short or long, fairly thick white wavy tangential bands, often connecting or touching the vessels and also ending abruptly ; parenchyma bands rather evenly distributed, but not very closely spaced. *Rays* fine to very fine, visible only under lens, closely spaced.

It is a hard and strong timber. The sample in the wood collection does not show any seasoning or other defects due to insect or fungus. It takes a fine polish and should prove ornamental if properly converted. The wood is suitable for construction and general carpentry work and also for furniture and cabinet work.

Material—

7974 Assam (0·72).

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S. S. GHOSH.

ERYTHROXYLACEAE

The family consists of two genera of shrubs and small trees widely distributed throughout the tropical regions of the world, particularly South America. Of the two genera, *Aneulophus* Benth., is a monotypic genus confined to tropical West Africa while *Erythroxylum* Linn. is a large genus comprising of about 200 species. Some botanists also include here *Necturopetalum* Engl. of tropical Africa(8). The members of this family were previously included under the *Linaceae* but are now generally considered to be distinct from it. From the point of view of wood anatomy also, the *Erythroxylaceae* is distinguished from the *Linaceae* in not having scalariform perforations in the vessels(4).

The importance of the family is due to cocaine which is obtained from the leaves of *Erythroxylum coca* Lam. of south America. The fruit of *E. monogynum* Roxb. of India is edible and pleasant. Leaves are also reported to have been used as food at times of scarcity(3), while an infusion of the wood and bark is useful in mild cases of dyspepsia and continued fever. The bark of *E. kunthianum* Wall. is said to be used(6) for chewing with *pan* (betel leaf).

The only genus found in India is described below.

ERYTHROXYLUM LINN.

A tropical genus of shrubs or small trees of about 200 species. Six species are reported to grow in the Indian region, three of which were available for study and are described here. The remaining three occur in the Western Ghats. These are *E. acuminatum* Walp., *E. obtusifolium* Hook. f. and *E. lanceolatum* Hook. f. The cultivation of *E. coca* was tried in several places in India but it was not a success. The plant is, however, sometimes grown in gardens for ornamental purposes.

The woods of the three species are generally similar in structure and are, therefore, described together. However, *E. kunthianum* is somewhat lighter and can be distinguished from the others by the characteristic radial arrangement of the vessels in long radial chains or clusters and the relatively distinct rays. In *E. burmanicum* Griff., the pores are somewhat larger than in the other two.

1. **E. burmanicum** Griff. [**E. cuneatum** (Wall.) Kurz.]—A small tree of Tenasserim, Burma and the Andaman Islands.

Description of the wood—See page 5.

2. **E. kunthianum** Wall.—*Dieng-pain-khar, dieng-pyllengtham* (Kh.), *dieng-juwat, dieng-sussi* (Synt.). A shrub or small tree 1–1·8 m. in height. *Bark* greyish, rough, thin, inner bark reddish with white streaks turning brown on exposure.

It occurs in the Khasi and Jaintia Hills at 900–1,700 m. elevation ; also frequently met with in the drier hill forests of Martaban and Tenasserim between 1,800–2,200 m.

Description of the wood—See below.

3. **E. monogynum** Roxb.—*Jeemthali, jivadali, ramanchi* (Kan.) *chemmana* (Mal.), *devadara, sembulichan, shemanathi, shemmuna* (Tam.), *adivi gerenta, devadaru, gadara, gadiri, gathara, pagadapu-katta* (Tel.) ; also known as bastard sandal. A shrub or a small tree growing up to 7·5 m. in height. *Bark* rough and dark brown.

The tree is common in the dry evergreen forests of Andhra Pradesh, Madras and Mysore in the dry hill forests of the Western Ghats at an elevation of 900 m. It often grows in the same habitat as *Santalum album* Linn. The tree extends to Ceylon also where it grows in drier parts.

Description of the wood—See below.

Description of the wood

(*Erythroxylum burmanicum, E. kunthianum* and *E. monogynum*)

[Pl. **31**, 181–183]

General properties—Sapwood and heartwood sharply demarcated but a distinct heartwood not observed in *E. kunthianum*. Sapwood whitish or pale brown ; heartwood dark reddish brown sometimes with a pinkish tinge ; wood in *E. burmanicum* and *E. monogynum* very hard and heavy to very heavy (sp. gr. 0·88–1·15 air-dry), but moderately hard and moderately heavy in *E. kunthianum* (sp. gr. 0·67 air-dry) ; sometimes lustrous with inconspicuous silver fleck on the radial surface ; usually interlocked-grained and fine to very fine and even-textured, often with an oily feel. Heartwood of *E. monogynum* has sometimes a pleasant resinous smell.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct but occasionally faintly marked by a narrow zone of denser fibrous tissue. *Vessels* small to very small, visible only under lens, moderately numerous to numerous (17–44 per mm.^{2}), solitary and in radial multiples of 2–3, occasionally up to 6, more or less evenly distributed, often with a pronounced tendency for radial alignment in *E. kunthianum*, sometimes may also be in radial or oblique clusters, or sometimes filled with tyloses in the heartwood ; vessel lines indistinct.

Parenchyma barely visible to just visible under lens, diffuse to diffuse-aggregate and also in association with vessels forming incomplete sheath varying in amount and visibility; usually indistinct or appearing as diffuse under hand lens in *E. monogynum* but distinctly visible in *E. kunthianum* in very fine closely spaced tangential lines forming an irregular network with the rays; the parenchyma is intermediate in *E. burmanicum* appearing as very fine, short, tangential lines less distinct than *E. kunthianum*, also forming incomplete sheath round the vessels. *Rays* fine to very fine, indistinct to just visible under hand lens, in *E. burmanicum* and *E. monogynum*; with a few somewhat broader ones just visible to the eye and distinct with lens in *E. kunthianum*, closely spaced.

The timber is heavy, strong and durable. Samples in the wood collection are in excellent condition and do not show any defects. The wood is not difficult to work with tools and can be brought to a very smooth surface. It takes a beautiful polish.

Uses—The timber apparently is not much in use at present except *E. monogynum* which is sometimes used for adulterating sandalwood. It should, however, be very useful for house posts, poles, agricultural implements and also turnery articles. It may be tried for knife handles and small tool handles. The wood of *E. monogynum* yields a reddish brown tar or oil on destructive distillation which is said to be used for preserving country boats.

Material—

E. burmanicum – 6766 Burma (0·97).

E. kunthianum – 7973 Assam (0·67).

E. monogynum – 1083 North Arcot, Madras (0·88), 1091 Madura, Madras (1·06), 2027 Mysore (1·09), 3896 Cuddapah, Andhra Pradesh (1·15), 4067 Cuddapah, Andhra Pradesh (0·98).

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S. S. GHOSH.

ZYGOPHYLLACEAE

The family consists of 26 genera and about 250 species, mostly herbs and shrubs and a few trees, distributed in the arid regions of the tropics and sub-tropics of the world. The systematic position of the genus *Balanites* Delile which has been included in this family here is not very clear. Bentham & Hooker placed it in the family *Simarubaceae* but it is now generally considered to belong to the *Zygophyllaceae*. Some botanists have even created a separate family, *Balanitaceae* to accommodate it(10). From the point of view of wood anatomy, though it has several characters including some highly specialized ones in common with other members of the *Zygophyllaceae*, it differs markedly from them in having large and conspicuous rays(4, 6).

From the timber point of view the family is of interest in that it furnishes the well-known "lignum-vitae" of commerce, produced by *Guaiacum officinale* Linn. of the West Indies and Central America. It is a much prized timber, and according to Record has been an article of trade for about 400 years for certain exacting uses. It is one of the heaviest and hardest woods in the world and is extremely resistant to abrasion, wear and tear. Most of the tissues, particularly fibres and vessels are heavily filled with resin, which is perhaps responsible for the self lubricating property of the wood, making it an ideal material for all types of bearings especially under water. It was, however, the extra-ordinary medicinal properties reported to be possessed by this wood that first attracted attention to it in Europe. The origin of the name 'Lignum-vitae' meaning wood of life can be traced to the supposed curative power of this wood in venereal and other diseases. It is not, however, used at present for this purpose, but the resin is sometimes used in gout and rheumatism. Tincture of guaiac prepared from this resin is reported to be useful in the detection of blood stains(8).

Two other closely allied genera, *Bulnesia* C. Gay and *Porlieria* Rinz both small trees of tropical and sub-tropical America, also produce very hard, very heavy and horn like timber. Of these, *Bulnesia* is sometimes used as a substitute for 'Lignum-vitae'. Among other important trees of the family, mention may be made of *Balanites aegyptiaca* (Linn.) Delile, almost every part of which has got some use. The bark, unripe fruits and leaves are used as an anthelmintic and purgative, while the juice of the bark is used in fish poison. Seeds are sometimes used in cough and colic. The kernels of the seeds yield an oil suitable for soap making and for lighting purposes. According to Moldenke the oil has antiseptic properties and is one of the many "balms" mentioned in the Bible. The pulp of the fruit is reported to be used for cleaning silk and cotton(1).

The woods of the family are characterised by very small to moderately large vessels varying in distribution from exclusively solitary to flame-like clusters. Parenchyma is mostly apotracheal, diffuse to diffuse-aggregate, and also in tangential bands delimiting growth rings in some species. The rays are usually fine. Ripple marks are numerous and always present. Invariably, all the wood elements, viz., vessels, parenchyma, rays and fibres are storied, which is a very characteristic feature of the family. But in *Balanites* the rays are very large and high and not storied as also the fibres. For this reason, ripple marks are not prominent in *Balanites*.

The family is represented in the Indian region by six genera of which only *Balanites* is woody and is considered here.

BALANITES DELILE

A small genus of spiny shrubs and small trees, distributed in North Africa, Abyssinia, Arabia, Syria and Burma. Two species are reported to grow in India and Burma of which samples of one were available for study and are described here. The other species *B. triflora* van Tieg. occurs in north Burma.

B. roxburghii Planchon [B. **aegyptiaca** (Linn.) Delile]—*Hin.*(Beng.), *regorea* (Guj.), *engua, hingota, hongot, hingu, ingudi* (Hind.), *hingabet* (Mar.), *nanjunda* (Tam.), *gari* (Tel.). A small spiny tree reaching about 6 m. in height. *Bark* thin, whitish-grey, hard and corky.

It is found in the drier parts of India from the Punjab to Sikkim, Bihar, Bengal, Orissa, Madhva Pradesh southwards and Bombay.

Description of the wood

[Pl. **31,** 185]

General properties—Wood yellowish-white turning pale brown on ageing ; moderately hard, moderately heavy (sp. gr. 0·68–0·78 air-dry), rather dull, straight to somewhat interlocked-grained, often with bark inclusions due to injury ; medium-textured.

Gross structure—A diffuse-porous wood with semi-ring-porous tendency. *Growth rings* fairly distinct delimited by a thin layer of thicker-walled fibres with scanty parenchyma and at places by tangentially aligned vessel clusters, 2–6 per cm. *Vessels* small to moderately large, very few to moderately numerous (2–12 per mm.^{2}), rather unevenly distributed being more numerous on the face of the ring, solitary or in multiples of 2–3 ; also sometimes in small clusters or groups, open ; vessel lines indistinct. *Parenchyma* inconspicuous, visible only under lens, diffuse to diffuse-aggregate forming an irregular reticulum ; also apparently as thin sheath round the vessels which is actually

made up of vasicentric tracheids and not parenchyma. *Rays* moderately broad to very broad, whitish in colour, distinct to the eye, rather widely spaced showing up as conspicuous flecks on the radial surface. *Ripple marks* present, distinct only under lens, very numerous, 90–100 per cm. *Gum canals* vertical, of the traumatic type, often present in uniseriate rows.

It is a moderately hard and moderately heavy timber but due to the small size and frequent inclusion of bark, the usefulness of the timber is limited. The wood is reported to be attacked by *Sinoxylon sudanicum* (Bostrychidae). One of the samples in the timber collection is damaged by borers. The wood is, however, locally used for fuel and also for walking sticks.

Material—

450 Ajmer (0·68), 1171 Ahiri Reserve, Bombay (0·78), 4466 Chanda, Bombay (0·68).

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S. S. GHOSH.

OXALIDACEAE

The family consists of about 8 genera and 900 species mostly herbs and shrubs, only a few attaining tree size. They are widely distributed both in the temperate and the tropical regions, the largest number occurring in South Africa and South America. The members of this family are closely related to the *Geraniaceae* where they were included in the system of Bentham and Hooker. In wood structure, the *Oxalidaceae* and *Geraniaceae* show close similarity in many respects. According to Heimsch, both these families are characterized by scanty paratracheal parenchyma, frequent occurrence of septate fibres and tendency towards "elimination of rays".

The family is not of much economic value either from the point of view of timber or other products. Two species of *Averrhoa* Linn. are often cultivated for their fruits. These are *A. bilimbi* Linn. and *A. carambola* Linn. The fruits are sour when green but become sweetish on ripening. These are eaten either raw or in the form of curries and pickles, and are specially relished in Bengal when prepared with fish. The dried fruits are cooling and antiscorbutic. It is reported(6) that ripe fruits are used as a remedy for bleeding piles and are useful in relieving thirst. The fruits contain oxalic acid and according to Gamble the juice of the fruits is used for removing iron stains from linen.

The family is represented in India by three genera of which only *Averrhoa* is woody and is dealt with here.

AVERRHOA LINN.

A small genus of evergreen trees. Two species are cultivated in India, viz.. *A. bilimbi* and *A. carambola*. According to some botanists these have been introduced into India from America by the Portuguese while others do not think so. *A. carambola*, the only species for which wood samples were available for study is described here. According to Gamble, the woods of the two species are easily distinguishable as *A. bilimbi* has relatively fewer pores and faint concentric lines. On the other hand, studies by Moll and Janssonius and Desch, have shown that the woods of the two species are very similar and cannot be distinguished on these characters. However, Moll and Janssonius state that in *A. bilimbi* the rays are often biseriate while *A. carambola* has uniseriate rays.

A. carambola Linn.—*Kardai* (Asm.), *kamarak, kamranga* (Beng.), *mak-hpiig, saungya, saunygga* (Burm.), *amrenga* (Garo), *kamarakha, tamarak* (Guj.), *kamrak karmal* (Hind.), *kiranelli, kamarakmara* (Kan.), *dieng-*

sobtreng (Kh.), *thei-rheiol* (Kuki), *pulichi*, *tamarat-tuka* (Mal.), *heinohjom* (Manip.), *kamaraka* (Mar.), *tamarata*, *tamarathai* (Tam.), *karomonga*, *tamartakaya* (Tel.). A small densely branched evergreen tree, 4·5–9 m. high. *Bark* dark grey.

Description of the wood

[Pl. **31**, 186]

General properties—Wood yellowish-white to light yellowish-brown, moderately hard, moderately heavy (sp. gr. 0·61 0·75 air-dry) ; somewhat lustrous ; straight-grained ; fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to indistinct, delimited by very fine lines of parenchyma and sometimes also by denser fibres, usually 1–5 per cm., rarely up to 10 per cm. *Vessels* small to very small, indistinct to just visible to the naked eye, moderately few to moderately numerous (8–14 per mm.^{2}), solitary or in radial multiples of 2–3, occasionally up to 5, with a tendency to be arranged in somewhat radial rows ; round to oval, open ; vessel lines inconspicuous. *Parenchyma* (*a*) in very fine interrupted tangential lines delimiting growth rings visible only under lens with difficulty and (*b*) diffuse, with a few cells also around the vessels, which are usually indistinct under lens. Besides these, lighter-coloured tangential bands simulating parenchyma are also present which are distinct under hand lens. These are actually not parenchyma but thinner-walled septate fibres with large lumen. In some samples, these bands are arranged at more or less regular intervals, alternating with darker coloured fibrous tissue of somewhat similar width, while in others, they may be rather inconspicuous and not so regularly distributed. *Rays* fine to very fine, uniformly distributed and closely spaced. *Pith flecks* occasionally present.

It is a moderately hard and fine-textured wood which should be easy to work and turn. The wood is, however, liable to be attacked by *Stromatium barbatum* Fabr. (Cerambycidae). One of the samples in the wood collection is damaged by borers, while another shows some damage due to fungus.

Uses—The wood is reported to be used for building purposes and furniture in the Sunderbans(3). It should be suitable for small turnery articles, toys, rulers, penholders, cheap scales, etc.

Meterial—

4833 Sunderbans, Bengal (0·61), 5817 Kanara, Mysore (0·65), 6490 Burma (0·75).

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S. S. GHOSH and S. K. PURKAYASTHA.

RUTACEAE

The family *Rutaceae* consists of about 140 genera and 1,300 species of aromatic trees, shrubs and a few herbs, distributed throughout the warm and temperate regions of the world, being most abundant in South Africa and Australia. Some of the genera at present included in it, are of considerable interest from the point of view of taxonomy, as well as anatomy of the secondary xylem. The monotypic genus *Chloroxylon* DC., which was previously placed under the *Meliaceae*(5), differs from that family in having oil glands in the leaves which is a characteristic feature of the *Rutaceae*. It is further distinguished from the *Meliaceae* by the yellowish colour of the wood and absence of septate fibres, and on these grounds its transfer to the *Rutaceae* appears to be in order. However, in the presence of a distinct storied structure giving rise to well-defined ripple marks, the wood resembles some of the *Meliaceae* more than those of the *Rutaceae*.

Similarly, the position of the Australian genus *Flindersia* R. Br., which is included under the *Meliaceae* in the Bentham and Hooker system, and by Hutchinson is also not very clear. From the occurrence of secretory cavities and cells in tissues other than secondary xylem, it appears to be more closely related to the *Rutaceae* than the *Meliaceae* and on this basis has been transferred to the former. In this connection, it is interesting to note that the genus has received considerable attention from several wood anatomists(13) who are all agreed that the correct position of *Flindersia* is not in the *Meliaceae* due to its non-septate fibres and homocellular rays. At the same time the wood structure differs from that of the *Rutaceae*, in the larger and less numerous vessels, wider rays and not infrequent absence of parenchyma delimiting growth rings(13). In colour also, the wood of most species of *Flindersia* is whitish or yellowish resembling the typical *Rutaceae*, but, in some species like *F. brayleyana* F.v.M. and others it may be a distinct shade of pink or reddish-brown as in the *Meliaceae*. Thus, from the point of view of physical and anatomical features, *Flindersia*, appears to occupy an intermediate position between the *Meliaceae* and *Rutaceae*, combining some characteristics of both the families. It has, therefore, been suggested by Harrar, Dadswell and others that a new monotypic family *Flindersiaceae* should be created to accommodate the genus.

The economic importance of the family apart from timber, is mainly due to the genus *Citrus* Linn. which provides several well-known fruits of commerce such as the orange, grape-fruit, tangerine, lemon, lime and pomelo or shaddock. Some species of a few genera like *Aegle* Correa, *Feronia* Gaertn. and *Clausena* Burm. are also occasionally cultivated for their edible fruit. The

pulp from the ripe fruits of *Aegle marmelos* (L) Correa and *Feronia elephantum* Correa is sweetish with a pleasant agreeable odour and is used for preparing a cool, refreshing drink or "sherbet" particularly during the hot summer months. The fruits of some species of *Zanthoxylum* Linn. and the leaves of *Murraya koenigii* Spreng. are much in demand for flavouring curries and soups.

A number of plants belonging to the family are of medicinal value and furnish several drugs and pharmaceutical products. Among the best known may be mentioned "folia Jaborandi" obtained from species of *Pilocarpus* Vahl. of America and the West Indies, and "Buchu leaves" from the South African *Barsoma betulina* Bart et Wendl and other allied species. Essential oils of some importance like "Oil of Bergamot" used in perfumery and "Oil of Rue" used in medicine are distilled from *Citrus bergamia* Risso and *Ruta graveolans* Linn. respectively. A few like the Chinese myrtle *Murraya exotica* Linn., are planted in gardens for ornament.

The most important timber yielding genera are *Flindersia*, *Chloroxylon* and *Zanthoxylum*. *Flindersia* furnishes many commercial timbers of Australia like "Queensland maple", silver ash, hickory ash and "crows ash". Of these, Queensland maple obtained from *F. brayleyana* F.v.M. and *F. pimenteliana* F.v.M. is one of the most valuable in the Australian market. It is somewhat similar to mahogany, and with walnut and cedar, ranks among the best cabinet woods in the world. Cairns hickory, produced by *F. ifflaiana* F.v.M. is considered to be one of the important constructional woods in Northern Australia. *Zanthoxylum flavum* Vahl. is the source of West Indian Satinwood, while *Chloroxylon swietenia* DC. furnishes East Indian satinwood, both well known in the timber trade. Among the relatively less known species, which provide timbers of local importance only are the South American *Balfourodendron riedelianum* Engl., and *Euxylophora paraensis* Huber, the Malayan *Merrillia caloxylon* Swingle (Ketenggah) and some of the Indian evodias. Several woods like *Esenbeckia alata* Pittier, *Murraya exotica* Linn., *Atalantia monophylla* Correa and *Limonia acidissima* Linn., are hard and very fine-textured resembling *Buxus* spp., and have been locally used or recommended for use in place of true boxwood for carving, engraving, turnery and mathematical instruments.

The family is a relatively homogeneous one with a somewhat uniform wood structure. Although the genera can be separated into more than one group on the basis of the anatomical structure, such groups do not coincide with the botanical divisions of the family recognized by the systematists. The woods of this family are usually pale yellowish-white without contrast between heartwood and sapwood. They are fine to moderately coarse-textured, although a few of them show fine to very fine-texture, resembling boxwood. The hardness and density vary from rather soft and light to extremely hard and heavy, but, the majority are rather dense and hard. The working qualities are generally

good. Resistance to decay is variable, being low to moderately high. Growth rings are usually distinct due to bands of concentric initial parenchyma occurring at regular to irregular intervals. The Indian rutaceous woods are mostly diffuse-porous, with the exception of *Evodia fraxinifolia* Hook. f., and *Evodia meliaefolia* Benth. The vessels are usually very small to small, sometimes visible but mostly indistinct without lens. Parenchyma is as a rule scantily developed, but the concentric bands are prominent. Some of these are undoubtedly initial ; others may not be so. Some genera show distinct aliform to aliform confluent parenchyma as in *Citrus*, *Clausena* and *Evodia roxburghiana* Benth. Rays are usually fine, indistinct or just visible to the naked eye and generally closely spaced. Some members contain gummy deposits in their vessels and parenchyma cells. Ripple marks are present only in *Chloroxylon swietenia*. Small pith flecks may be present in *Aegle*, *Atalantia*, *Clausena*, *Evodia*, *Glycosmis*, *Limonia*, *Micromelum* and *Zanthoxylum*. Traumatic gum ducts are of common occurrence and often show up as fine dark lines on the cross and longitudinal surfaces. This happens mostly in *Aegle*, *Atalantia*, *Chloroxylon*, *Citrus*, *Feronia*, *Limonia*, *Micromelum*, *Murraya* and *Zanthoxylum*. The wood of *Skimmia* is easily distinguished from that of other Indian genera by its characteristic flame-like arrangement of vessels.

In India and Burma there are about 19 genera, out of which 15 are described here. The remaining four, not taken into consideration, are given below :—

(1) *Luvunga* Hamilt.—A genus containing two species of climbing shrubs, growing in Assam and East Pakistan.

(2) *Melicope* Forst.—A genus containing only one species, viz., *M. indica* which is a shrub in the Nilgiri hills, Tenasserim and the Andamans.

(3) *Paramignya* Wight.—A genus containing 6 species of erect or climbing shrubs growing in Sikkim Himalaya, Khasi hills, Tenasserim and Ceylon.

(4) *Triphasia* Lour.—A genus containing only one species which is a shrub common in gardens of tropical countries including India.

Key to the genera

1. Wood semi-ring-porous to ring porous	.. *Evodia fraxinifolia* *E. meliaefolia*
1. Wood diffuse-porous	.. 2
2. Ripple marks present ..	.. *Chloroxylon*
2. Ripple marks absent ..	.. 3

3. Vessels evenly distributed 4
3. Vessels in clusters forming flame-like pattern .. *Skimmia*

4. Parenchyma distinct round the vessels, vasicentric to aliform confluent .. 5

4. Parenchyma indistinct, scanty round the vessels .. .. .. *Aegle, Atalantia, Clausena wampi, Glycosmis, Limonia, Micromelum, Murraya exotica, Vepris, Zanthoxylum*

5. Growth rings very faint, hardly visible to eye or under lens .. .. *Evodia roxburghiana*

5. Growth rings visible to eye distinct under hand lens 6

6. Rays usually moderately broad .. *Feronia*

6. Rays fine .. .. .. *Acronychia, Citrus, Clausena excavata, C. willdenowii, Murraya koenigii.*

1. ACRONYCHIA FORST.

A genus of about 20 species, mostly small trees, distributed in tropical Asia, China, Japan, Australia and the Pacific Islands. Only one species occurs in India and is dealt with here.

A. laurifolia Bl. [**A. pedunculata** (L.) Miq.]—*Loajan* (Asm.), *paling-changne* (Duff.), *bolgrak, bol-thimatchi* (Garo), *kogema-iaopa-phang* (Kach.), *bhutali, sonemau* (Kan.), *dieng-soh-phlang* (Kh.), *kanalei, mutta-nari* (Mal.), *tempor* (Mechi.), *ing-long-pharse-arong* (Mik.), *paowlay, puanle* (Nep.), *akenda* (Sinh.), *dieng-soh-newriong-blei, sarmon-blai* (Synt.). It is a large shrub or small to medium-sized tree up to about 12 m. in height and a metre in girth. *Bark* greyish-brown with a sweet scent, fairly thick up to about 12 mm., and somewhat corky outside. It is used in external application for ulcers and sores, while the roots are reported to be a fish poison.

It is distributed throughout the sub-Himalayan tract from Dehra Dun to Assam, at elevations up to about 1,200 m. while in the south it occurs in Mysore, Kerala and Madras States ascending to 2,100 m. in the Western Ghats. It is also found in the Andamans, Burma and Ceylon and extends to several South-East Asian countries.

Description of the wood

[Pl. 32, 187]

General properties—Heartwood and sapwood not distinguishable in the sample examined ; wood pale yellowish-brown, sometimes with dirty brown discoloration ; moderately heavy (sp. gr. 0·66 air-dry) ; moderately hard ; somewhat lustrous on the radial surface ; fairly straight-grained and rather fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* fairly distinct to the eye as well as under lens, usually demarcated by concentric bands of parenchyma and sometimes also by denser zones of fibres with comparatively few or scanty vessels, about 5-8 per cm. ; often difficult to distinguish from the rather numerous false marks, which are similar to the true ones except that they are somewhat discontinuous. *Vessels* small to very small, moderately numerous to numerous (17–28 per mm.^{2}) with some tendency to be unevenly distributed, being scanty in certain fibrous tracts particularly in the late wood ; mostly in radial multiples of 2–5, with a few solitary, oval to somewhat rounded in outline, frequently plugged with yellow gummy deposits ; vessel lines inconspicuous on the longitudinal surfaces. *Parenchyma* fairly abundant, visible to the eye and distinct under the lens (*a*) in concentric bands delimiting growth rings, and (*b*) vasicentric or aliform to aliform confluent connecting two or more vessels tangentially, often extending for a considerable distance and ending abruptly. *Rays* fine and closely spaced, just visible to the eye.

There is practically no information regarding the strength and other properties of this wood, which according to Gamble is but little used in India. It is, however, said to yield a good charcoal much favoured by goldsmiths(31) while in Java it is reported to be used though rarely in constructing the upper parts of houses(14). Being fine-textured and moderately hard it is also used for carving in the Philippines(45). The wood of the Malayan *A. porteri* Hook. f., which from the description given by Desch appears to be similar in practically every respect, is said to be "not durable, but used in building". The timber, however, is not comparable to the Australian "Brush ash" or "yellow wood" obtained from *A. baueri* Schott which is very much harder and heavier and considered particularly suitable for tool handles, coach and wagon frames and some forms of cabinet work.

Material—

4838 Dehra Dun, Uttar Pradesh (0·66).

2. AEGLE CORREA

It is a small genus of three or four species of trees distributed mainly in tropical Asia and Africa. The only species occurring in India is described here.

A. marmelos (Linn.) Correa—**Bael.** *Bela* (Beng.), *mak-pyin, okshit, ope-sheet* (Burm.), *sherbili-phang* (Cach.), *belethi* (Garo), *mahaka, mahaka dibur, maika* (Gond), *bael, bel, bili, siriphal* (Hind.), *hpunja* (Kach.), *bila-patri* (Kan.), *soh-bel* (Kh.), *belana* (Khond), *lohagasi* (Kol.), *kuyalam, kuvalap-pazham* (Mal.), *baelo* (Or.), *bilwa* (Sans.), *singjo* (Sant.), *katori* (Sindhi), *bela, beli, kurku, vilva, vilvam, vilva-pazham* (Tam.), *bilva-pandu, maluramu, marat, maredu, patir* (Tel.). A small to medium-sized tree, up to 12 m. in height and about a metre in girth with a straight and somewhat fluted bole. *Bark* greyish and somewhat corky outside, with shallow vertical grooves, rather thick exceeding 10 mm. even in small branches.

The tree is considered very sacred amongst Hindus and is much valued for its fruit and medicinal properties. The fruits are astringent, digestive and stomachic and are used in the half-ripe condition as a specific for diarrhoea and dysentery. The pulp of the ripe fruits is mildly laxative, sweet, aromatic and cooling and with some sugar and milk makes a popular and refreshing drink. The mucilaginous substance surrounding the seeds particularly of young fruits is a good and handy adhesive giving a quick-setting cementing medium when mixed with lime and is also used for imparting added strength and brilliance to water colours. The bark especially of the roots is considered efficacious for intermittent fever, and constitutes the main ingredient of the Ayurvedic drug "dasamula". It is also sometimes used as a fish poison. The leaves are aromatic, astringent and carminative and are regarded as essential for some religious ceremonies(29, 59).

It occurs in the natural state throughout the sub-Himalayan tract from the Jhelum eastwards, in Central and South India and Burma and is often cultivated all over India on account of its sacred character and medicinal importance.

Description of the wood

[Pl. **32**, 188]

General properties—Heartwood and sapwood not distinguishable ; wood pale yellow or yellowish-white, turning light yellowish-brown on exposure ; hard to very hard and heavy (sp. gr. 0·76–0·94 air-dry), with moderate lustre and smooth feel, but without any characteristic taste or smell. The strong aromatic odour described as occurring in freshly exposed wood(36), appears to refer to only green timber from freshly cut trees, as none of the ten specimens in our collection gave out any appreciable aroma ; usually straight-grained to occasionally somewhat curly, or wavy-grained particularly in the radial plane and fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct, demarcated by pale yellow conspicuous lines of initial parenchyma, discontinuous and false growth marks often common, 2–10 per cm. *Vessels* small to very

small, moderately numerous to numerous (11–35 per mm.^{2}), solitary, mostly in radial multiples of 2–3, or more, sometimes in small to large clusters, rounded to oval in outline, tyloses lacking, but, vessels often plugged with orange-yellow gum ; vessel lines inconspicuous. *Parenchyma* visible to the eye in concentric lines delimiting the growth rings at regular to irregular intervals. *Rays* fine, fairly closely spaced. *Pith flecks* occasionally present. Concentric *vertical gum ducts* sometimes observed.

Strength—It is a very strong, hard and tough timber. For strength figures of the timber see appendix I.

Seasoning—It is a highly refractory timber, liable to surface cracking, warping and twisting. The best method of seasoning is by green conversion, followed by stacking under cover, so as to ensure slow and uniform drying. In log form, the wood is liable to stain and is also attacked by the beetles which work under the bark, but, the damage is confined only to the periphery.

Natural durability—It seems fairly durable when not in contact with the ground or in an exposed position. From graveyard tests, the life of the timber has been found to range from 22–29 months, with an average of about 26 months. The heartwood is not very liable to white ant and borer attack.

Insect attack—Dead wood is attacked by *Aeolesthes holosericea* Fabricius, *Coptops aedificator* Fabricius, *Derolus volvulus* Fabricius and *Xylotrechus smei* Laporte & Gory and dry wood is attacked by *Stromatium barbatum* Fabricius (Cerambycidae).

Working qualities—The timber is hard and does not machine or plane to a good finish. It has a tendency to chip leaving an uneven surface. It turns easily and takes a good polish, but, is very liable to split when finished, unless thoroughly seasoned.

Supply and uses—The tree is not often cut as it is valued for its fruit. A fair supply is possible from the Uttar Pradesh. The species can only yield small to medium sized logs. The wood is used as posts, shafts, pestles of oil and sugar mills, axles, naves and other parts of carts and for agricultural implements. In Assam it is used for carving. In Ceylon it is said to be very suitable for furniture. It is not a furniture timber but may be considered suitable for small tool handles. Kinns suggests its use for small turnery-ware but not for framed up work, as it warps and twists. The wood is suitable for making charcoal for producer-gas plants. It is a medium class fuel wood.

Material—

248 Garhwal, Uttar Pradesh (0·88), 268 Garhwal, Uttar Pradesh (0·94), 441 Ajmere, Rajasthan (0·80), 638 Goalpara, Assam (0·84), 1176 Ahiri Reserve, Bombay (0·84), 2486 Calcutta,

West Bengal (badly damaged by insects), 2785 Melghat, Bombay (0·85), 3790 Ganjam, Orissa (0·76), 5789 Panch Mahals, Bombay (0·93), 6198 Dehra Dun, Uttar Pradesh (0·81).

3. ATALANTIA CORREA

A genus of small, evergreen armed or unarmed trees or shrubs containing about 18 species, distributed in tropical Asia, China and Australia. About 6 species are known to occur in South India, Ceylon and Burma, of which two are described here. *A. ceylanica* Oliv., *vakinaran* (Sinh.), *peykuruntu* (Tam.) is a small thorny tree of Malabar, Nilgiris Anamalais, Travancore and Ceylon ascending up to 1,500 m. *A. racemosa* W. & A., *adwi nimbe* (Kan.), *katta naragam* (Tam.) is a small thorny tree of Mysore, Andhra Pradesh, Kerala and Ceylon ascending up to 1,200 m. *A. caudata* Hook. f. is a glabrous, unarmed shrub of Khasi Hills ascending up to 1,200 m. *A. macrophylla* Kurz is an evergreen tree of the coastal forests of the Andamans. The timbers of both the species described here are practically similar in all respects.

1. **A. missionis** Oliv. [**Pamburus missionis** (Wt.) Swingle]—*pamburu* (Sinh.), *kuruntu* (Tam.). A small glabrous tree with sharp thorns and a green bushy head.

It is found in South India on the Eastern Ghats as well as in the evergreen forests of the Western Ghats from North Kanara southwards, eastern slopes of Nilgiris and Anamalais and also in Ceylon.

Description of the wood—See below.

2. **A. monophylla** DC.—*Shaukvaing, tawshauk, tawthanbya thee* (Burm.), *jungli nimbu* (Hind.), *adavi-nimba, kan limbe* (Kan.), *ramser* (Lush.), *mal naranga* (Mal.), *bankamla, ching-kamla* (Manip.), *makad-limbu, makur limbu ran limbu* (Mar.), *kata narunga, narguni* (Or.), *kathe-elumichcham-param, katta naragam, katyalu, perunkuruntu* (Tam.), *adivi nimma, arawi nim, yerra monukudu* (Tel.). A small evergreen thorny tree 6–9 m. high and 60–90 cm. in girth with a deeply fluted stem. *Bark* shows white-grey to dark brown patches and is smooth. It is found throughout the mountainous regions of South India, Bihar, Orissa, Assam and Ceylon extending to the Andamans and Burma.

Description of the wood—See below.

Description of the wood

(*Atalantia missionis* and *A. monophylla*)

[Pl. **32**, 189–90]

General properties—Sapwood and heartwood indistinct ; wood yellow when freshly cut, becoming yellowish-brown with age ; very hard ; very heavy

(sp. gr. 0·95–1·08 air-dry) ; lustrous ; fairly straight to slightly twisted-grained fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct, 3–12 per cm. demarcated by concentric bands of initial parenchyma ; false and discontinuous growth rings quite common. *Vessels* small to very small, numerous to very numerous (20–40 or more per mm.^{2}), evenly distributed, solitary or in radial multiple of 2–5 rarely more or in clusters, rounded to oval in outline, open as well as plugged with yellow or brownish gum-like substance ; vessel lines inconspicuous. *Parenchyma* visible to the eye, in concentric bands. *Rays* fine to very fine, closely spaced. *Gum ducts* in concentric rows occasionally present. *Pith flecks* are sometimes present.

Strength—The timber is very close-grained and very hard. For strength figures of *A. monophylla* see appendix I.

Seasoning—Refractory to season, developing serious cracks unless great care is taken ; probably sawing the logs and billets up to the centre on one side, as is done with boxwood, might reduce serious splitting.

Durability—A durable timber under cover. It is not the class of timber which requires treatment.

Working qualities—Very hard, but easy to saw when green. On high speed machines it works very satisfactorily and on a lathe the surface produced is excellent. It is extremely fine-textured wood, resembling boxwood and works to a smooth finish taking a high polish.

Supply and uses—A fair quantity is available in some places in South India. It is used for small knife handles, pen-holders, mathematical instruments, small turnery objects and engraving purposes. The wood when of some size is valuable in cabinet making. Since the wood is strong and shock resistant it is recommended for camp furniture.

Material—

A. missionis – 7664 South Coimbatore, Madras (1·08).

A. monophylla – 3515 Khurdha Forests, Orissa (0·95), 6084 Salem, Madras (0·95).

4. CHLOROXYLON DC.

The genus contains the single species *C. swietenia* DC., which is indigenous to India and Ceylon.

C. swietenia DC.—**Satinwood.** *Bhirwa* (Baigas), *bhira, bilgu* (Gond), *bheria, billu, halda, hardi* (Guj.), *bhera, bherul, bhirra girya* (Hind.), *bittula, hurihuli, mashwal, masula, huragalu* (Kan.), *sali, sengel* (Kol.), *behru, bharhul,*

kharwar (Or.), *buruta* (Sinh.), *burus, mududad, mutirai, porasu, purush* (Tam.), *bilgu, billu, billydu* (Tel.). A moderate-sized deciduous tree with a straight cylindrical stem about 1–1·5 m. in girth, and a clear bole of about 3 m. in Madhya Pradesh and Bombay. The tree is somewhat larger in South India and attaining its maximum size in Ceylon, logs sometimes running to a girth of about 2·5 m. *Bark* rough, yellowish, corky.

It is found in dry deciduous forests of Singhbhum and Palamau in Bihar on the east, also in the Central and Southern India, from the Madhya Pradesh southwards to Ceylon.

Description of the wood

[Pl. **32**, 191]

General properties—Wood light yellow, cream-yellow to golden-yellow with satin lustre, the inner portion of the log being somewhat darker than the outer ; but, no distinct heartwood present. The natural golden-yellow colour darkens in time to a light brown shade. A remarkably lustrous wood with a smooth feel, often showing a handsome ribbon figure ; somewhat fragrant when freshly cut but without characteristic taste ; hard to very hard ; heavy to very heavy (sp. gr. 0·75–1·00 air-dry) ; straight to interlocked-grained ; even and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct, demarcated by fine concentric initial parenchyma bands at regular to irregular intervals, 3–10 per cm., sometimes up to 18 in slow grown trees. *Vessels* small to very small, numerous to very numerous (32–40 or more per mm.^{2}) solitary, mostly in radial multiples of 2–6 or more, rarely in clusters, round to oval in outline, open or plugged with yellowish or brownish deposits ; vessel lines inconspicuous on the longitudinal surfaces. *Parenchyma* visible to naked eye in concentric initial bands at regular to irregular intervals. *Rays* fine, evenly distributed, fairly closely spaced to closely spaced. *Ripple marks* present, just visible to fairly distinct to the eye, clearly visible and usually well defined under the lens. *Vertical gum ducts* in concentric lines occasionally present in some specimens.

Strength—Satinwood is a very dense, hard and strong timber. For strength figures from tests conducted at the Forest Research Institute, Dehra Dun, see appendix I.

Seasoning—Both boards and scantlings of the timber show decided tendency towards surface cracking, cupping and twisting. There was no evidence of insect attack either in the logs, girdled trees or converted timber. When converted green and exposed to the atmosphere, the wood tends to darken somewhat on the surface. This darkening effect is more pronounced and penetrates deeper, in boards and scantlings seasoned after immersion in water.

Girdling and seasoning in the log prevent the change in colour altogether. Girdling also reduces the surface cracking more than any other method, giving on the whole the best results.

It is very essential to give this wood ample protection from too rapid drying immediately after conversion and also to stack pieces with care to avoid cupping and twisting. The logs should be converted during the rainy season. The timber is reported to kiln season well with little degrade(36).

Natural durability—There are conflicting opinions regarding the natural durability of this timber. Generally it is thought to be a good durable timber. According to Pearson and Brown it is "a very durable timber and little subject to borers and white ant attack", while Gamble mentions a case in which sleepers of satinwood lasted twenty years in the Ceylon railways. Experiments conducted at the Forest Research Institute, Dehra Dun, regarding its durability, however, do not confirm this. The average life of untreated timber from Madhya Pradesh was found to be about 39 months only with a minimum of 34 months and maximum of 46 months.

Insect and fungus attack—Dead wood is liable to be attacked by some Anthribidae and Cerambycidae borers ; newly felled or fallen logs are attacked by a few species of shot-hole borers (Platypodidae and Scolytidae), but are less susceptible to pin-hole borer attack. Tests against soil burrowing termites in Ceylon have shown this timber to be immune to attack. The logs "are also subject to the borings of large grubs which leave holes from $\frac{1}{4}$ to 1 inch in diameter. These generally occur on the outside of the tree under the bark, rarely beyond the sapwood, but often reduce the proportion of convertible wood(20)". Damage by Ambrosia (pin-hole borer) beetles and by longhorn beetles is sometimes present.

C. swietenia is attacked by *Fomes caryophylli*, a usually parasitic fungus causing heart-rot in standing trees. The fungus attacks through broken branches or other similar wounds.

Working qualities—The timber is fairly difficult to work by hand and moderately hard to saw and machine especially when dry. It is often brittle and difficult to work. The interlocked and wavy-grain makes the timber liable to pick up in planing, especially on quarter-sawn surface. It has a dulling effect on tools, and on account of its high density, requires to be firmly held while machining, to prevent riding or chattering on the cutters(12). The timber finishes well and turns excellently. It glues well and takes a fine and lasting polish. Veneers made out of this timber are reported to be extremely brittle and fragile and as such great care is needed to avoid damage in handling and storage(3).

Supply and uses—It is uncommon in the east and west zone but common in the south zone and most common in central zone. The largest turn over is

from the Godavari District of Andhra Pradesh ; apparently, however, it does not reach such large dimensions as in Ceylon. East Indian satinwood is in demand in the United Kingdom and America, where it is used in cabinet work and for brush backs. A small quantity is exported from South India, but the bulk of the demand is met by Ceylon. Supplies are more than sufficient to meet it.

The timber has two distinct classes of uses, the first based on its strength and durability and the other on account of the highly ornamental character. Thus, it is in great demand for poles, posts and rafters, and is used in railway sleepers, bridge construction, for ploughs, oil mills, pestles, in well construction and in Madras for cart shafts, axles, naves, felloes and spokes. On the other hand, being a highly figured wood, when quarter-sawn, it is prized for cabinet work, picture frames, brush backs, veneers, furniture, interior decorative work, panelling, carving, turnery and other fancy goods. It has been tested and found a first class timber for slate frames(44). It has been also found suitable for jute bobbins. It is used for mathematical instruments, stethoscopes and for partition boards, and panels in upper class railway carriages.

Material—

1069 North Arcot, Madras (0·94), 1153 Ahiri, Bombay (0·87), 1239 Gumsur, Orissa (0·87), 1412 Seoni, Madhya Pradesh (0·93), 2742 Jamui Reserve, Bombay (0·78), 3443 Palamau, Bihar (0·75), 3572 Khurda Forests, Orissa (0·92), 3823 Ganjam, Orissa (0·99), 4065 (0·94), 4448 (0·96), 5332 Mandla, Madhya Pradesh (0·83), 5759 Hoshangabad, Madhya Pradesh (0·91), 7458 Upper Godavari, Andhra Pradesh (0·92), 7459 Upper Godavari, Andhra Pradesh (0·95), 7837 Patna, Orissa (1·00).

5. CITRUS LINN.

A genus of evergreen, usually armed shrubs or trees, distributed throughout the tropical and temperate regions of the world. It is believed to be a native of the sub-tropical and tropical regions of Asia and the Malay Archipelago. Most of the species are cultivated in India. There is considerable difficulty in classifying the species of this genus, partly because of their close resemblance and partly because of the tendency to hybridize. Many recent classifications have been made by different workers and authors, but, none of them has found general acceptance. Recently Tanaka has classified the genus into 31 species. He has also pointed out that the number of species is even larger than this as a few species for which the material was not available were not included in his list. For the purpose of wood we have adopted the old classification as given by Brandis.

1. **C. aurantium** Linn.—*Ribo-sing-king* (Abor.), *humutia tenga* (Asm.), *kamala nimbu, narangi, nebu* (Beng.), *kabala, leinmaw, maksawk, tun-mapa* (Burm.), *jamera, janmera* (Garh.), *narangi* (Guj.), *kumla-nebu, limun narangi, nebu, santara* (Hind.), *cheru-narnna, heralay, kithale* (Kan.), *silum-kung* (Lep.), *mahura-naranna* (Mal.), *narangi* (Mar.), *generu-ay* (Miri), *santala* (Nep.), *chechu, collungie pullam, elumich-cham-pazham, kitchli, naran-gam, narattai* (Tam.), *ganjanimma, naranga-pandu, nimma-pandu, kittali, mallikanarangi* (Tel.). It is a medium-sized evergreen, thorny tree. *Bark* thin, greenish-grey in colour.

The tree is a native of China or Cochin China though widely cultivated in sub-tropical regions. In India, it grows wild or apparently so in the valleys of Garhwal, Kumaon, and Sikkim and Khasi Hills up to 1,200 m. and also on the eastern slopes of the Nilgiris. The cultivated form is grown everywhere, but the areas of concentrated cultivation lie in Sikkim, Assam, Madhya Pradesh, Coorg and the Punjab. Mandarin oranges are cultivated in South India, in Madras and Mysore and also in West Bengal, Bombay, Andhra Pradesh, Uttar Pradesh and Kashmir.

Description of the wood—See page 26.

2. **C. decumana** Linn. [**C. maxima** (Burm.) Merr.]—*Rebab-tenga* (Asm.), *batavi nimbu, bator-nebu* (Beng.), *shaukpan, shaukton, shaukwaing, shouk-ton-oh* (Burm.), *obakotru* (Guj.), *chakotra, mahanimbu, sadaphal* (Hind.), *lumbo, sangatrani* (Lep.), *chakotre, sakotra hannu, sakkota* (Kan.), *pampara masam* (Mal.), *papnassa* (Mar.), *sangkatra* (Nep.), *bombalinas, pambalimasu* (Tam.), *edapandu, pampala masam* (Tel.). It is also known as the shaddock or pumelo. An evergreen tree, about 4·5–6 m. high. It is a native of Malaysia and Polynesia and was introduced into India and Ceylon from Java. *Bark* thin, greyish-brown or greenish.

It is cultivated throughout India, more especially in the Punjab, Uttar Pradesh and also in Coorg, Mysore, Madras and Bombay.

Description of the wood —See page 26.

3. **C. medica** Linn.—*Bakol-khowa-tenga, jora tenga* (Asm.), *bara nebu, begura, bijaura, goranebu, honsa, korna nebu, lebu, nebu, nibu, patinebu* (Beng.), *kywegaw, mak-sun-ting, shankthakwa, shouk-ta-kwah, taw-shauk, thanbaya* (Burm.), *naya-changney* (Duff.), *balank, bijoru, khatalimbu, metalimbu, motunimbu, turanj* (Guj.), *bara nimbu, bijaura, galgal, jambira, kutla, limbu, mitha, nibu, nibua, nimbu, pahari kaghzi, pahari nimbu* (Hind.), *lawihkri, lawihpaw-ma, shalawi* (Kach.), *soh manong* (Kh.), *jamira* (Kol.), *bijaura, bijori, dodda nimbe-hanum, gajanimbe, imbe, limbe, madala, mahaphala, nimbe*

hanu, rusaka (Kan.), *kachikung* (Lep.), *tume han-thor* (Mik.), *erumichinarakam, gilan, matalanarakam, rusakam* (Mal.), *haijange* (Manip.), *idalimbu, limbu, nava lung, sakar nimbu, thora limbu* (Mar.), *bimbiri* (Nep.), *bijaurinimbu, khatta nimbu, nimbu* (Punj.), *begapura, madhu-kartika, matulunga, phalapura, vijapura* (Sans.). *jambir* (Sant.), *shashni jamir* (Sylh.), *dieng soh sarman* (Synt.), *champazham, kadaranarathai, elimichum, kolumichangai, nartham pazham* (Tam.), *gajaninma lungamu, naradabba, nimmapandu, periya elumichcham-pazham* (Tel.), *misser* (Tipp.). It is also known as citron, lemon, sweet and acid lime.

It occurs throughout the sub-Himalayan tract up to 900 m. and is probably wild and indigenous within the area. It is also found near Chittagong and in the Khasi Hills, and is wild in Mayurbhanj Hills, Ganjam and Vizagapatam up to 900 m. In the Western Ghats of Coorg, Malabar, Nilgiris and Travancore it is common up to 1,200 m. elevation.

Description of the wood—See below.

Description of the wood

(*Citrus aurantium, C. decumana* and *C. medica*)

[Pl. **32**, 192, **33**, 193]

General properties—Sapwood and heartwood indistinguishable in colour. Wood light yellowish, turning brownish with age ; moderately hard ; moderately heavy (sp. gr. 0·65–0·74 air-dry) ; somewhat lustrous ; straight to twisted-grained ; even and fine to medium coarse-textured.

Gross structure—A diffuse porous wood. *Growth rings* present, rather indistinct, demarcated by concentric bands of parenchyma, 2–5 per cm. ; discontinuous and false rings present. *Vessels* small to very small, moderately numerous to numerous (11–24 per mm.^{2}) rather evenly distributed, solitary or in radial multiples of 2–3, rarely in clusters, oval or somewhat angular in outline, usually open, occasionally filled with yellow or brown deposits ; vessel lines inconspicuous. *Parenchyma* visible to naked eye, distinct under hand lens, vasicentric, aliform to aliform confluent, also in fine concentric initial bands demarcating the growth rings. *Rays* fine and closely spaced. *Vertical gum ducts* occasionally present in concentric lines.

Strength—Timbers are tough, strong and close-grained.

Insect attack—*C. aurantium*—Dead wood is liable to be attacked by Anthribidae, Buprestidae, Cerambycidae and Curculionidae ; wood of newly dead trees is attacked by shot-hole borer (Scolytidae).

C. decumana—Partly dead stems are attacked by *Chelidonium cinctum* Guerin (Cerambycidae); dry wood is attacked by *Stromatium barbatum* Fabricius (Cerambycidae).

C. medica—Dead wood is liable to be attacked by some borer species of Buprestidae and Cerambycidae ; dry wood is attacked by *Stromatium barbatum* Fabricius (Cerambycidae).

Uses—The woods of the different species are very similar in their structure and properties and are used all over the world for making small articles of turnery, fancy boxes and novelties, inlay-work and particularly for manufacture of sticks(41, 42). Some specimens of *C. aurantium* may be strong enough for walking sticks and even golf clubs(21). The wood of *C. medica* is tough and close grained and makes good walking sticks ; the wood is also suitable for agricultural implements, when of sufficiently large size.

Material—

C. aurantium – 3371 Rajabhatkhawa, West Bengal (0·71). Heavily attacked by insects.

C. decumana – 4510 Dehra Dun, Uttar Pradesh (0·65).

C. medica – 4812 Dehra Dun, Uttar Pradesh (0·74).

6. CLAUSENA BURM.

A genus of about 23 species of unarmed trees and shrubs, chiefly Indo-Malayan with a few in China, Africa and Australia. According to Tanaka, ten species are known to grow in India of which 5 are of some economic importance. *C. heptaphylla* W. & A., *pyindawthein* (Burm.), *karan-phal, pan-kafur* (Beng.), is a strongly aromatic bush or small tree, 1·8–2·4 m. high. It is found on the hills of Ganjam up to 1,500 m., in Western Ghats in Wynaad, Malabar, Anamalai, Palni and Travancore at 900 to 1,500 m. It is also found in lower Bengal, Khasi Hills, Chittagong and Burma. *C. pentaphylla* DC., *ban-nimbu, ratanjot, surajmukha, teyrar* (Hind.) is a highly aromatic shrub, about 1–2 m. high, distributed from Garhwal to Sikkim, in the forests of Pilibhit, Gorakhpur, and Oudh. *C. indica* Oliv., *karivappilei, vepillei* (Tam.), is a shrub or small tree of the evergreen forests of the Western Ghats from Konkan southwards and Ceylon. *C. suffruticosa* W. & A., *kala maricha* (Beng.), is a shrub or small tree distributed in Chittagong, Khasi Hills and China. *C. macrophylla* Hk. f. and *C. wallichii* Oliv., are two shrubs of Tenasserim in lower Burma. Three species for which samples were available are described here. Out of the three *C. wampi* Blanco was introduced into India from China and is cultivated in certain parts of India for its fruits. The woods of the three species differ somewhat in their anatomical structure and physical properties and can often be recognized in the field as given below.

Parenchyma other than those delimiting growth rings relatively abundant, aliform to aliform confluent, and prominent under lens. Vessels usually plugged with yellowish deposits	*C. excavata**, *C. willdenowii*
Parenchyma other than those delimiting growth rings scanty, indistinct or not visible even under lens. Vessels usually open	*C. wampi.*

1. **C. excavata** Burm. f.—*Bengjari, narasingha* (Asm.), *dulia-maricha* (Beng.), *pyindawthein, seiknan, seitnan* (Burm.), *sam-sweng* (Garo), *dawhke, samdaukhi* (Kach.), *dieng-tyrur* (Kh.), *duki potum, ote armu* (Kol.), *theng-sah-soh-arong* (Mik.), *agnijhal* (Or.). A small unpleasantly aromatic shrub. *Bark* thin, smooth and dark brown.

It occurs in the eastern sub-Himalayan tract, Chota Nagpur, Bengal and Burma, often in sal and eng forests. It is also found in Malacca, Penang, Sumatra, Java and Borneo.

Description of the wood—See page 29.

2. **C. wampi** Blanco. [**C. lansium** (Lour.) Skeels.]—*Ampeach, ampich* (Hind.). A small aromatic evergreen tree. *Bark* grey, thin.

It is indigenous to China and is cultivated in certain parts of India for its fruits, particularly in the eastern portion of the Punjab, Chota Nagpur and also in Chittagong.

Description of the wood

General properties—No colour distinction between heartwood and sapwood; wood yellowish-white, often turning light brown with age; hard; heavy (sp. gr. 0·92 air-dry); somewhat lustrous; straight to twisted-grained; fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to naked eye, demarcated by thin to thick concentric initial parenchyma bands, some appearing at irregular intervals. *Vessels* small, not visible to naked eye, numerous (27–40 per mm.^{2}), rather evenly distributed, solitary and in radial multiples of 2–4 or more, very often in clusters, open; vessel lines inconspicuous on the longitudinal surfaces. *Parenchyma* in concentric initial bands demarcating the growth rings. *Rays* fine, fairly closely spaced to closely spaced.

Insect attack—Dry wood is liable to be attacked by *Stromatium barbatum* Fabricius (Cerambycidae).

Uses—It is a tough timber and can be put to uses where strength and toughness are required.

* *C. willdenowii* is usually much harder and heavier than *C. excavata* and can sometimes be distinguished from it on this basis.

Material—

4745 Dehra Dun, Uttar Pradesh (0·92).

3. **C. willdenowii** W. & A. [**C. dentata** (Willd.) Roem.]—*Sidemnyok, terhilnvok* (Lep.), *kariveppila, potti* (Mal.). *madanay* (Nep.), *weda-pana* (Sinh.), *kat vepillei, potti, kattuk kariveppilai* (Tam.). A shrub or small tree.

It grows in Sikkim Himalayas up to 600 m. and in the evergreen forests of the Western Ghats in the Nilgiris and Travancore and is also common in Burma and Ceylon.

Description of the wood—See below.

Description of the wood

(*Clausena excavata* and *C. willdenowii*)

[Pl. **33**, 194]

General properties—Sapwood and heartwood indistinct ; wood yellowish-white turning brown with-age, moderately hard and moderately heavy (sp. gr. 0·68–0·71 air-dry) in *C. excavata*, but very much harder and heavier (sp. gr. 0·94 air-dry) in *C. willdenowii*, somewhat lustrous ; straight-grained and fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct, demarcated by concentric bands of initial parenchyma at regular to irregular intervals which are prominent and clearly visible to the eye in *C. willdenowii*, but somewhat fine and less distinct in *C. excavata*. *Vessels* small, not visible to naked eye, moderately numerous to numerous (15–30 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–4 or more occasionally to quite often in clusters, open or plugged with yellow deposits ; vessel lines inconspicuous on longitudinal surfaces. *Parenchyma* in thin to thick concentric initial bands just visible or distinct to the eye, also aliform to aliform confluent but scanty and indistinct or barely visible even under lens. *Rays* fine, closely spaced.

Uses—The timber produced by *C. willdenowii* is hard, heavy and strong, and can be used for articles like tool handles, cart wheels, cart spokes and the like where strength is required. The wood of *C. excavata* is said to be suitable for making axe handles(6).

Material—

C. excavata – 3354 Darjeeling, West Bengal (0·71), 5386 Ruby Mines, Burma (0·68).

C. willdenowii – 4719 Travancore, Kerala (0·94).

7. EVODIA FORST.

A genus of unarmed shrubs or trees, mostly aromatic, consisting of about 45 species, distributed from Madagascar through South-East Asia to Australia and the Pacific Islands. About seven species occur in India of which three are dealt with here. Among those not described, *E. glabra* Blume is a tree of the Andamans and Malaya. *E. rutaecarpa* Hook. f. *muka-asing* (Abor.), *bora-asing* (Miri) is a small tree about 9 m. high, found in the inner valleys of the Sikkim Himalayas and the Khasi Hills at 2,150-3,050 m. It also occurs in China and Japan. *E. triphylla* DC., is a shrub common in north Cachar Hills and Burma Hill forests above 600-1,500 m. *E. viticina* Wall. is an evergreen shrub of Tavoy and Tenasserim.

Out of the three species studied, *E. fraxinifolia* and *E. meliaefolia* are practically similar in all respects and cannot be distinguished with certainty. They are, therefore, described under one head. However, there are some slight differences by which it may be possible to differentiate them sometimes. *E. meliaefolia* is usually medium to somewhat coarse-textured, while *E. fraxinifolia* is rather fine to medium-textured. *E. fraxinifolia* is often semi-ring-porous or shows only a tendency towards ring porosity, while *E. meliaefolia* is a true ring-porous timber. Further, the pore size in *E. fraxinifolia* is generally somewhat smaller than in *E. meliaefolia*. The wood of *E. fraxinifolia* and *E. meliaefolia* can be easily distinguished from that of *E. roxburghiana* as given below :—

Wood diffuse-porous ; parenchyma aliform to aliform confluent ; growth rings usually indistinct	.. *E. roxburghiana*
Wood distinctly ring to semi-ring porous ; parenchyma not visible ; growth rings always distinct	.. *E. fraxinifolia*, *E. meliaefolia*.

1. **E. fraxinifolia** Hook. f.—*Dieng-bora-pram, dieng-lambu-synrang, dieng sngiyat* (Kh.), *kanu* (Lep.), *kanukpa, khankpa* (Nep.), *dieng-sa-tyng-klong, dieng-subu-klong* (Synt.). A small or medium-sized tree, 60-90 cm. in girth with 3 to 4·5 m. clear bole. *Bark* brown or ashy-grey, rather smooth, but warty with rather large lenticels, yellowish-white inside.

It is found in the eastern Himalayas from Nepal to Sikkim, Khasi and Jaintia Hills in Assam at altitudes of 900-2,150 m. and the Chin Hills of Burma.

Description of the wood—See page 31.

2. **E. meliaefolia** Benth.—*Maiphak, mipak* (Asm.), *kinthat-putgyi, kyetmack, metyun* (Burm.), *dieng-si-ing, dieng-saw-ngiang-jerep* (Kh.), *peju* (Lep.), *bora-asing* (Miri), *thulo khanakpa* (Nep.), *ankhijhora* (Or.), *machli-poma* (Sylh.), *dieng-soh-tong-klong* (Synt.). A large tree, up to 26 m. high and 2·4 m. in girth. *Bark* greenish-white, nearly smooth but covered with

large lenticels, inside uniformly pale, dull brownish-yellow, soon turning to chocolate colour, fibrous 5–13 mm. thick, somewhat mucilaginous.

It occurs in the eastern Himalayas ascending to 1,800 m. in Sikkim and Bhutan. It is also found in Assam, Upper Burma and South Tenasserim.

Description of the wood—See below.

Description of the wood

(*Evodia fraxinifolia* and *E. meliaefolia*)

[Pl. **33**, 195, 196]

General properties—Heartwood and sapwood not clearly defined; wood white or light yellowish-white turning brownish with age, a little liable to stain; very soft to soft: very light to light (sp. gr. 0·27–0·43 air-dry) lustrous, with smooth feel; straight-grained; medium to rather coarse-textured.

Gross structure—A ring-porous to semi-ring-porous wood. *Growth rings* distinct to the eye, demarcated by fine initial parenchyma and large-sized early wood vessels almost at regular intervals, 1–2 per cm. in fast grown, and 3–6 per cm. in rather slow grown trees. *Vessels* small to moderately large or large, solitary or in multiples of 2–3 oval, usually open, only a few filled with yellowish deposits; vessel lines rather conspicuous on the longitudinal surfaces. *Parenchyma* visible to naked eye as fine faint lines, demarcating the growth rings. *Rays* fine to broad, not very closely spaced. *Pith flecks* observed in *E. meliaefolia*.

Strength - The timber has not been mechanically tested for its strength. It is a soft, fibrous wood, and not very strong.

Seasoning—It is not a refractory timber to season. It seasons easily without splitting. It is not liable to warp. Green conversion and open stacking of converted material under cover or kiln seasoning are recommended to obtain the best results. It is a little liable to stain.

Natural durability—The timber of *E. fraxinifolia* is not durable. It is said that it will not stand exposure, but that it lasts fairly well under cover. The timber of *E. meliaefolia* is said to be durable. From the structure, there should be no difficulty in treating them with preservatives.

Insect attack—Dead wood of *E. fraxinifolia* is liable to be attacked by some Cerambycidae, Curculionidae and Mordellidae borers; newly felled or fallen logs are attacked by some shot-hole borers (Platypodidae and Scolytidae). The wood of *E. meliaefolia* is said to be immune to white ant attack.

Working qualities—The timber is soft, easy to saw and works to a fair finish.

Supply and uses—*E. fraxinifolia* is common round Darjeeling and Shillong but nowhere in large quantities. A good supply is available at Shillong. It is used locally for posts of huts and to a limited extent for tea boxes. The timber after seasoning could be used for ceiling boards, for partition work and is excellent for match splints and boxes. The timber of *E. meliaefolia* is said to be used for shingles and looms in Assam ; it may also do well for cigar boxes.

Material—

E. fraxinifolia - 5455 Assam (0·39), 6111 Darjeeling, West Bengal (0·27).

E. meliaefolia - 3341 Sibsagar, Assam (0·42), 6424 Burma (0·43), 7231 Darjeeling, West Bengal (0·31).

3. **E. roxburghiana** Benth. [**E. lunu-ankenda** (Gaertn.) Merr.]—**Kambli.** *Midauma-baphang* (Cach.), *kabale* (Kan.), *kanalu, kattuchampakam* (Mal.), *lunu-ankenda, nebede* (Sinh.). A small to medium-sized tree up to 15 m. high and 1·2 m. in girth. *Bark* corky and greyish-white outside, slightly reticulately fissured, inside greenish-white with a touch of red, about 6·5 mm. thick.

It is common on the hills of southern India, common in Kanara, Coorg and Wynaad and Nilgiri forests up to 2,150 m. and in Assam, in Sibsagar, Nowgong and Khasi and Jaintia Hills at 1,200 m. It is also found in the forests of Tenasserim, the Andamans and Ceylon from 600-1,800 m.

Description of the wood

[Pl. **33**, 197]

General properties—Heartwood and sapwood indistinct ; wood light yellowish to greyish-white ; soft ; light (sp. gr. 0·38-0·50 air-dry) ; lustrous ; straight-grained ; rather fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct or faintly marked. *Vessels* small to moderately large, moderately numerous (10–18 per mm.^{2}), evenly distributed, solitary and in radial multiples of 2–4 or more, a few in clusters, oval in outline, usually open, a few plugged with yellowish deposits; vessel lines visible rather inconspicuous on longitudinal surfaces. *Parenchyma* visible to the naked eye, distinct under hand lens aliform to aliform confluent. *Rays* fine, fairly closely spaced to closely spaced.

Seasoning—It seasons easily without splitting.

Natural durability—It is probable that the timber is not attacked by powder-post beetles, but may be liable to sap-stain unless carefully seasoned.

Insect attack—Dead and dry wood and converted timber is liable to be attacked by *ghoon* borers (Bostrychidae) ; newly felled or fallen logs and newly

dead trees are attacked by the shot-hole borer – *Xyleborus noxius* Sampson (Scolytidae).

Working qualities—It is difficult to work but finishes well and takes a fine polish.

Supply and uses—Fair supplies are available from the south zone, where it is common. It is used to a limited extent for planks, rafters, match splints and plywood. It is reported to be suitable for cabinet work. It is also good for light packing cases.

Material—

6524 Burma (0·38), 7425 Coorg, Mysore (0·50).

8. FERONIA GAERTN.

The genus contains only 2 species. Of these *F. lucida* Teysm. & Binn., is distributed in Indo-China and Java. *F. elephantum* Correa, is the only Indian species and is described here.

F. elephantum Correa [**F. limonia** (L.) Swingle]—*Bela, kaitha, kathbel* (Beng.), *kwet, makpyen-sum, thi, thibin* (Burm.), *kavit* (Guj.), *bilin, kait, kaithbilin, kat-bel, kavitha* (Hind.), *balal, bel, belada, bilwar, byala, byala da nannu* (Kan.), *vilam* (Mal.), *kauth, kavat, kavith, kawat, kovit* (Mar.), *koeta, koito* (Or.), *kapi-priya, kapita* (Sans.), *kainta, kochbel* (Sant.), *diwal* (Sinh.), *elaka, meladik-kuruntu, velaga, vellam, vila, vilva, vilatti, vellanga* (Tam.), *elaka, kapitr, kavit, vallanga, vela, velaga, vellanga* (Tel.). A medium-sized deciduous, spinuous tree, 60 cm.–1·2 m. in girth with a short, erect, cylindrical stem and thorny branches. *Bark* dark grey to nearly black, very rough, thick, wrinkled, with shallow longitudinal furrows.

It is found in dry forests of India from the Ravi eastwards through Uttar Pradesh and Orissa and southwards through Madhya Pradesh, Bombay, Gujarat, Konkan and Kanara. In Promo district of Burma and dry regions of Ceylon it is common. It is also found in the dry regions of Java and Indo-China, and is often cultivated.

Description of the wood

[Pl. **33**, 198]

General properties—Sapwood and heartwood indistinct in colour ; wood yellowish-white to grey with inconspicuous brownish-grey streaks along the grain ; hard, heavy (sp. gr. 0·83 air-dry) ; somewhat lustrous, fairly straight to slightly interlocked-grained ; even and medium-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to the eye, demarcated by fine concentric bands at regular to irregular intervals,

2–4 per cm.; false growth rings common. *Vessels* moderately small to moderately large, moderately numerous (10–18 per mm.^{2}) evenly distributed, solitary or in multiples of 2–3, rarely in clusters, oval or round in outline, usually open, a few filled with deposits; vessel lines inconspicuous or just visible on longitudinal faces. *Parenchyma* vasicentric, aliform to aliform confluent. *Rays* fine to moderately broad, not prominent but visible to the eye; evenly distributed, fairly closely spaced. *Vertical gum canals* occasionally present in concentric lines.

Strength—Gamble, quoting Skinner and Cunningham, gives the co-efficient of transverse strength as 645 and 623 at 50 lb. and 49 lb. weight respectively which is about 80 per cent of teak. The timber, however, is much harder and finer-textured than teak.

Seasoning—Somewhat refractory to season, but with moderate care in stacking and green conversion, splitting can be checked to a great extent.

Durability—A moderately durable timber in exposed positions and durable under cover. It is not the class of timber that could be easily treated.

Insect attack—Dry wood is attacked by *Stromatium barbatum* Fabricius (Cerambycidae).

Working qualities—The timber is not difficult to saw and works to an extremely smooth surface. It is also easy to work with hand tools and takes a fine polish.

Supply and uses—It is not available anywhere in large quantities. Only very small quantities are available in Uttar Pradesh. More common in the Deccan and Thana districts of Bombay. It is fairly common on the cotton soil in North Chanda, Nagpur, Wardha; not common in Burma. It is a good timber, suitable for rafters and general constructional work. It might be a useful pattern wood. Gamble quoting Brandis states that the timber is used for house-building, naves of wheels, oil crushers, and agricultural implements. It is also used for ornamental carving, and may be useful for shoe-lasts, pen-holders, rulers and similar articles.

Material—

6077 Kurnool, Andhra Pradesh (0·83).

2487 Calcutta, West Bengal (0·72).

9. GLYCOSMIS CORREA

A genus of evergreen unarmed shrubs or small trees, distributed in the Indo-Malayan region. Tanaka has described 14 species growing in India. The only species for which wood samples were available is dealt with here.

G. pentaphylla (Retz.) Correa—*Ghagolladi, chaul-dhowa, hengena-poka, hengna-poka, tultha-poka* (Asm.), *ashhoura, as-sera, kowa-tuti, matkhila, rang-gach* (Beng.), *maukti, obok, tawshauk* (Burm.), *serebilijira* (Cach.), *tasung-changpe* (Duff.), *ban-nimbu, ghutrua, girgitti, makranda, pilrupotala, potali, potla* (Hind.), *manikyan* (Kan.), *dieng-kasiar, dieng-soh-sning* (Kh.), *panal* (Mal.), *kirmira* (Mar.), *chingchoi-arong, hiunmucha, jami-reng-reng-arong, pleg-ik-arong, theng-lokso-arong, thengpitungmeng, wo-chora-a-anarong* (Mik.), *chouldua, howmonicho* (Or.), *bon-jamir* (Sylh.), *dieng-kajat-ske* (Synt.), *kula-pannai* (Tam.), *gonji, gulunga, gungi* (Tel.). An evergreen unarmed shrub or small tree, 1·2 to 3 m. high with stem up to 13 cm. diameter. *Bark* corky, light, greyish-yellow or blackish. According to systematists *G. pentaphylla* is a very variable plant which is divided by some botanists into several species, but almost all are more or less connected by intermediate forms.

It is found throughout India, Burma and Ceylon, except in very dry regions, often as underwood in moist forests in tropical and sub-tropical Himalayas ascending to 2,150 m. in Assam, Uttar Pradesh, Bihar and Orissa, Konkan and Kanara. It also grows in Malacca and China extending to the Malay Archipelago and Australia.

Description of the wood

[Pl. **34**, 199]

General properties—No colour distinction between heartwood and sapwood ; wood light yellowish-white ; moderately hard ; moderately heavy (sp. gr. 0·66 air-dry) ; dull to somewhat lustrous ; straight-grained ; fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct to the eye and under hand lens too many concentric bands appear at close intervals making it difficult to say which are true growth marks and which are not. *Vessels* small to very small, numerous (25–32 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–4, very often in clusters, oval, and open ; vessel lines inconspicuous on longitudinal faces. *Parenchyma* distinct under hand lens, in concentric bands ; few discontinuous and false bands also present. *Rays* fine, not visible to the eye, closely spaced. *Pith flecks* present.

The wood is tough, moderately hard and close-grained ; mostly used locally for small household articles.

Material—

3284 Chittagong, East Pakistan (0·66) (badly attacked by insects).
6485 Burma (0·66).

10. LIMONIA LINN.

A small genus of about 6–7 species of small, armed or unarmed trees, distributed in tropical Asia, the East Indies and tropical Africa. About 2–3

species occur in India, of which one is a small timber tree and is described here. *L. alata* W. & A., *tumpat-kurundu* (Sinh.) is a small pretty tree, found in evergreen forests of the Deccan and Carnatic from the Krishna southwards and in Ceylon and the Andamans ; *L. alternans* Wall., is a small, unarmed shrub of Lower Tenasserim.

L. acidissima Auct. (non Linn.) [**Hesperethusa crenulata** (Roxb.) Roem.]—*Thanatka, thihaza, thu-huya-za* (Burm.), *beli, bilashin, kath bel* (Hind.), *kadbela, kadinimbi, kaduveladu, kadvilpatri, naibela, naibullal, navi-bel, nimbaimara* (Kan.), *belsain* (Kharw.), *cherrukat narragam* (Mal.), *kawat, nai-bel, padara kawat, tondsha* (Mar.), *behenta, bhenta* (Or.), *bilan* (Punj.), *kat kitchillee, katuvela, kuranga, elimichai, mahamilvam, nai-vela* (Tam.), *adivi-munukudu, morphai-torelka, nimma, tholu velaga, tor-elaga, tori-elaga, torrayellaka* (Tel.). A small, spinous, straight-stemmed tree up to 45 cm. in girth and 7·5 m. high, but the average girth being about 15–20 cm. with a height of 4·5 m. *Bark* thin, light brown, corky, slightly cleft vertically.

It is found in the sub-Himalayan tract from the Ravi eastwards ascending to 1,200 m. almost throughout the dry hill forests in the Punjab, Uttar Pradesh, Assam, Bihar, Orissa, Madhya Pradesh, Bombay, Mysore, Madras, Andhra, and Upper Burma forests down to Prome.

Description of the wood

[Pl. **34**, 200]

General properties—No colour distinction between sapwood and heartwood ; wood light lemon-yellow, turning light brown with age, or even darker ; hard to very hard ; heavy to very heavy (sp. gr. 0·92–0·98 air-dry) ; somewhat lustrous with smooth feel like boxwood ; straight to twisted-grained, quite often with small knots and slightly wavy fibres ; even and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct with the naked eye delimited by concentric initial bands at regular to irregular intervals, usually 1–4 per cm. but, sometimes as many as 4–12 per cm. in slow grown trees. Double and apparently false and discontinuous bands also common. *Vessels* small to very small, moderately numerous to numerous (18–30 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–3 or more, with some clusters, rounded to oval in outline, and quite often plugged with yellowish deposits ; vessel lines inconspicuous on the longitudinal surfaces. *Parenchyma* distinct to naked eye, in concentric bands. *Rays* fine and closely spaced. *Pith flecks* frequently present. *Gum ducts* sometimes present in concentric lines embedded in parenchyma.

Seasoning—A refractory timber to season and liable to develop surface cracks, though end cracks and splits are not very serious. Effort should be made to season the timber slowly. As in the case of boxwood, it might be

advantageous to saw the small logs along their entire length up to the centre on one side, soon after felling. The timber is said to season well under shade and green conversion is recommended.

Natural durability—It is said to be very durable and immune to insect and fungus attack. It is not the class of timber that requires treatment.

Insect attack—Dead wood is liable to be attacked by *Demonax limoniae* Gardner (Cerambycidae).

Working qualities—A dense and fine-textured timber, often containing many small tight knots, but not so fine-textured as boxwood. Very hard, though not really difficult to saw either by hand or by machine ; planes to a very smooth, shining surface, tested for turnery work and proved suitable for the purpose. It also takes a good polish.

Supply and uses —Only fair quantities of the timber can be expected from each state. It is used for the axles of carts, walking sticks, oil pressers and rice pounders. It is used as posts in Madras, and furnishes a good fuel. It might possibly be found suitable for mathematical instruments such as scales and rulers, beading and inlay work in cabinet making, toys, egg-cups, and similar small articles ; a bossible substitute for boxwood for engraving. Being very tough and strong it should be tried for tool handles, welding hammer shafts and mallet-heads.

Material—

3570 Khurdha, Orissa (0·93), 3822 Ganjam, Orissa (0·98), 3846 Gumsur, Orissa (0·92), 4565 Saharanpur, Uttar Pradesh (0·97), 6063 Kangra Division, Punjab (0·96).

11. MICROMELUM Bl.

The genus consists of about 6 species of small trees, distributed in the Indo-Malayan region. Brandis has described only two Indian species while Tanaka has described 5 species as growing in India. The only species represented in the Dehra Dun collection is described here.

M. pubescens Bl. [**M. integerrimum** (Buch.-Ham.) Room.]—*Bhaluk-dat, bhaura, bno-jamir, gobor-hura, gobor huti, hilaguti-gach, padragota, sagladi* (Asm.), *ban-kunch, dulia maricha, mandraj* (Beng.), *ta-nyeng-hpo, tanyinbo* (Burm.), *dieng-ja-iao, dieng-soh-rang-soi, dieng-soh-sat, dieng-syrngam* (Kh.), *soitani* (Kol.), *kambrong, kongsung-kung, tamsung-kung* (Lep.), *san-mani* (Mech.), *thing-hanse* (Mik.), *lasmani* (Nep.), *wal-karapincha* (Sinh.), *koroi-phula* (Sylh.), *dieng-soh-tlai-shree, dieng tyrpei* (Synt.), *kakaipalai* (Tam.). A handsome evergreen tree. *Bark* yellowish-grey, somewhat rough outside, thin ; yellowish inside.

It is found in central and eastern Himalaya, in the Khasi and Naga Hills ascending to 1,200 m. and in West Bengal, Chittagong and also in the hills of Ganjam and Vizagapatam and the West Coast, Burma, Ceylon and the Andamans.

Description of the wood

[Pl. **34**, 201]

General properties—No colour distinction between heartwood and sapwood ; wood yellowish-white to grey turning brownish with age ; moderately hard to hard ; moderately heavy to heavy (sp. gr. 0·69–0·85 air-dry), lustrous with slight silver fleck on radial surface ; straight-grained ; rather fine and even-textured.

Gross structure—A diffuse-porous timber. *Growth rings* distinct to the naked eye, demarcated by concentric bands of soft tissues, usually 1–4, but up to 10 or more per cm. in slow grown trees ; discontinuous and false rings common. *Vessels* small to very small, moderately numerous to numerous (12–30 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–3, rounded to oval in outline, open or frequently plugged with yellowish deposits ; vessel lines inconspicuous or just visible on the longitudinal surfaces. *Parenchyma* visible to the eye, in concentric bands usually demarcating growth rings. *Rays* fine, visible to the eye, fairly closely spaced to closely spaced. *Vertical gum ducts* occasionally observed in concentric lines. *Pith flecks* occasionally present.

Material—

3355 Darjeeling, West Bengal (0·72), 5418 Burma (0·69), 6528 Burma (0·85).

12. MURRAYA LINN.

A small genus of unarmed shrubs or small trees. It consists of about 4 species distributed in the Indo-Malayan region. *M. exotica* Linn., is now cultivated widely as an ornamental plant in the tropics.

Woods of two species were available for study and are described here. They can usually be recognized easily by the following key :—

Soft tissue in concentric bands occurring at unequal distance ; vessels frequently plugged with yellow deposits .. .. *M. exotica*

Soft tissue vasicentric or aliform to aliform confluent ; vessels mostly open .. .. .. *M. koenigii.*

M. exotica Linn. [**M. paniculata** (L.) Jack]—*Kamini* (Beng.), *meke, moksongayok, pyinmana, taw-ngayok, thanatka* (Burm.), *juti-mersolo, marchulu,*

(Garh.), *pitondi*, *rakat-berar* (Gond.), *atal*, *bilgar*, *girgitti*, *haril*, *juti*, *marchula*, *malai lakri* (Hind.), *chinjai-mailo-phang*, *misai-athep*, *sinsri-kanthou* (Kach.), *nargan*, *pandry* (Kan.), *otali* (Kol.), *shitzam* (Lep.), *ling-kun* (Lush.), *deijir*, *dengjir-arong* (Mik.), *kolong-asing* (Miri), *simali* (Nep.) *ban mallika*, *harkankali* (Or.), *athel* (Sant.), *etteriya* (Sinh.), *konji* (Tam.), *kerepaku*, *naga golunga* (Tel.) ; sometimes also known as Andaman satinwood. In Malaya it is known as *kemuning*. A handsome evergreen shurb or small tree, up to a metre in girth and 7·5 m. high, with dense spreading crown. *Bark* thin, grey to yellowish and corky outside, smooth, fragrant, compact and granular within.

It is distributed throughout the outer Himalayas from the Ravi eastwards to Assam, ascending to 1,350 m. in Uttar Pradesh, Bihar, Orissa, South and West India ; usually common in the underwood, in ravines and forests, throughout the hotter parts of India, Burma, the Andamans, Ceylon. It also occurs in China, Australia and the Pacific Islands.

Description of the wood

[Pl. **34**, 202]

General properties—No colour distinction between sapwood and heartwood in the specimens examined. Wood whitish-yellow, fading to greyish-yellow to brown with age and sometimes with dark olive or black streaks near the centre. Reyes, however, states that sapwood may be up to 4 cm. thick, buff coloured or light yellow and quite distinct and sharply marked off from the heartwood which is clay coloured. Hard to very hard ; heavy to very heavy (sp. gr. 0·83–1·03 air-dry) ; somewhat lustrous with smooth feel ; straight to curly-grained ; even and very fine-textured.

Gross structure—A diffuse-porous timber. *Growth rings* visible to the eye, distinct under hand lens, delimited by conspicuous concentric bands of parenchyma at irregular intervals, 10–22 per cm. ; discontinuous bands common making it difficult to say which are true growth marks and which are not. *Vessels* very small to small, not visible to naked eye ; moderately numerous to numerous (15–32 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–3 rarely more or in clusters, rounded to oval in outline, frequently plugged with yellowish deposits ; vessel lines inconspicuous. *Parenchyma* in concentric bands delimiting growth marks. *Rays* fine to very fine, visible only with a lens, closely spaced. *Gum ducts* occasionally present in concentric lines.

Strength—A fairly strong and very hard timber. Pearson and Brown give the following strength figures based on the tests carried out by Professor Everett at the Sibpur Civil Engineering College on a small number of air-seasoned specimens.

Transverse strength in lb. per sq. in.		Compression parallel to the grain, in lb. per sq. in.
Breaking strength	Modulus of elasticity or Young's modulus	
15,365	1,747,000	10,660

Seasoning—A very refractory timber to season, similar to boxwood in this respect. A slow process of seasoning should be adopted to retard splitting. The timber should be felled and converted soon after the monsoon in order to allow as long a period for seasoning as possible before the hot dry wind sets in. Based on observations made by Strugnell, Dosch reports that Kemuning (*M. exotica*) is not subject to splitting. Burkill, however, says that it splits unless carefully seasoned.

Natural durability—A durable timber under cover. The timber does not require preservative treatment. According to Reyes the timber is very durable in the Philippines.

Working qualities—Moderately easy to saw and works to a very smooth surface, but not easy to work by hand. It is good for turnery and in this respect is somewhat similar to boxwood. However, according to the report given by authorities at the Imperial Institute on material from Ceylon, the timber is unlikely to take the place of boxwood in the market(14). Our own experience is that it is a good timber for turnery work but not of the same class as boxwood which is *par excellence*.

Insect and fungus attack—Foxworthy states that the much admired appearance of some pieces, seems to be due to the growth of a fungus. Schneider states that it is rarely attacked by beetles.

Supply and uses—Supplies are available in small quantities all along the foot-hills of the Himalayas as also from the West Coast forests. A small quantity could perhaps be obtained annually from Burma. The Andamans can also supply a small quantity. The timber is used for tool handles, turnery, inlay, cabinet work and walking sticks. It is probably unsuitable for engraving, but, should be suitable for rulers, scales, pen-holders, better class brush backs, set squares, and similar articles.

Material—

519 Andamans (0·98), 3195 Andamans (1·03), 3495 Singbhum, Bihar (0·83), 5211 Andamans (0·91), 5212 Andamans (1·00), 5213 Andamans (0·97), 6053 Dehra Dun, Uttar Pradesh (0·84).

2. **M. koenigii** (Linn.) Spreng—*Bishahari, narsingha, nor-hing* (Asm.), *barsanga* (Beng.), *kyaungthwe* (Burm.), *gani, gondela* (Garh.), *sam-khatsi* (Garo), *barsanga, gandbela, gandhla, harri, katnim, nimkathia* (Hind.), *kari beyu kuri bevu* (Kan.), *godaninb, karhi-nimb, kudia-nim, poospala* (Mar.), *thengsakso* (Mik.), *mechia-sag* (Nep.), *bowala gandi, brasan* (Or.), *gandla* (Punj.), *karapincha* (Sinh.), *paribadhra, surabhi-nimbu* (Sans.), *kamwepila, kari-vempu, karu-vembu, karu-veppilai, katta-vappilu, mishta-nimb* (Tam.), *karepak, kare paku, kari-vepa, kari-vepa-chettu, karsepak* (Tel.). A shrub or small tree with a strong smell usually 1·5–4·5 m high but sometimes reaching 6 m. in height and 20 cm. in diameter. *Bark* thin, grey to dark grey to almost black outside, with shallow net-like fissures.

It occurs in the sub-Himalayan tract and adjacent plains from the Ravi eastwards along the foot of the Himalayas up to Sikkim, throughout Assam up to 900 m. in Khasi Hills, Bihar, Orissa, Bengal and southward to Travancore and Andhra; a common undershrub in the Dun, Saharanpur, Pilibhit, Kheri, Gonda and Gorakhpur forests in Uttar Pradesh, generally running wild in ravines and on wastelands. It also occurs in Burma, and has been introduced in the Andamans.

Description of the wood

[Pl. **34**, 203]

General properties- No colour distinction between heartwood and sapwood; wood yellowish-white to grey, moderately hard; moderately heavy (sp. gr. 0·61 air-dry); somewhat lustrous; straight-grained; fine and even-textured.

Gross structure- A diffuse-porous timber, showing a slight tendency towards ring porosity. *Growth rings* distinct under hand lens, 3–6 per cm.; false growth rings also common. *Vessels* very small to small, not visible to naked eye, numerous to very numerous (30–40 and over per mm.^{2}), evenly distributed, mostly in radial multiples of 2–4 or more, or in clusters, somewhat oval in outline, open, vessel lines inconspicuous. *Parenchyma* vasicentric, aliform and aliform confluent also in concentric initial bands demarcating the growth rings. *Rays* fine, visible only with lens, closely spaced.

Fungus and Insect attack—Two wood rotting fungi, viz., *Fomes fastuosus*, a wound parasite causing a white pocket rot and *Fomes ribis*, causing a white rot have been recorded. Dead and dry wood is attacked by *ghoon* borers *Dinodeus mangiferae* Lesne (Bostrychidae); newly felled or fallen wood and newly dead or dying trees are attacked by shot-hole borers (Platypodidae).

Uses—The wood is mostly used for agricultural implements. It has only local importance.

Material—

3265 Saharanpur, Uttar Pradesh (0·61).

13. SKIMMIA THUNB.

The genus contains about 3 species of strongly scented unarmed shrubs distributed in the Himalayas, China and Japan. Only one species found in India is described here.

S. laureola Sieb. & Zucc.—*Narpati* (Garh.), *limburnyok, timburnyok* (Lep.) *chumlani, chumloni* (Nep.), *barru, ner, patrang, shalangli, shashra, shashri* (Punj.). A gregarious, evergreen, strongly aromatic shrub, up to a little over 3 m. in height, with stems usually up to 12·5 cm. diameter, occasionally more. *Bark* thin, greyish-white or bluish-grey, smooth.

It is common in the Himalayas from the Indus eastwards to Bhutan at 1,500–3,350 m. ; Khasi and Jaintia Hills in Assam ; a common undershrub in the Dun Valley, it also occurs in Afghanistan.

Description of the wood

[Pl. **34**, 204]

General properties—No colour distinction between heartwood and sapwood ; wood white with brownish tinge ; moderately hard ; moderately heavy (sp. gr. 0·64 air-dry) ; somewhat lustrous ; aromatic when freshly cut ; straight-grained and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to indistinct to the eye, demarcated by concentric parenchyma bands and somewhat denser late wood fibres, at regular to irregular intervals, 7–8 per cm. *Vessels* extremely small, indistinct to the eye, very numerous arranged in groups or forming a characteristic "flame-like" pattern ; vessel lines inconspicuous. *Parenchyma* visible to eye as faint lines, distinct under hand lens, in concentric bands, demarcating growth rings. *Rays* fine, closely spaced.

The wood is locally used for hoe and axe handles and other agricultural purposes.

Material—

2330 Darjeeling, West Bengal (0·64), 2864 Simla, Himachal Pradesh (0·64).

14. VEPRIS COMM.

A genus of unarmed shrubs or trees. The only species occurring in India has been described here.

V. bilocularis Engl. Syn. **Toddalia bilocularis** W. & A.—A handsome, evergreen, unarmed, small to middle-sized tree, reaching about 1 m. in girth.

It is found in the Western Ghats, Konkan, Kanara, Travancore and Malabar from 600–1,200 m. in moist forests.

Description of the wood

[Pl. **35**, 205]

General properties—No colour distinction between heartwood and sapwood ; wood pale yellow when freshly cut turning brownish-yellow on exposure, very hard ; very heavy (sp. gr. 1·00 air-dry) ; lustrous ; straight-grained ; fine and even-textured.

Gross structure—A diffuse-porous timber. *Growth rings* distinct to the naked eye, demarcated by concentric bands of parenchyma, 1–18 per cm. ; some bands appear too close to be true growth marks. *Vessels* very small to small, not visible to the naked eye, moderately numerous to numerous (14–28 per mm.^{2}) evenly distributed, solitary or in radial multiples of 2–3, rarely more ; rounded or oval in outline ; frequently filled with yellow deposits ; vessel lines inconspicuous. *Parenchyma* distinct to eye, in thin to thick concentric bands at irregular intervals demarcating growth rings. *Rays* fine, indistinct to just visible to naked eye, fairly closely to closely spaced.

Strength properties—It is a tough timber and can stand considerable shock.

Seasoning—It may be difficult to season as it splits badly during seasoning.

Supply and uses—It is an excellent wood for helves and handles, cart wheels, and spokes. It was also tried for shuttles in textile and jute mills, but was found unsuitable(43).

Material—

7616 Madras (1·00).

15. ZANTHOXYLUM LINN.

The genus consists of over 150 species of small to medium-sized trees and erect or climbing shrubs, often with stout prickles, widely scattered throughout the tropical and sub-tropical regions. About 11 species occur in India and Burma, two of which are timber trees of commercial importance. The genus is also represented by timber species in tropical America, Africa, East Indies, Malay Peninsula, Indo-China, Australia and Formosa. The tropical American *Z. flavum* Vahl. and other species of *Zanthoxylum* provide the timber, West Indies satinwood which is well known in the timber market of the world.

Among the Indian species not dealt with here *Z. hamiltonianum* Wall. [*Fagara hamiltoniana* (Wall.) Engl.] – *bagh-anchora, tejmaibih, tezmoi, tezmuri* (Asm.), *rikam-ruibi* (Miri), *changre* (Naga). *parpar timur, purpuray timur* (Nep.), is a climbing thorny evergreen shrub distributed in Sikkim, Assam and Upper Burma. *Z. khasianum* Hook. f., *soh-mrit, dieng-tiw-shiah, soh-umiuw* (Kh.), is a large aromatic woody climber of Khasi hills at 1,500 1,950 m. *Z. oxyphyllum* Edgew. [*Fagara oxyphylla* (Edgew.) Engl.]— *mezenga* (Asm.), *siritakdangji* (Lep.), *bhainsi, timur, lahara timur* (Nep.), is a climbing shrub found in Himalayas from Garhwal to Bhutan at 1,850-2,450 m., Khasi and Garo Hills, Sibsagar and Lakhimpur districts of Assam.

Five species for which wood specimens were available are described here. Of these, *Z. acanthopodium, Z. alatum, Z. budrunga* and *Z. rhetsa* have woods which are very similar in all respects and indistinguishable. The fifth species *Z. ovalifolium*, is described here separately, as the wood shows marked differences in some characters. It is distinctly harder, heavier and tougher than the others.

1. **Zanthoxylum acanthopodium** DC.—*Chyingbawngla, jangbawngla* (Kach.), *dieng jaior-khlaw, dieng-soh-khlam, dieng-soh maijur, dieng-soh-mio, jayurkhlam, soh-jing-bain* (Kh.). *nangryupat tembar, timbur* (Lep.), *bogay timur, boke timur* (Nep.), *dieng ja-jaur* (Synt.). It is an erect shrub or small tree 1 to 3 m. high with stem up to 7·5 cm. in diameter. *Bark* 3 mm. thick, greyish-brown, shining, studded with large conical corky bases of the prickles. It occurs in Naini Tal between 1,500 2,300 m. and is apparently found in the outer Himalayas from Kumaon to Sikkim, Khasi Hills in Assam and Kachin hills of Burma.

Description of the wood—See page 45.

2. **Z. alatum** Roxb.—*Nepali dhania* (Beng.), *tejmal tezbal* (Garh.), *durmur, tejbel, tezmal, timbur, timur* (Hind.), *sungru, sungrukung* (Lep.), *balay timur, bale timur* (Nep.), *tumbaru* (Sans.). It is a strongly aromatic shrub or occasionally a small tree. *Bark* corky, greyish-brown in old trees with thick conical prickles from a corky base. It is found in the outer Himalayas from the Indus eastwards, ascending to 2,150 m.; Khasi and Naga Hills, hills of Vizagapatam and Ganjam above 1,350 m.; Upper Burma hill forests above 750 m.

Description of the wood—See page 45.

3. **Z. budrunga** Wall. (**Fagara budrunga** Roxb.)—*Bajarmuni, bajna, bazarnali, brojonali* (Asm.), *badrang, kanta horina* (Beng.), *hmet kaung, kathitsu, mayanin, mayanin-kyetsu* (Burm.), *bajrang, chingirphang* (Cach.), *sumet-chheng* (Garo), *budrung* (Hind.), *chyingbawng, jangbawng, jingbawng* (Kach.), *dieng-ka synrang* (Kh.), *sing-i-te* (Kuki), *nyngdoij* (Manip.),

tingang-arong (Mik.), *ongret* (Naga), *timur* (Nep.), *morai* (Or.), *bajrang* (Sylh.). An aromatic tree, armed with prickles, with a straight bole, 12–18 m. high and 1·2 m. in girth but is usually smaller, with 4·5–6 m. clear bole. *Bark* grey or greyish-brown, and corky with fine reticulate fissures outside, covered with thick, conical prickles from a corky base.

It is found scattered throughout eastern Himalayas, Khasi Hills, North Bengal, Chittagong, Orissa, Lower Burma and the Andamans ; also in the Eastern Ghats, and hills of Vizagapatam at 1,050 m.

Description of the wood—See below.

4. **Z. rhetsa** DC. (**Fagara rhetsa** Roxb.)—**Mullilam.** *Bajarmali, bajarmani* (Asm.), *kanta horina* (Beng.), *jingar-phang, malaphang, thenthe-lau-phang* (Cach.), *bolmicheng, shumi-chheng* (Garo), *pepuli, pepull* (Hind.), *jamin, jisumi-mara, jummina, sessal* (Kan.), *dieng-nadkor, dieng-soh-aruin, dieng-soh-mirik* (Kh.), *jur-thoum-thing* (Kuki), *katta murakku, mulillam* (Mal.), *kokli, tessul, thriphal, tirphal, tisul* (Mar.), *hanjor, thing-nang-arong* (Mik.), *onger-asing* (Miri), *katu-kina, ratu kina* (Sinh.), *reddi, rhetsa, rhetsa man, vengurla* (Tel.). It is a large tree, usually 1·2–1·5 m. in girth, and 20 m. in height ; but may grow up to 2·5 m. in girth and 25–30 m. in height in Rumpa hills in Andhra Pradesh. *Bark* corky and cream coloured outside, studded with conical spines about 5 cm. long.

It is found in the Eastern and Western Ghats from North Kanara and Konkan southwards to Travancore being at its best in Rumpa hills and about the Godavari in Andhra Pradesh ; in Assam it occurs scattered throughout the state.

Description of the wood

(*Zanthoxylum acanthopodium*, *Z. alatum*, *Z. budrunga* and *Z. rhetsa*)

[Pl. **35**, 206, 208]

General properties—No colour distinction between heartwood and sapwood ; wood greyish-yellow to canary-yellow when first exposed, fading to pale yellowish-grey ; moderately hard ; moderately heavy (sp. gr. 0·48–0·74 air-dry), rather dull to lustrous with smooth feel, and with slight silver fleck on radial surface ; straight-grained to somewhat wavy-grained ; even and medium-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to the naked eye, delimited by pale conspicuous lines of initial parenchyma and somewhat denser latewood fibres at regular to irregular intervals, 1–15 per cm. *Vessels* small to moderately large in size, just visible to fairly distinct to the naked eye ; moderately numerous to numerous (12–33 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–4, occasionally more, round to

oval in outline, open or frequently plugged with yellow deposits ; vessel lines rather inconspicuous on the longitudinal surfaces. *Parenchyma* visible to naked eye at regular to irregular intervals demarcating growth rings. *Rays* fine, not closely spaced to fairly closely spaced. *Vertical gum canals* occasionally present in concentric lines embedded in the parenchyma cells.

Strength—The wood of all these species is moderately hard and strong and is said to be similar to that of *Adina cordifolia* in strength. For strength figures of *Z. budrunga* and *Z. rhetsa* see appendix I.

Seasoning—The wood of *Z. rhetsa* seasons well without difficulty, not being subject to splitting. The wood of *Z. budrunga* also seasons without much degrade except for extension of original defects, such as end splitting and surface cracking.

Insect attack—Dead wood of *Z. budrunga* is attacked by some Brenthidae and Curculionidae borers.

Dead wood of *Z. rhetsa* is attacked by *Neocallia pubescens* Fisher (Cerambycidae) and *Xyleborus noxius* Sampson (Scolytidae).

Natural durability—*Z. budrunga* is said to be a moderately durable timber when used under cover. The wood of *Z. rhetsa* is moderately durable in exposed conditions and durable under cover. Graveyard tests carried out at this Institute, showed that the average life of untreated wood is 57 months.

Working qualities—The timber is easy to saw and work either by hand or on machine, finishing to a good smooth surface and taking a high polish. *Z. budrunga* is one of the best turnery woods standing up well to high speed repetition lathes and moulding work. In this respect it resembles haldu, *Adina cordifolia*. Carving is easy but not recommended for fine jobs. Wax polishing is not favoured. It may be used for light furniture, decorative panelling, etc. *Z. rhetsa* is not smooth in sawing machine but takes a shining surface on planing machine. Nails and screws can be easily driven in and are retained tight in position(48). It takes stain, polish and paint quite satisfactorily.

Supply and uses—*Z. budrunga* is fairly common in Western Assam; not uncommon in the middle and south Andamans. The tree is found scattered wherever it occurs, so that it could only be worked out commercially with other species. *Z. rhetsa* is a fairly common tree in the Tellicherry Ghat forests of Malabar, but, rather uncommon in the west zone ; the wood of *Z. budrunga* is used locally in Assam for house posts and looms. It has been tested for match splints and match boxes and passed as suitable. It should prove suitable for jute bobbins, and could be used for planking, panels, and similar purposes for which *Adina cordifolia* is used. The timber of *Z. rhetsa*

is used in South India as planking, rafters, scantlings, axe handles, legs of beds and for chairs. Quarter-cut boards could be used for panelling and other ornamental purposes. It is used for turnery articles, veneers and plywood, furniture and cabinet making and heavy packing cases, for packing machinery and similar stores. *Z. rhetsa* has also been found suitable for the manufacture of improved woods like 'Staypak' and 'compreg' for textile mill accessories (Narayanamurti, *Bull. Nat. Inst. Sci.*, No. 6, 1955).

In the Philippines it is used for making fine furniture and walking sticks. Reyes remarks that the timber is so similar to maple (*Acer* spp.) that it can be used as a substitute for it.

Material—

Z. acanthopodium – 3415 Darjeeling, West Bengal (0·48).

Z. alatum – 107 Simla, Himachal Pradesh (0·62), 2339 Darjeeling, West Bengal (0·49).

Z. budrunga – 3324 Darjeeling, West Bengal (0·61), 5523 Assam (0·74), 6123 Kurseong, West Bengal (0·70), 6704 Burma (0·64).

Z. rhetsa – 3962 Godavari, Andhra Pradesh (0·65), 6065 Kanara, Mysore (0·69), 7638 Kanara, Mysore (0·68).

5. Z. ovalifolium Wight. [Fagara ovalifolia (Wt.) Engl.]—*Armadal, armadalu* (Kan.), *dieng-shih, dieng-siniath, tew-kalong* (Kh.), *nange timur* (Nep.). It is an aromatic shrub or small tree. *Bark* thin, greyish-brown, with white vertical streaks.

It is found in the eastern Himalayas, Khasi Hills at 1,200–1,500 m., Assam, Sikkim and Upper Burma; also occurs in Western Ghats from South Kanara to Tinnevelly up to 1,200 m. and the Andamans.

Description of the wood

[Pl. 35, 207]

General properties—No colour distinction between heartwood and sapwood; wood light yellow, turning brownish on exposure; hard; heavy (sp. gr. 0·89 air-dry); somewhat lustrous, with smooth feel; straight-grained; fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* faint or inconspicuous to the naked eye, distinct under hand lens; 15–20 per cm.; discontinuous rings common. *Vessels* small to very small, not visible to eye, very numerous (over 40 per mm.^{2}) evenly distributed, solitary, 2–4 or more in radial multiples or in clusters, round to oval in outline, open; vessel lines inconspicuous on longitudinal surfaces. *Parenchyma* in concentric bands

demarcating growth rings. *Rays* fine, indistinct to eye, distinct under hand lens, closely spaced.

The wood is hard, heavy, tough and close-grained and can be used for many purposes for which *Murraya exotica* is now used.

Material—

3353 Darjeeling, West Bengal (0·89).

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B. S. NEGI.

SIMARUBACEAE

A family of about 32 genera and 200 species of shurbs and small to large trees widely distributed throughout the world, but chiefly in the tropical and in the warmer regions of the northern hemisphere.

The members of the family are usually characterized by bitter bark, even the wood being bitter in some of the genera. The bitter principle obtained from some of them is used in medicinal preparations as a febrifuge and as an anthelmintic. Well known among them is Quassia which is principally extracted from the wood chips of *Aeschrion excelsa* (Sw.) Kuntze, syn. *Picraena excelsa* Lindl. of West Indies and *Quassia amara* Linn. of tropical America. In India, a substitute for Quassia is obtained from the bitter wood of *Picrasma quassioides* (D. Don) Benn. From the point of view of timber, the family is not of much importance except *Simaruba* Aubl. of tropical America, and *Ailanthus* Desf. of South-East Asia, China and Australia, which are used for boxes, packing cases and plywood. The tree of heaven, *Ailanthus altissima* (Mill) Swingle which is indigenous to China and Japan, is well known for its luxuriant growth and is often planted in many countries including India.

The family is heterogeneous both from the point of view of morphology as well as anatomy, very few characters being common throughout the group. Although it is closely related to the *Rutaceae* in external characters(1), none of the timbers examined by us showed any great resemblance to rutaceous woods except perhaps *Harrisonia* R. Br. Webber who has made a comprehensive study of the woods of this family has come to the following conclusions :

(1) Out of six sub-families recognized by Engler, each of the four sub-families *Alvaradoideae, Irvingioideae, Kirkioideae* and *Picramnioideae* represents a natural group having more or less homogeneous structure. The *Alvaradoideae* is characterised by the presence of vasicentric tracheids with spiral thickening. Heimsch also mentions the occurrence of septate fibres in bands or patches in *Alvaradoa* Liebm. The *Irvingioideae* is usually distinguished by the presence of confluent or banded parenchyma. The *Kirkioideae* has got scanty parenchyma in the vicinity of the vessels and the fibres are also septate. In the *Picramnioideae* parenchyma is either absent or very sparse. According to Heimsch, *Picramnia* Sw. and *Alvaradoa* possess the most heterogeneous rays in the family.

(2) The woods of the *Surianoideae* are more heterogeneous than the four sub-families mentioned above though they have some characters in common. Here the parenchyma varies from almost absent to diffuse and paratracheal and is also storied in two genera.

(3) The *Simaruboideae* which includes the largest number of genera, exhibits a wide range of structural variation and is the most heterogeneous among all the sub-families. The parenchyma shows considerable variation and almost all types are met with in addition to vasicentric. In some, storied arrangement is also present(12). The rays are predominantly multiseriate (homocellular to heterocellular) and in some cases these are also storied.

All the genera described in this book belong to the sub-family *Simaruboideae* except *Irvingia* Hook. f. They vary considerably in weight, hardness and texture, being very light, soft and coarse-textured in *Ailanthus* and very hard, very heavy and fine-textured in *Harrisonia*. The woods are diffuse-porous except *Picrasma quassioides* which is true ring-porous and also some samples of *Ailanthus* which may sometimes show a tendency towards ring-porousness. Woods of all these genera are characterized by vasicentric to aliform parenchyma which varies in quantity and visibility. The vessels range from large in *Ailanthus* to small in *Harrisonia*. They are solitary or in short radial multiples, and are usually few to moderately numerous. However, according to Webber, vessels in this sub-family vary from "very few to very numerous (number per sq. mm. from 0 in *Simaruba* to 117 in *Holacantha*)". The rays may be very broad as in *Ailanthus* or very fine in *Samadera* Gaertn. Ripple marks traceable to storied parenchyma are present in *Picrasma* Bl., but they are not always conspicuous under hand lens. Webber has also reported ripple marks in *Ailanthus grandis* Prain, *A. malabarica* DC., *Harrisonia bennettii* Hook. f. and *Samadera indica* Gaertn. but specimens examined by us did not reveal this characteristic. Normal vertical gum canals have been reported to be of common occurrence in *Castela* Turp. and *Simaruba*(16). Among the genera examined, traumatic vertical gum canals have been recorded in *Ailanthus* spp. and *Samadera indica*. In *Ailanthus altissima* (Mill) Swingle occasionally very broad and large rays are reported to undergo gummosis forming gum canals(20). *Irvingia*, which is included in the sub-family *Irvingioideae*, differs from all the other genera dealt with here, in having abundant parenchyma in broad bands at regular intervals.

About 8 genera are indigenous to the Indian region and wood specimens of five of these genera were available for study which are described here. The remaining genera are—*Brucea* Mill, *Eurycoma* Jack. and *Suriana* Plum. ex Linn., all of which are shrubs. *Brucea* is represented by two species, *B. mollis* Wall. and *B. amarissima* (Lour.) Merril. syn. *B. sumatrana* Roxb. The former is found in the eastern Himalayas, Assam and hills of Burma and the latter in Burma and also probably in Assam. The other two genera are represented by solitary species. *Eurycoma longifolia* Jack occurs in Tenasserim in Burma while *Suriana maritima* Linn., is reported to be an uncommon littoral species growing in the coastal regions of Andamans, Burma and Ceylon.

Key to the woods

1. Wood ring-porous ; latewood vessels very small, usually in clusters. Wood bright orange-yellow, very bitter .. .. .. *Picrasma quassioides*

1. Wood diffuse-porous 2

2. Parenchyma in fairly broad, distinct, long or short bands at regular intervals. Wood yellow-brown, very hard, very heavy .. *Irvingia*

2. Parenchyma not in broad bands .. 3

3. Growth rings delimited by thin lines of parenchyma 4

3. Growth rings not delimited by parenchyma. Wood soft, yellowish-white, coarse-textured .. *Ailanthus*

4. Paratracheal parenchyma forming thin sheath round the vessels, indistinct or hardly visible under the lens. Wood very hard, very heavy .. .. .. *Harrisonia*

4. Paratracheal parenchyma forming "eyelets" with long lateral extensions, sometimes connecting vessels 5

5. Rays visible to the eye. Ripple marks present. Wood rather coarse-textured .. .. *Picrasma javanica*

5. Rays not visible to the eye. Ripple marks absent. Wood fine-textured .. .. .. *Samadera indica.*

1. AILANTHUS DESF.

A small genus of large trees distributed in South-East Asia, China and Australia. All the four species indigenous to India, have been dealt with here. *A. altissima* (Mill.) Swingle syn. *A. glandulosa* Desf. of Japan and China is sometimes planted in Northern India as an ornamental tree. The wood of this species is characterized by ring-porous structure.

The woods of the four species described here are very similar in anatomical structure and are, therefore, described together. However, *A. malabarica* DC. is often finer textured than the rest, usually the paratracheal parenchyma being comparatively less distinct and the rays not broad.

Recently fossil woods showing some affinity to this genus have been reported from the Deccan Intertrappean beds(19).

1. **A. excelsa** Roxb.—**Maharukh.** *Ardusi, moto aduso* (Guj.), *chora nim, ghorkaram, limbado, mahrukh, marukh, narup* (Hind.), *dhup, helbewa, peetherai* (Kan.), *peenari, perumarium* (Mal.), *maharukha, varul* (Mar.), *gorwi-kawat, mahala, mahanim* (Or.), *perumaruthe, peruppi, pimaran, pinari, periamaram* (Tam.), *peddamanu, peddamanpata, pedu* (Tel.). A large tree 18–25 m. in height and 2–2·5 m. in girth. *Bark* light grey and smooth when young, turning greyish-brown and rough in old trees. The tree yields a gum which is not of much importance at present. The bark is aromatic and is used in indigenous medicine as febrifuge and tonic.

It occurs mostly in the central part of India throughout Madhya Pradesh and also in Andhra Pradesh, Orissa and Chota Nagpur in the east, and Gujarat on the west. The tree is often cultivated.

Description of the wood—See page 54.

2. **A. grandis** Prain.—**Gokul.** *Borpat, borkeseru, koranga, ring, sarag-phula* (Asm.), *lalang-baiong* (Jaintia), *diang-ehas* (Khasi), *sileng-asing* (Miri & Abor.), *gokul* (Nep.). A lofty tree, sometimes up to 45 m. in height with a cylindrical bole. *Bark* grey and smooth.

It is found throughout Assam and North Bengal.

Description of the wood—See page 54.

3. **A. kurzii** Prain.—A large tree 24–36 m. in height and 1·5 to 2·5 m. in girth. *Bark* grey, smooth.

It occurs in the Andaman Islands where it is common, and also in Pegu Yoma, Burma.

Description of the wood—See page 54.

4. **A. malabarica** DC. [**A. triphysa** (Dennst.) Alston].—**Maharukh.** *Dhup, hal-maddi* (Kan.), *mattipal, pongilyam* (Mal.), *guggula-dhup* (Mar.), *mattipal, peru, perumaram* (Tam.), *maddipalu, peddamanu* (Tel.). A large tree with tall cylindrical trunk. *Bark* grey, rough and often shows bright reddish grains of resin. The tree yields an aromatic resin which is used for burning as an incense and also used for making "*agar-batti*". The resin is also used in dysentery and the bark in indigenous medicine as tonic and febrifuge. The collection of this resin is usually done from natural exudations. To induce the flow of the resin, the bark is sometimes also induce.

It is found in the Western Ghats from Kanara southwards to Travancore up to 1,500 m. elevation, and also in Ceylon and Lower Burma.

Description of the wood—See page 54.

Description of the wood

(*Ailanthus excelsa*, *A. grandis*, *A. kurzii* and *A. malabarica*)

[Pl. **35**, 209–210 ; Pl. **36**, 211–212]

General properties—Sapwood and heartwood not clearly demarcated. Wood whitish to light yellow or greyish, turning brownish-yellow on ageing ; often discoloured due to sap-stain ; soft ; light (sp. gr. 0·34–0·45 air-dry) ; straight-grained ; coarse-textured ; somewhat lustrous when fresh and often showing prominent silver figure on the radial surface.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct, but occasionally denser bands of fibres and tangential alignment of vessels may give the impression of growth marks. *Vessels* large to very large, distinctly visible to the eye, very few to few (1–5 per mm.^{2}), solitary or in radial multiples of 2–3 or more, rarely in clusters in *A. excelsa*, round to oval, open ; vessel lines distinct to the eye. *Parenchyma* usually distinct, paratracheal, vasicentric to aliform with long, thick or fairly thick lateral extensions, occasionally joining up with similar extensions from other vessels to form confluent bands, which are usually conspicuous in *A. malabarica*. *Rays* apparently of two types – broad and fine ; the broad ones are distinctly visible to the eye and widely spaced but usually less conspicuous in *A. malabarica* ; the finer ones are only visible under hand lens in between the broad rays ; ray-flecks broad and conspicuous. *Gum canals* vertical of traumatic type occasionally present. *Pith flecks* occasionally observed in *A. excelsa*.

Strength—It is a light and soft timber but has not been tested so far at this Institute. According to Pearson and Brown the timber is fairly strong for its weight and holds nails well.

Seasoning—The timber is easy to season, even large sections can be seasoned without any degrade. As it is very susceptible to stain, green conversion and rapid seasoning are recommended. In kiln drying it presents no difficulty and according to Rehman, it takes about 4–5 days to season.

Natural durability—The wood is easily perishable in the open. 'Graveyard' tests at Dehra Dun showed that *A. grandis* has an average life of 17 months in contact with the ground.

Insect and fungus attack—Dead wood of *A. excelsa* is liable to be attacked by *Sphenoptera mediocris* (Buprestidae), while that of *A. malabarica* is attacked by some Anthribidae and Cerambycidae borers and also by white ants (*Termes ceylonicus* Holmgren). The dry wood is also attacked by *Lyctoxylon japonum* Reitter (Bostrychidae). The timber is very easily susceptible to sap-stain and fungal decay.

Preservative treatment—It is easily treatable.

Working qualities—It is an easy wood to work on machines or by hand but *A. excelsa* is reported to be only "fair" for match splints as the timber is too open in structure and the fibres are liable to tear up.

Supply and uses—*A. grandis* is available in limited quantities from Assam but *A. excelsa* and *A. malabarica* are available in large quantites throughout Central and South India.

The timber is mainly used for the manufacture of light packing cases and box shooks. It is also good for match splints but not a very suitable timber for match boxes ; *A. malabarica*, however, is usually preferred for the purpose because it gives a higher yield than others due to its clear cylindrical stem. It is a common wood for slate frames, core stock for laminboards, toys and drums. It is also used for catamarans and according to Pearson and Brown for boat building on the west coast.

Material—

A. excelsa – 4464 Chanda, Bombay (0·45), 5122 Madras (0·39), 5355 Nagpur, Bombay (0·34).

A. grandis – M 594 Assam.

A. kurzii – 8081 Andamans.

A. malabarica – 6300 Burma (0·44).

2. HARRISONIA R. Br.

A very small genus of spiny shrubs or small trees distributed in tropical Asia and Africa. Two species occur in the Indian region, of which, samples of *H. bennettii* Hook. f. only were available for study. The other species *H. brownii* A. Juss. is a common straggling shrub of the deciduous forests of the Middle and South Andamans.

H. bennettii Hook. f. [**H. perforata** (Blanco) Merr.]—*Soogyin* (Andaman), *mai-hki, mai-si, tabu* (Burm.). A scandent shrub or a small thorny deciduous tree. Gamble states that the spiny stems of this tree give the impression of *Toddalia* Juss. and *Pterolobium* R. Br. *Bark* thin, greyish-white.

It occurs in Andaman Islands and in the dry forests of Burma.

Description of the wood

[Pl. **36**, 213]

General properties—Sapwood and heartwood distinct ; sapwood white when fresh turning light brown on ageing ; heartwood brown with darker

streaks due to deposits in the fibres ; hard, heavy to very heavy (sp. gr. 0·89–0·95 air-dry), straight to slightly interlocked-grained ; even and rather fine textured.

Gross structure—A diffuse-porous wood. *Growth rings* fairly distinct, demarcated by fine lines of parenchyma and sometimes also by darker bands of fibres, 2–3 per cm. *Vessels* small, hardly visible to the eye as pin-pricks, moderately numerous (13–18 per mm.^{2}), occasionally rather crowded in the early wood, usually arranged in radial multiples of 2–3 and showing sometimes a tendency towards radial alignment, open or sometimes plugged with pale yellow deposits ; vessel lines visible to the eye, numerous. *Parenchyma* scanty, in thin lines delimiting growth rings, just visible to the eye ; also as scanty vasicentric sheath which is visible under lens with difficulty. *Rays* fine to very fine, visible under lens, closely spaced, evenly distributed ; radial flecks inconspicuous.

The wood has a tendency to develop longitudinal cracks. A very hard and very heavy timber which should be suitable for constructional purposes. It should also do well for tool handles.

Material—

4874 Burma (0·95), 5000 Minbu, Burma (0·89).

IRVINGIA HOOK. F.

A small genus of about 8 species, usually trees, distributed in tropical Africa and Asia. Two species occurring in Burma have been dealt with here.

1. **malayana** Oliv. ex A. W. Benn.—*Pauh kijang* (Malaya). A large tree reported to grow even up to 60 m. in height in the Malay Peninsula(6) and often with big buttresses. *Bark* smooth, greyish-white, not bitter.

It occurs in Burma and in the Malay Peninsula.

Description of the wood—See below.

2. **I. oliveri** Pierre—*Taung-thayet* (Burm.). A tree occurring in Cambodia and Cochin-China and also probably in Tenasserim, Burma(11).

Description of the wood—See below.

Description of the wood

(*Irvingia malayana* and *I. oliveri*)

[Pl. **36**, 214]

General properties—Sapwood and heartwood indistinct. Wood light brown with yellow cast and streaked with whitish (sometimes turning greenish

in patches) lines on the longitudinal surfaces traceable to parenchyma bands ; very hard, heavy to very heavy (sp. gr. 0·87–1·03 air-dry), fairly straight-grained, rather uneven and medium-textured ; an attractive figure due to alternating bands of parenchyma and fibres is noticeable on the plain sawn surfaces.

Gross structure—A diffuse-porous wood. *Growth rings* apparently distinct to the eye, delimited by denser bands of fibres with scanty vessels and parenchyma, 3–4 per cm. But whether these are true annual rings or not requires confirmation. *Vessels* moderately large, moderately few (5–8 per mm.^{2}), solitary and in radial multiples of 2–3, round to oval in shape, open ; vessel lines distinct. *Parenchyma* abundant, visible to the eye in numerous broken or long tangential bands touching, enclosing or connecting vessels ; also forming thin sheath round the vessels, visible under lens. *Rays* fine, visible under lens, closely spaced and evenly distributed ; ray-flecks distinct.

A hard and strong timber but has not been tested for strength so far. According to Desch it is not a durable timber and is more susceptible to termite attack than to fungal decay. It is suitable for constructional purposes but not in outside locations.

Material—

I. malayana – 5626 Winsaw reserve forest Burma (0·95).

I. oliveri – 6142 Burma (0·87), 6537 Burma (1·03).

PICRASMA Bl.

A small genus of trees and shrubs distributed in tropical and sub-tropical regions of the world. Two species occur in the Indian region, both of which are dealt with here.

The two species described here are easily distinguished from each other on the basis of vessel distribution. *P. javanica* Bl., is diffuse-porous while *P. quassioides* (D. Don) Benn. is ring-porous.

1. **P. javanica** Bl.—*Nimtita, putichal* (Asm.), *taungkamaka* (Burm.), *bon-poshla, bor-jagreng, thigisin* (Garo), *tungchir-kung* (Lep.), *singka-asing* (Miri & Abor), *aeo* (Naga), *teju* (Nep.). A small to middle-sized evergreen tree. In the Andamans, the tree grows up to 6 to 9 m. in height and about 1 m. in girth. *Bark* dark brown, smooth, thin. All parts of the tree especially the bark and the twigs are very bitter. The bark is used in indigenous medicine as a febrifuge.

It is found in Nepal, Sikkim, North Bengal, Assam, the Andamans and Lower Burma.

Description of the wood

[Pl. **36**, 215]

General properties—Sapwood and heartwood indistinct in the samples examined. Wood white turning yellow to brownish-yellow on ageing; soft to moderately hard; light (sp. gr. 0·39–0·50 air-dry); straight-grained; even and coarse-textured. Wood slightly bitter in taste.

Gross structure—A diffuse-porous wood occasionally tending towards semi-ring porousness. *Growth rings* distinct, delimited by thin lines of parenchyma, 2–4 per cm. *Vessels* moderately large, visible to the eye, moderately few (5–9 per mm.^{2}), solitary and in radial multiples of 2–3, occasionally in small clusters or short oblique groups with a tendency towards tangential alignment in the early wood in some rings; round and open; vessel lines distinct to the eye. *Parenchyma* whitish, visible to the eye as (*a*) fine lines delimiting growth rings, and (*b*) paratracheal forming thin sheath round the vessels, aliform to aliform confluent, with fairly broad lateral extensions which may run for considerable distance and connect several vessels particularly in the latewood. *Rays* lighter in colour, rather fine, visible to the eye, widely spaced and evenly distributed; ray flecks inconspicuous. *Ripple marks* present, traceable to storied parenchyma, but not always distinct under hand lens.

The wood is soft to moderately hard and can be used for light packing cases, interior fittings, etc.

Material—

1977 Andamans (0·42), 6832 Burma (0·39), 7129 Burma (0·50).

2. **P. quassioides** (D. Don) Benn.—*Puthorin*, *bera*, *mathu*, *bering*, *pesho*, *kashbar*, *bergo*, *tutai*, *tithai*, *tritu* (Himachal & Punj.), *charangi*, *bharangi*, *beringi* (Hind.), *karui* (Jaunsar), *dieng khlang* (Kh.), *shama bairangi* (Nep.). A small tree. *Bark* light brown, smooth, thin. Every part of this tree is bitter and perhaps more so than that of *P. javanica*. Bark, wood and root are used as febrifuge.

It is found in the outer foot-hills of North-West Himalaya occasionally ascending up to 2,400 m. from Kashmir to Nepal and Bhutan. Kanjilal *et al* also mention the occurrence of this species in Khasi Hills, Assam. Recent studies on the timber which drifted down the Brahmaputra river after the great earthquake of 1950 have indicated the presence of this species in the North-East Frontier Agency and the adjoining areas(8).

Description of the wood

[Pl. **36**, 216]

General properties—Sapwood and heartwood distinct. Sapwood straw-coloured, heartwood bright orange-yellow when fresh, becoming yellow-brown

with age ; moderately hard ; light (sp. gr. 0·52 air-dry), straight-grained ; uneven and medium-textured ; lustrous. Wood very bitter in taste.

Gross structure—A ring-porous wood. *Growth rings* distinct delimited by larger earlywood vessels and thin lines of parenchyma, 6–16 per cm., but may be extremely slow grown locally when the growth rings are not recognizable. *Vessels* in early wood few, moderately large, visible to the unaided eye, arranged in one or occasionally two rows on the face of the growth ring ; solitary or in radial or tangential multiples of 2–3 and occasionally in clusters, roundish, open ; transition from early to latewood abrupt ; latewood vessels very small indistinct to the eye, sometimes even individually indistinct under lens, unevenly distributed, often in small groups or clusters ; vessel lines distinct in the earlywood. *Parenchyma* distinct only under hand lens (*a*) in thin whitish lines delimiting growth rings, and (*b*) paratracheal forming a very thin sheath round the vessels or vessel groups. *Rays* lighter in colour than the background, visible to the eye, rather fine, widely spaced ; ray flecks not very distinct. *Ripple marks* present but not always distinct under hand lens.

It is a moderately hard timber with a pleasing appearance. From the examination of the sample it appears that the seasoning property as well as the natural durability are not likely to be unsatisfactory.

Uses—The wood yields a bitter principle which is used as a substitute for Quassia. The timber on account of its colour should be suitable for fancy articles, toys and for light furniture.

Material—

4413 Garhwal, Uttar Pradesh (0·52).

SAMADERA GAERTN.

A small genus of trees occurring in Madagascar and tropical Asia. The only species found in the Indian region is dealt with here.

S. indica Gaertn.—*Kathai* (Burm.), *karingota* (Mal.), *nibam* (Tam.). A small evergreen tree growing up to 9–11 m. in height and about 20 cm. in diameter. *Bark* pale, transversely cracked. It is used as a febrifuge. According to Bor, "the seeds act as an emetic. They also contain an oil which is said to be of value in the treatment of rheumatism. An infusion of the leaves is a good insecticide and is deadly to termites". The decoction of the wood is also used as a tonic.

It is found on the west coast in the evergreen forests and along the backwaters of Kerala and probably in the Andamans. It is much planted for hedges especially in north Kerala. It also grows in Ceylon as well as in Tenasserim and Mergui in Burma.

Description of the wood

[Pl. 37, 217]

General properties—No colour distinction between sapwood and heartwood. Wood light yellow turning brown-yellow, soft, light (sp. gr. 0·39 air-dry), straight to slightly interlocked-grained, fine-textured. Wood bitter in taste.

Gross structure—A diffuse-porous wood. *Growth rings* distinct, delimited by thin lines of parenchyma, 2–4 per cm. *Vessels* small, indistinct or barely visible as pin-pricks to the eye, moderately few (5–8 per mm.^{2}), solitary and in radial multiples of 2–3, occasionally more, round to oval, open ; vessel lines inconspicuous. *Parenchyma* scanty, distinct only under lens, (*a*) in thin whitish lines delimiting growth rings, and (*b*) paratracheal, forming thin sheath round the vessels, with very fine, long or short lateral extensions, sometimes connecting adjacent vessels. *Rays* fine to very fine, visible only under lens, and closely spaced.

The timber is light and soft and has a pleasing colour. It is easy to saw and plane, both by machine and hand. It can be turned but has sometimes a tendency to pick up fibres to some extent. Therefore, it may not be suitable for high class turnery work. Due to its softness, the timber is not good for chisel work. It is an easy timber to season and the durability may not be bad.

Supply and uses—The timber is available in fair quantity from the west coast. It is suitable for small articles such as toys, foot rules, scales, shoe-heels, pin-cushion bases, brush backs, light packing cases and cheap furniture. The wood is said to be of medicinal value and the infusion is taken as a tonic(10).

Material—

3907 Kerala (0·39).

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S. S. GHOSH.

OCHNACEAE

The family *Ochnaceae* comprises about 22 genera and some 400 species of trees or shrubs, rarely herbs, widely distributed throughout the tropics, mostly in South America.

The family is of little commercial importance. The only species of commercial value is *Lophira alata* Bank, from West Africa. The wood is reported to be very hard and durable, chiefly used for sleepers(6). Mani oil is also obtained from its seeds.

Besides *Ochna* Linn., which is dealt with here, *Gomphia* Schreb., is represented in India by about 3 species of small trees distributed in South India, Andamans, Ceylon and Burma. The wood is reported to be red to reddish brown, hard, close and even grained. According to Lewis, the timber is durable and useful for posts, rafters and the like.

OCHNA LINN.

Glabrous trees or shrubs, distributed in tropical Asia and Africa. Out of about 100 species from different countries, some 6–7 species have been reported to grow in the Indian region. Woods of two species were available for study and have been dealt with here.

1. **O. squarrosa** Roxb.—*Sinwe* (Burm.), *mudah, narole* (Kan.), *buin champa, champa balsa, koniari, nobunisero, pata champa, tangar champa* (Or.), *mal-kera* (Sinh.), *chilanti* (Tam.), *sunari, yerra-juvi* (Tel.). A shrub or small tree. *Bark* brown in colour smooth and thin.

It is found in most part of India, Burma and Ceylon. Common in Orissa, Bombay and Mysore.

Description of the wood—See below.

2. **O. wallichii** Planchon—*Khimdabeng* (Asm.), *yo-da-yah* (Burm.). A small straight stemmed deciduous tree. *Bark* greyish patchy, smooth.

It is found in Assam and Burma, and common in all the localities in the deciduous forests of Andamans.

Description of the wood—See below.

Description of the wood

(*Ochna squarrosa* and *O. wallichii*)

[Pl. 37, 218]

General properties—Wood light brown to deep reddish-brown in colour; moderately hard to hard; moderately heavy (sp. gr. 0·78–0·95 air-dry); slightly interlocked-grained; even, fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* usually indistinct. *Vessels* small to very small, numerous to very numerous (30–40 per mm.^{2}), solitary or in radial multiples of 2–4. *Parenchyma* not distinct under hand lens. *Rays* moderately broad, medium spaced, pinkish occasionally having some whitish deposits, distinct on tangential surface ; ray flecks distinct but inconspicuous.

According to Chalk(2) the wood of *O. arborea* Burch, of South Africa (sp. gr. 0·88-0·98 air-dry) seasons well with a tendency to surface checking. It is not difficult to work by hand and gives a fine finish, and turns well.

Uses—The wood is used for walking sticks. It is also used in the Andamans for making huts. Bourdillon says that the wood of *O. squarrosa* "is worthy of attention for inlaying and carving but requires careful seasoning as it warps badly". It may also be suitable for axe and other tool handles.

Material—

O. squarrosa – 1305 Orissa (0·80), **3639** Orissa (0·85).

O. wallichii – 1978 Andamans (0·88), 3132 Burma (0·89), 6398 Burma (0·95), 6295 Burma (0·78).

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BURSERACEAE

A family of resiniferous trees consisting of 16–20 genera and about 600 species which are widely distributed throughout tropical Asia, America and Africa. From the point of view of number of species, the family is best represented in tropical America.

The family is well known for the aromatic oleo-resins which exude from the trees when the bark is incised. These resins are known from very early times for their use as incense, in medicine and perfumery. The most important of them are "elemi", "frankincense" and "myrrh". Elemi is obtained from several species of the genus *Canarium*, the best known being the Philippines *C. luzonicum* A. Gray, which is the source of commercial Manila elemi. Its main present day uses are for varnishes, printer's ink and in the preparation of ointments. It is also locally used for caulking boats and for torches. Frankincense comes from the genus *Boswellia*, mainly from *B. carteri* Birdw., and *B. frereana* Birdw., from North-East Africa and Southern Arabia, while myrrh is the exudation from the trunk of several species of *Balsamodendron* (*Commiphora*).

The seeds and fruits of some species are edible. The seeds of *Canarium ovatum* Engl. (pilinut) of the Philippines and of *C. commune* Linn. (Java almond) of the Malay Peninsula which is also occasionally cultivated in India are used as a substitute for almonds and yield 55 to 75% of fatty oils. Similarly, the fruit of *C. album* Raeusch. of Indo-China, and *C. pimela* Koen of China are eaten as a substitute for olive. The fruits of *Bursera serrata* Colebr., and *Garuga pinnata* Roxb. of India are also edible.

The family is characterized by the presence of intercellular canals or ducts which have been recorded practically in all the organs of the trees – fruits, flowers, leaves, roots and stem. They are always present in the phloem tissue and, therefore, serve as a diagonstic feature of great importance. In some species these are also present in the pith (*Balsamodendron, Boswellia, Canarium*, and *Sorindeia*) as well as in the wood rays.

The majority of the woods of this family are light and soft, with poor reputation for durability except one or two species of *Santiria* of Malay Peninsula which have a high silica content. Gaboon mahogany (*Aucoumea klaineana* Pierre) of West Africa is the most important commercial timber of the family, which is used extensively in Europe and U.S.A. for surface veneers, plywood and cigar boxes. In India, *Canarium euphyllum* is of commercial importance due to its use in match industry.

The colour of the timbers of this family varies from greyish to yellowish-white or yellowish-brown to reddish-brown. The weight, hardness and texture

of the woods do not vary to any great extent. The majority of the woods are moderately heavy and moderately hard, straight to somewhat interlocked-grained and often coarse-textured. But among the Indian timbers, *Balsamodendron mukul* Hook. and *Canarium euphyllum* Kurz are very soft and light. In anatomical structure, the woods show close similarity. Vessels are usually moderately large except in *Balsamodendron mukul* where they are small. The vessels do not show any characteristic pattern or arrangement in their distribution, being mostly solitary or in short radial multiples and occasionally in small irregular clusters. They are moderately numerous to few, and are often filled with tyloses. Parenchyma is poorly developed, and is confined to the vicinity of the vessels, and is hardly visible under the lens. The rays are moderately broad to fine, and fairly closely spaced. Storied arrangement of the rays has not been observed in any of the Indian species, but Heimsch reports local storeying of the rays in some species of *Canarium, Trigonochlamys* and *Santiria*. Radial gum canals are characteristically present in the multiseriate rays of several genera of the family. These have been observed in some species of *Balsamodendron, Boswellia, Bursera, Canarium, Dacryodes, Elaphrium, Garuga, Protium,* and *Santiria*. Amongst the Indian genera, radial gum canals which are occasionally visible under hand lens have been observed in *Balsamodendron, Boswellia,* and *Garuga* but this has not been observed in *Bursera serrata* (*Protium serratum*) or *Canarium* spp. Longitudinal canals of traumatic type are sometimes met with in *Canarium* and *Protium*. Pith flecks are not usually common but Webber reports the presence of abundant and large pith flecks in some of the genera.

Taxonomic position of some species and perhaps also genera is still not well defined. Gamble has described 6 Indian genera under this family, viz., *Balsamodendron, Boswellia, Bursera, Canarium, Filicium* and *Garuga*. Of these, *Filicium* is now generally accepted as belonging to the family *Sapindaceae*. This transfer is also justified from the point of view of wood anatomy (see under *Sapindaceae*). Brandis, however, describes all except *Filicium* under this family and also includes another genus *Protium* having two closely allied Indian species, *P. caudatum* W. & A. and *P. pubescens* W. & A., both occurring in South India. But, Gamble includes *P. caudatum* under *Balsamodendron*. Since no wood specimen of this species was available, its position could not be examined from the point of view of wood anatomy. Of the other Indian genera described by Brandis, *Bursera* having only one species, *B. serrata* is, now usually considered to belong to the genus *Protium*. This genus has a very wide distribution in the tropics of both the old and new world, mainly in tropical America ; whereas the genus *Bursera* is confined only to tropical America. The species described by Brandis under *Balsamodendron* are now all placed under *Commiphora*. In view of the differences present in the occurrence of radial intercellular canals in the Indian and foreign members of some genera particularly

Canarium and *Protium*, it may be worthwhile re-examining their systematic position. In this connection, Desch also remarks that "on the basis of the presence or absence of radial canals, or deposits of silica, the taxonomic position of some of the Malayan species would appear to be in need of revision, and this may be true of species from other regions".

The woods of 9 species out of about 30 occurring in the Indian region (belonging to 5 genera) were available for study. These are very similar in structure and offer considerable difficulty in separating them. Therefore, a hand lens key for separating them has not been attempted.

1. BALSAMODENDRON KUNTH

(COMMIPHORA JACQ.)

A genus of spiny trees and shrubs, distributed in tropical and sub-tropical regions of Africa and Asia. A number of species particularly *Commiphora molmol* Engl., of Somaliland yield gum-oleo-resin known as "myrrh" which is an important article of commerce. Myrrh is obtained from resin ducts occurring in the phloem parenchyma by incising the bark. It is reported that the tissue between these ducts often collapses and large resin cavities are formed in the bark(15).

The resin has medicinal properties and is used as a tonic, stimulant and antiseptic, particularly as mouth washes and dentifrices. It has been used for ages as an incense and for perfumes, and is sometimes given to cattle to improve the flow of milk. The Indian species *Balsamodendron mukul* and *B. roxburghii* yield a gum-resin which is a blood purifier and is astringent, antiseptic and said to be useful also in snake-bite and scorpion-sting.

Brandis enumerates 4 Indian species under this genus, of which only one was available for study and is described below.

B. mukul Hook. [**Commiphora mukul** (Hook. ex Stocks) Engl.]— *Gugal, guggul, mukul, ranghan* (Beng.), *gugal, guggul, mukul, ranghan-turb, uugar* (Guj.), *gogil, gugal, guggul, mukul, ranghan turb, sind-gum-gugal* (Hind.), *gugal, guggala, guggule, mukul* (Kan.), *guggala, guggule, mukul* (Mar.), *devadhupa, guggulu, konshikaha* (Sans.), *gugal, guggul, mukul, ranghan turb* (Sind.), *gugula, jatayu, javayu, ratadummula* (Sinh.), *gukkal, gukkulu, maisachi, maishakshi, maishakshi gukkal* (Tam.), *guggul, gugul, mahi-sakrh, mahi-saksh gugal, maisachi, maisakshi* (Tel.). A stunted bush or dwarf tree attaining a height of 1·2 to 1·8 m. with a knotty trunk. *Bark* greenish-yellow, peeling off in shining thin papery rolls.

It occurs frequently in the arid rocky lands of Mysore, Deccan, Khandesh, Kathiawar and Rajputana. It also grows in Sind and Baluchistan of West Pakistan.

Description of the wood

[Pl. 37, 219]

General properties—Sapwood white, often discoloured ; heartwood small, reddish-brown ; soft ; light (sp. gr. 0·32–0·42 air-dry) ; medium-fine-textured ; interlocked-grained.

Gross structure—A diffuse-porous wood occasionally giving the impression of semi-ring-porous structure. *Growth rings* distinct, delimited by fine lines of thick-walled flattened fibres, 9–11 per cm. *Vessels* moderately small to small, just visible to the naked eye, moderately numerous to numerous (11–23 per mm.^{2}), evenly distributed but with a tendency to be aligned tangentially on the face of the ring, mostly solitary and a few in short radial multiples, round to oval, mostly open ; vessel lines fine. *Parenchyma* vasicentric, scanty, not visible under hand lens. *Rays* moderately broad to fine, rather widely spaced. *Radial gum canals* present, occasionally visible under hand lens as dark dots on the tangential surface.

The wood is soft and light and is susceptible to fungal attack. It is locally used as floats in fishing nets. It may also be suitable for small toys and the like.

Material—

448, Ajmer, Rajasthan (0·42), 2919 Rajasthan (0·32).

2. BOSWELLIA Roxb.

A small genus of small to large-sized trees mainly confined to Africa, with a few in West Asia and a solitary species in India. The frankincense which is obtained from some African and Arabian members of this genus is of commercial value and is often sold in the Bombay market.

The gum-oleo-resin from *B. serrata* Roxb., which is known as Indian olibanum or Indian frankincense or salai-guggal, is used as an incense and sometimes also in the preparation of ointments for sores. The turpentine and the rosin obtainable from the gum-oleo-resin can be used as substitutes for *chir* (*Pinus roxburghii* Sargent) turpentine and rosin. The rosin is suitable for the preparation of varnishes as well as in the manufacture of shellac. When decolourized and dissolved in xylene, it can also be used as a substitute for Canada balsam as a mounting medium for microscopic slides.

The method of tapping *Boswellia serrata* trees for gum-oleo-resin is to shave off the entire outer bark all round the tree up to a depth of one-third the thickness of the bark with the help of a special blazing equipment. The first blaze is made at the end of the rainy season and consists of about 10 cm., thick band cut all round the tree. The gum-oleo-resin which oozes out in small globular

droplets is usually collected after about a month by scraping the initial blaze and at the same time making a fresh blaze about 5 cm., in width on the upper side of the previous blaze. Subsequent collection and fresh blazes are made in a similar way until the end of March. But as the cost of collection of the gum-oleo-resin is not economical, the tapping is not practised to any great extent except in Sheopur Forest Division of Madhya Pradesh(25).

B. serrata Roxb.—**Salai.** *Kundro, luben, salai* (Beng.), *thabi-ben* (Burm.), *kundur* (Duk.), *bor-salai, bor-salei, bor-salla, ganga, salla* (Gon.), *dhup, gugali, gugul, mukul sali, saliya* (Guj.), *glabra, kundur, luban, salai, salaia, salar, salci, saleh, saler, saleya, salga, salhe, sali, salpe, salphullie, selgond, silai* (Hind.), *chitta, chittu maddi, dhupadamara, maddi, madi, salga* (Kan.), *salga, sali* (Kol.), *anduga, anduku, domsal, dumsal, guggar, salai guggar* (Kumaon), *kundurukka-maram, vella-kundirukkam* (Mal.), *gigulla, salai, salai-dhup, salaya-dhup, selga, salphali, salphullia, salphullie* (Mar.), *gugguli, kunduru, salasi-niryasa, sallaki* (Sans.), *salga* (Sant.), *kundrikam* (Sinh.), *dhupan, gugulu, guggulu, gugulu-kundrikum, kulikili, kundrikam, kundrikam-morada, kundruk-kampishin, kungiliam, kungli, kungli-parangi-sambrani, morada, parangi-shambi-rani* (Tam.), *adak, andaka, andu, anduga, anduga-pisunu, anduku, guggilam, parangi, parangi-sambrani* (Tel.). A small to medium-sized or large deciduous tree about 12 to 18 m. in height and 1 to 1·5 m. in girth, sometimes also attaining 2·5 m. in girth and a clear bole of 4·5 m. *Bark* thick, greenish-ash coloured, exfoliating in thin smooth papery flakes.

A gregarious tree in deciduous forests of Rajputana, Madhya Pradesh, Bihar, Orissa, Andhra Pradesh, Madras and Bombay, often mixed with *Sterculia urens*, and ascending up to 1,150 m. It also occurs in the Siwaliks of Ambala and Saharanpur.

Description of the wood

[Pl. 37, 220–221]

General properties—Heartwood sharply demarcated from the sapwood. Sapwood wide, white to dirty white but very often discoloured due to fungal stain ; heartwood small and except in large logs not always present, brown to greenish-brown sometimes with pleasing darker stripes. Wood dull with unpleasant smell when fresh ; moderately hard and moderately heavy but heartwood hard and heavy (sp. gr. 0·57–0·88 air-dry) ; straight to somewhat interlocked-grained and coarse-textured.

Gross structure—A diffuse-porous wood. *Growth rings* absent, but occassionally denser fibrous tissues may give the impression of growth marks. *Vessels* usually moderately large to moderately small, fairly distinct to the naked eye, moderately few to moderately numerous (7–13 per mm.^{2}), uniformly

distributed, solitary or in radial multiples of 2 to 4, and sometimes in small clusters, round to oval in shape ; heartwood vessels plugged with tyloses and also brownish-yellow deposits ; vessel lines distinct. *Parenchyma* not distinct even under hand lens. *Rays* just visible to the eye, moderately broad under lens, usually short, and not closely spaced ; ray-flecks rather inconspicuous. *Radial gum canals* present. Sometimes visible on the tangential surface as black-dots to the naked eye and usually distinct under hand lens.

Strength—It is not a very strong timber and, therefore, not suitable for purposes where strength is the main criterion. However, Trotter states that ammunition boxes made out of this timber showed greater strength than similar boxes made of teak(30). For strength figures see appendix I.

Seasoning—Sapwood dries very rapidly and without any appreciable degrade. Slight warping may, however, occur particularly in planks containing original shakes. But the heartwood is highly refractory to seasoning as it dries very slowly and suffers from severe shakes which may make the timber even unfit for proper use. Sapwood planks of about 2·5 cm. thick have been found to dry in about 2 months, if properly stacked ; whereas heartwood planks of the same thickness do not dry even in one year. It is advisable, therefore, to separate the sapwood from the heartwood and season them separately. Since the sapwood is extremely liable to fungal discoloration, decay and insect attack, it should be stacked under rapid drying conditions immediately after conversion. Kiln-seasoning of the sapwood offers no difficulty and is recommended for this wood. To minimize the damage due to fungus and insect as far as possible, the conversion should be done in dry weather.

Natural durability—The timber is easily susceptible to decay and should not be used in exposed situations. "Graveyard" tests carried out at the Forest Research Institute showed that the heartwood lasts for 13–44 months with an average life of 21 months.

Insect and fungus attack—Dead wood, dry wood and converted timber are liable to be attacked by some *ghoon* borers (Anobiidae, Bostrychidae and Lyctidae) ; dead wood and newly felled logs, etc., are also liable to be attacked by some borers of Brenthidae, Buprestidae, Cerambycidae, Curculionidae, Lymexylonidae, Platypodidae and Scolytidae. Chatterjee, Bhasin and Bhatia have studied the salai borers in detail. They have found that the most important borer of *B. serrata* is *Atractocerus reversus* Walk. (Scolytidae). This species does not oviposit on the green living bark, and hence there is no danger to healthy standing trees. *Salai* logs with bark on may be kept safely for a period of one month after felling. For protection against insect damage, it has been suggested that the logs should be placed in a single row but not in contact with each other and also avoiding deep stacking. To accelerate drying, rotating of

logs is recommended. All rejected timbers, slabs, off-cuts, fuel-dumps, etc., in depot and saw-mill yards are to be removed and clean factory-hygiene practised. Adzing off the infested sapwood is one of the simplest methods of protection.

B. serrata is easily attacked by sap-stain fungi which impart a blue colour to the timber. The converted timber is also attacked by a number of wood rotting fungi like *Daedalea flavida*, *Polystictus leoninus*, *Trametes corrugata*, *T. lactinea*, *Schizophyllum commune* and *Ganoderma lucidum* producing white rot in the timber. The last one also attacks the root of living trees.

Preservative treatment—Heartwood is very refractory to treatment, side and end penetration being practically nil. But the sapwood is very easily treatable with preservatives. According to Trotter "even an open tank treatment with a good preservative would go a long way towards increasing the utility of this wood for a variety of purposes".

Working qualities—It is easy to saw and work, finishing to a smooth surface. It also turns well. The dark coloured and handsomely streaked heartwood is very attractive and also takes an excellent polish. However, difficulties in seasoning make it unsuitable for many uses. The wood is reported to have no siliceous inclusions(1).

Supply and uses—Large supplies are available from Bihar, Orissa, Madhya Pradesh, Jhansi division of the Uttar Pradesh and East Khandesh division of Bombay. Its use is, however, restricted due to its great susceptibility to discoloration. *Salai* is mainly used for all types of packing cases, ammunition and other types of boxes, cheap grade furniture and household articles. It is used for making platters, spoons, bowls, sheaths of knives and swords, masts for boats, oars as well as for co-operage, e.g., tubs, buckets and casks. It is also used for match-manufacture and is reported to be good for splints only and not so good for boxes, due to the timber sometimes being interlocked-grained. It is suitable for low grade plywood provided the timber is kept free from fungal discoloration. The timber is reported to be good for charcoal which is said to have been used for iron-smelting in Madhya Pradesh. It has also been found suitable for certain types of cheap paper. Newsprint also is now being manufactured from it in Madhya Pradesh. The wood was tried for pencil making but was not found suitable(27). It is a suitable timber for compregnation and the improved wood made out of it may be used as fish-plates (Narayanamurti and Kartar Singh, *Indian For. Leafl.*, 77, 1945).

Material—

1112 Saharanpur, Uttar Pradesh (0·57), 2780 Melghat, Bombay (0·42) (damaged), 5879 Raipur, Madhya Pradesh (0·57), 7438 Vellore, Madras (0·66), 7439 Vellore, Madras (0·59), 7848 Salem,

Madras (0·88), 7849 Salem, Madras (0·67), 7850 Salem, Madras (0·84).

3. BURSERA Linn.

A genus of trees or shrubs. According to Brandis only one species *B. serrata* Colebr., is indigenous to India. However, this species is now generally regarded as belonging to the genus *Protium*.

B. aloexylon Engl. and *B. delpechiana* Poiss. ex Engl., are the sources of Mexican linaloe or lignaloe oil. *B. delpechiana* is cultivated in Mysore for its oil. *B. tomentosa* Planch. of Venezuela yields tacamasha resin which is used for incense and medicine. *B. gummifera* Linn., known as turpentine tree of South America is the source of American elemi.

B. serrata Colebr. [**Protium serratum** (Colebr.) Engl.]—*Mirtenga, murtenga, najor, nihor* (Asm.), *engla, hengla* (Cach.), *thikring* (Garo), *mohi* (Gon.), *chitrika, lindwi, mirimah, mirtenga* (Hind.), *kariar* (Kan.), *diengsoh-mir* (Kh.), *karonda* (Kharw.), *saradi* (Khond.), *kandior* (Kol.), *bil* (Lush.), *neoli* (Mechi.), *kichejanthar, kisianthor-arong* (Mik.), *garur, limbru, nimburu, suru potrimoi* (Or.), *urmu* (Sant.), *kungiliam* (Tam.), *chitrek, chitreka, chitrika* (Tel.) ; also known as Indian red pear. A middle-sized to large, evergreen tree, attaining a height of 15 to 27 m. and girth of 1 to 2·5 m. having a clear bole of 9 to 15 m. *Bark* grey to reddish-brown, 2 cm. thick, slightly cracked, exfoliating in irregular flakes.

A tree of eastern moist zone of Bengal, Assam, Orissa, Chittagong and tropical forests of Upper and Lower Burma. It also occurs in Rajmahal hills, extending to Eastern Ghats especially in valleys and along water courses.

Description of the wood

[Pl. 37, 222–223]

General properties—Sapwood light brown or pinkish, occasionally with yellowish blotches ; heartwood red turning dull brown or brick red with age. Wood hard to moderately hard ; moderately heavy to heavy (sp. gr. 0·58–0·86 air-dry) ; straight to slightly interlocked-grained, occasionally also wavy grained ; medium-fine-textured and somewhat lustrous.

Gross structure—A diffuse-porous wood. *Growth rings* usually indistinct but occasionally rows of thick-walled and darker coloured fibres give the impression of growth marks. *Vessels* mostly small to medium-sized, just visible to fairly distinct to the naked eye, moderately few to moderately numerous (9–20 per mm.^{2}), evenly distributed ; solitary or in radial multiples of 2 to 3, rarely in oblique pairs ; heartwood vessels heavily plugged with

tyloses; vessel lines distinct. *Parenchyma* indistinct even under hand lens. *Rays* medium to fine, but usually indistinct to the naked eye due to lack of any colour differentiation with the surrounding tissue; somewhat closely spaced and evenly distributed. *Radial gum canals* absent. *Fibres* in the heartwood heavily filled with reddish-brown gum-like deposits.

Strength—It is a fairly strong, tough, and moderately hard timber. This has not been tested for strength so far.

Seasoning—The timber does not give trouble in seasoning except that it dries, rather slowly and is liable to develop numerous fine surface cracks. End-splitting and warping can be avoided if sufficient care is taken in drying the timber. It needs protection against rapid drying conditions. Green conversion followed by close stacking under cover is recommended for this timber. In order to allow it to dry slowly, it is desirable to convert the logs during or at the end of the rainy season. From seasoning point of view girdling the trees also gives very good results except for a slight danger from insect attack.

Natural durability—It is a fairly durable timber when used under cover. "Graveyard" tests at Dehra Dun carried out with samples from Burma gave an average life of 64 months in contact with the ground. The timber received from Bihar and Orissa showed durability of a higher class, with an average life of about 92 months.

Insect and fungus attack—The sapwood is susceptible to insect and white ant attack as well as fungal decay if left long in the log form.

Preservative treatment—Heartwood very refractory to treatment, side and end penetration being practically nil.

Working qualities—It is a comparatively easy wood to work and saw. It also polishes well. When judiciously quarter-sawn, decorative features of the wood can be brought out and the timber can be used for making attractive panelling and furniture.

Supply and uses—Large supplies are available from the eastern part of India. The timber is used locally for house posts, ploughs, carts, and planks. It is also suitable for furniture making, mirror and picture frames. It has been used also for railway sleepers. Straight-grained samples may be suitable for pencil making.

Material—

313 Burma (0·74), 5567 Burma (0·86), 6073 Singbhum, Bihar (0·78), 6438 Burma (0·75).

4. CANARIUM LINN.

A large genus of medium-sized to large trees occurring in tropical Asia and Africa. Many of the trees yield oleo-resins of commercial importance. Some of these are soft and aromatic due to high proportion of essential oil present in them. These are known as "elemis" while others which are hard and brittle with little or no fragrance are called "dammars". The best known and most widely used elemi is the "Manila elemi" produced by *C. luzonicum* A. Gray of the Philippines. This oleo-resin is obtained by removing the bark from the main bole in narrow horizontal strips from several places. The oleo-resin on exudation is collected when it has partly solidified. It is pale yellow in colour, soft and granular when fresh and has a fragrant balsamic odour. It is used for a variety of purposes such as, in perfumery, lithographic work, varnish industry and medicine(15). The Indian species of this genus yield dammars, most important of which is the "black dammar" obtained from *C. strictum* Roxb. It has a shining black appearance and is hard and brittle. The main uses of black dammar are for the manufacture of varnish and bottling wax and also as a substitute for Burgundy pitch plasters. The method of tapping the tree consists of making vertical cuts on the bark and lighting a fire round the base of the tree(19).

Other Indian species of this genus also yield dammars, but no systematic tapping appears to have been done for the collection of resin. The hard amber coloured resin of *C. bengalense* Roxb., is reported to be a good substitute for shellac when mixed with beeswax for the purpose of finishing crepe. It is aromatic and used at present as an incense. *C. sikkimense* King yields a hard aromatic amber coloured resin while *C. resiniferum* Brace ex King gives a blackish tar like resin, both of which are used for incense and illuminant torches. The resin of *C. euphyllum* Kurz of Andamans is reported to be used for binding arrows and for burning.

The genus is represented in India by seven species of which three are described here. Besides these, three samples marked 703, 3592 and 6003 as *C. sikkimense* King from North Bengal were also available for study. All the three samples of this species, are, however, characterized by aliform to aliform confluent parenchyma which is visible even to the naked eye (Pl. 38, 226). This feature is not met with in other members of this family. Microscopically these are characterized by non-septate fibres which make their identity very doubtful. Pearson and Brown have also described one of these as *C. sikkimense* but we are of the opinion that all these samples are wrongly named and probably belong to *Ailanthus*. Another sample marked 6744 as *Canarium* sp. near *Subulatum* Guillaumin from Bhamo, Burma (sp. gr. 0·67 air-dry) in the timber collection is similar in structure to all the three species described

on next page.

The woods of the three species of *Canarium* described below are very similar in anatomical structure and are indistinguishable. However, *C. euphyllum* Kurz stands out from the other two as being lightest and softest.

1. **C. bengalense** Roxb.—*Komker-asing* (Abor.), *bisjang, dhuna, nerebi. nerevi* (Asm.), *satrai-phang* (Cach.), *borsamphol, tekreng* (Garo), *narockpa* (Lep.), *hijung-arong, inghet-ki-ik-arong* (Mik.), *komker-asing* (Mir.), *gokul, gokul dhup* (Nep.) ; also known as East Indian Copal or East Indian Dhuna. A middle-sized to tall tree with a straight cylindrical bole up to 3·5 m. in girth. *Bark* greyish-white, rather smooth, with numerous lenticels, exfoliating in thin irregular flakes, 13 mm. to 18 mm. thick. The bark yields an aromatic oleo-resin. It occurs in the evergreen forests of North Bengal and Assam ascending up to 900 m.

Description of the wood—See below.

2. **C. euphyllum** Kurz—**White dhup.** *Dhup* (Andamans) ; also sometimes erroneously called Indian white mahogany. A large deciduous evergreen tree, attaining a height of 25 to 40 m. with a long, clear and cylindrical bole of 12–18 m. and girth of 1·2–4·2 m. *Bark* whitish-grey, smooth with numerous small protuberances.

It is found in the deciduous forests of Andaman Islands being commonly associated with padauk (*Pterocarpus dalbergioides* Roxb.). It also occurs in North Arakan in Burma.

Description of the wood—See below.

3. **C. strictum** Roxb.—**White dhup.** *Doopamara, tendalake* (Coorg), *kalla dammar* (Guj.), *gugul, kalla dammar* (Hind.), *halemaddu, manda-dhup, ral dhup, raldhupada* (Kan.), *karunkungiliam, karuttukungiliyam, kundrikam, kunthirikka-payin, pantham, pantappayan, thelli* (Mal.), *dhup, gugul, raldhup* (Mar.), *congiliam marum, karang-kunthrikam, karangkunthrikkam, karapu dammar, karapu kongiliam, karinkunthirkkam, karinkunthirikkam, karum, karunkungiliam, kundrikam* (Tam.), *nalla rojan, nalla rojanamu* (Tel.). A large to very large tree with an exceedingly straight and cylindrical stem, up to 30 m. in height and 1 m. in girth. *Bark* pale-grey, rough and yields the black dammar of commerce.

It is found in the evergreen forests of Western Ghats in Bombay, Mysore and Travancore up to 1,350 m. elevation.

Description of the wood—See below.

Description of the wood

(*Canarium bengalense, C. euphyllum* and *C. strictum*)

[Pl. **38**, 224–225, 227]

General properties—Sapwood and heartwood usually not distinct but in *C. bengalense* heartwood may sometimes be reddish and distinct from sapwood.

Wood creamy-white often with pinkish or yellowish cast when fresh but turning yellowish-grey to pinkish-grey or brown with age ; lustrous ; and moderately hard and moderately heavy (0·55–0·79 air-dry) in *C. bengalense* and *C. strictum* ; very soft to soft and very light to light (0·30–0·43 air-dry) in *C. euphyllum* ; usually interlocked-grained and coarse-textured.

Gross structure—All are diffuse-porous woods. *Growth rings* rather indistinct, sometimes may be fairly distinct due to narrow layer of thick-walled fibres, 3 to 7 per cm. ; sometimes up to 10 per cm. *Vessels* mostly moderately large, moderately few to few (4–12 per mm.^{2}), evenly distributed, solitary or in short radial multiples of 2 to 3, occasionally more ; roundish to oval in shape, open or partially plugged with tyloses ; occasionally yellowish-white deposits may also be found in some vessels ; vessel-lines distinct on the longitudinal surfaces. *Parenchyma* scanty, confined as a thin layer round the vessels, indistinct even under hand lens. *Fibres* usually not distinct under hand lens but may be just visible in *C. euphyllum*. *Rays* moderately broad, just visible or fairly distinct to the eye rather widely spaced. *Radial gum canals* absent.

Strength—*Canarium bengalense* and *C. strictum* are moderately heavy, moderately hard and moderately strong timbers but *C. euphyllum* is light, soft and comparatively much weaker timber. For strength figures of *C. euphyllum* and *C. strictum*, see appendix I. For *C. bengalense*, Prof. Everrett(11) gives the following strength figures based on tests carried out on two specimens :—

		Tons per sq. in.
Shearing strength along the grain	(1)	0·680
	(2)	0·613
Crushing strength along the grain	(1)	2·72
	(2)	2·92
Bending strength	(1)	2·15
	(2)	2·83
Stiffness, from bending test, E.	(1)	273
	(2)	243

Seasoning—The timbers are not refractory to season. As they are susceptible to fungus and insect attack, they should be converted soon after felling and dried quickly. As the timbers require rapid drying conditions, vertical stacking is recommended for air-seasoning. Kiln-seasoning is, however, the best method for drying this timber particularly in moist places like the Andamans.

Natural durability—The timbers are easily perishable in exposed conditions. "Graveyard" tests carried out at this Institute with *C. euphyllum* and

C. strictum from Andamans and Madras respectively showed that the former has an average life of 9 months (Min. 7, Max. 14 months) while the latter lasts for 11–36 months with an average of 20 months.

Insect and fungus attack—Dead wood, dry wood and converted timber are liable to be attacked by some *ghoon* borers of Anobiidae, Bostrychidae and Lyctidae. Newly felled or fallen logs are also attacked by borers belonging to Cerambycidae, Curculionidae, Mordellidae, Platypodidae and Scolytidae. The woods are easily prone to attack by moulds and wood rotting fungi.

Working qualities—The wood is not difficult to saw and work but very fast grown samples of *C. euphyllum* may cause trouble in machining and may produce woolly surface due to tearing of thin-walled fibres. All the timbers have good peeling qualities except the very fast grown logs. The wood turns well but finish is not good, fine edges being easily chipped off. Quarter-sawn boards often show decorative figure due to the interlocking of fibres.

Supply and uses—*C. euphyllum* is available from the Andamans in large quantities. Limited supplies of *C. strictum* are available from the west coast while small quantities of *C. bengalense* are likely to be available from Assam and Bengal. *C. euphyllum* is mainly used for splints as well as for boxes in match industry and is considered to be India's second best quality matchwood. It is also largely used for light packing cases and internal fittings in furniture trade. The timber is also suitable for cheap grade plywood. *C. strictum* and *C. bengalense* are suitable for the same purposes but are chiefly used for light packing cases, veneers and plywood. It is suitable for lamination ; skis made of laminated *Canarium* in the Composite Wood Branch of the Forest Research Institute were subjected to practical tests and were found to be light and strong for general purposes(13, 23). Modified wood (Staypak) of this timber has been found to be very tough and may be used for pulleys, mallet heads, tool handles, etc.

Material—

C. bengalense – 4886 Assam (0·68), 5179 Kamrup, Assam (0·62), 5180 Kamrup, Assam (0·55).

C. euphyllum – 5338 Andamans (0·30), 5829 Andamans (0·43).

C. strictum – 4533 Travancore, Kerala (0·65), 4614 Travancore, Kerala (0·53), 5848 Coimbatore, Madras (0·65), 5929 South Kanara, Mysore (0·79), 5957 Palghat, Kerala (0·59).

5. GARUGA ROXB.

A small genus of medium-sized to large trees, distributed in India, South East Asia, north-western Australia and the Pacific Islands. Two species are

indigenous to India, both of which are described here. The trees are considered valuable from the point of view of re-afforestation and have been tried experimentally in several parts of the world. The woods of the two species are indistinguishable.

1. **G. gamblei** King [**G. floribunda** Decaisne var. **gamblei** (King) Ex. Smith Kalkman].—**Garuga.** *Sapochi-kuing* (Lep.), *bon-misri, bonthaiphang* (Kach.), *bankung-asing* (Miri), *dabdabbi, dabdabe* (Nep.). A very large spreading tree having clear bole of about 20 m. and up to 3 m. in girth. *Bark* ashy-grey, nearly smooth, exfoliating in irregular flakes.

It occurs in the foot-hills of North Bengal and in Assam up to an elevation of 900 m. It also grows along Western Ghats in Malabar and Nilgiris up to 1,500 m. elevation.

Description of the wood—See page 78.

2. **G. pinnata** Roxb.—**Garuga.** *Sibon-asing* (Abor.), *gendeli poma, kechechi, paharijiga, pani-amora, rohimola, rohimala, sriamla, thotmela, thotmola* (Asm.), *fum, joom, jum, kharpat, nilbhadi, nilbhodi, tinn, tum* (Beng.), *chinok, chinyop, chinyuk, chiok, sinyok* (Burm.), *kanman* (Garh.), *agri, chidampha, chigambol, chitompa, dumi* (Garo), *gargu, gharri, gupri, kekar, kekra, kosomara, kosomera, kosromba* (Gon.), *bonthaiphang, kusimb, roum poma* (Guj.), *bania, garirukh, ghogar, ghurria, gurja, jiga, kaikar, kaikra, kakar, kankar, kekar, kharpat, maharut, mohdi, titmer, tum* (Hind.), *kaman, katula, kharpat, kitmira, sarota, tilmadi* (Kumaon), *aranelli, armu, balaga, hala, halabalagi, garge, godda, godde, kadambatte* (Kan.), *dieng-khiang, dieng-soh-khmut, dieng-soh-pyjiar, synrang* (Kh.), *somepotri dope, sompotri do dope* (Khond), *armu, nia-jowa* (Kol.), *thing rot* (Kuki), *kekked* (Kurku), *maldid, rom* (Lep.), *annakara, kosramba* (Mal.), *kakad, kanhyana, kanghur, kangkur, kekda, kekara, kudak, kurak, kuruk, kutimba* (Mar.), *tejhi-arong* (Mik.), *bonkung-asing* (Miri). *aule dabdabe, dabdabe* (Nep.), *mohi, sompotri* (Or.), *karolu, katila, katmanna, katula, kharpat, kilmira, kitmirria, sarrota* (Punj.), *kandwer, kakur, karur* (Sant.), *arunelli, karre vemba, karre vembu, karvambu* (Tam.), *garga, gargu, garuga, garugo, garugukaluguda* (Tel.), *bombuk bombus, toisim-taito* (Tipp.). A medium-sized to large deciduous tree 18–25 m. in height and 1–2 m. in girth, with a clear bole of 9–15 m. *Bark* about 25 mm. thick, pale-grey or brown, and peeling off in hard flakes. The tree exudes a greenish-yellow gum resin which is not of much importance. The leaf juice mixed with honey is given in asthma. The fruit is beneficial in stomach troubles and stem juice in eye diseases(7). The leaves and shoots are also used as fodder.

It is widely distributed all over India from Siwalik hills eastwards to Assam often mixed with sal. It is a common tree in all dry forests of Madhya Pradesh, Andhra Pradesh, Mysore, Madras and extends into the moist zone of

Western Ghats and Satpuras, ascending up to 1,150 m. It is also found in Andaman Islands. In East Pakistan, it occurs in Chittagong and in Burma in mixed forests.

Description of the wood

(*Garuga gamblei* and *G. pinnata*)

[Pl. **38**, 228 ; Pl. **39**, 229–230]

General properties—Sapwood large, whitish to dull grey, often with yellow to yellowish-brown blotches to sap-stain, heartwood reddish-brown sometime with darker patches due to heavy infiltration; moderately soft to moderately hard ; light to moderately heavy (sp. gr. 0·47–0·68 air-dry) ; rather lustrous, straight to interlocked-grained, occasionally showing silver-grain effect on radial surface ; coarse-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct, but occasionally may be demarcated by darker bands of fibrous tissue. *Vessels* moderately large to large, usually moderately few (about 7 per mm.^{2}), sometimes moderately numerous and up to 12 per mm.^{2}, evenly distributed, solitary or in radial multiples of 2 to 4, occasionally more, round to oval in shape, heartwood vessels mostly plugged with tyloses ; yellowish-white to brown deposits may also sometimes fill up the vessel cavity ; vessel lines distinct. *Parenchyma* scanty in the immediate vicinity of the vessels, not visible even under hand lens. *Rays* hardly visible to the eye but distinct with a lens, moderately broad, evenly distributed and somewhat widely spaced. *Radial gum canals* present, occasionally visible under hand lens as darkish dots on the tangential surface.

Strength—*G. pinnata* is a moderately hard, moderately heavy and strong timber. For strength figures see appendix I.

Seasoning—It is a moderately refractory timber and is sometimes liable to surface cracking, splitting and warping though not of very serious nature. It is a rather slow drying timber and takes a long time to season. Since the sapwood is highly susceptible to insect attack and fungal decay, conversion of the logs immediately after felling and careful stacking under shelter to avoid rapid drying are recommended. Kapur states that "girdling and seasoning in the log resulted in severe depreciation of the sapwood, whereas green conversion and water-seasoning caused more surface-cracking in the heartwood".

Natural durability—It is not a durable wood unless properly seasoned and kept under cover. "Graveyard" tests conducted at the Forest Research Institute, Dehra Dun, showed that the untreated heartwood has an average life of 13 months only.

Insect and fungus attack—Dead wood is attacked by some species of Anthribidae, Bostrychidae (*ghoon* borer), Brenthidae, Cerambycidae and Curculionidae; dry wood and converted timber are attacked by *ghoon* borers (Bostrychidae and Lyctidae); newly felled or fallen wood is attacked by shot-hole borers (Platypodidae) and Scolytidae. Sapwood is highly susceptible to fungal decay.

Preservative treatment—Heartwood refractory to treatment and only partially treatable.

Working qualities—The timber is easy to work and no special adjustment to saws or cutter is necessary. It planes by machine and by hand to a good finish. It also turns fairly well but sometimes inclined to chip on fine edges. The wood is reported to have no siliceous inclusions(1).

Supply and uses—Large supplies are available from many localities especially Madhya Pradesh and Bombay states. The timber is available in moderate quantities from the eastern part of India and very little from the north and south. The wood is mainly used for planking, packing cases and boxes, temporary constructional work, roofing, cheap grade furniture as well as drawer sides, bottom runners and other interior fittings. It is also reported to be used for canoes and drums. It has been found suitable for cotton reels, toy-making and cheap grade pencils as well as for third grade plywood.

Material—

G. gamblei – 5678 Darjeeling, West Bengal (0·54), 7975 Assam (0·57).

G. pinnata – 225 Garhwal, Uttar Pradesh (0·62), 346 Gorakhpur, Uttar Pradesh (0·63), 648 Darjeeling, West Bengal (0·52), 1107 Chanda, Bombay (0·62), 1389 Chittagong, East Pakistan (0·68), 5302 Dehra Dun, Uttar Pradesh (0·56), 6310 Burma (0·47), 6476 Burma (0·67), 7228 Garo Hills, Assam (0·50), 7278 Goalpara, Assam (0·58), 7359 Darrang, Assam (0·66), 7378 Chittagong, East Pakistan (0·60).

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MELIACEAE

The family consists of about 45 genera and more than 1,000 species of mostly trees and shrubs distributed throughout the tropics of the world, a few also occurring in the sub-tropical and temperate regions of eastern coast of Australia, and New Zealand.

The family is of great economic importance from the point of view of timber as well as other products. Many of the trees contain a characteristic bitter principle. Some of them are held in great esteem for their medicinal properties, while a few are poisonous to fish and birds, and some again are sources of tanning material. The most important among the medicinal plants is the *neem* tree (*Azadirachta indica* A. Juss). It is a remarkable tree, almost every part of which is utilized in one form or other. The leaves are considered efficacious for liver ailments and skin diseases. The dried leaves are widely used to protect books, documents and woollen clothes against moths and insects. The young twigs are in great demand for brushing teeth all over the country wherever available. The bark and the oil extracted from the seeds are bitter and used in various pharmaceutical preparations, the latter being also used in the manufacture of soaps and other products. Similarly root, bark, fruits, flowers, leaves and seed oil of *Melia azedarach* Linn. are used in different medicinal and insecticidal preparations. The bark of several other trees like *Amoora rohituka* W. & A. [*Aphanamixis polystachya* (Wall) Parker], *Cedrela toona* Roxb. and *Soymida febrifuga* A. Juss. also finds use in medicine. The bark and pulp of the fruit of *Walsura piscida* Roxb. are poisonous and are sometimes employed as fish poisons. Another species of this genus is reported to have use in hair wash for removing lice. The fruit of *Heynea trijuga* Roxb. is poisonous to birds and the extract of the bark and young branches is reported to be lethal to frogs. The bark of several trees are tanniferous and can be used for tanning leather. The most important among these are *Carapa* spp., *Chukrasia tabularis* A. Juss. and *Soymida febrifuga*. Among the less important products of this family, mention may be made of red and yellow dye obtainable from the flowers of *Cedrela toona* Roxb. and *Chukrasia tabularis*. Further, several trees like *Azadirachta indica*, *Carapa* spp., *Chukrasia tabularis* and *Soymida febrifuga* also yield gums which are used mostly for adhesive purposes. Besides these, the stones from the fruits of *Melia azedarach* are used all over India for rosaries and necklaces.

Swietenia mahagoni Jacq. and *S. macrophylla* King., the true mahoganies of commerce are the oustanding timbers of this family. Due to great popularity of mahogany for high class cabinet work and ship-building, demand for this timber once increased to such an extent, that the raising of plantations became necessary, and was undertaken not only in Central America, its original

home, but also in other countries like India, Ceylon, Philippines and Indonesia. Further, a large number of timbers from various countries having a superficial resemblance to mahogany were introduced under the name of mahogany with or without qualifying adjectives to meet the demand. According to Melville, as many as two hundred timbers from different families came to be known as mahogany in the world market. Of these, *Khaya ivorensis* A. Chev. (African mahogany) and other species of *Khaya* A. Juss. and *Entandrophragma cylindricum* Spr. (sapele mahogany) and others of Africa are very closely allied to *Swietenia* Jack, both from the point of view of morphology and anatomy. These are generally accepted in the trade as nearest substitutes of true mahogany on account of the similarity in colour, grain, texture, figure and other properties.

Besides mahogany, the family also includes a number of other valuable timbers. Among the important ones, mention may be made of the well known *toon* of India, Cedar of Central America, and calantas of the Philippines, all of which are the products of the genus *Cedrela* Linn. or *Toona* M. Roem. *Toon* is probably the most common poor man's furniture wood of north India, being cheap, light, easy to work and finish. Cedar of Tropical America is a well known timber for high grade cigar boxes. The calantas of the Philippines is also used for making cigar boxes and for furniture and cabinet work. The crabwood, *Carapa guianensis* Aubl. of Tropical America, is a popular wood for furniture and constructional work and is sometimes substituted for mahogany. *Lovoa klaineana* Pierre, known as African walnut, is an important timber of West Africa and is often exported to Europe and America as mahogany substitute. Although the colour of this timber is yellowish brown, it comes very close to African mahogany from the point of view of grain, texture, density and other properties. Chickrassy (*Chukrasia tabularis* A. Juss.) of India and Burma is another handsome timber which often produces beautiful figure and is in demand for high-class cabinet work and also for general constructional purposes. This timber resembles to a great extent sapele mahogany (*Entandrophragma cylindricum*) of west Africa and may be used in place of true mahogany. Several species of *Dysoxylum* Bl., particularly *D. malabaricum* Bedd., the white cedar of India, and *D. fraseranum* Benth, the Australian rose mahogany, are elegant timbers for furniture and cabinet work. Other timbers of this family are also in great demand, but on account of their limited supplies, they are usually of local importance only.

The woods of this family usually have a pleasing appearance, some of them exhibiting an attractive figure. Because of this, and the ease with which they can be seasoned and worked with both machine and hand tools, they are in great demand by the cabinet makers ; some of them are also famous for their steadiness and durability.

The predominating colour of the timbers is reddish or reddish-brown but a few like *Dysoxylum malabaricum*, *Chisocheton* spp. and *Heynea trijuga* may be yellowish-white to yellow or grey. Many of the timbers are aromatic and have a distinctive odour, the best known being the cigar box cedar or spanish cedar obtained from *Cedrela odorata* Linn. of Central America and other species of *Cedrela*. Several species of *Dysoxylum* are also characterized by distinctive scent. For example *D. fraseranum* Benth. of Australia is reported to have rose-like fragrance while *D. alliacium* Blume of Java is said to smell like that of onions. But *D. malabaricum* of India has a faint sour cedary odour. Among the other timbers which are scented mention may be made of *Aglaia* Lour., *Lansium* Rump. some species of *Amoora* Roxb. and *Reinwardtiodendron* Koord.

The timbers of the family vary to a great extent in weight and hardness, ranging from light and soft in *Melia composita* Willd. to very heavy and very hard in *Soymida febrifuga*. However, most of them belong to the category moderately heavy and moderately hard. Similarly in texture, although most of them are of medium type, a few may be fine like *Cipadessa* Bl. or coarse like *Walsura* Roxb. Interlocked or wavy grain is a common feature in this family. Some of the known figures like stripe, ribbon, mottle, fiddle-back, and roe, etc., are traceable to variation in the grain.

The woods of the family have received considerable attention of the wood anatomists of many countries on account of their commercial importance. Among the more recent contributions on the systematic Wood Anatomy of the family are by Kribs, Heimsch and Panshin. Besides these, a detailed account of the important commercial timbers of Africa (12, 13), America (72, 73), Australia (5, 7, 22), India (31, 66, 89), Malay Peninsula (23, 28), and Philippine Islands (79, 83), has been given by various workers. It may be of interest to note here that the genera *Chloroxylon* DC. and *Flindersia* R. Br. which were previously placed in this family have now been transferred to *Rutaceae* based mainly on the occurrence of secretory cells and cavities. From the point of view of wood anatomy also the transfer of these genera is justified. Further, critical study of wood anatomy by Kribs, has helped to throw light on the generic positions of some timbers of this family. However, more work is necessary to clear up some confusions which still appear to exist in the case of certain genera and species. It may be mentioned here that while working on the woods of this family a number of samples in the wood collection of this Institute was found to be not correctly named, particularly those belonging to the genera, *Amoora*, *Aglaia* and *Dysoxylum*. The mistakes probably crept in due to the apparent similarity in certain morphological characters of some of these trees. In the anatomical structure of the wood also, there is considerable overlapping of characters between certain genera which may cause confusion in their identification.

The woods of this family are characterized by diffuse-porous structure except *Cedrela* and *Melia* Linn. which show ring-porous to semi-ring-porous structure. Growth rings are apparently distinct and delimited by concentric bands of parenchyma, in *Azadirachta* A. Juss., *Carapa* Aubl., *Cedrela*, *Chukrasia* A. Juss., *Cipadessa* (in part), *Heynea* Roxb., *Lansium* (in part), *Melia*, *Soymida*, *Swietenia* and *Walsura* but absent or indistinct in *Aglaia*, *Amoora*, *Chisocheton* Bl., *Sandoricum* Cav. and some species of *Lansium* and *Dysoxylum*. Vessels are generally moderately large to small and not numerous but very small and indistinct to the eye in *Carapa*, *Cipadessa*, *Lansium* and some species of *Aglaia* and *Walsura*. In the diffuse-porous woods, vessels are usually distributed without any characteristic pattern or arrangement except in *Cipadessa* where radial chains are often noticeable. However, there may some time be a tendency in some species of *Dysoxylum*, *Swietenia* and *Walsura* also for the vessels to be arranged in chains. In the latewood of *Melia*, the vessels are arranged characteristically in clusters, a feature of importance in its easy diagnosis. Tyloses are absent in the vessels, but gums and other deposits are very often present in the heartwood. The colour of these deposits varies from yellow, orange-yellow to reddish-black and may sometimes be of value in identification. *Parenchyma* is very variable in this family and is perhaps the most useful diagnostic end-grain feature. Based on the distribution of parenchyma the woods can be distinguished into two broad groups. In the majority of the woods, the parenchyma occurs in the form of concentric bands apparently delimiting growth rings in association with various other types of parenchyma. In the rest, such bands are absent, the parenchyma being usually associated with vessels. In the former class are included *Azadirachta*, *Carapa*, *Chukrasia*, *Cipadessa*, *Dysoxylum malabaricum*, *Swietenia* and *Soymida*, where only the tangential lines simulating growth rings are distinct to the eye, paratracheal parenchyma being very scanty and indistinct even under lens. But in *Dysoxylum* (in part), *Heynea*, *Lansium* (in part) and *Walsura*, which also come under the same group, the growth rings are fine and visible only under lens while the paratracheal parenchyma is abundant and distinct to the eye. It may vary from patches round the vessels with fairly thick lateral extensions or in thick paratracheal confluent bands as in *Heynea* to wavy bands at more or less regular intervals as in *Dysoxylum*. In the second group, the parenchyma may be abundant in thick tangential bands as in *Chisocheton* or in wavy tangential lines as in *Amoora rohituka* (*Aphanamixis polystachya*). But it is scanty and inconspicuous in *Amoora wallichii* King and *Sandoricum indicum* Cav. In the former, it is just visible under the lens round the vessels while in the latter it forms a thin sheath round the vessels with fine wing-like projections which are distinct only under lens. Diffuse parenchyma is also present in both of these woods but these are scarcely visible under lens. Parenchyma is, however, very variable in *Agalaia*, being vasicentric or aliform confluent forming short

or long tangential lines. Of the two ring-porous timbers, in *Cedrela*, parenchyma is poorly developed round the vessels and it is only the initial bands of parenchyma that are visible clearly. Although in *Melia* the parenchyma distribution in the earlywood is similar to *Cedrela*, the latewood shows characteristic parenchyma associated with the vessel clusters. Rays are mostly not conspicuous in this family except in *Cedrela*, *Melia*, *Soymida* and *Swietenia*. Ripple marks or storied structure are sometimes present in *Carapa* and *Swietenia* and when present can be used with advantage in identification. Gum canals of the traumatic type in tangential rows have sometimes been found to occur in a number of timbers. These have been recorded in *Azadirachta indica* A. Juss , *Carapa*, *Cedrela*, *Chukrasia*, *Heynea*, *Melia*, *Sandoricum*, *Soymida* and *Swietenia*. Pith-flecks are occasionally present in some woods, e.g., *Cedrela* and *Walsura*.

The family is represented in India by 19 genera of which three were not available for study. These are *Beddomea* Hook. f., *Munronia* Wight and *Turraea* Linn. *Beddomea* is represented by 2 species namely, *B. indica* Hook. f., a large shrub, and *B. simplicifolia* Bedd., a small tree, both occurring in the Western Ghats. The only species of *Munronia* is *M. wallichii* Wight, a shrub growing in Sikkim, Khasi Hills and the Nilgiris. *Turraea* has got one species, *T. villosa* Benn. – a large shrub occurring in the Western Ghats from Mahabaleshwar southwards.

The study of the woods of the sixteen genera available at the Institute wood collection has shown that while some of the timbers have sufficient distinguishing features to make their identification comparatively easy, there are several others which may offer considerable difficulty due to their apparent similarity in texture and anatomical structure. In the latter case it may not always be possible to distinguish them with certainty without the help of a microscope. The following key, however, is likely to be of help in the field identification of timbers of this family.

Key to the woods

1. Wood ring-porous to semi-ring-porous .. 2

1. Wood diffuse-porous 5

2. Wood typically ring-porous, earlywood zone crowded, consisting of several rows of large vessels ; transition from early to latewood abrupt 3

2. Wood semi-ring-porous, earlywood zone not crowded, usually with only one row

of larger vessels on the face of the growth rings ; transition from early to latewood gradual .. .. .. **Cedrela toona*, *C. microcarpa*, *Melia composita*.

3. Latewood vessels in clusters, forming flame-like or zig-zag patterns. Wood not aromatic .. 4

3. Latewood vessels neither in clusters nor form flame-like or zig-zag pattern. Wood aromatic *Cedrela serrata*

4. Earlywood zone with 4–8 or more rows of large vessels ; latewood vessels individually indistinct under lens but arranged in conspicuous flame-like pattern .. .. *Melia azedarach*

4. Earlywood zone with 2–3 rows of large vessels ; latewood vessels distinct under lens and not arranged in distinct flame-like pattern .. *Melia birmanica*

5. Parenchyma in tangential lines simulating growth rings 6

5. Parenchyma not in tangential lines simulating growth rings 19

6. Paratracheal parenchyma scanty and indistinct to the eye. Growth-rings usually distinctly visible 7

6. Paratracheal parenchyma abundant, distinct to the eye. Growth rings visible only under lens 16

7. Ripple marks present 8

7. Ripple marks absent 9

8. Vessels minute and rays fine, wood dark reddish or purplish brown and fine-textured. Transition from sapwood to heartwood abrupt .. .. .. *Carapa*

8. Vessels not minute and rays moderately broad, wood pinkish or light reddish-brown and medium-textured. Transition from sapwood to heartwood gradual .. *Swietenia*

* The cedrelas can be distinguished from *M. composita* by the presence of characteristic cedary smell. In older samples, where odour cannot be used with certainty, *M. composita* can be distinguished under the microscope from *Cedrela* spp. by the presence of small tracheid-like vessels with spiral thickening. Sometimes in the extreme latewood of *M. composita*, the vessels may also show a tendency to form clusters, a feature not present in *Cedrela*.

9. Vessels minute, indistinct to the eye. Rays fine to very fine, closely spaced. Wood fine-textured 10

9. Vessels moderate-sized usually visible to the eye. Rays moderately broad to fine, not closely spaced. Wood medium-textured.. .. 11

10. Vessels numerous, often in short radial chains. Wood brown to reddish-brown, aromatic.. *Cipadessa*

10. Vessels not numerous and not arranged in chains. Wood dark reddish-brown with a purplish cast. Wood without odour .. *Carapa*

11. Wood straw-coloured or golden-yellow to buff or grey 12

11. Wood pinkish, reddish-brown to red .. 13

12. Growth marks usually thick and undulating and lighter in colour than the background. Rays pale-yellow. Wood with faint cedary smell .. .. *Dysoxylum malabaricum*

12. Growth marks not thick and undulating. Rays pinkish to reddish-brown. Wood without any smell .. .. *Chukrasia*

13. Wood very heavy and very hard. Tangential bands of parenchyma sometimes thick and partially embed vessels .. .. *Soymida febrifuga*

13. Wood moderately heavy, moderately hard. Tangential bands of parenchyma seldom embed vessels 14

14. Tangential lines of parenchyma usually equally spaced .. .. .. *Chukrasia*

14. Tangential lines of parenchyma often irregularly spaced 15

15. Vessels usually scanty, often roundish, and sometimes in clusters. Brownish gummy deposits often fill up vessels cavities .. .. *Azadirachta*

15. Vessels usually moderately numerous, oval, sometimes with a tendency towards radial alignment. Dark reddish-brown or almost black gummy deposits often present in vessels .. .. *Swietenia*

16. Wood heavy to very heavy 17

16. Wood moderately heavy 18

17. Wood odorous; fine-textured, pale-yellow to yellowish-brown in colour, with distinct pleasant odour .. .. .. *Lansium anamallayanum*

17. Wood grey-brown to red-brown in colour, without any odour .. .. .. *Walsura*

18. Wood fragrant; pinkish to reddish-brown. Parenchyma in fine wavy lines .. *Dysoxylum*

18. Wood not fragrant; yellowish-white to yellowish-grey. Parenchyma, aliform to aliform-confluent, sometimes forming broad tangential or wavy bands .. .. *Heynea*

19. Parenchyma scanty, visible only under lens as a thin sheath round the vessels or inconspicuously aliform 20

19. Parenchyma abundant, distinctly visible to the unaided eye 22

20. Vessels moderately large, visible to the eye. Wood not scented .. .. *Amoora wallichii, Amoora cucullata.*

20. Vessels minute, indistinct to the eye. Wood usually sweetly scented 21

21. Vessels scanty. Parenchyma often forming fine wing-like projections from vessels. Wood light to moderately heavy .. .. .. *Sandoricum indicum*

21. Vessels numerous. Parenchyma do not form wing-like projections. Wood heavy .. *Aglaia andamanica*

22. Parenchyma in thick, long bands alternating regularly with slightly wider bands of fibre. Wood cream-yellow to greyish-brown .. *Chisocheton*

22. Parenchyma in thin, broken lines, sometimes connecting or joining vessels at irregular intervals. Wood brown to red, seldom yellowish in colour 23

23. Wood heavy, sometimes with sweet smell .. *Aglaia*

23. Wood light to moderately heavy without any characteristic smell 24

24. Wood brownish-yellow, fine-textured. Vessels indistinct to the eye .. .. *Lansium decandrum*

24. Wood red to reddish-brown, medium coarse-textured. Vessels visible to distinct to the eye 25

25. Wavy parenchyma lines numerous, fairly closely spaced .. .. *Amoora rohituka*

25. Wavy parenchyma bands few, widely spaced .. *Dysoxylum hamiltonii*

1. AGLAIA LOUR

A large genus consisting of small to moderate-sized trees distributed in the Indo-Malayan region and southern China. About 20 species are reported to occur in India and Burma of which six were available for study and are described here. Of the remaining species, *A. barberi* Gamble, *A. bourdillonii* Gamble, *A. canarensis* Gamble and *A. minutiflora* Bedd. – *pira mattipala* (Tam.), *poonjara* (Mal.), occur in Western Ghats and Travancore ; *A. khasiana* Hiern. is found in Mikir Hills and Khasi and North Cachar hills of Assam ; *A. fusca* King, *A. ganggo* Miq. and *A. glaucscens* King are from Andamans ; and *A. carssinerria* Kurz, *A. griffithii* Kurz, *A. oligophylla* Miq. and *A. paniculata* Kurz are found in Burma. Besides these Haines has described another species *A. hasslettiana* Haines from Orissa. He considers that this species unites *Aglaia* and *Amoora*. It is interesting to note that from anatomical point of view *Amoora rohituka* which is characterized by wavy parenchyma bands resembles some aglaias to some extent and is sometimes difficult to distinguish from them in the field. Among the species mentioned above the wood of *A. ganggo* and *A. minutiflora* is reported to be fragrant.

The timbers are similar in physical properties as well as in anatomical structure and cannot be separated with certainty except *A. andamanica* Hiern. This species is distinguishable from the rest by the presence of very small and numerous vessels and inconspicuous vasicentric parenchyma.

1. **A. andamancia** Hiern.—**Aglaia**. *Letauk* (Andamans). A moderate-sized tree, 12–21 m. in height and 1–2 m. in girth. *Bark* brownish-green and peels off in flakes.

It is fairly common in deciduous and semi-deciduous forests of Andamans.

Description of the wood—See page 91.

2. **A. argentea** Bl.—**Aglaia.** A small evergreen tree found in tropical forests of the eastern slopes of the Pegu Yoma and in the Andaman and Nicobar Islands. It also occurs in Malay Peninsula.

Description of the wood—See page 91.

3. **A. edulis** A. Gray.—**Aglaia.** *Momai lateku* (Asm.), *dieng-soh-longar* (Kh.), *thing-ril-char* (Kuki), *khrang* (Mik). A fairly large tree up to 23 m. in height and 1·5–2 m. in girth with a clear bole of 7·5 to 12 m. and fluted stem. Bark grey, smooth, exfoliates in flakes, thin and exudes a thin milky sap. The fleshy integuments of the seeds are edible.

It grows in Sibsagar, Mikir Hills, North Cachar hills and Khasi Hills of Assam up to 600 m. elevation.

Description of the wood—See page 91.

4. **A. maiae** Bourd.—**Aglaia.** A handsome moderate-sized tree up to 18 m. in height and 30 cm. in diameter. *Bark* dark reddish-brown or mottled brown and white, smooth, peeling off in flakes, 6 mm. thick.

It grows in the hill forests of Travancore up to 370 m. elevation.

Description of the wood—See page 91.

5. **A. previridis** Hiern.—**Aglaia.** *Thaidubriki buphang* (Cach.), *Sanu lahasune, bale mauwa* (Nep.), *palit-kung* (Lep.). A small tree. *Bark* greyish-brown, somewhat rough, gives out an aromatic smell when cut.

It grows in lower and middle hill forests of Darjeeling and Sikkim and in Cachar and Khasi Hills of Assam up to 600 m. elevation.

Description of the wood—See page 91.

6. **A. odoratissima** Bl.—**Aglaia.** *Karagil, punyava* (Mal.), *chokla, vegula chokla, kanna kompu* (Tam.), *verra oryewa aduga* (Tel. and Kan.). An evergreen tree reaching up to 24 m. in height and 75 cm. in diameter in Travancore but medium-sized to small elsewhere. *Bark* brownish-grey or light brown, smooth to somewhat rough, peeling off in rectangular scales. The fruit is edible.

It is widely distributed in peninsular India but apparently not common in any locality except probably Travancore. Two varieties are sometimes recognized, e.g., variety *beddomei* occurring in Eastern Ghats from Ganjam to Godavari hills of the Deccan and Travancore up to 900 m., and variety *courtallensis* found in Western Ghats in the hills of Tinnevelly. The northern limits of distribution of this species in Midnapore, West Bengal in the east and Mount Abu in Rajasthan in the West. A solitary record of this species has also been made from Garo Hills, Assam.

Description of the wood—See page 91.

Description of the wood

(*Aglaia andamanica, A. argentea, A. edulis, A. maiae, A. odoratissima* and *A. perviridis*)

[Pl. **39**, 231–234]

General properties—Sapwood straw coloured to light greyish-yellow ageing to light brown. Heartwood when fresh pinkish-brown, orange-brown or reddish-brown on exposure. The transition from sapwood to heartwood rather gradual in most of the samples examined. Wood hard to very hard, heavy (sp. gr. 0·73–0·94 air-dry) ; often slightly lustrous, usually interlocked-grained, sometimes with curly or wavy grain, mostly fine-textured ; some specimens handsomely streaked ; freshly exposed heartwood of some species frequently has a pleasant odour.

Gross structure—All are diffuse-porous woods. *Growth rings* apparently distinct in most of the species but these may or may not be true annual rings. These are often demarcated by darker and denser bands of fibrous tracts with scanty vessels and parenchyma ; sometimes the growth rings appear to be delimited by thin lines of parenchyma, particularly in *A. edulis*, 5–9 per cm. *Vessels* small to very small, but just visible to the eye and moderately few to moderately numerous (5–17 per mm.^{2}) except in *A. andamanica* where they are very much smaller and indistinct and usually numerous (20–30 per mm.^{2}) ; solitary or in short radial multiples of 2 to 3 but sometimes more up to 6 giving the impression of chain-like arrangement in *A. andamanica* ; more or less evenly distributed except in the region of growth marks where the vessels are less numerous as in *A. edulis* ; round to oval in outline, often filled with yellow or orange coloured deposits in the heartwood which improves the visibility of the vessels. Vessel lines fine, not conspicuous on the longitudinal surfaces. *Parenchyma* lighter in colour than the background, yellowish in sapwood and orange coloured to pale brown in heartwood, usually visible to distinct to the eye except in *A. andamanica* where it is mostly inconspicuous ; parenchyma rather variable not only in different species but also in various specimens of the same species ; mainly paratracheal confluent forming short or long thin wavy bands in *A. argenta*, *A. edulis*, *A. maiae*, and *A. odoratissima* ; but more often aliform with short, thin extensions ; at places wing-like or joining similar extensions from other vessels as in *A. perviridis* ; vasicentric or forming indistinct eyelets in *A. andamanica* ; also in fine, more or less continuous lines delimiting growth marks in some specimens. *Rays* fine to very fine, rather indistinct to the eye lighter in colour than the background of the wood, often wavy and ending abruptly, closely spaced ; sometimes showing inconspicuous ray-flecks in some samples. *Pith flecks* occasionally present (*A. andamanica*).

Two samples collected from Nicobar Islands in the recent expedition to that island and identified as *Aglaia* spp. are interesting to record here. In anatomical structure although the difference is not marked, in physical properties they

show considerable difference from the timbers of other localities. Sapwood is grey, while the heartwood is pinkish-brown turning to light red on exposure. Both the timbers when fresh had a faint agreeable smell. The important points of difference between these and other species mentioned above are that the Nicobar timbers are moderately soft, moderately heavy and easy to work. They can be finished to a smooth surface and when cut properly, show fairly good figure.

Strength—The woods are hard and strong. *Aglaia edulis* and another consignment of *Aglaia* from Assam have been so far tested for strength at this Institute. For strength figures, see appendix I.

The two Nicobar timbers mentioned above have also been subjected to some small scale tests, the results of which are given below :—

Number	Moisture %	Specific gravity	Wt. in lb. per cu. ft. 12% m.c.	Compression parallel to grain Maximum crushing stress lb./sq. in.	Hardness Radial in lb.
G/A 10652 (Heartwood)	15·2	651	45	8691	1195
G/A 10658 (Sapwood)	14·9	530	37	8206	780

Bourdillon gives the value of P (coefficient of transverse strength) for the following species :—

A. odoratissima : Weight per cu. ft. = 57 lb. and P = 896.

A. maiae : Weight per cu. ft. = 57 lb. and P = 1061.

Seasoning—*A. odoratissima* from Mysore has been experimented at the Forest Research Institute, Dehra Dun. Kapur and Rehman have summarized the results as follows :—

"Material seasoned in the form of 2″ × 2″, 2″ × 4″, and $3\frac{1}{4}$″ × $3\frac{1}{4}$″ scantlings. The initial average moisture content of the wood at the time of stacking was 33 per cent, while some of the samples showed as high as 60 per cent, moisture in the interior. After 12 months' seasoning the moisture came down to 10 to 11 per cent, with practically no moisture gradient and no drying stresses. During the early stages some fine surface cracks were noticed on the wood, which closed up completely at the end of seasoning. The heart shakes did not extend at all. The 2″ × 2″ scantlings suffered from spring, cup and twist, but the 2″ × 4″ scantlings retained their shape better. The wood is not difficult to air-season. In order to avoid damage due to warping of wood, it is preferable to cut it into the form of wide planks of the required thickness, and, after the seasoning is complete, to reconvert the planks into scantling sizes",

In kiln seasoning the timber requires great care as it is liable to develop certain amount of surface cracking and end splitting.

Natural durability—None of the Indian species has been tested at the Institute. However, according to Burkill *A. argentea* is not durable while *A. odoratissima* is "fairly durable" among the timbers also found in Malay Peninnsula. As regards Philippine species, Reyes records that *A. clarkii* Merr. is durable and lasts for about six years in contact with the ground but *A. diffusa* Merr., *A. harmsiana* Perkins and *A. luzoniensis* Merr. and Rolfe. are only moderately durable in contact with the ground. As regards *A. laevigata* Merr., it is reported to be very durable even when exposed to the weather. It would, therefore, appear that the durability of different species is variable.

Insect and fungus attack—Dead wood of *A. odoratissima* is liable to be attacked by *Pagiophloeus umbricidus* Marshall (Curculionidae). *Fomes rimosus* is a wound parasite on living trees causing decay in the heartwood and also attacks felled logs. None of the samples in the Dehra Dun collection is damaged either by insect or fungus.

Working qualities—The wood is hard to very hard and somewhat difficult to saw and work. Sometmes specimens with interlocked-grain may give trouble in sawing and smooth working. Usually it does not tear up under the plane, and can be brought to a smooth surface. Some specimens have pleasing colour and attractive appearance due to good figure.

Supply and uses—It is available in limited quantities in East and South zones. The timbers are mainly used locally for house posts and also sometimes for other constructional purposes. It is also used for tent pegs, axe handles, agricultural implements and spokes of wheels. The specimens which have attractive figure should be suitable for high class cabinet work.

Material—

A. andamanica – 7827 Andamans (0·90), 7828 Andamans (0·92), 7829 Andamans (0·83), 7830 Andamans (0·85).

A. argentea – 6357 Burma (0·80).

A. edulis – 7535 Sibsagar, Assam (0·89), 7954 Nowgong, Assam (0·89), 7955 Nowgong, Assam (0·94), 7956 Nowgong, Assam (0·87), 7957 Nowgong, Assam (0·83).

A. maiae – 4535 Travancore (0·73).

A. perviridis – 7976 Assam (0·88).

A. odoratissima – 3964 Godavari, Andhra Pradesh (0·94), 4852 Travancore (0·93), 6412 Burma (0·85), 6711 Tinnevelly, Madras (0·80).

2. AMOORA Roxb.

It is a comparatively small genus of medium-sized to large evergreen trees. There are about 25 species mostly distributed in the Indo-Malayan region. Seven species have been described from India and Burma of which 3 are dealt with here. The species for which samples were not available for study are : *A. canarana* Benth. and Hook. – *karagil* (Tam.), *chinnagil* (Mal.) and *A. lawii* Bedd. – *madrasada* (Kan.) are trees of western ghats ; the former is found in Anamalais and Travancore hills up to 1,000 m. and the latter in Malabar and Tinnevelly ; *A. chittagonga* Hiern. – *gangru-changul* (Duffla), *ponthi-kechauphang* (Mik.), *tagat-thitto* (Burm.) occurs in Upper Assam, Chittagong in East Pakistan and Lower Burma ; while *A. manii* King is confined only to South Andamans.

The timbers of the genus *Amoora* in the Institute collection show considerable variation in anatomical structure. *Amoora rohituka* W. and A. is characterized by the presence of prominent wavy parenchyma bands, while in *A. wallichii* King, parenchyma is scanty and usually indistinct even under hand lens. *A. cucullata* Roxb. occupies an intermediate position in having vasicentric parenchyma which occasionally extends side ways in thin lines and sometimes may even link up neighbouring vessels. The systematic position of some of the species of this genus was also not very clear and some of them were actually placed in the genus *Aphanamixis* by some workers. Kribs on the basis of wood anatomy has also supported the transfer of certain species to *Aphanamixis* and has indicated the differences between *Amoora* and *Aphanamixis* as follows :—

Aphanamixis	*Amoora*
Wood parenchyma abundant, in continuous tangential lines, 4–6 per mm.	Wood parenchyma scarce, not visible with lens ; occurs diffuse as scattered cells.
Rays 1–2 cells wide, mostly uniseriate.	Rays 1–3 cells wide, mostly 2–3 cells.

Amoora cucullata Roxb. seems nearer to *Aphanamixis* than *Amoora*, the wood parenchyma occurring in short tangential lines, and the rays being 1–2 cells wide and mostly uniseriate.

The transfer of *Amoora rohituka* to the genus *Aphanamixis* is, therefore, in conformity with wood anatomy. Dadswell and Ellis have also suggested that *A. nitidula* Benth. should be referred to *Aphanamixis* on the basis of anatomical structure.

1. **A. cucullata** Roxb.—*Bor-amari* (Asm.), *amur*, *latmi*, *natmi* (Beng.), *thitni* (Burm.). A middle-sized to large tree sometimes reaching up to 24 m. in height and 2 m. in girth. *Bark* grey and thin.

It is found in the Sundarbans of both West Bengal and East Pakistan and also in the coastal region of Burma. It is said to occur in Sibsagar, Assam but is very rare.

Description of the wood—See page 97.

2. A. rohituka W. & A. [Aphanamixis polystachya (Wall.) Parker].—**Pitraj.** *Amora amari, amari, boga amari, hakhori-bakhori, lota amari* (Asm.), *lahasune, pitraj, rohina, taktaraj* (Beng.), *chayakeya, thitni, thanthatkyi* (Burm.), *bol-samphal, eng-gokmi* (Garo), *harin harra, harin-khana, sohaga* (Hind.), *mullu-muttaga* (Kan.), *bhota-mayna, dieng-rata, dieng-lang-marei, dieng-soh-khyltam-blang, jharua* (Kh.), *sikru* (Kol), *bagu-rata, kak-sok-thing, mouksa-khislam-phang, thai-dau-ing, thing-ril-char* (Kuki), *kaledj-zho, tangaruk* (Lep.), *kargil, chem-maram* (Mal.), *rohada* (Mar.), *wakek-turang* (Mik.), *bandriphal, gokul, jutraj* (Nep.), *rohituka* (Sans.), *vaidraj, beri rata* (Sylh.), *malampulavum, vellakongu, vengul* (Tam.), *chawa-manu* (Tel.). An evergreen tree usually medium sized, sometimes attaining 18–24 m. in height and up to 2·5 m. in girth. In the foot-hills of the Himalayas, the clear bole is often between 3–4·5 m. but in the Chittagong Hill Tracts of East Pakistan it is reported to be sometimes as much as 15 m. *Bark* greyish-brown to dark brown, rough, exfoliating in circular pieces, rather thin with a faint pleasant smell. The juice from the bark is astringent and used in spleen and liver complaints. The oil from the seed is used as liniment in rheumatism.

It has a fairly wide distribution, occurring along the sub-Himalayan tracts from Gonda in Uttar Pradesh eastwards, Bihar, northern part of West Bengal, Assam, and the Andaman and Nicobar Islands. Also found in Western Ghats and adjoining hill ranges from North Kanara to Tinnevelly, extending further southwards to Ceylon. Towards the east it spreads from Chittagong in East Pakistan to Burma and Malay Peninsula.

From early literature and historical records it appears that this tree had a wider distribution and was not an uncommon tree even in the Punjab, near about 100 B.C. The name of the town Rohtak in the Punjab has been identified with the ancient city of Rohitaka of the Mahabharata. In this connection, Sahni has made the following interesting remarks. "The name Rohitaka, it has been suggested, was given to this place owing to the abundance here of the plant known in Sanskrit as *Rohitaka* (Latin *Amoora rohituka* W. & A. synonym : *Andersonia rohituka* R.)". Further he has stated that the tree might have become extinct in the Punjab during historic times.

Description of the wood

[Pl. **40**, 236]

General properties—Sapwood and heartwood not always clearly demarcated but Desch states that sapwood is sharply differentiated from heartwood

in Malayan samples of this species. Sapwood yellowish with pinkish to reddish tinge ; heartwood red when fresh, turning dull reddish-brown on ageing ; moderately hard ; moderately heavy (sp. gr. 0·56–0·68 air-dry) ; somewhat lustrous when first exposed but usually becoming rather dull on long exposure, straight to slightly interlocked-grained and medium-textured ; occasionally some logs are fairly fine-textured, showing a rather attractive figure due to growth marks and interlocked-grain.

Gross structure—A diffuse-porous wood. *Growth rings* usually indistinct but occasionally may be demarcated by denser fibrous bands, 2 to 4 per cm. *Vessels* moderately large, few to moderately few (3–10 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–4, sometimes giving the impression of obliquely radial chain arrangement, round to oval in shape, open or filled with dark coloured gum-like deposits ; vessel lines usually long and conspicuous on the longitudinal surfaces. *Parenchyma* visible to the eye and distinct under lens, rather abundant in straight to wavy bands alternating with wider bands of fibres, often touching and connecting the vessels or vessel multiples and sometimes ending abruptly ; also vasicentric, in thin sheath round the vessels and at times extending as short or long fine lines. *Rays* fine to very fine, distinct only under lens, closely spaced, often slightly bent round the vessels, producing inconspicuous ray flecks on the quarter sawn surface. *Pith flecks* occasionally present.

Strength—It is a fairly hard and strong timber. Samples from Nowgong, Assam have been tested at the Institute and the strength figures are given in Appendix I.

Seasoning—The timber is equally easy to air-season in the form of planks or scantlings. Specimens in the wood collection are free from checks or cracks.

Durability—The timber is durable. The "graveyard" tests carried out with a specimen received from Assam gave the following results :

Untreated average life (heartwood) 135 months, minimum 83 months, maximum 144 months.

Preservative treatment—The timber has not been tested so far. Pearson and Brown, however, state that "its structure leads one to believe that it should absorb antiseptics readily".

Insect and fungus attack—*Fomes geotropus* and *Trametes lactinea* have been recorded on fallen logs of this species. Both the fungi cause white fibrous rot in the heartwood. There is no record of insect attack in this timber, all samples in the F.R.I. wood collection being free from any insect damage.

Working qualities—According to Pearson and Brown it saws and works well both by hand and on machines. It also turns easily and smoothly on a

lathe and can be brought to a smooth finish. It takes a good polish. Rodger states that sawmill workers complain that the dust causes irritation of the throat and nose.

Supply and uses—Though the tree has got a wide distribution it is no where abundant. A limited supply is available mainly from Assam and the West coast of India. It is available, however, in fair quantities from Chittagong in East Pakistan and also from Burma.

A timber which should prove useful for many purposes, it is at present used for furniture, cabinet making and general construction. It has been approved as suitable for plywood and battens for teachests. In Chittagong, it is reported to be used for dug-outs, canoes, knees of boats and also for roof structure and frames of walls of houses. In Burma, it is used for building purposes as well as for boxes, canoes and turnery. It is used for shingles in Ceylon. The timber appears to be particularly useful for planking and may also serve well for door and windows.

Material—

711 Chittagong, East Pakistan (0·68), 1261 Tezpur, Assam (0·61), 1362 Gonda, Uttar Pradesh (0·64), 2331 Darjeeling, West Bengal (0·56), 5902 Moulmein, Burma (0·57), 6353 Burma (0·58).

3. A. wallichii King—**Amari**. *Dire-asing* (Abor), *lalchini* (Andaman), *amari*, *amur*, *bhoto-mayna*, *galing-asing* (Asm.), *lali* (Beng. and Nep.), *long-lephuphang* (Cach.), *kering-phong*, *ringok-me*, *samphal* (Garo), *wang-la-bei* (Kh.), *phul-rata*, *rongi-rata* (Sylh.), *sahatchakung* (Tipp.). It is a large tree 18–27 m. in height, occasionally over 30 m. and 2–3·5 m. in girth with a straight and cylindrical bole of 7·5–9 m. sometimes even up to 13 m. in length. *Bark* thin, brownish-yellow to grey, smooth or peeling off in flakes, and exuding a milky juice when cut.

It is fairly common in evergreen forests of Lower and Upper Assam, in sal and mixed plain forests and also in lower hill forests of North Bengal, Singbhum in Bihar and Mayurbhanj in Orissa. It is also found in evergreen forests of Middle and South Andamans and Lower Burma.

Description of the wood

(*Amoora cucullata*, *A. wallichii*)

[Pl. **40**, 235, 237 to 239]

General properties—Sapwood and heartwood not always clearly demarcated. Sapwood yellowish-grey to pinkish-yellow or pale red ; heartwood red, ageing to reddish-brown or pale greyish-brown sometimes with a tinge of yellow ; wood usually moderately hard ; samples from Assam and West Bengal,

light to moderately heavy (sp. gr. 0·49–0·69 air-dry) but samples from Burma moderately heavy to heavy (sp. gr. 0·62–0·87 air-dry), somewhat lustrous when fresh but often turn dull on exposure ; usually straight-grained but sometimes with interlocked-grain particularly noticeable in some samples from Burma ; medium to medium-fine in texture, Burma samples being usually somewhat coarser. Usually without any characteristic markings or figure but some specimens with interlocked-grain may show pleasant stripe figure when quarter sawn.

Gross structure—A diffuse-porous wood. *Growth rings* absent to indistinct, but occasionally darker bands of denser fibrous tissue as well as thin tangential lines of parenchyma give the impression of growth marks. *Vessels* usually moderately large and visible to the naked eye, but, sometimes larger and more distinct to the eye in some samples of *A. wallichii* while in *A. cucullata* they may often be comparatively smaller ; few to moderately few (3–10 per mm.^{2}), evenly distributed but may sometimes be crowded locally giving a porous look with coarse-texture, especially in the samples with larger vessels ; solitary or in radial multiples of 2 to 4, sometimes up to 8 in some samples from Burma, usually oval, sometimes roundish in *A. cucullata*, open or plugged with brown or dark coloured gum-like deposits, occasionally also whitish deposits observed in some samples ; tyloses absent ; vessel lines often long and conspicuous on the longitudinal surfaces. *Parenchyma* light brown in colour, usually scanty and hardly visible under lens in *A. wallichii* but sometimes noticeable as a thin sheath round the vessels (vasicentric) and also sparsely diffuse occurring as scattered cells which are often liable to be overlooked. In *A. cucullata*, however, the paratracheal parenchyma is comparatively better developed and more clearly visible under lens round the vessels sometimes forming short, thin, wing-like lateral extensions, which may rarely become connected with similar extensions from other vessels. Occasionally in *A. wallichii*, fairly thick tangential bands of parenchyma may be present at irregular distances. Pearson and Brown consider these bands as possibly of traumatic origin. *Rays* fine to very fine, indistinct to the eye, brownish in colour, and closely spaced ; ray-flecks inconspicuous but noticeable in sapwood because of the colour of the rays.

Strength—*A. cucullata* has not so far been tested for strength and other properties. Specimens of *A. wallichii* from Burma have been tested at Dehra Dun and the strength figures are given in Appendix I. It is a moderately heavy, moderately strong and moderately hard timber.

Seasoning—Samples of *A. wallichii* in the form of 25 mm. thick planks from Bengal tested at Dehra Dun showed that the timber can stand rapid air-seasoning. The initial moisture content between 60–70 per cent in August was reduced to 12–13 per cent in 2½ months' time without any degrade. Pearson and Brown also state that the timber seasons well and does not split even in

large dimensions. They have recommended that logs should be converted green and the sawn material open-stacked under cover to get the best results. Experience with this timber in Burma is different. Rodger states that "when air-seasoned, it tends to split and show surface cracks unless protected against rapid drying. Degrade from these causes can be avoided by kiln-seasoning". According to Rehman the timber is not difficult to kiln-season.

Durability—The timber is fairly durable. "Graveyard" tests carried out at Dehra Dun with a specimen received from Bengal gave the following results. Untreated average life of heartwood was found to be 81 months, minimum being 65 months and the maximum 96 months.

Insect and fungus attack—*A. wallichii* is susceptible to damage by some *ghoon* borers (Bostrychidae). Dead wood, and newly felled or fallen logs, etc., are attacked by some Brenthidae, Cerambycidae, Curculionidae, Platypodidae and Scolytidae borers. *Trametes corrugata*, a white rot fungus has been recorded in the logs.

Working qualities—The timber is easy to work and saw both by hand and on machines. It can be brought to a smooth finish and is amenable to good polish. Although not a decorative timber, it has got a pleasing colour. For Burma specimens Rodger, however, states that the wood is "open-grained and porous – must be well filled and bodied before french polishing". The timber is usually steady and is suitable for joinery and similar work. The peeling properties of *Amoora wallichii* have been tested at this Institute from two different localities. It has been found that the logs require soaking treatment before peeling. The Burma logs required a boiling treatment of two hours per inch of diameter of log in water raised to 190°F. for making them fit for peeling. Sometimes logs from Assam have been observed to be badly fluted and the core soft and spongy. This results in considerable loss during conversion.

Supply and uses—A fairly good supply of *A. wallichii* is available from the northern divisions of West Bengal, Assam and the Andamans and also from Burma.

The timber is good for all classes of furniture, doors and windows, and particularly good for planking and panelling. It is locally used for dug-outs, canoes, roof structures and house frames. It is also suitable for commercial plywood and packing cases. The timber is used for railway carriage building. Rodger states that it yields first grade charcoal. He has also recommended the timber for cigar boxes.

During the second world war, it was an approved timber for a variety of uses such as collapsible almirahs, awls, adzes, light axe helves, mosquito net

frames, tool boxes and chests, flagstaff, various types of handles, levers, ladders and heaving mallets.

Material—

A. cucullata—414 Sundarbans, Bengal (0·68), 5135 Bengal (0·59), 6653 Burma (0·76).

A. wallichii—1255 Tezpur, Assam (0·67), 5890 Garo hills, Assam (0·55), 5970 Goalpara, Assam (0·65), 6061 Kurseong, West Bengal (0·52), 6462 Burma (0·61), 6780 Burma (0·87), 7134 Burma (0·73), 7180 Burma (0·63), 7181 Burma (0·63), 7182 Burma (0·69), 7183 Burma (0·70), 7184 Burma (0·68), 7185 Burma (0·64), 7186 Burma (0·77), 7187 Burma (0·74), 7188 Burma (0·77), 7189 Burma (0·75), 7190 Burma (0·70), 7191 Burma (0·69), 7192 Burma (0·62), 7308 Darrang, Assam (0·49), 7366 Jalpaiguri, West Bengal (0·69), 7375 Lakhimpur, Assam (0·67), 7395 Chittagong, East Pakistan (0·56), 7506 Sibsagar, Assam (0·60), 7517 Jalpaiguri, West Bengal (0·62).

[The samples marked 6146 (0·60) and 6251 (0·61) from Tavoy, Burma, originally marked *Aglaia andamanica* were found to be actually *Amoora wallichii* on microscopical examination].

3. AZADIRACHTA A. JUSS.

A very small genus of tall, evergreen trees. One species, *A. integrifolia* Merr. is indigenous to Philippine Islands and the other *A. indica* A. Juss. which is dealt with here is widely distributed in the Indo-Malayan region and is also frequently planted in tropical Africa and elsewhere.

There has been some confusion in the generic position of *Azadirachta* and *Melia*. Kribs on the basis of wood anatomy has come to the conclusion that with the exception of *Azadirachta integrifolia* Merr., all other species of *Azadirachta* should be placed under *Melia*. The anatomical differences between these two genera have been given by him as follows :—

Azadirachta	*Melia*
Woods diffuse-porous	Woods ring-porous.
Minute pores do not form wavy tangential bands.	Minute pores form wavy tangential bands.
Gum-ducts not observed.	Gum-ducts present or absent.
Rays 1–3 cells wide.	Rays 1–8 cells wide.

The structure of the wood of *A. indica* which is described below agrees mainly with the diagnostic features of *Azadirachta* outlined by Kribs. On

anatomical grounds the separation of *A. indica* from the Indian melias and its inclusion in a distinct genus *Azadirachta* therefore appears to be justified.

A. indica A. Juss.—Well known as *neem* or margosa tree ; also sometimes known as Indian lilac. *Nim* (Beng.), *bavlamaka, kamaka, tamabin, thamaka, thin, thin-borotamakha* (Burm.), *bal-nimb, nim, nimb, ninb* (Hind.), *danujhada, kohumba, libado, limba, limbado, limbra* (Guj.), *bemu, bevina, bevu, kay-bevu, kaype-bivu, nimba olle-bchu* (Kan.), *betain nim* (Kumaon), *arytikta, arya-veppu, nimban, pisumarddam, raja-veppu* (Mal.), *balanta-nimba, kadukhajur, limba nimbay* (Mar.), *kakopholo, limbo, nimbu, nimo* (Or.), *neeb, nib, nim* (Punj.), *arishta, nimba, vishirnaparana, vranasodhakari, vavaneshta* (Sans.), *nim* (Sant.), *nimuri* (Sind.), *arulundi, kaduppagai, kinji, malugam, niriyasam, pisidam, sengumaru, ukkargandam, vambu, veppa, veppam, veppu, veruttam* (Tam.), *nimbamu, taruka, vemu, veppa, vappa, yeppa* (Tel.). A medium-sized to large tree with wide spreading branches and a clear bole 3–7·5 m. long 2–2·5 m. in girth. *Bark* greyish to dark grey with scattered small tubercles between numerous dark longitudinal and oblique wrinkled furrows.

From time immemorial, the tree has been held in great esteem in this country and references on the diverse uses of different parts of this plant are traceable in ancient literature and religious texts (53, 54). In *Brhatsamhita* it is stated that this tree is conducive to the welfare of the family if planted in the garden or in the house. Similarly, in *Padma Purana* also it has been enjoined that the planting of this tree increases longevity. Almost every part of this tree finds some use either in indigenous medicine or in everyday life, particularly in the rural areas. The medicinal and dietic values of various parts of this tree have been stressed both by Charaka and Susruta. Charaka has recommended it for "curing prurites" and for relieving "excitement of phlegm and bile". Susruta also has outlined various properties and uses of this tree. Some of his recommendations relate to the curative values in "destroying deranged phlegm, the affects of poison, *meha*, morbid discharges from the urethra, *kustha* (skin disease), fever, vomitting and itching of the body, etc., etc.". Susruta further mentions that the flowers subdue *pitam* (biliousness) and has curative value in skin affections.

The present day uses are also too numerous to be enumerated here. Some of the common uses may be mentioned here. The leaves are bitter ; when fresh they are eaten with vegetables as they are considered to be disinfectant and stimulating liver functions and as an appetizer. Leaves dried in the shade are used to protect books and clothes against insect attack. They are also used as poultice for boils and the decoction for ulcers and eczema. Young twigs have great demand for use as tooth brush and are considered good for pyorrhoea. Bark has an important place in indigenous medicine mainly as a bitter tonic and as an astringent. Seeds yield an oil known as *neem* oil

which is acrid and bitter in taste. Locally, it is commonly used in healing skin diseases, old wounds and ulcers, and in rheumatism. The oil is also taken internally as a medicine in certain diseases. It is further used in soap making, tooth paste and tooth powder. A gum exudes from the tree which is bright amber in colour and is used as demulcent, tonic and in catarrhal affections. It is like *Acacia* gum in properties and is sometimes sold in the trade mixed with it. The *neem* tree occasionally yields a toddy which is a milk-like emulsions with a pale yellow tinge. It is sweet and has the odour of ripe neem fruits. Ghose (33) who has analysed the toddy reports that it is like all other toddies and has no special medicinal property.

The tree is said to be wild in the dry forests of Andhra Pradesh and Madras and the dry zone of Burma. It is widely planted all over India and Burma as an avenue tree and also in gardens and villages, running wild in many places. It thrives best in the drier climate of the north-western parts of India and remains green in summer when other trees are often bare.

Description of the wood

[Pl. **40**, 240]

General properties—Sapwood yellow to yellowish-grey turning pale yellowish-brown on exposure ; heartwood reddish to reddish-brown darkening on exposure ; wood somewhat lustrous, hard to very hard, usually heavy (sp. gr. 0·72 to 0·83 air-dry) reported to be aromatic when fresh but specimens in the wood collection do not have any characteristic odour ; interlocked-grained, sometimes exhibiting ribbon-grain effect on the longitudinal surfaces ; usually medium to somewhat coarse-textured, occasionally little finer in texture when fast grown ; a good figure is often noticeable in plain sawn boards due to parenchyma bands as well as small knots.

Gross structure—A diffuse-porous wood but occasionally suggestions of ring porousness may be noticeable in very slow grown samples. *Growth rings* apparently distinct, demarcated by concentric lines of parenchyma but these lines are very irregularly distributed and sometimes too closely spaced to be considered as annual. *Vessels* usually moderately large and visible to the eye, occasionally small, few to moderately few (4–8 per mm.^{2}), somewhat unevenly distributed due to inconspicuous tangential alignment of the vessels, at places solitary or in radial multiples of 2 to 3 mostly 2, and occasionally in clusters, round to oval, usually filled with brownish gum ; vessel lines short and not conspicuous. *Parenchyma* (a) visible to the eye, lighter in colour than the background, in irregularly spaced thin tangential bands, some appearing continuous and apparently delimiting growth rings while others are discontinuous and sometimes very closely spaced ; (b) vasicentric, forming a thin sheath round the vessels or vessel groups or clusters, distinct only under lens ; also

sometimes in short tangential lines linking vessels laterally at irregular intervals. *Rays* just visible to the eye, fine to moderately broad, and somewhat widely spaced. *Gum canals* occasionally present in tangential bands containing dark contents.

Strength—It is a hard and strong timber. For strength figures see appendix I.

Seasoning—It has not so far been tested at Dehra Dun. However, Pearson and Brown give the following information :—

"The timber seasons well, better than would be expected from its somewhat coarse grain. W. C. Hart, writing from North Salem, says that it seasons well, even when converted from green logs. It is preferable to season boards cut from green logs in open stacks, placed under cover".

Natural durability—The timber is said to be durable even in outside locations.

Insect attack—It is reported to be resistant to insect attack. Reyes states that the Philippine species *A. integrifolia* (sp. gr. 0·568 air-dry) which is lighter than the Indian species, is moderately resistant to insects but not resistant to decay.

Working qualities—It does not appear to be difficult to saw and work. Pearson and Brown state that in this respect it is comparable to teak. It can be turned on a lathe and can be brought to a fair finish. The wood is suitable for carving but is not amenable to good polish. Numerous small knots are met with in some logs and when these are sound, produce attractive figure.

Supply and uses—The timber is available in limited quantities from Andhra Pradesh and Madras. Although the tree is widely planted throughout India, it is not usually felled as people hold it in high esteem. It is probably for this reason the use of the timber for constructional purposes is forbidden in religious texts like *Brhatsamhita*, *Silparatna* and *Matsya Purana*. The wood is mainly used for carving images of gods, toys and the like. It is reported to make good drums. Its other uses are for agricultural implements, carts, boards and panels. During the last war when there was great scarcity of timber, it was used for folding *charpoys*, mosquito net frames and as chopping blocks.

Material—

463 Ajmere, Rajasthan (0·72), 1053 Salem, Madras (0·83), 3910 Anantapur, Andhra Pradesh (0·80), 5788 Panch Mahals, Bombay (0·72).

4. CARAPA AUBL.

A small genus of about a dozen species distributed in the tropical regions of the world. There is some difference of opinion among botanists regarding

generic status of some of the species. The littoral species occurring in Asia, Australia and Philippines are now generally considered to belong to the genus *Xylocarpus* Koen., while the upland tropical American and tropical African species have been retained under *Carapa*. Although the woods of these two genera are very similar in structure, Kribs has pointed out certain differences as given below :—

Carapa	*Xylocarpus*
Color usually light reddish-brown.	Color usually dark red.
Pores distinct as small to large pin-holes.	Pores barely visible without lens.
Rays distinct on all sections.	Rays barely visible on the cross-section ; inconspicuous on the radial.
Ripple marks absent.	Ripple marks always distinct.

However, Kribs considers these difference to be probably due to environmental conditions. The two species described here have the characteristics of *Xylocarpus* mentioned by Kribs except that ripple marks are not always distinct in the samples examined by us. Further, Hess has reported that in *Carapa guianensis* Aubl. (crabwood) of tropical America, ripple marks also occur infrequently. Apparently, therefore, there is no clear anatomical basis for separating the woods of *Carapa* and *Xylocarpus*.

According to Brandis two species namely, *C. moluccensis* and *C. obovata* are reported to occur in the Indian region. However, these two species closely resemble each other in morphological characters. In this connection, Pearson and Brown quote the following remark by Parker on *C. moluccensis* Lam. : "This species very closely resembles *C. obovata*, and the one called by Brandis, *C. moluccensis* has a straight trunk where as *C. obovata* is crooked stemmed". Gamble also records the following interesting differences between these two trees as given by Heinig which according to him are varieties of the same species :—

"1. *moluccensis*. Reserved forest east of the Arpangassia. Grows to 60 ft. in height. Sends up blind root-suckers. Fruit, size of an orange, gives an oil.

2. *obovata*. Same localities. Grows to 40 ft. in height. Has no blind root-suckers. Fruit, size of a shaddock, used in tanning".

However, according to Bor, three species of *Xylocarpus* occur in India and Burma : (1) *X. molluccensis* (Lam.) Roem. found in Andamans (2) *X. granatum* Koen. found in the Andamans and in the coastal forests of India, Pakistan

and Burma and (3) *X. gangeticus* (Prain) C. E. Parkinson found in the Andamans only. This is reported to have pneumatophores which serve to distinguish it from *X. granatum.*

Due to the divergence of opinion regarding the number of species and their distribution in the Indian region, it is extremely difficult to give the exact distribution of timber species dealt with here. We have, therefore, followed Brandis as regards their occurrence.

The timbers of the two species dealt with here are very similar in anatomical structure and are, therefore, described together.

It is interesting to note here that trunks of *Carapa* trees along with *Heritiera* (sundri) have been found in the so-called peat bed near Calcutta which indicates that these trees flourished in the past in areas further to the north of their present day distribution. Anatomically the wood showed great similarity to the two existing species of the Sundarbans (32).

1. **C. moluccensis** Lam. [**Xylocarpus molluccensis** (Lam.) Roem]—*Passur, pussur* (Beng.), *kyana kyatnan, peng-lay-oang, pinleon* (Burm.). A small to middle-sized tree 4·5–9 m. in height and 45–90 cm. in diameter, often crooked and irregularly grown. In the Andamans, it is usually a small tree, while in Burma and the Sundarbans, it often reaches 14 m. in height and about 1 m. in girth. *Bark* thin, grey with longitudinal fissures, and peeling off in flakes. The bark is rich in tannin and contains about 24 per cent tannin. It is used for tanning leather. The bark and other parts of the tree are said to be extremely bitter.

The tree is found in the coastal forests of Sundarbans, Andaman Islands and in Burma.

Description of the wood—See page 106.

2. **C. obovata** Bl. (**Xylocarpus granatum** Koen.)—*Dhundul* (Beng.), *pinle-on, peng-lay-oang* (Burm.), *somunthiri* (Tam.), *chenugu* (Tel.). A small to moderate-sized tree, 6–12 m. in height, about 1–1·8 m. in girth. *Bark* smooth, yellowish-grey, peels off in flakes. The bark is reported to contain as much as 30% of tannin. It is good for tanning soles and heavy leather and for toughening fishing nets. It is also astringent and is used in indigenous medicine. A gum-resin also exudes from this tree which is sometimes used for medicinal purposes. The seeds yield an oil which is not of much value.

It is a tree of mangrove forests occurring in the Sundarbans, the Andaman Islands, Godavari estuary, west coast from Konkan southwards, Chittagong in East Pakistan and Burma.

Description of the wood See page 106.

Description of the wood

(*Carapa moluccensis* and *C. obovata*)

[Pl. 41, 241–242]

General properties—Sapwood and heartwood distinct. Sapwood pale grey to brownish-grey darkening on exposure ; heartwood reddish-brown to deep wine-red sometimes with purplish cast, turning darker and dull with age ; wood heavy but some samples in the wood collection are moderately heavy due to preponderance of sapwood (sp. gr. 0·62–0·81 air-dry) ; somewhat lustrous when fresh, occasionally with greasy feel ; straight to somewhat interlocked-grained, fine and even-textured, sometimes with beautiful mottled figure due to darker coloured parenchyma bands particularly in the sapwood.

Gross structure—A diffuse-porous wood. *Growth rings* delimited by concentric bands of parenchyma, often very closely spaced, 3–8 per cm. ; fairly distinct to the eye in the sapwood but usually not so in the heartwood. *Vessels* small to very small, distinct under lens, moderately numerous (9–18 per mm.^{2}), more or less evenly distributed, occasionally showing a tendency towards tangential alignment in the beginning of the growth ring, solitary or in radial multiples of 2 to 4 (mostly 2), roundish to oval in outline, and occluded in the heartwood with reddish-brown gum, occasionally also with chalky deposits ; tyloses absent ; vessel lines inconspicuous. *Parenchyma*, brownish in colour, distinct in sapwood but not so conspicuous in heartwood, occurring as thin concentric bands (apotracheal) delimiting growth rings ; also as a thin sheath round the vessels (vasicentric) just visible under hand lens, particularly in the sapwood ; diffuse parenchyma present but scanty and usually indistinct under lens. *Rays* fine to very fine, brownish in colour, distinct under lens only, not closely spaced, sometimes showing moderately conspicuous ray flecks on the radial surface. *Ripple marks* present but not always distinct ; when distinct about 30–35 per cm. *Gum canals* of traumatic type occasionally present in short or long tangential rows filled with dark coloured gummy substances.

Strength—It is a heavy and strong timber. *C. moluccensis* has been tested at the Institute and the strength figures are given in appendix I.

Seasoning—The timber is not difficult to season. It is not much liable to end splitting and surface cracking in plank form but heart shakes are likely to extend, and open out a good deal. Slow drying is essential for this wood to give the best results. *C. obovata* seasons well without any cracking, twisting or warping. Kapur and Rehman who tested some one inch thick planks of *C. moluccensis* from Burma found that while seasoning, there was considerable difference in moisture content between the surface and the interior, and for this reason they have recommended that drying of planks in 1 or 2 inches thickness should be carried out for two dry seasons or longer. Rodger states that it is a

very steady timber after seasoning, but requires care in seasoning as otherwise it is liable to warp. He further states that "it responds more satisfactorily to kiln-seasoning". However, Rehman reports that the timber requires great care in kiln-seasoning, and unless properly dried, it is liable to develop a certain amount of surface cracking and end splitting.

Natural durability—The timber is very durable. The heartwood of *C. moluccensis* from Burma which was tested at the "graveyard" at the Institute showed that it has an average life over 272 months, the minimum is 254 months while the maximum is over 301 months as some of the samples have not yet been rejected.

Insect attack—Dry wood of both the species is liable to be attacked by *Stromatium barbatum* Fabricius (Cerambycidae).

Working qualities—The timber of *C. moluccensis* works well with all machine tools and also by hand. The ordinary knife bevels are sufficient to produce a good surface, and no special adjustments are necessary in machine planing. After planing, the general colour of the timber darkens considerably and very quickly when left exposed to light. It turns and polishes very well and is quite suitable for furniture. In polishing it requires one coat of filler only. It is very steady when made up into furniture, sometimes showing an attractive colour and grain. However, *C. obovata* is reported to be rather difficult to saw and produces a somewhat rough surface. Only with difficulty it can be brought to a good finish.

Supply and uses—Limited quantities are available from the Andaman Islands, Sunderbans and West Coast of India. In Burma, the timber (mainly *C. moluccensis*) is available in fair quantity. Wherever available it is in great demand for house posts. The wood is locally used frequently for agricultural implements like felloes, spokes of wheels, etc., and also for tool handles and hand spikes. It is also suitable for door and window frames, shutters and for high class cabinet work. It is also used locally for boat building. Both *C. moluccensis* and *C. obovata* have been tested at F.R.I. for their suitability for pencil making. The former was found to be unsuitable while the latter proved satisfactory for second grade pencils. The timber is suitable for moulding for making small articles like toys, fancy articles and pen holders.

Material—

C. moluccensis – 2514 Burma (0·63), 6269 Burma (0·72), 6306 Burma (0·64), 6819 Burma (0·81).

C. obovata—2239 Andamans (0·62), 6262 Tavoy, Burma (0·75), 6609 Burma (0·74), 7557 Sundarbans, East Pakistan (0·71), 7591 Chittagong, East Pakistan (0·62).

5. CEDRELA LINN.

A large genus of medium-sized to very large trees found in Asia, Australia and tropical America. Some botanists consider the trees growing in Asia and Australia as belonging to the genus *Toona*, and retain those occurring in America in *Cedrela*. The main point of difference between these two genera is in the way the seeds are winged. The anatomical structure of the woods of these two genera does not show any fundamental difference. The inclusion of the genus *Toona* with *Cedrela* is, therefore, more in confirmity with anatomical structure. About six species are reported to occur in the Indian region of which three are described here. *C. febrifuga* C. DC. is a middle-sized tree up to 15 m. in height found in evergreen forests of North Bengal, and Lakhimpur and Sibsagar in Assam as well as in Upper Burma. *C. kingii* C. DC., is a medium-sized tree of North Bengal occurring in lower hill forests while *C. multijuga* Kurz is a tree of Lower Burma. Wood samples from these trees were not available for study.

In this connection, it may be recorded here that after the great earthquake of 1950 in Assam, among the very large number of woods drifted down the Brahmaputra and other rivers, several belonged to the genus *Cedrela*. Of these, some were found to be *C. toona* and *C. microcarpa* while others resembled very closely *C. serrata*, a species so far not recorded from that region.*

The following key will be of use in separating the three species described here :

Wood typically ring-porous. Earlywood zone conspicuous, consisting of 3–4 or more rows of large vessels ; transition from early to latewood abrupt.. *C. serrata*

Wood usually semi-ring-porous, occasionally ring-porous, or diffuse-porous. Earlywood zone not conspicuous, usually composed of one row of moderately large vessels ; transition from early to latewood gradual .. *C. microcarpa*
C. toona

1. **C. microcarpa** C. DC.—**Toon.** *Jatipoma* (Asm.), *tun, tuni* (Beng.), *tawtama* (Burm.), *khatimai-phang* (Cach.). A fairly large evergreen tree, 12–18 m. in height with clear stem of 6–9 m. and 1–2 m. in girth. *Bark* dark brown, rough, occasionally exfoliating in thin flakes, 13–18 mm. thick, aromatic and has the same characteristic smell like *C. toona*.

It is found in the hill forests of the Sikkim Himalayas at 600–1200 m., Duars and Tarai of North Bengal, and hills of Assam where it is said to be rare. It is also found in Chittagong Hill Tracts and Upper Burma.

Description of the wood—See page 111.

* S. S. Ghosh and S. K. Purkayastha. Glimpses of some timbers of North-East Frontier Agency and adjoining areas. *Proc. 47th Ind. Sc. Cong.* : Part III : Abstracts, 1960.

2. **C. serrata** Royle—**Hill Toon.** *Taungdama* (Burm.), *darl, darli, darlu, darloi* (Jauns.), *arl* (Kulu and Bashahr), *dal, dalla* (Kumaon), *drawa, drawi, duri* (Punj.). A moderate-sized to large deciduous tree up to 30 m. in height and up to 3 m. in girth depending upon locality, usually with a clear bole of about 6 m. and 1·5 m. in girth. *Bark* thick, dark grey or brown, rough with regular and fairly deep longitudinal cracks.

It occurs scattered in the Himalayas from the Indus to Nepal ascending up to 2,500 m. and is also found in Upper Burma.

Description of the wood

[Pl. **41**, 244]

General properties—Sapwood and heartwood distinct. Sapwood pinkish-white, turning greyish on exposure ; heartwood light red or reddish-brown when first exposed but darkening on exposure to a brick-red colour ; soft to moderately hard ; light to moderately heavy (sp. gr. 0·42–0·59 air-dry) ; lustrous particularly when quarter sawn ; usually straight-grained, moderately fine to somewhat coarse and uneven-textured ; wood aromatic and has a faint cedary smell when fresh. Darker streaks traceable to broad zone of large earlywood vessels filled with gum, alternating with lighter coloured latewood zones produce a pleasing figure, particularly in rotary cut veneers. Occasionally curly-grained specimens having good figure are also met with.

Gross structure —A distinctly ring-porous wood. *Growth rings* very pronounced and demarcated by a wide zone of large, earlywood vessels, 2 to 6 per cm. *Vessels* in the earlywood moderately large to large, roundish to oval, arranged in a belt of 3–4 or more rows, solitary or in radial multiples of 2, rarely 3 ; transition from early to latewood abrupt ; latewood vessels small to very small, roundish to oval, indistinct to the eye, moderately few, mostly solitary, a few also in radial multiples of 2, rarely more ; reddish-brown or dark coloured gummy deposits sometimes fill up the vessels, often distinct in the earlywood ; occasionally chalky deposits may also be present in some consignments ; vessel lines very prominent in the earlywood zone showing longitudinal stripes but inconspicuous and scanty in the latewood. *Parenchyma* not prominent, just visible under the hand lens, brownish in colour, in concentric lines delimiting growth rings and also round the vessels as a thin sheath which is usually not easily recognisable in the earlywood ; comparatively more distinct in the latewood forming thin vasicentric sheath of brownish colour. *Rays* brownish in colour, fine, just visible to the eye, rather lustrous and distinct on the radial surface. *Pith flecks* occasionally present.

Strength—The samples from Burma tested at the Institute were found to be moderately hard, moderately heavy and moderately strong. For test figures,

see appendix I. Sekhar and Negi give the following izod values for this timber :—

Izod values of Cedrela serrata from Burma

Brittleness, work absorbed in ft. lb.						Specific gravity	
Green		Air-dry		Kiln-dry			
M.C. %	Izod value	M.C. %	Izod value	M.C. %	Izod value	Green	Air-dry
40·0	7·3	14·7	5·2	11·7	4·9	0·474	0·498

Seasoning—No regular tests appear to have been carried out so far to find out its seasoning properties. It is, however, said to behave like *C. toona* but is probably less liable to split and warp.

Natural durability—It is a fairly durable timber. The "graveyard" tests carried out at this Institute with samples from Burma showed that it has an average life of 78 months, the minimum being 51 months and the maximum 101 months.

Insect attack—Dead trees or fallen logs, etc., are liable to be attacked by shot-hole borers (Platypodidae).

Working qualities—The timber is easy to convert and work, and machines well. It takes a good spirit polish. Pretty grain effects are often obtainable.

Supply and uses—The timber is available in limited quantities in hill districts of Punjab, Himachal Pradesh, Garhwal and Kumaon. It is used mainly for cheap furniture, packing cases and boxes, planking, ceiling, and locally for doors, windows and shutters. It is also suitable for musical instruments, plywood, toys and similar articles where lightness, easy working and finishing qualities, can be exploited with advantage.

Material—

25 Simla (0·54), 430 Chakrata, Uttar Pradesh (0·46), 782 Chamba, Himachal Pradesh (0·42), 920 Hazara, W. Pakistan (0·59), 4486 Dehra Dun, Uttar Pradesh (0·51), 5867 Chakrata, Uttar Pradesh (0·48).

3. **C. toona** Roxb.—**Toon.** *Henduri poma, jaipoma, jatipoma, poma* (Asm.), *tun* (Beng.), *latsai, maiyum tawtama, thitkado* (Burm.), *poma-khatmai* (Cach.), *lim, mahanim, tun, tuni* (Hind.), *kempugandapheri, manderrike, tundu* (Kan.), *diengbit, dieng sali, dieng saw, dieng tylleng* (Kh.), *katangai* (Kol.), *antei, hudu* (Kuki), *simal* (Lep.), *madagiri vembu, malar-veppu, mathagiri vembu, sandani vembu, vedi vembu* (Mal.), *tairel, taireny* (Manip.), *devdari, huruk, kuruk, mahanim, todu* (Mar.), *gorianim* (Melghat), *harbi-behrang, poma-*

arong (Mik.), *bobich, tuni* (Nep.), *mahalimbu* (Or.), *drawi, khusing* (Punj.), *tuni* (Sans.), *surja poma, suruj-bed* (Sylh.), *kuma* (Synt.), *santhana vembu, thevatharam, tunumarani* (Tam.), *nandichettu* (Tel.), *intei, kujya* (Tipp.). A large deciduous tree commonly attaining a height of 21–30 m. with clear bole of 9–12 m. and 2–3 m. in girth. *Bark* thick, grey or greyish-brown, smooth up to middle age but rough when old, exfoliating in irregular flakes, and aromatic. The bark is highly astringent and is used in indigenous medicine as a tonic and in chronic infantile dysentery and also for external application for ulcers. The flowers yield a red dye similar to *Nyctanthes arbortristis* Linn.

A very widely distributed tree occurring in the tract from the Indus eastwards from West Pakistan to Assam and Burma, ascending up to 1500 m. ; also in the evergreen forests of Western Ghats and other hills of South India. It is extensively cultivated as an avenue tree and also in gardens and plantations. Several varieties of this tree are recognised and one of them, *var. australis* C. DC. occurs in Australia.

Description of the wood—See below.

Description of the wood

(*Cedrela microcarpa* and *C. toona*)

[Pl. **41**, 243, 245, 246]

General properties—Sapwood pinkish to pale brown or yellowish-grey. Heartwood usually pinkish to brick-red when fresh or sometimes light brown with yellow or orange cast, often turning darker with age ; usually soft and light, but some specimens may also be moderately hard and moderately heavy (sp. gr. 0·37–0·61 air-dry) ; often lustrous, and usually straight-grained but samples with narrowly interlocked-grain are also sometimes met with ; moderately fine and slightly uneven textured, usually with pleasing figure due to growth rings and ray-flecks, if properly cut ; wood with a characteristic and pleasant cedary odour.

Gross structure—Usually semi-ring-porous, occasionally ring-porous or diffuse-porous. *Growth rings* distinct, not always conspicuous, usually delimited by concentric lines of initial parenchyma as well as by larger vessels arranged on the face of the growth marks, less than one to 5 rings per cm. *Vessels* of the earlywood often moderately large and arranged in a single row tangentially, but not crowded, visible to the eye, solitary or in radial pairs, round to oval, sometimes plugged with dark brown gummy substance ; transition from early to latewood gradual ; latewood vessels small, hardly visible to the eye, moderately few, majority solitary but some also in short radial multiples of 2–3, round to oval, occasionally filled with gummy substances ; vessel lines often distinct in the earlywood. *Parenchyma* inconspicuous, visible only under hand lens, brownish in colour delimiting growth rings and forming thin sheaths

(vasicentric) round the vessel multiples. *Rays* inconspicuous to visible to the eye, reddish-brown in colour, fine to moderately broad, rather widely spaced ; ray-flecks low but fairly conspicuous. *Gum canals* of traumatic origin occasionally present in long or short concentric rows with reddish-brown or blackish gummy deposits. *Pith flecks* sometimes present.

In this connection, it may be of interest to note that Chowdhury(16) while studying the formation of growth rings in *C. toona* found that the growth rings are delimited by the initial parenchyma cells as well as larger vessels resulting in the growth rings being distinct. Occasionally, however, fine bands of concentric parenchyma cells are formed in the middle of the growth rings which have no relation with the commencement or cessation of growth. These false marks are easily distinguishable from true ones as the vessels on either side of these lines are more or less of the same size. Dadswell and Ellis who have studied the Australian variety of *C. toona* have found that the only difference between the Australian and Indian timbers lies in the more definite ring-porosity and in the presence of fine septa in the fibres of the Australian variety.

Strength—The timber from Dehra Dun has been tested at the Institute. It has moderate strength properties. Strength figures are given in appendix I. *C. microcarpa* is very similar to *C. toona* in anatomical structure and is expected to behave more or less in the same way. Sekhar and Negi give the following izod values for *C. toona* from Dehra Dun.

Izod values of Cedrela toona

Brittleness, work absorbed in ft. lb.						Specific gravity	
Green		Air-dry		Kiln-dry			
M.C. %	Izod value	M.C. %	Izod value	M.C. %	Izod value	Green	Air-dry
112·2	6·5	15·0	4·7	14·4	3·9	0·424	0·435

Seasoning—Considerable information is available for *C. toona*. Girdling experiments carried out with this tree indicate that there is no difference between timbers from girdled and ungirdled trees as regards shrinkage and hygroscopicity. Kapur states that if ends of logs are protected against rapid drying, end splitting can be greatly minimised. He further recommends that the bark should preferably be left on the logs. Green conversion has also been recommended but conversion during rains is not desirable. Planks up to 2 inch thickness and squares up to 3 in. × 3 in. take about a year to air-season.

The chief defects of this timber which are usually noticeable during seasoning are warping, twisting, collapse, and some end splitting. However, it is possible to overcome warping and twisting to some extent by giving sufficient

care to the stacking of the timber, but, in interlocked-grained planks this cannot be avoided. In the case of collapse, the defects can be remedied after the timber is dry by subjecting it to steaming treatment at about 100°C. for 2 to 6 hours, depending upon the thickness of the material and the extent of collapse. In kiln-seasoning, the timber does not offer any difficulty except that the timber forms moisture pockets and is liable to severe case-hardening. Radial planks usually develop collapse. The timber, however, darkens to some extent in kiln-seasoning. Pearson reports that *toon* contracts while seasoning more than other timbers. Even when the timber is properly seasoned, *toon* is susceptible to expansion and contraction with the variations of humidity. Rehman who has made a survey of the seasonal variation of moisture content of some Indian woods also found that *toon* responds to the changes of atmospheric humidity very quickly.

Natural durability—The timber is durable in inside locations. In exposed positions, however, it is not durable. The "graveyard" tests carried out at this Institute with samples of *C. toona* from Burma showed that the heartwood has an average life of 31 months, minimum being 21 months and maximum 38 months.

Insect and fungus attack—Sapwood of *toon* is highly susceptible to borer attack. It is attacked by some Bostrychidae and Lyctidae (*ghoon* borers), Cerambycidae and Curculionidae borers. Shot-hole borers (Platypodidae and Scolytidae) attack newly felled or fallen logs and dead trees. It is reported that logs with bark on are quickly attacked by white ants and borers. *Toon* trees are readily attacked by *Fomes senex* which causes a heart rot in living trees. This fungus is a wound parasite and in avenues where *toon* is commonly planted, the trees are often subject to many injuries through which the fungus may enter the tree. The affected trees are not killed, as the heartwood only is attacked, but they become often hollow. It is also reported that if the logs are stored in the open for long the timber is liable to rot. Kapur records that the experience of Margherita factory on *toon* plywood is that it is liable to develop stain when exposed to damp.

Preservative treatment—Heartwood is rather difficult to treat and the penetration of preservatives is erratic. The sapwood is, however, readily treated.

Working qualities—It is a very easy timber to saw and work both by hand and on machines. It can be finished to a fairly smooth surface and takes a good polish if properly filled. Very fast grown samples may, however, become woolly and give trouble in planing and finishing due to the gelatinous or extreme thin-walled nature of the fibres. Similarly, interlocked-grained logs, which are occasionally met with, give trouble in conversion and planing. It is

excellent for peeling, and when green can be peeled without any soaking or pretreatment. The logs which have become fairly dry in storage, however, require boiling treatment for successful peeling. The veneers season well and are amenable to gluing and make up into handsome plywood. Rotary peeled veneers and radially sawn planks of *toon* usually have pleasant figure which can be profitably utilized for panelling purposes. Logs showing "fiddle-back", "roe" and "mottled" figure are also sometimes met with. Bending properties of *toon* have been studied by Rehman and co-workers. They have found it to be not a promising timber for this purpose. It has, however, been recommended for cheap type of bent wood furniture. Gray who has tested the acidity of *C. toona* found that it has a pH value of 5·1. As pH 4·5 has been considered the danger level below which accelerated corrosion is likely to occur, *C. toona* is not likely to corrode iron to any great extent. He has further found out that with 1 per cent solution of Ferric chloride, *toon* gives "medium stain". It is a very suitable timber for compression, lamination and compregnation. Recent studies by Narayanamurti have shown that lightly compregnated wood samples of *Cedrela toona* possess excellent wearing qualities and they do not split easily. Shuttles made from these modified woods compared favourably with cornel wood shuttles. Further, special type of very tough modified wood (staypak) prepared by him following Stamm's method gave the following strength figures (veneer thickness, $\frac{1}{8}$ in.).

Sp. Gr.	Tensile strength lb./sq. in.	Modulus of rupture lb./sq. in.	Compression Strength lb./sq. in.	R.I. Impact ft. lb.
1·44	25,663	25,834	17,821	17·4

Narayanamurti and Harcharan Singh have also made fibre boards on laboratory scale from *C. toona* and have tested their properties including thermal conductivity of the boards. Further, they have also given the chemical analysis of the wood(60).

Supply and uses—*Toon* is available in large quantities from Uttar Pradesh and in fair quantities from North Bengal and Assam and also from west coast. It may also be available in small quantities from other areas mainly from roadside trees and cultivated lands.

C. microcarpa is obtainable only in limited quantities from the Darjeeling Division of West Bengal and hills of Assam.

It is a cheap wood for furniture particularly for linings and backings and drawers, ceiling, floor boards, doors, panels, partition walls, frames, windows, and bent rims. It is also employed for making cigar-boxes, toys, musical instruments and carvings. During the last war, the timber was extensively used

for a variety of purposes, such as, almirah, tables, camp chair, collapsible cupboard, meat safe, various types of boxes, packing cases for acids and other articles, tool chests, skids and shore landing bridge. It is an important raw material for commercial plywood. Laminated *toon* wood has been recommended for a variety of purposes both in straight and bent shapes. It is also worth trying for rifle half wroughts. Compregnated *toon* wood has been found suitable for shuttles and laminated wood for picking sticks(59) used in textile industry in place of imported cornel wood (*Cornus* spp.), persimmon (*Diospyros virginiana* L.) and hickory (*Carya* spp.). Compregnated wood of this species has also been found suitable for bearings of dichromate padding machines, shuttle race boards, shuttle pins, bobbin ends, propellors, gears, mallet heads, pulleys and tool jigs(4). Both *C. toona* and *C. microcarpa* are good for cheap grade pencils.

Material—

C. microcarpa – 655 Darjeeling Terai, West Bengal (0·48), 3623 Darjeeling, West Bengal (0·49), 7252 Kalimpong Divn., West Bengal (0·48), 7332 Pankhaheri Range, West Bengal (0·46) 7562 Buxa Divn., West Bengal (0·54), 7569 Jalpaiguri, West Bengal (0·46).

C. toona – 8 Simla, Himachal Pradesh (0·55), 177 Madhya Pradesh (0·59), 727 Burma (0·54), 712 Chittagong, East Bengal (0·60), 763 South Kanara, Mysore (0·42), 803 Burma (0·56), 1054 Salem, Madras (0·57), 1191 Punjab (0·52), 1229 Sibsagar, Assam (0·46), 1266 Tezpur, Assam (0·42), 3476 Saranda Forest, Chota Nagpur (0·48), 4437 Uttar Pradesh (0·61), 6291 Burma (0·57), 6323 Kurseong, West Bengal (0·46), 6567 Burma (0·50), 7103 Burma (0·45), 7253 Kurseong, West Bengal (0·47), 7267 Kurseong, West Bengal (0·53), 7325 Jalpaiguri, West Bengal (0·55), 7543 Lakhimpur, Assam (0·37), 7563 Buxa Division, West Bengal (0·42), 7621 North Kanara, Mysore (0·49).

6. CHISOCHETON BL.

A fairly large genus of trees and shrubs distributed in the Indo-Malayan region. About four species occur in the eastern part of India and Burma of which three are described here. The trees can be easily spotted in the forest due to the large pear-shaped peach coloured fruits in long dangling clusters.

1. **C. divergens** Bl.—A tree occurring in Burma.

Description of the wood—See page 116.

2. **C. grandiflorus** Kurz—An evergreen tree 12–15 m. in height with a clear bole of 5·5–9 m. and about 1 m. in girth. *Bark* thin, rough and corky.

It is found in Martaban, Tenasserim and probably in the Andaman Islands.

Description of the wood—See below.

3. **C. paniculatus** Hiern.—*Bandordima* (Asm.), *aukchinsa, tagat-pyn* (Burm.), *rata, thaikhuokisin-bapang* (Cach.), *masru-siphel, makkhaibo* (Garo), *dieng-mar-iony, dieng-soh-khyllam-blang, dieng-soh-monashrieh, dieng-soh-run-blang* (Kh.), *khrankerarong, theng-kippi* (Mik.), *bandra, bandriphal* (Nep.), *ratapangpa* (Tipp.). A small evergreen tree scarcely exceeding 12 m. in height and 75 cm. in girth. *Bark* dark brown, plain but warty and exfoliating in round flakes.

It is found in the evergreen forests of the Duars and Terai in the lower hill forests of North Bengal throughout Assam ascending up to 900 m. elevation, and in Tripura, East Pakistan and Burma.

Description of the wood

(*Chisocheton divergens, C. grandiflorus* and *C. paniculatus*)

[Pl. **42**, 247, 248]

General properties—Sapwood and heartwood indistinguishable in the specimens examined ; wood creamy yellow when fresh, turning greyish-brown on ageing, but very often discoloured due to fungus attack ; wood moderately hard ; moderately heavy to heavy (sp. gr. 0·63–0·87 air-dry) ; fairly lustrous when fresh ; straight to somewhat interlocked-grained ; rather coarse and uneven-textured due to parenchyma bands. The timber exhibits "partridge mottling" on the flatsawn surface due to abundance of parenchyma bands.

Gross structure—A diffuse-porous wood. *Growth rings* not very distinct, delimited by a zone of fibrous tissue and also by long narrow bands of parenchyma. *Vessels* usually moderately large and visible to the eye but small to very small and indistinct to the eye in *C. grandiflorus*, moderately few (4–9 per mm.^{2}), rather evenly distributed, solitary or in radial multiples of 2–3 but sometimes up to 5 in *C. paniculatus*, mostly oval in outline, usually open, occasionally filled with whitish or yellowish-brown deposits ; vessel lines inconspicuous except in *C. divergens*. *Parenchyma* abundant, lighter in colour than the background, distinct to the naked eye in fairly thick, long, wavy tangential bands alternating with slightly wider bands of fibres, sometimes partially embedding or touching the vessels ; also in similar but short, undulating or occasionally anastomosing bands sometimes ending abruptly. *Rays* rather fine and rarely visible to the eye, fairly closely spaced ; radial flecks present on the radial surface but not conspicuous. *Pith flecks* observed in *C. divergens*.

It is a moderately hard and moderately heavy timber. The timber does not appear to be good from the point of view of seasoning as the samples in the Institute's wood collection show long and deep cracks. It is susceptible to

fungal decay and stain which often spoil the appearance of the timber. Malayan and Philippine species of this genus are also reported to be easily perishable. The samples examined, however, do not show any damage due to insect attack. Amos reports the presence of silica deposits in the rays and parenchyma cells in some species of *Chisocheton* and as such these timbers may give trouble in sawing.

Supply and uses—The supply of this timber is limited. Only small quantities are available from Assam and North Bengal. The timber is not used at present except locally for house posts. It may be suitable for temporary construction and also small articles where its good figure can be utilized.

Material—

C. divergens – 6779 Burma (0·63).

C. grandiflorus – 6148 Mergui, Burma (0·87), 6240 Tavoy, Burma (0·71).

C. paniculatus – 6672 Burma (0·65).

7. CHUKRASIA A. JUSS.

A very small genus of one or two species of large trees occurring in India and South East Asia. Some botanists consider it to be a monotypic genus while others recognise two species. Samples in the F.R.I. wood collection consist of *C. tabularis* A. Juss. from India and Burma and *C. velutina* Roem. from Burma and are, therefore, described as such. The Forest Botanist, however, is of the opinion that *C. tabularis* A. Juss. occurs all over South-East Asia while *C. velutina* W. and A. Syn. *C. tabularis* A. Juss. Var. *velutina* King is found only in India. Anatomically the two species described here are very similar and indistinguishable. The timbers of both are, therefore, described together. Rodger, however, states that *C. velutina* trees are rather small and the wood is harder and not so decorative as that of *C. tabularis*.

1. C. tabularis A. Juss.—**Chickrassy.** *Boga poma, chokoripoma, lahripoma* (Asm.), *chikrassi, pabba* (Beng.), *taw-yeng-ma, tawyinma, vinma, yeng-ma, vinma bin* (Burm.), *bol-dorch, chuma* (Garo), *dalmara, paruli, uruli* (Kan.), *tumsung-kung* (Lep.), *saiphra, akil malaveppu, mallei vapu* (Mal.), *lal devdari, pabba* (Mar.), *chany-hedini, herbi-beh, haribe* (Mik.), *hallurch-tuni, katli, ratatuni* (Nep.), *agil, aglay, agal, eleutharay, malei vembu, madagiri vembu, vedi vembu* (Tam.), *chittangukara, errapogada, madagari vembu* (Tel.), *thing-poi* (Tipp.). A large handsome tree with long, straight, clean trunk and large spreading crown, usually growing up to a height of about 24 m. and girth of about 2·5 m. Kanjilal *et al* mention the record of a tree from North-East Frontier Agency about 48 m. high and 8·5 m. in girth. *Bark* dark, greyish-brown or rusty brown with deep fissures and fairly conspicuous lenticels, thick. The

bark is astringent but not bitter and contains 15% tannin. Young leaves contain about 20% tannin. The flower is reported to yield a red or yellow dye. The tree yields a gum which is reddish or amber coloured and is soluble in water.

Though scattered the tree is common in Assam, the Terai, Duars and lower hill forests of North Bengal, hills of Deccan up to 1400 m., Western Ghats from Kanara to Tinnevelly, the Andaman Islands, Chittagong in East Pakistan and Burma.

Description of the wood—See below.

2. C. velutina Roem.—*Yang-ma, yinma* (Burm.). A tree. Rodger states that it is readily distinguished from the former by the velvety under-surface of its leaves and that the tree is rather small.

It grows in the dry and mixed forests of Burma.

Description of the wood—See below.

Description of the wood

(*Chukrasia tabularis* and *C. velutina*)

[Pl. **42**, 249 to 251]

General properties—Heartwood and sapwood not always very clearly demarcated due to the gradual grading of the sapwood into the heartwood. Sapwood greyish or yellowish-white, occasionally with pinkish tinge, turning darker on exposure, 25–76 mm. wide. Heartwood rather variable in colour, usually pale buff or brownish-yellow when freshly exposed ageing to dark brown or golden brown ; sometimes also light brown to brownish-red with a yellowish to greenish cast. Some samples in the wood collection are also dark grey with pinkish tinge ; highly lustrous with a beautiful satiny sheen. Wood moderately hard to hard, moderately heavy to heavy (sp. gr. 0·54–0·84) ; often straight-grained, sometimes irregularly interlocked ; rather even and fine-textured. An attractive wood showing handsome markings due to the dark colour of the growth rings, often with "fiddle-back", "roe and mottle", "splash mottle" and other types of figure in interlocked-grained samples.

Gross structure—A diffuse-porous wood. *Growth rings* usually distinct to the eye, about 2–4 per cm. delimited by concentric lines of parenchyma and also sometimes by dense and dark coloured fibrous tissue ; when both these are present, the growth rings are prominent ; occasionally, some parenchyma lines are too closely spaced to be considered annual. *Vessels* small, hardly visible to the eye, moderately few to moderately numerous (4–16 per mm^2), normally evenly distributed, but occasionally with a row of tangentially aligned vessels on the face of the growth ring giving the impression of semi-ring-porous structure, solitary or in radial multiples of 2–3 (usually 2), round to oval

in shape, often plugged with yellowish to orange deposits ; vessel lines rather numerous but not conspicuous. *Parenchyma* not abundant, brown to reddish-brown in colour, visible to the eye as concentric lines delimiting the growth rings ; also form a thin sheath round the vessels, hardly distinct under the lens due to more or less similar colour of the surrounding tissue. *Rays* fine to very fine, scarcely visible to the eye, light reddish-brown in colour, usually better seen in sapwood, fairly closely spaced ; fine ray-flecks noticeable on the quarter sawn surface. Gum canals vertical and of traumatic type occasionally present in tangential rows.

Strength—The timber is rather hard, and moderately strong. *C. tabularis* from Buxa, West Bengal, has been tested at the Institute and the strength figures are given in appendix I. Sekhar and Negi have also determined the izod values of this timber from samples obtained from the same locality as given below :

Brittleness, work absorbed in ft. lb.						Specific gravity	
Green		Air-dry		Kiln-dry			
M.C. %	Izod value	M.C. %	Izod value	M.C. %	Izod value	Green	Air-dry
47·3	8·0	12·7	9·4	12·4	7·4	0·568	0·595

Seasoning—The timber does not present much difficulty in seasoning. It is a moderately refractory timber which should be converted green and the sawn material stacked on battens under cover. Usually no degrade of any kind is noticeable except slight development of original heartshakes and end cracks. Pearson and Brown state that the wood develops very fine hair-like surface cracks, which are noticeable on the polished surface of timber not properly seasoned before being worked up. But Trotter states that this defect is noticeable in veneer form and not in solid wood. However, some of the specimens in the timber collection show very fine surface cracks but are otherwise in excellent condition. It is a steady wood which does not expand or contract due to changes in humidity. Kiln-seasoning is not difficult. According to Rodger, there is a possibility of collapse if the drying conditions are too severe at the beginning of treatment.

Natural durability—The timber is durable under cover but not in contact with the ground. The "graveyard" tests carried out with specimens received from Assam showed that the heartwood has an untreated average life of 57 months, the minimum being 52 months and the maximum 65 months.

Insect and fungus attack—Deadwood is liable to be attacked by the borer species of Anthribidae, Brenthidae and Buprestidae. *Fomes senex* causing a heart-rot of living trees has been recorded on over mature trees. *Fomes*

lividus a very common decay fungus causing a white fibrous rot also attacks the logs. Samples in the wood collection are free from insect or fungus damage.

Preservative treatment—The heartwood of *C. tabularis* is only partially treatable.

Working qualities—The timber is easy to saw and work and can be brought to a fine finish either by hand or machine. It is an excellent wood for conversion into veneers by rotary method as the logs are usually available in suitable girths with sufficiently hard cores. Interlocked-grained logs may, however, offer difficulty in sawing and finishing. It can be peeled green without any pre-treatment but bolts stored for sometime after felling should be given a soaking treatment in hot water before peeling. It can also be turned and carved well. If properly cut, the timber often shows handsome figure somewhat like mahogany. Some logs produce extremely beautiful veneers and boards which are highly prized. It takes a very high polish but it is preferable to polish it after allowing the natural colour to ripen to a suitable shade.

Supply and uses—Due to the scattered distribution of the trees, the supply of timber is no where abundant. Limited quantities are available from Assam, North Bengal and west coast, particularly Mysore. Good-sized logs are usually available from Kurseong and Buxa divisions of West Bengal and also in Assam and N.E.F.A.

Locally, the timber is used for constructional purposes, particularly for planking, beams, and house posts. In Chittagong it is reported to be used for dug-outs and canoes. It is an excellent timber for high class furniture and cabinet-making. Figured wood is particularly suitable for decorative work and panelling. Trotter reports that Burma logs have better percentage of figured stock than those from Bengal and Assam. It is also suitable for high class plywood, turnery articles, bobbins, pen holders and toys. During the last war the timber was used for camp bed-steads, invalid chairs, collapsible shelves, oars, assault bridge decking, pulleys and flag poles.

Material—

C. tabularis – 1260 Tezpur, Assam (0·54), 1401 Chittagong, E. Pakistan (0·70), 2197 Nowgong, Assam (0·68), 2516 Burma (0·79), 5577 Burma (0·71), 5842 Kurseong, Bengal (0·64), 6850 Burma (0·73), 7316 Cachar, Assam (0·75), 7321 Kalimpong, West Bengal (0·67), 7345 Jalpaiguri, West Bengal (0·67), 7376 Sadiya, Assam (0·65), 7421 South Mangalore, Mysore (0·76), 7507 Sibsagar, Assam (0·67), 7515 Lakhimpur, Assam (0·80), 7531 Kurseong, West Bengal (0·63), 7564 Buxa, West Bengal

(0·74), 7845 Tirunalveli, Madras (0·84), 7846 Tirunalveli, Madras (0·83), 7847 Tirunalveli, Madras (0·79).

C. velutina – 6669 Burma (0·76), 7101 Burma (0·80).

Gamble's specimens Nos. 764 from South Kanara and No. 1218 from North Kanara, Mysore, are not *Chukrasia tabularis* but *Dysoxylum malabaricum.*

8. CIPADESSA BL.

A very small genus of shrubs or small trees confined mostly to the Indo-Malayan region. The only species which occurs in India is described here.

C. fruticosa Bl.—[C. baccifera (Roth) Miq.]—*Nal-bila* (Hind.), *adusoge, sidugoli* (Kan.), *gud mei* (Mar.), *ranabili* (Or.), *chedubira, chandbera, purudona* (Tel.). A bushy shrub, but sometimes a small tree up to 6 m. in height and 15 cm. in diameter. *Bark* reddish-brown, rather smooth and thin.

It occurs in the dry forests of the central and western parts of India, Chota Nagpur, Orissa, Upper Burma, Ceylon, Java and the Philippines. It is common and grows gregariously on laterite hills, dry forests and near villages in Andhra Pradesh.

Description of the wood

[Pl. **42**, 252]

General properties—Sapwood and heartwood not well demarcated. Sapwood pale yellow or straw coloured, turning brownish-yellow; heartwood brown to reddish-brown with pinkish tinge moderately hard, moderately heavy (sp. gr. 0·68-0·73 air-dry), somewhat lustrous, straight to somewhat interlocked-grained, rather fine and even-textured, with a faint sweet smell sometimes resembling that of *toon* wood.

Gross structure—A diffuse-porous wood, sometimes with a tendency for semi-ring-porous structure. *Growth rings* distinct, delimited by thin, concentric lines of parenchyma and sometimes also by the darker colour of latewood fibres, 2–3, sometimes up to 5 per cm. *Vessels* small to very small, hardly visible to the eye, moderately numerous to numerous (12–38 per mm.^{2}), rather unevenly distributed, being relatively more numerous and with a tendency to tangential alignment in the earlywood, particularly on the face of the growth rings, usually in radial multiples or chains of 2 to 5, occasionally solitary, mostly oval and open rarely filled with chalky deposits ; vessel lines fine and inconspicuous. *Parenchyma* rather scanty, in thin lines demarcating the growth rings, visible to the eye ; also round the vessels forming thin sheaths, visible only under lens with difficulty. *Rays* fine to very fine, indistinct to the eye, and very closely spaced. Ray-flecks present but low and not conspicuous.

The wood is moderately hard, strong, and fine-textured and may, therefore, be suitable for small turnery articles and for carving. The samples in the wood collection although free from damage by insects and fungus, have rather deep cracks. The timber is used at present for fuel only.

Material—

3831 Ganjam, Orissa (0·73), 6717 Ganjam, Orissa (0·68).

9. DYSOXYLUM Bl.

A large genus of trees comprising well over a hundred species, the majority of which are distributed in the Indo-Malayan region. The genus, however, is spread over a wide area being also represented in Australia, New Zealand and Polynesia. About a dozen species occur in India, chiefly in Bengal, Assam, South India and the Andamans of which, specimens of only five were available for study and are dealt with here. The remaining species are :—*D. beddomei* Heirn.—*adanthai, chinnagil* (Tam.) a tree about 21 m. in height and 75 cm. in diameter occurring in evergreen forests of Travancore up to 1,000 m. ; *D. pallens* Hiern.—*bandordima* (Asm.), *nakkhaibo* (Garo) and *D. reticulatum* King—*bandordima* (Asm.), small to medium-sized trees of North Bengal and Assam ; *D. grande* Hiern.—*boga-banderdima* (Asm.), *tagatni* (Burm.), a middle-sized tree of Assam, East Pakistan and Burma ; *D. oliveri* Brandis is a large tree of Ruby Mines, Burma ; and *D. andamanica* King, *D. arborescens* Miq. and *D. thyrsoideum* Griff. small to medium-sized trees confined to Andaman Islands. Among these, Gamble has described the wood of *D. grande* based on the sample No. 4880 from Sylhet, but this sample is not correctly named and belongs to the genus *Dipterocarpus*.

The heartwood of several species both indigenous and foreign is scented. Among the Australian species, *D. fraseranum* Benth. is reported to have distinct rose-like fragrance which is usually persistent, while *D. muelleri* Benth. and *D. rufum* Benth. are "odourless or with a faint rather unpleasant odour when cut green "(22). *D. loureiri* Pierre of Indo-China is reported to have a smell akin to that of sandalwood and is burnt in temples. Reyes mentions that the Philippine timbers are as a rule scented. Desch, however, states that though the woods are fragrant in some species, others have a disagreeable smell like that of garlic, when freshy cut. *D. alliacium* Blume of Java is reported to smell somewhat like onions.

All the five Indian timbers examined are sweetly scented except *D. hamiltonii.*

Except for certain samples of *Dysoxylum malabaricum*, the anatomical structure as well as the general features of different species dealt with here are

more or less similar. Typical *D. malabaricum* is easily distinguished from other species due to the presence of distinct concentric lines of parenchyma delimiting growth rings, and the absence of wavy bands of parenchyma. The straw yellow or yellowish-brown colour of *D. malabaricum* also makes it conspicuous from others. It is interesting to note here that some specimens of *D. malabaricum* are reddish-brown in colour and also have abundant wavy parenchyma bands similar to those found in other species. Another point which may be mentioned here is that the frequency of vessels per unit area is comparatively more in both these types than the other species. *D. hamiltonii* can be distinguished from the other species owing to its lighter weight, larger and fewer vessels, widely spaced bands of parenchyma and lack of odour.

1. **D. binectariferum** HK. f.—*Bandardima* (Asm.), *kaledizho* (Lep.), *bon-dau-iung, rata* (Cach.), *bol-narang, kering-phong, masispel* (Garo), *agil* (Kan.), *kakso-kachal* (Kuki), *dingari, dingari-guphut, dingi-bomphang* (Mech.), *kharang-kelok-arong* (Mik.), *galingasing* (Miri), *kaksok* (Tipp.). An evergreen tree up to 15 m. in height and about 1 m. in girth. *Bark* grey with thin vertical fissures and horizontal wrinkles, often peeling off in papery flakes. The mature bark has a tannin content of about 15 per cent.

It is fairly common throughout Assam up to 900 m. and in the Duars, Terai and lower hill forests of North Bengal, in mixed forests and in association with sal ; also in the Western Ghats from Coorg to Anamalais and Tinnevelly but probably does not occur in Travancore. It also occurs in Chittagong, East Pakistan and Upper Burma.

Description of the wood—See page 128.

2. **D. hamiltonii** Hiern.—*Situk-payu* (Abor.), *gendheli-poma, keotai* (Asm.), *mauhidal* (Cach.), *bolasin* (Garo), *dieng-kyrbei* (Kh.), *inthei, thinsaphu* (Kuki), *siposhi kung* (Lep.), *katli-tun, lahsune chhalegach* (Nep.). A large evergreen tree 21–30 m. in height with a clear bole of 7·5–12 m. and 2–4 m. in girth. *Bark* dark brown. Both bark and flowers smell strongly of garlic which makes the tree easy to spot in the forests. It is said that this smell is usually stronger in young trees, but in older ones the cambial layer may have to be cut to get the smell. Bark is reported to be used for poulticing sores and also internally for stomach troubles.

It occurs in Assam up to an altitude of 750 m. and is also found in the Duars, Terai and lower hill forests of North Bengal up to 900 m. elevation in association with sal and in wet mixed forests.

Description of the wood

[Pl. **43**, 254]

General properties—Sapwood and heartwood not clearly differentiated. Sapwood pale brown, rather wide, about 6 cm. thick ; heartwood pinkish when

fresh, turning to light reddish-brown to red on ageing ; fairly lustrous and without any characteristic odour ; wood soft to moderately hard ; light to moderately heavy (sp. gr. 0·48–0·65 air-dry) ; straight to somewhat interlocked-grained ; usually medium-coarse-textured, sometimes finer in texture ; "ribbon" or striped figure due to interlocked-grain occasionally found on the longitudinal surfaces.

Gross structure—A diffuse-porous wood. *Growth rings* usually indistinct ; however, narrow dark bands of thicker-walled fibres visible on the end surface of the logs, give the impression of growth rings but these are probably not annual rings. *Vessels* moderately large to large, distinct to the eye, few to moderately few (2–6 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–3 ; often oval in shape and sometimes filled with brown gum-like deposits ; vessel lines distinct appearing as short or long darkish streaks. *Parenchyma*, (a) distinct to just visible to the eye, in rather widely spaced short or long narrow wavy lines either connecting or touching neighbouring vessels tangentially or by passing some of them and finally joining other distantly situated vessels or ending abruptly, sometimes also aliform with short lateral projections ; and (b) vasicentric rather inconspicuous as a thin sheath round the vessels. *Rays* fine, indistinct to just visible to the eye, somewhat widely spaced ; ray flecks narrow but lustrous and conspicuous.

The timber appears to be moderately strong but has not yet been tested at the Institute for strength. It is not refractory to seasoning and the samples in the wood collection also do not show any seasoning defects. According to the report of the Forest Entomologist, dry wood, beams and rafters are damaged by *Xylocarpa latipes* Drury (Xylocarpoidae) but the samples available for examination did not show any damage by insect or fungus. The timber is said to be very durable(45).

Supply and uses—The wood is said to be used in Assam for boats, canoes and house-building. It has got a pleasing appearance and should be suitable for light furniture, cabinet making, planking, panelling, plywood, boxes and for general utility purposes. The timber is available in limited quantities from Assam.

Material—

7244 Lakhimpur, Assam (0·59), 7377 Sadiya, Assam (0·48), 7536 Sibsagar, Assam (0·59), 7571 Lakhimpur, Assam (0·65).

Both the samples, viz., E 1259 and E 2189 described by Gamble as *D. hamiltonii* are not correctly named. E 1259 is *Chukrasia tabularis* while E 2189 belongs to the family *Lauraceae*.

3. **D. malabaricum** Bedd.—**White cedar.** *Bili-devdari* (Kan.), *vellagil* (Mal.). A large tree up to 36 m. in height and 1·5 m. in diameter. *Bark* grey with white warts.

It is found in the evergreen forests of Western Ghats from North Kanara southwards ascending to 900 m.

Description of the wood

[Pl. **43**, 255–257]

General properties—Sapwood and heartwood not very sharply demarcated. Sapwood usually narrow whitish or pale grey with yellow cast, sometimes discoloured by sap stain and turning darker on exposure. Heartwood usually straw-yellow when fresh, turning golden yellow or yellow-brown on ageing ; wood lustrous with faint, sour, cedary odour which persists for long. However, samples in the wood collection marked *D. glandulosum* which is considered a synonym of *D. malabaricum* do not emit any such pleasant odour. Howard, based on the study of consignments of this timber imported into England has also recorded similar experience. Wood moderately hard, moderately heavy (sp. gr. 0·66–0·77 air-dry), straight to somewhat interlocked-grained, even and fine-textured with a greasy or oily feel. A pleasing striped figure due to parenchyma bands and also sometimes due to interlocking of the grain is noticeable on the longitudinal surfaces.

Gross structure—A diffuse-porous wood. *Growth rings* distinct, delimited by fairly thick, whitish, concentric lines of parenchyma (initial) 3–12 per cm. ; false growth marks are often met with. *Vessels* small, just visible to the eye but usually more distinct in the heartwood due to the deposits in them ; moderately numerous (9–22 per mm.^{2}), more or less evenly distributed, solitary or in radial multiples of 2–3 ; the latter may vary in proportion from sample to sample ; often appearing larger and more prominent under the hand lens, and when comparatively more numerous giving the impression of a distinct radial pattern ; round to oval in shape and often plugged with pale yellow or brownish-yellow deposits ; vessel lines fine but sometimes very conspicuous in seasoned timber, due to darkish gummy or oily deposits which may extend along the vessel lines as dark streaks, occasionally also staining the adjoining tissues. *Parenchyma*, (a) whitish and distinct to the eye as fairly thick concentric lines delimiting the growth rings ; frequently also in short tangential lines at very irregular distances ; (b) vasicentric, forming a very thin sheath round the vessels or vessel multiples, visible only under lens. *Rays* fine, barely visible to unaided eye, almost of the same colour as the back-ground, fairly closely spaced ; ray-flecks inconspicuous.

Two samples No. 4534 and 5849 (Plate **43**, fig. 257) from Travancore and from South Coimbatore, Madras, are different in certain respects from the description given above. These are reddish-brown in colour, harder and heavier (sp. gr. 0·82–0·83 air-dry) respectively and finer textured. The characteristic white lines of parenchyma which delimit the growth rings in typical *D. malabaricum* are not present in these samples. Here, the growth rings are not very

distinct as no single character seems to delimit them. The growth marks may be caused either by bands of parenchyma or by thicker-walled fibres or both ; vessels are also very small, indistinct to the eye and often in longer radial multiples up to 7. *Parenchyma* is abundant and distinct to the eye in fairly thick wavy lines connecting several vessels and ending abruptly, occasionally aliform with wing-like extensions ; also in fairly straight and long bands simulating growth rings.

The view expressed by Pearson and Brown that more than one species have been listed under *D. malabaricum* appears to be justified from anatomical point of view and it would be worthwhile to study them critically from systematic point of view also. Further, it may be mentioned that during the course of routine identification in this laboratory we have come across many instances, in which samples received from South India as *D. malabaricum* consisted of both the two types described above.

Strength—It is a moderately strong, moderately tough and hard wood. From the point of view of strength and hardness, it is comparable to teak but stronger in shock resistance and shear. Strength figures are given in appendix I.

Seasoning—The timber does not give difficulty in seasoning except that wide boards, especially those containing centre heart may show splits in the centre. Although defects like warping, cupping and twists are negligible, the timber is rather liable to split along the original defects, if any. Green conversion and quick stacking soon after felling are recommended to minimise discoloration due to sapstain. The timber also kiln-seasons well. According to Rehman (74) one inch thick planks take 12–15 days to kiln-season under conditions laid down in Schedule IV of his classification.

Natural durability—A very durable timber. The "graveyard" test carried out at F.R.I. showed that the heartwood remains in sound condition even after 328 months.

Insect and fungus attack—It is said to be resistant to white ants and decay. Sapwood, however, is prone to discoloration due to fungus.

Working qualities—The timber is easy to work both by hand and machine. It can be brought easily to a good finish. It also takes a fine polish without preliminary filling. The plain-sawn boards often present fine "striped" or "mottled" figure with satin-like surface. The timber has got good bending qualities and is suitable for the manufacture of high class bent wood furniture. It also turns and peels well and can be carved and engraved. However, some consignments of this timber have been found to "sweat" or exude a brownish oily substance which affects polishing to some extent. Recently, this timber was tried successfully for making spools for cotton thread in place of imported birch (*Betula* spp.) but later on, it was discovered that the thread was being

stained due to the oily exudation. According to the manufacturer, oily patches appeared about 6 weeks after the spools were turned and finished. This defect can be removed to some extent by steaming. Similar defect in some Australian species such as *D. fraseranum* Benth. has also been reported by Swain. Boas has suggested "steaming or sponging" of such timbers with alcohol to remove these oily blotches. Another defect which has been reported in some Australian species of *Dysoxylum* is that their sawdust produces irritation in the mucous membrance of the nose, causing violent sneezing. But this disadvantage has not been reported by workers who have handled the Indian timber.

Purushotham who has studied the corrosive properties of Indian woods on metals reports that *D. malabaricum* corrodes lead and iron slightly. The action takes place within the first two days of exposure but has not been found to extend further afterwards. Properties of fibre boards made out of this timber have been studied by Narayanamurti and Harcharan Singh. They have also given the chemical analysis of the timber made by them in this connection (60).

Supply and uses—Large supplies are available from Kerala and coastal Mysore and Madras but the demand often exceeds supply. Being a valuable and well known timber some quantity is often exported. The most important use of the timber is in the manufacture of coconut oil casks in south India. It is also used for furniture, cabinet making, turnery articles and toys, mathematical instruments, veneers and plywood, door and window leaves, ceilings and floor boards. The timber is used by the Railways for interior fittings of passenger coaches. It is a suitable timber for match manufacture, both for boxes and splints. It is also used for heavy packing cases (for packing machinery and similar stores). During the last war, the timber was in much demand for making barrels, buckets, drums, rolling pins and tent poles. It appeared to be suitable for the interior fittings of motor car and bus bodies. It is also likely to be suitable for moulding and carving and for printers' blocks.

Material—

4534 Travancore (0·82), 5800 Kanara, Mysore (0·69), 5849 Coimbatore, Madras (0·83), 5956 Palghat, Kerala (0·77), 6028 Tellichery, Madras (0·67), 6122 Coorg, Mysore (0·70), 6715 Kanara, Mysore (0·73), 6721 Kanara, Mysore (0·66), 6783 Palghat, Kerala (0·72).

4. **D. procerum** Hiern.—*Galing-libor, katum-sing* (Abor.), *amari, lali* (Asm.), *thakhau-phang* (Cach.), *bol-chhachhat, holsachat, chachat, makhaibo* (Garo), *kasshok, thing-tupui* (Kuki), *siposhikung* (Lep.), *ratasahatta* (Lush.), *kharang* (Mik.), *lahsune* (Nep.). A large evergreen tree somewhat resembling *Amoora wallichii* in foliage but the tree is not so straight and the colour of

the bark is greyish-brown to dark brown or reddish and more rough than *A. wallichii*. Kanjilal *et al* state that a white milky resin exudes from the bark while Shebbeare reports that the bark does not exude any milky juice unlike *Amoora wallichii*. The flowers of this tree have a strong garlic-like smell.

The tree is fairly common in Assam, particularly in the evergreen forests of Upper Assam and in North Bengal near about the foot-hills and *sal* forests, and also occurs in Burma.

Description of the wood—See below.

5. **D. purpureum** Bourd. (**D. ficiforme** Gamble)—*Kar agil, puvil agil* (Mal.)—A large tree growing up to 30 m. in height and about 1 m. in diameter. Bourdillon states that "the tree has a strong resemblance to *D. malabaricum*, but the bark is smoother and the leaves are broader and softer than in that tree ".

The tree is endemic in Travancore growing at elevations between 300–600 m.

Description of the wood—See below.

Description of the wood

(*Dysoxylum binectariferum, D. procerum* and *D. purpureum*)

[Pl. **43**, 253, 258]

General properties—Sapwood pale yellow or pale greyish-yellow, sometimes with a pinkish tinge, susceptible to discoloration due to fungus ; heartwood pink or reddish-grey to red darkening to rather dull red brown on exposure, usually not lustrous but with faint and persistent fragrance in *D. binectariferum* and *D. procerum*. Bourdillon reports that *D. purpureum* has also a faint scent, but this is lacking in the sample examined in the wood collection. Wood moderately hard and moderately heavy in *D. binectariferum* (sp. gr. 0·67–0·72 air-dry), but hard and heavy in *D. purpureum* (sp. gr. 0·86 air-dry) ; straight to broadly interlocked-grained ; texture moderately fine, usually featureless but occasionally stripes due to the contrast between the parenchyma and fibrous layers may be noticeable.

Gross structure—A diffuse-porous wood. *Growth rings* not distinct but sometimes noticeable as faint lines delimited by darker coloured fibrous tissue and also by a more or less thin continuous line of parenchyma in *D. binectariferum* and *D. procerum*, 2–5 per cm. *Vessels* small to very small, indistinct or hardly visible to the eye, moderately few (5–11 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–3 or 4, mostly 2, oval in shape and frequently filled with yellowish-brown deposits ; vessel lines fine, not conspicuous. *Parenchyma* abundant, distinct to the eye ; (a) usually conspicuous in numerous

long, fairly straight or wavy thin bands partially embedding or touching vessels and more or less alternating with broader fibrous tracts; (b) aliform, and sometimes with short wavy lateral extensions which end abruptly and also (c) in fine, concentric lines delimiting the growth rings in *D. binectariferum* and *D. procerum*. *Rays* fine to very fine, hardly visible to the eye, rather closely spaced, with inconspicuous ray flecks.

Out of five samples of *D. procerum* in the wood collection, one bearing No. 6447 from Burma has anatomical structure similar to that of *D. binectariferum*. The description given above is based on this sample. Three samples No. 631 (Pl. 43, 258) from Duars, West Bengal (sp. gr. 0·63), No. 1434 from Assam (sp. gr. 0·61) and No. 3595 from Darjeeling, West Bengal, which have been described by Gamble under *D. procerum*, however, do not match with the structure of the sample No. 6447 mentioned above. From the point of view of anatomical structure, all the three specimens show great similarity with *Amoora wallichii*. Another sample No. 2484 from the Andaman Islands which is stated by Gamble to have a structure similar to that of *D. procerum* does not belong to this family at all.

Strength—None of the timbers has been tested at this Institute except *D. binectariferum* on which only certain preliminary tests have been made. These tests were carried out to compare 3-plywood and solidwood of this species from Burma. Central loading on a 6″×6″ plate of about 3/16 in. thickness gave the following results :—

	3-ply with casein glue	solid wood
Moisture content	17·3	12·9
Maximum load in lbs.	48	24
Deflection at maximum load in inches ..	0·97	0·27

D. purpureum is harder and heavier than *D. binectariferum* and *D. procerum* which are moderately hard and moderately heavy. However, Bourdillon gives the value of P (coefficient of transverse strength) as 708 and weight 52 lbs. per cu. ft. for *D. purpureum*.

Seasoning—Usually these timbers can be air-seasoned and kiln-seasoned without any difficulty(89). As the sapwood is liable to stain, green conversion and quick seasoning is preferable. It is reported that to avoid cupping, the timber should be quarter-sawn.

Natural durability—*D. binectariferum* only has been tested at this Institute. "Graveyard" tests with samples of this species showed that the heartwood has an average life of 83 months (minimum 74 months and maximum 87

months). Pearson and Brown as well as Trotter mention that this species is naturally durable under favourable conditions.

Insect and fungus attack—The wood of *D. binectariferum* is liable to attack by some bores belonging to Brenthidae and Curculionidae. The newly felled timber of this species is also attacked by shot-hole borers (Platypodidae and Scolytidae). The sample of *D. procerum* from Burma (No. 6447) in the timber collection is very badly damaged by borers. The sapwood of all the species is easily attacked by fungus.

Working qualities—The timber is not difficult to saw and work with machines. It can be brought to a fairly good finish. Pearson and Brown state that as far as possible the logs should be quarter sawn in order to prevent cupping.

Supply and uses—Limited supplies are available from Assam, North Bengal and forests of the west coast. The timber is mildly scented and is suitable for a variety of purposes such as good furniture, cabinet making, turnery, novelties and other utility articles, mathematical instruments, plywood, match manufacture and cigar boxes. It is also likely to be suitable for vats, casks and tanks.

Material—

D. binectariferum – 5653 Cachar, Assam (0·72), 6209 Buxa, West Bengal (0·68), 6276 Belgaum, Mysore (0·71), 6647 Burma (0·67).

D. procerum – 6447 Burma.

D. purpureum – 4623 Travancore (0·86).

10. HEYNEA ROXB.

A very small genus of trees or shrubs confined to the Indo-Malayan region. The trees are similar to *Walsura* and some earlier botanists like Kurz and others had united them. Though there is apparent similarity in colour of the woods of these two genera, they are not difficult to distinguish on the basis of anatomical structure. In *Heynea*, the parenchyma is proportionately more and is aliform or in confluent bands. *Walsura* is, however, characterized by fine lines of parenchyma which are fairly closely spaced and evenly distributed. Further, the rays in *Walsura* are homocellular or nearly so while in *Heynea*, the rays are distinctly heterocellular.

Only one species of *Heynea* occurs in India which is described below :—

H. trijuga Roxb.—*Chenenji, kapiakushi limbara* (Bombay), *rolang-phang, rothang-phang* (Cach.), *doddagli maddlu, kora, kuriya, tural* (Kan.), *ban-ritha* (Kumaon), *migliok kung, takta* (Lep.), *karukkati, korakadi* (Mal.), *gundira* (Manip.), *theng-are-arong* (Mik.), *akhaterwa, komal-siuli, yakushi* (Nep.),

karaikaru-vilangam (Tam.), *khag-men-chhi* (Tipp.). A small pretty tree 6–12 m. in height with a clear bole of 4·5–6 m. and about 1 m. in girth. *Bark* reddish-brown, marked with reddish cracks, rather thin. The bark, leaves and seeds have got a bitter, tonic principle, while the fruit is reported to be poisonous to birds. In the Malay Peninsula, thieves are reported to mix the fruit with opium and use it for stupefying people. The extract of the bark and young branches is said to be lethal to frogs. Seeds yield an oil which is used for burning(31).

The tree has a wide distribution in India. It grows in the sub-Himalayan tract up to 1,500 m. elevation from Kumaon eastwards to North Bengal. It also occurs in the plain and hill forests of Assam ascending to 600 m.; Chota Nagpur, in the Eastern Ghats up to 1,400 m., and in the Western Ghats where it is common from Mysore to Travancore up to 1,800 m. In Burma it occurs in the hill forests at an elevation of about 600–1,200 m. It is also found in southern China, Thailand, the Malay Peninsula and Sumatra.

Description of the wood

[Pl. **44**, 259, 260]

General properties—Sapwood and heartwood indistinct in the samples examined; wood yellowish-white when fresh, turning yellowish-grey, sometimes with brownish tinge and occasionally with dark streaks due to fungus attack; moderately hard; moderately heavy (sp. gr. 0·53–0·71 air-dry); fairly straight-grained; even and medium to somewhat fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* faint, distinct under hand lens, demarcated by fine band of parenchyma, 2–3 per cm. *Vessels* small to very small, moderately numerous (12–22 per mm.^{2}), evenly distributed, occasionally forming a tangential belt of pores at the early part of the growth ring, mostly in radial multiples of 2–3, occasionally up to 4, rarely solitary or in small irregular groups associated with parenchyma cells, usually open, oval to rounded in outline; vessel lines fine and inconspicuous on the longitudinal surfaces. *Parenchyma* whitish in colour, rather variable, from abundant and distinct to the eye to less copious and not so clear to the unaided eye; (a) paratracheal, aliform to aliform confluent, frequently forming wavy bands connecting several vessels tangentially; (b) also in thin lines delimiting growth rings. *Rays* rather fine, hardly or just visible to the eye, lighter in colour than the background of the wood and not so closely spaced. *Gum canals* vertical, occasionally present in short tangential rows, small to very small, visible only under hand lens.

It is a moderately hard and moderately heavy timber, but, so far has not been tested for strength and other properties. The specimens in the wood collection, however, show radial checks which often develop from the region of

the pith. Insect damage has not been observed in any of the specimens. One of the samples, however, is attacked by fungus.

Trametes versatilis is reported to attack cut stumps and felled logs, causing a white pocket rot.

Uses—The wood is used locally for house posts, beams and scantlings and agricultural implements.

Material—

3459 Singbhum, Bihar (0·71), 6208 Chaibassa, Bihar (0·53), 6587 Burma (0·63).

11. LANSIUM RUMPH.

A very small genus of trees or shrubs of the Indo-Malayan region, closely allied to *Aglaia*. *L. domesticum* Jack of the Malay Peninsula and Java is cultivated in South India, as well as in several parts of South-East Asia for its delicious fruits which are reported to contain vitamin C. But the rind of the fruit contains a poisonous substance. The bark is astringent and the decoction is used in dysentery. According to Brandis two species are indigenous to India and both are described here. One of these *L. decandrum* King was placed in the genus *Amoora* in the Flora of British India and also in Gamble's Manual of Indian timbers. The woods of the two species are more or less similar in colour, but differ to some extent both in physical properties as well as in anatomical structure. The wood of *L. anamallayanum* is harder and heavier than that of *L. decandrum*. In *L. anamallayanum*, the parenchyma is profusely developed in narrow wavy bands, and the growth rings are delimited by very thin lines of parenchyma ; whereas in *L. decandrum* the parenchyma is comparatively less developed being paratracheal and mostly confined to the neighbourhood of the vessels. Growth rings are also not delimited by parenchyma. Further, the rays in *L. anamallayanum* are exclusively uniseriate while in *L. decandrum* they are uniseriate to biseriate. The inter-vessel pits are also comparatively larger in the latter (about 5 μ) than the former (3 μ). From anatomical point of view, therefore, *L. decandrum* indicates closer similarity with the genus *Amoora* than *Lansium anamallayanum*.

1. **L. anamallayanum** Bedd.—*Chinnagil*, *vandakamin* (Mal.), *santhanaviri* (Tam.). A moderate-sized handsome tree up to 15 m. in height and 30 cm. in diameter. *Bark* grey, smooth.

The tree occurs in the Western Ghats from North Kanara southwards in Mysore, Kerala and Tinnevelly at 450 to 600 m. elevation.

Description of the wood

[Pl. 44, 261]

General properties—Sapwood and heartwood not differentiated in the sample examined. Wood pale yellowish, turning light brown with age and has

a faint pleasant odour like sandalwood ; hard to very hard ; very heavy (sp. gr. 0·97 air-dry) ; fairly straight-grained ; fine and even-textured.

Gross structure—A diffuse-porous wood. Growth rings faint, hardly distinguishable under hand lens, delimited by a very thin interrupted line of parenchyma ; occasionally may be distinct in places where the boundary of the growth rings is also indicated by a layer of darker coloured fibrous tissue, contiguous to the parenchymatous layer, 4–7 per cm. *Vessels* very small, visible only under hand lens, moderately numerous to numerous (15–24 per mm.^{2}), more or less evenly distributed, solitary or in radial multiples of 2–3, usually 2, roundish in outline, open, or filled with white deposits ; vessel lines inconspicuous on the longitudinal surfaces. *Parenchyma* abundant, whitish and visible to the naked eye (a) in numerous short or long thin wavy tangential bands, often touching or connecting the vessels ; the bands in the earlywood are comparatively wider, longer and less wavy than those of the latewood ; (b) in very thin interrupted lines delimiting growth rings which are just visible under hand lens. *Rays* fine to very fine, indistinct to the eye, lighter in colour than the back-ground, closely and evenly spaced ; ray-flecks low and inconspicuous.

It is a dense, hard and strong timber but has not so far been tested for strength and other properties at this Institute. Lushington, however, has given the value of P (coefficient of transverse strength) as 1041. The sample in the wood collection is free from any damage either by insect or fungus. Except for fine radial checks, the sample does not also show any seasoning defect. According to Rama Rao, the timber is insect resistant. Reyes reports that the wood of *L. domesticum* which is simialr to *L. anamallayanum* is resistant to drywood termites and powder-post beetles. This species has also been reported to be tough, elastic and durable(23).

Uses—The timber is not much in use at present. It has, however, been found to be mixed occasionally with sandalwood (*Santalum album*). It may be suitable for small turnery articles, toys, etc., and may also be tried for tool handles and house posts.

Material—

6720 Madras (0·97).

2. L. decandrum King.—*Songsun-kung, tangaruk* (Lep.), *bandre rite* (Nep.). A tree. *Bark* thin, grey.

It grows at an elevation from 600–1,800 m. in the Himalayas from Nepal eastwards and also in Kachin hills of Upper Burma.

Description of the wood

[Pl. 44, 262]

General properties—Wood brownish-yellow, somewhat lustrous, moderately hard ; moderately heavy (sp. gr. 0·64 air-dry) straight-grained fine and fairly even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct, but occasional bands of darker coloured fibrous tissue may, however, give the impression of growth rings. *Vessels* very small, not visible to the naked eye, moderately few to moderately numerous (8–12 per mm.^{2}), evenly distributed, solitary or rarely in multiples of 2 to 3, roundish in outline, open ; vessel lines inconspicuous on the longitudinal surfaces. *Parenchyma* visible to the naked eye as short, broken, fine wavy whitish lines ; under the hand lens distinct round the vessels forming thin sheath or wing-like structure often extending sideways joining other vessels – to give the impression of broken tangential lines. *Rays* fine, to very fine, indistinct to the eye, lighter in colour than the background, rather closely spaced ; radial flecks fine but distinct.

It is a moderately strong timber which has not so far been tested for strength, durability and other properties. The sample in the wood collection is badly damaged by powder-post beetles though apparently free from fungus attack. It may be tried for all purposes for which *Amoora* is suitable.

Material—

3392 Lebong, Darjeeling (0·64).

12. MELIA LINN.

A small genus of middle-sized or large trees occurring in the warmer parts of Asia and Australia but confined mostly to the Indo-Malayan region. *Melia azedarach* is widely planted as an avenue tree or round the villages in India and has been introduced in many parts of the world as an ornamental tree. Three species occur in India, Pakistan and Burma and are described here. Of the three species described here *M. azedarach* and *M. birmanica* resemble to a great extent except that the earlywood zone is wider and the characteristic arrangement of the latewood vessels is more prominent in the former. *M. composita* is somewhat different from these two both in physical properties as well as in gross structure. These can be separated as follows :—

1. Wood distinctly ring-porous with characteristic arrangement of the latewood vessels, moderately hard to moderately heavy 2

1. Wood semi-ring-porous to diffuse-porous, usually without any characteristic arrangement of latewood vessels, soft and light .. .. *Melia composita.*

2. Earlywood zone wide, consisting of 4–8 or more rows of large vessels. Latewood vessels usually individually indistinct under hand lens and form prominent flame-like, or zig-zag pattern .. .. .. *Melia azedarach.*

2. Earlywood zone comparatively narrow, composed of 1–3 rows of large vessels. Latewood vessels mostly individually distinct under lens. Flame-like pattern less conspicuous and confined only to the extreme latewood portion .. .. .. *M. birmanica*

1. **M. azedarach** Linn.—**Persian lilac.** *Ghora nim, mahanim* (Asm. and Beng.), *kamaka, tamaka* (Burm.), *denka* (Garh.), *bakan-binbodo* (Guj.), *bakain, bakaria, betain, deikna, darekh* (Hind.), *deknoi* (Jauns.), *betain* (Kumaon), *kattuveppu* (Mal.), *bakana-nimb, limbara, vilayati-nimb* (Mar.), *bakain, bakenu* (Nep.), *bakain, drek,* (Punj.), *malaivembu* (Tam.), *thurakayepa* (Tel.). Also known as bead tree, bastard cedar. A small to medium-sized deciduous tree with a short trunk and a large spreading crown, attaining up to 15 m. in height and 2 m. in girth ; often about 1 m. in girth with a clear bole of about 4 m. *Bark* greyish-brown to dark grey, with shallow longitudinal fissures, about 13 mm. thick.

Whether the tree is indigenous to India is not definitely known. It is commonly cultivated throughout India and Burma, and is frequently planted in tea gardens. The tree reproduces fairly well in many localities and is found to grow up to an elevation of about 2750 m. in Bashahr. According to Parker, it is not an uncommon tree in the forests along the base of the Himalayas. It is an ornamental tree which has been introduced in many parts of the world such as China, Africa, southern Europe and America.

Apart from being a fast growing and handsome tree, for which it is often planted as a roadside tree, it is often esteemed for medicinal properties of its root, bark, fruit, flower and leaves(14). The bark is bitter and is useful as an anthelmintic. The bark as well as the leaves and the fruit are also used in leprosy and scrofula both internally and externally. The seeds yield an oil which is similar to neem (*Azadiracta indica*) oil. The fruit contains a poisonous substance and is used in America for the preparation of an insecticide or flea-powder(8). The tree coppices well and the leaves are lopped for fodder(45).

Description of the wood—See page 136.

2. **M. birmanica** Kurz—*Paudama, taungtama, taw-thamaka, yadama* (Burm.). An evergreen tree, 18–21 m. in height, and about 2 m. in girth. *Bark* brownish-grey longitudinally fissured and corky, 13 mm. thick. The tree is very similar to *M. composita* and is likely to be mistaken for it.

It is found in Assam and in the plain forests of Upper Burma. Kanji Lal *et al* have described this under the name *M. superba* Roxb. Brandis considers this to be hardly different from *M. composita.*

Description of the wood—See page 136.

3. **M. composita** Willd.—**Malabar neem.** *Aming-gok, gingsimok* (Garo), *helbevu* (Kan.), *dieng-jarasang, soh-dieng-lang* (Kh.), *silot-kung* (Lep.), *kattuveppu* (Mal.), *kuriaput, limbara, nimbara* (Mar.), *hanti-pli-arong* (Mik.), *lapshi* (Nep.), *mahalimbu* (Or.), *malai vembu, masa veppu* (Tam.), *munnuthikaraka* (Tel.). A large deciduous tree up to 20 m. in height with a clear bole of 9 m. and 1·8 m. in girth. *Bark* dark brown or blackish and deeply cracked. The tree is similar to *M. azedarach* but the flowers are white. The pulp of the fruit is bitter and is said to be useful for colic.

It is found in the hill forests of North Bengal and Sikkim up to 1,800 m. and throughout Upper Assam and Khasi Hills ; in the Eastern Ghats in Orissa and Andhra Pradesh at 600 m. and in the Western Ghats from Kanara southwards at low elevation, rather common in Travancore. It is also found in Burma and Ceylon. On account of rapid growth it is planted as a shade tree in plantations especially in South India and is also useful for afforestation.

Description of the wood—See below.

Description of the wood

(*Melia azedarach, M. birmanica and M. composita*)

[Pl. **44**, 263–264 ; **45**, 265]

General properties—Sapwood yellowish-white (*M. azedarach*) to greyish or pinkish-white often with yellow cast (*M. composita*) ; heartwood light pink to light red when fresh (*M. composita*) to red or reddish-brown (*M. azedarach*) but dull grey brown in *M. birmanica*, the colour usually darkening on exposure. Moderately hard and moderately heavy in *M. azedarach* and *M. birmanica* (sp. gr. 0·55-0·61 air-dry) ; somewhat lustrous particularly in *M. composita*, without any characteristic odour or taste ; straight-grained, coarse and uneven-textured in *M. azedarach* and *M. birmanica* but comparatively finer and less uneven-textured in *M. composita*. The zones of earlywood vessels show up prominently on the longitudinal surfaces as darkish stripes in *M. azedarach* and less prominently in *M. birmanica*.

Gross structure—The wood is distinctly ring-porous in *M. azedarach* and *M. birmanica* but semi-ring-porous to nearly diffuse-porous in *M. composita*. *Growth rings* distinct, conspicuous and delimited by a broad belt of large earlywood vessels in *M. azedarach* and *M. birmanica* but less prominent in *M. composita* due to want of sharp difference in the size of early and latewood vessels ; in addition to the larger vessels, growth rings are also indicated by a belt of small tracheid-like vessels mixed with parenchyma cells in the earlywood ; 1–4 per cm. *Vessels* in *M. azedarach* and *M. birmanica* large to very small ; earlywood vessels large, crowded and appearing as a conspicuous belt consisting of 4–8 or more rows in *M. azedarach* and 1–3 or 4 rows in *M. birmanica* ; solitary or in radial

pairs or appearing as crowded groups; transition from early to latewood abrupt; latewood vessels in *M. azedarach* minute, hardly distinct individually under the hand lens but visible as numerous, small irregular groups or nests associated with parenchyma, often forming a characteristic flame-like, zig-zag, or oblique pattern, occasionally also in narrow tangential bands across the rays; in *M. birmanica*, the latewood vessels small but individually distinct under lens except for vessels in the extreme latewood portion where the vessels appear as fine zig-zag or oblique groups embedded in parenchyma; mostly solitary, occasionally in radial pairs. Vessels in *M. composita* moderately large, few, mostly solitary, sometimes in radial pairs; earlywood vessels slightly larger than those in the latewood, usually consisting of one row of vessels on the face of the growth ring but sometimes a belt of vessels up to 3 rows in width may be met with; transition from early to latewood rather gradual, latewood vessels small, just visible to the eye, seldom in groups, nests or patches, as in the other two species. Vessels in all the three species roundish in outline and often filled with reddish-brown or blackish gum-like deposits; vessel lines distinct, and rather prominent as broad longitudinal stripes in the earlywood of *M. azedarach* and *M. birmanica*. *Parenchyma* not abundant; (a) paratracheal round the vessels as light coloured tissue, comparatively more in the earlywood than in latewood; all the light coloured patches appearing as soft tissue under hand lens are not, however, made up entirely of parenchyma, but consist of small tracheid-like vessels (storied and with spiral thickening) occurring mixed with true parenchyma cells. These small vessels are particularly abundant both in the earlywood and latewood of *M. azedarach* but comparatively less in *M. birmanica* and rather few in *M. composita*; in the earlywood of *M. azedarach* and *M. birmanica*, parenchyma (together with the small tracheid-like vessels) almost embed the large vessels on the face of the ring and constitute the major part of the ground tissue of this zone; whereas in the middle of the ring, parenchyma forms a thin sheath round the vessels but in the latewood it is in irregular patches round the vessel groups, often joining similar patches to form a zig-zag, flame-like, oblique or irregular tangential pattern; in *M. composita* parenchyma is rather scanty, visible under hand lens as a thin sheath round the vessels or vessel groups, and rarely forms small irregular or oblique patches, round the small vessel groups in the extreme latewood portions of some rings; (b) also delimiting growth rings (often inconspicuous in *M. composita*) along with smaller vessels. *Rays* moderately broad, just visible to the eye, rather widely spaced, brownish in colour forming low but distinct ray-flecks on the radial surface. *Gum canals* vertical, occasionally present in tangential rows (traumatic) filled with dark contents.

The wood sample No. 4897 (Pl. **44**, fig. 264) marked *M. birmanica* in the collection is somewhat different. The colour is brownish-yellow with prominent whitish markings on the longitudinal surfaces. Its weight (sp. gr. 0·83) is

highest amongst all the species of this genus. In structure, the ring-porous character is not prominent. Growth rings are distinct to the eye delimited by narrow whitish concentric lines of parenchyma.

Strength—Only *M. azedarach* has been subjected to full scale tests at the Institute. It is a moderately heavy, moderately strong and moderately hard and tough timber. The strength figures are given in appendix I. *M. birmanica* which is somewhat comparable to *M. azedarach* in weight and hardness, may be similar in strength properties also. *M. composita* is, however, softer and lighter than the other two species. A. C. Sekhar, Officer-in-Charge of the Timber Mechanics Branch has supplied the following tentative figures for *M. composita* based on one sample only :—

Weight at 12% moisture content	.. = 28 lbs. per cu. ft.
Side hardness	.. = 650 lbs.
End hardness	.. = 750 lbs.
Maximum compression strength	.. = 5,300 lb./sq. in.

Pearson and Brown give the following strength figures based on Prof. W. C. Unwin's tests made on Ceylon specimens :—

Shear, parallel to the grain, in lb. per sq. in. ..	478
Crushing parallel to the grain, in lb. per sq. in. ..	3,042
Transverse strength, in lb. per sq. in. Total load.	5,712
Modulus of elasticity	739,424

The weight of the specimen tested was 20·39 lb. per cu. ft. which is rather low as compared to samples in our collection. The wood of this species from Assam and South India examined by us has been found to vary to some extent in weight.

Seasoning—*Melia azedarach* air-seasons very well without developing defects of any significance. Experiments conducted with this timber have shown that if it is protected against rapid drying, the timber can be seasoned by any method like girdling, seasoning in the log form, or after green conversion. Girdling, however, gives the best result though the other methods are also not inferior.

M. composita logs are liable to develop end-splitting and discoloration if left for long after felling. To avoid this defect, green conversion and open stacking of the sawn material under cover are recommended. The timber is reported to contract considerably across the grain like many other meliaceous timbers(66).

Natural durability—None of the timbers has been tested at the Institute. But *M. azedarach* is well-known for its durability and is reported to be resistant to white ants. According to Pearson and Brown, *M. composita* is not durable in exposed positions but moderately so under cover.

Insect and fungus attack—Drywood and deadwood of *M. azedarach* is attacked by Bostrychidae (*ghoon* borers) and newly felled or fallen wood is attacked by Platypodidae (shot hole borers). The heartwood of standing trees is also attacked by *Fomes senex*, an important wound-parasite. Parker states that the roadside trees "though handsome when young soon becoming hollow and scraggy". All the samples of *M. azedarach* in the timber collection are in good condition except one which shows borer attack. Two of the samples of *M. composita* are damaged by *ghoon* borers.

Working qualities—All the species are easy to saw and work, both by hand or machine and can be brought to a smooth finish. Due to the presence of broad earlywood zones, with large crowded vessels, *M. azedarach* and *M. birmanica* show quite an attractive figure. *M. composita* is not usually ornamental but may produce an attractive silver-grain effect when quarter-sawn. According to Sekhar, *M. azedarach* is very easy to turn, but sharp edges are liable to chip off, resulting in a rather rough finish. It takes a good polish provided filling is done before polishing. It can also be peeled for veneers.

Supply and uses—None of the timber species is available in sufficient quantities anywhere. *M. azedarach* is available from the north zone in small quantities while limited supplies of *M. composita* are available from west coast forests and Assam.

The main use of *M. azedarach* is for toys, small articles, sporting requisites like slips of handles of tennis racquets, packing cases and turnery articles. It is also suitable for cheap and light furniture and for making decorative plywood.

M. composita is chiefly used for light packing cases and ceiling planks. Rehman and Ishaq report that it is used for making cheap pencils although not very suitable for the purpose.

It is also suitable for plywood and for making cigar boxes. According to Talbot, it is used for musical instruments in North Kanara. Both *M. azedarach* and *M. composita* are very good fuel woods. For this reason and on account of their rapid growth, they are often planted for firewood. Rodger states that *M. birmanica* is likely to be suitable for boxes and matches.

Material—

M. azedarach – 145 Sainj Giri Valley, Punjab (0·55), 946 Lahore, West Pakistan (0·55), 1201 Madhopur, Punjab (0·61), 5803 Simla hills, Himachal Pradesh (0·51).

M. birmanica – 4897 Burma (0·83), 6553 Burma (0·61).

M. composita – 705 Darjeeling, West Bengal (0·49), 1093 Madura, Madras (0·40), 5660 Cachar hills, Assam (0·56), 6552 Burma (0·42).

13. SANDORICUM Cav.

A very small genus of evergreen trees mainly occurring in the Indo-Malayan region. Although they are usually small to medium-sized, Desch records that some of them may attain a height of 45 m. in the Malay Peninsula. *Sandoricum indicum* is the only species which occurs in India and Burma and is described here.

S. indicum Cav. (S. koetjape Merr.)—*Thitto* (Burm.), *sevai* (Tam.), *sevamanu* (Tel.). An evergreen tree, 24–27 m. in height and 2–2·5 m. in girth (6–9 m. clear bole) in Burma but smaller in Andamans where it is 9–12 m. in height. *Bark* grey, rough and wrinkled and contains a slightly toxic and bitter substance. The fruit is edible and the roots, which are aromatic, are used in diarrhoea and dysentery.

It is found in evergreen forests of Lower Burma, where it is also widely cultivated. It also occurs in South Andamans but Parkinson is of the opinion that it may not be indigenous to the Island. Recent exploration in the Nicobar Islands has, however, shown the occurrence of this tree in those Islands. The tree has been introduced in some regions of South India. It has a wide distribution in the Malay Peninsula, Indonesia and Philippine Islands.

Description of the wood

[Pl. 45, 266]

General properties—Sapwood pale grey to pale yellowish-grey ; heartwood light brown with pinkish or reddish-tinge, lustrous, when fresh with faint sweet smell, moderately hard, light to moderately heavy (sp. gr. 0·47–0·57 air-dry), straight to slightly interlocked-grained, medium to fine-textured, often producing a fine silver-grain effect on the radial surface.

Gross structure—A diffuse-porous wood. *Growth rings* usually indistinct, sometimes indicated by a narrow layer of flattened fibres. *Vessels* small to medium-sized, indistinct to visible to the eye, few to moderately few (4–9 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2, occasionally 3, often roundish, mostly open, sometimes partially filled with brownish deposits ; vessel lines fairly distinct to distinct. *Parenchyma* not abundant and visible only under lens, (a) paratracheal as a thin sheath round the vessels, often forming fine wing-like projections on both sides which may sometimes join up with

similar projections from other vessels forming short or long tangential bands ; (b) apotracheal, diffuse, scanty, scarcely noticeable under lens. *Rays* are fine to very fine, hardly visible to the eye, distinct under lens, reddish-brown in colour and closely spaced, often showing low but distinct ray-flecks. *Gum ducts* vertical, occasionally present in concentric rows (traumatic).

Strength—No regular test has been made on this species. However, some small scale test carried out on air-dry specimens from the Nicobar Islands gave the following figures :—

Sp. gr. = 0·443.

Wt. per cu. ft. at 12% moisture content = 31 lb. ;

Compression parallel to grain, maximum crushing strength = 5118 lb./sq. in. Samples from the Nicobar Islands appear to be lighter than the Burma specimens.

Seasoning—Reyes(79) states that the timber seasons well, not being subject to checking or splitting.

Natural durability—The timber is said to be moderately resistant to insect attack but perishable when exposed to moisture. "Graveyard" tests carried out in Philippines have shown that it is not at all durable, lasting even less than two years.

Insect attack—Reyes reports that the heartwood is moderately resistant while the sapwood is susceptible to drywood termites and powder-post beetles. One of the samples (sapwood) in the wood collection shows slight damage due to pin-hole borers. Rodger states that it is susceptible to "harbour borers".

Working qualities—The timber can be worked well without chipping and can be brought to a smooth finish. It also polishes well, producing a pleasing appearance.

Uses—Locally it is used for carts, boat-building and planking. It is suitable for light furniture, interior fittings, light boxes and plywood. In the Philippines it is reported to be used for carving, household implements and butcher's blocks. In Burma, the wood is liked for making sandals.

Material—

804 Burma (0·57), 5147 Burma (0·50), 6495 Burma (0·47).

The specimens from Nicobar Islands examined are: G/A 10325 (0·40), G/A 10330 (0·44), G/A 10657 (0·37).

14. SOYMIDA A. JUSS.

A monotypic genus confined to the dry forests of the Indian Peninsula.

S. febrifuga A. Juss.—*Soimi* (Gon.), *rainyi, rohun rohina* (Hind.), *some, sumbi* (Kan.), *palara* (Mar.), *sohan* (Or.), *rohini* (Sans.), *shem, shemmarom, somadanam, sombupattai, vadamalai-checkku* (Tam.), *somida, sumi* (Tel.). Also known as Indian red wood. A moderate-sized deciduous tree sometimes attaining a height of 21–24 m. and a girth of 2–3 m. with a symmetrical straight trunk, the clear bole rarely exceeding 4 m. in length. *Bark* greyish-brown or dark brown, rough, exfoliating in large plates, and fairly thick. The bark is bitter and is used in a number of ailments such as general debility, intermittent fevers, diarrhoea and dysentery. It also yields a strong red fibre suitable for ropes and is used in tanning giving a brown colour to the leather. The tree yields a gum in large lumps which is used for adhesive purposes.

It is found in the dry forests of Central and South India with Mirzapur hills and Rajasthan as its northern limits. It is common in Chota Nagpur, Orissa, Andhra Pradesh, Madhya Pradesh, Mysore and Gujarat.

Description of the wood

[Pl. 45, 267]

General properties—Sapwood and heartwood distinct. Sapwood small, whitish when fresh, turning grey or greyish-brown with age ; heartwood reddish-brown or bright red when fresh, turning dark reddish-brown to dark reddish-purple, often with distinct lighter coloured stripes ; hard, very heavy (sp. gr. 1·00–1·18 air-dry), somewhat lustrous when fresh, often turning dull and dark on ageing, with greasy feel, usually straight-grained occasionally twisted or interlocked-grained, coarse to medium-textured. "Silver grain" effect having a satiny lusture is sometimes noticeable in the quarter-sawn planks.

Gross structure—A diffuse-porous wood. *Growth rings* not well-defined. Numerous tangential lines of parenchyma visible to the eye especially in the sapwood, giving the impression of growth rings, which may not always be truly annual. However, in some samples growth rings are fairly distinct delimited by parenchyma at regular intervals in association with dark coloured fibrous tracts. *Vessels* small to medium-sized, just visible to the eye as whitish dots in the sapwood but not clear in the heartwood, moderately few (3–7 per mm.^{2}), solitary or in radial multiples of 2 to 3, usually more or less evenly distributed, though sometimes tangential belts of fibres with scanty, widely spaced vessels may be present ; round to oval in outline, and often plugged with orange-brown or red gummy substance ; vessel lines more distinct in heartwood due to the deposits which glisten. *Parenchyma* rather variable, abundant to less copious, visible to the eye in the sapwood but usually indistinct or just visible in the heartwood even under hand lens ; (a) apotracheal, in narrow tangential lines delimiting growth rings, and also in thick short or long bands, sometimes embedding or partially enclosing vessels, which are visible to the eye ; also diffuse, scanty,

sometimes visible only under hand lens as dots in the fibrous tracts ; (b) paratracheal in a thin sheath round the vessels and visible only under hand lens, occasionally extending sideways. *Rays* moderately broad, visible in the sapwood but not clear in the heartwood due to lack of contrast in colour, rather widely spaced ; radial flecks distinct but not conspicuous. *Gum canals* vertical, of traumatic type, occasionally present in short or long tangential rows.

Strength—A very hard, very heavy, very strong, and tough timber. For strength figures, see appendix I.

Seasoning—It is a highly refractory wood to season, as it is liable to severe degrade due to surface-cracking, splitting and warping. The sapwood of girdled trees or unconverted logs is also liable to damage by insects. For best results, the trees should be felled towards the beginning of the cold weather or towards the end of the rains, and converted promptly. The sawn material should be given sufficient protection against the sun and dry winds. Rehman reports that this timber is also very troublesome to kiln-season as it is very difficult to dry free from defects, particularly from the green condition. According to his schedule VII, one inch thick planks take about 24–30 days to dry, requiring at least three intermediate steaming operations besides initial and final steamings.

Natural durability—The heartwood of this timber is extremely durable even under unfavourable conditions. The "graveyard" tests carried out at this Institute have shown that it has a minimum life of about 25 years. Some of the test pieces have been found to remain sound even after 28 years.

Some wood remains of this species excavated from Sisupalgarh near Bhuvaneswar in Orissa(19) were found to be in fairly good condition even after 2,000 years. Recently, we had an occasion to examine some wood specimens from logs of *Soymida febrifuga* said to have been used as props in the ancient workings in the Huthi Gold Mines of Hyderabad which were all found to be in very good condition.

Insect attack—The sapwood of dry or converted timber is attacked by *Lyctus africanus* L. and *Trogoxylon spinifrons* Les. (*ghoon* borers) (Lyctidae). The heartwood is very resistant to insects but the deadwood is reported to be attacked by *Aeolesthes holosericea* Fabricius (Cerambycidae).

Working qualities—Although a very hard timber, it is not difficult to saw and work by hand and machine tools. It finishes well and takes a fine polish giving a very pleasant appearance somewhat similar to mahogany. It also turns well, without chipping off at fine edges. Pearson and Brown state that veneers obtained from this timber are very ornamental but suitable logs are not easily available. Tests carried out at this Institute with a consignment from Madhya Pradesh for conversion into veneers by rotary cutting were not very successful, due to badly interlocked fibres.

Supply and uses—Although total supplies may be considerable, the trees being often scattered, only limited quantity is available from different localities of central and southern zones.

The timber being hard and strong is mainly used for constructional purposes such as posts, beams and rafters, for ploughshores, bearings, oil crushers and pounders and well construction. Rama Rao quoting Drury mentions that it is used for constructional work in temples. It is also used for carving and for making turnery articles. It is specially suitable for all types of heavy construction, columns, bridges, piles, mine props, flooring and for certain types of furniture such as beds, tables, and chair legs. Haines reports that the charcoal of this timber is used for making gun powder. Ornamental veneers can be used for high class cabinet work, panelling, and for partition walls.

Material—

194 Madhya Pradesh (1·06), 1123 Madhya Pradesh (1·14), 1240 Ganjam, Orissa (1·16), 2113 Mysore (1·16), 3566 Orissa (1·08), 3824 Gullery Forest, Orissa (1·18), 4060 Andhra Pradesh (1·14), 5751 Panch Mahals Division, Bombay (1·00), 7836 Patna Division, Orissa (1·16), 8044 Keoryhar Division, Orissa.

15. SWIETENIA JACQ.

A well known genus of large to very large trees of tropical America and the West Indies which produces the true mahogany of commerce. Although the mahogany tree was discovered by the Spanish explorers in the West Indies in the sixteenth century, it was not botanically known as *Swietenia mahagoni* till 1760, when Jacquin named it in honour of Baron Von Swieten, a celebrated physician and botanist of Leyden. A second species, *S. humilis* was described by Zuccarini from Mexico in about 1836. Another new species under the name *S. macrophylla* was described in 1886 by Sir George King based on specimens grown in the Indian Botanical Garden, Calcutta, from seeds obtained from Hondurus. Since then several other species have also been described from Central and South America. These are *S. cirrhata* Blake from the west coast of Mexico ; *S. candollei* Pittier from Venezuela ; *S. tessmannii* Harnes and *S. krukovii* Gleason, both from the upper basin of the Amazon. But some botanists are of the opinion that the genus consists of only three species, namely *S. mahagoni*, *S. macrophylla* and *S. humilis* ; *S. cirrhata* is considered to be same as *S. humilis*, while the rest of the species are regarded as forms of *S. macrophylla*.

On account of its valuable timber, mahogany has been widely planted outside its natural habitat. It has been tried in India, East Pakistan, Burma, Ceylon, Indonesia, the Philippines and elsewhere with varying success. Out

of the two species tried, e.g., *S. mahagoni* and *S. macrophylla*, the latter has given comparatively more satisfactory results. In India, *S. mahagoni* was first planted in the Indian Botanical Garden, Calcutta, in 1795, and *S. macrophylla* in 1872. The latter species has been found to grow better and is said to be more suitable for Indian conditions. *S. mahagoni* has not been much of a success in forest plantation, and is mostly restricted to gardens. However, according to Laurie "*S. macrophylla* has thrived best in areas of fairly high rainfall of 80 inches to 150 inches and *S. mahagoni* in areas of lower rainfall 40 inches to 60 inches". He further states that "the large majority of mahagoni trees in the plantation made hitherto have badly forked boles, and the length of saleable log of export quality is frequently very short". The reason for the formation of such forked boles in both the species has been attributed mainly to the attack of a shoot-borer, *Hypsipyla robusta*.

Of the three valid species of mahogany, *S. humilis* is not of commercial importance as the supply is very limited. At present the main source of mahogany is from *S. macrophylla* obtained from continental North and South America. This is variously known in the trade as Honduras mahogany, tropical American mahogany, Mexican mahogany as well as Brazilian, Colombian, Costa Rican, Guatemalan, Panama and Peruvian mahogany, according to the country of origin. *S. mahagoni*, the original mahogany of commerce is rather scarce today. This is commercially famous as Spanish or Cuban mahogany, West Indian mahogany, San Domingo, Porto Rico or Jamaica mahogany. At present the timber is mainly available from Cuba and San Domingo.

Though mahogany is a characteristic wood, there is considerable variation in colour, texture, grain, figure, weight and hardness. The colour of the heartwood ranges from very pale pink to reddish-brown, darkening to deep, rich, brown-red on exposure, with a satiny or golden lustre. The wood is light to heavy (sp. gr. 0·35–0·85), medium-fine textured and straight to interlocked-grained. On the quarter-sawn surface, the logs with interlocked-grain often produce beautiful figure. *S. mahagoni* is usually darker in colour, denser and comparatively finer textured than *S. macrophylla*. Distinctive figure of mahogany is more often found in *S. mahagoni* than in *S. macrophylla* which has a tendency towards straighter grain. However, *S. macrophylla* shows considerable variation in physical properties which may be attributed to its wide distribution and different habitat. It is reported that in rich soil and rain forests the trees grow rapidly and produce comparatively light and soft timber. Whereas, in unfavourable conditions, the timber becomes dense and hard, and resembles *S. mahagoni* in appearance. *S. humilis* is similar to *S. mahagoni* in colour, weight and other properties. In anatomical structure, the three species are indistinguishable. *S. macrophylla*, however, has usually wider growth rings and comparatively larger vessels than the other two species.

Moreover, white deposits in the vessels are reported to be less common and ripple marks more prominent in *S. macrophylla* than in *S. mahagoni* (78).

The Indian grown samples of *S. mahagoni* and *S. macrophylla*, however, do not show any difference worth considering. In colour and other physical properties, the woods of both the species are very similar. The rate of growth in all the samples is rather fast and the vessels are moderately large to small. White deposits in the vessels are infrequent and ripple marks often not distinct in both. The only sample of *S. humilis* studied is rather dark in colour and somewhat finer in texture.

Since the discovery of mahogany, the pleasing appearance of the wood and its good working quality and stability attracted the attention of high class cabinet makers and designers of Europe. As such, the demand for this highly prized timber went on increasing, and by the middle of nineteenth century, it was apprehended that the supply might get exhausted. This made people search for timbers which could be substituted for genuine mahogany. According to Mell, the first consignment of timbers having a superficial resemblance to mahogany went to England from India. Later on "African mahogany", a product of *Khaya ivorensis* A. Chev. was also imported into England. The first consignment of African mahogany is said to have reached Liverpool in 1833 and by 1878 became one of the most important "mahoganies" imported into England. Since then many other timbers have been offered as mahogany from various countries. The number of timbers which have been passed off as mahogany has been recorded by Melville as nearly 200 belonging to 35 different botanical families. Of these, the largest number belongs to the family *Meliaceae* which alone accounts for over 50 species. The most important and nearest substitutes of true mahogany are the products of the genera *Khaya* A. Juss. and *Entandrophragma* C. DC. which are also botanically closely related. The former is known as "African mahogany", and the latter as "Sapele mahogany". Some of the other important substitutes are Brazilian mahogany, Para mahogany, or crabwood (*Carapa guianensis* Aubl.), Gaboon mahogany (*Aucoumea klaineana* Pierre), Australian mahogany (*Dysoxylum fraseranum* Benth.), Birch mahogany (*Betula* spp.), *Guarea cedrata* Pellegr. ex A. Cheval and *G. thompsonii* Sprague and Hutchinson, *Cedrela* spp., *Lovoa klainemna* Pierre, *Turraeanthus africana* Pellegrin, *Pseudocedrela kotschyi* Harms, Philippine mahogany (some species of *Shorea* Roxb., *Parashorea* Kurz. and *Pentacme* A. DC.), Burma mahogany (*Pentace burmanica* Kurz), and Cherry mahogany [*Mimusops djave* Engl. and *M. heckelii* A. Cheval]. Among the Indian timbers which are substituted for mahogany are, *Carapa* spp., *Chukrasia tabularis* A. Juss., *Soymida febrifuga* A. Juss., *Pterocarpus dalbergioides* Roxb., *Cedrela toona* Roxb. and *Canarium euphyllum* Kurz.

1. S. humilis Zucc.—**Mahogany.** A medium-sized tree. In its original home it grows in dry places on the west coast of Mexico and Central America,

usually at higher elevations than *S. macrophylla*. In India, it has been planted in the Indian Botanical Garden, Calcutta. The wood described here is from this garden.

2. S. macrophylla King.—**Mahogany.** Also known as Honduras, Colombian, Mexican, Brazilian and Peruvian mahogany, large leaved mahogany, and sometimes known in Bengal as *bara mahagoni*. A large to very large evergreen tree. In its natural habitat, it sometimes grows to a very large size reaching up to 45 m. in height, with a clear bole of 18–24 m. and 3–3·5 m. in diameter, the average being 1–2 m. In India under favourable conditions, the tree grows fast and may reach a height of 30 m. with a girth of about 2·5 m. in 39 years (91). *Bark* greyish-brown, fairly smooth to somewhat rough, flaking off in small patches.

Natural habitat of this tree is southern Mexico, eastern coast of Central America – Honduras, Guatemala, Republic of Honduras, Nicaragua, Costa Rica, Panama and Venezuela in South America where the rainfall is fairly high. In India, the tree has been widely planted as an avenue tree especially in the west coast and Bengal. This has also been introduced in forest plantations and has done well in most of the states of South India, particularly Kerala and Chittagong in East Pakistan.

Description of the wood—See page 148.

3. S. mahagoni Jacq.—**Mahogany.** It is well known in the trade as Spanish or Cuban Mahogany, and according to the country of origin, as West Indian, San Domingo, Porto Rico and Jamaica Mahogany. In Kerala it is sometimes known as *cheriamahogany*. A magnificent evergreen tree similar to *S. macrophylla* but with smaller leaves. It is a more beautiful tree than *S. macrophylla* with a handsome spreading habit. Troup mentions that some trees in the Indian Botanical Garden, Calcutta, had attained a height of 36–39 m. and a girth of 4–5·5 m. in about 120 years.

Its original home is in the West Indies – Bermuda, Bahama Islands, Cuba, Jamaica, Haiti, Dominican Republic, Puerto Rico, and southern Florida.

The tree has been widely planted in India since its first introduction at the end of the 18th century, mostly for shade and ornamental purposes in avenues and gardens. Attempts to grow this tree in forest plantations have not been much of a success. As compared with *S. macrophylla*, this species is apparently less hardy and requires greater attention and protection. However, some fine specimens of this tree can be seen in the Indian Botanical Garden, and in and around Calcutta. The trees have mostly been planted in South India and in Bengal with varying success.

According to Benthal, the bark of this tree has medicinal properties and is used as an astringent and also as a substitute for Cinchona in the West Indies.

Description of the wood

(*Swietenia humilis*, *S. macrophylla* and *S. mahagoni*)

[Pl. 45, 268–70]

General properties—Sapwood yellowish-white to pale brownish-grey ; heartwood usually pinkish when fresh, darkening on exposure to varying shades of red-brown to brick red, often with a satiny or golden lustre ; usually moderately hard and moderately heavy (sp. gr. 0·54–0·76), straight to interlocked-grained and medium coarse to somewhat fine-textured. Among the samples examined, one sample of *S. mahagoni* is heavily interlocked while the rest are nearly straight or only slightly interlocked-grained. Although a variety of attractive figures is generally found in these timbers, the figure is not so conspicuous in Indian specimens due to their relatively straighter grain.

Gross structure—A diffuse-porous wood. *Growth rings* apparent in most samples, delimited by bands of parenchyma which vary considerably in width from fine and barely visible to the eye to broad and distinct to unaided eye. True annual rings formed by the initial bands of parenchyma are easily distinguishable in discs as concentric bands which are continuous all around the disc. In small samples or portions of a disc, however, it is difficult to distinguish between true and false marks which are quite common. False marks may often be very close to the true growth marks giving the impression of double row of parenchyma cells delimiting the growth rings or sometimes may be spaced wide apart. These can, however, be distinguished by their discontinuous nature in the discs. In addition to initial parenchyma, growth rings are sometimes conspicuous due to the presence of a narrow layer of denser fibrous tissue in the latewood. The rate of growth in most of the samples examined is rather fast and varies usually from less than 2 rings per cm. to about 3 rings per cm. *Vessels* moderately large to small, visible to somewhat indistinct to the eye, few to moderately numerous (3–15 per mm^2), even to unevenly distributed, sometimes being scanty locally, solitary or in radial multiples of 2–3 or more, rarely in clusters or groups, round to oval, often plugged with reddish-brown to reddish-black glistening gum-like substance, occasionally with whitish deposits in some of the vessels ; vessel lines distinct on the longitudinal surfaces, often containing reddish-brown deposits ; occasionally also dark spots may be noticeable apparently due to the oozing out of gum-like substance from the vessels. *Parenchyma* (a) apotracheal, distinct, in brownish bands delimiting growth rings as well as in thick or thin interrupted lines simulating growth marks ; (b) paratracheal forming a thin sheath round the vessels, usually inconspicuous under lens due to lack of contrast in colour between the surrounding tissue, rarely extending sideways and connecting neighbouring vessels. *Rays* moderately broad to fine, visible or indistinct to the eye, usually fairly closely spaced

but always not so ; ray-flecks low but fairly conspicuous which along with twisted or interlocked-grain when present may give rise to beautiful figure in the wood. In Indian grown mahogany, rays are comparatively wider than those from Central America. *Ripple marks* usually indistinct, when present not conspicuous due to the rays being irregularly storied. However, ripple marks are reported to be distinct in timbers grown in their natural habitat, about 20–25 per cm. Due to this, the American mahoganies often show a beautiful figure, giving an effect very similar to the texture of some fabrics. *Gum canals* vertical of traumatic type occasionally present in short or long tangential bands.

Strength—Indian grown timber has not been tested so far at the Institute. However, one consignment consisting of six logs of *Swietenia macrophylla* grown in Malabar was tested in 1931 at the Forest Products Research Laboratory, Princes Risborough, England (20). The results of various mechanical and physical tests carried out on these specimens along with figures obtained in similar tests at the Forest Products Laboratory, Madison, Wisconsin, on Central American Mahogany for comparison are reproduced below. This has been made possible by the kind permission of the Director, Forest Products Research Laboratory, England. The logs tested were from trees approximately 33 years old. The sizes of logs varied from 12′ 3″ to 16′ 3″ in length and 4′ $2\frac{1}{2}$″ to 5′ $9\frac{1}{2}$″ in girth.

TABLE I

Mechanical and physical properties of timber in the green condition grown in India and in Central America

NOTE :—All mechanical properties are expressed in inch and lb. units.

Property	Grown in	
	India	Central America
Static Bending		
Moisture content per cent	33·5	58
Specific Gravity (A)	0·48	0·45
Fibre stress at Limit of Proportionality ..	4650	6120
Fibre stress at Maximum Load	8230	9240
Modulus of Elasticity (1000 lb./sq. in.) ..	1020	1290
Work in lb./cu. inch to Limit of Proportionality	1·18	1·60
Work in lb./cu. inch to Maximum Load ..	6·7	10·2
Work in lb./cu. inch .. TOTAL ..	9·8	

(*contd.*)

TABLE I

Mechanical and physical properties of timber in the green condition grown in India and in Central America—(Concld.)

Type of failure : Compression followed by simple tension

Property	Grown in	
	India	Central America
Compression Parallel to Grain		
Moisture content per cent	33·2	
Specific Gravity (A)	0·471	
Fibre stress at Limit of Proportionality ..	2640	4040
Fibre stress at Maximum Load	4410	4540
Modulus of Elasticity (1,000 lb./sq. inch) ..	1175	
Type of failure : Shear in body of specimen		
Hardness		
Moisture content per cent	32·8	
Specific Gravity (A)	0·478	
Load per impression in lb.		
Radial	924	650
Tangential	907	
End	1080	750
(A) Specific gravity dry, based on dry weight and volume as tested		
Cleavage		
Moisture content per cent	29·7	
Load per inch width in lb.		
Radial	393	
Tangential	444	
Tension perpendicular to grain ..		
Moisture content per cent	35·6	
Load per square in. in lb.		
Radial	662	360
Tangential	740	

The strength properties of Indian grown mahogany as compared with the Central American Mahogany have been summarized by them as follows :—

" 1. The Indian-grown mahogany is approximately 6 per cent heavier than the Central American.

2. The Indian mahogany is about 10 per cent lower in strength value in static bending and is less stiff than the other.

3. In compression parallel to grain, the fibre stress at maximum load which measures the ultimate strength as a strut or column shows that the Indian grown mahogany is only some 2 per cent lower in value.

4. The Indian timber is considerably harder than the Central American, the side grain hardness being about 40 per cent and the end hardness 33 per cent greater respectively.

5. The resistance to splitting as measured by the test in tension perpendicular to grain is considerably greater in the Indian grown mahogany where it is almost double the value of the same property in the Central American timber".

In this connection, recent studies on the plantation-grown and natural-grown mahogany of Central America by Wangaard & Muschler (93) are also of interest. Their conclusions are as follows :—

"In most air-dry properties young plantation-grown Mahogany is surpassed by the slightly heavier wood typical of forest-grown Mahogany. Static-bending strength and crushing strength are lower for plantation-grown material approximately in proportion to its lower density. Modulus of elasticity is, however, very much lower in the case of plantation-grown material than for representative forest-grown timber. The two types of Mahogany are equivalent in shock resistance, and the plantation-grown wood shows greater values for side hardness, compression across the grain, and shear than does forest-grown material. Plantation-grown wood is apparently deficient in tension across the grain and cleavage resistance".

However, the Indian-grown timber specimens examined by us appear to be somewhat heavier than those of Central America. The heavier weight may perhaps be partly due to high infiltration content.

Seasoning—Mahogany is well known for its good seasoning properties. It can be rapidly air-seasoned or kiln-dried easily. It does not normally develop defects like warping or checking unduly. A small consignment of Indian grown *S. macrophylla* tested at the Wood Seasoning Branch of this Institute indicated that the timber is liable to develop fine surface cracks during seasoning. This defect can, however, be avoided by careful handling and stacking of sawn material protected from the sun and hot winds.

Experiments conducted on Indian grown mahogany at Princes Risborough, England have shown that the timber can be kiln-dried with ease and rapidity without any appreciable degrade. It was further observed that the timber had good standing properties. No appreciable cupping was noticed in thin boards recut from seasoned planks.

Shrinkage of mahogany is very low and movement in service is also small. Dickinson and co-workers give the following figure for the plantation-grown and natural-grown *S. macrophylla* :

Source	Shrinkage (per cent)			
	Radial	Tangential	Longitudinal	Volumetric
Plantation-grown Honduras	2·4	4·2	0·42	6·6
Natural-grown Central America	2·7	3·3	..	6·0
Mexico, Nicaragua ..	3·6	5·1	..	9·0

Natural durability—Mahogany has the reputation of being very durable. Pieces of high class furniture lasting over a century are examples of its high durability. It is, however, reported to have little resistance to marine borer attack. Although it is considered to be immune to termites, according to Forest Products Research Laboratory, Princes Risborough, England, it is susceptible to attack by drywood termites in the West Indies.

Insect and fungus attack—The sapwood of mahogany is susceptible to the attack of powder-post beetles (Lyctidae) and is almost never used. Therefore, it is customary in America to remove the sapwood before the logs are shipped. The deadwood is attacked by some Curculionidae and Bostrychidae ; drywood and converted timbers are attacked by *ghoon* borers *Lyctus africanus* Lense and *Minthea rugicollis* Walker (Lyctidae) ; newly felled or fallen wood is attacked by some shot hole borers (Platypodidae and Scolytidae) ; green trees are bored by the larva of *Zeuzera coffeae* Nietner (Corsidae). *Daedalea flavida* – a common decay fungus causing white-rot has been recorded on felled logs of *S. mahagoni*. Dickinson & co-workers report that the plantation-grown mahogany varies "in its resistance to attack by white-rot organism, ranging from moderately durable to very durable. It was consistently very durable in tests involving a brown-rot fungus".

Working qualities—It is one of the foremost timbers among the hardwoods from the point of view of natural beauty and working qualities. It can be easily worked by hand or machine with very little ill-effects on the tools.

Based on the results of various tests like planing, boring, shaping, turning, etc., mahogany can be ranked among the first grade timbers. It finishes extremely well particularly when the timber is straight-grained and takes a high polish on account of which the timber has come into special prominence in the furniture industry in Europe and America holding a premier position among the high class cabinet woods. Due to its pleasing colour, lusture and grain, the timber produces a beautiful figure well-known in the timber trade. In fact, terms like "stripe", "ribbon", "mottle", "fiddle-back", "crotch" and "swirl" were first used in describing various types of figure in mahogany. The famous "crotch" figure is found where the tree forks out into two equal branches. Other well-known types of figure are generally associated with inter-locked and wavy grain. However, in Indian-grown mahogany, such beautiful figure is not usually met with. Indian samples tested at Princes Risborough did not show any characteristic figure and all crotches were found defective. But in working qualities like planing, moulding and recessing and jointing compared favourably with Honduras grown mahogany. Practical tests carried out with this timber have indicated that manufactured articles also retain their shape and size remarkably well like other commercial mahoganies.

Mahogany is an excellent wood for veneer and plywood work and can be peeled without any soaking treatment. Though it is generally considered not good for bending, according to Forest Products Research Laboratory, Princes Risborough, the Indian grown timber possess "moderately good bending properties".

Supply and uses—In India, limited supplies are available from plantations in the south and in West Bengal. The best and largest plantations are in Kerala and better supplies are likely to be available from that State. According to Laurie trees in India are very often badly forked and logs of long lengths are usually not available.

Mahogany first came into use as a ship-building timber in the early part of the sixteenth century. It is reported that Sir Walter Raleigh's ships were repaired in the West Indies with this timber in 1597. In the eighteenth century, it came into prominence in Europe as the chief timber for ship-building. Though later on, mahogany lost its ground to teak, iron and steel in the ship-building industry, it gained an enviable reputation in the field of high class furniture and cabinet making. By the nineteenth century, it became the most favoured timber for select furniture, particularly for carved and ornamental pieces. The timber was greatly admired by Royal households and nobility in England and Europe and this made possible the evolution of various types and styles of furniture, particularly in the 18th and 19th centuries.

The present day uses of this timber are also many. It is still considered to be one of the best furniture woods in spite of changes in taste and fashion.

Besides home and office furniture, fixtures and panelling, it is used in the manufacture of gramophone, radio and television cabinets, pianos and organs, models or patterns, bowls, brush-backs, inlay work, jewellery boxes, medicine cabinets, printers blocks, rulers and slide rules, sewing machine covers and stands, novelties and carved wood work. In ship-building, it is used extensively for hulls of small motor crafts and yachts, deck fittings, skylights and companion wings, cabin fittings, planking, bulwarks, rails, gangway, ladders and others. It is an excellent timber for plywood, and highly figured stock is prized for decorative panelling and furniture.

In India also, mahogany furniture was the fashion in the latter part of the last century as well as in the early part of the present century. Those who could not afford it, used to be content with giving mahogany-like finish to other timbers. Now with the change of taste though it is not so much sought for, it is still ranked amongst the first class cabinet woods. Whenever available, this is used for furniture and cabinet making though Indian grown timber is not highly figured. It is one of the approved timbers for first grade commercial and marine plywood. It is also used for turnery articles and toys. It has also been tried for jute mill rollers with success. Rehman reports that *S. mahagoni* is suitable for second grade pencils.

Material—

S. humilis – 6707 Indian Botanical Garden, Calcutta (0·71).

S. macrophylla – 3923 Indian Botanical Garden, Calcutta (0·54), 6706 Indian Botanical Garden, Calcutta (0·68), 6726 Nilambur, Kerala (0·62).

S. mahagoni – 1361 Indian Botanical Garden, Calcutta (0·68), 4568 Saharanpur Botanical Garden, Uttar Pradesh (0·63), 6708 Indian Botanical Garden, Calcutta (0·67), 6725 Nilambur, Kerala (0·67), 7471 Bhagalpur, Bihar (0·76).

16. WALSURA Roxb.

A small genus of small to medium-sized or fairly large trees which are mainly confined to the Indo-Malayan region. About eight species have been reported from India and Burma, of which four are dealt with here. Among the species not available for study are : *W. candollei* King and *W. hypoleuca* Kurz medium-sized trees occurring in Andaman islands and Burma ; *W. tubulata* Hiern. – *palami, kharri* (Nep.), a tree 12–18 m. in height with a clear bole of 6–9 m. and 1–1·5 m. girth found in Duars in North Bengal and Nowgong and Khasi Hills in Assam ; and *W. multijuga* King a tree of Upper Burma.

The woods of the four species described here are very similar in anatomical structure and cannot be distinguished from one another. However, *W. robusta*

for which only one sample was available was found to differ from others in having the growth rings delimited by fibres only. In minute anatomy, this sample is characterized by hetero-cellular rays while in other species the rays are homo-cellular or nearly so.

1. W. glauca C. E. C. Fischer—A tree up to 24 m. in height occurring in South Tenasserim in Burma.

Description of the wood—See below.

2. W. piscidia Roxb.—*Per illa picha* (Mal.), *mundika* (Or.), *malaivirali*, *velasura* (Tam.), *walurasi* (Tel.). A middle-sized to large tree up to 27 m. in height and 60 cm. in diameter. *Bark* greyish-brown, tessellated, showing a somewhat rectangular pattern, thin. The bark is highly poisonous and is used as a fish poison. It is also used as a hair wash to kill vermin and in the preparation of ointment for itches. The pulp of the fruit is also used as a fish poison.

It is found on the Western Ghats from North Kanara southwards to the Anamalais and Travancore ; also in dry evergreen forests of Mysore, Andhra Pradesh, Orissa and in the southern part of Bihar.

Description of the wood—See below.

3. W. robusta Roxb.—*Lali* (Asm.), *gyobo* (Burma), *mogchouphong* (Cach.), *bol-dublok*, *bol-khrenthi*, *khrauchi* (Garo), *diengsoh-phlang* (Kh.), *theng-rali* (Mik.). A small or middle-sized evergreen tree up to 21 m. in height and 1·5–1·8 m. in girth. *Bark* dark grey or brown, fairly thick.

In Assam it occurs at the foot of the Mikir, North Cachar and Garo Hills. It also grows in the Middle and South Andamans and in the plains and lower hill forests of Pegu Yoma and Tenasserim in Burma.

Description of the wood—See below.

4. W. villosa Wall.—*gyobo* (Burma). A moderate-sized tree, 9–15 m. in height. *Bark* blackish-grey, longitudinally fissured, fairly thick.

It is fairly common in Upper and Lower Burma.

Description of the wood

(*Walsura glauca*, *W. piscidia*, *W. robusta* and *W. villosa*)

[Pl. **46**, 271–274]

General properties—Sapwood and heartwood indistinct in the samples examined. One sample of *W. piscidia*, however, shows a deep red to almost black, concentric and wide zone of tissue in the middle of the sample which appears to be due to some sort of injury in the early life of the tree. Wood varies in colour from grey to greyish-brown, yellow-brown to light red-brown or orange-brown ; very hard, heavy to very heavy (sp. gr. 0·85–0·99 air-dry),

usually coarse and uneven-textured due to numerous parenchyma bands, occasionally may be medium-fine in *W. piscidia*. An inconspicuous "partridge mottling" figure may be noticeable on the tangential surface due to alternate bands of parenchyma and fibres.

Gross structure—A diffuse-porous wood. *Growth rings* usually inconspicuous, delimited by thin lines of parenchyma, sometimes distinct in *W. glauca* and *W. piscidia* due to the presence of dark fibrous tracts with scanty vessels contiguous to the lines of parenchyma, 2–6 per cm.; in *W. robusta* growth rings delimited only by denser zones of fibres with scanty vessels, which may or may not be annual, about 7 per cm. *Vessels* small to very small, indistinct in *W. piscidia* or just visible to the eye as pin pricks in others, usually moderately numerous (9–22 per mm.^{2}) but often more numerous (over 30 per mm.^{2}) in *W. piscidia*, more or less evenly distributed, solitary or in radial multiples of 2–3 or more, mostly 2, round to oval in shape, usually open sometimes filled with whitish or pale brown deposits; vessel lines fine and not conspicuous. *Parenchyma* abundant, visible to the eye mostly as thin to somewhat thick (in *W. villosa*), wavy, paratracheal bands joining several vessels tangentially and sometimes also ending abruptly, arranged more or less at equal intervals alternating with wider bands of fibre except in the region of the growth rings where the parenchyma is poorly developed; also in narrow tangential lines delimiting growth rings, distinct only under the lens. *Rays* fine to very fine, distinct only under the lens, closely spaced; ray flecks low and inconspicuous. *Pith flecks* occasionally present in *W. piscidia*.

Strength—The wood is very hard and strong but has not so far been tested at this Institute. Bourdillon gives the value of P (coefficient of transverse strength) as 947 and weight 59 lbs. for *W. piscidia*.

Seasoning—Seasoning properties of these timbers may not be bad. The samples in the collection are free from cracks, checks or splits except for fine surface cracks noticed in *W. piscidia*. Kanjilal *et al*, however, state that both *W. tubulata* and *W. robusta* are liable to split irregularly. But for the Philippine species, *W. aherniana* Perkins, Reyes mentions that the seasoning qualities are good.

Natural durability—The timber appears to be durable. All the samples in the wood collection are in very good condition and even the oldest samples have not been damaged either by insects or fungus except *W. glauca* which shows slight fungus attack. Both the heartwood and the sapwood of the Philippine species, *W. aheniana* are reported to be resistant to drywood termites and powder-post beetles and very durable for interior work but moderately durable in outside locations or in contact with the ground.

Insect attack—Deadwood of *W. robusta* is attacked by *Xyleborus kraatzi* Eichhoff (Scolytidae).

Working qualities—It is a difficult timber to saw and work but can be brought to a good finish and is also likely to take a fine polish.

Uses—The timber is used locally and is suitable for agricultural implements, cart shafts and axles, and general construction work.

Material—

W. glauca – 6621 Burma (0·98).

W. piscidia – 4232 Cuddapah, Andhra Pradesh (0·99), 4627 Travancore, Kerala (0·96).

W. robusta – 1986 Andamans (0·90).

W. villosa – 6284 Burma (0·88), 6534 Burma (0·95), 7125 Burma (0·85).

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DICHAPETALACEAE

A family of three or four genera and about 125 species of small trees and shrubs which occur throughout the tropics.

Members of this family are not of much commercial importance. The fruits and leaves of some species of the genus *Dichapetalum* are edible. But a few African species of this genus, notably *D. toxicarium* Engl. have fruits and leaves which are highly poisonous to animals. No timber of commercial importance is produced by members of this family. The only genus found in the Indian region is dealt with here.

CHAILLETIA DC. (DICHAPETALUM THOU.)

A large genus of small trees and shrubs which occur in the tropical regions of the world. Four species have been reported from the Indian region of which one was available for study. The species which are not represented in our collection are *C. andamanica* King is a small tree or shrub of the Andamans and *C. helferiana* Kurz and *C. longipetala* Turez are small trees found in Tennesserim.

C. gelonioides Hook. f. [**Dichapetalum gelonioides** (Roxb.) Engl.]—*Moakurra* (*Beng.*), *kili* (Mal.), *dingraliarong* (Mikir), *rokpoletak* (Miri & Abor.). A small tree which in favourable localities attain up to 12 m. in height and 75 cm. in girth. *Bark* greyish-yellow, wrinkled, with prominent lenticels in horizontal lines, thin.

It occurs in Western Ghats from Konkan southwards, Assam, Chittagong Hill tracts, Burma and Ceylon.

Description of the wood

[Pl. **46**, 275]

General properties—Wood pale yellow to yellowish-brown ; moderately hard ; moderately heavy (sp. gr. 0·64–0·68 air-dry) ; straight-grained ; medium-textured, ribbon figure prominent on the radial surface.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to indistinct, delimited by bands of fibrous tissue, about 2 per cm. *Vessels* small to very small, usually indistinct to the eye, numerous (about 27 per mm.^{2}), evenly distributed, solitary or in radial or oblique pairs ; vessel lines indistinct or barely visible to the eye. *Parenchyma* indistinct to eye, just visible under the hand lens, mostly in the vicinity of the vessels forming a sort of sheath, and also occasionally diffuse. *Rays* apparently of two size classes, broad and

fine to very fine, the former distinctly visible to the eye, being of a lighter colour than the ground tissue and widely spaced ; the latter visible only under the hand lens, 3 to 4 between the broad rays ; radial flecks prominent.

The timber has not yet been tested for strength, durability, etc. It appears to be not a strong timber and the samples examined are also discoloured by sap-stain and are badly cracked.

Uses—The timber is not much used at present. Kanjilal *et al* consider the timber to be "capable of being used for agricultural implements, tents pegs, etc." It appears to be suitable for light constructional work after treatment.

Material—

5473 Belgaum, Mysore (0·68), 6508 Burma (0·64).

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S. K. PURKAYASTHA.

OLACACEAE

A family of trees, shrubs and climbers occurring in the tropics and subtropics. About 22 genera and more than 250 species are included in the family.

From the point of view of commercial products, the family is not of much importance. Fruits of a few species are edible. The kernel of *Ximenia americana* Linn., yields a product that has been used as a substitute for *ghee*. The timbers are mostly used locally. However, well known among them is the Manwood or Black Manwood, *Minquaria* sp., of South America which has the reputation of being very strong and durable and is much in demand for railway sleepers and house posts (16). *Ximenia americana* is sometimes used as a substitute for sandalwood.

Olacaceae is represented in the Indian region by about 10 genera, six of which were available for study.

The woods vary in colour from pale yellow to reddish-brown, mostly hard and moderately heavy to heavy. They are characterized by small to very small vessels (except *Olax*) and diffuse to diffuse-aggregate parenchyma (except *Schoepfia*). The rays are fine to very fine with the solitary exception of *Phlebocalymna*.

Key to the genera

1. Parenchyma distinct to the eye in wavy bands .. *Schoepfia*
1. Parenchyma indistinct to the eye, diffuse to diffuse-aggregate 2
   2. Vessels mostly in radial multiples of 2–4 .. *Anacolosa, Strombosia*
   2. Vessels mostly solitary 3
3. Rays prominent to the eye .. .. *Phlebocalymna*
3. Rays not visible or just visible to the eye .. 4
   4. Vessels moderately large, 5–19 per mm.^{2}, wood pale yellow, moderately heavy .. *Olax*
   4. Vessels small, 25–48 per mm.^{2}, wood reddish-brown, heavy .. .. .. *Ximenia.*

1. ANACOLOSA Bl.

A genus of trees or shrubs of the Indo-Malayan area. Four species have been reported from the Indian region of which only one was available for study.

The species not available for study are (1) *A. ilicoides* Mast., a small tree of Khasi Hills and Upper Burma ; (2) *A. griffithii* Mast., a shrub or a small tree of Tenasserim and (3) *A. puberula* Kurz, a large shrub of the Andamans.

A. densiflora Bedd.—*Kai-adi, kalmanikkom, katta vekkali, malam kara, mottakayadi* (Mal.), *kalmanikkam, kal pottan, katta vekkali* (Tam.). A large tree occurring in the Anamalais and Travancore hills up to 750 m.

Description of the wood

[Pl. **46**, 276]

General properties—Sapwood large, grey to yellowish-brown, heartwood pink to reddish-brown ; hard to very hard ; very heavy (sp. gr. 0·96 air-dry) ; straight-grained ; very fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to indistinct, delimited by fibrous tissue which may or may not be annual, 3–5 per cm. *Vessels* very small, barely visible under the hand lens, numerous (about 25 per mm.^{2}), more or less evenly distributed, solitary or in radial multiples of 2–4 with a tendency for radial alignment ; vessel lines indistinct or barely visible to the eye. *Parenchyma* visible only under hand lens, diffuse or diffuse-aggregate forming an irregular network with the rays. *Rays* very fine, indistinct to the eye, visible only under hand lens, rather closely spaced.

The timber has not yet been subjected to a full scale test at Dehra Dun. Bourdillon gives the value of P (coefficient of transverse strength) = 630 and weight 46 lb. per c. ft. His experiments appear to have been conducted with unusually light samples. The sample examined, however, is badly split. Both Bourdillon and Rama Rao also state that it splits badly.

Uses—According to Chowdhury and Ghosh "It is a strong timber suitable for constructional purposes and for house posts. It also turns well and may be used for making toys and small articles of novelty".

Material—

6194 Tinnevelly, Madras (0·96).

2. OLAX LINN.

A genus of small trees, shrubs or climbers which inhabit the tropical regions of the old world. About five species are indigenous to Indian region of which one was available for study.

O. scandens Roxb.—*Koko-aru* (Beng.), *lelaw, lelu* (Burm.), *dheniani, arthil* (Hind.), *karru* (Kan.), *madalkura* (Khond), *rimmel* (Kol.), *harduli, urchiri* (Mar.), *bodobodoria* (Or.), *ehir* (Sant.), *kadalranchi* (Tam.), *kurpolur*,

murki malle, tigenaku, turkavepa (Tel.). A large rambling or climbing shrub. *Bark* grey, thick.

It occurs in the sub-Himalayan tract in Kumaon, in Bihar, Chota Nagpur, South India, Chittagong and Burma.

Description of the wood

[Pl. 47, 277]

General properties—Wood pale yellow to light yellowish-brown, moderately hard, moderately heavy (sp. gr. 0·57–0·73 air-dry); straight to twisted-grained and medium-textured.

Gross structure—A diffuse-porous wood with a tendency for semi-ring-porousness. *Growth rings* distinct to indistinct delimited by somewhat dark coloured fibrous tissue having very few vessels and also occasionally due to the difference between the early and latewood vessels, 3–5 per cm. *Vessels* usually moderately large to small, occasionally large to very large in places, moderately few to moderately numerous (5–19 per mm.^{2}), rather unevenly distributed, usually more crowded and larger in the early part of the ring, mostly solitary, round to oval, usually open but plugged with tyloses in one sample ; vessel lines distinct to the eye. *Parenchyma* visible only under hand lens, diffuse to diffuse-aggregate. *Rays* fine to very fine just visible to the eye, closely spaced, radial flecks indistinct.

No information is available regarding the strength and other properties of the wood. From the examination of the samples in our collection, the wood appears to be refractory to seasoning and prone to borer attack.

Uses—The wood is not at present used for purposes other than fuel.

Material—

1184 Ahiri Reserve, Bombay (0·61), 2762 Moharli Reserve, Madhya Pradesh, 3467 Singhbhum, Bihar (0·67), 3494 Singhbhum, Bihar (0·63), 3820 Ganjam, Orissa (0·73).

3. PHLEBOCALYMNA GRIFF.

A genus of small trees and shrubs confined to the Indo-Malayan region. Of the two species reported from Burma, one was available for study and is described here.

P. griffithiana Mast. (**Gonocaryum griffithianum** Kurz)—*Wun-the-gye, wun-the-che* (Burm.). A shrub or small tree occurring in Martaban and Tenasserim.

Description of the wood

[Pl. 47, 278]

General properties—Wood pale yellow; moderately hard; moderately heavy (sp. gr. 0·67 air-dry); straight-grained and medium-textured, with prominent silver-grain effect on the radial surface.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to indistinct, delimited by darker coloured fibrous tissue, which may or may not be annual, about 2 per cm. *Vessels* small to very small, not visible or just visible to the eye, moderately numerous (11–20 per mm.^{2}), mostly solitary, occasionally a few appearing to be in tangential or oblique pairs, roundish, open ; vessel lines barely visible to the eye. *Parenchyma* visible only under hand lens, diffuse to diffuse aggregate. *Rays* apparently of two types broad to very broad, distinct to the eye and fine to very fine visible only under hand lens, the former widely spaced and the latter 4–5 between the broad ones ; radial flecks distinct.

Uses—The timber is not much used at present. It may be tried for decorative purposes where its beautiful silver-grain can be profitably utilized.

Material –

6392 Burma (0·67).

4. SCHOEPFIA SCHREB.

A genus of shrubs and small trees distributed throughout the tropics. Of the two species growing in the Indian region, one was available for study and is described here.

S. **fragrans** Wall.—*Kop-kwai* (Burm.), *dieng-khaokhorai*, *dieng-shlengkhlaw*, *so-kymphurkhlaw* (Kh.), *dieng-sa-niriang-blai*, *dieng-sarumi* (Synt.). A tree up to 12 m. in height and 30 cm. in girth. *Bark* whitish, corky.

It occurs in the Khasi Hills at 900–1,800 m. and in Upper Assam and in Tenasserim.

Description of the wood

[Pl. 47, 279]

General properties—Wood pale yellow, but greyish in patches due to discolouration ; lustrous ; moderately hard ; moderately heavy (sp. gr. 0·59 air-dry) ; straight-grained, fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct, delimited by more or less continuous bands of parenchyma and also by thinner bands of parenchyma in the latewood, about 1 ring per cm. *Vessels* small to very small, individually indistinct, but vessel multiples appear as pin-pricks to the naked

eye, numerous (12–20 per mm.^{2}) ; evenly distributed ; mostly in radial multiples of 2–3 ; occasionally solitary, open, round ; vessel lines indistinct to the eye. *Parenchyma* visible to the eye, in wavy paratracheal bands which end abruptly. *Rays* fine to very fine, indistinct or just visible to the eye, fairly closely spaced, radial flecks inconspicuous. *Ripple marks* not visible, sometimes only a suggestion of ripple marks visible under hand lens.

No information is available regarding the properties of the wood of this species. Record and Hess, however, state that the American species are "very easy to work, taking a lustrous natural polish ; durability probably rather low". The specimen examined was discoloured in places by sap-stain.

Uses—The timber is not used at present. It may be tried for cabinet work.

Material—

6575 Burma (0·59).

5. STROMBOSIA Bl.

Evergreen trees or shrubs of this genus occur in the tropical Africa and in the Indo-Malayan region. Two species have been reported from India which are described here.

1. **S. ceylanica** Gardner—*Kalavarai, kalkadamba* (Mal.). A large tree. *Bark* white, scaly.

It is found in the Western Ghats from Konkan southwards but nowhere in abundance.

Description of the wood—See below.

2. **S. javanica** Bl.—*Dedali* (Malaya). A large tree up to 24 m. in height and 1·2 m. in diameter.

It occurs in Tenasserim, Malaya and West Java.

Description of the wood—See below.

Description of the wood

(*Strombosia ceylanica* and *S. javanica*)

[Pl. 47, 280–81]

General properties—Sapwood and heartwood not distinguishable in the specimens examined. Wood yellowish-brown in *S. javanica*, pale brown with a pinkish tinge in *S. ceylanica* ; lustrous ; moderately hard (*S. javanica*) to hard (*S. ceylanica*) ; moderately heavy (sp. gr. 0·65 air-dry) in *S. javanica*

to heavy (sp. gr. 0·85 air-dry) in *S. ceylanica* ; straight-grained in *S. ceylanica* but interlocked-grained in *S. javanica* ; fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct but occasional bands of fibrous tissue devoid of vessels, or zones of more numerous vessels may, however, give the impression of growth rings. *Vessels* small to very small, indistinct to the eye, but the vessel multiples may sometimes be visible as pin-pricks, numerous (23–44 per mm.^{2}) ; mostly in radial multiples of 2–3 or more, radially aligned, round to oval, open or filled with tyloses. *Parenchyma* visible only under hand lens, diffuse to diffuse-aggregate. *Rays* fine to very fine, just visible under hand lens, closely spaced.

No information is available for strength and other properties of *S. ceylanica*. According to Foxworthy, *S. javanica* is easy to work and retains its shape well but difficult to polish and splits badly if freshly cut logs are left exposed to sun. The experiments conducted by Foxworthy showed that the timber lasts for more than five years in contact with the ground. Kent, as quoted by Burkill, tested specimens of *dedali* wood (*S. javanica*) from two sources and found it considerably less elastic than many other woods he had examined. The Philippine species *S. philippinensis* (Baillon) Rolfe (sp. gr. 1–1·22 air-dry), is reported (17) to be " very strong ; subject to checking when seasoned in large pieces ; for a hardwood it is not difficult to work and takes a high polish ; heartwood durable ".

Uses—In Malaya, *S. javanica* was formerly extensively used for house building but now as sufficient supplies are not available it is not much used. *S. ceylanica* is also not available in large quantities. However, it appears to be suitable for constructional purposes. It may be worthwhile trying for bobbins and shuttles.

Material—

S. ceylanica – 7644 East Kanara, Mysore (0·85).

S. javanica – 6318 Burma (0·65).

6. XIMENIA PLUM. EX LINN.

A genus of shrubs or small trees which occur in the tropical zone of the world. The only species found in the Indian region is described here.

X. americana Linn.—*Pinle-kayin, pinlezi* (Burm.), *kandarakkarai, nakkarai, nekri* (Kan.), *chiru-illanti, kadaransi, kalai, kaltanji, madukarai, shenkarai, siruyilandai* (Tam.), *billa, kondanakkera, nagaragandanam, naggiri, uranakkera, uranechra* (Tel.). A spiny shrub attaining up to 4·5 m. in height and a girth of 10–13 cm. in South India. According to Record and Hess in Central America it grows up to 9 m. in height. *Bark* reddish-brown, rough with deep fissures.

It is a root parasite with a very wide distribution in the tropics mostly in the coastal regions. In the Indian region it is found in the dry forests of Andhra, Madras, Mysore and Bombay and in the coastal regions of Andamans and Tenasserim.

Description of the wood

[Pl. 47, 282]

General properties—Sapwood yellowish-brown, heartwood reddish-brown; slightly lustrous; very hard; heavy (sp. gr. 0·90 air-dry); reported to have mild fragrant smell when fresh (6, 11), but the specimen examined did not have any smell; twisted-grained; fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to indistinct, delimited by darker bands of fibrous tissue and also occasionally by zones of more numerous vessels, which may or may not be annual, about 6 per cm. *Vessels* small, barely visible to the eye, numerous to very numerous (25–48 per mm.^{2}), more or less uniformly distributed but with a tendency to form zones of more numerous vessels, as a rule solitary, round, mostly filled with yellowish-brown gummy deposits; vessel lines inconspicuous. *Parenchyma* indistinct even under lens. *Rays* fine to very fine, not visible to the eye, not very distinct even under the hand lens, due to the lack of difference in colour between the rays and the ground tissue, closely spaced; radial flecks inconspicuous.

According to Record and Hess the wood is "not difficult to work, taking a high natural polish; durability rather high".

Uses—The wood is reported to be pleasantly scented when fresh and is sometimes powdered and substituted for sandalwood. It is suitable for the manufacture of turnery articles and other small articles like toys, etc.

Material—

3986 Cuddapah, Andhra Pradesh (0·90).

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S. K. PURKAYASTHA.

ICACINACEAE

A family of about 60 genera and 200 species of trees, shrubs and woody climbers distributed widely in the tropics.

From economic point of view, the family is not of much importance. The leaves of *Citronella gongonha* (Mart.) Howard of South America are, however, sometimes used as a substitute for the true "Mate" or Paraguay tea produced by *Ilex paraguensis* St. Hil. As regards wood, *Ottoschulzia* Urb. of West Indies is rather hard and strong, and used for fancy turnery articles, etc. *Poraqueiba sericea* Tul., is reported to be used to a limited extent in Brazil for carpentry and general construction (12). In South Africa, *Apodytes dimidiata* E. Mey., is used for felloes of carts and wagons (4). In Malaya, *Cantleya corniculata* (Becc.) Howard is occasionally used for furniture and constructional purposes (5).

The wood anatomy of the family has been worked out in great detail by Bailey and Howard (1). On the basis of vessel character the sub-family Icacinoideae, to which all but 3 genera of the family belong, has been divided into three groups : (I) vessels of both primary and secondary xylem with scalariform perforations, (II) vessels of the secondary xylem with both scalariform and simple perforation, and (III) vessels of the secondary xylem with simple perforation. In group I, the vessels are numerous and isolated from one another, and more or less uniformly distributed throughout. In group III, on the contrary, the vessel multiples are of common occurrence. In group II, the distribution of the vessels is variable and appears to hold intermediate position between group I and group III. This difference in vessel distribution and vessel perforation has also been found to be correlated with the nodal structure. The first two groups of plants have trilacunar (primitive) nodes while the third group consists of genera with unilacunar (advanced) nodal structure. The parenchyma distribution has also been found to be somewhat related to the vessel distribution. In group I, the parenchyma is dominantly diffuse or apotracheal type. In group II, it is transitional and variable and in group III, it occurs in varying mixtures of apotracheal and paratracheal types.

Included phloem occurs in the climbing shrubs of the tribe Sarcostigmateae and the stems of the climbing plants of the tribes Iodeae and Phytocrene exhibit various types of anomalous structure. The three genera described here fall into three different categories of Bailey and Howard – *Apodytes* in group I ; *Gomphandra* (*Stemonurus*) and *Mappia* in group II and III, respectively, and are, therefore, easily recognisable.

The family is represented in the Indian region by about 10 genera of mostly climbing shrubs. The three arboreal genera are dealt with here.

Key to the genera

1. Parenchyma in tangential bands; vessels arranged in radial multiples of 2–3 .. .. *Mappia*
1. Parenchyma diffuse to diffuse-aggregate. Vessels mostly solitary 2
   2. Rays fine to very fine, barely visible to the naked eye .. .. .. *Apodytes*
   2. Rays very wide, prominent to the naked eye *Gomphandra*.

1. APODYTES C. E. MEY.

A small genus of trees and shrubs which are natives of tropical Asia and Africa. Three species have been reported to grow in the Indian region, of which the wood of only one species was available for study. The remaining two are *A. benthamiana* Wight. and *A. beddomei* Mast., occurring in the Western Ghats, in the evergreen forests of Nilgiris, Anamalais and Travancore. The former has also been recorded in Assam.

A. cambodiana Pierre.—An evergreen tree of Burma, attaining a height of about 20 m.

Description of the wood

[Pl. **48**, 283]

General properties—Wood greyish-brown, moderately hard, moderately heavy (sp. gr. 0·76 air-dry) ; somewhat twisted grained ; fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct but occasionally bands of darker coloured fibrous tissue devoid of vessels may give the impression of growth rings. *Vessels* moderately large to just visible to the eye, moderately numerous to numerous (16–26 per mm.^{2}), evenly distributed, predominantly solitary, but occasionally due to scalariform perforation plates or due to overlapping of vessel ends appear in pairs, oval, open ; vessel lines indistinct. *Parenchyma* distinct only under hand lens, diffuse to diffuse-aggregate forming indistinct network with the rays. *Rays* fine to very fine, slightly broader ones visible to the eye after moistening, distinct under hand lens, the finer ones barely visible with lens, rather closely spaced.

No information is available regarding the properties of this timber. But some information available (4) on South African species *A. dimidiata* may be useful as an indication of the properties of this timber. *A. dimidiata* is said to

saw freely and plane evenly and smoothly by hand or machine taking a high polish. But it is not durable. The central portion of the log is usually discarded as it shrinks unevenly and splits. Apart from the central portion, the wood seasons well and has an average linear shrinkage of 7 per cent from green to air-dry condition.

Uses—The South African species is almost entirely used for felloes of cart and wagon. Pieces too small for felloes are used for spokes and handles.

Material—

6816 Salween, Burma (0·76).

2. GOMPHANDRA WALL.

A genus of shrubs and small trees which are natives of tropical Asia and Australia. About six species grow in India and Burma. Two wood samples, one of *G. polymorpha* Wight. and another marked *G. axillaris* Wall. [*Stemonurus axillaris* (Wall. ex Lindl.) Miers.] from Travancore were available for study. The latter specimen may also belong to *G. polymorpha* Wight., because *G. axillaris* Wall., is said to be confined to Khasi and Jaintia hills of Assam. Both the samples have been lumped together and described under *G. polymorpha.*

G. polymorpha Wight. (**Stemonurus polymorpha** Miers.)—*Kambuli* (Tam.). A large shrub to a small tree. *Bark* pale greyish-brown, thin.

It is found in the Western Ghats from North Kanara southwards, Nilgiris and Anamalais up to 1,800 m. elevation, also in Ceylon.

Description of the wood

[Pl. 48, 284]

General properties—Wood greyish-brown ; soft ; light (sp. gr. 0·50–0·59 air-dry) ; straight-grained, coarse-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct but occasionally concentric bands of darker coloured fibrous tissue may give the impression of growth rings. *Vessels* small, indistinct to barely visible to the eye, moderately few to moderately numerous (8–19 per mm.^{2}), evenly distributed, mostly solitary, occasionally in oblique or tangential pairs due to overlapping of vessel ends or due to scalariform perforation plates, oval, open ; vessel lines indistinct. *Parenchyma* indistinct to the eye, distinct under hand lens, diffuse to diffuse-aggregate, forming a sort of an ill-defined network with the rays. *Rays* very broad, lighter in colour than the ground tissue, prominent to the eye, widely spaced ; ray flecks prominent.

The timber is soft and perishable. Bourdillon gives the co-efficient of transverse strength (P) = 358.

Uses—It is suitable for the manufacture of light packing boxes.

Material—

3816 Nilgiris, Madras (0·59), 4619 Travancore, Kerala (0·50).

3. MAPPIA Jacq.

A genus of trees and shrubs occurring in tropical Asia and America. Besides the species dealt with here, three more species have been reported to grow in the hills of South India. But Brandis considers them to be the same.

M. foetida Miers. [**Nothapodytes foetida** (Wt.) Sleum.]—*Hedare, kodsa, peenari* (Kan.), *ganera, kala-gaura, kalgur* (Mar.), *arali, chorla* (Tam.). A large shrub or a medium-sized tree up to 9 m. in height and 45 cm. in diameter. *Bark* greenish-grey, rough and wrinkled.

It occurs in Western Ghats from Konkan southwards, in Nilgiris and Aanamalais at 1,500–2,150 m. elevation, in the hills of North Bengal at 1,800 m. elevation and also reported from Lakhimpur, Assam.

Description of the wood

[Pl. 48, 285]

General properties—Wood yellow, turning pale yellowish-brown on exposure ; moderately hard ; moderately heavy (sp. gr. 0·57 air-dry) ; straight-grained ; medium-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to indistinct, delimited by thin lines of parenchyma, 3–4 per cm. *Vessels* small to very small, distinct only under lens, moderately numerous (9–18 per mm.^{2}), evenly distributed, mostly in radial multiples of 2–3, and occasionally more, oval, open ; vessel lines indistinct. *Parenchyma* abundant, distinct to the eye, in fairly thick lines or thin bands, usually in short and slightly undulating lines in the middle of the ring and fairly straight continuous bands in the early and latewood. *Rays* apparently of two types, moderately broad and very fine ; the former distinct to the naked eye, widely spaced and the latter just visible under the hand lens, closely spaced between the broader rays.

The timber is susceptible to insect and fungus attack. The dry wood is liable to be attacked by *Stromatium barbatum* Fabr. (Cerambycidae). The sample examined is discoloured in places by sap-stain. According to Record and Hess, the wood of the American species *M. racemosa* Jacq. is moderately hard and strong, having good working qualities and probably low in resistance to decay.

Uses—It is suitable for packing boxes and internal fittings.

Material—

5692 Coimbatore, Madras (0·57).

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S. K. PURKAYASTHA.

AQUIFOLIACEAE

The family consists of 4 or 5 genera and about 300 species of shrubs and small to rarely large trees. It is widely distributed in temperate and tropical regions of the world, although rare in Africa and Australia.

The economic value of the family centres round the genus *Ilex* Linn. Mate or Paraguay tea is made from the leaves of *I. paraguensis* St. Hil., of South America. Leaves of a few other species of *Ilex* are also sometimes used for making beverages like tea (14). The evergreen glossy leaves and bright red fruits especially of *I. opaca* Ait., the American Holly, are extensively used for Christmas decorations. A decoction of the roots of *I. cymosa* is reported to be used for curing fever in Malaya (3). From the point of view of commercial timbers, the most important species is *Ilex opaca* Ait., the American Holly, a small tree of eastern United States, and *I. aquifolium* L., the European Holly, an evergreen tree indigenous to western Asia and Europe. The whitish wood is chiefly used for turnery, carvings, inlay work and occasionally dyed black to imitate ebony, specially for piano keys (2). Other species are also put to use in a limited extent for same uses as the American and European Hollies. However, Record and Hess state that the wood of the largest tree, *I. guianensis* (Aubl.) Kuntze of tropical America, which grows to a height of 40 m. is inferior in texture and colour to the Holly wood of commerce.

The family is represented in India by a single genus namely *Ilex* Linn. The woods of the other genera of this family are also reported to be similar to *Ilex* in appearance and structure with the exception of *Nemopanthes* Rafin of North-East America, which is ring-porous. According to Dadswell and Record, the woods of the genera *Byronia* Endl., *Nemopanthes* Rafin and *Phelline* Labill., have less conspicuous rays than *Ilex*.

ILEX LINN.

A large genus with over 250 species of shrubs or small trees, widely distributed in both temperate and tropical regions of the world, being well represented in Brazil and Guiana. About 25 species are reported to grow in the hills of India and Burma of which 9 are described here.

The woods show considerable variation in general properties like weight, hardness and texture as well as in anatomical structure, particularly in the size and arrangement of vessels. But since the number of samples available for study was too small for drawing any definite conclusion, no key for separating the various species is given here and the woods have been grouped together

for the purpose of description. However, *I. hookeri* can be easily distinguished from the rest by the flame-like arrangement of the vessels, and heavy weight. Again, the wood of *I. godajam* and *I. sulcata* are also distinct from the others because of larger and fewer vessels in them.

1. **I. denticulata** Wall.—*Thudai* (Kan.). A large tree. *Bark* grey, somewhat rough, 13 mm. thick.

It is common in Western Ghats, Sholas of Nilgiris and Anamalai at 1,800–2,450 m. elevation.

Description of the wood—See page 177.

2. **I. dipyrena** Wall.—*Ilso, thinkiyo* (Dotial), *gardar, kandai, kandela, kandir* (Garh.), *kanderu* (Jauns.), *kandai, kandailo banj* (Nep.), *diusa, dodru, drunda, kadera, kalucho, kandara, kanderu, kandlar, kandlu, kanjlu, kanjru, karelu, kateru, krucho, shangula* (Punj.). A small to medium-sized tree, attaining a height of 9–12 m. and having a clear bole of 1·5–4·5 m. and a girth of 60–90 cm. Trees of much larger girth have also been recorded. *Bark* thin, light grey or dark grey, smooth, often with large horizontal wrinkles and sometimes with conspicuous vertical lines of lenticels.

It occurs throughout the Himalayas at 1,500–3,200 m. elevation from Jhelum valley eastwards to Bhutan, common in shady oak forests.

Description of the wood—See page 177.

3. **I. godajam** Colebr.—*Born-bokul, hati-kerepa, tirsam* (Asm), *protharong, theng-sang, theng turni* (Mik.), *theng-ngoitheh* (Tipp.). A small to large deciduous tree, often attaining over 30 m. in height with a clear bole of 6–7·5 m. and about 2·5 m. in girth. *Bark* pale, ashy smooth, excepting for warts and fine close horizontal wrinkles.

It grows in the *Tarai* regions of Darjeeling and Sikkim in sal forests, extending to Assam and Sylhet.

Description of the wood—See page 177.

4. **I. hookeri** King—*Lisay, lisc* (Nep.). A small tree. *Bark* grey, somewhat rough, 3 mm. thick.

It is met with in Sikkim Himalayas at 2,750–3,050 m. elevation common in *Rhododendron* forest on mount Tonglu. It is also found in China.

Description of the wood—See page 177.

5. **I. insignis** Hook. f.—*Tonglong kung* (Lep.), *hare* or *lise, lasumi* (Nep.). A small evergreen tree 6–12 m. in height and 60–150 cm. in girth with a clear bole of 1·5–4·5 m. *Bark* grey and smooth.

It is a small tree of Darjeeling and Sikkim hills at 1,600–2,450 m. elevation.

Description of the wood—See page 177.

6. **I. odorata** Ham.—*Son* (Dotial), *gadaru, gadgair* (Garh.), *gadkan-ira, gadmel, garkanla, garshun* (Kumaon). A small evergreen tree up to 12 m. high and 1·2 m. girth. *Bark* pale brown, slightly rough owing to the presence of raised circular lenticels.

It is found in the outer ranges of the Himalayas, Simla to Nepal and Sikkim, ascending to 900–1,800 m. elevation.

Description of the wood—See below.

7. **I. sulcata** Wall. [**I. umbellata** (Wall.) Loes.]—*Bikha-kulia, kotoki* (Asm.), *bol, bol-thajong, mikachhak* (Garo), *dieng-jali* (Kh.), *cheknam, theng-pisumi* (Mik.). A shrub or medium-sized tree. *Bark* greenish-white outside, plain or with shallow horizontal wrinkles.

It occurs generally in deciduous forests at low elevations in Khasi and Garo hills of Assam. It is also distributed in Sylhet and Burma.

Description of the wood—See below.

8. **I. venulosa** Hook. f.—*Dieng-lalih, dieng-soh-saw* (Kh.). A shurb or moderate-sized tree. *Bark* grey, fairly smooth.

It grows in Khasi and Naga hills of Assam at 1,200–1,700 m. elevation.

Description of the wood—See below.

9. **I. wightiana** Wall.—*Horralu* (Badaga), *hurulu* (Kan.), *vellodai, velloday* (Tam.). A large tree, often attaining a great girth. *Bark* greyish-white, smooth, 13 mm. thick.

It is distributed along Western Ghats, common in the Sholas in Nilgiri hills, less so in Anamalais and Travancore hills.

Description of the wood—See below.

Description of the wood

(*Ilex denticulata, I. dipyrena, I. godajam, I. hookeri, I. insignis, I. odorata, I. sulcata, I. venulosa* and *I. wightiana*)

[Pl. **48**, 286–288 ; **49**, 289–292]

General properties—Wood white or greyish-white turning pale greyish to yellowish-brown on exposure ; moderately hard to hard ; light to heavy but mostly moderately heavy (sp. gr. 0·50–0·79 air-dry) ; straight to slightly twisted grained ; medium-fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct, but occasionally fine lines of denser fibrous tissue along with tangential rows of vessels may give the impression of growth rings. *Vessels* very small, just visible under hand lens and very numerous (over 50 per mm.^{2}), appearing as pin pricks to the unaided eye and moderately numerous to numerous (12–22

per mm.^{2}) in *I. godajam* and *I. sulcata*; mostly in radial multiples of 2–3, more or less uniformly distributed but with a tendency in some to be grouped into long radial rows as in *I. dipyrena* and arranged in flame-like pattern in *I. hookeri*; usually not filled with any deposits; vessel lines barely visible in *I. godajam* and *I. sulcata* and indistinct in the rest. *Parenchyma* diffuse, visible under hand lens only in *I. godajam* and *I. sulcata* and sometimes also in *I. insignis* and *I. odorata* but indistinct in other species. *Rays* apparently of two types, broad and fine; the former distinct to the eye and widely spaced; and the latter barely visible under hand lens, closely spaced between the broad ones; radial flecks distinct. *Pith flecks* observed only in one sample of *I. dipyrena*.

No recent information on the properties of the timber is available. According to Beddome the wood of *I. denticulata* is much valued and said not to warp or crack but Gamble says that it is not held in much esteem on the Nilgiris, and the specimens warp a good deal. Troup states that *I. dipyrena* is hard and close grained and it seasons and polishes well. But from the examination of the samples available for study, the timber appears to be refractory to seasoning as most of the specimens have cracked or warped. The Holly wood of commerce is also reported to shrink considerably and requires considerable care in drying to avoid checking and warping. According to Brown and Panshin, the American Holly is moderately strong in bending, moderately weak in end-wise compression and high in shock resistance. It carves, turns and works well with tools and is not durable in contact with the ground. The Indian species are also likely to have similar properties.

The timber is easily susceptible to borer attack. Specimens of *I. dipyrena*, *I. sulcata* and *I. wightiana* studied, are damaged by borer attack. Detailed information available for three species is given below :—

I. dipyrena—Drywood is attacked by *Stromatium barbatum* Fabr. (Cerambycidae); newly felled or fallen wood is attacked by some shot-hole borers (Platypodidae and Scolytidae).

I. hookeri—Deadwood is attacked by *Megopis tibialis* White (Cerambycidae) and *Xenomimetes sikkimensis* Marshall (Curculionidae).

I. wightiana—Drywood is liable to be attacked by *Stromatium barbatum* Fabr. (Cerambycidae).

Uses—It is suitable for all purposes for which European and American Hollies are used, provided the timber is seasoned well. It is useful in the manufacture of turnery articles like bowls, platters, etc., mathematical instruments, carvings, inlay work, novelties and cabinet work.

Material—

I. denticulata – 4050 Nilgiris, Madras (0·58), 6460 Nilgiris, Madras (0·63).

I. dipyrena—21 Simla, Himachal Pradesh (0·69), 4765 Tehri-Garhwal Uttar Pradesh (0·69).

I. godajam – 7166 Burma (0·68).

I. hookeri – 5087 Darjeeling, West Bengal (0·79).

I. insignis – 355 Darjeeling, West Bengal (0·60), 3407 Darjeeling, West Bengal (0·64).

I. odorata – 256 Garhwal, Uttar Pradesh (0·50).

I. sulcata – 6749 Burma (0·74).

I. venulosa – 7977 Assam (0·61).

I. wightiana – 3874 Nilgiris, Madras (0·55).

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S. K. PURKAYASTHA.

CELASTRACEAE

The family comprises of about 50 genera and 400 species of trees, shrubs and woody climbers distributed all over the world with the exception of sub-arctic and arctic zones. Geological history of the family shows that some of the genera were distributed in Greenland, and Alaska during Cretaceous and Tertiary Periods though they are not growing there at present (1, 20).

The family is not of much economic importance. Several *Euonymus* species such as *E. europaeus* Linn., and *E. alatus* Reg. are grown ornamentally. The even-grained and fine-textured woods of the small trees are used locally for carving and engraving purposes and also for turnery articles. Small branches of *Euonymus* spp., are often used for walking sticks, watch-maker's pegs and tooth picks.

Out of the 13 genera of *Celastraceae* occurring in India, 9 have been dealt with here. Of the remaining 4 which are not taken into consideration, *Hippocratea* Linn., and *Celastrus* Linn., are scandent shrubs, *Salacia* Linn., is a climbing shrub and *Glyptopetalum* Thw., is an erect shrub.

The woods of the *Celastraceae* range in colour from white to various shades of brown. The heartwood is usually not distinct. The weight and hardness fluctuate between wide limits from soft and light to hard and heavy. The texture is even and ranges usually from medium to fine. Woods are usually diffuse-porous but with a tendency for ring-porousness in some species and distinctly ring-porous in *Celastrus*. The vessels are mostly medium-sized to small. They occur singly or in short multiples. Tyloses are usually wanting. Parenchyma which is distinct under hand lens, is commonly in thick or thin tangential lines* but indistinct in *Euonymus* and *Siphonodon*. Rays are fine to very fine and closely spaced.

Key to the genera

1. Parenchyma indistinct under hand lens .. 2
1. Parenchyma distinct under hand lens .. 3
   2. Vessels very numerous, indistinct or barely visible under hand lens .. .. *Euonymus*
   2. Vessels moderately numerous, moderately large and distinct under hand lens *Siphonodon*
3. Parenchyma in short interrupted lines forming a sort of net-work with the rays .. .. *Kurrimia*
3. Parenchyma in more or less continuous bands .. 4

* In *Gymnosporia*, the tangential bands which look like parenchyma under the hand lens are actually made of septate fibres. In *Elaeodendron*, on the other hand, the bands are composed of a mixture of septate fibres and parenchyma (22). According to Metcalfe and Chalk, in some genera of this family including the above two genera, the bands may be composed of septate fibres in one species and of parenchyma in another.

4.	Vessels in long radial chains ..	.. *Microtropis*
4.	Vessels not in chains ..	.. 5
5.	Bands of Parenchyma thin ; wood light	.. *Lophopetalum, Kokoona littoralis.*
5.	Bands of Parenchyma thick ; wood heavy	.. *Elaeodendron, Gymnosporia, Kokoona filiformis, Pleurostylia.*

1. ELAEODENDRON JACQ. FIL.

The genus *Elaeodendron* comprises of 30 species of small trees or shrubs distributed in the tropical and sub-tropical regions of the world. They are natives of South Africa, tropical Asia, America, Australia and the Malaya Archipelago. In the Indian region two species have been reported to grow of which one is dealt with here. The other species which was not available for study is *E. subrotundum* King, a small tree growing in Andaman Islands.

E. glaucum Pers.—*Raj-jehul* (Beng.), *dhebri* (Garh.), *chanlai, dhakka-nisur, jamrasi, mutmur* (Gon.), *alan* (Guj.), *ajari, bakra, bhutekassi, chanli, chouri, daberi, dabero, jamuva, jangela, jamrasi, loonia, mamri, metkur, miri, mokha-pisi-tondora, mutmur, niuri, paniala, rasi, rohi, sami, shanriya, thanki* (Hind.), *kannire, kanurmara, mookurichi, mukarive, mukarti, mukkarite, thamaroja* (Kan.), *bakra, bhutta janwa, mirandu, padrium* (Kash.), *miri, thanki* (Kol.), *chikyeng* (Lep.), *bilur, burkas, butapala, karumiraka, tamruj* (Mal.), *aran, bhuta, bilur, burkas, butapala, tamruj* (Mar.), *mokha-pisi-tondora* (Or.), *bakra, chanli, daberi, jamoa, jamuva, janwa, mamri, mirandu, mirga, miri, movurdonn, morindu, padrium, shanriya* (Punj.), *neonri, niuri* (Sant.), *bhutan kusan, bhutani-kusamis, booliyi, botanskam, chehipaimaram, irgoli, irkoli, kanniramaram, kanniroi, karkava, karuvati, kasrukuva, keevi, kiri, kurkuvu, maram, neradi, nerosi, neridi, nirija, pirai, piyari* (Tel.). A moderate-sized to large tree up to 30 m. in height and 2 m. in girth. *Bark* dark grey, exfoliating in woody scales, blood-red inside, thin.

It is distributed in the sub-Himalayan tract and outer valleys ascending to 1,800 m. from Ravi to Sikkim, and is also found in Madhya Pradesh. It occurs on the Western Ghats in evergreen and monsoon forests, about the foot of the Nilgiris and in the moist forests of Anamalais at 600 m. elevation and in the Coimbatore plains.

Description of the wood

[Pl. **49**, 293]

General properties—No colour distinction between sapwood and heartwood in any of the specimens examined. Wood light brown, sometimes with

a red tinge ; moderately hard to hard ; moderately heavy to heavy (sp. gr. 0·71–0·91 air-dry) ; lustrous ; straight to twisted-grained ; fine to medium-textured showing an attractive partridge mottling on tangential surface.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct, darker bands of fibrous tissue or closer bands of septate fibres may, however, occasionally give the impression of growth marks. *Pores* small to very small, distinct only under the hand lens, numerous (20–35 per mm.^{2}), solitary or in radial pairs, evenly distributed, round, open ; vessel lines indistinct or barely visible to the eye. *Parenchyma* apotracheal, in thick concentric or wavy bands alternating with broader bands of fibres which are distinct to the eye due to their lighter colour. These are acutally composed of a mixture of septate fibres and parenchyma cells. *Rays* fine to moderately broad, visible to the naked eye, closely spaced. Radial flecks not conspicuous.

A moderately hard timber but has not yet been subjected to full scale tests at Dehra Dun. According to Gamble the co-efficient of transverse strength is between 511 to 513 and average weight 53 lb., per cubic foot. It seasons well but thin planks are apt to warp unless carefully seasoned. It polishes well, absorbing little polish (2). The timber gives a pleasant figure when flat sawn. The timber is fairly durable. All the samples examined are in sound condition except one which is damaged by borer.

Uses—It is used for house building purposes. The wood is suitable for furniture, cabinet work where its pleasant figure can be utilized. It may also serve well for picture frames and other small articles.

Material—

183 Mandla, Madhya Pradesh (0·76), 235 Garhwal, Uttar Pradesh (0·91), 1182 Ahiri Reserve, Bombay (0·79), 2335 Darjeeling Terai, West Bengal (0·86), 2781 Melghat, Bombay (0·71) (slightly damaged by borer), 2991 Garhwal, Uttar Pradesh (0·85), 4695 Dehra Dun, Uttar Pradesh (0·77).

2. EUONYMUS LINN.

The genus comprises of about 100 species of upright, or climbing shrubs and small trees which are distributed in the mountainous regions of tropical Asia and the Malay Archipelago, and a few also scattered over Europe and North America. In India about 30 species are known to occur of which 8 are dealt with here.

1. **E. crenulatus** Wall.—It is a small evergreen tree, found in the Nilgiris and the higher parts of Western Ghats.

Description of the wood—See page 184.

2. **E. frigidus** Wall.—*Chure lahara* (Nep.). A straggling shrub about 1·2–1·5 m. in height.

It occurs in Sikkim at an elevation of 2,150–3,650 m. and in the Khasi Hills at 1,500–1,800 m. elevation in the shady situations.

Description of the wood—See page 184.

3. **E. hamiltonianus** Wall.—*Agnium, agnu* (Hind.), *dadul, dharua* (Jauns.), *brahmani* (Kash.), *dieng-soh-sat-khlaw, jaminrei-dhkar* (Kh.), *banchor, brahmani, chual, karum, lanchu, mana, naga, papar, pash, ranai, rithu, sidhera, siki, singi, skioch, watal* (Punj.). A small to large deciduous shrub or a tree about 12 m. in height and nearly 1·8 m. in girth. *Bark* pale brown, thick corky, ashy-grey and deeply furrowed.

It is found in the Himalayas at the elevation of 1,200–2,750 m. and is also found in Khasi Hills and Manipur.

Description of the wood—See page 184.

4. **E. javanicus** Bl.—A shrub or a small tree, occurring in Burma, Malayan Peninsula and Java and is also distributed in the Philippine Islands.

Description of the wood—See page 184.

5. **E. lacerus** Ham.—*Pinna* (Garh.), *banchir, banchu, chikan, dudhapu, kioch, mara, pinni* (Hind.), *angao, lichhoi* (Jauns.). A shrub or a small deciduous tree 1·2 m. in girth and 7·5 m. in height. *Bark* pale grey and sometimes silvery, fairly smooth.

It occurs throughout the central and inner ranges of Himalayas from Indus to Sikkim between 2,000 and 3,200 m. elevation and is also found in the Kurram valley.

Description of the wood—See page 184.

6. **E. pendulus** Wall.—*Bhambela* (Jauns.), *chopra, garur, kurku, pincho, tulli* (Punj.). A small evergreen tree or a large shrub up to 2·7 m. in girth and 14 m. in height. *Bark* pale, ashy-brown or almost whitish, rough, corky, exfoliating in small irregular flakes.

It occurs throughout the Himalayas from Jhelum to Nepal between 1,500 m. and 2,450 m.

Description of the wood—See page 184.

7. **E. theaefolius** Wall.—A shrub sometimes trailing on other trees, found in Nepal, Khasi Hills and Manipur.

Description of the wood—See page 184.

8. **E. tingens** Wall.—*Gwali, kum-kum, kungku* (Hind.), *bhambeli, roni* (Jauns.), *kasuri, newar* (Nep.), *chopra, kungku, marmakoul* (Punj.). A small

evergreen tree up to 7·5 m. in height and 2·5 m. in girth. *Bark* grey or pale ashy, rough, corky outside and yellow within.

It is found in temperate Himalayas from Sutlej to Nepal at an altitude of 2,000–3,050 m.

Description of the wood—See below.

Description of the wood

(*Euonymus crenulatus, E. frigidus, E. hamiltonianus, E. javanicus, E. lacerus, E. pendulus, E. theaefolius* and *E. tingens*)

[Pl. **49**, 294 ; Pl. **50**, 295]

General properties—No colour distinction between sapwood and heartwood of any of the specimens examined. Wood pale yellowish-brown, moderately hard ; mostly moderately heavy (sp. gr. 0·49–0·78 air-dry) ; straight and even-grained ; very fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct, demarcated by darker bands of fibrous tissue, 5–12 per cm. *Vessels* extremely small, individually indistinct even under hand lens and very numerous, but slightly bigger and distinct under hand lens and numerous to very numerous (30–62 per mm.^{2}) in *E. frigidus, E. pendulus, E. theaefolius* and *E. tingens* ; solitary or in radial multiples of 2 ; open, vessel lines indistinct. *Parenchyma* not visible under the lens. *Rays* fine to very fine, barely visible to the eye distinct under hand lens, closely spaced.

Natural durability—*E. javanicus* is said to be durable when exposed.

Insect attack—Drywood of *Euonymus frigidus, E. hamiltonianus* and *E. lacerus* is attacked by *Stromatium barbatum* Fabricius (Cerambycidae).

Uses—Wood is suitable for carving and turnery and may be used as a substitute for box wood for making small articles such as spindles, pegs, spoons, etc. The wood is particularly suitable for watch makers pegs and tooth picks.

Material—

E. crenulatus – 5718 Coimbatore, Madras (0·78).

E. frigidus – 3406 Darjeeling, West Bengal (0·76), 5444 Darjeeling, West Bengal, (0·60).

E. hamiltonianus – 172 Rawalpindi, West Pakistan (0·49), 778 Kalatop Forest, Punjab (0·52), 919 Hazara, West Pakistan (0·56), 3012 Simla, Himachal Pradesh (0·63), 4770 Tehri-Garhwal, Uttar Pradesh (0·62).

E. javanicus – 6810 Burma (0·64), 7110 Burma (0·71).

E. lacerus – 67 Simla, Himachal Pradesh (0·68), 2883 Simla, Himachal Pradesh (0·72), 3011 Simla, Himachal Pradesh (0·70).

E. pendulus – 86 Simla, Himachal Pradesh (0·55), 2837 Simla, Himachal Pradesh (0·64).

E. theaefolius – 3308 Darjeeling, West Bengal (0·74).

E. tingens – 32 Simla, Himachal Pradesh (0·71), 2844 Simla, Himachal Pradesh (0·70).

3. GYMNOSPORIA W. & A.

The genus *Gymnosporia* comprises of evergreen shrubs or small trees with often spinescent branches, distributed in the tropical and sub-tropical regions, especially Africa. About 20 species are indigenous in India, of which only 3 are available for study. Woods of these are indistinguishable.

1. **G. emarginata** Roth—*Ikari, inguli, yenkul* (Mar.), *bali-bhams, gonro kosai* (Or.), *chinta* (Tel.). A thorny shrub. *Bark* whitish-grey.

It occurs on the Eastern Ghats in dry deciduous forests and on the slopes of Nilgiris and Anamalais.

Description of the wood—See below.

2. **G. montana** Lawson [G. spinosa (Forsk.) Fiori]—*Babur, danta* (Gon.), *baikal, gajchinni* (Hind.), *dajkar, kharai, kingaro, mareila, talkar* (Punj.), *dantausi, danti, pedda chintu* (Tel.). A small tree or a large shrub.

It is found in the Madhya Pradesh on the trap and cotton soil and also on the northern slopes of Nilgiris. It is common in Rajasthan, Punjab and Afghanistan.

Description of the wood—See below.

3. **G. royleana** Wall.—*Darim, gwale, tallidhar* (Hind.), *badlo, bugriwala, darim, gwala, kadewar, kandazera, kander, kandiari, kandu, kharasa, kura, lei, parmium, pataki, phupari, suraghzai* (Punj.). A stiff thorny distorted shrub 2·5–3 m. in height. *Bark* thin, brown somewhat rough and corky.

It is distributed on the outer North-West Himalaya east of Kumaon at an altitude of 300 to 1,200 m. and is also found on the Western Ghats.

Description of the wood

(*Gymnosporia emarginata, G. montana* and *G. royleana*)

[Pl. **50**, 296]

General properties—Heartwood and sapwood indistinct. Wood is yellowish-brown, moderately hard, moderately heavy to heavy (sp. gr. 0·62–0·79 air-dry) ; straight-grained and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct, occasionally darker coloured bands of fibrous tissue devoid of parenchyma or soft tissue may, however, give the impression of growth marks. *Vessels* indistinctly visible to the naked eye but distinct under lens, small to very small, numerous (25–40 per mm.^{2}); but very numerous in *G. royleana* (45–55 per mm.^{2}); solitary or in radial multiples of 2, occasionally plugged with deposits ; vessel lines indistinct. *Parenchyma* distinct to the eye, lighter in colour, in moderately broad bands alternating with wider bands of darker coloured fibrous tissue, about 24 per cm. These are actually composed of septate fibres but give the impression of parenchyma under the hand lens. *Rays* indistinct to the naked eye but distinct under the lens, fine to very fine and closely to somewhat widely spaced.

The samples examined show surface cracking. One sample of *G. spinosa* is damaged by wood rotting fungus.

Uses—Due to the fine texture this wood is suggested for use in carving and turnery. The attractive partridge mottling figure may be utilized in furniture and cabinet making.

Material—

G. emarginata – 3866 Anantpur, Andhra Pradesh (0·69).

G. montana – 1162 Ahiri Reserve, Bombay (0·62), 2752 Moharli Reserve, Madhya Pradesh (0·67).

G. royleana – 913 Salt range, West Pakistan (0·76), 2932 Simla, Himachal Pradesh (0·75), 2950 Sutlej valley, Punjab (0·79).

4. KOKOONA THW.

A genus of branching trees, distributed in the Indo-Malayan regions. 2 species occurring in Burma were available for study and are dealt with here. These can be easily distinguished on the basis of vessels and parenchyma distribution and are, therefore, described separately.

1. **K. filiformis** C. E. C. Fischer—*Fawee* (Malay). A tree 9–12 m. in height occurring in South Tenasserim, Browning Island and Victoria Point at sea-level.

Description of the wood

[Pl. **50**, 297]

General properties—Heartwood and sapwood indistinct. Light to dark brown, very hard, heavy (sp. gr. 0·91–0·93 air-dry), twisted-grained and coarse-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct but occasionally darker coloured bands of fibrous tissue, devoid of parenchyma, give the impression of growth marks. *Vessels* just visible to the naked eye, but distinctly visible under the lens, moderately small, moderately numerous to numerous (13 to 25 per mm.^{2}), solitary, open ; vessel lines inconspicuous. *Parenchyma* in the form of white apotracheal bands alternating with wider bands of fibrous tissue, distinct to the naked eye, about 15 per cm. *Rays* fine and closely spaced and indistinctly visible to the naked eye but clearly seen under the lens.

The samples examined are sound but are surface checked. They show mottling on the flat sawn surface.

Uses—It may be used for house building and also prove useful in the manufacture of furniture.

Material—

6671 Burma (0·93), 7133 Burma (0·91).

2. K. littoralis Lawson—A large tree growing on low lands inundated during the rains. It occurs in Lower Burma.

Description of the wood

[Pl. **50**, 298]

General properties—Wood pale-brown, moderately hard, moderately heavy (sp. gr. 0·57 air-dry), straight-grained and coarse-textured.

Gross structure—Growth rings distinct, delimited by fibrous tissue, 8–9 per cm. *Vessels* moderately large, visible to the eye, moderately few (5–9 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2, oval, open ; vessel lines distinctly visible to the naked eye. *Parenchyma* indistinct to the eye, but distinct under lens in the form of thin wavy apotracheal lines, about 10 per cm. *Rays* fine to very fine, indistinct to the naked eye but fairly visible under lens and closely spaced.

The sample was not attacked by any insect or borer but showed surface cracking.

Uses—It is suitable for all purposes for which *Lophopetalum* is used.

Material—

278 Burma (0·63), 2513 Burma (0·54), 6308 Burma (0·57).

5. KURRIMIA WALL.

A genus of trees distributed in India, Ceylon and the Malay Peninsula. Wood samples of 2 species were available for study and are dealt with here.

1. **K. paniculata** Wall.—*Kadapala* (Tam.). A large tree occurring in Western Ghats, Tinnevelly and Travancore. According to Brandis, the species found in South India is *K. biparitata* Lawson, and *K. paniculata* Wall. is a Malayan species.

Description of the wood—See below.

2. **K. pulcherrima** Wall. [**K. robusta** (Roxb.) Kurz]—*Hinguri* (Asm.), *shilkoi* (Beng.), *koliori* (Hind.), *dieng-mat-wei, dieng-soh-ngang* (Kh.), *tunser* (Mik.). A large evergreen tree, 12–15 m. in height and 1·5 m. in girth. *Bark* dark greyish-brown outside, light greenish-brown and mottled with minute dots inside.

It occurs in the Western Duars, Assam, Sylhet, Chittagong, Burma, Siam and Cochin-China and is also found in the South Andamans, Singapore and Sumatra.

Description of the wood—See below.

Description of the wood

(*Kurrimia paniculata* and *K. pulcherrima*)

[Pl. **50**, 299–300]

General properties—Heartwood and sapwood indistinct. Wood pale brown to dark brown, moderately hard to hard, light to moderately heavy (sp. gr. 0·53–0·70 air-dry) ; straight-grained and coarse-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct to indistinct, when distinct demarcated by darker bands of fibrous tissue devoid of parenchyma. *Vessels* moderately large, moderately numerous (9–17 per mm.^{2}), solitary or in radial multiples of 2, open ; vessel lines distinctly visible to the naked eye. *Parenchyma* abundant, barely visible to the eye, distinct under the lens, in the form of thin lines forming a sort of network with the rays. *Rays* fine to very fine, numerous, closely to rather widely spaced.

According to Bourdillon, the co-efficient of transverse strength = 505 ; weight = 40 lb. per c. ft. The wood of *Kurrimia paniculata* is reported to be easy to work.

Uses—Used in Sumatra and Malay Peninsula for posts, beams, floor boards but it must be kept dry to preserve it from decay.

Material—

K. paniculata – 4538 Travancore, Kerala (0·53), 4634 Travancore, Kerala (0·70).

K. pulcherrima – 6535 Burma (0·66).

6. LOPHOPETALUM WIGHT.

A genus of trees and shrubs distributed in India, Malaya and Java. In the Indian region 6 species are found, of which 3 are dealt with here. The remaining three species are :—*L. celastrioides* Lawson, *L. filiforme* Lawson and *L. floribundum* Wight., all trees of Burma. The woods of three species described here are very similar in structure and indistinguishable from one another.

1. **L. fimbriatum** Wight.—*Rumin* (Asm.), *raktan* (Beng.). A large tree nearly 30 m. in height. *Bark* grey, rough outside with horizontal wrinkles and uniformly pink inside.

It occurs in the hill tracts of Sikkim, Sylhet, Chittagong and the Khasi and Jaintia Hills, and is also found in Martaban and Tenasserim.

Description of the wood—See below.

2. **L. wallichii** Kurz -*Kalbo*, *mondaing* (Burm.). A large glabrous deciduous tree 15–21 m. high, the clear stem 9–12 m. long and girth 1·8–2·5 m. *Bark* about 17 mm., thick, smooth, grey and soft.

It is found all over Pegu Yoma and Martaban down to Tenasserim.

Description of the wood See below.

3. **L. wightianum** Arn.—**Banati**. *Banati-kalpale*, *banati*, *venkadavan*, *venkotta*, *venkottei* (Kan.), *karuka*, *venkatava*, *venkotta* (Mal.). A lofty evergreen tree about 30 m. in height and 1 m. in diameter. *Bark* mottled brown and white, smooth.

This tree inhabits the west coast from Konkan southwards. It occurs also in Sikkim, Sylhet, Chittagong, the Khasi and Jaintia Hills and from Martaban down to Tenasserim.

Description of the wood—See below.

Description of the wood

(*Lophopetalum fimbriatum*, *L. wallichii* and *L. wightianum*)

[Pl. **51**, 301, 302]

General properties—Heartwood and sapwood indistinct. Wood yellowish-brown in colour ; soft to moderately hard ; light to moderately heavy (sp. gr. 0·44–0·63 air-dry) ; straight-grained and somewhat coarse-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct. *Vessels* moderately large, moderately few to moderately numerous (4–18 per mm.^{2}) ; mostly in groups of 2 to 3, occasionally solitary, oval, open ; vessel lines conspicuous on the longitudinal surfaces. *Parenchyma* visible to the naked eye in the form of thin white wavy lines running tangentially, about 25 per cm. *Rays* fine to very fine, fairly closely spaced, indistinct to the naked eye but distinct under the lens.

Strength—No strength figures for *L. fimbriatum* are available. Strength figures for *L. wightianum* tested at Dehra Dun are given in Appendix I. The timber is moderately hard and strong. Pearson and Brown consider it to be about equal in strength to that of *Gmelina arborea*.

Pearson and Brown quoting Wilson give the following data for *L. wightianum*:

Transverse Strength in lb. per sq. in.	
Breaking strength	Modulus of elasticity, or Young's modulus
8,580	11,65,000

Further, according to them this shows the timber to be approximately 60 per cent of the strength of teak. Gamble, quoting Bourdillon, gives the value of co-efficient of transverse strength as 457 and according to Wilson's test, it works out to 475.

Seasoning—It is not easy to season. Though a little liable to develop long radial splits yet such splits are not numerous, it neither warps nor twists.

Durability—Timber is not durable in the open or in contact with the ground. "Graveyard" tests carried out with *L. wightianum* at Dehra Dun showed that the wood lasts in contact with ground for 25–32 months and has an average life of 31 months.

Working qualities—It is a nice wood to work with hand tools and presents no difficulty in sawing, works to a fine smooth surface, takes good polish and can easily be peeled on a rotary cutter. Test material of *L. wightianum* received from Madras showed that the logs were seriously damaged by insects and large patches of blue stain were found in the sap and through to the heart. This timber requires to be converted and made up immediately after felling.

Supply and uses—*L. wightianum* is available in fair quantities from the south zone and also in limited quantities from the west zone. The timber is suitable for house building purposes such as ceiling boards, door frames and rafters. It is also used for furniture and cabinet making. The timber is much used for box and packing cases and in the manufacture of veneers and plywood. *L. wightianum* can be used for pencil making after requisite treatment. It is also used for the match industry. It is a suitable timber for the manufacture of artificial limbs (18).

Material—

L. fimbriatum – 5989 Burma (0·63), 6403 Burma (0·44), 7122 Burma (0·94).

L. wallichii – 1947 Tavoy, Burma (0·47), 2248 Andamans (0·40), 6316 Burma (0·60), 6505 Burma (0·60).

L. wightianum – 723 South Kanara, Mysore (0·45), 853 South Kanara, Mysore (0·44), 4618 Travancore, Kerala (0·44), 6027 Telicherry, Kerala (0·45).

7. MICROTROPIS WALL.

A small genus of trees, erect scandent or epiphytic shrubs, distributed in the mountains of India, Ceylon, the Malay Archipelago and Java. In the Indian region 9 species are found, out of which 3 are dealt with here. Of the remaining species, *M. densiflora* Wight, *M. latifolia* Wight, *M. wallichiana* Wight, *M. ramiflora* Wight and *M. stocksii* Gamble are small trees of Western Ghats while *M. bivalvis* Wall. is small tree found in Tenasserim, Burma. The woods of the 3 species described here are indistinguishable.

1. **M. discolor** Wall.—*Ruglim* (Lep.), *toykhati* (Lush.), *mori* (Sylh.). A large shrub or a small glabrous evergreen tree. *Bark* brown or grey, thin, exfoliating in rectangular or irregular flakes, blaze finely fibrous, brittle.

It is found in Kumaon, Sikkim from the foot of the hills ascending up to 2,150 m., hills and plains of Assam and Sylhet and is also common in Martaban and Tenasserim.

Description of the wood—See below.

2. **M. microcarpa** Wight—A shrub or a small tree.

It is common in the Shola forests of Nilgiris and Palni at 1,800–2,450 m. elevation and is also found in the Western Ghats from Konkan southwards.

Description of the wood —See below.

3. **M. ovalifolia** Wight.—An evergreen shrub or a small tree.

The plant is distributed in the Shola forests of higher ranges of Nilgiris and Palni at 1,800–2,450 m.

Description of the wood—See below.

Dsecription of the wood

(*Microtropis discolor*, *M. microcarpa* and *M. ovalifolia*)

[Pl. **51**, 303–304]

General properties—Heartwood and sapwood indistinct. Timber is yellowish-white or greyish-brown in colour ; moderately soft, moderately heavy (sp. gr. 0·56–0·59 air-dry) ; slightly twisted-grained ; fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* faintly visible to the naked eye and demarcated by darker coloured fibrous tissue devoid of

parenchyma, 4-5 per cm. *Vessels* small to very small, moderately numerous (12–20 per mm.^{2}), in radial groups up to 8, open ; vessel lines inconspicuous. *Parenchyma* in the form of thin white wavy tangential bands distinctly visible to the naked eye. *Rays* barely visible to the eye, but distinct under the lens, fine to very fine, closely spaced in *M. discolor* and *M. microcarpa* but widely spaced in *M. ovalifolia*.

Durability—Its resistance to decay is low.

Uses—Suitable for spools and similar articles of turnery and as a general purpose timber but presumably of no commercial possibilities because of the small size and inaccessibility of the trees.

Material—

M. discolor – 3345 Darjeeling, West Bengal (0·56).

M. microcarpa – 3742 Conoor, Madras (0·59).

M. ovalifolia – 3858 Ootacamund, Madras (0·53), 4084 Ootacamund, Madras (0·58).

8. PLEUROSTYLIA WIGHT.

A genus consisting of glabrous shrubs distributed in the mountains of India, Ceylon, Mauritius and the Madagascar. In India only one species is found which is dealt with here.

P. wightii W. & A. – *Panaka, piyari* (Singh), *chiru-piyari, gettisaranai, karikkuvaggai, karuvali* (Tam.), *kuntichintha, piyari* (Tel.). A small evergreen tree or a large glabrous shrub with grey bark, tasellated in small squares.

It is found in the Western Ghats from Konkan southwards and is also common in the sub-alpine forests of Madras often near water courses. It is also found in the rather dry parts of Ceylon and the northern borders of Malaya, and is common in Mauritius and Madagascar.

Description of the wood

[Pl. **51**, 305]

General properties—Sapwood and heartwood indistinct ; wood reddish-brown ; moderately hard to hard ; heavy (sp. gr. 0·82–0·87 air-dry) ; lustrous, straight-grained and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct and demarcated by darker coloured fibrous tissue devoid of parenchyma, 3–5 per cm. *Vessels* small to very small, numerous to very numerous (24–55 per mm.^{2}), mostly solitary, rarely in groups up to 3, round, open ; vessel lines inconspicuous. *Parenchyma* in the form of light coloured wavy apotracheal bands distinctly visible to the naked eye. *Rays* visible to the eye, moderately broad and closely spaced.

No recent strength data are available. Gamble quotes the results of the experiments made by Prof. W. C. Unwin, F.R.S., of the Imperial Institute on the Ceylon wood as follows :—

Resistance to shearing along the fibres	.. 745 lb. per sq. in.
Crushing stress	.. 2·768 tons per sq. in.
Co-efficient of transverse strength ..	.. 5·784 tons per sq. in.
Co-efficient of elasticity ..	.. 658·3 tons per sq. in.

The samples show surface cracking and they exhibit tortoise shell mottling on the flat sawn surface.

Uses—The wood is used for combs in Andhra Pradesh. It is recommended for use as a decorative furniture wood.

Material—

3955 Godavari, Andhra Pradesh (0·82), 7539 Chittoor, Andhra Pradesh (0·82), 7541 Godavari, Andhra Pradesh (0·85), 7614 Godavari, Andhra Pradesh (0·87).

9. SIPHONODON Griff.

A genus consisting of two species of small glabrous trees distributed in the Malay Peninsula, Java and Australia. In the Indian region only one species is found which is dealt with here.

S. celastrineus Griff.—*Hpunja, myauk-okshit, woibaw* (Burm.). A small evergreen tree, 9–15 m. high, the clear stem 6–7 m. long, and girth ·6–1·2 m. *Bark* dark grey, brittle, granular and rough.

It occurs in the ravines in Rajmahal hills in Bihar but is not common and is also found in Sikkim, Martaban, eastern slopes of Pegu Yoma in Burma. It also grows in Java and Philippine Islands.

Description of the wood

[Pl. **51**, 306]

General properties—Sapwood and heartwood indistinct. Wood yellowish-brown ; soft to moderately hard ; moderately heavy to heavy (sp. gr. 0·71–0·75 air-dry) ; straight to slightly twisted-grained and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct, demarcated by fibrous tissue, 5–8 per cm. *Vessels* small to very small, moderately few to moderately numerous (10–15 per mm.^{2}), solitary or in groups of 2 to 3, open ; vessel lines visible to the naked eye on longitudinal surfaces. *Parenchyma* indistinct. *Rays* distinct to the naked eye moderately broad and closely spaced.

Insect attack—Drywood is liable to be attacked by *Stromatium barbatum* Fabricius (*Cerambycidae*).

Uses—The timber is used locally for house posts and general construction.

Material—

5101 Toungoo, Burma (0·75), 5021 Tharrawaddy, Burma (0·59), 6166 Tavoy, Burma (0·76), 6245 Tavoy, Burma (0·75), 7170 Burma (0·71).

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P. N. NIGAM.

RHAMNACEAE

The family *Rhamnaceae* comprises about 45 genera and over 500 species of erect or scandent shrubs and small to medium-sized trees. Though it has an extensive distribution throughout the temperate and tropical regions of the world, many of its members are confined mostly to dry and arid areas.

The family is of little significance from the point of view of timber, but includes a few species of considerable medicinal value and some others of local importance as sources of dyestuffs and other commercial products. The well-known laxative "Cascara sagrada" is the product of *Rhamnus purshiana* DC. of California, while the bark of the Indian species *R. wightii* W. & A. often exported under the name 'rakta rohida', gives a drug similar to "Cascara". The roots of the American *Ceanothus americanus* Linn., contain the alkaloid "ceanothin" and are said to have been used in the treatment of syphilis. In India, a number of other plants like *Gouania leptostachya* DC., *Ventilago madraspatana* Gaertn. and *Zizyphus jujuba* Lam. are also used locally in indigenous medicine (18).

Some members of the *Rhamnaceae* yield valuable dyes. Among the best known are the yellow and green dyes obtained from several species of *Rhamnus* Linn., which are used in the textile industry and for calico printing (3). The root bark of *Ventilago madraspatana* Gaertn. gives an orange dye which is an article of some importance in South India (11). The root bark of *Zizyphus jujuba* Lam. and fruits of *Z. zylopyrus* Willd. are used for tanning leather (2, 9).

Zizyphus jujuba and *Z. xylopyrus* are important host trees for Lac cultivation in various parts of India (11, 16, 31). The leaves of these and a few other species of *Zizyphus* Juss. are sometimes used for feeding silkworms, while the fruits which are edible and somewhat resemble plums are commonly sold in the *bazaar* (market) all over India. The fruits of some species of *Sageretia* Brongn. are also edible and the leaves of *S. theezans* Brongn., are reported to be used as a substitute for tea in China (25). The European buckthorn *Rhamnus cathartica* Linn. is commonly grown as a hedge plant in Europe and North America.

Though of little economic value as a source of commercial timbers, the family *Rhamnaceae* is of some interest from the timber point of view also, as providing one of the hardest and heaviest known woods in the world – the "Black ironwood" or "Axe-master" of the West Indies obtained from *Krugiodendron ferreum* (Vahl.) Urban. The dark brown heartwood of this species is exceedingly dense, hard and horn-like with an air-dry specific gravity ranging from 1·34 to 1·42. It is also very fine-textured, capable of taking a high

polish and very resistant to decay, but like most other woods of the family has no commercial possibilities (25). However, the genus *Zizyphus* provides some timbers which are of secondary importance. *Z. chloroxylon* (L.) Oliv., the Jamaican cogwood or greenheart is a dense, fine-textured wood once considered to be one of the best timbers for cogs and rollers in sugar and coffee factories in the West Indies, but being scarce is not of much importance. Wood of *Zizyphus* seems to have been popular also among the ancient Indians. Study of the wood remains from Harappa Excavations (7) has shown that *Zizyphus* sp. was used for pounding grains as far back as five thousand years ago, as it is done even to-day in the villages of India.

The *Rhamnaceae* are represented in India by about 12 genera and approximately 50 species, mostly shrubs and woody climbers. Only two genera *Rhamnus* and *Zizyphus* which attain tree size and provide timbers of some local importance are described here in detail. Besides these two, small wood samples of five more genera were also available for examination, but being mostly climbers and straggling or erect shrubs they do not actually come within the scope of this work. However, in view of the interesting features shown by some of them a brief reference to their wood structure may not be out of place here.

Of these five genera, *Berchemia floribunda* Wall. (2864 Darjeeling, West Bengal), *Gouania leptostachya* DC. (5369 Pilibhit, Uttar Pradesh and 5572 Burma) and *Ventilago madraspatana* Gaertn. (2923 and 3843 Madhya Pradesh and 6448 Burma) are large climbers or scrambling shrubs, with soft, usually light (sp. gr. 0·44–0·66 air-dry) and extremely porous and coarse-textured woods, characterized by large pores (Pl. **52**, 307). These woods are of no commercial value.

The genus *Sageretia* Brongn. is represented in the Indian region by about five species of erect or straggling shrubs and small trees, of which wood samples of three viz., *S. branderthiana* Aitch. (914 Simla, Himchal Pradesh), *S. oppositifolia* Brongn. (4841 Mussoorie, Uttar Pradesh) and *S. theezans* Brongn. (2946 and 2951 Simla, Himachal Pradesh) were available. All are rather hard, heavy (sp. gr. 0·80–1·05 air-dry) and fine-textured and are also very similar in their end-grain structure as seen under hand lens. They are all characterized by (a) distinct growth rings demarcated by thin lines of parenchyma, (b) very small, numerous to very numerous and evenly distributed vessels which may be solitary or in short radial multiples of 2–3 or more, and (c) fine to very fine, numerous, closely spaced rays (Pl. **52**, 311). It is, however, interesting to record here that the only specimen of *S. brandrethiana* Aitch. examined differs from the others in that it has a distinct suggestion of ripple marks on the tangential surface, a feature which has so far not been reported in any member of the *Rhamnaceae*. But the specimen is not backed by any herbarium material and as its bark structure also is entirely different

from that of the other Indian sageretias, there may be some doubt about its authenticity.

Scutia indica Brongn. is a thorny shrub of the dry hills of South India, sometimes used for hedges. The single specimen examined (4255 Nellore, Andhra Pradesh) shows a whitish light-coloured sapwood, which is sharply demarcated from the very much darker reddish-brown heartwood and is fairly hard, heavy (sp. gr. 0·89 air-dry) and medium-fine-textured. The wood is featured anatomically by numerous small to medium-sized vessels mostly in radial multiples of 2–5, parenchyma in faint rather inconspicuous lines delimiting growth rings and fine to very fine, fairly close and evenly spaced rays (Pl. 52, 312).

The woods of the *Rhamnaceae* show considerable variation in their appearance, structure and properties which is often helpful in their separation in the field. The two main Indian genera *Rhamnus* and *Zizyphus* described here can easily be distinguished by the flame-like arrangement of vessels which is a striking diagnostic feature of most species of *Rhamnus*, but entirely lacking in *Zizyphus*. Further, *Rhamnus* is characterized by apparently two types of rays moderately broad and fine, the former visible to the eye, whereas in *Zizyphus*, the rays are all of the same type being very fine and indistinct to the eye.

1. RHAMNUS Linn.

A large genus of about 150 species of shrubs or small to medium-sized trees, widely distributed in the temperate regions of northern hemisphere and in the tropical mountains. Seven species are indigenous to India, and have been described here except *R. procumbens* Edg., a small shrub occurring in the Himalayas, from Sutlej to Kumaon at 2,150–3,000 m. elevation which was not available for study. The woods of the 6 species studied show some difference as regards the vessel size and distribution and can be grouped as follows :—

Vessels arranged in prominent flame-like pattern; individual vessels indistinct or barely visible under lens	*R. persicus* *R. purpureus* *R. triqueter* *R. virgatus*
Vessels show only a tendency to flame-like arrangement; individual vessels distinct under lens ..	*R. nepalensis* *R. wightii.*

1. **R. nepalensis** Wall.—*Biringa, biringguli, thelurikang* (Asm.), *nakaling-arong, ring-kang-akikarong* (Mik.), *midoubri-doukha* (Kach.), *achal*

(Nep.). A large bushy shrub with many long straggling branches. *Bark* thin, blackish, more or less smooth.

It is distributed in central and eastern Himalayas ascending to 1,300 m. and extending to the hills of Burma. It also occurs in Ganjam and the Eastern Ghats.

Description of the wood—See page 199.

2. **R. persicus** Boisser—*Karai chhetulo* (Garh.), *chirla* (Hindi), *charyula* (Kumaon), *kukei, nar, nikki kander, jalidar, kuchni* (Punj.). An armed shrub or a small tree, 2–6 m. high with short stout bole. *Bark* thin and dark ashy-brown, peeling off in small flakes or vertical strips.

It ascends up to 4,000 m. in the Himalayas extending from Afghanistan to Kumaon in Uttar Pradesh.

Description of the wood—See page 200.

3. **R. purpureus** Edgew.—*Bakauro, banaru* (Garh.), *luhish, phish* (Jauns.), *payan* (Kumaon), *bat sinjal, chaterni, kunji, mimarari, rangrek, tadra, tudhi, tunani, janani* (Punj.). A large deciduous shrub or a small to middle sized tree up to 7·5 m. high and less than a metre in girth. *Bark* thin, smooth and ashy-grey with brownish-tinge having short dark vertical lines.

Distributed in North-West Himalayas extending from Indus to Kumaon and along the banks of river Sharda to Nepal between 1,400–3,000 m. Fairly common in ravines and open shady regions.

Description of the wood—See page 200.

4. **R. triqueter** Wall.—*Gaunth, gaunta* (Hindi), *katheru* (Jauns.), *fogora, gardhan, phulla* (Punj.), *gudlej* (Simla). An unarmed shrub or small tree up to 6 m. high. *Bark* thin, greyish-brown, exfoliating in small regular woody scales.

Distributed in North-West Himalayas and sub-Himalayan region from Jhelum to Kumaon at 900–2,150 m. elevation.

Description of the wood—See page 200.

5. **R. virgatus** Roxb.—*Chaurdha, chhendula, chhithula* (Garh.), *chato, chedwala, chadua* (Hind.), *chaulda, thauthow* (Jauns.), *chaurdha, chaudul, charyulo, spite* (Kumaon), *chakra, chatr, dadur, gogera, kanji, mamral, nior, niutni, phipai, reteon, romusk, setapajja, shomfol, sindrol, tadru* (Punj.). A deciduous shrub or small tree, 2–4·5 m. high. *Bark* dark grey, thin, peeling off in horizontal papery flakes.

Distributed in the Himalayas at 600–3,000 m. elevation from Indus eastwards to Khasi and Jaintia Hills at 1,200–1,500 m. elevation. It also occurs

in the Nilgiris and Palni hills and the hills of Tinnevelly at 1,500–2,150 m. in South India.

Description of the wood—See page 200.

6. R. wightii W. & A.—*Rakta rohida, rakta zorar* (Mar.). A large glabrous shrub. *Bark* brown with conspicuous diamond shaped lenticels.

Distributed at higher elevations in the Deccan in Amarkantak, Pachmarhi, Mahendragiri hills (1,200 m.) and also from Konkan southwards to Nilgiris and Ceylon.

Description of the wood—See below.

Description of the wood

(*Rhamnus nepalensis* and *R. wightii*)

[Pl. 52, 308]

General properties—Wood light brownish-grey ; moderately hard ; moderately heavy (sp. gr. 0·62 air-dry) ; straight-grained and rather fine-textured.

Gross structure—A diffuse-porous to semi-ring porous wood. *Growth rings* distinct under lens, delimited by thick-walled latewood fibres and by tangentially aligned vessels in the earlywood especially in *R. wightii*, usually 3–4 per cm. but up to 12 per cm. in *R. wightii*. *Vessels* small, just visible to the eye as pin pricks, distinct under lens, numerous (26–33 per mm.^{2}), solitary or in radial pairs, unevenly distributed, more numerous and with a tendency to be arranged in tangential rows in the earlywood especially in *R. wightii* ; latewood vessels tending to be in small clusters or groups which may often be arranged in flame-like pattern in indistinct oblique lines, particularly in *R. nepalensis* ; vessel lines fine, just visible to the eye. *Parenchyma* scanty, indistinct under hand lens. *Rays* fine to very fine, apparently of two size-classes, comparatively broader ones just visible to the naked eye and very distinct under lens, rather widely spaced, very fine rays visible only under lens, closely spaced.

The samples available for examination are small branches only. These are also very badly damaged by borers. Being available in very small sizes, the wood does not seem to have any commercial possibilities except perhaps for walking sticks and the like.

Material—

R. nepalensis – 3346 Darjeeling, West Bengal, 3364 Duars, West Bengal (0·62).

R. wightii – 3745 Nilgiris, Madras.

Description of the wood

(*Rhamnus persicus, R. purpureus, R. triqueter* and *R. virgatus*)

[Pl. 52, 309–310]

General properties—Sapwood yellow to grey turning brownish with age ; heartwood orange-brown to red or reddish-brown sharply differentiated from the sapwood ; hard to very hard ; heavy to very heavy (sp. gr. 0·84–1·10 air-dry) but moderately heavy in *R. purpureus* (sp. gr. 0·63–0·76 air-dry), where only sapwood was available for study ; straight to interlocked-grained, fine-textured ; occasionally showing pleasant figure traceable to interlocked-grain.

Gross structure—All are diffuse-porous woods except *R. purpureus* which is ring-porous. *Growth rings* distinct, delimited by thick-walled latewood fibres, and by a row of large earlywood vessels in *R. purpureus*, 2–9 per cm. *Vessels* only in *R. purpureus* distinct under lens in the earlywood as a single row of comparatively large vessels ; in others minute and individually indistinct to barely visible under lens but often visible to the eye due to their being arranged in groups or clusters as a lighter coloured tissue producing a characteristic zig-zag or flame-like pattern ; vessel lines indistinct except in the earlywood of *R. purpureus*, but vessel groups collectively visible as dark lines on the longitudinal surfaces. *Parenchyma* scanty, in association with the vessel groups or clusters and sometimes diffuse on the face of the growth ring, usually indistinct under lens. *Rays* fine to very fine, apparently of two size-classes ; comparatively broader ones just visible to the unaided eye, rather widely and unevenly spaced ; very fine ones visible only under lens, closely spaced.

All are hard and heavy woods. The specimens in the wood collection are in sound condition except for some surface cracks. One sample of *R. purpureus* is, however, damaged to some extent by borers.

Uses—The timber is suitable for turnery and carved articles as well as for agricultural implements. The wood is at present used mostly for fuel and produces very good charcoal.

Material—

R. persicus – 5004 Dehra Dun, Uttar Pradesh (1·00).

R. purpureus – 70 Simla, Himachal Pradesh (0·66), 4418 Jaunsar, Uttar Pradesh (0·63), 4707 Jaunsar, Uttar Pradesh (0·76).

R. triqueter – 4808 Jaunsar, Uttar Pradesh (0·93).

R. virgatus – 79 Simla, Himachal Pradesh (0·90), 2877 Simla, Himachal Pradesh (0·84), 4780 Garhwal, Uttar Pradesh (1·11).

2. ZIZYPHUS Juss.

A genus of about 60 species of shrubs and small to medium-sized trees widely distributed in the temperate and tropical regions of the world but most numerous in the Indo-Malayan region. Of about 14 species indigenous to India, six are described here. Besides these, small wood samples of 3 more species were also available for study. These are :—(1) *Z. oenoplia* Mill. – *Makai, makoh* (Hindi). A thorny straggling or climbing shrub which grows throughout the greater part of India and Burma and is considered to be the most troublesome pest in Madhya Pradesh. The wood (sample No. 2753) has a structure like that of a climber. (2) *Z. oxyphylla* Edgw. – *Beri, pitni* (Punj.). An erect thorny shrub occurring in the sub-Himalayan region from Indus to Ganga at 600–1,800 m. elevation. The wood (sample No. 2949) shows a semi-ring-porous structure with a row of larger vessels on the face of the growth rings and scanty paratracheal parenchyma and (3) *Z. incurva* Roxb. A large shrub of Nepal, Bhutan, Manipur and Burma. The wood sample examined (sample No. 8067) is from a plant grown in New Forest, Dehra Dun. The wood is whitish with reddish cast and in anatomical structure it resembles other species described in detail here.

The woods of the 6 species described below show great similarity in anatomical structure and it is, therefore, not possible to separate them under the hand lens. However, *Z. trinervia* for which only one sample was available for study differs from the rest on account of its distinct heartwood, finer texture and extreme hardness.

1. **Z. jujuba** Lam. (**Z. mauritiana** Lam.) – **Ber.**—*Gange asing* (Abor), *ber, bogri, boguri* (Asm.), *ber, boroi, kuki, kul* (Beng.), *renga* (Bhil.), *ziben zi* (Burm.), *theng khi* (Garo), *ringa* (Gond.), *baer, ber, beri, bayr, jangra* (Hindi), *thai ganggi* (Kach.), *ilangi, ilantai, jelchi, yelchi* (Kan.), *dieng soh-broi* (Khas.), *jamunjan* (Kol.), *elantha* (Mal.), *ber, bhor* (Mar.), *thakri arong* (Mik.), *badari, baderi, badri vadari* (Sans.), *mahadebava, massan, masun* (Sinh.), *jom, jonom* (Sant.), *bora, cherumulli, elandopphazam, elandi, elanthic, ilantai, yellandai, yellande* (Tam.), *rega panda, regi, rege, rengha* (Tel.). A small to medium-sized tree or a large shrub, 6–15 m. high and about 0·5 m. in girth ; branchlets usually having spines but sometimes unarmed. *Bark* dark greyish or brownish-grey, rough and deeply furrowed. It is reported to be useful in diarrhoea. The tree appears to have an important place in domestic rites and rituals of ancient India. Even at the present time, in ceremonies like worshipping of Saraswati (goddess of learning), *kul* (fruit) forms an unavoidable ingredient. In *Purana*, it is enjoined that "vadari trees are, in all situations, conducive to prosperity but if in the east they give sons and on the south, confer wealth on the owner". It may be of interest to note here that *Brhatsamhita* while discussing the art of exploring presence of water in dry

regions mentions that the region where *kul* (*Zizyphus jujuba*) occurs in association with grasses like *kusa, nalika,* etc., water will be found 3 purusas (about 6·40 metre) below the ground. In ancient texts we also come across the suitability of the young twigs of this tree as tooth-brushes ensuring longevity to the user. Practically all parts of this tree have some uses in the localities where they grow, e.g., buds or young leaves in blood dysentery, fruits when eaten raw help digestion and purify blood, decoction of roots in fever while powder is applied to ulcers or old wounds (20, 21).

It is found throughout India and Burma in all dry forests either wild or naturalized ascending up to 1,500 m. in the Himalayas. Largely cultivated for its fruits not only in India but also throughout the tropics.

Description of the wood—See page 203.

2. **Z. nummularia** W. & A.—*Bhor, jhalbhor, jhadia beri, jhald beri, jhar ber, kanta ber, jhari* (Hindi), *pampali, paragi, parpailigidda* (Kan.), *gangar, jungar* (Mar.), *bal, ber, birar, jhari kanta, kokan ber, malla* (Punj.), *ajapriya, bhukantak* (Sans.), *ganor, gangra, nundo-jangro* (Sind.). A bushy shrub about 4·5 m. high and 15 cm. in diameter. *Bark* grey.

Distributed in drier parts of the Punjab, Sind, Baluchistan and Rajputana. It is common in Uttar Pradesh, Madhya Pradesh, and grows right up to the drier parts in Cape Comorin in South India. It is gregarious and very common on black soil.

Description of the wood—See page 203.

3. **Z. rugosa** Lam.—*Bon boguri, dhidao-boguri* (Asm.), *myank zi* (Burm.), *tauling-asi-kur, thai-gangni-hogra* (Cach.), *dumat foul, khankhri-wakbuk, khong khani-makbul, tengkhi-makbil* (Garo), *bhandher, churna, churni, dhaura, sagra, sura, suram* (Hindi), *workner* (Kuki), *thoddali, toddali* (Mal.), *turan* (Mar.), *garo sal, sumusram* (Mech.), *bata bakuri-arong* (Mik.), *harray baer, rukh baer* (Nep.), *chunnukoli* (Or.), *dhanesh, sekra* (Sant.), *bon boroi* (Sylh.), *charai* (Tam.). A large shrub or small tree 12 m. high and about one metre in girth. *Bark* dark brown or nearly black, rough woody, with deep irregular cracks, exfoliating in small hard rectangular scales.

Distributed in valleys and lower hills of north-west Himalayas and sub-Himalayan tract extending from Dehra Dun east-wards to Sikkim, Assam and Burma. Also in Central India and from Konkan southwards up to 1,800 m. elevation.

Description of the wood—See page 203.

4. **Z. trinervia** Roxb. (**Z. glabrata** Heyne ex Roth.)—*Karakala* (Mal.), *karukara, karukava, kottei* (Tam.). A small unarmed tree up to 9 m. high.

It occurs in North-East Himalayas, Nilgiris and Annamalai Hills to Travancore at low elevation in dry localities.

Description of the wood—See below.

5. **Z. vulgaris** Lam. (**Z. jujuba** Mill non. Lam.)—*Ban, barj, baryan, birari, kandika, kandiari, phitniber, simli, sinjli* (Punj.). A shrub or a small tree, 6–9 m. high and 1 to 2 m. in girth.

It occurs wild in West Pakistan from Ravi to Indus ascending up to 1,800 m. cultivated in the Punjab, Kashmir, Baluchistan and South Europe.

Description of the wood—See below.

6. **Z. xylopyrus** Willd.—*Ghattol, ghotia* (Gon), *bhad ber, beri, chitena, chittania, ghat ber, ghont, goti, gotala, kakor, kat-ber, sitaber* (Hindi), *challe, mullukare* (Kan.), *karkalla* (Kol.), *kotta* (Mal.), *bhorgote, goti* (Mar.), *got, goto, gotoboro, kanta bohul* (Or.), *kakuri* (Sinh.), *karkat* (Sant.), *kottei, nari-ilantai* (Tam.), *goti* (Tel.). A large straggling and armed shrub or a small tree, attaining 3 m. bole and girth of 60–120 cm. *Bark* grey or reddish-brown with thick oblong exfoliating scales.

Distributed in sub-Himalayan tract from Sutlej eastwards to Nepal and Bengal. It is found throughout the dry forests of Uttar Pradesh, Bihar, Orissa, Madhya Pradesh and Rajputana. In South India, it grows along the western coast from Konkan to Kerala.

Description of the wood

(*Zizyphus jujuba, Z. nummularia, Z. rugosa, Z. trinervia, Z. vulgaris* and *Z. xylopyrus*)

[Pl. **53**, 313–317]

General properties—No colour distinction between sapwood and heartwood in any of the samples examined except in the solitary sample of *Z. trinervia* available for study which shows a distinct purple-coloured heartwood sharply differentiated from the pale reddish-brown sapwood. Wood in other species light yellowish-brown or whitish with reddish-tinge; hard and moderately heavy to heavy (sp. gr. 0·56–0·85 air-dry); but very hard and very heavy in *Z. trinervia* (sp. gr. 1·15 air-dry); generally interlocked-grained; medium-textured but fine-textured in *Z. trinervia.*

Gross structure—A diffuse-porous wood with a tendency towards semi-ring-porous structure in some samples. *Growth rings* usually distinct delimited by fine line of parenchyma and also by thicker-walled latewood fibres 1–9 per cm. *Vessels* mostly small, appearing as pin-pricks to the naked eye but moderately large and distinct to the eye in the earlywood of some samples, especially in *Z. jujuba, Z. nummularia* and *Z. vulgaris*; very small and visible only under lens or at least appearing as whitish specks to the naked eye in *Z. trinervia*;

often few to moderately numerous (4–19 per mm.^{2}) but numerous (25–39 per mm.^{2}) in *Z. trinervia* ; more or less evenly distributed but sometimes may be rather crowded in the early part of the growth ring in some samples, solitary or in radial multiples of 2–4, occasionally more, mostly oval, open or plugged with whitish deposits, occasionally also filled with reddish-brown deposits ; vessel lines distinct except in *Z. trinervia*. *Parenchyma* – (*a*) paratracheal, variable in amount and visibility even in the same species but visible to the eye in *Z. trinervia* due to the colour difference and in *Z. xylopyrus* on account of more development of parenchyma ; however, the common patterns met with in the species studied are as follows :—(*i*) as thin sheath round the vessels in *Z. rugosa* and *Z. trinervia* ; (*ii*) aliform or 'eye-let', sometimes with short, thick or thin lateral extensions, forming interrupted wavy tangential lines in *Z. jujuba*, *Z. nummularia* and *Z. vulgaris* ; and (*iii*) fairly thick and long tangential bands joining vessels in *Z. xylopyrus* ; (*b*) apotracheal – in thin lines delimiting growth rings, visible to the eye in *Z. trinervia* but distinct only under lens in the remaining species. *Rays* very fine, visible only under lens, closely spaced often brownish in colour. *Pith flecks* occasionally present in *Z. rugosa* and *Z. xylopyrus*.

Strength—It is a hard, heavy and tough timber. *Z. jujuba* has been tested at this Institute and the strength figures are given in appendix I.

Seasoning—The wood of *Z. jujuba* is reported to crack and warp during seasoning (26). Pearson and Brown, however, state that "it seasons with no great difficulty though logs should not be left exposed to the direct rays of the sun ; if protected, the timber appears to season as well in the log as it does if converted green". Further, according to them *Z. xylopyrus* also seasons fairly well in log form. In kiln-seasoning, *Z. jujuba* requires great care as it is liable to develop certain amount of surface cracking and end splitting (25). Howard, however, mentions that this timber has good standing qualities.

Natural durability—None of the timbers has been subjected to "graveyard" tests at this Institute, but they appear to be fairly durable under cover. Pearson and Brown state that *Z. xylopyrus* is more durable than *Z. jujuba*.

Insect attack—The wood is known to be damaged by a number of borers. The drywood of *Z. jujuba* and *Z. rugosa* is attacked by *ghoon* borers (Bostrychidae) and that of *Z. nummularia* by *Stromatium barbatum* Fabricius (Cerambycidae). The deadwood of *Z. jujuba* is attacked by *Celosterna scabrator* Fabricius (Cerambycidae) and that of *Z. rugosa* by *Coloborhombus fulvus* Bates (Cerambycidae).

Working qualities—The timber is comparatively easy to saw and work but may sometimes give trouble due to interlocked-grain. It is also reported to turn well.

Supply and uses—The timber is not available in commercial quantities except in the central zone of India where *Z. jujuba* is available in small quantities. The timber is mainly used locally for agricultural implements, cart wheels, oil mills, paddy pounders, legs of bedsteads, tool handles and house posts. It is also used for boot and shoe lasts, sandals, golf clubs, tent pegs and walking sticks. *Z. jujuba* is suitable for picker arms used in textile mills (31), cheap grade pencils (27), and also for furniture. Troup mentions its use for gun stocks.

Material—

Z. jujuba – 1128 Ahiri Reserve, Bombay (0·85), 4736 Saharanpur, Uttar Pradesh (0·69), 5314 Dehra Dun, Uttar Pradesh (0·56), 6066 Kanara, Mysore (0·68), 6273 Dehra Dun, Uttar Pradesh (0·62).

Z. nummularia – 442 Ajmere, Rajasthan (0·70), 2931 Simla, Himachal Pradesh (0·63), 3077 Sabathu, Punjab (0·61).

Z. rugosa – 2336 Darjeeling, West Bengal.

Z. trinervia – 5634 Coimbatore, Madras (1·15).

Z. vulgaris – 885 Multan, West Pakistan (0·69).

Z. xylopyrus – 2736 Moharli Reserve, Madhya Pradesh (0·78), 3559 Khurda Forests, Orissa (0·71), 4735 Saharanpur, Uttar Pradesh (0·76), 6067 Kanara, Mysore (0·78), 6274 Dehra Dun, Uttar Pradesh (0·66).

Specimen No. 3508 from Orissa described by Gamble under *Z. xylopyrus* is not correctly named. It does not belong to this family.

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SAPINDACEAE

There is difference among botanists regarding the exact scope of this family, and the systematic position of some of the genera included in it. The *Aceraceae*, *Hippocastanaceae* and *Staphyleaceae* described later are all included in the *Sapindaceae* by Bentham and Hooker; while Engler and Prantl treat them as distinct families. Hutchinson places the *Hippocastanaceae* under the *Sapindaceae* but considers the *Aceraceae*, *Staphyleaceae*, *Akaniaceae* and *Melianthaceae* as separate families of which the last two do not come within the scope of this book. On the other hand, based on cytological evidence, Foster concludes that the *Aceraceae* have a common origin with the *Staphyleaceae*. The arrangement followed here is the same as that of Metcalfe and Chalk in their "Anatomy of the dicotyledons", the *Aceraceae*, *Hippocastanaceae* and *Staphyleaceae* being excluded from the *Sapindaceae* and described separately. From the point of view of the anatomical structure of the woods of the various Indian genera studied, it appears that such an arrangement is justified. The salient anatomical features of all these families based primarily on Indian woods are summarized below :—

TABLE II.—*Comparative anatomy of the Sapindaceae and their allies*

Characters	Sapindaceae	Aceraceae	Hippocastanaceae	Staphyleaceae
VESSELS ...	(1) Round to oval	Round to oval	Often angular	Often angular
	(2) Perforation always simple	Perforation simple	Perforation simple to scalariform	Perforation always scalariform
	(3) Intervessel pitting usually small and alternate	Intervessel pitting fairly large and alternate	Intervessel pitting fairly large, alternate to opposite	Intervessel pitting fairly large, opposite to scalariform
	(4) Spiral thickening usually absent	Spiral thickening always present	Spiral thickening always present	Spiral thickening occasionally present
FIBRES ...	(1) Always with simple pits	Always with simple pits	Simple to bordered pits	Always with bordered pits
	(2) Usually septate	Non-septate	Non-septate	Non-septate
RAYS ...	(1) Usually narrow mostly uniseriate	Usually fairly broad and multiseriate	Always narrow and uniseriate	Both narrow uniseriate and broad multiseriate
PARENCHYMA	(1) Scanty to abundant	Usually scanty	Usually scanty	Usually scanty
	(2) Parenchyma delimiting growth rings sometimes present	Parenchyma delimiting growth rings always present	Parenchyma delimiting growth rings always present	Parenchyma delimiting growth rings absent

From Table II, it would appear that *Staphyleaceae* is furthest removed from the *Sapindaceae*, while the *Aceraceae* and the *Hippocastanaceae* occupy a more or less intermediate position. *Filicium* Thw. which was originally placed under the *Burseraceae* (20) differs from that family in having small intervessel pitting and narrow uni- or biseriate rays. Further, horizontal gum canals which are generally a characteristic feature of the *Burseraceae* are also absent in this genus. In all these characters, it agrees well with the *Sapindaceae* and, therefore, its transfer to this family seems justified.

The family *Sapindaceae* in its restricted sense as considered here consists of about 120 genera and well over 1000 species of trees, shrubs and climbers, chiefly distributed in the tropical and subtropical regions of the world. It is well represented both in the eastern and western hemispheres. Two of the largest genera – *Serjania* Plum ex Schum and *Paullinia* Linn. are lianas with about 300 species occurring in America. Both of them are characterized by anomalous structure. It is interesting to note here that species of some genera like *Pseudima* Radlk., *Pseudopteris* Baill., *Talisia* Aubl., *Toulicia* Aubl. and *Tripterodendron* Radlk., have a striking and unusual palm-like habit, with a clear branchless stem and a collection of leaves at the top. The family is equally interesting from the point of view of taxonomy as it is composed of a large number of genera, about one half of which are monotypic (21). From the fossil records it appears that the *Sapindaceae* date back to the upper Cretaceous reaching their best development in the Eocene (1).

Though the family is not of any special significance from the point of view of timber, the fruits of various species are of considerable economic importance. Some yield edible fruits which are delicious and highly prized for dessert, in the Indo-Malayan region. The best known among them are 'litchi' produced by *Nephelium litchi* Camb. and the 'rambutan' obtained from *Nephelium lappaceum* L. The West African 'akee apple' or vegetable marrow is furnished by *Blighia sapida* Koen. The seeds of *Paullinia cupana* Kunth are reported to be used in Brazil for making some sort of bread, while the roasted seeds are used in the preparation of a refreshing beverage somewhat similar to coffee (42). The fruits of *Sapindus laurifolius* Vahl. and *Sapindus mukorossi* Gaertn. contain over 10 per cent of saponin in the rind and are commonly employed for washing and cleansing in place of soap (9). Similarly, fruits of *Harpullia cupanoides* Roxb. are said to be used for the same purpose in Ceylon as they also contain saponin (33).

A number of plants belonging to this family possess tonic, astringent, narcotic and poisonous properties, and as such are often used all over the world in medicine and also as a fish poison (10). In South America, crushed plants of *Paullinia* and *Serjania* are said to be thrown in rivers and streams to stupefy fish (42). Among Indian species, *Harpullia cupanoides*, *Sapindus laurifolius* and *S. mukorossi* are reported to be fish poisons. A plaster made

from the seed kernels of *S. laurifolius* with vinegar is said to be efficacious for bites of reptiles and scrofulous swellings, while the juice from the bark and the fruits is applied to the nose in case of lock-jaw (33). Kusum (*Schleichera trijuga* Willd.) is considered to be the best tree for lac cultivation, the lac produced on it being of very high quality giving the finest-coloured shellac (51). The oil obtained from the seeds of this tree – reputed to be the original "Macassar oil" of hair-dressers – is said to be a stimulant for hair-growth on the scalp, a cure for itch and useful for external application, and massage in rheumatism. The powdered seeds are reported to be applied to ulcers of animals and for removing maggots. An embrocation of tender leaves of *Dodonea viscosa* Linn. in boiling water is said to be a useful remedy for sprains and bruises, while in the Punjab the bruised leaves are applied to the bitten part and the juice given internally in case of snake-bite (30). Some of the handsome species like *Filicium decipiens* Thw. with its fern-like leaves are planted as ornamentals, while *Dodonea viscosa* is popular throughout India as a hedge plant.

Though several genera provide woods which are dense hard and heavy, the family *Sapindaceae* in the sense described here, does not include many timbers which can be considered to be of much commercial importance, except perhaps some species growing in Australia. The best known of these is Australian "tulip wood", *Harpullia pendula* Planch. It is regarded as one of the handsomest among Australian timbers, mainly used for decorative panelling, cabinet work and a variety of ornamental articles (4). "Brush teak", *Ratonia tenax* Benth. and "Wild quince", *Nephelium semiglaucum* F.V.M. and a few others are also excellent hardwoods which rank as some of the finest in Australia (2). In the Indo-Malayan region the only woods of some commercial importance are furnished by *Schleichera trijuga* (*Kusum*) and *Pometia* spp. (*thitkandu* and *kasai*) and to a very limited extent by *Filicium decipiens* Thw. (18, 39).

About 20 genera belonging to the *Sapindaceae* are represented in the Indian region. Fourteen of these for which wood samples were available for study are dealt with here. Among those not studied are *Guioa* Cav. and *Lepidopetalum* Bl. which are included by some botanists (31) under *Cupania* Plum. along with *Arytera* Bl. and *Mischocarpus* Bl. Two species of the former – *G. fuscidula* Radlk. (*Cupania fuscidula* Kurz) and *G. squamosa* Radlk. (*Cupania glabrata* Hiern) are small trees of Tenasserim in Burma, while *Lepidopetalum* is represented by a single tree species – *L. jackianum* Radlk. (*Cupania jackiana* Hiern) in the Nicobar Islands. *Zollingeria macrocarpa* Kurz – *wetkyut* (Burm.) is a large deciduous tree of Burma. *Thraulococcus erectus* Radlk. and *Stocksia brahuica* Benth. are both erect shrubs with very much restricted distribution in the Indian region, the former being confined to the southern part of the Western Ghats and the latter to Baluchistan.

Apart from the above there is another genus *Aphania* Bl. which is represented in India by about four species. These were formerly included under *Sapindus*. Two small wood samples of *Aphania rubra* Radlk. Syn. *S. attenuatus* Wall. and *A. danura* Radlk. Syn. *S. danura* Voigt. were available for study. The former is usually a shrub rarely attaining a height of 4·5–6 m. occurring throughout Assam in the evergreen forests in Sikkim and North Bengal. The latter also is a small evergreen tree or shrub of the hills of Assam and extends through Chittagong and Burma to the Andaman Islands. It is interesting that from the point of view of wood structure both these species with their well-developed apotracheal, diffuse-aggregate or reticulate parenchyma seen clearly under the hand lens are distinct and easily distinguishable from *Sapindus* and their inclusion in a separate genus *Aphania*, therefore, seems justified.

The woods of majority of the genera described here are similar in appearance, general properties and anatomical structure and possess many features in common which often make their correct identification in the field rather difficult. However, like the Javanese, Malayan and Philippine woods of the family which have received considerable attention from several workers (18, 36, 43), they show marked variation in the amount and distribution of parenchyma. Though Desch is of the opinion that "the amount of parenchyma is not a good feature on which to base any system of grouping of the woods of this family", so far as field identification of the Indian woods is concerned, this is perhaps the most important character which is of value in classifying a group of timbers which is otherwise homogeneous.

The woods range in colour from pale yellowish or pinkish-grey or brown to deep red or reddish-brown, the lighter yellowish shades usually predominating in *Erioglossum*, *Harpullia*, *Lepisanthes* and *Sapindus*. Usually there is no distinction between sapwood and heartwood except perhaps in some samples of *Filicium*, *Nephelium*, *Pometia* and *Schleichera* and a few others where the wood towards the periphery may be of a somewhat lighter shade than that near the centre. In weight and hardness they are moderately heavy to very heavy (sp. gr. 0·62–1·21 air-dry) and moderately hard to very hard, being comparatively lighter and softer in *Harpullia* and some species of *Sapindus* and sometimes varying considerably within the same genus. As a rule, the woods are fairly straight or slightly wavy-grained and medium to rather fine-textured, excepting *Pometia* and *Sapindus mukorossi* which are somewhat coarse-textured. They do not possess any characteristic odour or lustre, but in the single species of *Lepisanthes* available for study, the wood has a pronounced bitter taste, which is of considerable diagnostic value.

With the solitary exception of *Sapindus mukorossi* which is distinctly ring-porous, the woods are all diffuse-porous and somewhat similar in structure, featured anatomically by fairly distinct growth rings delimited by the denser

latewood or somewhat interrupted to more or less continuous line of parenchyma, medium-sized to small or very small vessels which are mostly solitary and in short radial multiples excepting in *Dodonea* where they tend to be in longer multiples and clusters, and extremely fine, low, rays which are numerous and closely spaced and visible only under lens. In *Pometia* and *Sapindus mukorossi*, however, the vessels are much larger and clearly visible to the eye, with tendency to be predominantly solitary in the former. Though the woods of the family generally exhibit uniformity in their vessel and ray character even under the microscope, the parenchyma differs considerably in the various genera studied and offers the best means for separating them in the field. Apart from occurring as a fine, broken or somewhat continuous light-coloured line delimiting the growth rings in most genera, the parenchyma may be predominantly paratracheal, apotracheal or occasionally both. The paratracheal parenchyma varies considerably in different genera from extremely scanty to abundant and banded as given below :—

(*a*) It is usually very sparse in *Arytera*, *Dodonea*, *Mischocarpus*, *Schleichera* and *Xerospermum* (in part), limited only to a few cells adjoining the vessels, forming at best an interrupted sheath not visible or indistinct even under the lens.

(*b*) It is relatively better developed, occurring as a narrow but complete sheath round the vessels clearly visible under the lens in *Filicium**, *Pometia* and *Xerospermum* (in part), and forming distinct eyelets and occasionally connecting adjacent pores in *Harpullia*.

(*c*) Parenchyma associated with vessels is, however, best developed in *Erioglossum*, *Lepisanthes* and *Sapindus*, where it is profuse, forming prominent, confluent, wavy or straight, light-coloured bands distinctly visible to the eye and conspicuous under the lens.

The apotracheal parenchyma, on the other hand, is as a rule poorly developed in most of the genera, being usually absent or indistinct even under the lens. But in some genera like *Arytera* and *Mischocarpus*, it may be diffuse and relatively somewhat abundant. In these genera it occurs as scattered and occasionally locally numerous crystalliferous cells appearing as whitish specks against the darker background under the lens. Similar diffuse parenchyma may also be found in association with fairly well developed paratracheal parenchyma as in *Harpullia*.

The woods of two genera – *Allophylus* and *Paranephelium*, show under the lens and even to the unaided eye, what appear to be well developed bands or patches of soft tissues or parenchyma. Such bands or patches may or may not be in association with the vessels. Though scarcely distinguishable from parenchyma in the gross, when examined under the microscope these light-coloured bands or areas are seen to be made up of septate fibres with very

* Occasionally in some samples of *Filicum*, the vasicentric sheath may not be distinct due to the parenchyma cells being filled with dark coloured deposits.

thin walls and large lumen. It is sometimes possible to distinguish them from true parenchymatous bands even under hand lens due to their boundaries being invariably poorly defined and not sharply demarcated from the ground mass. It is interesting to record here that similar bands of thin-walled septate fibres simulating parenchyma are also found in some members of the *Celastraceae* (40) and *Oxalidaceae**. Storied structure and gum-ducts were not observed in any of the samples examined though the latter have been recorded in *Harpullia* by Desch.

Owing to the general uniformity in the structure and properties of the woods it is not always possible to distinguish them with certainty in the field. However, many of them can be separated or grouped as given below :—

Key to the genera

1.	Wood ring-porous	*Sapindus mukorossi*
1.	Wood diffuse-porous	2
2.	Parenchyma (apart from those delimiting growth rings) abundant, distinctly visible to the eye and predominantly banded ..	3
2.	Parenchyma (apart from those delimiting growth rings) not abundant, indistinct to the eye, usually scanty, vasicentric to aliform	6
3.	Parenchyma in bands independent of the vessels, but often including them	*Allophylus*
3.	Parenchyma in association with vessels, aliform confluent to banded	4
4.	Wood with distinct bitter-taste	*Lepisanthes*
4.	Wood without any bitter-taste	5
5.	Boundaries of soft tissues or parenchyma† usually poorly defined and not sharply demarcated from the background	*Paranephelium*
5.	Boundaries of soft tissues or parenchyma always well defined and sharply demarcated from the fibrous background	*Sapindus laurifolius*‡ *Erioglossum*

* S. S. Ghosh and S. K. Purkayastha. Characteristic arrangement of Septate fibres in the wood of *Averrhoa* Sp., *Sci. & Cult.*, **25**, 690, 1960.

† Under the microscope, these are seen to be made up of thin-walled septate fibres.

‡ *Sapindus* generally shows a slightly greater tendency to parenchyma distribution of the aliform and aliform confluent type than *Erioglossum* where the zonate and banded structure is more conspicuous.

6. Parenchyma round the vessels distinct under lens, forming a complete sheath or eyelet 7

6. Parenchyma round the vessels indistinct under lens, very scanty 9

7. Parenchyma round the vessels distinctly aliform, occasionally connecting adjacent vessels. Wood usually yellowish or greyish-brown .. *Harpullia*

7. Parenchyma round the vessels vasicentric appearing as a lighter-coloured, thin sheath. Wood usually pinkish or reddish-brown 8

8. Vessels large to medium-sized, distinctly visible to the eye. Wood rather coarse-textured .. *Pometia*

8. Vessels small to very small, indistinct or barely visible to the eye. Wood relatively fine-textured .. .. .. *Xerospermum glabratum Filicium*

9. Diffuse parenchyma present, visible under lens as scattered, whitish specks against the darker background .. .. .. *Arytera, Mischocarpus*

9. Diffuse parenchyma absent or if present not visible even under lens 10

10. Vessels usually small to very small, not visible to the eye, often with a tendency to be arranged in long radial multiples. Wood very fine-textured .. .. .. *Dodonea*

10. Vessels usually medium-sized to small just visible to the eye, mostly solitary and in short radial multiples. Wood usually medium-textured .. .. .. *Nephelium** *Schleichera* *Xerospermum ferrugineum*

1. ALLOPHYLUS LINN.

A large genus of over 120 species of shrubs or small trees about half of which are American, the others being distributed in the tropics of the Old

* Often *Nephelium litchi* can be distinguished from the others, by very much deeper red colour and somewhat finer texture. Growth rings are absent or indistinct in *Xerospermum ferrugineum* and this is sometimes helpful in separating it from *Schleichera*, where they are usually sinuate and well defined.

World. In the Indian region it is represented by less than half a dozen species, some of which are considered as only varieties or forms of the two main species, *A. cobbe* Bl. and *A. zeylanicus* Linn. Wood specimens were available for study for only the former which is described below. *A. zeylanicus* – *Kantiernyok* (Lep.) is a shrub or small tree of Sikkim ascending up to 900 m. and also occurs in Assam, the Malay Peninsula and Ceylon.

A. cobbe Bl.—*Atya-chiraita, chitta* (Beng.), *kasabally, murele bhendy, sidisale, siduguli* (Kan.), *arhik-bouna* (Lush.), *mukkannan-peru* (Mal.), *morvel, tipani, titwi* (Mar.), *kandakola, kontakura* (Or.), *bu-kubbe, kobbe* (Sinh.), *amarai, muvelneeli, naimarom, perrakudikai, sirusalle* (Tam.), *guaguti, namilikalu, salikukudu* (Tel.), *chi-cchi-rum* (Tipp.). A large extremely variable shrub sometimes attaining the size of small tree about 6 m. in height and 40 cm. in girth. *Bark*, dark brownish-grey, fairly smooth and thin.

It is distributed throughout South India ascending up to 1,800 m. and is also found in the hills of Assam, Chittagong, the Andaman Islands, Burma and Ceylon.

Description of the wood

[Pl. 53, 318]

General properties—Heartwood not distinguishable from sapwood. Wood pale brown ; moderately hard, moderately heavy (sp. gr. 0·72 air-dry), fairly straight-grained, even and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct but occasionally flattened thick-walled fibres may give the impression of growth marks. *Vessels* small to very small, not visible to the eye, numerous to very numerous (20–50 per mm.^{2}), evenly distributed, solitary and in radial multiples of 2–4 occasionally more, mostly round in outline, open and devoid of tyloses ; vessel lines just visible on the longitudinal surfaces as very fine scratches. *Parenchyma* very scanty limited to a few cells round the vessels and indistinct even under lens ; but whitish patches or wavy tangential bands resembling parenchyma* present and distinct to the eye. These bands are usually independent of the vessels, though often touching or including them and ending abruptly. *Rays* very fine not visible to the eye, but visible under lens, numerous and closely spaced.

Little is known regarding the strength and other properties of the wood. Standing trees and newly felled logs are liable to be attacked by the shot-hole borer *Xyleborus formicatus* Eichoff. The wood appears to be tough and elastic and on this account seems to be used for bows in Ceylon (20). Being compact and even-textured, it may perhaps be useful for small turnery articles.

* Under the microscope, these whitish bands are seen to be made up of very thin-walled septate fibres with large lumen which stand out in sharp contrast from the alternating layers of the denser thick-walled fibres.

Material*—

3752 Nilgiris, Madras (0·72).

2. ARYTERA Bl.

A small genus of about 20 species of trees, mostly confined to the Malay Peninsula and Archipelago, South China and Australasia. The only species represented in the Indian wood collection at Dehra Dun is dealt with here.

A. littoralis Bl. Syn. *Cupania adenophylla* Planch.—*Lamu* (Burm.). A small tree about 7·5–9 m. in height, attaining a somewhat larger size in Malaya. It extends from Upper Tenasserim in Burma to the Malay Archipelago and occurs also in the Andaman Islands.

Description of the wood

[Pl. 54, 319]

General properties—No distinction into heartwood and sapwood in the specimen examined, wood pinkish-grey ; hard ; heavy (sp. gr. 0·90 air-dry) ; straight-grained and medium-fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* distinct, usually delimited by the darker coloured and denser latewood, sometimes further accentuated by a fine, whitish very much interrupted line formed by scattered parenchyma cells, 3–12 per cm. *Vessels* medium-sized to small, indistinct or barely visible to the eye, moderately numerous, occasionally fewer or somewhat more numerous (8–24 per mm.^{2}), mostly solitary and in short radial multiples of 2–3, rarely more, round to oval in outline, open or plugged with whitish chalky deposits ; vessel lines distinct on the longitudinal surfaces. *Parenchyma* scanty, limited to occasional cells delimiting growth rings, and also sparsely diffuse, visible with a lens as minute whitish specks against the darker ground mass (due to their crystalliferous nature) ; also round the vessels as a thin incomplete sheath, not visible or indistinct even under lens. *Rays* very fine, visible only under the lens, numerous and very closely spaced.

The wood is hard, heavy, and tough and is likely to be suitable for agricultural implements, like rice pounders and tool handles. In the Philippines it is said to be used for rafters and fencing (43).

Material—

7138 Burma (0·90).

3. DODONEA Linn.

A genus of about 50 species mostly shrubs or occasionally trees, the majority of which are confined to Australia. It is represented in the Indian region by a single species which is described below.

Dodonea viscosa Linn.—*Aliar, paniphul* (Beng.), *hmaing* (Burm.), *sanatta, walayati mehndi* (Hind.), *bandare, bundurgi* (Kan.), *krali, vrali*

* Specimen No. 1988 from the Andaman Islands described by Gamble under this species is not *Allophylus*. Microscopic examination has shown that it is one of the *Anonaceae*.

(Mal.), *jakhmi, lahanlokhandi, lutchmi, paorki* (Mar.), *mohara* (Or.), *sanatta, mendru* (Punj.), *eta werella, werella* (Sinh.), *virali* (Tam.), *bandedu, bandhari* (Tel.). It is usually a shrub occasionally attaining the height of a small tree as in the Nilgiris at higher elevations of 1500–1800 m. *Bark* variable in colour ranging from reddish-brown to grey, thin, usually exfoliating in long thin strips.

It has an extensive distribution throughout the tropical and sub-tropical regions of the world – in South East Asia, Australia, Africa, America and the West Indies. In the Indian region it is found in the North-West Himalayas, from the plains up to 1350 m. and throughout the drier parts of Central and South India, where it is commonly gregarious often forming extensive tracts. It also occurs in Chittagong in East Pakistan, South Tenasserim in Burma, Ceylon and the Andaman Islands. It is also frequently planted all over the country for hedges, and in gardens for topiary work.

Description of the wood

[Pl. 54, 320]

General properties—No distinction into heartwood and sapwood, though occasionally in some samples the wood towards the periphery may be somewhat pale or lighter-coloured than in the centre; colour variable, ranging from light yellowish-brown to deep reddish-brown sometimes with dark-brown or blackish streaks or markings ; very hard, very heavy (sp. gr. 0·91–1·21 air-dry) fairly straight-grained to very much twisted-grained, fine to very fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct to distinct, in the latter case usually delimited by a lighter-coloured line of parenchyma which may occasionally be distinct even to the unaided eye, 2–16 per cm. *Vessels* small to very small, not visible to the eye, moderately numerous to very numerous (10 to over 50 per mm.^{2}), evenly to somewhat unevenly distributed, solitary and in radial multiples of 2–4 or more, the latter often predominating, occasionally almost exclusively in long radial multiples of up to 7 with a few clusters as observed by Heimsch ; round to oval in outline, usually open and free from tyloses but sometimes with whitish deposits ; vessel lines indistinct or barely visible on the longitudinal surfaces. *Parenchyma* (*a*) often occur as a more or less continuous line delimiting growth rings occasionally visible to the unaided eye ; (*b*) also paratracheal and scanty, limited to a few cells forming a narrow interrupted or incomplete sheath round the vessels or vessel groups, usually indistinct or hardly visible even under the lens. The predominantly aliform and locally confluent type described by Moll and Janssonius as occurring in the Javanese sample was not observed in any of the Indian wood specimens studied. *Rays* fine to very fine, not visible to the eye but usually distinct under the lens, numerous and closely spaced.

The wood is hard, strong and tough and may do well for tool handles, for which it is reported to be used. It appears to be rather difficult to season as most of the samples in the wood collection at Dehra Dun are badly cracked and split. Deadwood is liable to be attacked by *Raphuma rhea* Gahan (Cerambycidae) two of our samples showing large borer holes. It provides a good fuelwood with high calorific value (14) and is reported to be used for walking sticks, turnery and engraving (20). But from what could be made out from the wood samples available for study, there appears to be little justification for considering it as a possible substitute for boxwood (49).

It may be of interest to note here that it is one of the many timbers which were found some 45 m. below the river bed at the time of the recent construction of Ganga bridge at Mokameh, Bihar (13). Radio carbon dating of these timbers has shown that they are at least 30,000 years old. A comparative anatomical study of these woods has revealed that *Dodonea* has got the capacity of resisting degradation of tissues much better than the other timbers found at the bridge site. The structure of this timber is also preserved admirably well during all these years.

Material*—

894 Salt Range, West Pakistan (1·20), 3730 Nilgiris, Madras (1·10), 3877 Nilgiris, Madras (1·21), 5438 Visakhapatnam, Andhra Pradesh (1·11), 5493 Cuddapah, Andhra Pradesh (0·91), 5536 Rawalpindi, West Pakistan (1·19), 5593 Kashmir (1·11), 5697 Nilgiris, Madras (1·14), 7161 Burma (0·93).

4. ERIOGLOSSUM Bl.

A small genus of shrubs or trees with only two species, both confined to South-East Asia. Of these, one occurs in the Indian region and is considered here.

E. rubiginosum Bl.—*Bara-horina* (Beng.), *aukchinsa*, *chyabu*, *chyabu-nut*, *tseik-chay* (Burm.), *abigran* (Garo), *ritha* (Hind.), *mukti-moya*, *nunga*, *sona-mahanga* (Or.), *korali*, *mani-punyam* (Tam.), *ishi rashi*, *undurugu* (Tel.). A large shrub or small to medium-sized tree up to about 10 m. in height and a metre in girth with a clear bole of 2·4–4·5 m. *Bark* dark-grey and warty outside peeling off in large flakes exposing the dark-brown or blackish interior, about 6 mm. thick.

It occurs in the Eastern Ghats of Andhra Pradesh and Orissa ascending up to 600 m., in the Andaman Islands and also in North East India in the Sikkim Terai and Assam extending through East Pakistan, Burma and Malaya to Indonesia and Australia. It is also found in the Philippines.

* Specimen D. 3967 from Cuddapah included under *Dodonea viscosa* by Gamble is not correctly named. It belongs to the family *Meliaceae*.

Description of the wood

[Pl. 54, 321]

General properties—Sapwood and heartwood not distinct in the specimens examined though a pinkish-brown heartwood has been reported by Kurz and others (15) ; wood yellowish-grey or pale-brown with a pinkish tinge, somewhat darkening on exposure ; usually hard and heavy (sp. gr. 0·94 air-dry), but occasionally somewhat lighter and softer ; straight-grained and medium-fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct to the eye, but relatively better defined under the lens, delimited by a continuous line of soft tissues, which, however, is not always easily distinguishable from the bands of parenchyma occurring throughout the growth ring. *Vessels* small to medium-sized, indistinct or just visible to the eye, few to moderately few (2–10 per mm.^{2}), evenly distributed, mostly solitary and in radial pairs, sometimes in longer multiples of 3–4 ; round to oval in outline, usually open but occasionally plugged with whitish deposits ; vessel lines fairly distinct on the longitudinal surfaces. *Parenchyma* paratracheal and abundant, clearly visible to the eye and prominent under the lens forming relatively long or broken wavy, tangential bands connecting the vessels ; also in a more or less continuous but somewhat finer band delimiting growth rings. *Rays* very fine not at all visible to the eye, but distinct under lens as numerous, fine, closely spaced white lines standing out clearly against the darker background.

There is no reliable information based on tests regarding its strength and other properties. However, the Philippine timber (43) has been described as hard, heavy and strong though not durable when exposed to the weather. Of the two specimens in the wood collection at Dehra Dun one shows borer damage while the other is badly discoloured as a result of fungal attack. It has been reported (8) that the timber does not split in drying and is said to be used for rice pounders and tool handles. It may perhaps also be used for constructional work under cover.

Material—

4662* Oudh, Uttar Pradesh (0·55), 6371 Burma (0·94).

5. FILICIUM THW.

This small genus which was originally included in the *Burseraceae* by Bentham and Hooker, consists of three species of shrubs and trees, limited in

* Apart from being very near the pith and rather fast grown, this sample as already mentioned by Gamble is small and poor and cannot be considered quite representative of the species, especially as regards the general properties.

distribution to tropical Asia and East Africa. The only Asiatic species which comes within the scope of this book is dealt with below.

Filicium decipiens Thw.—*Kattunelli, niroli, nirvoli, valmurichha* (Mal.), *pehimbiya* (Sinh.), *athadali, athalangi, chittiraivempu, iruvillapalai, katupuveras, ningal* (Tam.). A moderate-sized to large tree, occasionally reaching a height of about 27 m. and a girth of nearly 3 m. *Bark* reddish-grey to blackish-brown, rough.

It occurs in the forests of the Western Ghats from the Nilgiris, southwards ascending up to 1500 m. and in Ceylon. It is also often planted.

Description of the wood

[Pl. 54, 322]

General properties—Sapwood and heartwood usually fairly distinct, though the transition may not always be sharp. Sapwood greyish-white with a pale-pinkish or brownish tinge, rather wide ; heartwood reddish-brown, darkening considerably on exposure. Wood very hard ; very heavy (sp. gr. 0·95 air-dry) ; straight-grained, even and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct or inconspicuous to the eye, more clearly defined under the lens, delimited by somewhat darker latewood fibres and a fine interrupted line of parenchyma 2 to 4 per cm. *Vessels* usually small, indistinct or barely visible to the eye as white dots, moderately numerous to numerous (12–31 per mm.^{2}), more or less evenly distributed, mostly in radial multiples of 2 to 4, occasionally solitary ; round to oval in outline, open or plugged with whitish deposits or reddish-brown gummy substance ; vessel lines inconspicuous. *Parenchyma* visible only under lens, forming a narrow, rather inconspicuous sheath round the vessels or vessel groups, often giving an impression of thick-walled vessels, also occurring as a fine, usually interrupted but sometimes more or less continuous light-coloured line delimiting the growth rings. *Rays* very fine, not visible to the eye, but clearly seen under the lens as fine, light coloured parallel lines, rather closely spaced.

Strength—Though the timber has not so far been subjected to any standard strength tests at the Forest Research Institute, Dehra Dun, it appears to be tough and fairly strong. Bourdillon gives the value of P (co-efficient of transverse strength) as 902 and weight 59 lb.

Seasoning—The timber is reported to season with considerable degrade developing surface and end cracks of a serious character. Though the best method of dealing with this rather difficult timber can be found out only after actual seasoning trials, prompt conversion after girdling or under water storage and close-piling under cover have been suggested for satisfactory results (39).

Natural durability—It is reported to be durable (33).

Working qualities—The timber though hard is fairly easy work with tools. It can be sawn without much difficulty and planes and turns well to a good finish.

Supply and uses—Moderate supplies are available from Kerala and the adjoining districts of Madras. The timber closely resembles Kusum (*Schleichera trijuga* Willd.) in structure and properties and should be suitable for most purposes for which the latter is used as in sugar and oil mills, for hubs of wheels and felloes, tool handles and agricultural implements like rice pounders, ploughs, etc. It is used in South India for furniture and in constructional work as beams and posts. On account of its strength, toughness and durability, it may do well for bottom boards of railway carriages and wagons (39).

Material—

4662 Travancore, Kerala (1·03), 6132 Tirunelveli, Madras (0·99), 6199 Madras (0·95).

6. HARPULLIA Roxb.

A tropical genus of about 25 species of trees distributed in South-East Asia, Northern Australia and Madagascar. Brandis recognizes only a single species as occurring in the Indian region which is described here.

H. cupanioides Roxb.—*Harpulli, jurbisi* (Beng.), *tagat-kwedaung* (Burm.), *bidsale* (Kan.), *jong-kitil-thing* (Kuki), *chittila madakku, unatharavi* (Mal.), *pundalu, na-imbul* (Sinh.), *neikottei* (Tam.). A medium-sized to large tree attaining in favourable localities as in Chittagong hills and parts of Burma a height of 24–27 m. with a clear bole of 15–18 m. and a girth of about 2–4 m. In India it grows to a much smaller size rarely exceeding 15 m. in height and about 1 m. in girth. *Bark* light coloured, usually pale-greyish or greenish-brown with darker or blackish lenticels, rather smooth, 3 6 mm. thick. Fruits are reported to be used for washing purposes.

It is common in the Western Ghats from Konkan southwards and is also found in Assam and Andaman Islands. Outside India it occurs in Ceylon, Chittagong Hill Tracts of East Pakistan, Burma, South China, Malay Peninsula and Java. The relatively smaller tree occurring in Western Ghats and Ceylon is considered by some botanists as a distinct species, *H. imbricata* Thw. Wood samples from both the regions were available for study. No difference, however, in their anatomical structure was noticeable.

Description of the wood

[Pl. 54, 323]

General properties—No distinct heartwood in the specimens examined, though in the Australian species, *H. pendula* Planch a small dark-brown

heart-wood and a wide pale-yellow sapwood have been reported. *Wood* light yellowish-white or greyish turning pale-brown on exposure, occasionally with dark-greyish or brownish-black streaks ; somewhat soft to moderately hard ; moderately heavy (sp. gr. 0·65–0·69 air-dry) ; straight-grained, even and moderately fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct to distinct, in the latter case delimited usually by somewhat denser latewood fibres, associated with some parenchyma cells, 3–5 per cm. *Vessels* usually small, occasionally medium-sized, indistinct or just visible to the eye as white dots, moderately few to moderately numerous (8–20 per mm.^{2}) rather evenly distributed, mostly solitary and in short radial multiples of 2–3, occasionally with longer multiples and a few clusters ; round to oval in outline, usually open, but sometimes filled with white chalky deposits ; vessel lines distinct on the longitudinal surfaces. *Parenchyma* (*a*) predominantly paratracheal, not visible to the eye but distinct under the lens forming light-coloured sheaths or eyelets round the vessels frequently connecting adjacent vessels or vessel groups by lateral extensions, (*b*) diffuse, scanty, barely visible under the lens as minute whitish specks ; and also (*c*) sometimes delimiting the growth rings as a faint broken line, not very distinct even with a lens. *Rays* fine to very fine, not visible to the unaided eye, but distinct under the lens, numerous and closely spaced. *Gum-ducts* not observed in the samples examined, though Moll and Janssonius have recorded the presence of horizontal canals in the rays of the Javanese samples. Desch has also reported this feature in the Malayan species, *H. confusa* Bl.

It is a moderately hard and moderately heavy timber but has not been tested so far. However, Bourdillon gives the value of P (co-efficient of transverse strength) as 530 and weight 50 lb. The timber appears to be not durable and rather susceptible to decay as both the specimens examined show discolouration due to fungal attack. Being softer and lighter, it is in no way comparable to *Harpullia pendula* Planch, the well-known and handsome tulipwood of Australia which is used for cabinet work and decorative panelling (2, 4). The Indian species is not known to be used at present but may do well in general carpentry as well as for packing cases and crates.

Material—

4717 Travancore, Kerala (0·69), 7116 Burma (0·65).

7. LEPISANTHES Bl.

A tropical Asiatic genus of approximately 20 species of shrubs or trees confined mostly to the Indo-Malayan region. About half a dozen species are recorded in the Indian region of which four attain tree size. Of the tree species,

L. deficiens Radlk. syn. *Hemigyrosa deficiens* Bedd. is a small tree of the Western Ghats, while *L. andamanica* King is mostly confined to the Andaman Islands. *L. burmanica* Kurz, is a small tree of Burma with a straight, almost unbranched palm like trunk and is also found in Assam. The wood samples of these were not available for study. The only species *L. tetraphylla* Radlk. represented in the wood collection at Dehra Dun is described here.

L. tetraphylla Radlk. Syn. *Hemigyrosa canescens* Thw.—*Kaluyette, kurpah, mooltaga* (Kan.), *eskombo* (Khond), *kurpa, lakhandi, lokaneli* (Mar.), *panikusum* (Or.), *kuhamathi, nekota* (Tam.), *korivi* (Tel.). A medium-sized, usually crooked tree, about a metre in girth. *Bark* ash-grey in colour, somewhat rough.

It is fairly widely distributed on the Eastern Ghats, though nowhere common, ascending up to 900 m. in Madras, coastal Andhra Pradesh and Orissa. On the Western Ghats it is comparatively restricted being confined only to parts of Konkan and is also found in Ceylon and Tenasserim.

Description of the wood

[Pl. 54, 324]

General properties—Wood yellowish-white when freshly exposed, turning yellowish-brown with age, without any distinction into sapwood and heartwood in the single sample examined ; very hard and very heavy (sp. gr. 1·00 air-dry), with a distinct bitter taste, straight-grained and medium-textured.

Gross structure—A diffuse-porous wood with occasional tendency for semi-ring-porousness. *Growth rings* not always very distinct to the eye but often distinct under lens delimited by a somewhat wider, straighter and continuous band of parenchyma adjoining denser fibrous tract with scanty or no vessels in the latewood, 2–6 per cm. *Vessels* moderately large to small usually medium-sized, the larger ones in the earlywood clearly visible to the eye, few to moderately few (3–9 per mm.^{2}), more or less uniformly distributed, solitary or in short radial multiples of 2–3 or more ; round to oval in outline, often filled with white chalky deposits ; vessel lines somewhat inconspicuous on the longitudinal surfaces. *Parenchyma* whitish, conspicuous to the eye as broad, wavy, somewhat broken and occasionally anastomosing tangential bands connecting the vessels but fairly straight and continuous on the face of the growth ring. *Rays* extremely fine, not at all visible to the eye, but seen under the lens as numerous, very closely spaced white lines against the darker background.

It is interesting to note that the anatomical structure of *L. palawanica* Radlk. described by Reyes and that of *Lepisanthes* sp. given by Desch does not agree with the description given above, the wood parenchyma in the Philippine and Malayan species being comparatively very sparse, restricted to only a narrow sheath round the vessels. But in *L. montana* described by Moll and

Janssonius, the amount of parenchyma and the nature of distribution are about the same as in *L. tetraphylla* described here. From the point of view of anatomical structure it appears that there is considerable variation in parenchyma distribution in different species of this genus. In view of this, further co-operative research by systematists and anatomists is desirable to clarify the position of some of the timbers of this genus.

There is no information available about the various properties and uses of the Indian timber, which however, appears to be much heavier, harder and stronger than the Philippine and Malayan species. It appears to be a tough timber and may do well for agricultural implements, tool handles and heavy constructional work. The plain sawn boards show an attractive "partridge-mottling" figure which can profitably be utilized for making decorative articles.

Material—

5643 Tinnevelly, Madras (1·00).

8. MISCHOCARPUS Bl.

This genus and *Arytera* described earlier are included by some botanists under *Cupania* along with *Lepidopetalum* and *Guioa* not considered in this book. About a dozen species of trees comprise *Mischocarpus*, which is limited in its distribution to the Indo-Malayan region and Australasia. Among the species occurring in the Indian region, wood samples were available for only *M. fuscescens* Bl. which is dealt with here. *M. sundaicus* Bl. Syn. *Cupania lessertiana* Camb. is a small to medium-sized tree of the Andamans, Mergui in Burma and Malay Peninsula, while *M. pentapetalus* Radlk. Syn. *Cupania sumatrana* Miq. is a small tree found in the Khasi Hills of Assam, Sylhet in East Pakistan and Tenasserim in Burma.

M. fuscescens Bl.—*Seingangaw, taungsagaing* (Burm.). A medium-sized to large tree of the Chittagong Hills, Burma, the Malay Peninsula and Java. In India, it has been reported as occurring only in the north-east in the oak forests of Manipur at about 1200 m. elevation.

Description of the wood

[Pl. 55, 325]

General properties—No distinction into heartwood and sapwood observed in the samples studied. Wood pale pinkish-brown or grey occasionally with a faint purplish tinge when fresh, turning light reddish-brown on exposure, moderately hard to hard, moderately heavy to heavy (sp. gr. 0·74–0·77 air-dry) ; lustrous especially when quarter-sawn ; straight-grained and medium-textured.

Gross structure—A diffuse-porous wood. *Growth rings* usually indistinct, but sometimes fairly distinct, delimited by denser and darker coloured fibres and also occasionally by scattered parenchyma cells in the region of the growth marks, 2–8 per cm. *Vessels* medium-sized to small, just visible to the eye, moderately few to moderately numerous (7–15 per mm.^{2}), evenly distributed mostly solitary and in short radial multiples of 2–3 ; round to oval in outline, usually open but sometimes filled with whitish or pale yellowish-brown deposits ; vessel lines distinct on the longitudinal surfaces. *Parenchyma* diffuse, sparse, but visible under lens as white dots due to their crystalliferous nature, also round the vessels forming a thin incomplete sheath not visible or indistinct even under lens. *Rays* fine to very fine visible only under the lens, numerous and closely spaced. *Pith flecks* common, often large and light reddish-brown in colour.

The wood resembles very closely *Arytera littoralis* from which it is practically indistinguishable. It is said to be good for tool handles and agricultural implements.

Material—6486 Burma (0·74), 7158 Burma (0·77).

9. NEPHELIUM LINN.

(Including *Euphoria* Comm., *Litchi* Sonner., and *Otonephelium* Radlk.)

Systematists differ regarding the scope of this genus and there appears to be some confusion about synonymy. In its wider sense as recognized by Brandis and considered here, *Nephelium* consists of about 30 species of shrubs and trees which are predominantly Indo-Malayan in their distribution. It is represented in the Indian region by seven species of which five occur in the natural state. The other two *N. litchi* Camb. and *N. lappaceum* Linn. are introduced species and are often cultivated for their fruit, the latter chiefly in Ceylon. *N. griffithianum* Kurz. and *N. hypoleucum* Kurz. are small to medium-sized evergreen trees confined to Burma while *N. gardneri* Thw. is a rare tree of Ceylon. *N. longana* Camb. and *N. stipulaceum* Bedd., the only two species found growing naturally in India proper are described below along with the commonly planted litchi tree.

According to Radlkofer the species referred to above should be grouped under four distinct genera – *Euphoria*, *Litchi*, *Otonephelium* and *Nephelium* (7). From the point of view of wood anatomy, Desch also has described the position of *Euphoria*, *Litchi* and *Nephelium*. He has indicated that they differ mainly in the amount of wood parenchyma which is best developed in *Nephelium* being visible even to the naked eye. Of the four genera outlined by Radlkofer, all except *Nephelium* in its restricted sense are represented in the Indian wood collection at Dehra Dun by *Nephelium longana* Camb.

(*Euphoria longana* Lamk.), *Nephelium litchi* Camb. (*Litchi chinensis* Sonner.) and *Nephelium stipulaceum* Bedd. (*Otonephelium stipulaceum* Radlk.). But from the point of view of their wood structure, there is hardly any noticeable difference between them to justify their treatment separately. These have, therefore, been described here together.

1. **N. litchi** Camb. (**Litchi chinensis** Sonner.)—**Litchi.** *Lesi, lisi* (Asm.), *lichu, nichu* (Beng.), *Kyetmauk, tayokzi* (Burm.), *litchi* (Hind.). A handsome evergreen tree, usually small, occasionally somewhat larger. *Bark* grey rough, 2–3 mm. thick.

It is a native of China, extensively cultivated in North India from Saharanpur to West Bengal for its delicious fruit.

Description of the wood—See below.

2. **N. longana** Camb. (**Euphoria longana** Lamk.)—Commonly known as the longan ; *tagong-asing* (Abor), *kath-lechi, mirgach, naga-lichi, tokra* (Asm.), *anshphal* (Beng.), *gyobo, kyetmauk, tawthayet* (Burm.), *samphal-bol* (Garo), *asri-phang, asuri-baphang* (Kach.), *kanakindeli* (Kan.), *diengloba* (Kh.), *marli-thing* (Kuki), *kalpuvam, mulei, pasakolta, poripuna, shempuna, sholapuvam* (Mal.), *wumb* (Mar.), *mora* (Sinh.), *kattupuvan, nurai, puvatti, shempuvan* (Tam.). A medium-sized to fairly large tree about 18 m. in height and up to 1·5 m. in girth with a tall straight cylindrical stem, reported to be buttressed at the base in Assam. *Bark* pale yellowish-grey or brown, usually smooth and rather thin.

It is distributed throughout the Western Ghats from the Konkan southwards extending to Ceylon and ascending up to 900 m. In the north-east, it is found in the hills of Assam and also occurs in South China, Burma and Malaya.

Description of the wood—See below.

3. **N. stipulaceum** Bedd. [**Otonephelium stipulaceum** (Bedd.) Radlk.]—*Pavirimulei* (Mal.). A handsome medium-sized tree up to 18 m. in height and over a metre in girth. *Bark* 2–3 mm. thick.

It has a more restricted distribution than the previous species, being confined to the evergreen forests of the Western Ghats from the Nilgiris southwards ascending up to 900 m. elevation.

Description of the wood—See below.

Description of the wood

(*Nephelium litchi, N. longana* and *N. stipulaceum*)

[Pl. 55, 326]

General properties—Wood reddish-brown in all the three species, but comparatively of a very much deeper shade of red in *N. litchi* with a narrow,

light pinkish or greyish-brown sapwood which may sometimes gradually merge into the darker coloured heartwood. Wood hard to very hard ; heavy to very heavy (sp. gr. 0·86–1·10 air-dry), straight to somewhat wavy-grained, and medium to fine-textured.

Gross structure—All are diffuse-porous woods. *Growth rings* indistinct to fairly distinct, in the latter case usually delimited by somewhat darker and denser latewood fibres and also occasionally by what appears to be a fine line of parenchyma*, 4–20 per cm. *Vessels* medium-sized to small but usually small and indistinct or just visible to the eye in most specimens of *N. litchi* and *N. longana* examined, but somewhat larger, being mostly medium-sized and relatively more distinct in *N. stipulaceum* ; moderately few to moderately numerous (6–20 per mm.^{2}), more or less evenly distributed, mostly solitary and in short radial multiples of 2–3, occasionally with longer groups of 4–5 particularly in *N. litchi* ; round to oval in outline, usually open, occasionally a few filled with whitish or light-coloured deposits ; vessel lines visible on the longitudinal surfaces, somewhat more distinct in *N. stipulaceum*. *Parenchyma*, rather sparse, limited to a few cells round the vessels forming at best an inconspicuous and incomplete sheath, not visible or indistinct even under lens ; also occasionally as scattered cells delimiting the growth rings. *Rays* very fine, not at all seen with the naked eye but clearly visible under lens, numerous and closely spaced.

Strength—All the three woods are very hard and heavy and appear to be strong and tough being very similar to Philippine alupag, *Euphoria didyma* Blanco and alupag-amo, *Litchi philippinensis* Radlk. (43). Bourdillon gives the value of P (co-efficient of transverse strength) as 1061 and weight 61 lb. for *N. longana*. Strength figures of *N. litchi* are given in appendix I.

Seasoning—There is no information regarding the species described here but all the samples in the wood collection show splits and cracks. Reyes, however, states that the Philippine timbers referred to above season well with little or no degrade.

Natural durability—Bourdillon describes the wood of *N. longana* as durable, while Burkill writing about *N. litchi* from Malay Peninsula, states that "the timber is said to be nearly indestructible". The basis for the latter statement is not known, but according to Reyes the closely allied *Euphoria didyma* and *Litchi philippinensis* are durable even under exposed conditions and in contact with the ground and are moderately resistant to marine borers.

Insect and fungus attack—Deadwood of *N. litchi* and *N. longana* has been reported to be liable to attack by shot-hole and other borers. All samples in the wood collection at Dehra Dun were found to be free from insect attack and fungal decay except *N. stipulaceum* which shows slight borer damage.

* Microscopic examination shows that these light-coloured lines, occasionally delimiting the growth rings, are invariably made up of thin-walled septate fibres, interspersed with a few crystalliferous parenchyma.

Preservative treatment—The timbers are not known to have been treated with preservatives so far, but probably may not require any such treatment for general use.

Working qualities—Being very hard and heavy, they are likely to be somewhat difficult to work but can be brought to a good finish with sharp tools.

Supply and uses—Of the three species described, litchi (*Nephelium litchi*) is cultivated in India for its fruit and it may not be possible to exploit it for the timber. As regards the other two species, only very limited supplies are likely to be available locally from the forests of the Western Ghats particularly Kerala. The Philippine timbers are reported to be used for posts, beams, joists, rafters, etc., in general construction ; also for flooring, agricultural implements, salt water piles, keels and keelsons of ships, bearings and other purposes for which a very hard and heavy wood is required. The wood of litchi trees is reported to be used in South China for knees and similar parts of junks (46). The Indian woods, particularly *N. litchi* and *N. longana* should do equally well for most of these uses and may also be tried for carriage and wagon building provided supplies are available in the required size. *N. longana* has also been reported as good for furniture by Burkill.

Material*—

N. litchi – 3260 Saharanpur, Uttar Pradesh (0·87), 4762 Dehra Dun, Uttar Pradesh (1·10).

N. longana – 4539 Travancore, Kerala (0·98), 4668 Travancore, Kerala (1·04), 6427 Burma (0·98).

N. stipulaceum – 4688 Travancore, Kerala (0·90).

10. PARANEPHELIUM Miq.

A small genus of about four species of large shrubs or small trees, having a limited distribution in South-East Asia. The genus is represented in the Indian region by two species, both of which are confined to Burma. *P. xestophyllum* Miq. is a small evergreen tree of Upper Tenasserim for which no wood samples were available for study. The other species represented in the wood collection at Dehra Dun is described below.

P. hystrix W. W. Smith—*Dawng-khreng, thawk-apo, thawkat* (Burm.). A big shrub or small tree with a somewhat crooked stem, and grey bark. It is found in Upper Burma, mostly at elevations from 300 to 450 m.

Description of the wood

[Pl. 55, 327]

General properties—Heartwood not distinct from sapwood in the sample examined. Wood pale-yellowish or greyish-brown with a reddish tinge ; hard and heavy (sp. gr. 0·82 air-dry) ; straight-grained, even and fine-textured.

* Specimen D. 1278 from Anamalai Hills described by Gamble under *N. longana* has not been included here as microscopic examination shows that it does not belong to the *Sapindaceae*.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct to fairly distinct, delimited by somewhat denser and darker coloured fibrous tissue and may or may not be true annual rings, 3–6 per cm. *Vessels* medium-sized to small, indistinct or just visible to the eye, moderately few to moderately numerous (6–16 per mm.^{2}), fairly evenly distributed, mostly solitary and in short radial multiples of 2–3, occasionally in longer multiples, round to oval in outline, mostly open but sometimes plugged with whitish deposits; vessel lines rather inconspicuous. *Parenchyma* very scanty limited to few cells round the vessels and not discernible under the lens; whitish wavy tangential bands and patches round the vessels which appear like parenchyma to the eye are actually large, thin-walled, septate fibres, as in *Allophylus cobbe* described earlier. *Rays* very fine, visible only under the lens, numerous and closely spaced.

There is little or no information regarding the utility of this wood. The single specimen in Dehra Dun collection shows heavy damage due to shot-hole borer. The wood is hard and heavy and fine-textured and is likely to be suitable for small turnery articles.

Material—

5553 Burma (0·82).

11. POMETIA FORST.

It is a small genus of 4–5 species of trees, predominantly Indo-Malayan but also occurring in the Philippines and Java. *Pometia pinnata* Forst. the only representative of the genus in the Indian region is described here.

P. pinnata Forst.—*Badoh*, *thitkandu* (Andamans), *thabyay* (Burm.), *bulu-mora*, *galmora*, *naimbul* (Sinh.). A medium-sized to large tree up to 27 m. in height with a clear bole of about 12 m. and a girth of 1·8 to 3 m. often heavily buttressed at the base. *Bark* pinkish-brown, smooth, exfoliating in small flakes, thin.

It is a very common tree of the Andamans. The tree is fairly well distributed in the Malay Peninsula, where the timber along with that of other species of *Pometia* is known under the name *kasai*. It also occurs in Ceylon, Burma, Java and the Philippines.

Description of the wood

[Pl. 55, 328]

General properties—Sapwood and heartwood not always sharply distinguished, but sometimes fairly distinct, the former being a pale pinkish-grey and the latter ranging from light red to deep reddish-brown; moderately hard to hard; moderately heavy to heavy (sp. gr. 0·68–0·85 air-dry); somewhat lustrous; straight to moderately wavy or interlocked-grained and medium to moderately coarse-textured.

Gross structure—A diffuse-porous wood. *Growth rings* present, not always clearly visible to the eye, but very distinct and sharply defined under lens, delimited by a straight or somewhat wavy, light coloured line of parenchyma, 5–20 per cm. *Vessels* mostly medium-sized to large, clearly visible to the eye and rather conspicuous under the lens, few to moderately few (3–7 per mm.^{2}), uniformly distributed, mostly solitary and in short radial multiples of 2–3, the former often predominating, occasionally with a few longer groups of smaller vessels ; round to somewhat elliptic in outline, usually open but occasionally filled with reddish-brown deposits ; vessel lines distinct to fairly conspicuous on the longitudinal surfaces. *Parenchyma* (*a*) paratracheal, occurring as a narrow vasicentric sheath, visible only under lens ; (*b*) also as straight or somewhat wavy light-coloured line delimiting growth rings, usually distinct and sometimes rather conspicuous under lens. *Rays* very fine, not visible to the eye, but distinct under the lens, numerous and closely spaced.

Though no data regarding strength and other properties pertaining to the Andaman timber are available, some tests have been carried out at Manila on timber of the same species from the Philippines. The information given here is based mostly on these tests supplemented to some extent by data available on the Malayan Kasai timber (*Pometia* spp.).

Strength—It is a moderately strong timber and has been described by Burkill as flexible and tough. The strength figures given below are based on the tests carried out by the Bureau of Forestry, Manila (43) and should serve as a useful guide.

Strength figures from tests on small clear samples of Pometia pinnata Forst.

Moisture content at test per cent	Specific gravity		Static bending		Compression crushing strength at elastic limit in kg. per cm^2.		Shear parallel to grain in kg. per cm^2.	Hardness load in kg. to embed 1·12 cm. steel ball ½ its diameter	
	At test	Oven-dry based on volume at test	Modulus of rupture in kg. per cm^2.	Modulus of elasticity in kg. per cm^2.	Parallel to grain	Perpendicular to grain		End	Side
47	0·84	0·57	706	102,000	256	57·4	83·4	452	453

Seasoning—According to Reyes the timber is "subject to excessive warping and shrinking and must be seasoned with care", the amount of shrinkage being 4·9 per cent tangentially, 2·4 per cent radially and 0·2 per cent along the grain. Also from some consignments of thitkandu recently received from

the Andamans it appears that the timber is liable to splitting during drying, unless seasoned with care.

Natural durability—Based on graveyard tests carried out by the Bureau of Forestry, Manila, the timber has been described by Reyes as "durable for interior work, moderately durable when exposed to the weather and in contact with the ground". According to Desch, Malayan Kasai timber from an undetermined species of *Pometia* was found to be not resistant to marine borers.

Insect and fungus attack—There is no information available regarding *P. pinnata*. However, one of the specimens in the Dehra Dun collection shows borer damage in the outer lighter-coloured portion. Desch also reports that one specimen each of *P. macrocarpa* and *P. ridleyi* in the Malayan collection "has been lightly attacked by powder-post beetles, but none have been discoloured by sapstain fungi".

Preservative treatment—The timber is probably not very difficult to treat with preservatives, as treated railway sleepers of kasai (*Pometia* spp.) have proved very satisfactory in Malaya. According to Desch "Four hundred forty-four sleepers were treated by a full-cell process (pressure 195 lb. per sq. in. and temperature 170°F.) with a mixture of 50 per cent creosote and 50 per cent Diesel oil ; the average absorption was 4·1 lb. per cu. ft. After 13 years, only 21 per cent of the sleepers were rejected". The same treatment, however, did not prove very effective against marine borers, a 6 ft. 6 in. long and 5 × 10 in. in section piece with an absorption of 6·9 lb. per cu. ft. remaining serviceable for only two years (50).

Working qualities—The timber is easy to work and takes a beautiful polish. Schneider, based on tests carried out by Gardner, states that it can also be bent well when steamed.

Supply and uses—The only supplies are from the Andamans, where the timber is available in fairly large sized logs of more than 2 metres in girth. Reyes gives a number of uses for this timber in the Philippines such as beams, joists, rafters, flooring and ceiling in interior construction, masts, spars and frames in boat building, agricultural implements and tool handles, furniture and cabinet work. It has even been recommended for tight cooperage and sporting goods. However, in Malaya, kasai timber is said to be of not much economic importance apart from its use as fuel. The Andaman timber being botanically identical with the Philippine species, appears to be a good timber of its class and is likely to prove satisfactory for most uses for which the Philippine timber is used.

Material—

1973 Andamans (0·68), 8075 Andamans (0·83), 8080 Andamans (0·85).

12. SAPINDUS LINN.

A fairly large genus of shrubs or trees distributed almost throughout the tropics of the world, but best developed in the Indo-Malayan region. About 3 species occur in the Indian sub-continent of which two are described here.

S. mukorossi Gaertn. is distinctly ring-porous, and can be readily separated from *S. laurifolius* Vahl, which is always diffuse-porous and somewhat harder and heavier.

1. S. laurifolius Vahl (S. emarginatus Vahl)—*Bor-ritha* (Beng.), *ritha* (Hind.), *andala*, *antwala*, *aralakai*, *aratala*, *kantalkai* (Kan.), *pasakotta*, *urulinji*, *uruangi* (Mal.), *ardal*, *pitha*, *ritha* (Mar.), *muktamanji*, *muktamaya*, *rentha* (Or.), *penela*, *puvela* (Sinh.), *bunthikottai*, *kavadi-pungai*, *naikottai*, *nithavanji*, *panalai*, *pounanga*, *pucha*, *puchankottai*, *pungankottai*, *puvamkottai* (Tam.), *kunkudu* (Tel.). A medium-sized to large tree about 18 m. in height and 1·5 m. in girth. *Bark* grey, shining, peeling off in rough scales. The tree is well known for its fruit which is used for washing clothes particularly woollen garments and silk fabrics as well as for cleaning hair. Several parts of this tree have also got medicinal use.

It is widely distributed in the evergreen forests of the Western Ghats from Konkan southwards and occurs throughout the drier districts of Andhra Pradesh, though nowhere common.

Description of the wood—See below.

2. S. mukorossi Gaertn.—*Ritha* (Asm. & Beng.), *magyibauk* (Burm.), *dodan*, *kanmar*, *ritha*, *thali* (Hind. & Punj.), *haithal-bang*, *phuwathai* (Cach.), *hinghi* (Kuki), *thidak-dak-arong* (Miki.), *haitaguti*, *manichal* (Miri), *dieng-spieng-rah* (Synt.). A small to large tree up to over 18 m. in height and about 1·8 m. in girth. *Bark* dark-greenish grey or brown, fairly smooth with vertical fissures, peeling off in irregular flakes. Fruits have got similar properties as *S. laurifolius*.

A native of China, it occurs apparently in a wild state, though probably not indigenous – in the North-West Himalayas from the Sutlej eastwards, usually at elevations between 600–1,200 m. Elsewhere in North India, it is largely cultivated, but sometimes it may run wild as in the deciduous forests of Assam.

Description of the wood—See below.

Description of the wood

(*Sapindus laurifolius* and *S. mukorossi*)

[Pl. 55, 325, 326]

General properties—Wood yellowish-white to pale brownish-yellow, darkening on exposure, with no distinct heartwood in any of the samples examined ;

hard, heavy to very heavy (sp. gr. 0·77–1·06 air-dry) in *S. laurifolius*, but only moderately hard and moderately heavy (sp. gr. 0·62 air-dry) in *S. mukorossi* ; fairly straight to moderately wavy-grained ; medium and even-textured in *S. laurifolius* to somewhat coarse and uneven-textured in *S. mukorossi*.

Gross structure—Wood typically diffuse-porous in *S. laurifolius* but distinctly ring-porous in *S. mukorossi*. *Growth rings* indistinct to fairly distinct in *S. laurifolius*, delimited by somewhat denser fibres and occasionally by a fine and fairly continuous band of parenchyma ; very distinct in *S. mukorossi*, clearly demarcated by conspicuous belt of large earlywood vessels ; about 3–12 per cm. in both the species. *Vessels* in *S. laurifolius* moderately large or medium-sized to small, the larger ones visible to the eye, few to moderately numerous (2–12 per mm.^{2}), usually moderately few, evenly distributed, mostly solitary and in short radial multiples of two, occasionally more ; of two distinct sizes in *S. mukorossi*, those in the earlywood large, distinctly visible to the eye, forming a conspicuous belt or zone of 1–2 rows on the face of the growth rings ; transition from early to latewood abrupt ; latewood vessels usually very small, just visible under lens arranged in long or short radial multiples and clusters, surrounded and connected by light-coloured bands of parenchyma ; round to oval in outline, usually open but not infrequently plugged with light pinkish-brown or whitish deposits ; vessel lines just visible to fairly distinct on the longitudinal surfaces in *S. laurifolius* but relatively more conspicuous in the earlywood of *S. mukorossi*. *Parenchyma* abundant, clearly visible to the eye (*a*) paratracheal, in fairly thick short or long, wavy lines connecting several vessels ; also sometimes in eyelets with or without short lateral extensions in *S. laurifolius* ; on the other hand in the earlywood of *S. mukorossi*, parenchyma mostly forms a sheath round the vessels or vessel groups but in the latewood, vessels are connected by interrupted tangential lines ; (*b*) in fine lines delimiting growth rings. *Rays* very fine in *S. laurifolius*, not at all visible to the eye, but seen under the lens as numerous, fine, whitish or light-coloured lines, closely and evenly spaced ; somewhat less fine in *S. mukorossi*, just visible to the eye, distinct under lens, rather widely and unevenly spaced.

Strength—Both species considered here have not so far been subjected to any standard tests at Dehra Dun, but from its structure and general properties *S. laurifolius* appears to be stronger and tougher of the two. Some limited tests on the latter were carried out in 1906 by Prof. Everett (49), the results of which are summarized on page 233.

Bourdillon gives the value of P (co-efficient of transverse strength) as 725 and weight 66 lb. while the corresponding figures of Skinner as given by Gamble are 682 and 64 lb.

Strength figures from tests on three specimens of Sapindus laurifolius Vahl

Specimen	Shearing strength along the grain in tons per sq. in.	Crushing strength along the grain in tons per sq. in.	Bending strength in tons per sq. in.	Stiffness from bending tests E.
1	1·310	4·05	...	...
2	1·680	4·14	...	...
3	0·965	3·94	5·32	630

As regards seasoning, natural durability and other properties, hardly any information is available. Talbot, however, reports that the wood of *S. laurifolius* is not durable, splitting and cracking on exposure. The latter is supported to some extent by the fact that many of the samples in the Dehra Dun collection show some tendency to splitting and checking particularly along the rays. Both the timbers also appear to be susceptible to insect attack, as evidenced by borer damage in some of the samples examined.

The indigenous species *S. laurifolius*, though widely distributed in South India is by no means a common tree and as such commercial supplies are not likely to be available. The wood, according to Gamble "is very little used, occasionally only for carts and in building". It is also said to be used for oil mills (6). Being hard and heavy, the timber should be suitable for constructional purposes preferably after treatment.

Material—

S. laurifolius—2259 Andamans (0·77), 3209 Cuddapah, Andhra Pradesh (0·97), 5123 (0·98), 5191 South Arcot, Madras (1·06), 5192 South Arcot, Madras (1·05).

S. mukorossi—117 Kulu, East Punjab (0·71), 3050 Sutlej Valley (0·622).

13. SCHLEICHERA WILLD.

A genus of trees confined to the Indo-Malayan region. *S. trijuga* Willd., the only species, is described below.

S. trijuga Willd. [S. oleosa (Lour) Oken.]—**Kusum**. *Kuhumb* (Bhil.), *gyo, mai-khaw, maikyang, thakabti* (Burm.), *chendala* (Coorg), *komur, pusku* (Gon.), *gausam, kasma, kosam, kusum* (Hind.), *akota, chakota, sagada, sagadi* (Kan.), *baru* (Kol & Santal), *puvam* (Mal.), *kohan, koon, kusumb, peduman* (Mar.), *kusamo, swad, kusum* (Or.), *kon* (Sinh.), *karanachi, kula, pulichi, pumaratha, puvam, puvan, puvathi, puvu* (Tam.), *busi, may, pulusari, puska, roatanga* (Tel.). A medium-sized to large tree, up to 24 m. in height and 2·4–3·6 m. in girth but usually with a short clear bole of about 6 m. in length

and often fluted. *Bark* grey or brown outside, reddish inside, exfoliating in small rounded or irregular plates, about 8 mm. thick. It is one of the best trees for lac cultivation. Leaves and twigs are lopped for fodder, fruits are edible and the seeds yield an oil which is used for hair oil as well as for burning. It has also got some medicinal use.

It occurs throughout the dry deciduous forests all over India except perhaps in Assam, Bengal and the Andamans, ascending up to 600 m. in Kerala and up to 900 m. in the sub-Himalayan tract. Outside India it is found in the deciduous forests throughout Burma, in Ceylon, the Malay Peninsula and Java.

Description of the wood

[Pl. 56, 331]

General properties—Sapwood brownish-white merging imperceptibly into uniform, light reddish-brown heartwood. Wood very hard, very heavy (sp. gr. 0·91–1·08 air-dry), only one of the eleven specimens studied, being not heavier than water ; straight to somewhat interlocked-grained and even and medium-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct to fairly distinct, undulating, delimited by somewhat darker and denser latewood fibres, 5–16 per cm. *Vessels* moderately large or medium-sized to small, the former just visible to the eye, few to moderately numerous (4–18 per mm.^{2}), mostly moderately few, more or less evenly to somewhat unevenly distributed, predominantly solitary and in short radial multiples of 2–3, with longer multiples in some samples ; round to oval in outline, usually open and devoid of tyloses but in some samples not infrequently filled with white chalky deposits ; occasionally reddish-brown gummy deposits also present ; vessel lines rather fine, but fairly distinct on the longitudinal surfaces. *Parenchyma* very scanty in the vicinity of the vessels and diffuse, usually indistinct even under lens. *Rays* very fine, visible only under lens, very numerous and closely spaced.

Strength—A very strong and tough timber of about the same strength class as or even slightly superior to the best and strongest sal (*Shorea robusta* Gaertn.). It has been subjected to standard strength tests at the Forest Research Institute, Dehra Dun, the results of which are given in appendix I.

Seasoning—A highly refractory timber requiring great care in seasoning. It is prone to deep and severe surface cracking and is often likely to become useless on this account if kept long in log form. Prompt conversion immediately after felling and slow seasoning by close stacking under cover, protected from hot dry winds are recommended for best results. According to Kinns, it is also possible to kiln-season the timber satisfactorily without

much degrade, if it is not allowed to remain in large sizes after felling and before charging the kilns.

Natural durability—It is not as durable as one would expect from its weight and hardness. In exposed situations and in contact with the ground the timber has been found to be not very durable, giving an average life of only 55 months in actual "graveyard" tests carried out at Dehra Dun, with a range of 39–95 months (45). Pearson and Brown, however, state that the timber is "durable to very durable under cover, and is not very subject to borer and white ant attack".

Insect and fungus attack—Lewis says that kusum "is subject to the attacks of a stem-boring beetle (*Diapus impressus*), dead trees being also bored into by the Carpenter Bee". According to the Forest Entomologist, Dehra Dun, newly felled or fallen wood is liable to be attacked by shot-hole borers (Platypodidae and Scolytidae). *Irpex flavus* a slash decay fungus and *Polyporus weberianus* a parasitic fungus have also been recorded on standing trees. However, all the eleven wood samples in the Forest Research Institute collection showed no trace or sign of any insect damage or fungal attack.

Preservative treatment—The timber is not difficult to treat with preservatives, even heartwood being easily treatable.

Working qualities—The timber is rather difficult to saw when green and even more so when dry. Conversion of logs on band saws has proved to be not very satisfactory or practicable. However, this is possible on a frame saw, though with some difficulty and after careful adjustments. Once converted, with proper care, the timber can be planed and worked to a very good surface both with hand and machine, as it is capable of taking a fine and lasting polish hardly any filler being necessary. It is also suitable for painting. In spite of difficulties in sawing, surprisingly enough, the timber can be turned with comparative ease and finishes well.

Supply and uses—It is a common and important forest tree of South India, fairly large supplies of the timber being available from the south zone (Andhra Pradesh, Kerala, Madras and Mysore) as well as the East zone mainly from Bihar. Limited or somewhat smaller quantities are also available from the west and centre zones chiefly from Bombay and Madhya Pradesh (25). It is a timber of considerable importance similar to sal in many respects, but lacking its durability. However, this can be remedied to a large extent by suitable preservative treatment, as even the heartwood is readily treatable. The timber is suitable for most purposes where hardness strength and toughness are of importance and as such it is commonly used for oil and sugar mills, rice pounders, agricultural implements and tool handles, felloes, stocks and hubs of cart-wheels. It may be considered a useful constructional timber as well being suitable for beams, trusses and posts and often used in mines for side

props in shafts and galleries. Untreated timber, being susceptible to decay on exposure to the weather and in contact with the ground has not proved satisfactory for rail-road sleepers in Ceylon. However, if properly treated it should make a strong durable and good sleeper wood, equally suitable for flooring and paving. It also yields an excellent fuelwood and charcoal.

Material—

191 Mandla, Madhya Pradesh (1·04), 206 Garhwal, Uttar Pradesh (1·02), 536 Dehra Dun, Uttar Pradesh (1·03), 732 South Kanara, Mysore (1·07), 1110 Ahiri Reserve, Bombay (1·04), 2515 Burma (1·02), 2769 Melghat, Bombay (0·91), 3533 Khurdha, Orissa (1·01), 5738 Surat, Bombay (1·00), 6560 Burma (1·08), 7420 South Kanara, Mysore (1·07).

14. XEROSPERMUM BL.

A genus of about 8–9 species of shrubs or trees distributed mostly in the Indo-Malayan region. Six species to all of which the name *rambutan pachat* is commonly applied (18) occur in the Malay Peninsula. Three or four species have been recorded from the Indian region. Woods of two species were available for study and are dealt with here.

1. **X. ferrugineum** C. E. C. Fisher—*Law-gaw-pan*, *kala-min-gyin*, *mai-kasan* (Burm.). A medium-sized straight-stemmed tree about 18 m. in height and 0·9–1·2 m. in girth. It occurs in the Shan and Karen hills and South Tenasserim in Burma.

Description of the wood—See below.

2. **X. glabratum** (Wall.) Radlk.—*Bura* (Beng.), *khuranchi*, *shanpi* (Garo), *buru-buphang* (Kach.), *dieng-so-moniar-shree* (Kh.), *khoirao* (Naga). It is variable in habit ranging from a bush or shrub to a fairly large tree up to 18 m. in height and 1·2–1·5 m. in girth. *Bark* dark-brown or grey outside, often rough and warty and brittle.

Though by no means a common tree, it is found in the evergreen forests of Upper Assam and the Surma Valley as also in the hill districts ascending up to 900 m. In Burma, it has been reported from Tenasserim.

Description of the wood—See below.

Description of the wood

(*Xerospermum ferrugineum* and *X. glabratum*)

[Pl. **56**, 332]

General properties—Wood pinkish-grey or light reddish-brown without any sharp distinction into sapwood and heartwood, though sometimes the wood

towards the centre may be of a deeper shade than in the periphery; moderately hard to hard and moderately heavy to heavy (sp. gr. 0·72–0·93 air-dry) in *X. glabratum*, somewhat harder and heavier (sp. gr. 0·97 air-dry) in *X. ferrugineum*; straight-grained; medium to moderately fine-textured, usually finer in *X. glabratum*.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct in *X. ferrugineum*, but sharply defined and rather conspicuous in *X. glabratum* being delimited by narrow, darker and denser latewood and often also by a fine, interrupted or continuous line of parenchyma, 4–20 per cm. *Vessels*, usually small to very small,. indistinct or barely visible to the eye in *X. glabratum*, but slightly larger, often medium-sized and rather distinct in *X. ferrugineum*, moderately few to moderately numerous (6–16 per mm.^{2}) in *X. glabratum* but relatively scanty, few to moderately few (4–9 per mm.^{2}) in *X. ferrugineum*, fairly uniformly distributed, mostly solitary and in radial pairs, occasionally in longer multiples 3, rarely 4, round to oval in outline, usually open, but sometimes plugged with whitish deposits; vessel lines clearly visible on the longitudinal surfaces. *Parenchyma* scanty, (*a*) vasicentric, in *X. ferrugineum* limited to only a few cells adjoining the vessels forming a very narrow incomplete sheath, not visible or indistinct even under lens, but relatively better developed in *X. glabratum* occurring as a distinct light-coloured sheath round the vessels, visible under lens; (*b*) also as a broken to more or less continuous line delimiting growth rings in *X. glabratum*; occasionally diffuse, barely visible under lens as white specks due to their crystalliferous nature in *X. glabratum*. *Rays* very fine, not at all visible to the eye distinct under lens, numerous and very closely spaced.

Uses—The only information available pertains to the Malayan timbers, which according to Desch are not known to be used at present. Burkill, however, quoting Ridley says that *X. intermedium* Radlk. is "hard, very durable, light-brown and used for building" while *X. nornhianum* Bl. is described as "strong, used for mills, carts, ploughs and rice-pounders". All the samples in the Dehra Dun collection were found to be free from insect damage and decay, and it is, therefore, likely that the timbers are durable at least under cover. Being hard and heavy and somewhat similar to Malayan woods, they should prove suitable for agricultural implements, general construction in protected situations and perhaps even for tool handles.

Material—

X. ferrugineum—6586 Burma (0·97).

X. glabratum—6620 Burma (0·72), 6763 Burma (0·93).

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K. RAMESH RAO.

ACERACEAE

The family *Aceraceae*, which is included under *Sapindaceae* by Bentham and Hooker, consists of two or three genera of mostly trees or shrubs. Although in anatomical structure the two families show general similarity, the *Aceraceae* is distinguished from the *Sapindaceae* by the usually larger inter-vessel pitting, broader rays and absence of septate fibres. Of the two commonly accepted genera of this family, *Acer* Linn. consists of about 150 species widely distributed in the north temperate regions and tropical mountains, while *Dipteronia* which is confined to China has only a couple of species. Some botanists consider that *Acer negundo* Linn., the box-elder of the United States and Mexico should be raised to the rank of a genus *Negundo* Moench. with the name *N. aceroides* Moench. (38), while others do not support this change. Heimsch, on the basis of wood anatomy, favours its retention under *Acer*. Besides the above there is another genus *Dobinea* Buch.-Ham. the exact affinities of which are not yet very clear. Though it is generally considered to belong to the *Anacardiaceae*, it was placed under the *Sapindaceae* in both "Flora of British India" and Gamble's "Manual of Indian Timbers". From the anatomical structure of *D. delavayi* Baill. given by Heimsch, it appears to have greater affinity with the *Anacardiaceae*. Bor, however, states that the only Indian species of this genus, *D. vulgaris* Ham. occurring in the hill forests of north Bengal, and the Naga and Mishmi Hills in Assam fits better in the *Aceraceae*. As no wood sample of this species was available for study, it has not been possible to throw any light on its systematic position from the point of view of wood anatomy.

The importance of the family is due to *Acer* which is not only a source of valuable commercial timber, but is also of considerable economic interest on account of the high sugar content in the sap of some of the species. Though practically all American species have a sweet sap, only in a few like the sugar maple, *A. saccharum* Marsh., and black maple *A. nigrum* Michx. f. is the sugar content high enough to make the commercial extraction profitable. The sap which has an average sucrose content of 2–3 per cent is tapped by drilling holes into the wood for processing into maple sugar and other products. The production of maple syrup and sugar is an industry of considerable importance in North-Eastern United States and some parts of Canada, like Quebec and Ontario (28, 35). Among the Indian maples, *A. papilio* King of Sikkim and the eastern Himalayas is said to yield sugar (9). Many of the maples are planted as avenue trees and cultivated as ornamentals in gardens on account of their handsome foliage which takes on brilliant hues of yellow, gold, scarlet and brown in autumn. Leaves and branches of a few Indian species like *A. villosum* Wall. and *A. cultratum* Wall. are lopped for fodder.

Maple is one of the most important commercial timbers of America, Europe and Japan and is also imported to India in considerable quantity for specialized uses. Usually two types of maple wood are recognized in the American trade, viz., hard maple and soft maple. The former is the product of *A. saccharum* and *A. nigrum*, and is harder, heavier and stronger than soft maple. It is available in very large quantities and is considered to be one of the leading woods of America for various uses such as for flooring, furniture, boxes and crates, shoe lasts, hammer handles, novelties, motor car parts, spools, bobbins, wood distillation and wood pulp. Hard maple is also more attractive due to conspicuous rays, and selected stock with "fiddle-back" figure is in great demand for violins, while wood showing "bird's eye" (37) is highly prized for ornamental veneers. The soft maples are mainly produced by *A. saccharinum* Linn. and *A. rubrum* Linn. and have similar uses where hardness and strength are not important factors. Among the other American maples mention may also be made of Oregon or Pacific maple or big leaf maple *A. macrophyllum* Pursh., which differs from the soft maple in the colour of the heartwood. Sycamore, *A. pseudoplatanus* Linn., Norway maple, *A. platanoides* Linn., and *A. campestre* Linn. are important commercial maples of Europe which are widely used in the turnery trade for brush backs and woodenware. Japanese maple, *A. palmatum* Thunb. and others are very similar to *A. saccharum* and are used as a substitute for hard maple. There are several Indian species of maple which also yield valuable timber. They are, however, not exploited fully due to difficulties of extraction and transport.

The woods of the two genera, *Acer* and *Dipteronia* Oliver are characterized by diffuse-porous structure and very scanty parenchyma except at the boundary of the growth rings. *Dipteronia**, however, differs from *Acer* in having numerous pore clusters. The anatomical structure of the different species of *Acer* described here is singularly uniform, and except for some variation in colour, hardness and weight, they are so similar as to be practically indistinguishable from one another. In their gross structure, they closely correspond to the American soft maples but can usually be distinguished from the imported hard maple and sycamore where the rays often tend to be of two distinct sizes, a feature rarely found in the Indian maples.

ACER TOURNEF.

A large genus of nearly 150 species of trees with a wide geological as well as geographical distribution. First making its appearance in the upper Cretaceous, it is well represented in the Tertiary (1, 12). At present the genus reaches its best development in eastern part of North America and eastern Asia. It is confined mostly to the northern hemisphere excepting for a single

* Under the microscope, *Dipteronia* is further distinguished from *Acer* by its heterocellular rays and absence of spiral thickening in the vessels.

species *A. niveum* Bl. which occurs in Assam, Burma, the Philippines and the Malay Peninsula and extends across the equator to the mountains of Indonesia.

Acer is represented in the Indian region by about sixteen indigenous species of medium to large-sized trees, which occur mostly in the Himalayas and some also in the hills of Assam and Burma. Besides these, several exotic species have been introduced in the forest plantations particularly in the Punjab. Wood samples were available for only eleven which are described below. As it is not possible to distinguish the woods of the different species from their gross structure, they are considered together for the purpose of this book.

A. caesium Wall.—**Maple.** *Kamia, kanchula, kanjula* (Garh.), *jerimu, shumanjra* (Himachal), *barakainju, kainjal, kainju* (Jauns.), *kanar* (Kash.), *kanjiol, khami, kilu* (Kumaon), *bodal, kalindra, kanzal, kaun, mandar, salima, tarkhana, tilpattar, trekhan* (Punj.), *kanshin* (Tibet). It is one of the largest and commonest maples in the western Himalayas. In favourable localities, it is a tall tree with a straight trunk attaining a height of 21–24 m. and a girth of 3·6–3·9 m. Osmaston states that in Kumaon he measured a tree 27 m. in height and 4·5 m. in girth. *Bark* pale grey, with darker silvery patches, rather rough, peeling off in small, thin, irregular flakes.

It is distributed in the western Himalayas from the Indus to Nepal, chiefly at altitudes from 2,100–3,000 m., sometimes tending to be gregarious in patches. It may occasionally descend to 1,200 m. or extend as high up as even 3,600 m.

Description of the wood—See page 245.

2. **A. campbelli** Hook.—**Maple.** *Daom, daom-kung, dom, yali, yatli-kung* (Lep.), *kabashi, kapasi* (Nep.). This is the commonest and the largest among the East Himalayan maples. It often attains a height of 30 m. or more with a clear bole of 12–18 m. and a girth of 3-4·5 m. *Bark* grey and smooth.

It is found in Sikkim and the eastern Himalayas at high elevations from 2,100–3,000 m.

Description of the wood—See page 245.

3. **A. caudatum** Wall.—**Maple.** *Yalishin* (Bhut.), *jarima, kamia, kimia, rath-kanchula* (Garh.), *kandaru, kanjara, kanzlo* (Himachal), *kainjla, kainjili* (Jauns.), *yatli-kung* (Lep.), *kabashi, khansing, lekh kapasi* (Nep.). A medium-sized to fairly large tree attaining 15–18 m. in height with a clear bole of 6–9 m. and a girth of 2–2·5 m. *Bark* dark-grey or silvery-brown, somewhat rough, exfoliating in irregular thin flakes.

It is distributed in the western Himalayas from Kashmir to Nepal and also in Sikkim chiefly at high elevations from 2,100–3,300 m. The tree growing

in Sikkim is regarded by some botanists as a distinct species, *A. pectinatum* Wall.

Description of the wood—See page 245.

4. A. hookeri Miq.—**Maple.** *Pale, pale-kung* (Lep.), *laharakapasi, lalkabashi, lalkapasi* (Nep.). A small to medium-sized tree, 6–9 m. in height and about 1 m. in girth with a clear bole of 3–4·5 m. *Bark* brown, rather deeply cracked, about 8 mm. thick.

It is found in the eastern Himalayas in Bhutan and Sikkim at 2,100–3,000 m. elevation.

Description of the wood—See page 245.

5. A. laevigatum Wall.—**Maple.** *Dieng-soh-tyrkhum, dieng-than, dieng-tyrthia-iong* (Kh.), *tungnyok* (Lep.), *cherauni, putli, saslendi, thali kabashi* (Nep.). A medium-sized to large tree reaching up to 18–24 m. in height and 2·5–3·5 m. in girth with a clear bole of 12–18 m., sometimes irregularly buttressed. *Bark* grey or greenish-grey, smooth or with horizontal furrows, thick.

It occurs both in the western and eastern Himalayas from the Jumna eastwards to Bhutan at altitudes from 1,500–2,700 m., being rather scarce in the west and relatively more common in the east. It is also found in the Khasi and Jaintia Hills of Assam at 900–1,800 m., where though not common, it has a somewhat gregarious tendency.

Description of the wood—See page 245.

6. A. oblongum Wall.—**Maple.** *Kirmola, kirmoli, phandgao, pharbanj* (Garh.), *pangoi, paranga* (Jaunsar.), *dieng-soh-khru* (Kh.), *galiya, pangyala, parpat, phatgab, phatgal, potai, putli,* (Kumaon), *buzimpala, mugila, phirphiri* (Nep.), *dieng-ialoh* (Synt.). A middle-sized to large tree attaining a height of about 24 m. often irregularly buttressed at the base. *Bark* greenish-grey and fairly smooth with shallow longitudinal cracks in young stems, but pinkish-brown and rough in older trees, peeling off in thick irregular flakes, 5 to 10 mm. thick.

It is found scattered throughout the lower Himalayas from the Jhelum to Bhutan ascending up to 1,800 m. Compared with other Indian maples it grows at relatively lower elevations descending as low as 600 m. It also occurs in the Khasi and North Cachar Hills of Assam and the Northern Shan States of Burma.

Description of the wood—See page 245.

7. A. pentapomicum J. L. Stewart—**Maple.** *Kakkri, kilpattar, kitla, kukandra, kunghi, teon, tian, tilpatto, trekhan* (Punj.). A small to medium-sized tree, usually not exceeding a metre in girth. *Bark* grey, thin, showing

an irregular tesselated pattern due to shallow vertical fissures being joined in a ladder-like fashion by similar horizontal cracks.

It is confined only to the Punjab and North-West Himalayas, occurring at elevations from 600–2,100 m.

Description of the wood—See page 245.

8. A. pictum Thunb. [A. monomarmoratum (Nichols) Rehd.] **Maple.** *Dumitha, gadh-papri, gadkimu, potli* (Garh.), *dhadonjra* (Himachal), *dudh-kainju, kabasi, kainchli, kainjli* (Jauns.), *bankimu, chindia, chitulia, pata, tikta, tilavi* (Kumaon), *jerimu, kakru, kilpattar, kanjar, kanzal, laur, tar-khana, tian, trekhan* (Punj.). A medium-sized to large tree up to 21 m. in height and 1·8 m. in girth. Though trees up to 3 m. have been recorded, it does not reach the size of *A. caesium,* and is often irregularly fluted at the base with knotty excrescences. *Bark* grey, thin, fairly smooth with shallow cracks.

It is a common maple of the western Himalayas, occurring throughout the outer and middle ranges from the Indus to Nepal and probably extends to Bhutan. It is found from 1,200–2,700 m. but is more common in the mixed forests above 2,100 m.

Description of the wood—See page 245.

9. A. sikkimense Miq.—**Maple.** *Lahara kapasi* (Nep.). A small to medium-sized tree 6–9 m. in height and about 1 m. in girth with a clear bole of 3–4·5 m. *Bark* grey, thin.

The tree is found in the Sikkim Himalayas and Bhutan from 2,100–2,700 m.

Description of the wood—See page 245.

10. A. thomsonii Miq.—**Maple.** *Kabashi* (Beng.), *melo kapasi* (Nep.). A large tree 18–27 m. in height and 1·8–3 m. in girth with a clear bole of 9–12 m.

It is distributed in the eastern Himalayas in Sikkim and Bhutan and also in Manipur and the hills of Upper Burma, occurring at elevations above 1,200 m. and below 3,300 m.

Description of the wood—See page 245.

11. A. villosum Wall.—**Maple.** *Mandra* (Garh.), *karendera* (Himachal), *kainju* (Jauns.), *gobar-kami* (Kumaon). A medium-sized to fairly large tree up to 18 m. in height and over 2 m. in girth. *Bark* pale-brown or silvery-grey, fairly smooth, thin.

It is found in the western Himalayas from the Jhelum to Kumaon at higher elevations from 2,100–2,700 m.

Description of the wood—See page 245.

Description of the wood

(*Acer caesium*, *A. campbellii*, *A. caudatum*, *A. hookeri*, *A. laevigatum*, *A. oblongum*, *A. pentapomicum*, *A. pictum*, *A. sikkimense*, *A. thomsonii* and *A. villosum*).

[Pl. 56, 333–335]

General properties—No distinction into sapwood and heartwood in any of the samples studied. Wood light-yellowish or pinkish-white when freshly cut turning greyish-brown, sometimes with a pinkish tinge ; soft to moderately hard and light to moderately heavy (sp. gr. 0·39–0·78 air-dry), often showing considerable variation in the same species ; among all the Indian species described some samples of *A. oblongum* and *A. pictum* appear to be somewhat harder and heavier than the others, while *A. thomsonii* is perhaps the softest and the lightest ; fairly lustrous especially on the quarter-sawn surface ; usually straight but sometimes wavy-grained, even and fine to very fine-textured. The beautiful mottled figure known as "bird's eye" for which some of the foreign maples like the American rock maple (*A. saccharum*) are well known, does not appear to be a feature of the woods of the Indian species studied.

Gross structure—All are diffuse-porous woods but occasionally a mild tendency for semi-ring-porousness may be noticeable in some samples. *Growth rings* present, usually distinct, delimited by the slightly denser latewood fibres and a fine line of parenchyma, often visible on the longitudinal surfaces as brownish lines, 2–16 per cm. *Vessels* small to very small, usually distinct only under lens, mostly solitary with some radial multiples of 2–3 or more, moderately numerous to very numerous (10 to over 50 per mm.^{2}), evenly distributed, round to oval in outline, usually open ; vessel lines indistinct or just visible to the eye as fine scratches. *Parenchyma* indistinct to the eye, visible with a lens as a fine, usually interrupted, but occasionally more or less continuous line delimiting the growth rings ; also round the vessels, very sparse and indistinct even under lens, except in some samples of *A. oblongum* where a narrow, somewhat interrupted vasicentric sheath round the vessels may be visible under lens. *Rays* moderately broad to fine—the broader ones occasionally as broad as or even wider than the vessels, distinctly visible to just or barely visible to the eye, and the finer ones visible under lens, interspersed between the wide rays, fairly closely spaced ; ray-flecks fairly conspicuous in some samples. *Pith flecks* occasionally observed in some samples of *A. hookeri*, *A. laevigatum*, *A. sikkimense* and *A. thomsonii*.

Strength—Exact data based on standard tests of authenticated specimens of known Indian species are not available. But, from limited tests made on some commercial samples of *Acer* spp. from Uttar Pradesh and Himachal Pradesh, it appears that Indian maple is very much inferior to American

rock or sugar maple (*A. saccharum*) in all strength properties and also weaker than English sycamore (*A. pseudoplatanus*). However, it compares favourably with soft maple (*A. saccharinum*) and Oregon or Pacific maple (*A. macrophyllum*). Strength figures of Indian maples which may be regarded as purely tentative are given below together with those of foreign maples taken from data published by the Forest Products Research Laboratory for comparison (13, 14).

TABLE III.—*Comparative strength figures of Indian and foreign maples*

Trade name	Botanical name	Wt. per cu. ft. at 12% moisture content in lb.	Seasoning	Static Bending		Impact Bending	Compression parallel to grain.
				Modulus of Rupture in lb. per sq. in.	Modulus of elasticity in 1,000 lb. per sq. in.	Maximum height of drop of 50 lb. hammer in in.	Maximum crushing stress in lb. per sq. in.
Indian maple	*Acer* spp.	37	Green	7,250	1,109	35	3,240
			Kiln-dried	11,750	1,358	34	5,660
Soft maple	*Acer saccharinum*	34	Green	6,800	1,330	29	2,920
			Air-dried	11,800	1,710	30	5,920
Pacific maple	*Acer macrophyllum*	34	Green	7,400	1,100	23	3,240
			Air-dried	10,700	1,450	28	5,950
Hard maple	*Acer saccharum*	46	Green	10,100	1,680	54	4,570
			Air-dried	17,200	2,200	55	8,320
Sycamore	*Acer pseudoplatnus*	35	Green	9,000	1,300	29	3,840
			Air-dried	13,600	1,460	33	6,730

Seasoning—*A. campbellii* is a non-refractory timber to season, with little tendency to warping, splitting and surface checking. But as it is prone to discoloration if kept in log form, the logs should be converted into planks or scantlings immediately after felling and subjected to rapid drying conditions. It can be kiln-seasoned without much difficulty requiring about 13 to 16 days to season (40). According to Kinns *A. oblongum* also "seasons well, both naturally and by artificial means" but being susceptible to discoloration in log form should be converted green and "preferably kiln-seasoned". As regards other species not much definite information is available ; but as they are very similar in anatomical structure and general properties, they may be expected to behave more or less in the same manner. Pearson and Brown, however, mention that *A. caesium* if left in the log form or in large dimensions may develop honey comb cracks, while *A. thomsonii* is liable to produce deep end splits, if not carefully seasoned.

Natural durability—None of the species appears to be durable, all tending to decay rapidly in the log or if exposed in the open. In actual graveyard tests at Dehra Dun *A. campbellii* was found to have an average life of only 9 months with a maximum of 14 months.

Insect and fungus attack—Sapwood of *A. caesium* and *A. campbellii* in newly felled logs or dying trees is liable to be attacked by pinhole and shothole borers (Platypodidae and Scolytidae), while the drywood of most species is subject to damage by the longhorn beetle *Stromatium barbatum* Fabricius (Cerambycidae). The timber is also very susceptible to decay due to fungal attack.

Preservative treatment—No information is available regarding the amenability of the Indian species to preservative treatment. However, the related sycamore (*A. pseudoplatanus*) of England is said to be very easily treatable (13) while the American soft maple (*A. saccharinum*) is only moderately resistant. Considering that the Indian maples are not very different from sycamore and soft maple in their structure, they may not be very resistant to the entry of preservatives.

Working qualities—The Indian maples are generally easy to work both with machines as well as by hand, and in this respect are comparable with soft maple rather than rock maple which is relatively harder to work. Straight-grained timber as a rule planes and finishes easily and can be turned satisfactorily. It takes stain and polishes without much difficulty and like soft maple may be expected to glue with ease. *A. campbellii* has been found to peel easily, yielding a good general utility plywood. The veneers season well and hold glue satisfactorily.

Supply and uses—Were it not for the difficulties of extraction, commercial quantities of at least a few species like *A. pictum* and to a smaller extent *A. oblongum* and *A. caesium* could perhaps be made available particularly from the western Himalayan region comprising East Punjab, Himachal Pradesh and Uttar Pradesh. Limited supplies of *A. campbellii* and possibly *A. thomsonii* are also likely to be available from the Kurseong and Kalimpong Divisions of West Bengal. Though supplies from individual species may not be large, the total outturn taking into account all the Indian maples is likely to be not inconsiderable, if properly exploited.

The Indian maples are comparable with the American soft maple not only in their anatomical structure but also as regards their strength and other properties. It is, therefore, reasonable to expect that they will prove suitable for most purposes for which the American timber is used. Being of uniform, fine texture and easy to carve, they are used for kitchen woodenware, bowls, platters, drinking cups, jars for storing *ghee*, spoons, shoe lasts, etc., and if properly seasoned should do well for brush backs and various types of turnery articles including textile accessories like spools and cotton bobbins for which imported maple is used. It is one of the few Indian timbers suitable for gun and rifle parts and is also used in the built up frames of tennis and badminton rackets. The relatively heavier and harder ones like *A. oblongum* are locally used for agricultural implements and tool handles. Most of them should

prove suitable for planking and joinery, while selected timber may do for furniture, cabinet work and even musical instruments. *A. campbellii* has been found suitable for the manufacture of commercial and moisture-proof plywood (marine plywood). Others like *P. oblongum* and *A. caesium* may turn out to be equally satisfactory for these purposes. Straight-grained and very fine-textured wood of species like *A. caesium* should be good for tooth-picks, hospital applicators, pill-boxes and watchmaker's pegs. All of them furnish a good fuel wood. Being of the same class as imported soft maple, and offering a relatively wide range in weight, hardness and texture, Indian maple seems to have good possibilities, if sufficient supplies could be made available.

Material—

*A. caesium** – 431 Jaunsar, Uttar Pradesh (0·61), 915 Hazara, West Pakistan (0·65), 6099 Upper Bashahr, Himachal Pradesh (0·61).

A. campbellii – 436 Darjeeling, West Bengal (0·62), 686 Darjeeling (0·60), 6109 Darjeeling (0·56).

A. caudatum – 27 Simla, Himachal Pradesh (0·66), 41 Simla (0·65), 74 Simla (0·61), 3007 Simla (0·51).

A. hookeri – 2338 Darjeeling (0·54).

A. laevigatum – 684 Darjeeling (0·66), 5136 (0·63).

A. oblongum – 221 Garhwal, Uttar Pradesh (0·73), 2944 Sutlej valley (0·62), 6050 Dehra Dun, Uttar Pradesh (0·71), 6634 Burma (0·71).

A. pentapomicum – 4843 Chamba, Himachal Pradesh (0·60).

A. pictum – 432 Jaunsar, Uttar Pradesh (0·56), 3008 Simla (0·60), 6072 Chakrata, Uttar Pradesh (0·78).

A. sikkimense – 3102 Darjeeling (0·53).

A. thomsonii – 3103 Darjeeling (0·54), 6108 Darjeeling (0·44), 7154 Burma (0·39).

A. villosum – 62 Simla (0·60), 167 Kangra, East Punjab (0·50), 3006 Simla (0·54).

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* Specimen H. 33 from Simla, described by Gamble, under this species is not *Acer* but *Aesculus indica* to which *Acer caesium* has some superficial resemblance.

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K. RAMESH RAO.

HIPPOCASTANACEAE

A small family of shrubs and trees consisting of two genera and about twentyfour species. *Billia* Peyr. with two species is confined to Mexico, Central America and tropical South America. The other genus, *Aesculus* Linn. has a wide distribution occurring throughout the north temperate regions of both the hemishperes. The family is closely allied to the *Sapindaceae* with which it is included by Bentham and Hooker, Brandis and Hutchinson. From the point of view of wood structure, it seems to occupy an intermediate position between the *Staphyleaceae* and the *Sapindaceae* (see table under *Sapindaceae*).

Except for a few species of *Aesculus* it is not of much economic importance. However, several species of *Aesculus* are grown as ornamentals on account of their handsome foliage and striking inflorescence. *A. hippocastanum* Linn., a native of Greece and Asia Minor, is the well-known horse-chestnut which is commonly cultivated in gardens and planted as an avenue tree. Fruits and seeds of *A. indica* Colebr. are of medicinal value and also serve as cattle fodder. During famine, the soaked and ground embryos are eaten mixed with flour by hill people in India. The fruit is said to be given to horses for colic, while, the oil from the seeds is used for external application in rheumatism. Seeds of some species of *Aesculus* contain saponins and are used as fish poison (16).

A few species yield timber of commercial value, the most important being the buck-eye (*A. octandra* Marsh. and *A. glabra* Willd.) of the United States, the horse-chestnut (*A. hippocastanum*) of Europe, the Japanese *tochi-no-ki* (*A. turbinata* Bl.), and the Indian horse-chestnut *A. indica*.

The only genus which occurs in India is described below :

AESCULUS LINN.

A temperate genus of about 20 species of shrubs or trees. It is found widely distributed in North America, Europe and Asia, reaching its best development in the United States of America. In India, it is represented by two species, *A. indica* and *A. punduana* both of which attain tree size and are described here. The woods of the two species are similar in structure but can be easily distinguished as given below :

Wood very fine-textured ; vessels minute, not visible to the eye, very numerous (usually over 50 per mm.^{2}) .. .. *A. indica*

Wood medium-fine-textured ; vessels medium-sized to small, just visible to the eye, moderately numerous (usually 10–20 per mm.^{2}) ..	.. *A. punduana*

Apart from differences in size and frequency of the vessels, the two woods are essentially similar in anatomical structure and are, therefore, described together.

1. **A. indica** Colebr.—**Horse-chestnut.** *Kanor* (Himachal), *bankhor, gugu, kankar, pangar* (Hind.), *kandar, kandur, pangar* (Jauns. & Kumaon), *kakra, kishing, han, hane, hannudun* (Kash.), *bankhor, gu, gun, kanor, pu* (Punj.). A large deciduous tree up to 36 m. in height and 3·6 m. in girth., often irregularly fluted at the base in old and large trees. According to Gamble in suitable localities it may even attain a girth of 7·5 m. Osmaston has recorded from North Garhwal a tree 43·5 m. in height and 3·9 m. in girth. *Bark* grey and smooth in young trees of less than a metre in girth, but darker and shaggy in older and larger trees, peeling off upwards in long strips up to 5 cm. in width and as much as 50 cm. in length giving a striking look.

It is found throughout the North-West Himalayas from Nepal westwards in Uttar Pradesh, Himachal Pradesh, East Punjab and Kashmir and across the Indus. It usually occurs at high elevations from 1,200–3,000 m., often forming gregarious patches, particularly in the shady ravines of the inner ranges.

Description of the wood—See below.

2. **A. punduana** Wall. (**A. assamica** Griff.)—*Sarlokasing* (Abor.), *ilkuhia, raman-bih* (Asm.), *kataw-chying-krang, pun-pan, segabin, wesinni, yemyaw* (Burm.), *bol-nawak, bol-rimmu, rimot* (Garo), *phrado-buphang* (Kach.), *dieng-chaang-kenrop, dieng-dala, dieng-dula, dieng-sang-kenrop* (Kh.), *dingari, kangkhir khola, kanki kola* (Mechi), *phaklang-jan-arong* (Mik.), *ramonasing* (Miri), *ngraurau* (Naga), *dingri, cherimugri, satpate* (Nep.). A small to medium-sized or fairly large and handsome tree, resembling *A. indica*. In the Duars of North Bengal it is reported to reach a height of 12–15 m. with a clear bole of 6–9 m. and a girth of 1·8–2·4 m. *Bark* has been described by Kanjilal as "greyish and warty outside" and 6 mm. thick.

It is distributed in North Bengal, Assam, Upper Burma and Tenasserim, where it ascends up to 1,200 m. and also extends further eastwards to Thailand and Tonkin.

Description of the wood—See below.

Description of the wood

(*Aesculus indica* and *A. punduana*)

[Pl. **56**, 336 ; Pl. **57**, 337]

General properties—No distinction into heartwood and sapwood in any of the samples examined. Wood usually creamy-white with a pinkish-tinge

to pale pinkish-brown ; soft to moderately hard ; light to moderately heavy (sp. gr. 0·42–0·59 air-dry) ; fairly straight-grained but some specimens of *A. indica* show prominent wavy-grain giving rise to beautiful "fiddle-back" figure with silky sheen when quarter sawn ; texture even, medium-fine in *A. punduana* to very fine in *A. indica.*

Gross structure—A diffuse-porous wood but rarely a tendency towards semi-ring-porous structure may be met with. *Growth rings* distinct, delimited by a fine, tangential line of parenchyma, 1–20 or more per cm. *Vessels* moderately large or medium-sized to small, visible to the eye and moderately numerous (10–20 per mm.^{2}) in *A. punduana*, very small, not at all visible and very numerous (over 50 per mm.^{2}) in *A. indica*, solitary and in radial multiples of 2–4 or more with some clusters, which may occasionally be arranged obliquely and evenly to somewhat unevenly distributed in some samples of *A. indica*, usually open ; vessel-lines clearly visible on the longitudinal surfaces in *A. punduana*, but barely visible or indistinct in *A. indica*. *Parenchyma* visible as a fine, continuous, light or dark coloured line demarcating growth rings, relatively thicker and more prominent in *A. punduana*. *Rays* all of one size, very fine, not at all visible to the eye, but seen under lens, numerous and closely spaced, with a tendency towards storied arrangement in some specimens of *A. indica*. *Ripple marks* occasionally present in *A. indica* irregular and rather poorly defined, about 25 per cm.

No data are available regarding the strength and other properties of *A. punduana*. The information given below is based mainly on *A. indica* which is very similar to the European species – *A. hippocastanum* in respect of most properties.

Strength—No standard strength tests have so far been carried out. However, according to Pearson and Brown, the timber may probably belong to the same strength class as toon (*Cedrela toona*).

Seasoning—Like the European horse-chestnut little trouble is experienced in seasoning the timber. It can be seasoned without any appreciable degrade except perhaps for some slight extension of original heart-shakes. As the timber may be prone to discoloration if kept long in the log form, conversion as soon as possible after felling is desirable.

Natural durability—Not durable in exposed situations, but fairly so under cover. The timber has not been subjected to any "graveyard" tests.

Insect and fungus attack—Standing and living trees of *A. indica* are attacked by the beetle *Aeslesthes sarta* Solsky (Cerambycidae), while the deadwood is subject to damage by various members of the Curculionidae. However, the timber like that of the European species is likely to be immune from attack by powder-post beetles (Lyctidae). Newly felled logs and deadwood

of *A. punduana* are liable to be attacked by some borers (Cerambycidae, Platypodidae, Scolytidae and Curculionidae). A number of decay fungi viz., *Lenzites betulina*, *Merulius tremellosus*, *Polyporus adjustus* and *Polystictus versicolor* are known to cause white fibrous rot in felled timber of *A. indica*.

Preservative treatment—No records of antiseptic treatment of the wood are available for the Indian species. But the European horse-chestnut is reported to be permeable (7) and easily treatable with creosote which it absorbs readily.

Working qualities—Being a moderately soft timber, with uniform and fine-texture, it is very easy to work with hand and machine tools and should be suitable for turnery work and carving. It finishes cleanly to a good surface and takes polish well, though liable to absorb considerable quantities of the polish. The European species has fairly good bending properties and is stated to glue exceptionally well (6) and there is no reason why the Indian species – *A. indica* should not prove equally satisfactory. Rotary-cut veneers of *A. hippocastanum* are known to be used for basket-making (7) but exact information regarding the peeling quality of *A. indica* is not available. It has, however, been reported to yield a good plywood (20).

Supply and uses—*A. indica* grows only in hilly areas at high elevations and is, therefore, not fully exploited. Were it not for the difficulties and high cost of extraction, fairly large supplies of the timber should be available from Himachal Pradesh, East Punjab, Kashmir and Uttar Pradesh.

The wood is locally used for building, packing cases and water troughs. Due to its fine, even-texture and ease of working, it easily lends itself for the manufacture of various wooden articles, such as carved toys, platters, drinking cups, plates, vases and containers for butter, *ghee*, fruits, etc. It is one of the timbers used for the better class mathematical instruments like set-squares, T-squares and rulers. Straight-grained timber appears to be suitable for watchmakers' pegs and tooth-picks and might even do for match sticks. Selected and wavy-grained stock sometimes yields handsome boards with pleasing figure. Being very similar to the European species in all its properties, it should prove equally satisfactory for all uses to which that timber is put in the United Kingdom, viz., brush-backs, general turnery, pattern-making, rollers for blinds, broom handles, dairy and kitchen utensils, fruit storage trays and racks, and food containers. It may also be well worth trying for the manufacture of artificial limbs in India as the closely allied American buckeye produced by *A. octandra* and *A. glabra* has been found suitable for the purpose (2).

The wood of *A. punduana* is similar to that of *A. indica*, though not so fine-textured, and should be capable of being put to more or less same type of uses such as for platters, cups, vases, toys and packing cases.

Material—

A. indica—31 Simla, Himachal Pradesh (0·51), 166 Kangra, East Punjab (0·42), 936 Hazara, West Pakistan (0·52), 5344 Deoband, Uttar Pradesh (0·48), 5815 Simla, Himachal Pradesh (0·59), 7746 Kulu, East Punjab (0·47), 7747 Kulu, East Punjab (0·48), 7748 Kulu, East Punjab (0·57).

A. punduana—3139 Buxa Reserve, West Bengal (0·47).

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STAPHYLEACEAE

The *Staphyleaceae* is a small family of some five or six genera and about twentyfive to thirty species of shrubs or trees found in Asia, Europe and America, confined mostly to the northern hemisphere. Fossil records of the family have been reported from the Tertiary of North America (11). The genera at present included in the family were described by Bentham and Hooker under the *Sapindaceae*. However, their treatment as a separate family distinct from the *Sapindaceae* by Engler and Prantl, and Hutchinson seems more justified on grounds of the anatomical structure of the woods of the genera considered here (see table under *Sapindaceae*).

The family is hardly of any economic value. Leaves of some species of *Turpinia* Vent. are given to cattle as fodder, while the fruits yield an oil said to be used for burning and in medicine. A few are cultivated as garden plants. None of the woods is of commercial importance, but *Turpinia* and *Staphylea* Linn. produce woods which are used only locally.

Only two genera *Staphylea* and *Turpinia* are represented in India and are included in this book. The woods are similar in appearance and physical properties, being light-coloured ranging from yellowish-grey to light-brown, soft to moderately hard, straight-grained and rather fine-textured. Anatomically they bear a general resemblance to some woods of the *Theaceae* and are characterized by small numerous vessels which are usually solitary, scanty parenchyma restricted mostly to a few cells round the vessels but not visible under lens, and rays of two distinct sizes. The numerous fine uniseriate rays are barely visible even under the lens, and are interspersed with a few fairly broad multiseriate ones which are clearly visible to the eye. This last feature is very characteristic and serves to distinguish them easily from the woods of the *Sapindaceae* in which the rays are, as a rule, all of the same type being fine and almost exclusively uniseriate or partly biseriate.

The woods of the two genera described are very similar in their gross structure and cannot always be distinguished with certainty in the field. However, in *Staphylea* the vessels are generally smaller and the wood is invariably finer textured and somewhat harder and heavier than in *Turpinia*. *Turpinia* is also usually available in much larger sizes than *Staphylea*.

1. STAPHYLEA Linn.

The genus *Staphylea* consists of less than a dozen species of shrubs, rarely attaining the size of a small tree and confined mostly to the north temperate

regions of the world. It is represented in India by a single species which is described below.

S. emodi Wall.—*Sablata, surkhi* (Garh.), *banbakhru, banshagali, chitra, chual, guldan, kaghania, naydaun* (Hind.), *chitra, marchob* (Jauns. & Punj.), *karis* (Kumaon), *nagdaun* (Punj.). A shrub or small tree sometimes attaining a height of 6 m. and a girth of 50 cm. *Bark*, pale-whitish or grey with dark-brown longitudinal anastomosing streaks or reticulations.

It is found in the North-West Himalayas from the Indus to the Sarda River, Uttar Pradesh, and usually occurs scattered at high elevations from 750 m. to 2,700 m. in mixed coniferous forests.

Description of the wood

[Pl. 57, 338]

General properties—Sapwood and heartwood not distinct. Wood pale yellowish-grey or buff darkening on exposure ; moderately hard ; moderately heavy (sp. gr. 0·58–0·67 air-dry) ; straight-grained, even and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* usually present, indistinct to fairly distinct, delimited by somewhat denser latewood fibres, 5–16 per cm. *Vessels* very small, not at all visible to the eye, but seen under the lens as fine pin-pricks, very numerous and evenly distributed, almost exclusively solitary or nearly so, rounded to oval to somewhat angular in outline and always open ; vessel lines not visible on the longitudinal surfaces. *Parenchyma* not visible to the eye or even under the hand lens. *Rays* of two distinct sizes, moderately broad and very fine, the former distinctly visible to the eye, few and widely spaced, often running out at short distances radially, the latter just visible under the lens, numerous and closely spaced.

The wood has not so far been tested and as such no information is available regarding its strength and other properties. The dry timber is liable to be attacked by *Stromatium barbatum* Fabricius (*Cerambycideae*). Of the two specimens in the Dehra Dun collection, one shows heavy damage due to this beetle. The wood cuts and finishes smoothly and on account of its fine and uniform texture should prove suitable for small turnery articles, particularly watch pegs, hospital applicators, tooth picks, etc., where size is not of much importance. Only limited quantities of the wood are likely to be available locally in the hilly regions of Himachal Pradesh, East Punjab and Uttar Pradesh, where it is chiefly used for walking sticks. It is believed that sticks made of this wood keep off snakes (14).

Material—

2900 Nagkanda, Simla, Himachal Pradesh (0·58), 4419 Garhwal, Uttar Pradesh (0·67).

2. TURPINIA VENT.

A small genus of about 10 species having a fairly wide distribution in the tropics of both the old and the new world, chiefly in the Indo-Malayan region, the West Indies, Mexico and Central and South America. According to the "Flora of British India" and Brandis, it is represented in the Indian region by a single species, *T. pomifera* DC. However, Kurz and Gamble consider the high level form found at elevations from 900–2,100 m. as a distinct species, *T. nepalensis* Wall. From the point of view of wood structure the two are exactly alike and, therefore, following Brandis, they are described here as one.

T. pomifera DC. (including **T. nepalensis** Bedd.)—*Takku assing* (Abor.), *bon-keseru, gobar-khutla, mota amari, pani-let-ku* (Asm.), *janoki-jamun* (Beng.), *doukyama, lahkra-la, sat-ta-mane, taw-petsut, touk-sha-ma* (Burm.), *piyu-nekphi, takre-changne* (Duff.), *bol-dikim, gongmajaching, kothamari, kilamari* (Garo), *nila* (Kan.), *thaisram-phang* (Kach.), *dieng-iong, dieng-ja-anthri, dieng-soh-long-anthri, dieng-soh-sang-kei* (Kh.), *murgut* (Lep.), *pambavetti, santha* (Mal.), *kala-dingart* (Mechi), *thekjoai, thekejoy, khrang arong* (Mik.), *sidumbulli-asing* (Miri), *nagpat, thali* (Nep.), *kankumbala, kukulman* (Sinh.), *dieng-ja-rasi* (Synt.), *kanali, nila* (Tam.). A medium-sized to large tree up to 21 m. in height and over 2·5 m. in girth with a clear bole of 6 m. or more. At higher elevations it grows to a relatively smaller size, with much smaller leaves, flowers and fruits. *Bark* 3–5 mm. thick, pale brownish-grey, with the surface somewhat crinkled or showing reticulation due to fine horizontal cracks and vertical fissures, outer layer being soft and corky.

It occurs throughout the Western Ghats from Konkan southwards to Travancore hills and Ceylon and in Nepal, Sikkim, Assam, Chittagong hills and Burma extending to the Malay Peninsula and even south China.

Description of the wood

[Pl. 57, 339]

General properties—Sapwood indistinct from heartwood in all the specimens examined. Wood pale greyish-brown occasionally with darker streaks, faintly suggestive of walnut ; soft to moderately hard ; light to moderately heavy (sp. gr. 0·45–0·59 air-dry) ; somewhat lustrous ; usually straight-grained with even and medium-fine to fine-texture.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct to fairly distinct demarcated by slightly denser and darker latewood fibres. *Vessels* small to very small, numerous to very numerous (30 to over 50 per mm.^{2}), evenly distributed, or sometimes less crowded in the earlywood, mostly solitary, occasionally appearing in radial or oblique pairs, somewhat angular in outline and free of deposits or tyloses ; vessel lines in listinct to just visible

on the longitudinal surfaces. *Parenchyma* not visible even under lens. *Rays* of two classes – moderately broad and very fine, the former visible to the eye but few and widely spaced, and the latter seen only under lens, closely spaced.

Little information is available on the strength and other properties of the wood. Bourdillon gives the value of P (coefficient of transverse strength) as 388 and weight of wood 28 lb. Newly felled logs are attacked by shot-hole borers (Scolytidae), while the dry timber is susceptible to damage by *Stromatium barbatum* Fabricius (Cerambycideae). Being soft, straight-grained and rather fine-textured, it is easy to cut and appears capable of a smooth finish.

Uses—According to Lewis the wood is used for tea-boxes in Ceylon. In Assam it is used for fuel, but Kanjilal *et al.* are of opinion that the wood might be suitable for toys and cooperage. It is worth trying for small turnery articles and might do well for cheaper grade utility pencils.

Material—

*649 Darjeeling, West Bengal (0·48), *3108 Darjeeling, West Bengal (0·48), *3734 Coonoor, Madras (0·59), 4594 Kerala (0·47), *5445 Darjeeling, West Bengal (0·45), 6302 Burma (0·57), 6470 Burma (0·58).

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K. RAMESH RAO.

* These wood specimens are of the high level form, from over 1,500 m. elevation which is considered by some botanists as a distinct species *T. nepalensis* Wall.

SABIACEAE

The Sabia family consists of about 4 genera and about 90 species of small to medium-sized trees, upright shrubs and climbers, distributed in South-East Asia, China, Japan and tropical America but mainly confined to Indo-Malayan region. The members of the family mostly belong to the genera *Sabia* Colebr. and *Meliosma* Bl. The other two genera *Phoxanthus* Benth. and *Ophiocaryon* Schomb consist of one or two species occurring in the Amazon basin.

The family is not of much economic importance but the genus *Meliosma* Bl. includes some ornamental shrubs and several handsome trees chiefly of hilly regions of India. The greenish-white flowers of the climbing shrub of *Sabia lanceolata* Colebr. of Assam are sweet scented. According to Burkill the fruit of *Meliosma nitida* Bl. is edible. The bark of *M. buchaniifolia* Merr. is reported to be used for incense (2).

The family is represented in the Indian region by 2 genera of which one is dealt with here. The other genus *Sabia* is represented mostly by climbing shrubs.

MELIOSMA Bl.

It is a large tropical genus of trees and shrubs, rarely climbers found throughout the tropics but most abundantly represented in Indo-Malayan region. About 10 species of trees have been reported to grow in the Indian region. Of these 4 species were not available for study. These are :—*M. collettiana* King – a middle-sized tree of Upper Burma, *M. manii* Lace – a small tree of Khasi Hills, Assam and Upper Burma, *M. pinnata* Roxb. – a small to medium-sized tree of Khasi Hills, Assam, Chittagong and Eastern Ghats; and *M. wightii* Planch. – a small to large-sized tree of Western Ghats, Kerala and Ceylon. The woods of these species have been described by Gamble except that of *M. manii*. They are characterized by small to medium-sized vessels either in clusters or short radial multiples, and broad to moderately broad rays with conspicuous silver grain.

The woods of 6 Indian species studied show considerable variation as regards distribution of vessels but the number of samples available for study was so limited that no definite conclusion regarding their classification could be drawn.

1. **Meliosma arnottiana** Wight [**M. microcarpa** (W. & A.) Craib]— *Massivara* (Kan.), *kalavi*, *kallavi* (Mal.), *nikadawulu* (Sinh.), *huli-makay*, *huli mukki*, *kusavi*, *tagari*, *thagari* (Tam.). A medium-sized to large, straight tree, 12–18 m. in height, and 1·2-1·5 m. in girth. *Bark* brownish-grey, smooth, with concave lenticels, rather thick.

It is found in the Western Ghats from South Kanara to Tinnevelly at an elevation of 1,200–2,150 m., very common in the Nilgiris and Anamalai hills at 600–1,200 m., rare in Khasia hills, also in Ceylon.

Description of the wood—See page 261.

2. **M. dilleniaefolia** Bl.—*Palmoya* (Dotial), *moya* (Garh.), *kann, kanna, karkon, parenga, philli, porda* (Himachal Pradesh), *goi* (Jauns.), *gulpha, goguna, gweb* (Kumaon), *siamunu* (Nep.), *bakraina, bakarshang, bakrasang, shapra* (Punj.). A small shrub or a tree 3–11 m. in height and 90 cm. in girth. *Bark* pale brown to dark-grey, smooth, with thick concave lenticels.

It is found throughout the Himalayas from the Beas eastwards to Bhutan at 1,200–3,350 m. elevation.

Description of the wood—See page 261.

3. **M. pungens** Walpers—*Kharas* (Garh.), *bekesh, bushkua, kapper* (Himachal Pradesh), *bushkua* (Jauns.), *bhumis, gardar, gogsha, gogua, gugua, kharas* (Kumaon). A tree up to 15 m. in height and 1·2–2·1 m. in girth. *Bark* pale brown to reddish-brown, fairly smooth, 4–8·5 mm. thick, longitudinally wrinkled with concave lenticels.

It is found throughout the Western Himalayas from Sutlej to Nepal at 750–2,450 m. elevation ; also in China and Japan.

Description of the wood—See page 261.

4. **M. simplicifolia** Roxb.—*Gurban-asing* (Abor.), *dhapapatia, dibru, hengunia, larubandha, phoko, pichola, shankonaro, thowlhowa, tolao* (Asm.), *lalay, pet-taung-gyaing* (Burm.), *bon-khoklu* (Cach.), *babari-chi, borsiring, simnabat, thaukhu-khokhra* (Garo), *dieng-la-pia, dieng-nong-krow, dieng-lyng krong* (Kh.), *nah-pui, thing-erkum* (Kuki), *hingman* (Lep.), *gokpak* (Maghi), *kallavi, kathi kilavi* (Mal.), *kokoh, koko* (Mechi), *phaglan-jan-arong* (Mik.), *nitak-asing* (Miri), *koasa* (Naga), *churri, koshru, kosru* (Nep.), *elbedda* (Sinh.), *dantrungi* (Sylh.), *kadiri, kallavi, kucoavir, tagari* (Tam.), *holemogge, kaneamogge, masuala, mathe, tode* (Tel.). A small to medium-sized tree with rather straight slender stem. *Bark* greyish or nearly white, smooth except on branches, 7·5–12·5 mm. thick.

It is found in sub-Himalayan tract from Nepal to Sikkim and in Khasi Hills, at 600–1,200 m. elevation ; Chittagong, Tenasserim, Upper Burma ; also in the forests of Western Ghats from Mysore to Kerala and Ceylon.

Description of the wood—See page 261.

5. **M. thomsoni** King—*Sindure dabdabe, sinduri dabdabbi* (Nep.). A large tree of Sikkim. *Bark* greyish-brown, smooth, 13 mm. thick.

It is found in the middle hill forests of Darjeeling and Sikkim Himalayas at 600–1,800 m. elevation. It is planted in the tea gardens of Darjeeling Terai for fuel (12).

Description of the wood—See below.

6. **M. wallichii** Planchon—*Dieng-sngit* (Kh.), *himan* (Lep.), *debdabbi, nunewalai* (Nep.), *dieng-chidit, dieng-la myrsiang, dieng-sniat* (Synt.). A middle-sized to large tree up to 18 m. in height and 1·5 m. in girth. *Bark* dark grey or greyish-brown, often with horizontal wrinkles.

It is found in the Himalayas from Kumaon eastwards to Khasia and Jaintia hills in Assam at about 750–2,450 m. elevation. Gamble states that the tree is often fast grown especially from coppice shoots.

Description of the wood—See below.

Description of the wood

(*Meliosma arnottiana, M. dilleniaefolia, M. pungens, M. simplicifolia, M. thomsoni* and *M. wallichii*)

[Pl. **57**, 340–342 and Pl. **58**, 343–345]

General properties—Sapwood and heartwood not distinct ; wood pale brown to reddish-brown ; moderately soft, but very soft in *M. arnottiana* and *M. wallichii* ; mostly light (sp. gr. 0·42–0·55 air-dry), but often very light in *M. arnottiana* and *M. wallichii* and moderately heavy in *M. simplicifolia* (sp. gr. 0·65 air-dry) ; slightly lustrous ; straight and even-grained but rather uneven in *M. arnottiana, M. dilleniaefolia* and *M. wallichii* ; mostly coarse-textured but fine in some samples of *M. dilleniaefolia* and *M. simplicifolia.*

Gross structure—Wood diffuse-porous with a ring-porous tendency in *M. arnottiana, M. dilleniaefolia* and *M. wallichii. Growth rings* usually distinct but somewhat indistinct in *M. pungens*, delimited by thin band of darker latewood fibres, and in the species showing ring-porosity, by larger and more numerous earlywood vessels, 2–4 per cm. *Vessels* mostly moderately large, just visible to the eye but larger in *M. arnottiana* and *M. wallichii*, and smaller in *M. dilleniaefolia* and *M. pungens* ; small to very small, indistinct to the eye in the latewood of the species showing ring-porosity ; moderately numerous to numerous (11–29 per mm.^{2}) ; but moderately few in *M. arnottiana* and *M. wallichii* (4–10 mm.^{2}), evenly distributed except in the species showing a tendency for ring-porosity ; solitary, in short radial multiples of 2–4 and in small irregular clusters but usually in larger clusters in *M. dilleniaefolia*, and also occasionally in tangential pairs due to the overlapping of vessel ends ; usually radially aligned in *M. pungens* ; angular in shape and mostly open ; vessel lines visible to the naked eye on the longitudinal surfaces except in *M. dilleniaefolia.* Scalariform perforation plates distinct under the hand lens on the longitudinal

surfaces and also occasionally on the end surfaces of *M. pungens*, *M. simplicifolia* and *M. thomsoni*. Fibres thin walled and individually visible under hand lens ; very distinct in *M. arnottiana* and *M. wallichii*. *Parenchyma* indistinct to the eye but distinct under hand lens, vasicentric, scanty, forming a thin sheath round the vessel or vessel-clusters ; and also scattered on the face of the growth rings, but usually indistinct under hand lens. *Rays* of two types, broad to moderately broad, and fine to very fine. The former lighter in colour, prominent (*M. arnottiana* and *M. wallichii*) to distinct to the eye (*M. dilleniaefolia*, *M. simplicifolia* and *M. thomsoni*) except in *M. pungens*, where the colour difference is not so sharp ; widely and evenly spaced, but usually very widely spaced in *M. arnottiana* and *M. wallichii*. The finer rays somewhat widely spaced between the broad rays, distinct under the hand lens only in *M. arnottiana*, *M. dilleniaefolia* and *M. wallichii*. Radial flecks prominent, very conspicuous in *M. simplicifolia* and *M. thomsoni*. *Pith flecks* observed in *M. simplicifolia* and *M. pungens*.

Strength—The wood is rather moderately soft except in *M. arnottiana* and *M. wallichii* which are very soft and light. According to Bourdillon the value of P (the coefficient of transverse strength) for *M. arnottiana* is 325 and weight 21 lb. per cu. ft. and for *M. simplicifolia* P is 370 and weight 31 lb. per cu. ft.

Seasoning properties—The woods of *M. arnottiana* and *M. simplicifolia* are liable to warp (5). From an examination of the samples in our collection it appears that the woods of other species are also liable to develop large end cracks along the rays. According to Tang, the wood of *M. cuneifolia* Franch of China also develops large cracks when air-dried.

Natural durability—No information is available regarding durability of Indian species. However, the American and Malayan species are reported to be poorly resistant to decay, but they may be moderately durable under cover (4, 15).

Insect attack—Drywoods of *M. dilleniaefolia* and *M. pungens* are liable to be attacked by *Stromatium barbatum* Fabr. (Fam. Cerambycidae) and newly felled and dead or dying trees of *M. simplicifolia* are liable to be attacked by shot-hole borers (Platypodidae). The specimens of *M. arnottiana* and *M. thomsoni* represented in our collection are very sound but the sample of *M. wallichii* has been reduced to powder by borers.

Preservative treatment—It has not so far been tried for antiseptic treatment. From the wood structure point of view it appears that the timber may not be difficult to treat with preservatives.

Working qualities—It is very easy to saw and work with tools. The wood of *M. simplicifolia* is reported to take good polish.

Supply and uses—The timber is not available in large quantities. The wood of *M. arnottiana* is reported to be used for floats. The timbers of *M. dilleniaefolia*, *M. simplicifolia* and *M. thomsoni* may be tried for internal fittings and light packing cases. Attractive figure on the quarter-sawn planks especially of *M. simplicifolia* and *M. thomsoni* can be utilized for the manufacture of light furniture. It may also be tried for the manufacture of plywood.

Material—

M. arnottiana – 3905 Coonoor, Nilgiris, Madras (0·50), 4608 Travancore, Kerala (heavily attacked by borer).

M. dilleniaefolia – 60 Nagkanda, Simla, Himachal Pradesh (0·53), 2892 Nagkanda, Simla, Himachal Pradesh (0·52), 4769 Deota, Tehri-Garhwal, Uttar Pradesh (heavily attacked by borer).

M. pungens – 4910 Upper Tons Valley, Tehri-Garhwal, Uttar Pradesh (0·52) (slightly attacked by borer).

M. simplicifolia – 6210 Buxa Division, West Bengal (0·43), 2339 Sivoki, Darjeeling, West Bengal (0·53), 6413 Burma (0·65), 4635 Travancore, Kerala (0·48), 7978 Assam (0·45).

M. thomsoni – 4866 Tukdah, Darjeeling, West Bengal (0·49).

M. wallichii – 361 Rangbul (heavily attacked by borer).

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D. N. BADOLA.

ANACARDIACEAE

A large family consisting of about 65 genera and over 500 species of trees, shrubs and woody climbers, occurring mostly in the tropical and sub-tropical regions of the world. The available fossil history indicates that the members of the family might have developed either in the late Cretaceous or early Tertiary, becoming widespread in both the New and Old World during the Tertiary period. Although fossil plant remains have been found in many countries, e.g., Germany, England, U.S.A., Brazil, India and Indonesia, records of fossil woods are very meagre.

The family is of considerable economic value. It produces edible fruits, gums and resins, tans, dyes, drugs and also several timbers of commercial importance. Among the fruits, the most important is mango (*Mangifera indica* Linn.) which is universally relished. Of late, cashew-nut obtained from *Anacardium occidentale* Linn. of South America has assumed great importance in this country. The tree is largely cultivated in India particularly near the sea coast. The nuts have become very popular and are largely eaten in India and are also exported. The ripe fruits of *Spondias mangifera* Willd. (hog plum) are eaten raw while unripe ones are used for making pickles and for imparting sour taste to "curries". The kernels of *Buchanania mangifera* Roxb., are also eaten raw or roasted and form a substitute for almonds. *Pistacia vera* Linn. originally a native of Iran and Syria is cultivated in Southern Europe and U.S.A. for its nuts which are used for dessert and for flavouring ice-creams and sweets.

A number of species like *Anacardium occidentale* Linn., *Buchanania latifolia* Roxb. and *Lannea grandis* Engl. yield gums which are used in calico printing, paper-sizing and as adhesives. Natural varnish is also obtained from several trees such as *Holigarna*, *Semecarpus* and *Rhus*. The celebrated black varnish of Burma, used in the preservation of wood work and also in lacquer work, is a product of *Melanorrhoea usitata* Wall. A snow-white wax used for making candles is obtained from *Rhus succedanea* Linn. and is sometimes known in Europe as Japanese wax. "Mastic gum" obtained from *Pistacia lentiscus* Linn. and *P. terebinthus* Linn. of the Mediterranean region, is used for preparation of perfumes, flavouring wines and in confectionery. Other species of *Pistacia* such as *P. integerrima* Stewart of India also yield similar resins.

Some of the species of *Rhus* are highly astringent and are used as tans. The ground leaves of the Sicilian Sumach, *R. coriaria* Linn. which are rich in tannin, are employed in the manufacture of soft leather for gloves and book binding, and also for mordanting certain aniline dyes. *R. cotinus* Linn. of India is also used for tanning leather. The juice obtained from incisions in the

bark of *Anacardium occidentale* and from the pericarps of the marking nut tree, *Semecarpus anacardium* Linn., is commonly used as an indelible black ink for marking cotton and linen. The horn-like, dull-red galls known as *kakrasingi* found on the branches and young shoots of *Pistacia integerrima* are considered to possess tonic properties and are useful in cough, asthma and lung diseases. The juice of some trees like *Holigarna*, *Rhus* and *Semecarpus* is poisonous and causes blisters.

The timbers of the family exhibit a wide range of variation in colour, weight, hardness and durability. In many of the timbers the heartwood is very small or indistinct from the sapwood as in *Anacardium*, *Buchanania*, *Holigarna*, *Mangifera*, *Semecarpus*, *Spondias* and *Swintonia*. These woods usually vary from pale yellow to yellowish-grey in colour, light to moderately heavy in weight and are not durable, the lightest among them being *Spondias mangifera* Willd. (sp. gr. 0·33 air-dry). On the other hand, in *Gluta*, *Lannea*, *Parishia*, *Pistacia* and *Rhus*, the heartwood is very distinct and varies in colour from yellow with a greenish cast to deep-brown or brick-red, sometimes also beautifully mottled with dark streaks. These woods are mostly moderately heavy to heavy with medium to high durability, the heaviest among the Indian woods being *Gluta* (sp. gr. 1·15 air-dry). However, the heaviest timber of the family is produced by the genus *Astronium* of tropical America (sp. gr. 1·28 air-dry). The woods are mostly coarse-textured but a few like *Pistacia* and *Nothopegia* have fine texture. Among the highly coloured and durable timbers of the family are the two widely known American woods Quebracho (*Schinopsis* spp.) and Zebrawood or Kingwood (*Astronium* spp.). *Gluta* and *Melanorrhoea* of the Indian region also produce highly ornamental and durable woods but being available in very small quantities do not have more than local importance. Several other genera such as *Anacardium*, *Buchanania*, *Holigarna*, *Lannea*, *Mangifera*, *Semecarpus* and *Spondias* produce general utility woods which are in great demand. The timber of *Campnosperma* Thw. is largely used in Malaya for match manufacture. *Pistacia* and *Rhus* usually produce attractive, strong and durable timbers, but because of their small size have got only limited uses.

The woods are mostly diffuse-porous except *Spondias axillaris* Roxb., *Pistacia integerrima* and some species of *Rhus*. The growth rings are usually indistinct. The vessels are mostly moderately large to large and few and are conspicuous on longitudinal surfaces, but are small to very small and numerous in some diffuse-porous species of *Rhus*, *Pistacia* and *Nothopegia*. Tyloses are usually present in the heartwood partially or completely filling up the vessel cavity. *Parenchyma* is usually not well developed in this family. It is hardly visible even under hand lens in *Lannea grandis* and *Mangifera longipes*. In the majority of the timbers, however, the parenchyma though rather scanty, is visible with a lens occurring mostly round the vessels as a thin sheath or as inconspicuous eye-lets. But in *Bouea*, *Gluta*, *Melanorrhoea*, *Swintonia* and

Mangifera, parenchyma is distinct and sometimes conspicuous as fairly thick long or short tangential bands. Rays are of two classes, moderately broad and fine but rather inconspicuous in most cases. Radial gum canals have been recorded in *Buchanania, Gluta, Lannea, Parishia, Pistacia, Mangifera longipes, Rhus, Spondias* and *Swintonia*. However, these may not always be distinct under hand lens.

Seventeen out of about twenty genera of *Anacardiaceae* occurring in India have been dealt with here. The remaining three genera, *Dobinea* Buch.-Ham. ex D. Don., *Solenocarpus* Wight & Arn. and *Tapiria* Juss. are represented by solitary species of small trees or shrubs for which wood samples were not available for study. As regards *Dobinea*, there is difference of opinion as to its correct systematic position. Hooker in Flora of British India includes it under *Sapindaceae* while Brandis places it under *Anacardiaceae*. Gamble has put it under the tribe *Acerineae* of *Sapindaceae*. Bor is of the opinion that its proper place is in *Aceraceae*.

Due to the great similarity in colour, texture and anatomical structure, many of the woods present great difficulty in their proper identification in the field. For the successful separation of the various genera, help of the microscope often becomes necessary. The following key, however, may be of help in distinguishing some of the genera.

Key to the woods

1. Wood ring-porous 2
1. Wood diffuse-porous 6

2. Earlywood zone wide, consisting of 3–7 rows of large vessels. Wood yellow to yellowish-grey, light .. .. .. *Rhus punjabensis*
2. Earlywood zone narrow, consisting of 1–2 rows of larger vessels 3

3. Latewood vessels mostly in clusters or in long radial multiples, very numerous, transition from early to latewood abrupt 4
3. Latewood vessels mostly solitary, not numerous. Transition from early to latewood gradual .. 5

4. Latewood vessels mostly in clusters, arranged in wavy or zig-zag pattern. Heartwood yellowish-brown with dark streaks, heavy .. .. .. *Pistacia integerrima*
4. Latewood vessels mostly in long radial multiples or chains. Heartwood bright yellow, moderately heavy .. .. *Rhus cotinus*

5.	Wood light pinkish-brown	*Spondias axillaris*
5.	Wood greyish-white or yellow	*Rhus*
6.	Vessels minute, indistinct to the eye ..	7
6.	Vessels moderately large to large, distinct to the eye	9
7.	Parenchyma indistinct under lens	*Pistacia terebinthus*
7.	Parenchyma distinct under lens in paratracheal confluent lines or delimiting growth rings ..	8
8.	Parenchyma in paratracheal confluent lines and in 'eyelets'; vessels not numerous. Wood white or pale pinkish-yellow ..	*Nothopegia*
8.	Parenchyma neither confluent nor in 'eyelets' but only delimiting growth rings; vessels numerous. Wood reddish-brown	*Rhus mysorensis*
9.	Parenchyma indistinct under lens	10
9.	Parenchyma distinct under lens	11
10.	Sapwood and heartwood distinct; sapwood yellowish-grey, heartwood reddish-brown	*Lannea*
10.	Sapwood and heartwood indistinct. Wood yellowish-grey	*Mangifera longipes*
11.	Parenchyma round the vessels only, forming thin sheath or 'eyelets'. Apotracheal tangential bands of parenchyma absent ..	12
11.	Parenchyma in conspicuous apotracheal tangential bands at regular or irregular intervals ..	13
12.	Sapwood and heartwood distinct; sapwood greyish-brown, heartwood pinkish or reddish-brown	*Parishia*
12.	Sapwood and heartwood indistinct; wood pale yellowish or greyish-brown ..*	*Anacardium*, *Buchanania*, *Dracontomelum*, *Drimycarpus*, *Holigarna*, *Semecarpus* *Spondias*

* *Buchanania* and *Spondias* can sometimes be separated from other timbers of this group by the large radial gum canals that are present on the tangential surfaces. However, sometimes there may be difficulty in spotting these canals due to discoloration to which these timbers are easily susceptible. Further, with experience separation of some other members of this group may also be possible under hand lens on the basis of minor differences in vessels size, parenchyma distribution as well as weight, hardness and texture. A reference to the descriptions of these timbers may often be helpful for this purpose.

13. Parenchyma round the vessels visible to unaided eye; tangential bands of parenchyma not numerous .. .. .. *Mangifera*

13. Parenchyma round the vessels indistinct or barely visible under lens; tangential bands of parenchyma numerous 14

14. Wood heavy to very heavy; sapwood and heartwood distinct, sapwood pale grey or grey-brown, heartwood dark reddish-brown .. .. .. *Bouea, Gluta, Melanorrhoea*

14. Wood light to moderately heavy; sapwood and heartwood indistinct, wood greyish-white to grey .. .. .. *Swintonia.*

1. ANACARDIUM LINN.

A genus of small to large trees indigenous to tropical America, especially Brazil. *Anacardium occidentale* L., the cashew-nut tree was introduced into India about 400 years ago by the Portugese, and is now almost naturalized in several parts of India particularly coastal regions, where it is used for reclamation work.

The cultivation of this tree has assumed great importance for its nuts which are eaten either raw or fried and have become very popular as a dessert and in the manufacture of sweets. The nuts are largely exported and occupy an important position in the foreign trade of India. The shell oil, obtained from the hard pericarp of the fruit is also exported in large quantity. Besides being used as a waterproofing agent, it also finds use in a number of industrial products, such as paints, varnishes, adhesives, pigment for gums, inks, oil-cloth, industrial flooring tiles, waterproof paper, typewriter ribbons and automobile brake-linings. The milky sap from the bark, which turns black on exposure, is used for marking linen. The tree also yields a gum which is used as an adhesive in book-binding.

A. occidentale Linn.—*Hijli badam, hijuli, kaju* (Beng.), *mak-mong-si-ho, shitkale, sihosayesi, thayet, thee-hoh-thayet, thee hot, thee-noh, thihon thayet, thihothayet, tihotiva-si* (Burm.), *kaju* (Hind.), *gera bija, gerligai, geru, geru bija, geru-peppu, godambe, govamba, gove, jidi, jidi vate, kempu geru, kempu-gerubija, turaka geru* (Kan.), *kaju* (Mar.), *andi paruppu, kappal-cherunkuru, kappal mavu, kappal sera, kappamava kuru, karmavu, kashu-mavu, parangi mavu, paranki mavakuru, patiri mavu, portugi mavu, pritikannavu* (Mal.), *bajan,*

bhollia ambo, hijila bodamo, honka bhollia, lanka ambo, lonka-bhollia (Or.), *andima, andimangottai, kallarma, kola mavu, kottai mundi, kotti, mindiri, mundiri-kottai, mungidi, munthri, munthri kottei, rolla mavu, seram, sigidima, tirigai, uttumabalam* (Tam.), *jeedipappu, jidianti, jidi-mamidi, jidi-mamidi-vittu, mokkamamidi, montamamidi-vittu, muntha-mamidi* (Tel.). Cashew-nut tree. Also sometimes called Goa almond and Ceylon mango. An evergreen small to medium-sized tree, growing to a height of 12 m. with a clear bole of 2·5–4·5 m. and 60–90 cm. in girth. *Bark* grey, rough, cracked and thick.

The tree is cultivated in many parts of India particularly in the coastal regions. In Kerala, Mysore and Goa on the west coast, it is almost naturalized and grows gregariously. It is also cultivated in Andhra, Orissa (Balasore, Ganjam and Puri), West Bengal (Midnapore) and the Andamans. The cashew-nut tree has been introduced and naturalized in the coastal regions of many other parts of the world such as Pakistan (Chittagong), Burma (Tenasserim), the Philippine Islands, Ceylon, Madagascar and South Africa.

Description of the wood

[Pl. **58**, 346]

General properties—Sapwood and heartwood indistinct. Wood pale-grey to brownish-grey, often discoloured occasionally with pinkish tinge turning dirty greyish-brown with black streaks ; light (sp. gr. 0·42–0·47 air-dry), soft ; sometimes lustrous, with slight silver grain effect on the radial surface ; straight to somewhat interlocked-grained ; rather coarse and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct. *Pores* moderately large to small, easily visible to just visible to the naked eye, few to moderately few (3–8 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–4, oval in outline, usually open, occasionally filled with tyloses ; vessel lines conspicuous on the longitudinal surfaces. *Parenchyma* vasicentric to aliform, not very conspicuous under hand lens being of the same colour as the wood. *Rays* fine, pinkish to brownish in colour against the greyish background, distinct under hand lens, and closely spaced, sometimes showing inconspicuous ray-flecks.

Strength—The timber is light and soft and is only moderately strong. Bourdillon gives the coefficient of transverse strength P as 317, and weight 30 lb.

Record gives the following figures for *A. excelsum* (Bert. & Balb.) Skeels of Central America : sp. gr. 0·56 air-dry ; weight 35 lb. per cu. ft. Static bending (lb. per sq. in.) : modulus of rupture 7,175 ; modulus of elasticity 1,683,500. Endwise compression (lb. per sq. in.) : maximum crushing strength 8,230 ; modulus of elasticity 1,800,000.

Seasoning—No data are available for this species. However, as the structure of the wood is very similar to that of *Holigarna*, *Parishia* and *Spondias* which are all easy to season, it is not expected to prove troublesome in this respect. For *A. excelsum*, Cooper reports that when kept dry it keeps shape well but is liable to warp and check when exposed.

Natural durability—The timber is not very resistant to decay, especially in contact with the ground.

Insect and fungus attack—Deadwood and newly felled timber are attacked by some borers belonging to Bostrychidae, Buprestidae, Cerambycidae, Platypodidae and Scolytidae. It is very susceptible to sap-stain and wood rotting fungi.

Working qualities—It is not difficult to saw and work with tools but planing may sometimes give trouble due to the picking up of fibres particularly on the radial surfaces. According to Cooper, *A. excelsum* takes polish well, after sand papering and waxing. It also holds nails without splitting.

Uses—The timber is used locally for box and packing cases, general carpentry and construction, cheap furniture and for making wooden utensils. During the last war it was one of the approved timbers for crates. The timber is also said to be used for boat building and charcoal in Burma and Ceylon.

Material—

4624 Travancore (0·42), 6836 Burma (0·47).

2. BOUEA MEISSN.

A very small genus of fruit trees of the Indo-Malayan region. Three species are reported to be introduced into India but the wood of only *B. burmanica* Griff. was available for study. The fruit of *B. burmanica* is sometimes called *jungli am* due to a somewhat similar taste as that of mango, but is more acid and often used for making pickles. The tree also occasionally yields a gum.

B. burmanica Griff. [**B. oppositifolia** (Roxb.) Adelb.]—*Miriam*, *uriam* (Beng.), *baran*, *barine*, *mayan* (Burm.). A small to moderate-sized evergreen tree, 6–11 m. in height and 60–90 cm. in girth. *Bark* dark coloured, exuding yellowish juice, when cut.

The tree is found in the Sunderbans and in the evergreen forests of the Andamans. It also grows in Martaban and Tenasserim in Lower Burma and is cultivated in the moister parts of Burma.

Description of the wood

[Pl. **58**, 347]

General properties—Sapwood large, heartwood small. Sapwood yellowish-grey to yellow-brown, somewhat lustrous ; heartwood dark reddish-brown,

often with black streaks ; dull ; hard ; heavy (sp. gr. 0·77–0·88 air-dry) ; straight to slightly interlocked-grained ; medium and even-textured. Plain sawn faces of sapwood show up an ornamental zig-zag figure produced by brownish coloured parenchyma.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct ; sometimes tangential bands of parenchyma and denser fibrous tissue may, however, give the impression of growth rings. *Vessels* moderately large to small, clearly visible to just visible to the naked eye, very few to moderately few (1–8 per mm.^{2}), mostly solitary, occasionally in radial multiples of 2–3 or more, round to oval in outline, frequently plugged with tyloses ; vessel lines conspicuous on the longitudinal surfaces. *Parenchyma* fairly abundant, brownish in colour ; (*a*) apotracheal, visible to the eye, in long tangential bands irregularly distributed, often a number of them occurring very closely ; occasionally also in short, fine, tangential lines ending abruptly ; (*b*) paratracheal, rather inconspicuous under lens as a thin sheath round the vessels. *Rays* fine and closely spaced, brownish in colour, indistinct to just visible to the eye ; ray-flecks inconspicuous. *Pith flecks* occasionally present.

Strength—The timber has not been tested for strength. It is, however, hard, heavy and strong.

Seasoning—Except for one sample which shows longitudinal cracks, none of the samples in the wood collection shows any defect due to seasoning.

Natural durability—The wood is said to be very durable (23) but no recent confirmation is available. For the Malayan species, *B. macrophylla* Griff. and *B. microphylla* Hook. f., Desch reports that the heartwood is reputed for its durability. All the samples in the wood collection of this Institute are in sound condition except one which shows damage due to borer attack in the sapwood.

Uses—The timber is said to be used in the Sundarbans for parts of boats which do not come in contact with water. It appears suitable for planking, furniture, boxes and heavy packing cases, agricultural implements and also for small articles such as knife handles, tobacco pipes, etc.

Material—

2213 Andamans (0·88), 5382 Andamans (0·77), 5517 Thaungyin, Burma (0·78).

3. BUCHANANIA ROXB.

The genus consists of about 25 species of trees and shrubs distributed in tropical Asia, Australia and the Pacific Islands. About 9 species are reported to occur in India and Burma, out of which only three were available for study,

Of the remaining species *B. barberi* Gamble and *B. lanceolata* Wight - *mala mavu* (Mal.), are trees of evergreen forests of Kerala ; *B. platyneura* Kurz is a medium-sized tree (15–25 m. in height and about 1 m. in girth), common in evergreen forests of the Middle and South Andamans with pinkish and lustrous but perishable wood, while *B. acuminata* Turcz., *B. glabra* Wall. - *thittwet* (Burm.), and *B. florida* Schauer are small evergreen trees of Burma.

The woods of all the species are very similar in structure and are, therefore, described here together.

1. **B. angustifolia** Roxb.—*Cheru, malamavu* (Mal.), *markaria char, mota char* (Mar.), *kalma, kattuma, kolamavu, mudaima, mudamah, mudma, pulima* (Tam.), *chara, morli sara, muri chetu, pedda morali, pedda sara, peimota sara, tolmori* (Tel.). A medium-sized tree 6–9 m. in height and 60–90 cm. in girth. *Bark* dark brown, rough with irregular cracks, 13–20 mm. in thickness. The nuts of this tree are said to be superior to those of other species and are largely collected and eaten.

It occurs in the drier forests at low altitudes, chiefly in Andhra, Madras, Mysore, Kerala and Bombay. It also grows in Ceylon.

Description of the wood—See page 273.

2. **B. lancifolia** Roxb.—*Chikki, chivit, sivit* (Beng.), *thinbaung* (Burm). A large evergreen tree of Chittagong in East Pakistan and Arakan and Pegu in Burma.

Description of the wood—See page 273.

3. **B. latifolia** Roxb. (**B. lanzan** Spreng.)—*Pial, piyal, piyar* (Beng.), *pial* (Bhum.), *maihakhpu, lamboben, lombo, loneopomoa, lonepho, lonpo, lunbo, thitsibo* (Burm.), *kathbhilawa, muria, payala, pial, pural* (Garh.), *chirka, herka, herka marra, saraka, sarekha* (Gon.), *charoli* (Guj.), *achar, char, charoli, chironji, paira, pial, piyal, piyar* (Hind.), *dhurkalu, kolegeru, kolemavu, kolliceru, morale, morave, murkalu, murukali, murukalu muruku, muruku, nurchilla, nurkal, nuruke, nuskul* (Kan.), *tarub, tarum* (Kol.), *cheru, kalamavu, mora, mungapara, mungaperlu, moorghu, mural, naruvi, nuruvei* (Mal.), *achar, char, charoli, pyal-char* (Mar.), *char, chara, charo, charu* (Or.), *chrauli* (Punj.), *parop, tarop* (Sant.), *aima, carai, katimango, katmaa, katma-maram, kodaman-kattu maram, marum, modama, moda mavu, modwa, morala, moralai, morala sirtik, mudaima, paruppusedi, sarai, saraiparuppu* (Tam.), *chara, charu, chara mamidi, chara-chettu, chinna-moral, chiunamora, cinnamoralli, jaramamidi, jvaramamidi, morallu, morli, morlimorlu banka, morlu, morlu chettu, sara, sara chettu* (Tel.). A small to moderate-sized tree with a small crown attaining 18 m. in height with 6–7·5 m. clear bole, and 1–2 m. in girth. *Bark* 13–25 mm. thick, dark grey or nearly black, rough, tubercled, fissured or tessellated into

small square or quadrangular plates. The tree exudes a gum which is considered efficacious in diarrhoea.

The kernels of the seeds are eaten raw or roasted and also used in confectionery. The oil obtained from the kernel has local use in medicine in place of almond oil. The kernel also has got use in skin diseases as an ointment. The bark has a tannin content of 13·4 per cent which gives dark reddish-brown colour to leather.

The tree is found in dry deciduous forests throughout India, from the Sutlej eastwards to Nepal ascending in the sub-Himalayan tract to 900 m. frequently associated with sal (*Shorea robusta* Gaertn.), mahua (*Madhuca indica* J. F. Gmel.) and dhak [*Butea monosperma* (Lam.) Taubert.]. It is found in the forests of Uttar Pradesh, Bihar, Bengal, Orissa, Madhya Pradesh, Andhra, Mysore, Madras, Kerala and is scarce in the Punjab. It is also found all over Burma in dry forests associated with eng (*Dipterocarpus tuberculatus*).

Description of the wood

(*Buchanania angustifolia*, *B. lancifolia* and *B. latifolia*)

[Pl. **58**, 348 ; Pl. **59**, 349]

General properties—Sapwood not clearly demarcated from the heartwood. Wood white or greyish-white to grey-brown or light brown or pinkish (*B. lancifolia*), sometimes with a faint yellowish cast but often subject to discoloration due to sap-stain ; light to moderately heavy (sp. gr. 0·47–0·66 air-dry) ; soft to moderately hard ; fairly lustrous when first exposed, but liable to become dull with age ; straight to somewhat interlocked-grained ; even and coarse-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct, however, tangential bands of thick walled fibres which are visible to the naked eye, often give the impression of growth marks. *Vessels* mostly large and distinctly visible to just visible to the eye, very few to moderately few (2–9 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–3, less frequently in long multiples ; round to oval or somewhat angular in outline, open or frequently filled with tyloses ; vessel lines conspicuous on the longitudinal surfaces. *Parenchyma* distinct only under hand lens, brownish in colour, scanty, in a thin sheath round the vessels, sometimes forming inconspicuous 'eyelets'. *Rays* rather fine, just visible to indistinct to the eye, brownish in colour, apparently of two sizes – rather widely spaced and running for short distances ending radially, the finer ones inconspicuous even under lens, closely spaced between the broader ones ; ray flecks-fairly distinct in samples not discoloured by sap-stain. *Gum canals* present, horizontal, irregularly distributed, sometimes visible under hand lens as dark spots in broader rays on the tangential surface.

Strength—According to Pearson and Brown, *B. angustifolia* is moderately hard and probably about equal in strength to *B. latifolia* – that is, about half as strong as teak in transverse strength. *B. latifolia* which is moderately strong has been tested at this Institute and the strength figures are included in appendix I.

Seasoning—None of the timbers is refractory, and presents difficulties in seasoning. However, as the timbers are highly susceptible to discoloration and decay due to rapid fungal attack, quick conversion after felling is desirable. Pearson and Brown recommend that the logs should be converted when green and then the planks immersed in water followed by open-stacking under cover.

Natural durability—It is not a durable timber and is easily attacked by fungi and insects in exposed locations. According to Kanjilal *et al* the timber is fairly durable if kept dry and free from white ants. The "graveyard" test carried out in the Philippines with *B. arborescens* showed that the timber lasts much less than a year(39).

Insect and fungus attack—The timber is subject to attack by a large number of insects at various stages of extraction and conversion. *B. latifolia* is liable to be attacked by several borer species of Anthribidae, Bostrychidae, Brenthidae, Buprestidae, Cerambycidae, Curculionidae, Lycidae, Lymexylonidae, Platypodidae, Scolytidae and Lyctidae (*ghoon* borer). Howard reports that large size beetles make holes more than $\frac{1}{8}$ inch in diameter. All the samples of *B. angustifolia* in the wood collection are in sound condition. One sample of *B. lancifolia* is attacked by pin-hole borers. Some observations made on *B. arborescens* of the Philippines showed that heartwood is susceptible and sapwood is very susceptible to drywood termites and powder-post beetles.

In *B. lancifolia* a common decay fungus *Daedalea florida* and *Fomes melanoporus* causing white rot have been recorded.

Working qualities—*B. angustifolia* and *B. latifolia* are easy to saw, though somewhat rough and fibrous, and can be cut into moderately good planks. They are easily worked by hand tools and can be brought to a moderate finish. *B. lancifolia* is comparatively finer in texture and has a smooth surface. It also shows a silver grain effect on the radial surface. The wood is reported to stain clothes unless polished. Reyes reports that *B. arborescens* of Philippines works easily and takes a beautiful finish but according to Howard, *Buchanania* spp. from Borneo "produces a very rough surface under the tool : a wood generally possessing no characteristics to qualify it for commercial uses".

Supply and uses—*B. angustifolia* being a scattered tree is available in small quantities in the southern zone. *B. latifolia* is more common and is found both in the sal and dry forests of the Uttar Pradesh from which fairly large supplies are available. Good supplies of logs are also available from Madhya Pradesh, Andhra, Mysore and Madras, Bombay and Kerala.

The timbers are not much in use except for cheap boxes, packing cases and cratings. They are suitable for temporary construction, house building, cheap and light furniture. The timbers are also used for making toys and wooden articles like spoons, plates and other domestic utensils. *B. latifolia* is reported to be satisfactory for manufacture of matches particularly splints(64) but the Western India Match Co. Ltd., have found it unsuitable for the purpose. Locally, the timber is used for fuel and charcoal making. Krishna and Ramaswami give the calorific value of wood of *B. latifolia* to be 4,546 calories for sapwood and 4,612 calories for heartwood.

Material—

B. angustifolia – 5490 East Cuddapah, Andhra Pradesh (0·63), 5671 Madras (0·62), 6071 South Cuddapah, Andhra Pradesh (0·64).

B. lancifolia – 6354 Burma (0·50), 6361 Burma (0·66), 7128 Burma (0·61).

B. latifolia – 1124 Ahiri Reserve, Bombay (0·52), 1249 Gumsur, Orissa (0·49), 3531 Khurda forests, Orissa (0·57), 4425 – (0·49), 5300 Dehra Dun, Uttar Pradesh (0·47), 5880 Raipur, Madhya Pradesh (0·47), 6548 Burma (0·54), 7895 Porahat Divn., Bihar (0·57), 7896 Porahat Divn., Bihar (0·53), 7897 Porahat Divn., Bihar (0·59), 7898 Porahat Divn., Bihar (0·43), 7899 Porahat Divn., Bihar (0·55).

4. DRACONTOMELUM Bl.

A small genus of trees scattered throughout South-East Asia, from the Andaman Islands and Burma in the west to the Philippines in the north and the Fiji Islands in the south. *D. mangiferum* Bl., which is the only species growing in the Indian region is described here.

D. mangiferum Bl.—*Chinyok, ngabauk, payakoson, tawthitcha* (Burm.), is a tall handsome and conspicuous evergreen tree, 15–30 m. high and 1·5–3 m. in girth. *Bark* brownish-grey, inside reddish.

The tree is rather common especially in damp places along the streams in the Andaman and Nicobar Islands. In Burma, it is found in Myitkyiana, Katha and Mergui. It also occurs in the Malay Peninsula where it is called *sengkuang*. The fruit of this tree is like that of *Garuga pinnata* and is edible.

Description of the wood

[Pl. **59**, 350]

General properties—Sapwood and heartwood not distinct in the material examined ; wood dirty grey with pinkish or yellowish cast turning light brown with age, often discoloured due to fungal stain. Reyes, however, mentions that *D. dao* (Blanco) Merr. & Rolfe of the Philippine Islands has distinct

heartwood. Wood, rather lustrous, moderately hard to hard ; moderately heavy to heavy (sp. gr. 0·55–0·78 air-dry) ; straight to interlocked-grained ; rather coarse and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* absent or faintly marked by dark coloured bands of dense fibres, rather unevenly spaced, 3–9 per cm. *Vessels* large to small, distinct to just visible to the eye, very few to moderately few (1–10 per mm.^{2}), rather evenly distributed, usually solitary, or in radial multiples of 2–4, rarely more or in clusters, mostly round in outline, often filled with tyloses ; vessel lines rather conspicuous on the longitudinal surfaces. *Parenchyma* scanty, vasicentric to slightly aliform, visible only under hand lens ; occasionally also in narrow tangential bands, which are very irregular in distribution, and may be traumatic in origin. *Rays* brownish in colour, apparently of two sizes – moderately broad and fine, the former clearly visible or just visible to the eye, rather widely spaced ; finer ones visible only under lens interspersed between the broader ones which frequently bend round the vessels. *Gum canals* vertical, of traumatic type, occasionally present.

Strength—The timber is moderately hard and strong. It has not been tested so far at the Forest Research Institute, Dehra Dun. The strength figures based on four tests of the Philippine species, *D. dao* have been given by Garratt as follows :—

Moisture content	42 per cent
Specific gravity (at test)	0·84
Specific gravity (oven-dry, based on volume at test)	0·59
Fibre stress at elastic limit	5,330 lb. per sq. in.
Modulus of rupture	8,880 lb. per sq. in.
Longitudinal shear	320 lb. per sq. in.
Work to elastic limit	0·92 in.—lb. per cu. in.
Work to maximum load	7·18 in.—lb. per cu. in.

However, the wood of *D. mangiferum* growing in the Indian region appears to be comparatively lighter in weight and softer than that of Philippine *D. dao*.

Seasoning—No data are available for this species. According to Reyes, large-sized timbers of the Philippine *D. dao* are liable to produce checks when exposed to the sun while *D. edule* seasons well. He also gives shrinkage figures for *D. dao* as follows :—

Radial		Tangential		Longitudinal		Volumetric	
Green to Air-dry %	Air-dry to Oven-dry %	Green to Air-dry %	Air-dry to Oven-dry %	Green to Air-dry %	Air-dry to Oven-dry %	Green to Air-dry %	Air-dry to Oven-dry %
1·7	2·3	4·7	4·0	0·1	0·1	6·4	6·3

Natural durability—The timber does not appear to be very durable especially under exposed conditions. Philippine *D. dao* which has been tested has been found to be moderately durable in contact with the ground, and very durable for interior work.

Insect and fungus attack—Specimens in the Forest Research Institute wood collection are free from insect attack except one sample which shows some damage due to borers. The wood is, however, liable to develop sap-stain very quickly, which sometimes spoils the appearance of the timber. The heartwood of Philippine dao (*D. dao*) is reported to be resistant and the sapwood susceptibe to dry-wood termite and powder-post beetles.

Working qualities—The timber is not very difficult to work, and some specimens finish to a fairly smooth surface. However, Desch mentions that due to the interlocking of the grain and presence of silica, trouble may be experienced while working.

Supply and uses—The tree is common in all localities of the Andaman Islands. The timber is not known in commerce and at present not much used except locally. However, in anatomical structure it shows similarity to mango (*Mangifera indica*) and is likely to be suitable for purposes for which mango is used. Desch states that species of *Dracontomelum* with dark coloured heartwood are of value for ornamental work, furniture, etc., but not the sapwood. In the Malay Peninsula, *D. mangiferum* is reported to be used for house building. It is also said to be good for match splints but not for boxes. In the Philippines, wood of *D. dao* is used for variety of purposes such as furniture and cabinet work, veneer and plywood, and gun stocks. The buttresses have been used for making solid cart-wheels, wash bowls and table tops. The treated timber is used for house construction, flooring, and interior fittings. This timber is exported to the United States for furniture making. It is also stained to resemble mahogany and walnut.

Material—

6405 Andamans (0·55), 6487 Burma (0·78), 7825 Andamans (0·64).

5. DRIMYCARPUS HOOK. f.

It is a monotypic genus.

D. racemosus Hook. f.—*Amdah, am-selenga, amsia* (Assm.), *telsur* (Beng.), *taungthitsi, thitsibo* (Burm.), *babari, bolthekachu, khati* (Garo), *diengborrah, dieng-kani* (Kh.), *brong, brong-kung* (Lep.), *bombal* (Lush.), *kagi* (Nep.), *anjour* (Sylh.), *dieng-kabra, dieng-soh-rany* (Synt.). A medium-sized evergreen tree, usually 12–15 m. high and 60–90 cm. in girth, but, trees 24 m. in height have been recorded from Assam. *Bark* corky, smooth, greyish-yellow outside and reddish-brown inside.

It is found in the eastern Himalayas in Sikkim and Bhutan from 600–1,800 m., throughout Assam up to 1,200 m. and Sylhet and Chittagong in East Pakistan and Pegu Yoma in Burma. It also occurs in the Middle and South Andamans in evergreen hills. The tree has got some similarity with *Semecarpus* and may sometimes be mistaken for it in the field.

Description of the wood

[Pl. 59, 351]

General properties—Wood grey-yellow turning yellow-brown on exposure, often discoloured due to fungus stain ; moderately hard ; rather lustrous when first exposed ; moderately heavy (sp. gr. 0·61–0·72 air-dry) ; straight to slightly interlocked-grained ; medium to somewhat fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* very faint, demarcated by narrow layers of dark coloured fibres, 1–5 per cm. *Pores* moderately large to small, fairly distinct to just visible to the eye, few to moderately few (3–8 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–4 (mostly 2), rarely in small clusters, roundish to oval, open or partially filled with tyloses ; vessel lines rather distinct but fine. *Parenchyma* pale brown, clearly visible under lens when moistened, vasicentric to aliform with fine lateral extensions across the rays ; rarely also in fairly long tangential lines due to the joining up of similar extensions from other vessels. *Rays* fine, brownish in colour, apparently of two sizes – the broader ones just visible to the eye often curving round the vessels, rather unequally spaced ; fine rays visible in between the broader ones under lens ; ray-flecks present but not prominent.

Seasoning—No recent data are available. However, Sweet who carried out some experiments between 1918–21 has reported as follows :—

> "From data at hand, it appears that this species is subject to considerable damage by surface cracking and splitting and was depreciated to a limited extent by borers ".
>
> "Seasoning in the log minimized the surface cracking and gave the best general results in spite of some damage by borers ".
>
> "Water seasoning appears to have given slightly poorer results than green conversion".

Natural durability—No information is available but the timber is not expected to be very durable in outside locations. The samples in Forest Research Institute collection are in good condition except for slight discoloration.

Insect and fungus attack—Newly felled or fallen wood is liable to be attacked by some shot-hole borers (Platypodidae and Scolytidae). Felled or

girdled trees are attacked by Cerambycidae and Lamiidae (Longicorn borers) and *Xyleborinae* (pin-hole borers) and sapwood borers. The timber is susceptible to sap-stain rather easily.

Working qualities—It is rather hard and works up to a fairly smooth surface. It polishes well without absorbing much polish.

Uses—In Chittagong, the wood is mostly used for boats, especially for dug-outs and for the keels of boats and oars. It is said to resist the action of salt and brackish water. Its other uses are for planking, house building, cheap furniture and well construction.

Material—

6724 Botanical Garden, Calcutta (0·61), 6778 Sylhet, East Pakistan (0·72).

6. GLUTA LINN.

The genus consists of about 8–10 species, mainly Indo-Malayan in origin. They are small to very large evergreen trees with acrid, resinous juice. *G. renghas* Linn. yields a latex which is made into black lacquer. It is also poisonous and causes severe skin irritation.

The present and past distribution of this genus is very interesting. At present *Gluta* is mainly confined to Burma, Thailand, Malay Peninsula, Indo-China and as far north-east as Hainan Island. But two species are found to occur isolated from the present home of this genus – one, *G. turtur* March. in Madagascar and the other, *G. travancorica* Bedd. in Travancore in the extreme south-west coast of India. Recent researches on fossil woods carried out by Chowdhury(13, 14, 16) have indicated that the genus had a much wider distribution in the Middle Tertiary Period. It has been found that *Gluta* was growing in the Miocene Period in an area starting from east of Raniganj coalfields on the west up to Indo-China on the east indicating that the centre of distribution has shifted by about 1,000 miles towards the south-east.

Three species are reported to grow in India and Burma, of which two, one from India and the other from Burma are dealt with here. *G. elegans* Kurz, var. *helferi* Hook. f. which is a small evergreen tree of the sea coast of Tennaserim was not available for study. Another species from Burma received under the name *G. coarctata* Hook. f. (*G. velutina* Bl.) was also available, for study. The wood (specimen No. 6839) of this species differs considerably from *G. tavoyana* and *G. travancorica* in physical properties. Heartwood is indistinct in the specimen. The colour is light brown, rather lustrous, streaked at places due to discolouration by fungus. It is soft, light (sp. gr. 0·39 air-dry), straight to somewhat interlocked-grained and medium-fine-textured. But in anatomical structure, the timber resembles closely the other two species described here.

Horizontal gum canals present in the rays are also sometimes visible under hand lens on the tangential surfaces.

The two species described below are very similar and are indistinguishable.

1. **G. tavoyana** Hook. f.—**Gluta.** *Chay, thayet-thitsi, thoomay* (Burm.). A small to large evergreen tree attaining 15 m. in height, and up to 2 m. in girth, with a clear bole of 3·5–6 m. The tree is found in the coastal forests of Tenasserim, Tavoy and Mergui. The name *thayet-thitsi* is applied both to *Gluta tavoyana* and *Melanorrhoea glabra* and is, therefore, liable to be confused in the trade.

Description of the wood—See below.

2. **G. travancorica** Bedd.—**Gluta.** *Devadari* (Kan.), *chenkurunchi, thodappei* (Mal.), *senkurunji, shenchanthanam, shenkararu, shenkuram, shenkuranthi, shenkurani, shenkuravi* (Tam.). A very large evergreen tree. It attains a height of 36 m. and a girth up to 4·5 m. though usually about 2 m. in girth. *Bark* smooth, pinkish-grey, about 1 cm. thick.

The tree is confined to the evergreen forests, ascending to 1,200 m. in Kerala and also in the Tinnevelly district of Madras, where it is reported to be fairly common.

Description of the wood—See below.

Description of the wood

(*Gluta tavoyana* and *G. travancorica*)

[Pl. **59**, 352–353]

General properties—Sapwood sharply differentiated from the heartwood, usually narrow in large trees, pale grey with pinkish or yellowish tinge, often showing brownish streaks due to parenchyma bands, somewhat lustrous ; heartwood bright red or reddish-brown turning dark red on exposure, sometimes mottled with dark and pale crimson. Wood hard to very hard ; heavy to very heavy (sp. gr. 0·75–1·15 air-dry), with a smooth feel ; usually interlocked-grained often showing ribbon-grain effect on the longitudinal surfaces ; rather fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct, but often fine tangential bands of parenchyma and zone of thicker walled fibrous tissue may give the impression of growth rings. *Vessels* moderately large to large, visible to the naked eye, very few to moderately few (1–6 per mm.^{2}), rather evenly distributed, predominantly solitary, sometimes in radial multiples of 2–3, round to oval in outline, frequently plugged with brownish tyloses ; vessel lines conspicuous on the longitudinal surfaces. *Parenchyma* fairly

abundant, brownish in colour ; (*a*) apotracheal, visible to the eye in fine, long tangential bands giving the impression of growth marks and also in short interrupted lines, both sometimes very unevenly spaced ; (*b*) paratracheal, inconspicuous under hand lens as thin layers round the vessels. *Rays* usually indistinct to the eye, brownish in colour, fine to very fine and closely spaced ; occasionally moderately broad rays (containing gum duct) present at irregular intervals. *Gum ducts* horizontal, present in the rays and occasionally visible as black dots on the tangential surface in the sapwood ; vertical canals of traumatic type in long tangential rows have been observed in some samples.

Strength—The timbers are very hard and strong but somewhat brittle. Only *G. travancorica* has been tested for strength at the Forest Research Institute, Dehra Dun. The strength figures given in appendix I, may serve for both due to their similarity in structure.

Seasoning—*G. travancorica* is liable to certain amount of surface cracking and warping. Heavy degrade was noticed on account of development of original shakes in the planks experimented at the Wood Seasoning Branch of this Institute. To get the best results it is recommended that the material damaged by original shakes should be cut out in green condition and the sound material stacked under cover well protected against rapid drying. *G. tavoyana* is reported to season well, but as the sapwood is subject to the attack of pinhole borers, kiln-seasoning from a green state is recommended.

Natural durability—Both the timbers are durable to very durable. The 'graveyard' tests carried out at Dehra Dun gave the following results. Average life of untreated log of *G. tavoyana* (heartwood) is 300 months, with a minimum of 238 months and maximum of 335 months. Average life of untreated log of *G. travancorica* from Madras is 127 months (heartwood), with a minimum of 24 months and maximum 287 months. Both the timbers do not require treatment.

Insect and fungus attack—The sapwood is liable to be attacked by pinhole borers. Early conversion or storage in water is recommended to avoid damage of the logs. The timber is resistant to decay particularly the heartwood.

Working qualities—The timber often offers difficulty in sawing particularly when dry. It can, however, be brought to a fine finish and also takes excellent polish. It gives no trouble at joints if the timber is properly seasoned. As it works well with hand tools, the timber lends itself to turnery and carving.

Supply and uses—*G. travancorica* is available in limited quantities from Kerala and Madras States. A fair quantity of *G. tavoyana* is available from Burma. Though the timber is fine and handsome, its use has unfortunately been restricted due to the difficulty in extraction. For furniture, cabinet work, panelling, decorative interior joinery, and floor blocks the timber is excellent

due to its attractive appearance and good working qualities. It is also used for constructional purposes where hardness, weight and durability are the main criteria. For turnery articles, carving and inlay work, the wood is likely to be of value. It is said that when the wood is steeped in ferruginous mud it turns jet black, looking like ebony.

Material—

G. tavoyana – 4844 Tenasserim, Burma (0·78), 5148 Burma (1·15), 6030 Tenasserim, Burma (0·88), 6390 Burma (0·75).

G. travancorica – 1065 Tinnevelly, Madras (0·71), 3155 Tinnevelly, Madras (0·77), 4540 Travancore (0·90), 5816 Kanukatty, Madras (0·94), 7440 Tinnevelly, Madras (0·76).

7. HOLIGARNA HAM.

A small genus of large trees confined to the Indo-Malayan region. Most of the species have acrid juice which causes blisters. The juice of several species notably *H. arnottiana* is used as varnish and also for lacquer work. Nine species are reported to occur in India and Burma, of which five are dealt with here. Amongst the remaining species *H. ferruginea* March. is a large evergreen tree of Western Ghats in South Kanara and Coorg in Mysore and Anamalais in Madras ; *H. nigra* Bourd. also is a large evergreen tree of Travancore growing from 600–1,200 m. elevation, and produces a greyish-white, soft, wood ; while *H. albicans* Hook. f. and *H. kurzii* King are trees of Burma.

The woods of the five species described here are practically similar in all respects and are not distinguishable from one another.

1. **H. arnottiana** Hook. f.—*Holageru, holigar, hoolgeri, kadugeru, kagira, kalageri, kutigheri, kuttegeru* (Kan.), *chera, cheru, kattu-chera, naicheru* (Mal.), *holgeri, sudrabilo* (Mar.), *karunkarai, karunjarai, kattuchrai, kattu cheru, kattu-cherum* (Tam.). A large, straight, evergreen tree attaining a height of 18 m. and girth of about 2 m., occasionally up to 3 m. with a clear bole of 6–9 m. *Bark* ash coloured, rather smooth, about 1 cm. thick. All parts of the tree particularly bark, branches and fruit-rind exude a black caustic juice which causes blisters. For this reason the tree is not liked by the wood cutters. The juice is used as a varnish and also for water-proofing boats and indelibly marking linen and cloth. It has also use in the lacquer industry.

The tree occurs in the Western Ghats from Konkan southwards in Mysore, Kerala and Madras.

Description of the wood—See page 283.

2. **H. beddomei** Hook. f.—*Pal vidinyan* (Tam.). A large tree, 24 m. high and 60 cm. in diameter. *Bark* smooth, 4 mm. thick and exudes a black juice.

It is found in the hills of Malabar and Travancore in Kerala and Nilgiris and Anamalais in Madras up to 900 m. elevation.

Description of the wood—See below.

3. **H. grahamii** Hook. f.—*Cera, valiyaccera* (Mal.), *balwuli, bipte* (Mar.). An evergreen tree above 9 m. high but according to Talbot, may sometimes reach up to 30 m. in height. *Bark* smooth, thin, covered with scattered, raised, lenticular, corky cells ; inner bark reddish, hard, often fibrous.

The tree is found in the Western Ghats, in the hills of Mysore and Wynaad in Kerala.

Description of the wood—See below.

4. **H. helferi** Hook. f.—An evergreen tree, 9–15 m. high and 1–1·5 m. in girth with 4·5–9 m. clear bole. It is found in Martaban and Tenasserim in Burma.

Description of the wood—See below.

5. **H. longifolia** Roxb. [**H. caustica** (Dennst.) Oken]—*Barola* (Beng.), *she-che, thawka* (Burm.), *bonsu-buphang* (Kach.), *hlang-phalau* (Kuki), *katebel* (Lush.), *kherai* (Manip.), *jhawa* (Sylh.), *phol-hoi, pholoi-kung* (Tipp.). A large tree up to 30 m. in height and buttressed at the base. *Bark* ash coloured and exudes a caustic milky juice which turns black after exposure.

The tree is fairly common in the evergreen forests of Cachar in Assam, and south-eastern part of Sylhet and Chittagong Hill Tracts in East Pakistan. It is also found in Lower Burma.

Description of the wood—See below.

Description of the wood

(*Holigarna arnottiana, H. beddomei, H. grahamii, H. helferi* and *H. longifolia*)

[Pl. **59**, 354 ; **60**, 355–356]

General properties—No colour distinction between heartwood and sapwood. Wood dirty white to greyish-brown often with a yellowish cast, turning yellowish-brown with age, easily discoloured by fungus stain ; when fresh somewhat lustrous ; soft ; light (sp. gr. 0·36–0·50 air-dry) ; straight-grained and rather coarse-textured.

Gross structure—A diffuse-porous wood. *Growth rings* usually absent or faintly demarcated by dark coloured fibrous bands as in *D. grahamii*. *Vessels* large to small, easily visible to just visible to the eye, very few to moderately few (1–8 per mm.^{2}), rather evenly distributed, solitary or in radial multiples of 2–3 or more, occasionally in clusters, round to oval, open or plugged with

tyloses , vessel lines conspicuous. *Parenchyma* indistinct to just visible to the eye, distinct under lens, rather scanty as a thin sheath round the vessels, sometimes with wing-like extensions as in *H. longifolia*, occasionally also joining up similar extension from neighbouring vessels forming a thin tangential line. *Rays* brownish in colour apparently of two sizes – comparatively larger ones just visible to the eye, rather irregularly spaced, and the finer ones indistinct to the eye, closely spaced. *Pith flecks* occasionally present.

Strength—The timbers have so far not been tested at Dehra Dun. Pearson and Brown quoting Kann give the following strength figures for *H. arnottiana* :

TRANSVERSE STRENGTH

Weight, lb. per c. ft., air-dried	Breaking strength, in lb. per sq. in.	Modulus of elasticity or Young's modulus	Crushing strength parallel to grain in lb. per sq. in.
42	11,000	1,749,000	9,005

The value of P (coefficient of transverse strength) for *H. nigra* and *H. beddomei* has been given by Bourdillon as 418 and 308 respectively, the weight for both as 31 lb. per cu. ft.

Seasoning—*Holigarna arnottiana* is easy to season. But it is liable to develop stains and should not be left long in log form. Immediate conversion after felling and open stacking under cover will give best results.

Natural durability—The timbers of the genus *Holigarna* are not durable especially in exposed conditions. They are very easily attacked by insect and fungus and deteriorate rapidly. They are, however, moderately durable in inside locations and also in contact with water.

Insect and fungus attack—Deadwood of *H. arnottiana* is attacked by some species of Buprestidae and Cerambycidae ; drywood and converted timber are attacked by *Lyctus africans* Lesne (Lyctidae), while newly felled or fallen wood is attacked by shot-hole borers (Scolytidae). Drywood of *H. longifolia* is attacked by *Stromatium barbatum* Fabricius (Cerambycidae). The timbers are sometimes extremely liable to sap-stain and wood-rotting fungi.

Preservative treatment—*H. arnottiana* is reported to be easily treatable with creosote, complete penetration being obtained. Other species may be expected to behave in a similar way.

Working qualities—The timber offers no difficulty in working and sawing and can be finished to a fairly smooth surface. Some specimens which are free from fungus attack produce a pleasant silver grain figure on the quarter sawn planks. On account of straight-grain, the timbers are suitable for peeling.

Supply and uses—The timber is available in large quantities from forests of the Western Ghats in Mysore, Kerala and Madras States.

The timber is mainly suitable for light packing cases, cratings, boxes and similar purposes. It is also useful for both match splints and boxes, plywood and cheap grade pencils. However, the use of this timber is subject to its being protected from insect and fungus attack to which it is highly susceptible. It is reported to be used in the West Coast for boats and dug-outs(60).

Material—

H. arnottiana – 4676 Travancore (0·39), 6321 Coorg, Mysore (0·36).

H. beddomei – 4603 Travancore (0·48), 4715 Travancore (0·40).

H. grahamii – 7537 Kanara, Mysore (0·50).

H. helferi – 3287 Chittagong, East Pakistan (0·38), 7169 Burma (0·50).

H. longifolia – 6305 Burma (0·39), 6729 Sylhet, East Pakistan (0·42).

8. LANNEA A. RICH.

The genus consists of about 15 species of small to large deciduous trees distributed in tropical Africa and Asia. The only species found in the Indian region is *Lannea grandis* Engl. which is described here.

L. grandis Engl. [**L. coromandelica** (Houtt.) Merr.]—**Jhingan.** *Jia, kuhimala, ruhimala* (Asm.), *bhadi, bohar, ghadi, jia, jial, jiga, jiol, jir, jival, jiyal, lohar, lokar bhadi* (Beng.), *dowkagia* (Bhum.), *mai-kham, nabe, nahi* (Burm.), *adaliapoma, madabai, mandamai* (Cach.), *kalmina, kanman* (Garh.), *bol-agru, bol-chigamba, dumedome* (Garo), *dupri, gharri, gumpri, guprimarra, kaikra* (Gon.), *mavedi, modhal, monia* (Guj.), *ginyan, jhingan, kaimil, kamlai, kashmala, kimul, mayini, mohi, mohin, mowai, mowen, moyna* (Hind.), *dumpili, geru, godan, godda, goddel, gojal, gugul, punil, shimti, udi* (Kan.), *latang* (Kach.), *dieng-khiang, dieng-pasoh-pier, dieng-soh-knurnot, dieng-sur, dieng-tang-leng, dieng-thang, soh-lapeit-synrang* (Kh.), *dhoka, doka, nanam* (Kol.), *annakara, anakkariyan, kalasan, kalayam, kariyan, udi, uthi* (Mal.), *Maja, mewa, moee, moja, mohi, mohwai, moi, moyal, moyee, moyini, shimbat, shimti* (Mar.), *tiji-arong* (Mik.), *emu, gangadimohi, gongoromohi, indramai, mohi, moi, mooi, sorupotri* (Or.), *bara dabdabbi, jeol, halloray, hulurhe* (Nep.), *kembel, kamlai* (Punj.),

jingni (Sans.), *dhoka* (Sant.), *hik* (Sinh.), *anaikarai, kakaushil, odia, odiya-maram, udi, udia urisa, uthi, wodier, wude* (Tam.), *dumper, dumperti, dumpidi, dumpini, dumpri, gumpan, gumpani, gumpena, gumpina, gumpini, gumpna, odai manu* (Tel.), *toi-sing-taite* (Tipp.). A moderate to large-sized deciduous tree with a straight trunk, usually 12–18 m. high and 1·5–3·5 m. in girth. On poor sites the size may be only 1–1·5 m. in girth with a 3–4·5 m. long bole. In moister parts of Western Ghats, sub-Himalayan tract, Assam and the Andamans, trees having straight, clean bole of 12 m. in length and 2·5–3 m. in girth are fairly common. *Bark* 13 mm. thick, grey or greyish-black, smooth or slightly wrinkled when young, becoming rough and fissured with age, exfoliating in thin round or irregular plates, exposing a greyish or pinkish-white surface, streaked with irregular white or pink marks, mucilaginous inside.

A coarse fibre suitable only for poor quality ropes is obtained from the bark. The tree is reported to be tapped for gum in Saharanpur Siwaliks by making short, shallow cuts all over the bark. The gum is yellowish-brown, clear and brittle and has many local uses, such as, for sizing cloth and paper, adhesives for mixing with lime for white washing and plastering and as a preservative for fishing net in Burma. The bark is also used in medicine for eruptions and ulcers, while tooth powder made from it is a remedy for tooth-ache.

The tree has a very wide distribution in India and is found in the dry forests of all states except parts of the Punjab, Rajasthan and Saurashtra. It is found in the sub-Himalayan tract and the lower Himalayas from the Indus eastwards ascending to 1,200 m. common in Siwaliks, Dun and Saharanpur forests ; also throughout the area of Pilibhit, Oudh, Gorakhpur and Bundelkhand of Uttar Pradesh ; but not so common in Bengal and Assam, and scattered in Bihar and Orissa. It is also common in Khandesh and Deccan forests, where it is associated with *Boswellia serrata, Anogeissus latifolia* and other fire-resisting species ; very common in Travancore and in the deciduous forests of Mysore and Madras. In the Andamans the tree grows frequently in damp places along streams. It occurs also in Burma and Ceylon. It is a tree which is frequently planted.

Description of the wood

[Pl. **60**, 357]

General properties—Sapwood and heartwood distinct ; sapwood very wide, white or pale yellowish-grey when first exposed, turning dirty grey or light brownish-grey, sometimes with a purplish cast, often discoloured by sap-stain ; heartwood small, reddish-brown turning dark red or brownish-red with age, rather lustrous when fresh ; moderately hard ; moderately heavy (sp. gr. 0·49–0·73 air-dry) ; straight to interlocked-grained ; medium and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* wanting or very faint, visible only to the naked eye, demarcated by darker bands of fibres. *Vessels* moderately large to small, usually visible to the eye but more distinct in the sapwood than in the heartwood, moderately few to moderately numerous (6-16 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2-3, roundish to oval, open in sapwood but heavily plugged with tyloses in the heartwood; vessel lines rather inconspicuous. *Parenchyma* very scanty in the vicinity of the vessels and indistinct even under hand lens. *Rays* brownish to reddish in colour, usually fine but a few moderately broad, just visible to the naked eye, rather evenly distributed and fairly closely spaced. *Gum canals* horizontal, present in the rays, very small, but sometimes visible under hand lens as darkish dots.

Strength—The wood is fairly strong and moderately hard. There is considerable variation in the weight of this wood given by various workers. This may probably be due to the differences between the weight of heartwood and sapwood which have not been specifically mentioned. Jhingan tested at Dehra Dun did not prove to be very strong. But from the specimens examined in the wood collection, it appears that timber tested for strength is on the lighter side. For strength figures see appendix I.

Seasoning—It is a difficult timber to season, particularly due to distinctly different behaviour of the heartwood and sapwood. Experiments carried out at Dehra Dun have revealed that the heartwood takes longer time to season than any other Indian timber tested so far. This may probably be due to the heavy development of tyloses completely plugging the vessels and also on account of copious gummy and other deposits filling up the cells. Sapwood, however, dries out quickly but is extremely liable to decay and insect attack. The logs should be converted green, the sapwood being allowed to dry rapidly in a free circulation of air. Heartwood planks should be stacked for slow seasoning in a well protected place and should be given end coating to reduce splitting. For heartwood, nothing has so far been possible to hasten the rate of seasoning. Kiln-seasoning is also not satisfactory as it takes long time and the timber also shrinks. Girdling and seasoning in the log reduce the surface cracking and twisting of the heartwood, but result in almost total destruction of the sapwood.

Natural durability—The sapwood is not durable. It perishes very rapidly in outside locations from fungus and insect attack, especially if not well seasoned. Under cover it is moderately durable and is durable in contact with water. According to Cox, the heartwood is durable and is said to last 15-20 years. The 'graveyard' tests carried out at Dehra Dun, however, do not support this as none of the samples (heartwood) tested survived more than 13 months.

Insect and fungus attack—Drywood and converted timber are attacked by Anobiidae, Bostrychidae and Lyctidae (*ghoon* borers); deadwood is attacked by some species of Anthribidae, Curculionidae and one species of Lymexylonidae. Newly felled or fallen wood and dying trees are attacked by some shot-hole borers (Xyleborinae). The wood like that of sal, is frequently attacked by the Cerambycid beetle, *Plocederus obesus* Daporet.

Polystictus leoninus a fungus commonly found in the wet zones of North India as well as the dry forests of Madhya Pradesh grows commonly saprophytically on *Lannea grandis.*

Preservative treatment—The heartwood is very refractory to treatment due to heavy tyloses, gum and other deposits. The penetration of preservative is practically nil either from side or end. However, the sapwood is easily treatable. The very wide sapwood which is considered otherwise valueless due to its poor durability can be profitably utilized for many purposes after proper treatment.

Working qualities—Ordinarily the timber does not give any trouble in sawing and working, but the presence of heavy gummy deposits in the heartwood may sometimes cause trouble in conversion due to the edges of the saws being gummed up. The timber can be finished to a smooth surface by hand tools and also turns well. Care should, however, be taken in planing badly interlocked planks as the fibres are liable to tear up. The heartwood takes a beautiful polish but not the sapwood, as it absorbs considerable amount of polish even when a grain filler is used. It peels well, and makes cheap plywood.

Supply and uses—The total annual supply of this timber is considerable. It is available in almost every part of India. Large supplies are available from the central and southern zones particularly from some divisions of Madhya Pradesh, and East Khandesh, Panch Mahals and East and West Kanara Divisions. Good supplies are also available from eastern and northern zones.

Heartwood, which is superior to sapwood in appearance and durability, is usually very small except in favourable localities. The heartwood is used for posts, sugarcane presses, rice pounders, carving and turnery articles like combs, bowls, and wooden jars, furniture, cabinet work, rollers in jute mills, pencil making and pen holders. Sapwood is used for light packing cases, toys, small turnery and carved articles, wooden utensils, brush backs, boot trees, cheap quality matches, dug-outs, and parts of boats. The timber is used for veneers and plywood and is also suitable for paper making. If properly treated, it can be used for light constructional purposes. During the last war the timber was in demand for ammunition transit boxes and crates and cheap grade commercial plywood.

Material—

202 Mandla, Madhya Pradesh (0·59), 226 Garhwal, Uttar Pradesh (0·60), 447 Ajmere, Rajasthan (0·59), 516 Andamans (0·73), 661 Darjeeling, West Bengal (0·69), 1103 Ahiri Reserve, Bombay (0·49), 1414 Tharrawaddy, Burma (0·61), 1965 Chittagong, East Pakistan (0·72), 2342 Darjeeling, West Bengal (0·72), 2517 Burma (0·57), 2992 Garhwal, Uttar Pradesh (0·67), 3529 Khurda Forest, Orissa (0·78), 5306 Dehra Dun, Uttar Pradesh (0·49), 6076 Dehra Dun, Uttar Pradesh (0·69), 6311 Burma (0·41), 6482 Burma (0·51).

9. MANGIFERA LINN.

A genus consisting of 41 valid species of large to very large evergreen trees confined mainly to the Indo-Malayan region. The western limit of its distribution is Ceylon and India, the northern limit being the Himalayas, Yunnan (China) and Vietnam. In the east it extends up to Philippines and New Guinea, and in the south to the Sunda and Sulu Archipelago in the Indian Ocean. The world distribution of species according to Mukherjee is given below.

Geographical distribution of the species of Mangifera

India (including Assam, Chittagong and Sikkim)	3	Java	9
Ceylon	2	Borneo	10
Andaman Islands	3	Bali	2
Burma	6	Philippines	8
Siam	9	Celebes	4
Indo-China	10	Moluccas	5
Malay Peninsula	19	Timor	2
China	1	New Guinea	2
Sumatra	11		

The largest number of species and endemics occurs in the Malay Peninsula. *Mangifera indica* L. produces the well known mango fruit and is widely cultivated throughout the tropics. *M. caesia*, *M. foetida*, *M. odorata* and *M. kemanga* are also cultivated for their fruits in Malayasia and the Philippines where *M. indica* does not grow well.

Mukherjee who has made a special study of the genus *Mangifera* is of the opinion that "the genus had its origin somewhere in the Eastern Peninsula (comprising Burma–Siam–Indo-China and Malaya), during the Eocene

or an earlier period in the Cretaceous. The species have then spread to India and Ceylon in the west and to Eastern Malayasia and the Philippines through the Sunda Archipelago. The two main centres of species differentiation are the Assam–Burma–Indo-Chinese region and the Malay Peninsula. Other smaller centres are the Sunda Islands and the Philippines. Further, from the limited variation observed in the pollen grains and in the morphology, anatomy and cytology of the genus, Mukherjee has concluded that since its origin in the early Tertiary period, the characters of the genus have become more or less stabilized.

Flowers of *M. indica* L. and *M. odorata* Griff. are scented. At one time *am attar* used to be prepared from the flowers of *M. indica*. The ripe fruits of *M. fragrans* Maingay and *M. odorata* Griff. have the smell of turpentine.

Eight species grow in India and Burma of which four are dealt with here. The species which were not available for study are : (1) *M. andamanica* King, a small to middle-sized tree, 9–12 m. high and 1–2 m. in girth with pale bark, reported to grow in the Andaman Islands, (2) *M. camptosperma* Pierre – *Sinin-thayet, thayet, thayet-pya* (Burma), a tree 20–30 m. high occurring in Mergui, North Pegu and South Tenasserim in Burma and also in Vietnam and Thailand, (3) *M. foetida* Lour. – *Lamote* (Burm.) a tree 18–24 m. high, cultivated in Tenasserim in Burma. It grows in Malay Peninsula, Indonesia, Thailand and Vietnam, (4) *M. khasiana* Pierre, a tree of Khasi Hills, Assam. Mukherjee considers this to be a possible variety of *M. sylvatica* Roxb. as no further material has been found recently in the type locality.

The timbers of all the four species described here are indistinguishable from each other except *M. longipes* Griff., in which the parenchyma is indistinct even under lens, and which is also characterized by the presence of horizontal gum ducts.

1. **M. caloneura** Kurz—**Mango.** *Sinninthayet, tawthayet* (Burm.). An evergreen tree, 12–18 m. high and 1–2 m. in girth with a clear bole of 4·5–7·5 m. It is frequently found in the low mixed forests of the eastern and southern slopes of the Pegu Yoma and Martaban. It also grows in Thailand.

Description of the wood—See page 292.

2. **M. indica** Linn.—**Mango.** *Ghari am* (Asm.), *am* (Beng.), *krerk, kruk, mak-mong, ma-monton, takau, thayet* (Burm.), *bocho, jegachu, thekachu* (Garo), *marka, marka marra* (Gon.), *amba-nujhada* (Guj.), *am, amba, ambi, amiya, amri* (Hind.), *lamung, ma-mung, sagyaw, shagyaw, thaiguja-baphang, umung* (Kach.), *mavena, mavina mara, mavu, mawu* (Kan.), *dieng-soh-pien, dieng-thlai-nar* (Kh.), *ul, uli* (Kol), *amram, manna, mavu* (Mal.), *amba, ambi* (Mar.), *tharbi-arong* (Mik.), *keidi-asing* (Miri), *ambo, u-da* (Or.), *am, amb* (Punj.), *amra, madhuduta, rasala* (Sans.), *ul, uli* (Sant.), *amba* (Sinh.),

ma, maa, manga, mangas, mamaram (Tam.), *amramu, makaudamu, mamadi, mamid, mavi* (Tel.). A medium to large evergreen tree with a short unbuttressed trunk and spreading crown, 12–18 m. high and 1–2·5 m. in girth with 4·5–9 m. clean bole, sometimes attaining a height of 45 m. *Bark* about 25 mm. thick, brown, blackish or dark grey, rough with many small fissures and exfoliating in scales. The tree exudes a gum-resin when the bark is injured.

It grows throughout India excepting the north-western part, up to 900 m. elevation. According to Mukherjee, *Mangifera indica* had its origin in Assam-Burma zone. It occurs wild in the Himalayas, in the hills of Eastern and Western Ghats, Ceylon, forests of Central India, Orissa, Bihar, Bengal and Assam and extends through Chittagong Hill Tracts in East Pakistan to Burma, Thailand, Vietnam and the Malay Peninsula. It is extensively cultivated throughout the tropics and is now common in many parts of Southern Florida, Brazil, East and West Africa. In India, it is one of the most important fruit trees which is planted on a very large scale all over the country and occupies about 60 per cent of the total area under fruit cultivation.

The tree is intimately connected with the social and religious life of the people of India and has, therefore, a long historical background. Green leaves and flowers are aromatic and are commonly used in religious functions. The wood is an important item in lighting fire in the performance of *hom* or *havan*. Leaves are often used for decorations as well as an emblem of good omen in marriages and other social functions.

Many parts of the tree have medicinal properties, the leaves being used for scorpion-sting, bark for diarrhoea, haemorrhage and uterine troubles, seeds in asthma and kernel for haemorrhage. The ripe fruit is laxative and is also useful in haemorrhage while the unripe ones are useful in ophthalmia and eruptions. Old leaves are reported to contain a poisonous substance which is injurious to cattle when fed in large quantities.

Description of the wood—See page 292.

3. M. longipes Griff.—*Thayet-thee-nee, thayet-thini* (Burm.). An evergreen tree 24 m. or more in height 1–2 m. in girth with a clear bole of 5–10 m.

The tree is found in the fresh water swamp forests of Pegu plains. It also grows in Malay Peninsula, Indonesia and the Philippines.

Description of the wood

[Pl. **60**, 360]

General properties—Sapwood and heartwood indistinct ; wood pinkish-brown to brownish-grey, somewhat lustrous ; moderately hard ; moderately heavy (sp. gr. 0·59 air-dry) ; straight-grained and medium-textured.

Gross structure—A diffuse-porous wood, sometimes showing a tendency towards ring-porousness. *Growth rings* fairly distinct to the eye due to somewhat tangential alignment of vessels and thick-walled fibres, 2–4 per cm. *Vessels* small to moderately large, just visible to easily visible to the eye, moderately numerous (9–16 per mm.^{2}), more or less evenly distributed, but with a tendency towards tangential grouping in the earlywood, solitary or in radial multiples of 2–3, usually round in shape, partially filled with tyloses ; vessel lines distinct, brownish in colour, fairly numerous. *Parenchyma* scanty, vasicentric, usually not distinct under the lens. *Rays* distinct under lens, brownish in colour, closely spaced, apparently of two classes, the finer ones interspersed between the broader ones ; "silver grain" effect noticeable on the radial surface. *Gum canals* horizontal, small, sometimes visible under hand lens on the tangential surface, as dark dots in the rays.

Uses—In properties the timber may be expected to be similar to mango. The wood may be put to use for purposes for which mango is suitable.

Material—5036 Pegu, Burma (0·59).

4. **M. sylvatica** Roxb.—**Mango.** *Bon-am* (Asm.), *kosham* (Beng.), *hseng-neng-thayet*, *mak-mong-sang-yin*, *sinin-thayet*, *taw-thayet* (Burm.), *lakshmi-am* (Cach.), *jungli am* (Hind.), *katur* (Lep.), *chuchi-am* (Nep.), *hai bamin* (Tipp.). A lofty evergreen tree with a dense crown, 30–40 m. high, and 6–8 m. in girth. *Bark* brownish-grey, irregularly cracked, about 5 cm. thick. The inner layers exude a whitish gum.

The tree grows in Nepal, Sikkim and North Bengal and in the Khasi Hills from 300–1,300 m. elevation. It is sporadic in the evergreen forests of Upper Assam, Surma Valley, and Chittagong Hill Tracts in East Pakistan, and rare in the Andaman Islands and Martaban hills of Burma. It is also reported to occur in Thailand and Cambodia.

Description of the wood—See below.

Description of the wood

(*Mangifera caloneura*, *M. indica* and *M. sylvatica*)

[Pl. **60**, 358–359 ; **61**, 361]

General properties—Sapwood not always distinct from heartwood but sometimes a fairly large and distinct brown to dark brown heartwood with light and dark streaks observed in *M. indica*. Wood usually whitish-yellow, greyish-brown to buff in colour, often with a pinkish tinge, frequently discoloured by sap-stain ; soft to moderately hard ; light to moderately heavy (sp. gr. 0·52–0·68 air-dry) ; straight to interlocked-grained occasionally with wavy or curly grain giving rise to beautiful ribbon figure, and quilted

appearance on the longitudinal surfaces ; medium to coarse-textured ; rather lustrous when first exposed.

Gross structure—A diffuse-porous wood. *Growth rings* usually indistinct, but in some specimens long tangential bands of parenchyma at more or less regular intervals give the impression of growth marks. Concentric tracts of gelatinous fibres when present also give the impression of growth rings. *Vessels* large to small, distinct to the eye to just visible, very few to moderately numerous (1–16 per mm.^{2}), more or less evenly distributed, usually solitary or in radial multiples of 2 -3 or more, sometimes also in clusters, round to oval in outline, open or filled with tyloses ; vessel lines prominent on the longitudinal surfaces. *Parenchyma* very variable, abundant to scanty, distinct to inconspicuous to the eye ; (*a*) paratracheal, usually aliform and visible to the eye, sometimes with fine wing-like extensions ; also vasicentric forming thin inconspicuous sheaths round the vessels ; occasionally aliform-confluent in some samples from the West Coast ; (*b*) apotracheal, in thin tangential lines simulating growth marks and also ending abruptly ; often some of these lines are arranged very closely and others wide apart. *Fibres* indistinct under hand lens, but in samples with tension wood, clearly visible to the eye as dark wide bands due to the gelatinous nature of their cell-wall. *Rays* moderately broad to fine, just visible to the eye but distinct under hand lens, brownish in colour, closely spaced, often showing inconspicuous ray-flecks on the radial surfaces ; also visible on plain sawn surfaces as darkish spindle shaped structure under hand lens. *Pith flecks* occasionally present as small lighter coloured patches.

Strength—Mango is a fairly strong wood and in certain properties comes near teak. In weight it is slightly lighter than teak and in shock resistance and shear it is sometimes even better than teak. Strength figures of *M. indica* are given in appendix I. Judging from the anatomical structure, the other two species are likely to have similar strength properties.

Seasoning—So far only *M. indica* has been tested. The timber is not refractory to seasoning and gives no trouble in drying except for slight warping and twisting and sometimes a little cracking of knots. Usually the wood dries out quickly with little degrade but very large-sized planks have a tendency to split down the centre. As it is liable to stain and decay, green conversion followed by careful stacking in a well ventilated place is recommended. For best results, the timber should be cut and converted during the dry weather and seasoned on end (vertical stacking). Kiln-seasoning does not cause any degrade but improves the appearance of the timber. It is a steady wood when seasoned and retains its shape remarkably well.

In some consignments of mango particularly from South India, occurrence of tension wood has been reported by Ghosh and Rao. The extent of gelatinous

fibres varies considerably from tree to tree and in extreme cases is responsible for the development of serious cracks and splits.

Natural durability—It is not a durable timber in exposed positions. The "graveyard" tests carried out at Dehra Dun gave the following results : The average life of the untreated timber (heartwood) is about 25 months, with a minimum of 23 months and maximum of 33 months. However, in inside locations the wood is moderately durable, and it is reported to be very durable when in contact with water.

Insect and fungus attack—Drywood and converted timber of *M. indica* are attacked by Anobidae, Bostrychidae and Lyctidae (*ghoon* borers) ; deadwood is attacked by some species of Bostrychidae (*ghoon* borers), Cerambycidae and Curculionidae and by a few species of Anthribidae, Brenthidae, Buprestidae and Mordellidae ; newly felled or fallen wood and dead or drying trees are attacked by several species of Platypodidae and Scolytidae (shothole borers).

Fomes pachyphaleus has been frequently encountered growing parasitically on living trees, causing a white-rot in the heartwood. *Polystictus leoninus* is common as a saprophyte. *Polyporus gilvus*, a common fungus known both as a parasite and a saprophyte, has been recorded growing saprophytically on mango logs causing a white-rot.

Preservative treatment—It is an easy timber to treat with preservatives. Some experiments conducted in Malaya with *Mangifera* spp. showed that the timber absorbs at least 7 lb. per cu. ft. of creosote-diesel fuel mixture by mild open tank treatment.

Working qualities—Mango is a soft and easy wood to saw and machine, finishing to a moderate surface, and with proper filling takes a good and lasting polish. It peels well and is an important raw material for plywood all over India. The heartwood sometimes produces handsome veneers suitable for high grade cabinet work. According to Pearson & Brown, *M. sylvatica* saws with ease and machines to a smoother surface than *M. indica*. It can also be easily worked with hand tools.

Supply and uses—The timber comes from forests, cultivated areas and also from the roadside trees. It is usually available in limited quantities in almost any district in India, but never in very large quantities in one place, although quantity available from the north, south and eastern zones is fairly large. The timber of *M. sylvatica* is sold mixed with *M. indica* in the market. It is common in several districts of Assam especially in Goalpara and Sibsagar from where fair quantity is available. It is also common in the Darjeeling-Terai forests.

The quality of the timber from different parts of India varies considerably. The best grade of timber perhaps comes from the West Coast forests where the trees usually have long straight boles of good girth. Being a common, easily available and comparatively cheap timber, it is extensively used for a variety of purposes all over India. Its main uses are cheap furniture, lining, backing and shelf boards, floor and ceiling boards, planking, door and window frames, and general carpentry. It is one of the most important timbers used for making plywood for tea chests. The figured stock (curly grained) is suitable for high grade furniture and cabinet work. Other important uses are light and heavy packing cases, ammunition boxes, rifle and tool chests, agricultural implements, foot boards, bottom and frames of carts, hulls of boats, oar blades and dry cooperage. It is suitable for carving and turnery and is largely used for making various types of wooden utensils, particularly for bowls, spoons, and plates and is also suitable for certain type of bobbins. Mango is successfully used for light handles for scooping tools such as spades, shovels, rakes, etc., where lightness is an advantage and the timber is not subjected to severe shocks. During the last World War, mango trees were ruthlessly felled all over the country as it was specified for a variety of articles required by the Ordnance Department. The wood is sometimes also used for match splints and boxes, slate frames, brush backs and many other utility articles. Krishna & Ramaswami have determined the calorific value of mango (sapwood) to be 4,610 calories.

Material—

M. caloneura – 294 Burma (0·68), 2519 Burma (0·52).

M. indica – 637 Goalpara, Assam (0·58), 4901 Saharanpur, Uttar Pradesh (0·64), 6060 Kurseong, Bengal (0·61), 7396 Mangalore, Mysore (0·76), 7443 Nellore, Andhra Pradesh (0·66), 7444 Nellore, Andhra Pradesh (0·57), 7445 Nellore, Andhra Pradesh (0·54), 7446 Nellore, Andhra Pradesh, Madras (0·68), 7447 Nellore, Andhra Pradesh (0·68), 7623 North Kanara, Mysore (0·56), 7900 Saranda, Bihar (0·55), 7901 Saranda, Bihar (0·57), 7902 Saranda, Bihar (0·60), 7903 Saranda, Bihar (0·64), 7904 Saranda, Bihar (0·61).

M. sylvatica – 594 Darjeeling, West Bengal (0·64), 952 Golaghat, Assam (0·56), 5796 Buxa Range, West Bengal (0·58), 6103 Sibsagar, Assam (0·58), 6173 Sibsagar, Assam (0·55).

10. MELANORRHOEA WALL.

The genus consists of 8–10 species of large trees with acrid poisonous juice restricted to Indo-Malayan region. Two species are indigenous to

Burma, one of which, *M. usitata* Wall. extends up to Manipur in India. Both the timbers are very similar in anatomical structure and it is not possible to separate them. Further, the close resemblance of the genus to *Gluta* in both physical and anatomical features also makes their exact identification very difficult. In the Malay Peninsula, timbers of both the genera are sold under the name *rengas*.

The only fossil wood showing affinity to the genus *Melanorrhoea* has been recorded recently by Ghosh from Manipur.

1. **M. glabra** Wall.—**Thitsi.** *Thit-say-pen, thitsi* (Burm.). A middle-sized tree, found in the forests of Tenasserim, Tavoy and Mergui.

Description of the wood—See page 297.

2. **M. usitata** Wall.—**Thitsi.** *Ashadon, ayon, che, gave, hak, kwik, kyoung, lein, maihat, mai-hun, san, si, son, soothan, su, thitsaypen, thitsi, thu, thu-asaw, thu-saw, thutu, tunhat* (Burm.), *hkri, khri* (Kach.), *kheu* (Manip.). A large deciduous tree, 12–18 m. in height and 1·5–2·5 m. in girth with a clear bole of 5–9 m. It sometimes attains a girth of about 3 m., but as a rule trees above 2·5 m. in girth are not common.

The tree yields an oleo-resin which is well known in Burma as *thitsi*. The tapping is done by making two slanting notches to form a V. The notches are 20–25 cm. long and about 5 cm. deep. The apex of the cut points towards the base of the tree where the container (bamboo tube) is attached for the collection of the oleo-resin. The tapping is usually confined to the main bole up to a height of 7·5 m. The tree is tapped throughout the year except from middle of February to middle of June. The maximum yield is often obtained during the period July to October (4). Great care is needed to handle the oleo-resin as it is liable to produce blisters and swellings. The colour of the oleo-resin varies from red to black depending upon the season of collection. The pure black variety which contains the least amount of water is considered superior and fetches the best price. The chief constituent of this oleo-resin is urushic acid and is identified with the Japanese lacquer varnish obtained from *Rhus vernicifera* DC. It is extremely resistant to the actions of strong acids and alkalies. The main use of this oleo-resin is for lacquer work in Burma. In the liquid state, *thitsi* is used as a natural varnish which is said to enhance the durability of timber and also as a protection against white ants. It is used as a protective layer for wooden containers intended for storing water and also for caulking boats.

The tree is found in the drier forests of Burma up to 1,200 m. elevation where the predominant tree is *Dipterocarpus tuberculatus* Roxb. Sometimes it attains its best growth and development in certain forests in which *Pentacme suavis* A. DC. (ingyin) and *Shorea obtusa* (thitya) predominate. However,

at higher elevations, it is generally found in association with oaks and chestnuts. It is reported to be very abundant in some parts of southern Shan States. The extreme western limit of its distribution is Manipur in India.

Description of the wood

(*Melanorrhoea glabra* and *M. usitata*)

[Pl. **61**, 362–363]

General properties—Heartwood and sapwood distinct ; sapwood yellowish to yellow-brown, somewhat lustrous ; heartwood often showing alternating light and dark streaks due to parenchyma bands and gelatinous fibres ; reddish-brown to red or dark red, turning dull with age ; hard to very hard ; moderately heavy to heavy (sp. gr. 0·67–0·93 air-dry) ; straight to interlocked-grained, somewhat coarse and uneven-textured.

Gross structure—A typically diffuse-porous wood. *Growth rings* wanting or uncertain ; some concentric bands of parenchyma at regular to irregular intervals give the impression of growth marks but it is doubtful if they indicate true growth rings. *Vessels* small to large, just visible to easily visible to the eye, very few to moderately few (1–9 per mm.^{2}), rather unevenly distributed, majority solitary or in radial rows of 2–3 or more ; round to oval in outline, heavily tylosed in the heartwood ; vessel lines usually conspicuous as brownish to red lines on the longitudinal surfaces. *Parenchyma* abundant, brownish in colour (*a*) apotracheal in narrow to fairly wide bands visible to the eye, rather irregularly spaced and running more or less concentrically giving the impression of growth marks or ending abruptly ; sometimes a number of such bands may be very close to each other alternating with wide fibrous tracts ; (*b*) paratracheal, inconspicuous as thin sheath round the vessels, occasionally extending side ways. *Fibres* individually indistinct under hand lens, but sometimes wide, dark, concentric bands of gelatinous fibres occurring at irregular intervals indicate the presence of tension wood, which is distinctly visible to the eye. *Rays* mostly fine to very fine, not visible to the eye, closely spaced ; occasionally a few moderately broad rays containing horizontal gum-ducts present at irregular intervals on the end surface. *Gum-ducts*, horizontal, present in the rays and visible as black dots on the tangential surfaces particularly in the sapwood ; traumatic vertical gum-ducts in long tangential rows also occasionally present.

The strength and other properties given below relate to *M. usitata* which has been tested at this Institute. No data are available for *M. glabra* which is softer and lighter than *M. usitata*.

Strength—The timber is hard to very hard and strong, though according to Rodger there is a tendency to break under sudden strain. Strength figures are given in appendix I.

Seasoning —The timber is reported to dry very slowly but the shrinkage is remarkably small and once dried, the shape is well maintained. Pearson and Brown, however, state that the timber should not be left in the log form for long, but be converted immediately after felling with a view to avoiding possible development of cracks and other seasoning defects. From the anatomical point of view, however, the timber is liable to warping due to the presence of tension wood in some logs.

Natural durability—The timber is very durable. "Graveyard" tests carried out at the Forest Research Institute, Dehra Dun, reveal that it is a durable timber of first class ; average life of the untreated heartwood is 311 months with a minimum of 287 months and maximum of 335 months. The timber does not require antiseptic treatment.

Insect and fungus attack—Green standing trees of *M. glabra* and wood fallen on ground are attacked by *Termes parvidens* Holmgren (Termitidae). Drywood and converted timber of *M. usitata* are attacked by *ghoon* borers (Bostrychidae and Lyctidae), and deadwood by some species of Anthribidae, Brenthidae, Cerambycidae and Curculionidae. Newly felled wood is attacked by a few species of Platypodidae and Scolytidae (shot-hole borers). Both sapwood and heartwood of the specimens in the timber collection of this Institute have been found to be free from insect and fungus attack.

Working qualities —It is a difficult timber to saw and work, particularly when it is seasoned. For this reason, the use of the timber is rather restricted. However, sawing in green state is easier. Rodger states "in kiln-drying *thitsi*, timber is apt to get extremely horny and become very hard on cutters and saws." Desch considers that the dulling effect on the tools is due to the presence of silica in the rays. With hand tools, the timber can be brought to a smooth finish and polished excellently. Re-polishing may, however, be necessary due to the oozing out of the black resin from the rays. Though, handling green timber may sometimes cause skin eruptions, this drawback is overcome to a great extent by drying, no harmful effect being produced by seasoned timber after varnishing.

Supply and uses—*M. usitata* is a common tree in many parts of Burma. The finest trees are found in the Katha division where they grow to a great size. The timber is handsome and is suitable for high class furniture, cabinet making and panelling. It is also good for heavy constructional purposes such as beams, scantlings, bridges, house posts and pit props. The wood is suitable for making tool handles, ploughs and small attractive turnery articles.

Material—

M. glabra—6350 Burma (0·67).

M. usitata—551 Moulmein, Burma (0·85), 2518 Burma (0·93), 4491 Burma (0·80), 5566 Burma (0·82), 5765 Burma (0·73).

11. NOTHOPEGIA Bl.

A very small genus distributed in peninsular India and Ceylon. Gamble in his Flora of Madras Presidency has described six species from South India. However, the species described here is the only one represented in the wood collection at Dehra Dun.

N. colebrookiana Bl.—*Ambatti*, *mattigar*, *ulagera* (Kan.), *macheru* (Mal.), *sonemau* (Mar.), *bala* (Sinh.), *sorapalai* (Tam.). A tree with somewhat sharply buttressed stem, up to 21 m. high and 30 cm. in diameter. *Bark* pale greyish-brown, smooth or flaky and thin, exuding an acrid juice which becomes black on drying, and can be used as ink. Lewis reports that this may have been one of the "Secret-Inks" of the ancients. The plum-like fruit is sweet and is eaten.

It occurs in the Eastern Ghats in Andhra Pradesh and southwards at an elevation of 1,200 m. ; on the Western Ghats, it is found from Konkan southwards from 300–1,500 m. It grows also in Ceylon.

Description of the wood

[Pl. **61**, 364]

General properties—Wood white to pale pinkish-yellow, turning light brown on exposure, rather lustrous ; hard to very hard, heavy (sp. gr. 0·86–0·91 air-dry), straight to interlocked-grained ; even and fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* faintly marked, demarcated by thin tangential bands of fibres, 3–9 per cm. *Vessels* very small, not visible to the eye, but distinct under lens, moderately numerous (9–18 per mm.^{2}), evenly distributed, but with a tendency to be aligned in tangential rows, solitary or in radial multiples of 2–3, roundish to oval in outline, open ; vessel lines inconspicuous. *Parenchyma* lighter in colour than the background, visible to the eye, usually confluent as long or short, thick, wavy, tangential lines enclosing the vessels ; sometimes vasicentric to aliform or wing-like with thin short extensions. *Rays* fine to very fine, hardly visible to the eye, pale brown in colour, rather closely spaced ; ray-flecks inconspicuous.

One sample, No. 3860, differs from the above description in having numerous to very numerous vessels (20–40 or more per mm.^{2}) and abundant parenchyma in comparatively thick and occasionally anastomosing bands. The exact identity of this sample which comes from Cuddapah, Andhra Pradesh, therefore, appears to be somewhat doubtful.

The timber is hard, heavy and strong but has not so far been tested for strength and other properties. One of the samples (No. 3860) is badly attacked by borers. The wood though close-grained, is not difficult to work and can be planed to a smooth shiny surface. It is said to be non-durable.

Supply and uses—The supply of timber is rather limited. In Ceylon it is reported to be used for posts, props and scaffoldings, though probably not sawn for structural purposes. The timber is worth trying for the manufacture of small articles like mathematical instruments, rulers, small tool-handles and small turnery articles like pill and tablet boxes, and toys.

Material—

3860 Cuddapah, Andhra Pradesh (0·86), 6055 Madras (0·91).

12. PARISHIA HOOK. F.

A small genus of tall, evergreen trees, distributed from the Andamans and Burma through the Malay Peninsula to the Philippine Islands. The only species found in the Indian region is dealt with here.

P. insignis Hook. f.—**Red dhup**. A lofty deciduous tree, 24–40 m. high and 2·5–3·5 m. in girth with 9–18 m. clear bole. *Bark* grey, peeling off in flakes, and when cut exudes a milky juice.

The tree is fairly common in several localities of the Andaman Islands. In Burma, it occurs in Mergui.

Description of the wood

[Pl. **61**, 365]

General properties—Sapwood usually merges imperceptibly into the heartwood, though occasionally may be well demarcated. Sapwood large, white to pinkish-white turning greyish or greyish-brown with age, often discoloured due to fungal stain ; heartwood light pinkish-grey, ageing to pale brownish-grey with pinkish-tinge ; soft, usually light but some heartwood samples moderately heavy (sp. gr. 0·36–0·76 air-dry) ; lustrous when first exposed, but gradually becoming dull with age ; straight to slightly interlocked-grained ; medium-coarse and even-textured with a smooth feel ; silver-grain effect noticeable on the radial surface.

Gross structure—A diffuse-porous wood. *Growth rings* absent or faintly visible to the eye, demarcated by a faint line of denser latewood fibres, 2–4 per cm. *Vessels* moderately large to small, fairly distinct to the naked eye, few to moderately few (4–10 per mm.^{2}), evenly distributed, solitary or in radial multiples of 2–4, rarely in clusters, round to oval in outline, partially filled with tyloses ; vessel lines distinct. *Parenchyma* inconspicuous, distinct to just visible under hand lens in thin sheath round the vessels. *Rays* light pinkish-brown, indistinct or barely visible to the unaided eye, fine, rather widely and unevenly spaced ; ray-flecks reddish-brown, conspicuous. *Gum canals* horizontal, present in some of the rays, scattered all over the tangential surface

and sometimes visible to the eye as dark spots due to the colour of the gum, but, often distinct only under lens.

Strength—It is a rather light and soft timber. Strength figures are given in appendix I.

Seasoning—This is a non-refractory species but liable to stain, decay and insect attack and should be seasoned under rapid drying condition. In seasoning it does not warp or split. Logs should be converted green and the sawn timber stacked vertically under cover for rapid drying in order to avoid damage by mould. Storage in the form of logs is hazardous. A very easy timber to kiln-season—one inch thick planks taking only 4–5 days to dry without developing any case-hardening. Desch, based on experiments conducted by Thomas has reported that "although the figures for shrinkage are fairly high, there was practically no end-splitting despite the fact that an end-coating was not used."

Natural durability—It is not a durable timber in exposed locations or in contact with the ground. The "graveyard" tests carried out at Dehra Dun showed that the average life of the timber (heartwood) is 18 months, with a minimum of 14 months and maximum of 21 months.

Insect and fungus attack—Drywood is attacked by *Ptilinus binodulus* Motsch. (Ptinidae), *Heterobostrychus aequalis* Waterhouse (Bostrychidae) and *Minthea rugicollis* Walker (Lyctidae); newly felled or fallen wood is attacked by shot-hole borers (Platypodidae and Scolytidae). The timber is very susceptible to sap-stain and decay. The central portions of the logs are sometimes decayed like spongy heart.

Preservative treatment—Tests have not so far been made at Dehra Dun. However, from the results of tests carried out in the Malay Peninsula, it appears that the timber is not difficult to treat. In Malayan species it has been observed that there is some variation in the absorption of the preservative in the specimens from different trees. This may be due to the presence and variation in the amount of sapwood in different specimens as the sapwood merges imperceptibly into heartwood.

Working qualities—According to Pearson and Brown, it is easy to saw, and can be worked up to a moderately smooth surface. Though it is not difficult to peel, the veneers become woolly due to the pulling out and breaking of the fibres. However, experience of working *Parishia* timber in Malay Peninsula and Philippines is different. Desch reports that *Parishia* logs are "often exceedingly difficult to saw as the fibres pull out and wrap themselves round the saw teeth causing the latter to become jammed in the wood. In addition, the silica in the wood cause considerable blunting of the cutting edges." Reyes also reports that *Parishia* is difficult to saw but can be finished beautifully.

Supply and uses—Fair supplies of logs up to about 6 m. in length and 1 m. in diameter are available from the Andamans. The principal use of this timber is for packing cases, boxes and crates. Due to the large size of the logs available, it is suitable for boards, planking, bottoms of drawers, backing for cup-boards and partition work. It is also used in cheap-grade plywood.

Material—

5828 Andamans (0·36), 6411 Burma (0·76), 7468 Andamans (0·49).

13. PISTACIA LINN.

A small genus of trees or shrubs distributed mainly from the Mediterranean region to East Asia. One species is reported from Mexico. The genus is better known for fruits and gums than for timber. The most important is *P. vera* Linn. which produces the pistachio nuts (*pista*) of commerce. It is a small tree originally indigenous to Persia, Syria and western Asia, but is now widely cultivated and naturalized in southern Europe, northern Africa, and southern parts of the United States. The nuts form a very important ingredient of high class sweetmeats, confectionery and Indian milk preparations (*pyasa*, *khir*, etc.) and also for flavouring ice-cream and candy. In India, these nuts are usually imported from Afghanisthan. Another important species is *P. lentiscus* Linn. of the Mediterranean region, which yields "mastic gum" which is one of the most expensive resins. It is used in flavouring wines, perfumery, medicine, lithographic work, and as a cement by dentists. At present its main use is for high grade varnishes required for the protection of water colour and oil paintings.

Recently Zohary has thrown light on the evolution and migration of the genus. He has divided it into two groups—(1) Eu-Terebinthus, Bulmela, and Lentiscella and (2) Eu-Lentiscus. The first group is regarded as having arisen from *P. vera* and its descendent *P. khinjuk* Stocks, while the second which is morphologically more advanced than the first is said to have originated in the Cretaceous period in Tibet.

Only one species *P. integerrima* Stewart, is indigenous to India and another *P. terebinthus* Linn. is an introduced species. Both have been described here. Besides these, two more species grow in the Indian region. *P. khinjuk* is a tree of Baluchistan Hills growing at an elevation of 1,200 to 2,300 m. It yields a resin somewhat similar to that of *P. lentiscus* but darker in colour and inferior in quality. *P. coccinea* Coll. & Hensl. is a small tree of Shan Hills, Upper Burma, at 1,200 m. elevation.

The woods of the two species dealt with here are easily distinguishable. *P. integerrima* is distinctly ring-porous, with the latewood vessels arranged in

zig-zag pattern. *P. terebinthus*, on the other hand, is diffuse-porous, the vessels being uniformly distributed without any characteristic arrangement. The wood of this species is lighter than that of *P. integerrima*.

1. Pistacia integerrima Stewart—*Kakar* (Garh.), *kakra*, *kakrasingi* (Hind.), *kakkar*, *kakroi* (Jaunsari), *batkal*, *drek*, *gurgu*, *kakhar*, *kangar*, *karkar*, *tauhari* (Kash.), *hurkli*, *kaka*, *kakkar*, *kakkroi*, *kakla*, *kakra*, *kakrangche*, *kakraiu*, *kakring*, *kakrian*, *kanrai*, *kangar*, *khakkar*, *sish*, *tuga*, *tungu* (Punj.), *masna*, *sarawau*, *shne* (Pushto). A middle-sized deciduous tree, which reaches up to 12 m. in height and 3·5–4·5 m. in girth with short bole. *Bark* grey and rough. The leaf galls known as *kakrasingi* contain 20–75 per cent of tannin and an essential oil, and are used in medicine for cough, lung diseases and in dysentry and also as a tonic. It is also said to be an antidote for snake venom and scorpion sting.

It grows in the western Himalayas from the hills of West Pakistan (Punjab and N.W.F.P.) to Jaunsar, Garhwal and Kumaon in Uttar Pradesh at an elevation of 450–2,500 m. It is often cultivated in the plains as an ornamental and shade tree.

Description of the wood

[Pl. **61**, 366]

General properties—Sapwood and heartwood distinct; sapwood wide, white to pale yellow turning light yellow-brown on exposure, slightly lustrous; heartwood deep brown with yellowish tinge ageing to chocolate or dark grey-brown beautifully striped with dark lines due to rich deposits, rather dull; hard to very hard; heavy (sp. gr. 0·78–0·93 air-dry); straight to interlocked-grained; fine to medium-coarse and uneven-textured.

Gross structure—A ring-porous wood. *Growth rings* distinct but not conspicuous to the eye, demarcated usually by 1–2 rows of larger earlywood vessels, 2–6 per cm. *Vessels* in the earlywood small to moderately large, hardly visible to the eye but collectively visible as concentric rows; distinct under lens as a belt, usually one but sometimes up to 3 rows wide, mostly solitary, occasionally in radial multiples of 2–3; round to oval plugged with tyloses in the heartwood; latewood vessels extremely small, individually indistinct even under hand lens but the clusters visible to the eye due to lighter colour and arrangement; very numerous (over 40 per mm.^{2}), mostly in clusters arranged in oblique or zig-zag pattern, with tyloses occluding the pore cavity in the heartwood; transition from early to latewood abrupt; vessel lines inconspicuous on the longitudinal surfaces. *Parenchyma* indistinct even under lens; lighter coloured vessel clusters in the latewood often give the impression of vasicentric parenchyma. *Rays* brownish, lighter in colour than the background, indistinct or just visible to the eye but distinct under lens,

rather fine and closely spaced. *Gum-ducts* present, horizontal, sometimes visible under lens as minute dots on the tangential surface.

Strength—A hard to very hard, heavy, moderately strong and very tough timber. Strength figures are given in appendix I.

Seasoning—The timber has not been tested at Dehra Dun. However, Pearson & Brown are of the opinion that it is not a "refractory timber to season but if left in the log it sometimes develops radial splits. Green conversion into planks and stacking in fairly close piles under cover will probably give the best results. Coating the ends of the planks would be a further safeguard against end-splitting." Limaye reports that it seasons well with care. For the Philippine wood, Reyes also reports that it seasons well though there may be some checking and warping.

Natural durability—It is very durable even in outside locations.

Insect and fungus attack—Deadwood of *P. integerrima* is attacked by *Clytus monticola* Gahan., and drywood by *Stromatium barbatum* Fabricius (Cerambycidae). Sapwood of only one sample in the timber collection was found to be badly damaged by borers. Parker reports that large trees are almost invariably hollow.

Working qualities—Although a very hardwood, it is rather easy to saw and work with tools. It finishes to a smooth surface and takes polish well. It also lends itself to turning and carving.

Supply and uses—The timber is available in limited quantity from Jammu and Kashmir, Punjab and Uttar Pradesh in small dimensions. It is very handsome and is suitable for highly ornamental articles. Its uses are for high class cabinet work, picture frames, furniture, turnery, carving, inlay work and fine small joinery articles. It is suitable for tool handles, rifle stocks, and pistol grips.

Material—

227 Garhwal, Uttar Pradesh (0·93), 898 Murree, West Pakistan (0·92), 926 Hazara, West Pakistan, 2930 Simla (0·95), 6059 Rawalpindi, West Pakistan (0·81), 6062 Kangra, East Punjab (0·87).

One sample No. 11 from Simla (0·78) mentioned in Gamble's Manual differs from all others in having golden yellow colour, conspicuous growth rings and latewood vessels in long radial multiples and also in chains showing some resemblance to *Rhus cotinus*.

2. **P. terebinthus** Linn.—The Cyprus turpentine tree or the **Terebinth** tree. A tree up to 14 m. in height and 60 cm. in girth, common on the

islands and shores of the Mediterranean. It is sometimes planted in India as a garden tree.

Description of the wood

[Pl. **62**, 367]

General Properties—Wood light brown, darkening to reddish-brown on exposure ; rather dull, moderately hard ; moderately heavy (sp. gr. 0·69 air-dry) ; straight to slightly interlocked-grained ; even and rather fine-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct. *Vessels* small to very small, indistinct to barely visible to the eye, numerous to very numerous (30–40 or more per mm.^{2}), evenly distributed, solitary or frequently in radial multiples of 2–4 or more, occasionally may also be in small clusters, round to oval, partially filled with tyloses ; vessel lines inconspicuous. *Parenchyma* not visible to the eye or under hand lens. *Rays* almost of the same colour as the background, indistinct to the eye, mostly fine, but a few moderately broad and interspersed among the fine ones, rather closely spaced.

The sapwood of the sample examined is damaged by insect attack. It also shows cracks and splits. The wood is likely to be suitable for small turnery articles.

Material—

4522 Dehra Dun, Uttar Pradesh (0·69).

14. RHUS (TOURN.) LINN.

A genus of about 130 species of trees and shrubs having a wide distribution in tropical as well as temperate regions of both the hemispheres. *Rhus*, however, is a complex genus which has been split up into several genera by some botanists. Barkley has grouped the North American and West Indian species under six genera, viz., *Cotinus* (Tourn.) Mill., *Rhus*, *Toxicodendron* (Tourn.) Mill., *Actinocheita* F. A. Barkley, *Malosma* Engl. and *Metopium* P. Br., of which the first three have been indicated as occurring in India. Heimsch based on the study of the secondary xylem and the pollen morphology has also supported Barkley's classification.

Many members of this genus have an acrid juice which is highly poisonous and gives rise to blisters, inflammation, itching and acute pain when it comes in contact with the skin. Among the Indian species, *R. wallichii* Hook. f. and *R. succedanea* Linn. are dreaded for their poisonous sap. Singh reports that even water dripping from the leaves during rains causes blisters. Bhagat Singh reported a case in *Indian Forester* in which it is stated that a Forest Guard who blazed a *R. wallichii* tree with an axe had his eyes and face swollen the very next morning. But some people are reported to be not affected at

all by this poisonous sap. The other Indian species having toxic and irritant juices are *R. punjabensis* and *R. insignis*. Among the foreign species which are highly toxic mention may be made of Poison Sumac (*R. venenata* DC.), Poison Ivy (*R. toxicodendron* Linn.) of North America and the Japanese lacquer tree (*R. vernicifera* DC.).

About a dozen species are reported to occur in the Indian region mostly in the Himalayas from 600–2,400 m. elevation. The four species which are not available for study are :—(1) *R. griffithii* Hook. f., *darmi-asing* (Miri) a small tree with greyish brown bark, fairly common in Upper Assam and other hills and also in Sikkim ; the bark of this tree yields a brown gum when cut, while the wood is reported to be like that of *R. succedanea* ; (2) *R. khasiana* Hook. f. a middle-sized tree up to 14 m. in height with greyish-brown and rough bark, occurring in Khasi Hills in Assam and Chittagong in East Pakistan ; (3) *R. paniculata* Wall., *Kaunggale, pyizin, benwe* (Burm.), a small tree occurring in the Eastern Ghats in Rumpa Hills of Godavari, in Bhutan, and Upper Burma ; the bark of this tree is said to be used for adulterating *katha* ; (4) *R. amherstensis* W. W. Smith a tree growing in Amherst, Burma.

The woods of the 8 species available for study can be classified into three groups based on their anatomical structure. A key for their separation is given below :—

1.	Wood ring-porous, light to moderately heavy ..	2
1.	Wood diffuse-porous, heavy	*R. parviflora*, *R. mysorensis*
2.	Latewood vessels numerous, mostly in long radial multiples or in chains ; rays, closely spaced ..	*R. cotinus*
2.	Latewood vessels not numerous, mostly solitary or in small clusters ; rays not closely spaced ..	3
3.	Earlywood zone wide ; transition from early to latewood abrupt	*R. punjabensis*
3.	Earlywood zone narrow ; transition from early to latewood gradual	*R. insignis*, *R. succedanea*, *R. semialata*, *R. wallichii*

1. **Rhus cotinus** Linn. (**Cotinus coggyria** Scop.)—*Chaniat, jal tunga, tunga* (Garh.), *tung, tungoi* (Jauns.), *darengri* (Kash.), *chariant, gadtung* (Kumaon), *bana, bauru, banthra, bhan, larga, manu, paan, phan, titri, tugang, tung* (Punj.). Also known as Wig-plant, Smoke-tree, Indian sumach, Elm

leaved sumach, and Venetian sumach. A deciduous shrub occasionally a small tree reaching up to 6 m. in height and 1·5 m. in girth. *Bark* reddish-brown, rough and thin.

The leaves and bark which contain 18–22 per cent tannin are used for making soft leather for gloves and book-binding. The flowers as well as the leaves give out characteristic mango-like smell when rubbed. The pliable twigs are used for making baskets.

It is distributed in the Western Himalayas mainly as an under shrub of pine forests ascending to 1,800 m. from the Punjab to Kumaon. It is fairly common in open forests associated with oak and chir in Jaunsar, Garhwal and Kumaon. It is also found in West Pakistan, Western Asia, Southern Europe and China. A closely related species (*Cotinus americanus* Nutt.) which is often considered a variety of this plant occurs in America.

Description of the wood

[Pl. **62**, 368]

General properties—Sapwood narrow, white; heartwood bright yellow, streaked with brown or greenish-grey, turning dark brown superficially on ageing; somewhat lustrous; moderately hard; moderately heavy (sp. gr. 0·63 air-dry); straight to slightly interlocked-grained; rather fine and uneven-textured.

Gross structure—A ring-porous wood. *Growth rings* distinct, demarcated by a narrow zone of larger earlywood vessels, 5–7 per cm. *Vessels* moderately large in the earlywood, just visible to the eye, consisting of 1–2 rows, with rather abrupt transition to latewood; latewood vessels very small, individually indistinct even under hand lens, usually in long radial multiples or clusters aligned in radial rows, very numerous (40 or more per mm.^{2}); tyloses often fill up the vessel cavities; vessel lines of the earlywood zone conspicuous on the longitudinal surfaces. *Parenchyma* scanty, delimiting growth rings and also forming very thin sheaths round the vessels in the earlywood, visible under lens with difficulty. *Rays* fine of the same colour as the background, distinct only under lens, closely spaced.

Uses—The wood is not obtainable in sizes large enough to be of commercial value. However, it has attractive colour and appearance and is likely to be suitable for small turnery and carved articles, picture frames, etc. Gamble states that in South Europe, the wood is used for inlay and cabinet work. The heartwood appears to be durable, as in the sample examined the sapwood has almost been completely destroyed by insects while the heartwood is still quite sound. A yellow dye is obtained from the heartwood and is used in the textile and leather industry. Locally the dye is also used for colouring wool.

Material—85 Simla (0·63).

2. **R. insignis** Hook. f.—*Sehr-Kung* (Lep.), *kag-balayo, kag-phulai* (Nep.). A handsome small to medium-sized tree, 6–15 m. in height with a clear bole of 3–6 m. and 30 cm. to 1·5 m. in girth. *Bark* grey, thin, exudes a blistering juice which is sometimes used in colic.

The tree is found in the inner valleys of the Sikkim Himalayas at altitudes from 1,800 to 2,500 m. and also in the Khasi Hills.

Description of the wood—See page 310.

3. **R. mysorensis** Heyne (**R. mysorensis** G. Don)—*Amboni, amoni* (Bombay), *dasan, dasni, danonia, dasarni, davan* (Rajasthan), *chippamaram, sappula* (Tam.), *sitha* (Tel.). A shrub or small tree. *Bark* brown, rough and thin.

The tree is found in the Punjab, Rajasthan, throughout the dry stony lands in the Deccan Hill country, Dharwar, Bellary and Mysore, extending to the northern slopes of the Nilgiris. It also occurs in West Pakistan.

Description of the wood—See page 310.

4. **R. parviflora** Roxb.—*Tunga, tungla* (Garh.), *dungla, raitung, rannel, tumra, tung, tunga, tungla* (Hind. & Punj.), *dungla, ninawa, ninas, tumra* (Jauns.), *samak* (Kash.), *tang, tunga* (Kumaon). A small evergreen or subdeciduous shrub occasionally attaining 4·5 m. height and about 1 m. in girth. *Bark* thin, reddish-brown, rough, exfoliating in small woody scales. The fruit mixed with salt is used medicinally like that of tamarind. Gamble states that dried leaves are mixed with tobacco in Jaunsar.

The tree is distributed in the Himalayas from the Sutlej to Nepal, at 600–1,500 elevation, Pachmarhi hills in Madhya Pradesh and the hills of Andhra Pradesh.

Description of the wood—See page 310.

5. **R. punjabensis** Stewart—*Tituri* (Garh.), *titri, titroi* (Jauns.), *amlara, dasmila* (Kumaon), *arkhar, choklu, dor, halashang, halastang, kakkarein, kangar, palai, rashtu, tetar, titari, tiri, titrai, titri* (Punj.). A small or medium-sized deciduous tree up to 15 m. in height and 2 m. in girth. *Bark* dark brown or grey, exfoliating in rounded woody scales, about 20 mm. thick. The juice is very corrosive and raises blisters.

It is distributed in the Himalayas from Kashmir to Kumaon at an altitude of 750–2,500 m. Its common associates are *Aesculus, Juglans regia* and *Ulmus*.

Description of the wood—See page 310.

6. **R. semialata** Murr. (**R. chinensis** Mill.)—*Naga-tenga* (Asm.), *damphela, dasmila, dhamila, khunkia* (Garh.), *khetma, khitma* (Garo), *arkhoi, tibri*

(Jauns.), *gimbao* (Kach.), *dieng-soh-ma, soh-ma* (Kh.), *dharmil* (Kumaon), *takhril* (Lep.), *bakkiamela, bhagmili, bhakhimlo* (Nep.), *arkol, arkhar, chechar, dudla, hulashing, kakkeran, kakri, tatri, titri, wansh* (Punj.), *dieng-sa-ma* (Synt.). A small deciduous tree up to 10 m. in height with a clear bole of 3–4·5 m. and 50 cm. to 1 m. in girth. *Bark* grey, rough, with deep vertical furrows about 2 mm. thick, exuding an acrid juice. The fruit is edible and has an acid taste. It is reported to be used as a substitute for rennet in preparing curds (39). It is also used in medicine as a remedy for dysentery and colic. Gamble states that in Nepal a wax is obtained from the fruit and is called *omlu*.

The tree is distributed in the Himalayas from the Indus to Assam at an elevation of 900–2,100 m. and in Khasi hills above 750 m. It is common in blue pine (*Pinus wallichiana* Jackson), *chir* (*Pinus roxburghii* Sargent) and oak (*Quercus* spp.) forests with a tendency to occur in gregarious patches. It grows in Shan Hills, Upper Burma and Martaban and also in China and Japan.

Description of the wood—See page 310.

7. **R. succedanea** Linn.—*Kakra sringi* (Beng.), *bol-khat-thi, bol-michang* (Garo), *kakra-singi-kakar-sing* (Hind.), *dieng-kean, ding kain, kakain* (Kh.), *karkataka-shringi* (Kan.), *serhnyok* (Lep.), *raniwalai* (Nep.), *arkhol, arkol, choklu, hala, halai, holashi, hula-shing, lakhar, kakkrim, kakrin, rikhul, tatri, titar* (Punj.), *karkata-sringi* (Sans.), *diengsuit* (Synt.), *chingi* (Tam.), *kark-kara-sringi* (Tel.). A small to medium-sized deciduous tree up to 15 m. in height. *Bark* thin, dark grey, rough, exfoliating in irregular flakes. The juice is corrosive and is used as a varnish for lacquer work for which the tree is tapped in Japan. It is reported that excrescences of the branches are given to children as a remedy for diarrhoea and dysentery. The juice of the leaves also causes blisters. Seeds yield a wax which is used in candle-making and in the manufacture of floor polish.

The tree has a wide distribution in the Himalayas from the Indus eastwards to Assam at an elevation of 600–2,500 m. It is fairly common in the hills of Assam. It has also been reported to grow in Bhamo, Upper Burma and extends to China and Japan.

Description of the wood—See page 310.

8. **R. wallichii** Hook. f.—*Khonki, ulkhuru* (Garh.), *archoi, arkhoi* (Jauns.), *kathbhalai* (Kumaon), *bhalaio, chosi* (Nep.), *arkhar, arkhol, arkol, gadambal, harku, hulasa, kambal, lohasa, rihali, rikhul, uruk, urkur* (Punj.). A small or moderate-sized deciduous tree from 7·5 m. to 15 m. in height and about 1 m. in girth, often mistaken for walnut. *Bark* grey, smooth, with resin canals filled with white milky juice which turns black and raises blisters on skin. This secretion can be used as a varnish. The juice of the leaves is also very acrid and produces blisters.

The tree is found in the Himalayas at an elevation of 600–2,500 m. from Kashmir to Nepal through Himachal Pradesh, the Punjab and Jaunsar, Garhwal and Kumaon in Uttar Pradesh.

Description of the wood—See below.

Description of the wood

(*Rhus mysorensis* and *R. parviflora*)

[Pl. **62**, 369]

General properties—Sapwood pale yellowish-brown, heartwood reddish-brown, darkening on exposure ; hard to very hard ; heavy (sp. gr. 0·86–0·94 air-dry) ; rather dull ; straight to slightly interlocked-grained ; fine and even-textured.

Gross structure—A diffuse-porous wood. *Growth rings* finely marked by parenchyma and fibres, just visible to the naked eye, 2–8 per cm. *Vessels* very small to small, usually indistinct to the eye but vessel multiples just visible to the unaided eye, sometimes just a suggestion in *R. parviflora*, numerous (21–36 per mm.^{2}), evenly distributed, but with a tendency towards tangential alignment of slightly larger vessels at the beginning of the ring in *R. parviflora* ; solitary or in radial multiples of 2–3, occasionally more, giving the impression of pore chains in *R. parviflora*, round to oval sometimes filled with tyloses ; vessel lines inconspicuous. *Parenchyma* indistinct even under hand lens except in the region of the growth rings. *Rays* fine, lighter in colour than the background, barely visible to the eye, closely spaced.

Dead and drywood of *R. parviflora* is attacked by the *ghoon* borer *Xylodecte ornatus* Lesne (Bostrychidae). In the wood collection at Dehra Dun, the sample of *R. parviflora* is hollow in the centre due to damage caused both by insect and fungus. The sapwood also has been destroyed by borers. The wood of *R. mysorensis* is sound except for slight borer attack in the sapwood. *Fomes conchatus* causing a white-rot in the logs has been frequently recorded in *R. parviflora.*

At present the wood is locally used as fence-posts and as a fuel. The wood being hard, fine and even-textured is likely to be suitable for small turnery and other utility articles. It may also be tried for small tool handles.

Material—

R. mysorensis – 3248 Ajmer, Rajasthan (0·86).

R. parviflora – 4814 Jaunsar, Uttar Pradesh (0·94).

Description of the wood

(*Rhus insignis, R. punjabensis, R. semialata, R. succedanea* and *R. wallichii*)

[Pl. **62**, 370–371]

General properties—Sapwood and heartwood indistinguishable in samples examined. However, some of the species such as *R. succedanea* and *R. wallichii*

are reported to have distinct heartwood. According to Gamble, in the former the sapwood is greyish-white turning brown with age and heartwood yellow and small, while in the latter the sapwood is white and the heartwood reddish-brown, becoming yellow when dry. In the samples examined, the wood is white to greyish-white in *R. insignis* and *R. semialata*, yellow to yellowish-grey turning superficially brownish or reddish with yellow tinge on ageing in *R. punjabensis* and *R. wallichii*, and light brown with greyish-yellow tinge in *R. succedanea*; soft and light (sp. gr. 0·37–0·54 air-dry) except in *R. succedanea* and *R. wallichii* which are moderately hard and moderately heavy (sp. gr. 0·52–0·65 air-dry); dull to somewhat lustrous when freshly cut; usually straight-grained but some specimens may show slightly interlocked-grain; medium-coarse and uneven-textured. *R. punjabensis* and *R. wallichii* often show a pleasant figure due to the large earlywood vessels.

Gross structure—A ring-porous wood. *Growth rings* distinct, demarcated by large earlywood vessels associated with parenchyma, 1–11 per cm. *Vessels* in the earlywood moderately large to large (*R. punjabensis*), easily visible to the naked eye; earlywood zone wide, consisting of 3–7 rows of large vessels with abrupt transition to latewood in *R. punjabensis*, but very narrow (*R. insignis*) to narrow and with gradual transition to latewood in other species; earlywood vessels solitary or in radial multiples of 2–3; latewood vessels small to very small usually indistinct to the eye but appearing as pin-pricks in *R. succedanea* and *R. semialata*, but distinct under hand lens; smallest vessels occur in *R. punjabensis* being just visible under hand lens; latewood vessels few to moderately numerous, mostly solitary, occasionally in conspicuous clusters and in short radial multiples of 2–3; but one specimen of *R. punjabensis* (No. 19) shows extremely small and very numerous latewood vessels which are often in clusters; vessels round to oval in outline, sometimes filled with tyloses; vessel lines very distinct in the earlywood zone. *Parenchyma* scanty, mostly confined to the region of earlywood, barely distinct under hand lens. *Rays* fine to moderately broad, lighter in colour than the background of the wood, usually visible to the eye, not closely spaced.

Strength and seasoning—The timber has not been tested for strength, seasoning and natural durability. The wood, however, varies in weight and hardness. *R. insignis* being the lightest and softest. *R. punjabensis* and *R. semialata* are light and soft timbers, whereas *R. succedanea* and *R. wallichii* are moderately hard and moderately heavy. None of the timbers appears to be difficult to season as no seasoning defects have been observed in the samples in the timber collection.

Natural durability—The wood appears to be fairly durable under cover. Very old specimens of *R. punjabensis*, *R. insignis* and *R. succedanea* in the timber collection of this Institute are damaged mostly near the region of the bark.

Insect and fungus attack—Drywood of *R. insignis* and *R. punjabensis* is liable to be attacked by *Stromatium barbatum* Fabr. (Cerambycidae) while in the case of *R. semialata,* the deadwood is susceptible to the attack of *Erythrus westwoodi* White (Cerambycidae). The wood rotting fungi, *Fomes conchatus* (Pers.) Fries and *F. senex* Nees & Mout. causing white-rot, and *Stereum frustulosum* Lloyd causing a white-pocket-rot have been recorded in the felled timber of *R. punjabensis. Fomes ostricoloris* which produces a white-fibrous-rot having dark brown streaks in the logs commonly occurs in *R. wallichii.*

Working qualities—The timber is rather easy to work and can be brought to a good finish. It can also probably be turned well.

Supply and uses—The wood may be available from Punjab, Kashmir, Uttar Pradesh and Assam in small quantities. As any cuts on the trees exude a corrosive juice which on contact blisters the skin, they are not usually felled. Moreover the timber is only available in small sizes. Naturally the wood has very little commercial possibilities.

However, the woods of *R. punjabensis* and *R. wallichii* have an attractive appearance and figure and should be suitable for ornamental work, inlaying and cabinet work. The wood of *R. succedanea* is reported to be suitable for agricultural implements (39). *R. punjabensis* is said to be used for making tobacco pipes. *R. wallichii* is employed for making saw-frames, axe-handles and musical instruments in Kashmir.

Material—

R. insignis – 3104 Darjeeling, West Bengal (0·37).

R. punjabensis – 19 Simla, Himachal Pradesh (0·54), 4451 Jaunsar, Uttar Pradesh (0·45), 4767 Garhwal, Uttar Pradesh (0·51).

R. semialata – 2340 Darjeeling, West Bengal (0·41), 3079 Simla, Himachal Pradesh (0·46).

R. succedanea – 2907 Simla, Himachal Pradesh (0·52), 6835 Burma (0·65).

R. wallichii – 4826 Dehra Dun, Uttar Pradesh (0·58).

15. SEMECARPUS LINN.

The genus *Semecarpus* consists of about 40 species of trees with a blistering acrid juice, distributed in the Indo-Malayan region and extending to Australia. About thirteen species are endemic in Ceylon. In the Indian region about 8 species are reported to occur. Of these, four were available for study and are dealt with here. Of the remaining species only *S. prainii* King is found in India proper, while the rest occur in Burma and East Pakistan. *S. prainii* is a rather rare tree growing in the Andamans and in Cachar, Assam.

The woods of the four species described here are very similar in structure and cannot be distinguished with certainty.

1. **S. anacardium** Linn. f.—*Bar-bhola, bholaguti* (Asm.), *bela, bhala, bhela, bhelatuki, velama* (Beng.), *chaybeng, che, chyai-beng, khi-si, mai-ka-aung, thitsi-bo* (Burm.), *bhalao* (Garh.), *babari, bareri, bawarae, bol-agal* (Garo), *biba, kohaka, kohka, kokha-marra* (Gon.), *bhiamu, bhilamu* (Guj.), *belatak, bhailawa, bhela, bhelwa, bheyla, bhilaura, bilaran* (Hind.), *agni-mukhi, bhallataka, cheramara, ger, gerkavi, geru, gerubija, gheru, goddu-geru, karigeru, keru, kerubija, oorgero* (Kan.), *dieng-soh-bhala* (Kh.), *loso* (Kol.), *konghi, kongki, sukung* (Lep.), *chera, cherkkotta, cherkkuru, cheru, cherun kuru, kampira, shembiri, shengotta, temprakku, thenkotta* (Mal.), *biba, bibe, bibha, bibu, bibwa, bihba* (Mar.), *barla arong* (Mik.), *bhalai, bhalaiyo, kalo-bhalayo, pursho-bhola* (Nep.), *bhallia, bhollatoki, bhollia, olo-jem* (Or.), *bhela, bhiladar, bhilan, bhilawa* (Punj.), *arushkara, bhallataka, bhallatamu* (Sans.), *soso* (Sant.), *kalagam, kalambi, kavaga, krimugi, pallam, pallikkai, pudanashanam, se, seran, shaing, shayrang, shenkottai, sherankottai, sinduram, sombalam, tagilima, tembarai, vingi, virasagi* (Tam.), *bhallataki, bhallatamu, gudova jidi, jidi, vittulu, jiri, nalla-jidi, nolla-jidi, shaing-jiri, tummeda-mamidi* (Tel.), *bhilanvana* (Urdu), also known as marking nut tree. A moderate-sized handsome deciduous tree, usually 6–12 m. in height and 1–2 m. in girth, with a clear bole of 3–6 m. but sometimes attaining up to 21 m. in height in Kumaon (58). *Bark* dark brown to blackish-grey, rough exfoliating in irregular patches, 8–13 mm. thick, exuding a poisonous juice which causes blisters on the skin. The nut yields a juice, which is brown and oily when fresh but turns black on exposure, and is used all over the country for marking linen by washermen. The nuts are also used as vermifuge for goats and sheep. The oil of the nut is highly acrid and causes blisters. This is used as an external applicant in cases of rheumatism and leprosy.

The tree has a wide distribution and occurs in the sub-Himalayan tracts from the Beas eastwards up to an elevation of 1,000 m. It is fairly common in Uttar Pradesh, Bihar, Orissa, North Bengal and in the Brahmaputra Valley and hills of Assam, often occurring in association with sal. The tree is fairly abundant in Kerala up to 450 m. elevation and also occurs in Andhra Pradesh, Madras, Madhya Pradesh, Mysore and Bombay. It is also reported to grow in Burma and in the Chittagong Hill Tracts of East Pakistan.

Description of the wood—See page 314.

2. **S. auriculata** Bedd.—*Charei* (Mal.), *man charei, vellei charei* (Tam.). It is a large, handsome tree, 24 m. in height and about 60 cm. in diameter. *Bark* grey, smooth, 6–7 mm. thick. It is common in the evergreen forests of Kerala and Tinnevelly in Madras up to 900 m. elevation.

Description of the wood—See page 314.

3. **S. kurzii** Engler—*Bara bhilawa* (Hind.), *che* (Burm.). It is a handsome tree 12–21 m. in height and 1–1·5 m. in girth. *Bark* light grey and fairly smooth. The tree is scattered in the Andaman and Nicobar Islands and in Martaban, Burma.

Description of the wood—See below.

4. **S. travancorica** Bedd.—*Avukaram, malamcera, tencera* (Mal.), *kathashengkotta, kattu shenkottai, natu-sengote, pariyacceran, ponnaeceran, punnacharei* (Tam.). A large to very large tree about 30 m. in height and 1 m. in diameter. *Bark* grey, with black blotches, and exuding an acrid juice, similar to that of *S. anacardium*. It is found in the evergreen forests of Tinnevelly, Madras and Kerala up to an altitude of 1,200 m.

Description of the wood—See below.

Description of the wood

(*Semecarpus anacardium, S. auriculata, S. kurzii* and *S. travancorica*)

[Pl. **62**, 372]

General properties—No colour distinction between sapwood and heartwood. Wood greyish-white or buff to pale greyish-yellow when fresh, ageing to grey-brown ; soft to moderately hard ; light to moderately heavy (sp. gr. 0·38–0·63 air-dry), *S. auriculata* being the lightest ; straight to slightly interlocked-grained ; somewhat coarse and even-textured, often showing silvery flecks on the radial surface.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct, occasionally fine bands of thicker-walled fibres may, however, give the impression of growth rings. *Vessels* moderately large to large, visible to distinct to the eye ; very few to moderately few (1–8 per mm.^{2}), rather evenly distributed, usually solitary or in radial multiples of 2–5, rarely in clusters, round to oval, frequently filled with tyloses ; vessel lines conspicuous on longitudinal surface. *Parenchyma* paratracheal, not visible to the eye in all samples, usually vasicentric in *S. auriculata*, and vasicentric to aliform in *S. anacardium, S. kurzii* and *S. travancorica* ; occasionally with lateral extensions forming thin lines and joining similar extensions from other vessels in *S. anacardium* and *S. kurzii*. *Rays* distinctly visible to just visible to the eye, moderately broad to fine, the broader ones rather widely and unevenly spaced and often running only for short distances radially on the end surface ; finer rays usually evenly spaced ; on the radial surface, silver grain effect is noticeable.

Strength—It is a soft to moderately hard timber, which has not been tested for strength. However, for *S. anacardium*, Bourdillon gives the value of P, co-efficient of transverse strength as 230 and weight 35 lb.

Seasoning—No information is available on the seasoning properties of the timber but from the anatomical structure, it is not expected to give much trouble in seasoning. The samples in the wood collection also do not show any seasoning defects.

Natural durability—The timber is not durable and perishes rapidly in exposed situations.

Insect and fungus attack—Drywood is attacked by some *ghoon* borers (Anobiidae and Bostrychidae), and deadwood by borers of Anthribidae, Cerambycidae and Curculionidae ; freshly felled wood is attacked by shot hole borers (Platypodidae and Scolytidae). The timber is easily susceptible to sap-stain and decay.

Working qualities—Being fairly straight-grained the timber is rather easy to saw and work.

Supply and uses—The tree is found throughout India and supplies may be available from almost all the States. But it is not much extracted as the juice coming out of the bark on felling causes blisters to the axe-men. Moreover the wood is also reported to contain a juice which causes irritation when fresh. As such the timber is not much used. It is, however, suitable for cheap and light furniture, packing boxes and for crating. It is said that in Madhya Pradesh the timber is used for oars (77). It has, however, been reported to be fairly good for match splints and match boxes.

Material—

S. anacardium – 578 Darjeeling Terai, West Bengal (0·51), 627 Darjeeling Terai, West Bengal (0·49), 1157 Ahiri Reserve, Bombay State (0·63), 2341 Darjeeling Terai, West Bengal (0·54), 2746 Moharli Reserve, Madhya Pradesh (0·57), 5305 Dehra Dun, Uttar Pradesh (0·50).

S. auriculata – 4616 Kerala (0·38).

S. kurzii – 655 Burma (0·45).

S. travancorica – 4602 Kerala (0·48).

16. SPONDIAS LINN.

A small genus consisting of small to large fast-growing deciduous trees, widely distributed throughout the tropics of the Old and New World. The trees bear edible fruits for which they are often cultivated in many countries. In tropical America, *S. lutea* Linn., *S. purpurea* Linn. and *S. tuberosa* Arruda are well known for their fruits and have been introduced in other parts of the tropics. The last named species is considered to be one of the best (9). *S. dulcis* Forst. f.—*bilati amra* (Beng.), *bilayate amra* (Hind.), a fruit tree of

eastern Pacific is now widely cultivated in many hot countries including India. In Bengal where it is often cultivated for its large pleasant fruits, the tree does not attain a large size as in its native country. Three species which are indigenous to India are described here. One of them, *S. mangifera* Willd. (hog plum) is valued for its fruit and is often planted in gardens.

The woods of all the 3 species are very similar in structure except that *S. axillaris* is distinctly ring-porous while the other two are mostly diffuse-porous with an occasional tendency towards semi-ring-porous arrangement. From the point of view of wood anatomy, therefore, placing of *S. axillaris* in a separate genus *Poupartia* as proposed by some botanists, does not appear fully justified. Accordingly, following Brandis, they are described here together.

1. **S. acuminata** Roxb.—*Kattambate, kodambada* (Kan.), *ambada, ambut* (Mar.), *pulipilai* (Tam.). A moderate or large-sized, handsome tree with straight bole, considered by some botanists to be only a small leaved form of *S. mangifera* Willd. *Bark* olive-grey and smooth.

The tree is found from Konkan southwards, in coastal Mysore, Kerala and Madras.

Description of the wood—See page 317.

2. **S. axillaris** Roxb. (**Poupartia axillaris** King & Prain)—*Khamoli-mola, khamoli-sali, homoi tenga* (Asm.), *belam-changne* (Duff.), *agimmok, aming-gok, amung-gok, jharua, nihor* (Garo), *theseli-arong* (Mik.), *labshi* (Nep.), *deing-salait* (Synt.). A small to large evergreen tree often attaining in favourable localities a height of about 24 m. and a girth of 2 m. *Bark* brown or dark-grey to black, fissured, peeling off in long thin strips.

The tree is common in the sub-Himalayan tracts up to 1,500 m. in Nepal, Sikkim, North Bengal, as also in the Garo, Khasi, Jaintia Hills and North Cachar up to 1,200 m. It also grows in the Kachin Hills of Burma.

Description of the wood—See page 317.

3. **S. mangifera** Willd. (**S. pinnata** (Linn. f.) Kurz]—**Amra.** *Amor, amora, amratenga* (Asm.), *ambra, amna, amra* (Beng), *corre, gway, gwe, kyoroe, maikawk, mai-mak-kauk, owebaung* (Burm.), *ambi-thong, ambri-thong, thong-rong* (Garo), *hamara* (Gon.), *amara, ambodha, ambra, amra* (Hind.), *thaisudi-phang* (Kach.), *ambatta, kadambatte, murthiga* (Kan.), *dieng-soh-pair-kanthai* (Kh.), *ambo, amburri* (Kol.), *ambara, amra, amyan, bohamle* (Kumaon), *houchiling, ronchiling* (Lep.), *ambalam, ambazha, ambazhm, ampalam, kattam-bolam, kattam palam, mampuli* (Mal.), *heinig* (Manip.), *chiming-arong, suming-arong* (Miki), *dergi-asing* (Miri), *tamzen* (Naga), *amara* (Nep.), *ambota, amboto, ambuda* (Or.), *katambalam, kattumavu, kolamma, mampulichi* (Tam.), *adavimamidi, kondamamidi* (Tel.) ; also known as *amrataka* in Sanskrit. The

tree is also commonly known as hog plum. It is usually a small to middle-sized in North India but attains a large size in favourable localities reaching up to 30 m. in height and 1–3·5 m. in girth. *Bark* brown or grey, smooth but often with horizontal wrinkles and light vertical fissures ; it is 17–25 mm. thick, with a mango like smell, and is said to be a remedy for snake bite (5). The powdered bark is useful in dysentery and applied as a paste in rheumatism. On injury the tree exudes a gum which is sometimes used as an adhesive. The tree is also well known for its fruit which is used for making *chutny*, and also in curries for imparting acid taste. The fruit has medicinal value in dyspepsia and dysentery. The flower-buds are used for flavouring curries.

The tree occurs in almost all parts of India. It is found usually in dry forests throughout the plains and in river valleys and hills up to 1,500 m. It is common in open dry miscellaneous forests of Uttar Pradesh and throughout Bihar and Orissa, specially near rivers, lower hill forests of North Bengal and in the valleys and hills of Assam ; also widely scattered in the deciduous forests of Andhra Pradesh, Madras, Kerala, Mysore, the Andaman Islands, Chittagong in East Pakistan and all over Burma in mixed forests. It is frequently planted in villages in almost all the States. It also occurs in Ceylon and other East Asian countries, mostly cultivated.

Description of the wood—See below.

Description of the wood

(*Spondias acuminata*, *S. axillaris* and *S. mangifera*)

[Pl. **63**, 373]

General properties—Heartwood normally not distinguishable from sapwood ; occasionally, however, a pinkish or roseate-grey heartwood may be present. Wood usually greyish-white to grey, pale yellow or straw-coloured but light brown with pinkish tinge turning red on ageing in *S. axillaris* ; soft ; very light to light (sp. gr. 0·33–0·48 air-dry) ; often lustrous when freshly cut becoming dull on exposure ; straight-grained, even and coarse-textured but rather uneven and somewhat fine-textured in *S. axillaris*.

Gross structure—Diffuse-porous with occasional tendency towards semi-ring-porous arrangement in places in *S. acuminata* and *S. mangifera*, but ring-porous in *S. axillaris*. *Growth rings* usually indistinct in diffuse-porous species where occasionally a fine layer of thick-walled fibres and larger vessels may give the impression of growth rings ; but distinctly demarcated by a belt of larger earlywood vessels in *S. axillaris*, 1–2 per cm. *Vessels* in *S. axillaris* unevenly distributed, moderately large in the earlywood, consisting of a single row of tangentially aligned vessels, latewood vessels small, few to moderately numerous (4–12 per mm.^{2}) ; rather evenly distributed, with only occasional tendency for tangential alignment in the proximity of growth marks, large to

moderately large, distinct to the eye in *S. acuminata* and *S. mangifera* ; solitary or in radial multiples of 2–3, sometimes more, less commonly in clusters, round to oval, open or partially filled with tyloses ; vessel lines conspicuous. *Parenchyma*, vasicentric scanty, forming a very thin sheath round the vessels, inconspicuous to indistinct under lens. *Rays* moderately broad and fine, the former visible to the naked eye and widely spaced while the latter visible only under lens and closely spaced, ray flecks wide and distinct. *Gum canals* horizontal, few, sometimes visible on the tangential surface under lens as darkish spots within the broader rays.

Strength—The timber is soft and light and has not yet been tested for strength at this Institute. Bourdillon gives the value of P, co-efficient of transverse strength as 293 and weight 22 lb. per cu. ft. for *S. mangifera*.

Seasoning—It does not present any difficulty in seasoning and seldom cracks, splits or warps but is liable to stain unless carefully handled after felling. Green conversion and open piling of the sawn stock under cover should give good results. According to Pearson and Brown, it can also be kiln-seasoned rapidly. To avoid staining, kiln-seasoning soon after conversion has been recommended.

Natural durability—The timber is very susceptible to insect and fungus attack and perishes rapidly in the open. Under cover it is said to be only moderately durable. From the point of view of structure, the timber should not give trouble in preservative treatment.

Insect and fungus attack—Deadwood of *S. mangifera* is attacked by some borers of Anthribidae, Buprestidae, Curculionidae and Cerambycidae ; drywood and converted timber are attacked by *Dinoderus minutus* F. (Bostrychidae) and *Lyctus africanus* L. (*ghoon* borers) ; newly felled or fallen wood is attacked by shot-hole borers (Platypodidae and Scolytidae). The tree is often attacked by insects and a gum which is insoluble in water, exudes from the holes made by them (39). The timber is prone to fungus attack very easily.

Working qualities—It is easy to saw and work but can be brought only to a moderate finish due to its coarse-texture. It also peels well. The timber of *S. acuminata* tested at this Institute has been found to be good for plywood. The veneers season well and hold glue satisfactorily. The test figures for the plywood are given below :—

Strength (static bending) : average maximum load, 58 lb.

Glue adhesion : average, 204 lb. per sq. in.

Weight of the wood : 26 lb. per cu. ft. at 12% moisture content.

Though the wood absorbs much of the solution, it polishes well.

Supply and uses—As the trees are scattered, the timber is not available in large quantities from any State. Limited quantities are available from the

eastern and western zones. Logs of fairly large size are available from Mysore, Kerala and the Andaman Islands.

The timber is soft, light and perishable and, therefore, is not much in use. It has been found suitable for third grade non-ornamental plywood after treatment. The timber is fairly good for match splints and boxes. It is also used for making light packing cases. According to Troup the wood yields a fairly good unbleached pulp. It has been reported to be used as a float mixed with other light woods.

Material—

S. acuminata – 7625 North Kanara, Mysore (0·48).

S. axillaris – 4804 Darjeeling, West Bengal (0·40).

S. mangifera – 499 Darjeeling, West Bengal (0·44), 560 Burma (0·44); 1296 Cachar, Assam (0·37), 5299 Dehra Dun, Uttar Pradesh (0·33), 5953 Dehra Dun, Uttar Pradesh (0·37), 6288 Burma (0·42).

17. SWINTONIA GRIFF.

The genus consists of tall, evergreen trees which are distributed in East Pakistan, Burma, and the Malay Peninsula, extending to the Philippine Islands. Two species grow in Burma, one of which extends to Chittagong in East Pakistan and is described here.

S. floribunda Griff.—**Civit.** *Am-barola, boilam, boilsur, chivit, civit* (Beng.), *taung-thayet, thayet kan, thayet kin, thayet-kin-san, thayetle, thayet san, thin-baung* (Burm.). A lofty buttressed tree 24–36 m. in height and about 3 m. in girth with a clear bole of 12–18 m., but trees up to 45 m. in height with a clear bole of 30 m. and buttresses up to 6 m. have been recorded from Chittagong Hill Tracts. The lower portion of the stem in large trees is often hollow and decayed. *Bark* grey, or light grey, smooth, with shallow vertical fissures.

The tree is found in Chittagong and Lower Burma, along the coast of Tavoy and Mergui; very abundant in evergreen forests of Lower Burma, especially in Bassein and Tenasserim. Broadly speaking it is the commonest tree of the coastal evergreen hill forests from Akyab to Mergui.

Description of the wood

[Pl. **63**, 374–375]

General properties—No clear colour distinction between sapwood and heartwood. Wood greyish-white to grey, turning yellowish to pale yellowish-brown, occasionally with a pinkish tinge, usually discoloured due to fungal

stain ; rather lustrous when fresh ; soft to moderately hard ; light to moderately heavy (sp. gr. 0·49–0·65 air-dry) ; straight-grained ; even but somewhat coarse-textured, with slight to pronounced silver fleck on radial surface.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct ; occasionally fine concentric bands of parenchyma may, however, delimit the growth rings. *Vessels* moderately large to large, easily visible to the eye, very few to moderately few (1–9 per mm.^{2}), but occasionally in very slow grown portions may be up to 18 per mm.^{2} ; evenly distributed, often solitary or in radial multiples of 2–3, sometimes more, rarely also in clusters, round to oval in outline, occasionally filled with tyloses ; vessel lines conspicuous, clearly visible on the longitudinal surfaces. *Parenchyma* distinct to rather inconspicuous to the eye, (*a*) apotracheal in numerous interrupted or more or less continuous, fairly straight lines, either very closely or widely spaced, lighter in colour than the background ; (*b*) paratracheal, rather inconspicuous under lens in thin sheaths round the vessels, occasionally appearing as "eyelets". *Fibres* indistinct under lens but occasional patches of darker coloured gelatinous fibres visible to the eye. *Rays* apparently of two types, (*a*) moderately broad (containing gum ducts), widely and irregularly spaced, ending rather abruptly and visible to the eye ; (*b*) fine to very fine, visible only under the lens closely spaced. *Gum ducts* horizontal, present in the rays, sometimes noticeable as dark dots on the tangential surfaces under hand lens.

Strength—A moderately strong timber of medium weight but about 20–25% below teak in most of the strength properties. Strength figures are given in appendix I.

Seasoning—The timber is not refractory to seasoning, but should be dried quickly to avoid discolouration due to sap-stain. Green conversion followed by stacking in a ventilated shed has been recommended. It kiln-dries very satisfactorily and kiln-seasoning is, therefore, preferable to air-seasoning. If quick conversion is not possible, storage of logs in running water is desirable to avoid degrade. It is reported that the logs float several months after felling but if left too long, they are liable to decay.

Natural durability—It is not a durable timber and is quickly attacked by fungi and insects and is very susceptible to fungal discolouration in green condition. In the 'graveyard' tests carried out at the Forest Research Institute, Dehra Dun, the average life of the untreated heartwood was found to be 18 months. Rodger states that "when treated with preservative, even by simple painting with crude oil, it seems fairly durable."

Insect and fungus attack—Deadwood is attacked by some borers of Buprestidae and Curculionidae. Newly felled or fallen wood is attacked by shot-hole borers of Platypodidae and Scolytidae. The wood is susceptible

to termite attack also. The timber is easily subjected to sap-stain and wood rotting fungi. The lower portion of large trees sometimes becomes hollow due to decay.

Preservative treatment—Heartwood of this species is treatable but complete penetration is not always obtained.

Working qualities—It is an easy timber to saw and work and is not detrimental to knives or cutters. It does not always finish to a smooth surface, and may require a good filler for polishing. It holds nails well. It has been found to peel well for veneers and is suitable for plywood, provided the logs are free from fungal stain and long buttressed portions are avoided.

Supply and uses—The timber is available in large sizes and in commercial quantities from Tavoy and Mergui in Burma and also from Chittagong. The timber is mainly used for cheap house building and general construction. In Chittagong, it is reported to be used for boats and dug-outs, especially for hulls and keels. It is a good packing case timber for which purpose it was largely used during the last war. It is also suitable for veneers and plywood but due to its easy susceptibility to sap-stain and discoloration it is not considered a first grade wood for the purpose. It is also suitable for match boxes and for second quality splints.

Material—

6068 Chittagong, East Pakistan (0·57), 6069 Chittagong, East Pakistan (0·54), 6278 Chittagong, East Pakistan (0·53), 6344 Burma (0·63), 6396 Burma (0·62), 6853 Burma (0·60), 7416 Chittagong, East Pakistan (0·65), 7674 Chittagong, East Pakistan (0·49), 7675 Chittagong, East Pakistan (0·51).

One sample marked *S. schwenckii* Kurz. (Pl. **63**, Fig. 376) bearing number 6338 from Burma (specific gravity 0·53) in the timber collection shows great similarity in structure with that of *S. floribunda*.

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CORIARIACEAE

The only genus of the family namely *Coriaria*, is dealt with here. It does not produce any important article of commerce. The leaves of *C. myrtifolia* Linn. are, however, sometimes used for tanning leather.

CORIARIA LINN.

A small genus of shrubs and small trees, distributed from the Mediterranean to Japan and New Zealand, and from Chile to Mexico. The only species reported to grow in the Indian region has been dealt with here.

C. nepalensis Wall.—*Gogsa makola* (Garh.), *makola, masuri* (Hind.), *gangaru, gangeru, mosroi* (Jauns.), *balel, tadrelu* (Kash.), *bhojinsi* (Nep.), *archarru, litzaklo, kande, pajerra, raselwa, rau, shala* (Punj.). A straggling shrub or a small tree. *Bark* red or reddish-brown, rough. The whole plant is rich in tannin.

Distributed in the outer Himalaya from Indus to Bhutan ascending to 2,400 m. in North-West and to 3,500 m. in Sikkim. The hill station Mussoorie according to some people derives its name probably from the plant's vernacular name *masuri* as it is very common in the neighbourhood and grows wild all over.

Description of the wood

[Pl. 63, 377]

General properties—Sapwood light yellow to yellowish-brown, heartwood deep brown, hard to very hard (sp. gr. 0·62–0·74 air-dry); straight to slightly interlocked-grained; coarse-textured.

Gross structure—A diffuse-porous wood with a tendency for ring-porousness. *Growth rings* distinct, demarcated by large and more numerous vessels in early wood, 1–2 per cm. *Vessels* very small, individually indistinct even under hand lens, except in the earlywood; mostly in clusters of 3–4 which are visible to the naked eye, particularly in the earlywood, rather unevenly distributed, the clusters being arranged in more or less tangential rows, moderately few to moderately numerous (8–12 per mm^2.), usually more crowded in the earlywood, open; vessel lines distinct in the earlywood. *Parenchyma* vasicentric, forming thin sheath round the vessel-clusters, visible under hand lens. *Rays* broad to very broad, conspicuous to the eye, widely spaced, uniformly distributed forming conspicuous ray-fleck on the radial surface.

It is reported to take a good polish and is very handsomely marked. It has a tendency to crack longitudinally along the rays.

Uses—It can be tried for boxes and small articles. At present used only for firewood.

Material—

68 Simla, Himachal Pradesh (0·73), 2853 Himachal Pradesh (0·74), 2885 Nagkanda, Himachal Pradesh (0·62).

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M. H. KAZMI.

MORINGACEAE

The family *Moringaceae* is composed of single genus *Moringa* Juss.

The family is of little commercial importance. "Ben oil" of commerce is extracted from the seeds of *Moringa* and is used as a lubricant for delicate machinery. The leaves, flowers and young fruits are all eaten as vegetable. A gum is obtained by tapping the bark, which is not of much value. The bark also yields a coarse fibre from which mats, paper or cordages may be prepared.

MORINGA Juss.

The genus, *Moringa* contains about 10 to 12 species, commonly distributed in Africa, Arabia, India and Burma. It consists of small to large deciduous trees, which easily grow from cuttings and are cultivated throughout India and Burma. The only species reported to grow in the Indian region has been dealt with here.

M. pterygosperma Gaertn. (**M. oleifera** Lamk.)—*Sajina* (Asm.), *sohjna, sojna* (Beng.), *danthalun, kyelthatun, ushan* (Burm.), *munga ara, sanjna, sajuna, shajna, sohanjna, sondna, sunjna* (Hind.), *noogay, nugge, nuggi-mara* (Kan.), *mulgia* (Kol.), *muringa, muringo* (Mal.), *munagha, nunigha* (Or.), *shobhanjan, sigru* (Sans.), *swanjera* (Sind.), *moonga* (Santhal), *morunga, murangai* (Tam.), *mulaka, munga, munaga, saihan, sejan* (Tel.). A tree 3–4·5 m. in height. *Bark* grey, corky often with dark patches.

Indigenous in the sub-Himalayan region from East Punjab to north Uttar Pradesh, very common in low forests near rivers ; commonly cultivated throughout India.

Description of the wood

[Pl. **63**, 378]

General properties—Wood white when freshly cut, light yellow to deep yellow on ageing, often with dirty grey patches ; very soft ; very light (sp. gr. 0·32 air-dry) ; straight-grained ; coarse-textured.

Gross structure—A diffuse-porous wood. *Growth rings* indistinct to distinct, as faint marks demarcated by denser bands of fibres, 2–3 per cm. *Vessels* moderately large, few (3–5 per mm^2.) ; unevenly distributed, solitary or in radial multiples of 2–3, occasionally in short clusters, usually oval in shape, open ; vessel lines distinct on longitudinal surfaces. *Parenchyma* not visible to naked eye, distinct under lens (*a*) vasicentric as thin sheath round the vessels ; (*b*) diffuse, in abundance. *Rays* fine to very fine, closely spaced, uniformly distributed. *Ripple marks* distinct to naked eye.

The timber is too soft and light to be used as such except for floats, toys, sandwitched material, etc. Moreover, the timber requires care in kiln-drying otherwise it is liable to become honey-combed. Narayanamurti and Kartar Singh have studied compressed wood from it. Even on unit density basis improvement was noticed in the compressive strength and modulus of rupture in static bending (6).

Improved wood made from this timber may possibly be used in the textile industry for shuttles and picking sticks (5).

Material—

4423 Dehra Dun, Uttar Pradesh (0·32).

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APPENDICES

APPENDIX I.—*Mechanical*

Serial No.	Name of species	Locality from where tested	Specific gravity based on weight oven-dry and volume green	Weight per cu. metre at 12% m.c. in kg.	Shrinkage % green to oven-dry		
					Radial	Tangential	Volumetric
1	2	3	4	5	6	7	8
1	*Aegle marmelos* ..	Gonda, Uttar Pradesh	0 754	897	4·4	8·3	13·1
2	*Aglaia edulis* ..	Assam	0·702	817	4·1	8·4	..
3	*Aglaia* spp. ..	Assam	0·675	..	5·2	10·1	17·1
4	*Amoora rohituka* ..	Nowgong, Assam	0·576	75	3·3	8·3	12·5
5	*Amoora wallichii* ..	Katha, Burma	0·496	641	5·8	10·7	15·8
6	*Atalantia monophylla*	Puri, Orissa	0·786	897	5·1	8·6	13 9
7	*Azadirachta indica* ..	Uttar Pradesh	0 693	833	4·5	6·2	11·6
8	*Boswellia serrata* ..	Hazaribagh, Bihar	0·498	545	2·5	4·5	8·4
9	*Buchanania latifolia* ..	Sambalpur, Orissa	0·454	497	4·1	7·3	11·6
10	*Canarium euphyllum* ..	South Andaman	0·357	416	3·9	6·8	11·6
11	*Canarium strictum* ..	North Mangalore, Mysore	0·532	657	4·8	7·4	13·7
12	*Carapa moluccensis* ..	Burma	0·670	785	3·0	5·5	10·0
13	*Cedrela serrata* ..	Burma	0·474	561	3·8	6·3	10·8
14	*Cedrela toona* ..	Dehra Dun, Uttar Pradesh	0·424	481	3·4	7·3	11·3
15	*Chloroxylon swietenia*	Hoshangabad, Madhya Pradesh	0·771	..	5·8	7·7	13·9
16	*Chloroxylon swietenia*	Vizagapatam, Andhra Pradesh	0·834	961	5·1	6·5	11·3
17	*Chukrasia tabularis* ..	Buxa, Bengal	0·568	673	3·9	6·0	10·9

1 kg./cu. m. = 0·0624 lb./cu. ft.; 1 kg./cm^2 = 14·2233 lb./in.^{2}; 1 cm. = 0·3937 inch; 22·68 kgs. = 50 lb.

Properties of Woods

Condition	Static Bending		Impact bending	Compression parallel to grain	Serial No.
	Modulus of rupture kg. per cm.^{2}	Modulus of elasticity kg. per cm.^{2}	Max. height of drop of a 22·68 kg. hammer in cm.	Max. crushing stress kg./cm.^{2}	
9	10	11	12	13	14
Green	674·7	88,100	89	351·8	1
Air-dry	742·2	100,200	53	495·4	
Green ..	911·4	125,600	130	401·9	2
Air-dry ..	1214·8	135,800	145	596 8	
Green ..	929·5	136,100	130	412 3	3
Air-dry ..	..	..	..	..	
Green ..	733·7	103,562	94	356·7	4
Air-dry ..	965·8	113,475	89	531·2	
Green ..	613·0	107,148	79	309·9	5
Air-dry ..	982·1	130,419	81	581·7	
Green ..	833·9	103,100	58	451·9	6
Kiln-dry ..	1158·8	136,700	..	612·7	
Green ..	728·7	85,200	124	400·0	7
Air-dry ..	913·9	98,600	104	480·8	
Green ..	472·6	72,100	56	221·6	8
Air-dry ..	619·1	78,300	56	309·1	
Green ..	321·9	57,500	41	150·5	9
Kiln-dry ..	522·0	80,300	..	293·9	
Green ..	358·4	80,300	46	169·2	10
Air-dry ..	594·5	103,800	51	352·7	
Green ..	666·6	118,600	79	324·7	11
Air-dry ..	949·3	137,000	89	548·2	
Green ..	781·8	103,600	89	401·3	12
Air-dry ..	1011·6	121,300	76	619·2	
Green ..	582·8	87,700	61	301·7	13
Air-dry ..	909·8	114,700	58	502·9	
Green .	435·7	64,000	58	215 6	14
Air-dry ..	626·9	85,600	38	388·7	
Green ..	908·6	117,000	122	437·9	15
Air-dry ..	..	..	..	..	
Green ..	865·5	115,400	99	478·9	16
Air-dry ..	1272·3	151,900	86	794·5	
Green ..	589·6	83,500	71	284·5	17
Air-dry ..	866·1	113,100	94	508·6	

(*contd.*)

APPENDIX I.—*Mechanical*

Serial No.	Name of species	Locality from where tested	Specific gravity based on weight oven-dry and volume green	Weight per cu. metre at 12% m.c. in kg.	Shrinkage % green to oven-dry		
					Radial	Tangential	Volumetric
1	2	3	4	5	6	7	8
18	*Dysoxylum malabaricum*	South Coimbatore, Madras	0 581	737	4·7	8·1	14·9
19	*Garuga pinnata* ..	Dehra Dun, Uttar Pradesh	0 511	577	3 5	5·3	9·3
20	*Gluta travancorica* ..	Tinnevelly, Madras	0·621	721	3·1	5·7	9 4
21	*Lannea grandis* ..	Dehra Dun, Uttar Pradesh	0·497	561	3·0	5·4	8·4
22	*Lophopetalum wightianum*	North Mangalore, Mysore	0·374	465	3·4	5·5	9·9
23	*Mangifera indica* ..	Puri, Orissa	0·588	657	3 0	4·9	7·3
24	*Melanorrhoea usitata*	Burma	0·737	849	3·6	5·7	9·4
25	*Melia azedarach* ..	Punjab	0·491	..	5·0	8·5	13·5
26	*Nephelium litchi* ..	Dehra Dun, Uttar Pradesh	0 762	..	..	..	..
27	*Parishia insignis* ..	South Andaman	0·410	481	3·9	7·2	13·3
28	*Pistacia integerrima* ..	Jammu and Kashmir	0·733	881	3 9	7·6	10·0
29	*Schleichera trijuga* ..	Burma	0·897	1089	5·5	10·8	17·8
30	*Soymida febrifuga* ..	Madras	0 965	1121	4·2	6·2	11·0
31	*Swintonia floribunda*	Insein, Burma	0·551	641	3·2	6·0	10·8
32	*Zanthoxylum budrunga*	West Bengal	0·496	593	3·7	5·9	9·9
33	*Zanthoxylum rhetsa* ..	Eastern Kanara Div., Mysore	0·609	..	..	..	..
34	*Zizyphus jujuba* ..	Hoshangabad, Madhya Pradesh	0·597	705	4 0	7·0	..

Properties of Woods—(concld.)

Condition	Static Bending		Impact bending	Compression parallel to grain	Serial No.
	Modulus of rupture kg. per cm.^{2}	Modulus of elasticity kg. per cm.^{2}	Max. height of drop of a 22·68 kg. hammer in cm.	Max. crushing stress kg./cm.^{2}	
9	10	11	12	13	14
Green ..	661·2	109,200	104	318·8	18
Air-dry ..	1181·6	141,300	107	620·5	
Green ..	583·4	75,800	81	288·8	19
Air-dry ..	694·8	81,300	58	353·8	
Green ..	677·1	127,300	74	361·2	20
Air-dry ..	945·8	148,500	81	557·3	
Green ..	426·3	56,300	58	196·0	21
Air-dry ..	663·3	71,600	56	324·2	
Green ..	423·0	73,300	46	210 2	22
Air-dry ..	601·6	85,500	41	325·7	
Green ..	612·4	91,300	89	293·9	23
Air-dry ..	904·5	111,900	66	448·2	
Green ..	603·6	97,200	58	374·5	24
Air-dry ..	686·3	112,400	43	533·3	
Green ..	598·7	81,300	130	276 0	25
Air-dry ..	..	..	..	..	
Green ..	698·8	87,500	102	338·3	26
Air-dry ..	..	..	..	..	
Green ..	359·6	78,600	38	171·5	27
Air-dry ..	610·9	117,600	51	340·0	
Green ..	652·7	73,200	117	319·7	28
Air-dry ..	947·4	91,900	112	491·7	
Green ..	1126·6	162,900	142	607·2	29
Air-dry ..	1582·9	181,000	140	746·2	
Green ..	1076·8	122,200	109	599·9	30
Air-dry ..	1549·6	166,100	81	899·2	
Green ..	606·4	115,200	71	288·0	31
Air-dry ..	845·9	133,200	71	404·9	
Green ..	721·8	106,900	91	379·7	32
Air-dry ..	821·5	123,200	84	512·3	
Green ..	775·6	130,200	114	369·3	33
Kiln-dry ..	1296·0	154,200	..	636·0	
Green ..	616·6	66,200	163	282·1	34
Kiln-dry ..	837·1	79,100	155	447·5	

APPENDIX II

CLASSIFICATION OF WOODS ACCORDING TO ANATOMICAL STRUCTURE

(When a character is usually present in a genus or species, the name is printed in roman ; less frequent occurrence is indicated by italics).

I. RING-POROUS

*Cedrela
C. serrata
*Evodia fraxinifolia
*E. meliaefolia
Melia
*M. composita
**Meliosma*
Picrasma quassioides
Pistacia integerrima
Rhamnus purpureus
Rhus
Sapindus mukorossi
*Spondias axillaris

II. VESSELS EXTREMELY LARGE

Ailanthus
Gouania

III. VESSELS EXTREMELY SMALL

Aesculus indica
Anacolosa
Cipadessa
Dodonea
Euonymus
Erythroxylon
Gymnosporia
Ilex
Microtropis
Pistacia terebinthus
Pleurostylia
Staphylea
Strombosia
Turpinia
Zanthoxylum ovalifolium

IV. VESSELS FEW TO VERY FEW

Ailanthus
Dracontomelum
Moringa

V. VESSELS VERY NUMEROUS

Acer
Aesculus indica
Atalantia
Chloroxylon
Erythroxylon
Euonymus
Dodonea
Gymnosporia royleana

* Usually semi-ring-porous.

V. VESSELS VERY NUMEROUS—(*contd.*)

Ilex
Murraya koenigii
Pistacia terebinthus
Pleurostylia
Rhamnus
Skimmia
Staphylea
Turpinia
Ximenia
Zanthoxylum ovalifolium

VI. VESSELS IN LONG RADIAL MULTIPLES OR CHAINS

Cipadessa
Chloroxylon
Dodonea
Erythroxylon
Ilex
Meliosma
Microtropis
Rhus cotinus (latewood)
Strombosia

VII. VESSELS IN FLAME-LIKE PATTERN

Ilex hookeri
Melia azedarach (latewood)
Pistacia integerrima (latewood)
Rhamnus
Skimmia

VIII. VESSELS SOLITARY

Apodytes
Gomphandra
Ixonanthes
Kokoona filiformis
Olax
Phlebocalymna
Staphylea
Turpinia
Ximenia

IX. VESSELS IN CLUSTERS

Coriaria
Melia (latewood)
Meliosma
Picrasma (latewood)
Pistacia integerrima (latewood)
Sapindus mukorossi (latewood)

X. PARENCHYMA IN CONCENTRIC LINES (initial or terminal)

Acer
Acronychia
Aegle
Aesculus
Atalantia
Azadirachta
Carapa
Cedrela
Chloroxylon
Chukrasia
Cipadessa
Citrus
Clausena
Dodonea
Dysoxylum
Erioglossum
Filicium
Glycosmis

X. PARENCHYMA IN CONCENTRIC LINES (initial or terminal)—(*concld.*)

Harrisonia
Heynea
Lepisanthes
Limonia
Melia
Micromelum
Murraya
Picrasma
Pomotia
Rhus
Samadera
Sapindus
Skimmia
Soymida
Swietenia
Vepris
Walsura
Xerospermum glabratum
Zanthoxylum
Zizyphus

XI. PARENCHYMA DIFFUSE TO DIFFUSE AGGREGATE

*Anacolosa
*Apodytes
Arytera
*Balanites
**Erythroxylon*
*Gomphandra
Ilex
*Kurrimia
Mischocarpus
Moringa
Olax
Phlebocalymna
Strombosia

XII. PARENCHYMA IN APOTRACHEAL BANDS ENDING ABRUPTLY

Bouea
Gluta
Ixonanthes
Mangifera
Melanorrhoea
Swintonia

XIII. PARENCHYMA PREDOMINANTLY ALIFORM

†Aglaia perviridis
Ailanthus
Amoora cucullata
Anacardium
Buchanania
†Citrus
Dracontomelum
Drimycarpus
†Feronia
†Harpullia
Holigarna
Mangifera
†Nothopegia
†Picrasma
Samadera
Sandoricum
†*Zizyphus*

XIV. PARENCHYMA PREDOMINANTLY CONFLUENT

Aglaia
Acronychia
Clausena
Evodia roxburghiana
Heynea
Murraya koenigii
Nothopegia
Sapindus
Walsura
Zizyphus xylopyrus

* Usually with tendency towards reticulate arrangement.
† Usually with tendency towards confluent type.

XV. PARENCHYMA BANDED

‡Allophylus
Amoora rohituka (narrow bands)
‡Averrhoa
Chisocheton
Dysoxylum (except D. malabaricum)
‡Elaeodendron
Erioglossum
‡Gymnosporia
Irvingia
Kokoona
Lansium (narrow bands)
Lepisanthes
Lophopetalum (narrow bands)
Mappia
Microtropis (narrow bands)
‡Paranephelium
Pleurostylia
Schoepfia

XVI. RAYS CONSPICUOUS

Ailanthus
Balanites
Coriaria
Evodia meliaefolia
Gomphandra
Ilex
Meliosma
Phlebocalymna

XVII. RIPPLE MARKS

Aesculus indica
Balanites
Carapa
Chloroxylon
Moringa
Picrasma
Schoepfia
Swietenia

XVIII. LONGITUDINAL GUM CANALS (traumatic)

Aegle
Ailanthus
Atalantia
Azadirachta
Balanites
Carapa
Cedrela
Chukrasia
Chloroxylon
Citrus
Dracontomelum
Feronia
Gluta
Heynea
Limonia
Melia
Micromelum
Murraya
Sandoricum
Soymida
Swietenia
Zanthoxylum

XIX. RADIAL GUM CANALS

Balsamodendron
Boswellia
Buchanania
Garuga
Gluta
Lannea
Mangifera longipes
Parishia
Pistacia
Rhus
Spondias
Swintonia

‡ Bands are due to septate fibres or parenchyma intermixed with septate fibres..

XX. WOOD LIGHT TO VERY LIGHT

Acer
Aesculus
Ailanthus
Balsamodendron
Buchanania
Canarium euphyllum
Cedrela
Evodia
Holigarna
Melia composita
Meliosma
Moringa
Picrasma
Rhus
Samadera
Sandoricum
Semecarpus
Spondias

XXI. WOOD VERY HEAVY

Anacolosa
Atalantia
Chloroxylon
Dodonea
Erythroxylon
Filicium
Irvingia
Lansium
Lepisanthes
Limonia
Murraya exotica
Nephelium
Rhamnus persicus
Sapindus
Schleichera
Soymida
Vepris bilocularis
Walsura
Zizyphus trinervia
Xerospermum ferrugineum

APPENDIX III

CLASSIFICATION OF WOODS ACCORDING TO USES

AGRICULTURAL IMPLEMENTS

(Ploughs, yokes, harrows, etc.)

Aegle marmelos
Aglaia spp.
Arytera littoralis
Bouea burmanica
Carapa spp.
Feronia elephantum
Filicium decipiens
Heynea trijuga
Lepisanthes tetraphylla
Melanorrhoea spp.
Murraya koenigii
Pometia pinnata
Schleichera trijuga
Soymida febrifuga
Walsura spp.
Zizyphus spp.

ARTIFICIAL LIMBS

Acer spp.
Aesculus indica
Lophopetalum wightianum

BEARINGS

Soymida febrifuga

BOAT BUILDING

(*a*) *Catamarans*

Ailanthus spp.
Balsamodendron mukul
Canarium euphyllum
Meliosma spp.
Melia composita
Moringa pterygosperma
Samadera indica

(*b*) *Dug-outs*

Amoora spp.
Dysoxylum binectariferum
Garuga spp.
Holigarna spp.
Lannea grandis
Mangifera indica
Swintonia

(*c*) *Hulls*

Carapa spp.
Dysoxylum malabaricum
Mangifera spp.
Swietenia spp.
Zanthoxylum spp.

(*d*) *Masts and spars*

Pometia pinnata

(*e*) *Oars*

Amoora wallichii
Chukrasia spp.
Drimycarpus racemosus
Mangifera spp.
Semecarpus spp.
Zanthoxylum spp.

BOBBINS AND SHUTTLES

Acer spp.
Chloroxylon swietenia
Chukrasia spp.
Dysoxylum malabaricum
Lophopetalum wightianum
Mangifera spp.
Swietenia spp.
Zanthoxylum spp.

BOOT LASTS AND SHOE HEELS

Acer spp.
Aesculus indica (shoe heels)
Boswellia serrata (shoe heels)
Lannea grandis
Lophopetalum spp. (shoe heels)
Mangifera indica (shoe heels)
Samadera indica (shoe heels)
Sandoricum indicum (shoe heels)
Zizyphus jujuba

Brushbacks

Acer spp.
Aesculus spp.
Cedrela spp.
Chloroxylon swietenia
Chukrasia tabularis
Dysoxylum malabaricum
Lannea grandis
Murraya exotica
Samadera indica
Swietenia spp.
Zanthoxylum spp.

Buoys and floats

Balsamodendron mukul
Canarium euphyllum
Meliosma spp.
Moringa pterygosperma
Samadera indica
Spondias spp.

CARTS

Azadirachta indica
Bursera serrata
Elaeodendron glaucum
Mangifera indica

(*a*) *Axle and hubs*

Aegle marmelos
Chloroxylon swietenia
Feronia elephantum
Filicium decipiens
Limonia acidissima
Schleichera trijuga
Soymida febrifuga
Walsura spp.

(*b*) *Felloes of wheels*

Apodytes spp.
Carapa spp.
Chloroxylon swietenia
Clausena willdenowii
Filicium decipiens
Mangifera indica
Schleichera trijuga
Vepris bilocularis
Zizyphus spp.

(*c*) *Shafts*

Aeglo marmelos
Chloroxylon swietenia
Filicium decipiens
Schleichera trijuga
Walsura spp.
Zizyphus spp.

(*d*) *Spokes*

Apodytes spp.
Carapa spp.
Chloroxylon swietenia

COOPERAGE

(*a*) *Dry*

Boswellia serrata
Lannea grandis
Mangifera indica

(*b*) *Wet*

Acer spp.
Boswellia serrata
Dysoxylum malabaricum (oil casks and vats)
Mangifera indica
Pomotia pinnata

CIGAR BOXES

Cedrela spp.
Melia azedarach
Melia composita

FURNITURE AND CABINET MAKING

Acer spp.
Aesculus spp.
Aglaia spp.
Amoora spp.
Atalantia spp.
Azadirachta indica
Boswellia serrata (cheap)
Buchanania spp. (cheap)
Canarium spp. (cheap)
Carapa spp. (high class)
Cedrela spp.
Chisocheton spp.
Chloroxylon swietenia (high class)
Chukrasia tabularis (high class)
Dysoxylum malabaricum (high class)
Evodia roxburghiana
Garuga spp.
Ixonanthes khasiana
Lannea grandis (cheap)
Lepisanthes tetraphylla

FURNITURE AND CABINET MAKING—(*concld.*)

Lophopetalum wightianum (cheap)
Mangifera indica (cheap)
Melia azedarach
Murraya exotica
Pistacia integerrima
Pleurostylia wightii
Pometia pinnata
Samadera indica (cheap)
Sandoricum indicum (cheap)
Soymida febrifuga
Swietenia spp. (high class)
Zanthoxylum spp.

HOUSE BUILDING

(*a*) *Ceiling*

Amoora rohituka
Cedrela spp.
Chukrasia tabularis
Dysoxylum spp.
Evodia spp.
Lophopetalum wightianum
Mangifera indica
Melia composita
Pometia pinnata
Zanthoxylum spp.

(*b*) *Flooring*

Cedrela spp.
Chukrasia tabularis (parquet)
Dysoxulum spp.
Filicium decipiens
Gluta spp.
Kurrimia spp.
Mangifera indica
Pometia pinnata
Schleichera trijuga
Soymida febrifuga

(*c*) *Posts*

Aegle marmelos
Aglaia spp.
Anacolosa densiflora
Bursera serrata
Carapa spp.
Chukrasia tabularis
Filicium decipiens
Heynea trijuga
Kurrimia spp.
Lannea grandis
Lansium anamalayanum
Limonia acidissima
Nothopegia colebrookiana
Schleichera trijuga
Soymida febrifuga
Zanthoxylum spp.
Zizyphus spp.

(*d*) *Rafters*

Dysoxylum spp.
Garuga spp.
Mangifera indica
Pometia pinnata

(*e*) *General*

Aglaia spp.
Amoora spp.
Anacolosa densiflora
Boswellia serrata
Buchanania spp.
Carapa spp.

HOUSE BUILDING—(*concld.*)

(*e*) *General*—(*concld.*)

Cedrela spp.
Chailletia gelonioides
Chisocheton spp.
Dracontomelum mangiferum
Drimycarpus racemosus
Dysoxylum spp.
Elaeodendron glaucum
Erioglossum rubiginosum
Garuga spp.
Ixonanthes khasiana
Lannea grandis
Lepisanthes tetraphylla
Lophopetalum wightianum
Mangifera indica
Sandoricum indicum
Sapindus spp.
Schleichera trijuga
Soymida febrifuga
Strombosia ceylanica
Swintonia floribunda
Walsura spp.
Xerospermum spp.

MARINE PILES AND HARBOUR WORK

Melanorrhoea usitata
Nephelium spp.
Soymida febrifuga

MATCHES

Ailanthus spp.
Canarium spp.
Dracontomelum mangiferum
Dysoxylum malabaricum
Evodia fraxinifolia
Evodia roxburghiana
Holigarna spp.
Lannea grandis
Lophopetalum wightianum
Semecarpus spp.
Spondias spp.
Swintonia floribunda

MATHEMATICAL INSTRUMENTS

Aesculus spp.
Atalantia spp.
Averrhoa carambola (cheap foot rules)
Cedrela toona (cheap foot rules)
Chloroxylon swietenia
Dysoxylum malabaricum
Feronia elephantum
Ilex spp.
Limonia acidissima
Mangifera indica (cheap foot rules)
Murraya exotica
Nothopegia colebrookiana
Samadera indica (cheap foot rules)
Zanthoxylum spp.

MINE AND PITPROPS

Lannea grandis
Melanorrhoea spp.
Nothopegia colebrookiana
Schleichera trijuga
Soymida febrifuga

OIL AND SUGAR MILL ACCESSORIES

Aegle marmelos
Chloroxylon swietenia
Feronia elephantum
Filicium decipiens
Limonia acidissima
Schleichera trijuga
Soymida febrifuga
Zizyphus jujuba

MUSICAL INSTRUMENTS

Acer spp.
Azadirachta indica (drums)
Canarium euphyllum (guitars)
Cedrela spp.
Garuga pinnata (drums)
Melia composita
Rhus wallichii
Swietenia spp.

PACKING CASES

Ailanthus spp.
Amoora spp.
Boswellia serrata
Buchanania spp.
Canarium spp.
Cedrela spp.
Dysoxylum spp.
Evodia fraxinifolia
Evodia roxburghiana
Garuga pinnata
Gomphandra polymorpha
Harpullia cupanioides
Holigarna spp.
Lannea grandis
Lophopetalum spp.
Mangifera indica
Melia spp.
Parishia insignis
Samadera indica
Sandoricum indicum
Semecarpus spp.
Spondias spp.
Swintonia floribunda
Zanthoxylum rhetsa

PENCILS

Carapa obovata
Cedrela spp.
Garuga pinnata
Holigarna spp.
Lannea grandis
Lophopetalum wightianum
Melia composita
Swietenia spp.

PEN HOLDERS

Atalantia spp.
Carapa spp.
Cedrela spp.
Chukrasia tabularis
Dysoxylum malabaricum
Feronia elephantum
Holigarna spp.
Lannea grandis
Mangifera indica
Melia spp.
Murraya exotica
Zanthoxylum spp.

POLES

Garuga pinnata
Pometia pinnata
Schleichera trijuga

RAILWAY SLEEPERS

(*a*) *Treated* (with or without incision)

Chukrasia tabularis
Lannea grandis
Mangifera indica
Schleichera trijuga

(*b*) *Untreated* (all heart)

Bursera serrata
Chloroxylon swietenia

RAILWAY CARRIAGE AND WAGON BUILDING

Amoora spp.
Cedrela toona
Chloroxylon swietenia
Chukrasia tabularis
Dysoxylum malabaricum
Filicium decipiens
Schleichera trijuga

RICE POUNDERS

Arytera littoralis
Erioglossum rubiginosum
Filicium decipiens
Lannea grandis (heartwood)
Limonia acidissima
Schleichera trijuga
Soymida febrifuga
Zizyphus spp.

SPORTING REQUISITES

(*a*) *Billiard cue*

Dysoxylum malabaricum

(*b*) *Golf clubs*

Carapa spp.
Citrus aurantium
Chloroxylon swietenia

(*c*) *Gun and rifle stocks*

Acer spp.
Pistacia integerrima

(*d*) *Racquets* (Badminton, Squash and Tennis)

Acer spp.
Cedrela toona
Mangifera indica
Melia azedarach
Swietenia spp.

TENT POLES AND TENT PEGS

Aglaia spp.
Chailletia gelonioides
Chloroxylon swietenia
Dysoxylum malabaricum
Schleichera trijuga
Zizyphus spp.

TOOL HANDLES AND HELVES

Acer spp. (small tools)
Aegle marmelos (small tools)
Aglaia spp.
Amoora spp.
Arytera littoralis
Atalantia spp.
Carapa spp. (small tools)
Chloroxylon swietenia (small tools)
Chukrasia tabularis (small tools)
Clausena spp.
Erioglossum rubiginosum
Filicium decipiens
Lepisanthes tetraphylla
Limonia acidissima (small tools)
Murraya exotica
Pistacia integerrima (small tools)
Pometia pinnata
Rhamnus purpureus
Rhus wallichii
Schleichera trijuga
Skimmia laureola
Vepris bilocularis
Zanthoxylum ovalifolium
Zanthoxylum rhetsa
Zizyphus spp.

TOOTHPICKS AND WATCHMAKERS' PEGS

Acer spp.
Aesculus spp.
Euonymus spp.
Staphylea emodi

TOYS AND CARVED ARTICLES

Acer spp.
Acronychia laurifolia
Aegle marmelos
Aesculus spp.
Amoora spp.
Anacolosa densiflora
Atalantia spp.
Averrhoa carambola
Azadirachta indica
Balsamodendron mukul
Buchanania spp.
Carapa spp.
Cedrela spp.
Chloroxylon swietenia
Chukrasia tabularis
Cipadessa fruiticosa
Citrus spp.
Dodonea viscosa
Dysoxylum spp.
Euonymus spp.
Feronia elephantum
Gymnosporia spp.
Ilex spp.
Limonia acidissima
Mangifera spp.
Melia azedarach
Murraya exotica
Pistacia integerrima
Pleurostylia wightii
Rhamnus spp.
Samadera indica
Sandoricum indicum
Swietenia spp.
Turpinia pomifera
Ximenia americana
Zanthoxylum ovalifolium

VENEERS AND PLYWOOD

Acer spp. (commercial and marine)
Ailanthus spp.
Amoora spp.
Canarium spp.
Cedrela spp.
Chloroxylon swietenia (decorative)
Chukrasia spp. (decorative)
Dysoxylum malabaricum (decorative and marine)
Evodia roxburghiana
Garuga spp.
Holigarna spp.
Lannea grandis
Lophopetalum wightianum
Mangifera indica
Melia azedarach (decorative)
Melia composita
Parishia insignis
Sandoricum indicum
Spondias spp.
Swietenia spp. (marine and decorative)
Swintonia floribunda
Zanthoxylum rhetsa (aircraft)

APPENDIX IV

LATEST CHANGES IN NOMENCLATURE OF THE SPECIES DEALT WITH IN THE BOOK

Names given in the book	*Latest names**
ERYTHROXYLACEAE	
Erythroxylum burmanicum Griff.	Erythroxylum cuneatum (Wall.) Kurz.
ZYGOPHYLLACEAE	
Balanites roxburghii Planchon	Balanites aegyptiaca (L.) Delile
RUTACEAE	
Acronychia laurifolia Bl.	Acronychia pedunculata (L.) Miq.
Atalantia missionis Oliv.	Pamburus missionis (Wt.) Swingle
Citrus decumana Linn.	Citrus maxima (Burm.) Merr.
Clausena wampi Blanco	Clausena lansium (Lour.) Skeels.
Clausena willdenowii W. & A.	Clausena dentata (Willd.) Roem.
Evodia roxburghiana Benth.	Evodia lunu-ankenda (Gaertn.) Merr.
Feronia elephantum Correa	Feronia limonia (L.) Swingle
Limonia acidissima Linn.	Hesperethusa crenulata (Roxb.) Roem.
Murraya exotica Linn.	Murraya paniculata (L.) Jack.
Zanthoxylum budrunga Wall.	Fagara budrunga Roxb.
Zanthoxylum hamiltonianum Wall.	Fagara hamiltoniana (Wall.) Engl.
Zanthoxylum ovalifolium Wight.	Fagara ovalifolia (Wt.) Engl.
Zanthoxylum oxyphyllum Edgew.	Fagara oxyphylla (Edgew.) Engl.
Zanthoxylum rhetsa DC.	Fagara rhetsa Roxb.
SIMARUBACEAE	
Ailanthus malabarica DC.	Ailanthus triphysa (Dennst.) Alston
Harrisonia bennettii Hook. f.	Harrisonia perforata (Blanco) Merr.
BURSERACEAE	
Bursera serrata Colebr.	Protium serratum Engl.
Garuga gamblei King	Garuga floribunda Decaisne var. gamblei (King ex Smith) Kalkman

*Kindly supplied by Shri M. B. Raizada, Head of the Division of Forest Botany, Forest Research Institute, Dehra Dun.

MELIACEAE

Amoora rohituka W. & A.	Aphanamixis polystachya (Wall.) Parker
Carapa muluccensis Lam.	Xylocarpus molluccensis (Lam.) Roem.
Carapa obovata Bl.	Xylocarpus granatum Koen.
Chukrasia tabularis A. Juss.	Chukrasia velutina W. & A.
Cipadessa fruticosa Bl.	Cipadessa baccifera (Roth.) Miq.
Dysoxylum purpureum Bourd.	Dysoxylum ficiforme Gamble
Sandoricum indicum Cav.	Sandoricum koetjape Merr.

DICHAPETALACEAE

Chailletia gelonioides Hook. f.	Dichapetalum gelonioides (Roxb.) Engl.

OLACACEAE

Phlebocalymna griffithiana Mast.	Gonocaryum griffithianum Kurz

ICACINACEAE

Gomphandra axillaris Wall.	Stemonurus axillaris (Wall. ex Lindl.) Miers
Gomphandra polymorpha Wight.	Stemonurus polymorpha Miers
Mappia foetida Miers	Nothapodytes foetida (Wt.) Sleum.

AQUIFOLIACEAE

Ilex sulcata Wall.	Ilex umbellata (Wall.) Loes.

CELASTRACEAE

Gymnosporia emarginata Roth.	Gymnosporia emarginata Thw.
Gymnosporia montana Lawson	Gymnosporia spinosa (Forsk.) Fiori
Gymnosporia royleana Wall.	Gymnosporia royleana Laws.
Gymnosporia rufa Wall.	Gymnosporia rufa Laws.
Kurrimia pulcherrima Wall.	Kurrimia robusta (Roxb.) Kurz

RHAMNACEAE

Rhamnus nepalensis Wall.	Rhamnus napalensis (Wall.) Laws.
Scutia indica Brongn.	Scutia circumcissa (L. f.) Radlk.
Zizyphus jujuba Lam.	Zizyphus mauritiana Lam.
Zizyphus trinervia Roxb.	Zizyphus glabrata Heyne ex Roth
Zizyphus vulgaris Lam.	Zizyphus jujuba Mill.

	SAPINDACEAE
Dodonaea viscosa L.	Dodonaea viscosa (L.) Jacq.
Nephelium litchi Camb.	Litchi chinensis Sonner.
Nephelium longana Camb.	Euphoria longana Lamk.
Nephelium stipulaceum Bedd.	Otonephelium stipulaceum (Bedd.) Radlk.
Sapindus laurifolius Vahl	Sapindus emarginatus Vahl
Schleichera trijuga Willd.	Schleichera oleosa (Lour.) Oken
	ACERACEAE
Acer pictum Thunb.	Acer monomarmoratum (Nichols.) Rehd.
	HIPPOCASTANACEAE
Aesculus punduana Wall.	Aesculus assamica Griff.
	SABIACEAE
Meliosma arnottiana Wight.	Meliosma microcarpa (W. & A) Craib.
Meliosma dilleniaefolia Bl.	Meliosma dilleniaefolia (W. & A.) Walp.
Meliosma simplicifolia Roxb.	Meliosma simplicifolia (Roxb.) Walp.
	ANACARDIACEAE
Bouea burmanica Griff.	Bouea oppositifolia (Roxb.) Adelb.
Buchanania latifolia Roxb.	Buchanania lanzan Spreng
Gluta coarctata Hook. f.	Gluta velutina Bl.
Holigarna longifolia Roxb.	Holigarna caustica (Dennst.) Oken
Lannea grandis Engl.	Lannea coromandelica (Houtt.) Merr.
Rhus cotinus Linn.	Cotinus coggygria Scop.
Rhus mysorensis Heyne	Rhus mysorensis G. Don
Rhus semialata Murray	Rhus chinensis Mill.
Spondias acuminata Roxb.	Poupartia axillaris King & Prain
Spondias mangifera Willd.	Spondias pinnata (L. f.) Kurz
Swintonia schwenckii Kurz	Swintonia schwenckii Teysm & Binn. ex Kurz
	MORINGACEAE
Moringa pterygosperma Gaertn.	Moringa oleifera Lamk.

INDEX I

SCIENTIFIC NAMES

The references in heavy type are to the detailed accounts of the various species.

	PAGE
Acer Linn.	47, 240, 241, **241–248**
caesium Wall. ..	**242**, 244, **245–248**
campbellii Hook. .. .	**242**, 245–248
campestre Linn.	241
caudatum Wall. .	**242–243**, 245–248
cultratum Wall.	240
hookeri Miq.	**243**, 245–248
laevigatum Wall.	**243**, 245–248
macrophyllum Pursh. ..	241, 246
monomarmoratum (Nichols) Rehd.	**244**
negundo Linn. .. .	240
nigrum Michx. f. .. .	240, 241
niveum Bl. .. .	242
oblongum Wall.	**243**, 245–248
palmatum Thunb.	241
papilio King.	240
pectinatum Wall. .. .	243
pentapomicum J. L. Stewart	**243–244**, 245–248
pictum Thunb. .. .	**244**, 245–248
platanoides Linn.	241
pseudoplatanus Linn. ..	241, 246, 247
rubrum Linn.	241
saccharinum Linn.	241, 246, 247
saccharum Marsh. ..	240, 241, 245, 246
sikkimense Miq.	**244**, 245–248
species	245, 246
thomsonii Miq. .. .	**244**, 245–248
villosum Wall.	240, **244–248**
Aceraceae	207, 208, **240–249**, 266
Acronychia Forst. .. .	16, **16–17**
bauері Schott ..	17
laurifolia Bl. ..	**16–17**
pedunculata (L.) Miq. ..	**16**
porteri Hook. f.	17
Actinocheita F. A. Barkley ..	305
Adina cordifolia Hook. f. ..	46
Aegle Correa	13, 15, 16, **17–20**
marmelos (Linn.) Correa .	14, **18–20**
Aeschrion excelsa (SW.) Kuntze.	50
Aesculus Linn. . ..	250, **250–254**
assamica Griff.	**251**
glabra Willd.	250, 253
hippocastanum Linn. ..	250, 252, 253
indica Colebr. .	250, **251**, 251–254
octandra Marsh.	250, 253
punduana Wall. ..	250, 251, **251–254**
turbinata Bl.	250
Aglaia Lour.	83, 84, 89, **89–93**, 132
andamanica Hiern.. ..	88, 89, **89, 91–93**, 100
argentea Bl.	**90, 91–93**

	PAGE
Aglaia Lour.	
barberi Gamble ..	89
bourdillonii Gamble .	89
canarensis Gamble .	89
clarkii Merr. . .	93
crassinervia Kurz .	89
diffusa Merr. .	93
edulis A. Gray .	**90, 91–93**
fusca King	89
ganggo Miq. . ..	89
glaucescens King	89
griffithii Kurz . .	89
harmsiana Perkins . ..	93
haslettiana Haines	89
khasiana Hiern	89
laevigata Merr.	93
luzoniensis Merr. & Rolfe	93
maiae Bourd.	**90, 91–93**
minutiflora Bedd.	89
odoratissima Bl.	**90–93**
oligophylla Miq.	89
paniculata Kurz	89
perviridis Hiern	**90, 91–93**
Ailanthus Desf . ..	50, 51, 52, **52–55**, 73
altissima (Mill.) Swingle	50, 51, 52
excelsa Roxb.	**53, 54–55**
glandulosa Desf.	52
grandis Prain ..	51, **53, 54–55**
kurzii Prain	**53, 54–55**
malabarica DC. ..	51, 52, **53–55**
species	51
triphysa (Dennst.) Alston ..	53
Akaniaceae .	207
Allophylus Linn.	211, 212, **213–215**
cobbe Bl.	214, **214–215**, 228
zeylanicus Linn. . .	214
Alvaradoa Liebm. .. .	50
Amoora Roxb. ..	83, 84, 89, 94–100, 132, 134
canarana Benth. & Hook. ..	94
chittagonga Hiern .	94
cucullata Roxb. ..	88, 94, **94–95**, **97–100**
lawii Bedd. ..	94
mani King ..	94
nitidula Benth.	94
rohituka W. & A. ..	81, 84, 89, 94, **95–97**
wallichii King	84, 88, 94, **97–100**, 127, 128
Anacardiaceae ..	240, **264–323**
Anacardium Linn. ..	265, 267, **268–270**
excelsum (Bert. & Balb.) Skeels	269, 270
occidentale Linn.	264, 265, 268, **268–270**

	PAGE
Anacolosa Bl.	162, 162–163
densiflora Bedd. . ..	163
griffithii Mast.	163
ilicoides Mast. .. .	163
puberula Kurz	163
Andersonia rohituka R. .	95
Aneulophus Benth.	4
Anogeissus latifolia Wall. ..	286
Anonaceae	215
Aphanamixis Bl. .. .	94
polystachya (Wall.) Parker ..	81, 84, 95
Aphania Bl.	210
danura (Roxb.) Radlk. ..	210
rubra (Roxb.) Radlk. ..	210
Apodytes C. E. Mey ..	170, 171, 171 172
beddomei Mast. . ..	171
benthamiana Wight ..	171
cambodiana Pierre ..	171–172
dimidiata E. May	170
Aquifoliaceae	175–179
Arytera Bl.	209, 211, 213, 215, 223
littoralis Bl.	215, 224
Astronium Jacq.	265
species .. .	265
Atalantia Correa	15, 16, 20–21
caudata Hook. f.	20
ceylanica Oliv. .. .	20
macrophylla Kurz	20
missionis Oliv. .. .	20, 20–21
monophylla Correa ..	14, 20–21
racemosa W. & A. . .	20
Aucoumea klaineana Pierre .	64, 146
Averrhoa Linn.	10, 10–11, 212
bilimbi Linn. .. .	10
carambola Linn. .	10, 10–12
Azadirachta A. Juss.. ..	84, 87, 100–103
indica A. Juss. . .	81, 85, 100, 101–103, 135
integrifolia Merr.	100, 103
Balanitaceae	7
Balanites Delile . .	7, 8, 8–9
aegyptiaca (Linn.) Delile	7, 8
roxburghii Planchon	8–9
triflora Van Tieg ..	8
Balfourodendron riedelianum Engl	14
Balsamodendron Kunth. .	64, 65, 66–67
mukul Hook. . ..	65, 66, 66–67
roxburghii Arn. . ..	66
Barsoma betulina Bart et Wendl	14
Beddomea Hook. f. .. .	85
indica Hook. f. . ..	85
simplicifolia Bedd. . .	85
Berchemia floribunda Wall.	196
Betula species	126, 146
Billia Peyr. . ..	250
Blighia sapida Koen.	208
Boswellia Roxb. ex Colebr. .	64, 65, 67–71
carterii Birdw.	64
frereana Birdw. .	64
serrata Roxb. . ..	67, 68–71, 286
Bouea Meissn. .	265, 268, 270–271
burmanica Griff. ..	270, 270–271
oppositifolia (Roxb.) Adelb. ..	270
macrophylla Griff.	271
microphylla Hook. f. ..	271
Brucea Mill. .. .	51
Brucea Mill.	
amarissima (Lour.) Merril. ..	51
mollis Wall.	51
sumatrana Roxb.	51
Buchanania Roxb.	265, 266, 267, 271–275
acuminata Turcz.	272
angustifolia Roxb.	272, 273–275
arborescens Bl. ..	274
barberi Gamble	272
florida Schauer	272
glabra Wall. ..	272
lanceolata Wight ..	272
lancifolia Roxb. . ..	272, 273–275
lanzan Spreng. . ..	272
latifolia Roxb.	264, 272–275
mangifera Roxb.	264
platyneura Kurz	272
species	274
Bulnesia C. Gay	7
Bursera Linn.	65, 71–72
aloexylon Engl.	71
delpechiana Poiss. ex Engl. .	71
gummifera Linn.	71
serrata Colebr.	64, 65, 71, 71–72
tomentosa Planch. . ..	71
Burseraceae . ..	64–80, 208, 218
Butea monosperma (Lam.) Taubert.	273
Buxus spp.	14
Byronia Endl.	175
Campnosperma Thw.	265
Canarium Linn.	64, 65, 66, 73–76
album Raeusch.	64
bengalense Roxb.	73, 74, 74–76
commune Linn. .. .	64
euphyllum Kurz	64, 65, 73, 74, 74, 74–76, 146
luzonicum, A. Gray ..	64, 73
ovatum Engl.	64
pimela Koen.	64
resiniferum Bruce ex King ..	73
sikkimense King	73
species	65
strictum Roxb.	73, 74–76
Cantleya corniculata (Becc) Howard	170
Carapa Aubl.	84, 85, 86, 87, 103–107
guianensis Aubl.	82, 104, 146
obovata Bl.	104, 105–107
moluccensis Lam. ..	104, 105, 106–107
species ..	81, 146
Carya species	115
Castela Turp.	51
Ceanothus americanus Linn. ..	195
Cedrela Linn.	82, 83, 84, 85, 108–115
febrifuga C. DC.	108
kingii C. DC.	108
microcarpa C. DC.	86, 108, 108, 111–115
multijuga Kurz	108
odorata Linn.	83
serrata Royle	86, 108, 109–110
species	86, 146
toona Roxb.	81, 86, 108, 110–115, 146, 252

	PAGE
Celastraceae	180–194, 212
Celastrus Linn.	180
Chailletia DC.	160–161
andamanica King	160
gelonioides Hook. f.	160–161
helferiana Kurz	160
longipetala Turez	160
Chisocheton Bl.	84, 88, 115–117
divergens Bl.	115, 116–117
grandiflorus Kurz	115–116, 116–117
paniculatus Hiern	116–117
species	82
Chloroxylon DC.	13, 14, 15, 21–24, 83
swietenia DC.	14, 15, 21–24
Chukrasia A. Juss.	84, 85, 87, 117–121
tabularis A. Juss.	81, 82, 117, 117–118, 118–120, 124, 146
velutina Roem.	117, 118–120
velutina W. & A.	117
Cipadessa Bl.	83, 84, 87, 121–122
baccifera (Roth.) Miq.	121
fruticosa Bl.	121–122
Citronella gongonha (Mart.) Howard	170
Citrus Linn.	13, 15, 16, 24–27
aurantium Linn.	25, 26–27
bergamia Risso	14
decumana Linn.	25, 26–27
maxima (Burm.) Merr.	25
medica Linn.	25–27
Clausena Burm.	3, 15, 27–29
dentata (Willd.) Roem.	29
excavata Burm. f.	16, 28, 28–29
heptaphylla W. & A.	27
indica Oliv.	27
lansium (Lour.) Skeels	28
macrophylla Hook. f.	27
pentaphylla DC.	27
suffruticosa W. & A.	27
wallichii Oliv.	27
wampi Blanco	16, 27, 28, 28–29
willdenowii W. & A.	16, 28, 29
Commiphora Jacq.	64, 65, 66
molmol Engl.	66
mukul (Hook. ex Stock) Engl.	66
Corchorus species	1
Coriaria Linn.	324, 324–325
myrtifolia Linn.	324
nepalensis Wall.	324–325
Coriariaceae	324–325
Cornus species	115
Cotinus (Tourn.) Mill.	305
americanus Nutt.	307
coggygria Scop.	306
Cupania Plum.	209, 223
adenophylla Planch	215
fuscidula Kurz	209
glabrata Hiern	209
jackiana Hiern	209
lessertiana Camb.	223
sumatrana Miq.	223
Dacryodes Vahl	65
Dichapetalaceae	160–161
Dichapetalum Thou.	160, 160
gelonioides (Roxb.) Engl.	160
toxicarium Engl.	160
Diospyros virginiana Linn.	115

	PAGE
Dipterocarpus Gaertn. f.	122
tuberculatus Roxb.	273, 296
Dipteronia Oliver	240, 241
Dobinea Buch.-Ham.	240, 266
delavayi Baill.	240
vulgaris Ham.	240
Dodonea Linn.	211, 213, 215–217
viscosa Linn.	209, 215–217, 217
Dracontomelum Bl.	267, 275–277
dao (Blanco) Merr. & Rolfe	275, 276, 277
edule	276
mangiferum Bl.	275, 275–277
Drimycarpus Hook. f.	267, 277–279
recemosus Hook. f.	277–279
Dysoxylum Bl.	82, 83, 84, 88, 122–130
alliacium Bl.	83, 122
andamanicum King	122
arborescens Miq.	122
beddomei Hiern	122
binectariferum Hook. f.	123, 128–130
ficiforme Gamble	128
fraseranum Benth.	82, 83, 122, 127, 146
glandulosum Talbot	125
grande Hiern	122
hamiltonii Hiern	89, 122, 123, 123–124
loureiri Pierre	122
malabaricum Bedd.	82, 83, 84, 87, 121, 122, 123, 124–127, 128
muelleri Benth.	122
oliveri Brandis	122
pallens Hiern	122
procerum Hiern	127–128, 128–130
purpureum Bourd.	128–130
reticulatum King	122
rufum Benth.	122
thyrsoideum Griff.	122
Elaeodendron Jacq. fil.	180, 181, 181–182
glaucum Pers.	181–182
subrotundum King	181
Elaphrium Jacq.	65
Entandrophragma C. DC.	146
cylindricum Spr.	82
Erioglossum Bl.	210, 211, 212, 217–218
rubiginosum Bl.	217–218
Erythroxylaceae	4–6
Erythroxylum Linn.	4, 4–6
acuminatum Walp.	4
burmanicum Griff.	4, 4, 5–6
coca Lam.	4
cuneatum (Wall.) Kurz	4
kunthianum Wall.	4, 5, 5–6
lanceolatum Hook. f.	4
monogynum Roxb.	4, 5–6
obtusifolium Hook. f.	4
Esenbeckia alata Pittier	14
Euonymus Linn.	180, 182–185
alatus Reg.	180
crenulatus Wall.	182, 184
europaeus Linn.	180
frigidus Wall.	183, 184
hamiltonianus Wall.	183, 184
javanicus Bl.	183, 184
lacerus Ham.	183, 184
pendulus Wall.	183, 184–185

	PAGE
Euonymus Linn.	
species	180
theaefolius Wall.	183, 184–185
tingens Wall.	183–185
Euphoria Comm.	224
didyma Blanco	226
longana Lamk.	225, 225
Eurycoma Jack	51
longifolia Jack	51
Euxylophora paraensis Huber	14
Evodia Forst.	15, 30–33
fraxinifolia Hook. f.	15, 30, 30, 31–32
glabra Bl.	30
lunu-ankenda (Gaertn.) Merr.	32
meliaefolia Benth.	15, 30, 30–32
roxburghiana Benth.	15, 16, 30, 32–33
rutaecarpa Hook. f.	30
triphylla DC.	30
viticina Wall.	30
Fagara budrunga Roxb.	44
hamiltoniana (Wall.) Engl.	44
ovalifolia (Wt.) Engl.	47
oxyphylla (Edgw.) Engl.	44
rhetsa Roxb.	45
Feronia Gaertn.	13, 15, 16, 33–34
elephantum Correa	14, 33, 33–34
limonia (Linn.) Swingle	33
lucida Teysm & Binn.	33
Filicium Thw.	65, 208, 210, 211, 213, 218–220
decipiens Thw.	209, 219–220
Flindersia R. Br.	13, 14, 83
brayleyana F.v.M.	13, 14
ifflaiana F.v.M.	14
pimenteliana F.v.m.	14
Flindersiaceae	13
Garuga Roxb.	65, 76–79
floribunda Decaisne var. gamblei (King ex Smith) Kalkman	77
gamblei King	77, 78–79
pinnata Roxb.	64, 77–79, 275
Geraniaceae	10
Gluta Linn.	265, 266, 268, 279–282, 296
coarctata Hook. f.	279
elegans Kurz var. helferi Hook. f.	279
renghas Linn.	279
tavoyana Hook. f.	279, 280, 280–282
travancorica Bedd.	279, 280–282
turtur March.	279
velutina Bl.	279
Glycosmis Correa	15, 16, 34–35
pentaphylla (Retz.) Correa	35
Glyptopetalum Thw.	180
Gmelina arborea Linn.	190
Gomphandra Wall.	170, 171, 172–173
axillaris Wall.	172
polymorpha Wight.	172, 172–173
Gomphia Schreb	62
Gonocaryum griffithianum Kurz	164
Gouania leptostachya DC.	195, 196
Guaiacum officinale Linn.	7
Guarea cedrata Pellegr. ex A. Cheval.	146
thompsonii Sprague & Hutchinson	146
Guioa Cav.	209, 223
fuscidula Radlk.	209
squamosa Radlk.	209
Gymnosporia W. & A.	180, 181, 185–186
emarginata Roth.	185, 185–186
montana Lawson	185, 185–186
royleana Wall.	185–186
spinosa (Forsk.) Fiori	185
Harpullia Roxb.	210, 211, 212, 213, 220–221
confusa Bl.	221
cupanioides Roxb.	208, 220–221
imbricata Thw.	220
pendula Planch.	209, 220, 221
Harrisonia R. Br.	50, 51, 52, 55–56
bennettii Hook. f.	51, 55, 55–56
brownii A. Juss.	55
perforata (Blanco) Merr.	55
Hemigyrosa canescens Thw.	222
deficiens Bedd.	222
Heritiera Ait.	105
Hesperethusa crenulata (Roxb.) Roem.	36
Heynea Roxb.	84, 85, 88, 130–132
trijuga Roxb.	81, 83, 130–132
Hippocastanaceae	207, 208, 250–254
Hippocratea Linn.	180
Holacantha A. Gray	51
Holigarna Ham.	264, 265, 267, 270, 282–285
albicans Hook. f.	282
arnottiana Hook. f.	282, 282, 283–285
beddomei Hook. f.	282–283, 283–285
caustica (Dennst.) Oken.	283
ferruginea March.	282
grahamii Hook. f.	283, 283–285
helferi Hook. f.	283, 283–285
kurzii King	282
longifolia Roxb.	283–285
nigra Bourd.	282, 284
Hugonia Linn.	2
mystax Linn.	2
Icacinaceae	170–174
Ilex Linn.	175, 175–179
aquifolium Linn.	175
cymosa Bl.	175
denticulata Wall.	176, 177–179
dipyrena Wall.	176, 177–179
godajam Colebr.	176, 176, 177–179
guianensis (Aubl.) Kuntze	175
hookeri King	176, 176, 177–179
insignis Hook. f.	176, 177–179
odorata Ham.	177, 177–179
opaca Ait.	175
paraguensis St. Hill.	170, 175
sulcata Wall.	176, 177–179
umbellata (Wall.) Loes.	177
venulosa Hook. f.	177, 177–179
wightiana Wall.	177–179
Irvingia Hook. f.	51, 52, 56–57
malayana Oliv. ex A. W. Benn.	56, 56–57
oliveri Pierre	56–57
Ixonanthes Jack.	2, 2–3
khasiana Hook. f.	2–3
Khaya A. Juss.	82, 146
ivorensis A. Chev.	82, 146
Kokoona Thw.	186–187
filiformis C.E.C. Fischer	181, 186–187
littoralis Lawson	181, 187
Krugiodendron ferreum (Vahl.) Urban	195

PAGE

Kurrimia Wall. 180, 187–188
bipartita Lawson 188
paniculata Wall. 188
pulcherrima Wall. 188
robusta (Roxb.) Kurz .. 188
Lannea A. Rich. 265, 266, 267, 285–289
coromandelica (Houtt.) Merr. 285
grandis Engl. 264, 265, 285, 285–289
Lansium Rumph. 83, 84, 132–134
anamallayanum Bedd. .. 88, 132, 132–133
decandrum King 89, 132, 133–134
domesticum Jack. 132, 133
Lauraceae 124
Lepidopetalum Bl. 209, 223
jackianum Radlk. 209
Lepisanthes Bl. .. 210, 211, 212, 221–223
andamanica King 222
burmanica Kurz 222
deficiens Radlk. 222
montana Bl. 222
palawanica Radlk. 222
tetraphylla Radlk. 222, 222–223
Limonia Linn. 15, 16, 35–37
acidissima 14, 36–37
alata W. & A. 36
alternans Wall. 36
Linaceae 1–3, 4
Linum Linn. 1
angustifolium Huds. .. 1
usitatissimum Linn. .. 1
Litchi Sonner 224
chinensis Sonner 225, 225
philippinensis Radlk. .. 226
Lophira alata Bank 62
Lophopetalum Wight 181, 187, 189–191
celastrioides Lawson .. 189
filiforme Lawson 189
fimbriatum Wight 189, 189–190
floribundum Wight 189
wallichii Kurz 189, 189–191
wightianum Arn. 189–191
Lovoa klaineana Pierre . 82, 146
Luvunga Ham. .. . 15
Madhuca indica J. F. Gmel. . 273
Malosma Engl. 305
Mangifera Linn. 265, 266, 268, 289–295
andamanica King 290
caesia Jack. 289
caloneura Kurz 290, 292–295
camptosperma Pierre .. 290
foetida Lour. . .. 289, 290
fragrans Maingay 290
indica Linn. .. 264, 277, 289, 290, 290–291, 292–295
kemanga Bl. 289
khasiana Pierre 290
longipes Griff. .. 265, 266, 267, 290, 291–292
odorata Griff. 289, 290
species 294
sylvatica Roxb. 290, 292–295
Mappia Jacq. .. 170, 171, 173–174
foetida Miers 173–174
racemosa Jacq. 173

PAGE

Melanorrhoea Wall. .. 265, 268, 295–298
glabra Wall. .. 280, 296, 297–298
usitata Wall. .. 264, 296, 296–298
Melia Linn. .. 84, 85, 100, 134–140
azedarach Linn. 81, 86, 134, 135, 136, 136–140
birmanica Kurz .. 86, 134, 135, 135, 135–140
composita Willd. 83, 86, 134, 135, 136–140
superba Roxb. 135
Meliaceae 13, 81–159, 217
Melianthaceae 207
Melicope Forst. 15
indica Wight 15
Meliosma Bl. 259, 259–263
arnottiana Wight .. 259–260, 261–263
buchanifolia Merr. 259
collettiana King 259
cuneifolia Franch 262
dilleniaefolia Bl. 260, 261–263
manii Lace 259
microcarpa (W. & A.) Craib. .. 259
nitida Bl. 259
pinnata Roxb. 259
pungens Walpers 260, 261–263
simplicifolia Roxb. .. 260, 261–263
thomsoni King .. 260–261, 261–263
wallichii Planchon 261–263
wightii Planch. 259
Merrillia caloxylon Swingle .. 14
Metopium P. Br. 305
Micromelum Bl. 15, 16, 37–38
integerrimum (Buch. Ham) Roem. 37
pubescens Bl. .. . 37–38
Microtropis Wall. 181, 191–192
bivalvis Wall. 191
densiflora Wight 191
discolor (Wall.) 191, 191–192
latifolia Wight 191
microcarpa Wight 191, 191–192
ovalifolia Wight 191–192
ramiflora Wight 191
stocksii Gamble 191
wallichiana Wight 191
Mimusops djave Engl. .. 146
heckelii (A. Cheval.) .. 146
Minquaria species 162
Mischocarpus Bl. 209, 211, 213, 223–224
fuscescens Bl. 223, 223–224
pentapetalus Radlk. .. 223
sundaicus Bl. 223
Moringa Juss. 326, 326–327
oleifera Lamk. 326
pterygosperma Gaertn. .. 326–327
Moringaceae 326–327
Munronia Wight 85
wallichii Wight 85
Murraya Linn. 15, 38–42
exotica Linn. .. 14, 16, 38, 38–40, 48
koenigii Spreng 14, 16, 38, 41–42
paniculata (L.) Jack. .. 38
Nectaropetalum Engl. .. 4
Negundo Moench 240
aceroides Moench. 240
Nemopanthes Rafin . .. 175

	PAGE
Nephelium Linn. ..	210, 213, 224–227
gardeneri Thw.	224
griffithianum Kurz	224
hypoleucum Kurz	224
lappaceum Linn.	208, 224
litchi Camb. ..	208, 213, 224, 225, 225, 225–227
longana Camb. ..	224, 225, 225–227
semiglaucum F.V.M. ..	209
stipulaceum Bedd.	224, 225, 225–227
Nothapodytes foetida (Wt.) Sleum	173
Nothopegia Bl. ..	265, 267, 299–300
colebrookiana Bl.	299–300
Nyctanthes arbortristis Linn. ..	111
Ochna Linn.	62, 62–63
arborea Burch.	63
squarrosa Roxb.	62, 62–63
wallichii Planchon... ..	62–63
Ochnaceae	62–63
Olacaceae	162–169
Olax Linn.	162, 163–164
scandens Roxb.	163–164
Ophiocaryon Schomb	259
Otonephelium Radlk... .	224
stipulaceum Radlk. ..	225, 225
Ottoschulzia Urb.	170
Oxalidaceae	10–12, 212
Pamburus missionis (Wt.) Swingle	20
Paramignya Wight	15
Paranephelium Miq..	211, 212, 227–228
hystrix W. W. Smith. .	227–228
xestophyllum Miq. . ..	227
Parashorea Kurz	146
Parishia Hook. f. .	265, 266, 267, 270, 300–302
insignis Hook. f. ..	300–302
Paullinia Linn.	208
cupana H.B. & K.	208
Pentace burmanica Kurz ..	146
Pentacme A. DC.	146
suavis A. DC.	296
Phelline Labill.	175
Phlebocalymna Griff. ..	162, 164–165
griffithiana Mast. ..	164–165
Phoxanthus Benth. .. .	259
Picraena excelsa Lindl. ..	50
Picramnia Sw. .. .	50
Picrasma Bl.	51, 57–59
javanica Bl.	52, 57, 57–58
quassioides (D. Don) Benn.	50, 51, 52, 57, 58–59
Pilocarpus Vahl.	14
Pinus roxburghii Sargent ..	67, 309
wallichiana Jack	309
Pistacia Linn.	264, 265, 266, 302–305
coccinea Coll. & Hensl. ..	302
integerrima Stewart.	264, 265, 266, 302, 303, 303–304
khinjuk Stocks.	302
lentiscus Linn.	264, 302
terebinthus Linn. ..	264, 267, 302, 303, 304–305
vera Linn.	264, 302
Pleurostylia Wight	181, 192–193
wightii W. & A.	192–193

	PAGE
Pometia Forst.	210, 211, 213, 228–230
macrocarpa Kurz	230
pinnata Forst.	228–230
ridleyi King	230
species	209, 229, 230
Poraqueiba sericea Tul.	170
Porlieria Ruiz & Pav... ..	7
Poupartia Comm.	316
Poupartia axillaris King & Prain	316
Protium W. & A. .. .	65, 66, 71
caudatum W. & A. .	65
pubescens W. & A. .	65
serratum Colebr. Engl. ..	65, 71
Pseudima Radlk. .. .	208
Pseudocedrela kotschyi Harms	146
Pseudopteris Baill.	208
Pterocarpus dalbergioides Roxb. .	74, 146
Pterolobium R. Brown ..	55
Quassia amara Linn. . ..	50
Quercus species ..	309
Ratonia tenax Benth. .	209
Reinwardtia trigyna Planch. .	1
Reinwardtiodendron Koord. ..	83
Rhamnaceae ..	195–206
Rhamnus Linn.	195, 196, 197, 197–200
cathartica Linn. . ..	195
nepalensis Wall. ..	197, 197–198, 199
persicus Boisser	197, 198, 200
procumbens Edg. . ..	197
purpureus Edgew.	197. 198–200
purshiana DC. . ..	195
triqueter Wall. ..	197, 198, 200
virgatus Roxb. .	197, 198–199, 200
wightii W. & A. .	195, 197, 199
Rhododendron Linn.	176
Rhus (Tourn.) Linn.	264, 265, 266, 267, 305–312
amherstensis W. W. Smith .	306
chinensis Mill. .. .	308
coriaria Linn. . ..	264
cotinus Linn. ..	264, 266, 304, 306, 306–308
griffithii Hook. f. . .	306
insignis Hook. f. ..	306, 308, 310–312
khasiana Hook. f.	306
mysorensis G. Don. ..	308
mysorensis Heyne..	267, 306, 308–310
paniculata Wall. . ..	306
parviflora Roxb.	306, 308, 310
punjabensis Stewart ..	266, 306, 308, 310–312
semialata Murr.	306, 308–309, 310–312
succedanea Linn. ..	264, 305, 306, 309, 310–312
toxicodendron Linn. ..	306
venenata DC.	306
vernicifera DC.	296, 306
wallichii Hook. f. ..	305, 306, 309–310, 310–312
Rutaceae	13–49, 50, 83
Ruta graveolens Linn. ..	14
Sabia Colebr.	259
lanceolata Colebr.	259

	PAGE
Sabiaceae	259–263
Sageretia Brongn.	195, 196
brandrethiana Aitch.	196
oppositifolia Brongn.	196
theezans Brongn.	195, 196
Salacia Linn.	180
Samadera Gaertn.	51, 59–61
indica Gaertn.	51, 52, 59–60
Sandoricum Cav.	84, 85, 140–141
indicum Cav.	84, 88, 140, 140–141
koetjape Merr.	140
Santalum album Linn.	5, 133
Santiria Bl.	64, 65
Sapindaceae	65, 207–239, 240, 250, 255, 266
Sapindus Linn.	210, 211, 212, 231–233
attenuatus Wall.	210
denura Voigt.	210
emarginatus Vahl	231
laurifolius Vahl	208, 209, 212, 231, 231, 231–233
mukorossi Gaertn.	208, 210, 211, 212, 231, 231–233
Schinopsis species	265
Schleichera Willd.	210, 211, 213, 233–236
oleosa (Lour.) Oken.	233
trijuga Willd.	209, 220, 233, 233–236
Schoepfia Schreb.	162, 165–166
fragrans Wall.	165–166
Scutia indica Brongn.	197
Semecarpus Linn.	264, 265, 267, 278, 312–315
anacardium Linn.	265, 313, 314–315
auriculata Bedd.	313, 314–315
kurzii Engler	314, 314–315
prainii King	312
travancorica Bedd.	314–315
Serjania Plum ex Schum.	208
Shorea Roxb.	146
obtusa Wall.	296
robusta Gaertn.	234, 273
Simaruba Aubl.	50, 51
Simarubaceae	7, 50–61
Siphonodon Griff.	180, 193–194
celastrineus Griff.	193–194
Skimmia Thunb.	15, 16, 42
laureola Sieb. & Zucc.	42
Solenocarpus Wight & Arn.	266
Sorindeia Thou.	64
Soymida A. Juss.	84, 85, 141–144
febrifuga A. Juss.	81, 83, 87, 142–144, 146
Spondias Linn.	265, 266, 267, 270, 315–319
acuminata Roxb.	316, 317–319
axillaris Roxb.	265, 267, 316, 316, 317–319
dulcis Forst.	315
lutea Linn.	315
mangifera Willd.	264, 265, 316, 316–319
pinnata (Linn. f.) Kurz	316
Spondias Linn.	
purpurea Linn.	315
tuberosa Arruda.	315
Staphylea Linn.	255, 255–256
emodi Wall.	256
Staphyleaceae	207, 208, 250, 255–258
Stemonurus Bl.	170
exillaris (Wall.) ex Lindl. Miers	172
polymorpha Miers	172
Sterculia urens Roxb.	68
Stocksia brahuica Benth.	209
Strombosia Bl.	162, 166–167
ceylanica Gardner	166, 166–167
javanica Bl.	166–167
philippinensis (Baillon) Rolfe	167
Suriana Plum. ex Linn.	51
maritima Linn.	51
Swietenia Jacq.	82, 84, 85, 86, 87, 144–154
candollei Pittier	144
cirrhata Blake	144
humilis Zucc.	144, 145, 146, 146–147, 148–154
krukovii Gleason	144
macrophylla King	81, 144, 145, 146, 147, 147, 148–154
mahagoni Jacq.	81, 144, 145, 146, 147–154
tessmanni Harnes	144
Swintonia Griff.	265, 266, 268, 319–321
floribunda Griff.	319–321
schwenckii Kurz	321
Talisia Aubl.	208
Tapiria Juss.	266
Theaceae	255
Thraulococcus erectus Radlk.	209
Toddalia Juss.	55
bilocularis W. & A.	43
Toona M. Roem.	82, 108
Toulicia Aubl.	208
Toxicodendron (Tourn.) Mill.	305
Trigonochlamys Hook. f.	65
Triphasia Lour.	15
Tripterodendron Radlk.	208
Turpinia Vent.	255, 257–258
nepalensis Bedd.	257, 257–258
pomifera DC.	257, 257–258
Turraea Linn.	85
villosa Benn.	85
Turraeanthus africana Pellegrin	146
Ventilago madraspatana Gaertn.	195, 196
Vepris Comm.	16, 42–43
bilocularis Engl.	43
Walsura Roxb.	83, 84, 85, 88, 130, 154–157
aherniana Perkins	156
candollei King	154
glauca C. E. C. Fischer	155, 155–157
hypoleuca Kurz	154
multijuga King	154
piscidia Roxb.	81, 155, 155–157
robusta Roxb.	154, 155, 155–157
tubulata Hiern	154, 156
villosa Wall.	155–157

	PAGE
Xerospermum Bl. ..	211, 236–237
ferrugineum C. E. C. Fischer	213, 236, 236–237
glabratum (Wall.) Radlk. ..	213, 236–237
intermedium Radlk. ..	237
noronhianum Bl.	237
Ximenia Plum ex Linn. ..	162, 167–168
americana Linn.	162, 167–168
Xylocarpus Koen.	104
gangeticus (Prain) C. E. Parkinson	105
granatum Koen.	104, 105, 105
molluccensis (Lam.) Roem. ..	104, 105
Zanthoxylum Linn.	14, 15, 16, 43–48
acanthopodium DC. ..	44, 44, 45–47
alatum Roxb. . ..	44, 44, 45–47
budrunga Wall.	44, 44–45, 45–47
flavum Vahl.	14, 43
hamiltonianum Wall. ..	44
khasianum Hook. f. ..	44
ovalifolium Wight	44, 47–48
oxyphyllum Edgew	44
rhetsa DC.	44, 45–47

	PAGE
Zizyphus Juss. ..	195, 196, 197, 201–205
chloroxylon (Linn.) Oliv. ..	196
glabrata Heyne ex Roth.	202
incurva Roxb.	201
jujuba Lam. .	195, 201–202, 203–205
jujuba Mill non Lam.	203
mauritiana Lam. .. .	201
nummularia W. & A. ..	202, 203–205
oenopila Mill. . ..	201
oxyphylla Edgew . .	201
rugosa Lam. .	202, 203–205
species .	196
trinervia Roxb. .	201, 202–203, 203–205
vulgaris Lam. . .	203, 203–205
xylopyrus Willd.	195, 203–205
Zollingeria macrocarpa Kurz	209
Zygophyllaceae . .	7–9

INDEX II

TRADE AND COMMON NAMES

Name	Page	Name	Page
Abigran	217	Amboni	308
Achal	197	Ambota	316
Achar	272	Amboto	316
Acid lime	26	Ambra	316
Adak	68	Ambri-thong	316
Adalhapoma	285	Ambuda	316
Adanthai	122	Amburri	316
Adavimamidi	316	Ambut	316
Adavi-nimba	20	Amdah	277
Adivi gerenta . . .	5	American Holly	175
Adivi munukudu	36	—— Mahogany	145
Adivi nimma	20	—— Rock Maple	245
Adusoge	121	Aming-gok	136, 316
Adwi nimbe	20	Amiya	290
Aeo	57	Amlara	308
African Mahogany . ..	82, 146	Amna	316
—— Walnut . ..	82	Amo, Alupag	226
Agal .. .	117	Amoni	308
Agil	117, 123	Amor	316
Agimmok	316	Amora	316
Aglaia	89, 90	Amora amari	95
Aglay	117	Ampalam	316
Agnijhal . ..	28	Ampeach	28
Agni-mukhi	313	Ampich	28
Agnium	183	Amra	290, 316
Agnu	183	Amram	290
Agri	77	Amramu	291
Aima	272	Amrataka	316
Ajapriya	202	Amratonga	316
Ajari	181	Amronga	10
Akonda	16	Amri	290
Akhaterwa	130	Am-selonga	277
Akil malaveppu	117	Amsia	277
Akota	233	Amung-gok	316
Alan	181	Amur	94, 97
Aliar	215	Amyan	316
Almond, Goa ..	269	Anaikarai	286
Alupag-amo ..	226	Anakkariyan	285
Alupag, Philippine ..	226	Andaka	68
Am	290	Andala	231
Amara	316	Andaman satinwood	39
Amarai	214	Andima	269
Amari	95, 97, 127	Andimangottai	269
Amb	290	Andiparuppu	268
Amba	290	Andu	68
Ambada	316	Anduga	68
Ambalam	316	Anduga-pisunu	68
Amba-nujhada	290	Anduku	68
Ambara	316	Angao	183
Am-barola .. .	319	Anjour	277
Ambatta	316	Ankhujhora	30
Ambatti	299	Annakara	77, 285
Ambazha	316	Anshphal	225
Ambazhm	316	Antei	110
Ambi	290	Antwala	231
Ambi-thong	316	Aralakai	231
Ambo	290, 316	Arali	173
Ambodha	316	Aran	181

Name	Page
A—(*contd.*)	
Aranelli	77
Aratala	231
Arawi nim	20
Archarru	324
Archoi	309
Ardal	231
Ardusi	53
Arhik-bouna	214
Arishta	101
Arkhar	308, 309
Arkhoi	308, 309
Arkhol	309
Arkol	309
Arl	109
Armadal	47
Armadalu	47
Armu	77
Arthil	163
Arulundi	101
Arunelli	77
Arushkara	313
Arya-veppu	101
Arytikta	101
Ash, Brush	17
—— Crows	14
—— Hickory	14
—— Silver	14
Ashadon	296
Ashhoura	35
Asri-phang	225
As-sera	35
Asuri-baphang	225
Atal	39
Athadali	219
Athalangi	219
Athel	39
Atya-chiraita	214
Aukchinsa	116, 217
Auledabdabe	77
Australian rose mahogany	82, 146
Avukaram	314
Axe-master	195
Ayon	296
B	
Babari	277, 313
Babari-chi	260
Babur	185
Badari	201
Baderi	201
Badlo	185
Badoh	228
Badrang	44
Badri	201
Bael	18
Baelo	18
Baer	201
Bagh-anchora	44
Bagu-rata	95
Baikal	185
Bajan	268
Bajarmali	45
Bajarmani	45
Bajarmuni	44
Bajna	44
Bajrang	44, 45
Bakain	135
Bakana-nimb	135
Bakan-binbodo	135
Bakaria	135
Bakarshang	260
Bakauro	198
Bakenu	135
Bakkiamela	309
Bakol-khowa-tenga	25
Bakra	181
Bakraina	260
Bakrasang	260
Bal	202
Bala	299
Balaga	77
Balal	33
Balank	25
Balanta nimba	101
Balay timur	44
Balel	324
Bale mauwa	90
Bale timur	44
Bali-bhams	185
Bal-nimb	101
Balwuli	283
Ban	203
Bana	306
Banaru	198
Banati	189
Banati-balpale	189
Banbakhru	256
Banchir	183
Banchor	183
Banchu	183
Bandardima	123
Bandare	215
Bandedu	216
Bandhari	216
Bandordima	116, 122
Bandra	116
Bandre rito	133
Bandriphal	95, 116
Bania	77
Bankamla	20
Bankhor	251
Bankimu	244
Ban-kunch	37
Bankung-asing	77
Ban-mallika	39
Ban-nimbu	27, 35
Ban-ritha	130
Banshagali	256
Banthra	306
Bara-bhilawa	314
Bara dabdabbi	285
Bara-horina	217
Barakainju	242
Bara mahagoni	147
Baran	270
Bara nebu	25
Bara nimbu	25
Bar-bhola	313
Bareri	313
Barine	270
Barj	203

Name	Page
B—(*contd.*)	
Barla arong	313
Barola	283
Barru	42
Barsanga	41
Baru	233
Baryan	203
Bastard cedar	135
Bastard sandal	5
Bata bakuri-arong	202
Batavi-nimbu	25
Batkal	303
Bator-nebu	25
Bat sinjal	198
Bauru	306
Bawarae	313
Bawlamaka	101
Bayr	201
Bazarnali	44
Bead tree	135
Begapura	26
Bogura	25
Behenta	36
Behru	21
Bekesh	260
Bel	18, 33
Bela	18, 33, 313
Belada	33
Belam-changne	316
Belana	18
Belatak	313
Belethi	18
Beli	18, 36
Belsain	36
Bemu	101
Bengjari	28
Benwe	306
Ber	201, 202
Bera	58
Bergo	58
Beri	201, 203
Bering	58
Beringi	58
Berirata	95
Betain	101, 135
Bevina	101
Bevu	101
Bhad ber	203
Bhadi	285
Bhagmili	309
Bhailawa	313
Bhainsi	44
Bhakhimlo	309
Bhala	313
Bhalai	313
Bhalaio	313
Bhalaiyo	309
Bhalao	313
Bhallataka	313
Bhallataki	313
Bhallatamu	313
Bhallia	313
Bhaluk-dat	37
Bhambela	183
Bhambeli	183
Bhan	306
Bhandber	202
Bharangi	58
Bharhul	21
Bhaura	37
Bhela	313
Bhelatuki	313
Bhelwa	313
Bhenta	36
Bhera	21
Bheria	21
Bherul	21
Bheyla	313
Bhiamu	313
Bhiladar	313
Bhilamu	313
Bhilan	313
Bhilanvana	313
Bhilaura	313
Bhilawa	313
Bhira	21
Bhirra	21
Bhirwa	21
Bhojinsi	324
Bholaguti	313
Bhollatoki	313
Bhollia	313
Bhollia ambo	269
Bhor	201, 202
Bhorgote	203
Bhota-mayna	95
Bhoto-mayna	97
Bhukantak	202
Bhumis	260
Bhuta	181
Bhutali	16
Bhutani-kusamis	181
Bhutan kusan	181
Bhutekassi	181
Bhutta	181
Biba	313
Bibe	313
Bibha	313
Bibu	313
Bibwa	313
Bidsale	220
Big leaf Maple	241
Bihba	313
Bijaura	25
Bijauri nimbu	26
Bijori	25
Bijoru	25
Bikha-kulia	177
Bil	71
Bilan	36
Bilapatri	18
Bilaran	313
Bilashin	36
Bilatiamra	315
Bilayate amra	315
Bilgar	39
Bilgu	21, 22
Bili	18
Bili-devdari	124
Bilin	33
Billa	167
Billu	21, 22
Billydu	22

Name	Page
B—(*contd.*)	
Bilur	181
Bilva-pandu	18
Bilwa	18
Bilwar	33
Bimbiri	26
Bipte	283
Birar	202
Birari	203
Birch Mahogany	146
Biringa	197
Biringguli	197
Bishahari	41
Bisjang	74
Bittula	21
Black Ironwood	195
—— Manwood	162
—— Maple	240
Bno-Jamir	37
Bobich	111
Bocho	290
Bodal	242
Bodobodoria	163
Boga amari	95
Boga-banderdima	122
Bogapoma	117
Bogay-timur	44
Bogri	201
Boguri	201
Bohamle	316
Bohar	285
Boilam	319
Boilsur	319
Boke timur	44
Bol	177
Bol-agal	313
Bol-agru	285
Bolasin	123
Bol-chhachhat	127
Bol-chigamba	285
Bol-dikim	257
Bol-dorch	117
Bol-dublok	155
Bolgrak	16
Bol-khat-thi	309
Bol-khrenthi	155
Bol-michang	309
Bolmicheng	45
Bol-narang	123
Bol-nawak	251
Bol-rimmu	251
Bol-samphal	95
Bol-thajong	177
Bolthekachu	277
Bol-thimatchi	16
Bombal	277
Bombalinas	25
Bombukbombus	77
Bon-am	292
Bon boguri	202
Bonboroi	202
Bon-dau-iung	123
Bon-jamir	35
Bon-keseru	257
Bon-khoklu	260
Bonkung-asing	77
Bon-misri	77
Bon-poshla	57
Bonsu-buphang	283
Bonthai-phang	77
Booligi	181
Bora	201
Bora-asing	30
Bor-amari	94
Bor-jagreng	57
Borkeseru	53
Born-bokul	176
Boroi	201
Borpat	53
Bor-ritha	231
Bor-salai	68
Bor-salei	68
Bor-salla	68
Borsamphol	74
Borsiring	260
Botanskam	181
Bowala	41
Box Elder	240
Box wood	184, 217
Brahmani	183
Brasan	41
Brazilian mahogany	145, 146, 147
Brojonali	44
Brong	277
Brong-kung	277
Brush Ash	17
—— Teak	209
Buck-eye	250, 253
Buckthorn, European	195
Budrung	44
Bugriwala	185
Buin-champa	62
Bu-kubbe	214
Bulu-mora	228
Bundurgi	215
Bunthikottai	231
Bura	236
Burkas	181
Burma Mahogany	146
Buru-buphang	236
Burus	22
Buruta	22
Bushkua	260
Busi	233
Butapala	181
Buzimpala	243
Byala	33
Byala danannu	33
C	
Cairns hickory	14
Calantas	82
Carai	272
Cashew nut tree	268, 269
Cedar	14, 82
Cedar, Bastard	135
Central American Mahogany	151
Cera	283
Ceylon mango	269
Chachat	127
Chadua	198
Chagolladi	35

Name	Page
C—(*contd.*)	
Chakota	233
Chakotra	25
Chakotre	25
Chakra	198
Challe	203
Champa balsa	62
Champazham	26
Chandbera	121
Changre	44
Chaniat	306
Chanlai	181
Chanli	181
Chany-hedini	117
Char	272
Chara	272
Chara-chettu	272
Charai	202
Chara mamidi	272
Charangi	58
Charei	313
Chariant	306
Charo	272
Charoli	272
Charu	272
Charyula	198
Charyulo	198
Chaterni	198
Chato	198
Cahtr	198
Chaudul	198
Chaulda	198
Chaul-dhowa	35
Chaurdha	198
Chawa-manu	95
Chay	280
Chayakeya	95
Chaybeng	313
Che	296, 313, 314
Chechar	309
Chechu	25
Chedubira	121
Chedwala	198
Chehipaimaram	181
Cheknam	177
Chemmana	5
Chem-maram	95
Chendala	233
Chenenji	130
Chenkuruncbi	280
Chenugu	105
Chera	282, 313
Cheramara	313
Cherauni	243
Cheriamahogany	147
Cherimugri	251
Cherkkotta	313
Cherkkuru	313
Cherrukat narragam	36
Cherry Mahogany	146
Cheru	272, 282, 313
Cherumulli	201
Cheru-narnna	25
Cherun Kuru	313
Chest nut	297
Chest nut, Horse	250, 251, 252, 253
Chhalegach	123
Chhendula	198
Chhithula	198
Chi-cchi-rum	214
Chickrassy	82, 117
Chidampha	77
Chigambol	77
Chikan	183
Chikki	272
Chikrassi	117
Chikyeng	181
Chilanti	62
Chiming-arong	316
Chindia	244
Chinese Myrtle	14
Chingchoi-arong	35
Chingi	309
Ching-kamla	20
Chingirphang	44
Chinjai-mailo-phang	39
Chinnagil	94, 122, 132
Chinna-moral	272
Chinok	77
Chinta	185
Chinyok	275
Chinyop	77
Chinyuk	77
Chiok	77
Chippamaram	308
Chir	309
Chirka	272
Chirla	198
Chironji	272
Chiru-illanti	167
Chiru-piyari	192
Chitena	203
Chitompa	77
Chitra	256
Chitrek	71
Chitreka	71
Chitrika	71
Chitta	68, 214
Chittangukara	117
Chittania	203
Chittila madakku	220
Chittirai vempu	219
Chittu maddi	68
Chitulia	244
Chiunamora	272
Chivit	272, 319
Chokla	90
Choklu	308, 309
Chokoripoma	117
Chopra	183
Chora nim	53
Chorla	173
Chosi	309
Chouldua	35
Chouri	181
Chrauli	272
Chual	183, 256
Chuchi-am	292
Chuma	117
Chumlani	42

Name	Page
C—(*contd.*)	
Chumloni	42
Chunnukoli	202
Chure lahara	183
Churna	202
Churni	202
Churri	260
Chya-beng	313
Chyabu	217
Chyabu-nut	217
Chyingbawng	44
Chyingbawngla	44
Cinnamoralli	272
Citron	26
Civit	319
Cogwood, Jamaican	196
Collungie-pullam	25
Colombian Mahogany	145, 147
Congiliam marum	74
Cornel wood	115
Corre	316
Costa Rican Mahogany	145
Crabwood	82, 104, 146
Crows Ash	14
Cuban Mahogany	145, 147
Cyprus turpentine tree	304
D	
Dabdabbi	77
Dabdabe	77
Daberi	181
Dabero	181
Dadul	183
Dadur	198
Dajkar	185
Dal	109
Dalla	109
Dalmara	117
Damphela	308
Danonia	308
Danta	185
Dantausi	185
Danthalun	326
Danti	185
Dantrungi	260
Danujhada	101
Daom	242
Daom-kung	242
Darekh	135
Darengri	306
Darim	185
Darl	109
Darli	109
Darloi	109
Darlu	109
Darmi-asing	306
Dasan	308
Dasarni	308
Dasmila	308
Dasni	308
Davan	308
Dawhke	28
Dawng-khreng	227
Debdabbi	261
Dedali	166, 167
Deijir	39
Deikna	135
Deing-salait	316
Deknoi	135
Dengjir arong	39
Denka	135
Dergi-asing	316
Devadara	5
Devadari	280
Devadru	5
Devadhupa	66
Devdari	110
Dhadonjra	244
Dhak	273
Dhakka nisur	181
Dhamila	308
Dhanesh	202
Dhapapatia	260
Dharmil	309
Dharua	183
Dhaura	202
Dhebri	181
Dheniani	163
Dhidao-boguri	202
Dhoka	285, 286
Dhuna	74
Dhundul	105
Dhup	53, 68, 74
Dhup, Red	300
Dhupadamara	68
Dhupan	68
Dhurkalu	272
Diang-ehas	53
Dibru	260
Dieng bit	110
Dieng-borapram	30
Diengborrah	277
Dieng-chaang-kenrop	251
Dieng chidit	261
Dieng dala	251
Dieng dula	251
Dieng-ialeh	243
Dieng-iong	257
Dieng ja-anthri	257
Dieng-ja-iao	37
Dieng-jaiork-hlaw	44
Dieng-ja-jaur	44
Dieng jali	177
Dieng-jarasang	136
Dieng ja-rasi	257
Dieng juwat	5
Dieng-kabra	277
Dieng kajat-ake	35
Dieng-kani	277
Dieng-kasiar	35
Dieng-ka-synrang	44
Dieng-kean	309
Dieng-khaokhorai	165
Dieng-khiang	77, 285
Dieng khlang	58
Dieng-kyrbei	123
Dieng-lalih	177
Dieng lambu-synrang	30
Dieng-la-myrsiang	261
Dieng-lang-marei	95
Dieng-la-pia	260
Dieng-loba	225

Name	Page
D—(*contd.*)	
Dieng-lyng-knong	260
Dieng-mar-iony	116
Dieng-mat-wei	188
Dieng-nadkor	45
Dieng-nong-krow	260
Dieng-pain-khar	5
Dieng-pasoh-pier	285
Dieng-pyllengtham	5
Dieng-rata	95
Dieng sali	110
Dieng-sa-ma	309
Dieng-sang-kenrop	251
Dieng sa-niriang-blai	165
Dieng-sarumi	165
Dieng-sa-tyng-klong	30
Dieng-saw	110
Dieng-saw-ngiang-jerep	30
Dieng-shih	47
Dieng-shleng-khlaw	165
Dieng-si-ing	30
Dieng-sinialh	47
Dieng-sngit	261
Dieng-sngiyat	30
Dieng-sniat	261
Dieng-soh-broi	201
Dieng-sobtreng	11
Dieng-soh-aruin	45
Dieng-soh-bhala	313
Dieng-soh-broi	201
Dieng-soh-khlam	44
Dieng-soh-khmut	77
Dieng-soh-khru	243
Dieng-soh-khyllam blang .. .	116
Dieng-soh-khyltam-blang	95
Dieng-soh-knurnot	285
Dieng-soh-long-anthri	257
Dieng-soh-longar	90
Dieng-soh-ma	309
Dieng-soh-maijur	44
Dieng-soh-mio	44
Dieng-soh-mir	71
Dieng-soh-mirik	45
Dieng-soh-monashrieh	116
Dieng-soh-moniar-shree .. .	236
Dieng-soh-newriong-blei	16
Dieng-soh-ngang	188
Dieng-soh-pair-kanthai	316
Dieng-soh-phlang . ..	16, 155
Dieng-soh-pien	290
Dieng-soh-pyjiar	77
Dieng-soh-rang-soi	37
Dieng-soh-rany	277
Dieng-soh-run-blang	116
Dieng-soh-sang-koi	257
Dieng-soh-sarman	26
Dieng-soh-sat	37
Dieng-soh-sat-khlaw	183
Dieng-soh-saw	177
Dieng-soh-sning	35
Dieng-soh-tlai-shree	37
Dieng-soh-tong-klong	30
Dieng-soh-tyrkhum	243
Dieng-spieng-rah	231
Dieng-subu-klong	30
Dieng-sugsi	5
Dieng-suit	309
Dieng-sur	285
Dieng-syrngam	37
Dieng-tang long	285
Dieng-than	243
Dieng-thang	285
Dieng-thlai-nar	290
Dieng-tiw-shiah	44
Dieng-tyllong	110
Dieng-tyrpei	37
Dieng-tyrthia-iong	243
Dieng-tyrur	28
Dingari	123, 251
Dingari-guphut	123
Dingi-bomphang	123
Dingraliarong	160
Dingri	251
Dire-asing	97
Disua	176
Diwal	33
Dodan	231
Doddagli maddlu	130
Dodda nimbe-hanum . ..	25
Dodru	176
Doka .. .	285
Dom	242
Domsal .	68
Doopamara	74
Dor	308
Doukyama	257
Dowkagia	285
Drawa	109
Drawi	109, 111
Drek	135, 303
Drunda	176
Dudhapu	183
Dudh-kainju	244
Dudla	309
Dukipotum	28
Dulia-maricha	28, 37
Dumat foul	202
Dumedome	285
Dumi	77
Dumitha	244
Dumper	286
Dumperti	286
Dumpidi . . .	286
Dumpili	285
Dumpini	286
Dumpri	286
Dumsal	68
Dungla	308
Dupri	285
Duri	109
Durmur	44
E	
East Indian Satinwood	14, 24
Ebony	282
Edapandu	25
Ehir	163
Elaka	33
Elandi	201
Elandopphazam	201
Elantha	201
Elanthic	201

Name	Page
E—(*contd.*)	
Elbedda	260
Elder, Box	240
Eleutharay	117
Elimichai	36
Elimichum	26
Elm leaved sumach	306
Elumich-cham-pazham	25
Emu	285
Eng	273
Eng-gokmi	95
Engla	71
Engua	8
Errapogada	117
Erumichunarakam	25
Eskombo	222
Eta werella	216
Etteriya	39
European Buckthorn	195
—— Holly	175
F	
Fawee	186
Fogora	198
Fum	77
G	
Gaboon Mahogany	64, 146
Gadambal	309
Gadara	5
Gadaru	177
Gadgair	177
Gadh papri	244
Gadiri	5
Gadkan-ira	177
Gadkimu	244
Gadmel	177
Gadtung	306
Gajanimbe	25
Gajanimma lungamu	26
Gajchinni	185
Galgal	25
Galing asing	97, 123
Galing-libor	127
Galiya	243
Galmora	228
Gandbela	41
Gandhla	41
Gandi	41
Gandla	41
Ganera	173
Ganga	68
Gangadimohi	285
Gangar	202
Gangaru	324
Gange-asing	201
Gangeru	324
Gangra	202
Gangru-changul	94
Gani	41
Ganjanimma	25
Ganor	202
Gardar	176, 260
Gardhan	198
Garga	77
Garge	77

Name	Page
Gargu	77
Gari	8
Garirukh	77
Garkaula	177
Garosal	202
Garshun	177
Garuga	77
Garugo	77
Garugukaluguda	77
Garur	71, 183
Gathara	5
Gaunta	198
Gaunth	198
Gausam	233
Gave	296
Gendeli poma	77
Gendheli-poma	123
Generu-ay	25
Ger	313
Gera bija	268
Gerkavi	313
Gerligai	268
Geru	268, 285, 313
Gerubija	268, 313
Geru-poppu	268
Gettisaranai	192
Ghadi	285
Ghari am	290
Gharri	77, 285
Ghat ber	203
Ghattol	203
Gheru	313
Ghogar	77
Ghont	203
Ghora nim	135
Ghorkaram	53
Ghotia	203
Ghurria	77
Ghutrua	35
Gilam	25
Gimbao	309
Gingsimok	136
Ginyan	285
Girgitti	35, 39
Girya	21
Glabra	68
Gluta	280
Goa Almond	269
Gobar-kami	244
Gobar-khutla	257
Gobor-hura	37
Gobor-huti	37
Godambe	268
Godan	285
Godanimb	41
Godda	77, 285
Godde	77
Goddel	285
Goddu-geru	313
Gogera	198
Gogil	66
Gogsa makola	324
Gogsha	260
Gogua	260
Goguna	260
Goi	260
Gojal	285

Name	Page
G—(*contd.*)	
Gokpak	260
Gokul	53, 74, 95
Gokul-dhup	74
Gondela	41
Gongmajaching	257
Gongoromohi	285
Gonji	35
Gonro kosai	185
Goranebu	25
Gorianim	110
Gorwi-kawat	53
Got	203
Gotala	203
Goti	203
Goto	203
Gotoboro	203
Govamba	268
Gove	268
Green heart	196
Gu	251
Guaguti	214
Guatemalan Mahogany	145
Gudlej	198
Gud mei	121
Gudova jidi	313
Gugal	66
Gugali	68
Guggala	66
Guggar	68
Guggilam	68
Guggul	66
Guggula	68
Guggula-dhup	53
Guggule	66
Gugguli	68
Guggulu	66, 68
Gugu	251
Gugua	260
Gugul	66, 68, 74, 285
Gugula	66
Gugulla	68
Gugulu	68
Gugulu-kundrikam	68
Gukkal	66
Gukkulu	66
Guldan	256
Gulpha	260
Gulunga	35
Gumpan	286
Gumpani	286
Gumpena	286
Gumpina	286
Gumpini	286
Gumpna	286
Gumpri	285
Gun	251
Gundira	130
Gungi	35
Gupri	77
Guprimarra	285
Gurban-asing	260
Gurgu	303
Gurja	77
Gwala	185
Gwale	185
Gwali	183
Gway	316
Gwe	316
Gweb	260
Gyo	233
Gyobo	155, 225
H	
Haibamin	292
Haijango	25
Haitaguti	231
Haithal-bang	231
Hak	296
Hakhori-bakhori	95
Hala	77, 309
Halabalagi	77
Halai	309
Halashang	308
Halastang	308
Halda	21
Halemaddu	74
Halloray	285
Hallurch-tuni	117
Hal-maddi	53
Hamara	316
Han	251
Hane	251
Hanjor	45
Hannudun	251
Hanti-pli-arong	136
Harbi-behrang	110
Hardi	21
Hard Maple	241, 246
Harduli	163
Hare	176
Haribe	117
Haril	39
Harin harra	95
Harin-khana	95
Harkankali	39
Harku	309
Harpulli	220
Harray baer	202
Harri	41
Hati-koropa	176
Hedare	173
Heinig	316
Heinohjom	11
Helbevu	136
Helbowa	53
Henduri poma	110
Hengena-poka	35
Hengla	71
Hengna poka	35
Hengunia	260
Heralay	25
Herbi-beh	117
Herka	272
Herka marra	272
Hickory	115
Hickory Ash	14
Hickory, Cairns	14
Hijila bodamo	269
Hijli badam	268
Hijuli	268
Hijung-arong	74
Hik	286
Hilaguti gach	37

Name	Page
H—(*contd.*)	
Hill-Toon	109
Himan	261
Hin	8
Hingabet	8
Hinghi	231
Hingman	260
Hingota	8
Hingu	8
Hinguri	188
Hiunmucha	35
Hkri	296
Hlang-phalau	283
Hmaing	215
Hmet-kaung	44
Hog plum	264, 316, 317
Holageru	282
Holashi	309
Holemogge	260
Holgeri	282
Holigar	282
Holly, American	175
Holly, European	175
Holly wood	175
Holsachat	127
Homoi tenga	316
Honduras Mahogany	145, 147
Hongot	8
Honka bhollia	269
Honsa	25
Hoolgeri	282
Horralu	177
Horse-Chestnut	250, 251, 252, 253
Houchiling	316
Howmonicho	35
Hpunja	18, 193
Hseng-neng-thayet	292
Hudu	110
Hulasa	309
Hulashing	309
Huli-makay	259
Huli mukki	259
Hulurhe	285
Humutia tenga	25
Huragalu	21
Hurihuli	21
Hurkli	303
Huruk	110
Hurulu	177
I	
Idalimbu	25
Ikari	185
Ilangi	201
Ilantai	201
Ilkuhia	251
Ilso	176
Imbe	25
Indian lilac	101
Indian Maple	245, 246
Indian sumach	306
Indramai	285
Inghet-ki-ik-arong	74
Ing-long-pharse-arong	16
Ingudi	8
Inguli	185
Ingyin	296
Intei	111
Inthei	123
Irgoli	181
Irkoli	181
Ironwood, Black	195
Iruvillapalai	219
Ishi rashi	217
Ivy, Poison	306
J	
Jaipoma	110
Jakhmi	216
Jalidar	198
Jal tunga	306
Jamaica Mahogany	145, 147
Jamaican Cog wood	196
Jambir	26
Jambira	25
Jamera	25
Jamin	45
Jaminrei dhkar	183
Jamira	25
Jami-reng-reng-arong	35
Jamoa	181
Jamrasi	181
Jamunjan	201
Jamuva	181
Janani	198
Jangbawng	44
Jangbawngla	44
Jangela	181
Jangra	201
Janmera	25
Janoki-jamun	257
Janwa	181
Japanese Maple	241
Jaramamidi	272
Jarima	242
Jatayu	66
Jatipoma	108, 110
Javayu	66
Jayurkhlam	44
Jeedipappu	269
Jeemthali	5
Jegachu	290
Jelachi	201
Jeol	285
Jerimu	242, 244
Jhadia beri	202
Jhalbhor	202
Jhald beri	202
Jhar ber	202
Jhari	202
Jhari kanta	202
Jharua	95, 316
Jhawa	283
Jhingan	285, 287
Jia	285
Jial	285
Jidi	268, 313
Jidianti	269
Jidi-mamidi	269
Jidi-mamidi-vittu	269

Name	Page
J—(*contd.*)	
Jidi vate	268
Jiga	77, 285
Jingar-phang	45
Jingbawng	44
Jingni	286
Jiol	285
Jir	285
Jiri	313
Jisumi-mara	45
Jivadali	5
Jival	285
Jiyal	285
Jom	201
Jong-kitil-thing	220
Jonom	201
Joom	77
Jora tenga	25
Jum	77
Jummina	45
Jungar	202
Jungli am	270, 292
Jungli nimbu	20
Jurbisi	220
Jur-thoum-thing	45
Juti	39
Juti-mersolo	38
Jutraj	95
Jvaramamidi	272
K	
Kabala	25
Kabale	32
Kabashi	242, 244
Kabasi	244
Kachikung	25
Kadalranchi	163
Kadambatte	77, 316
Kadapala	188
Kadaranarathai	26
Kadaransi	167
Kadbela	36
Kadera	176
Kadewar	185
Kadinimbi	36
Kadiri	260
Kadugeru	282
Kadu-khajur	101
Kaduppagai	101
Kaduveladu	36
Kadvilpatri	36
Kag-balayo	308
Kaghania	256
Kagi	277
Kagira	282
Kag-phulai	308
Kai-adi	163
Kaikar	77
Kaikra	77, 285
Kaimil	285
Kainchli	244
Kainjal	242
Kainjili	242
Kainjla	242
Kainjli	244
Kainju	242, 244
Kainta	33
Kait	33
Kaitha	33
Kaithbilin	33
Kaju	268
Kaka	303
Kakad	77
Kakain	309
Kakaipalai	37
Kakar	77, 303
Kakaushil	286
Kakhar	303
Kakibira	2
Kakkar	303
Kakkarein	308
Kakkeran	309
Kakkrei	303
Kakkri	243
Kakkrim	309
Kakla	303
Kakopholo	101
Kakor	203
Kakra	251, 303
Kakraiu	303
Kakrangche	303
Kakrasingi	265, 303
Kakra-singi-kakar-sing	309
Kakra-sringi	309
Kakri	309
Kakrian	303
Kakrin	309
Kakring	303
Kakroi	303
Kakru	244
Kaksok	123
Kakso-kachal	123
Kak-sok-thing	95
Kakur	77
Kakuri	203
Kakru	244
Kala-dingart	257
Kalagam	313
Kala-gaura	173
Kalai	167
Kalamaricha	27
Kalamavu	272
Kalambi	313
Kala-min-gyin	236
Kalasan	285
Kalavi	259
Kalavarai	166
Kalayam	285
Kaledizho	123
Kaledj-zho	95
Kalgur	173
Kalindra	242
Kalkadamba	166
Kalla dammar	74
Kallarma	269
Kallavi	259, 260
Kalma	272
Kalmanikkam	163
Kalmanikkom	163
Kalmina	285
Kalo-bhalayo	313

Name	Page
K—(*contd.*)	
Kal-pottan	163
Kalpuvam	225
Kaltanji	167
Kalucho	176
Kaluyette	222
Kamaka	101, 135
Kamala nimbu	25
Kaman	77
Kamarak	11
Kamaraka	10
Kamarakha	10
Kamarakmara	10
Kamaranga	10
Kambal	309
Kambrong	37
Kambuli	272
Kamia	242
Kamini	38
Kamlai	285
Kampira	313
Kamrak	10
Kamranga	10
Kamwepila	41
Kanakindeli	225
Kanalei	16
Kanali	257
Kanalu	32
Kanar	242
Kanchula	242
Kandai	176
Kandailo banj	176
Kandakola	214
Kandar	251
Kandara	176
Kandarakkarai	167
Kandaru	242
Kandazera	185
Kande	324
Kandela	176
Kander	185
Kanderu	176
Kandiari	185, 203
Kandika	203
Kandior	71
Kandir	176
Kandlar	176
Kandlu	176
Kandu	185
Kandur	251
Kandwer	77
Kaneamogge	260
Kangar	303, 308
Kanghur	77
Kangkhir khola	251
Kangkur	77
Kanhyana	77
Kanjar	244
Kanjara	242
Kanji	198
Kanjiol	242
Kanjlu	176
Kanjru	176
Kankar	77, 251
Kanki kola	251
Kankumbala	257
Kan-limbe	20
Kanman	77, 285
Kanmar	231
Kann	260
Kanna kompu	90
Kanniramaram	181
Kannire	181
Kannıroi	181
Kanor	251
Kanrai	303
Kanshin	242
Kanta ber	202
Kanta bohul	203
Kanta-horina	44, 45
Kantalkai	231
Kantiernyok	214
Kanu	30
Kanukpa	30
Kanurmara	181
Kanzal	242, 244
Kanzlo	242
Kapasi	242
Kapiakushi limbara	130
Kapi-priya	33
Kapita	33
Kapitr	33
Kappal-cherunkuru	268
Kappal mavu	268
Kappal sera	268
Kappamava kuru	268
Kapper	260
Karagil	90, 94, 128
Karai-chhetulo	198
Karaikaru-vilangam	131
Karakala	202
Karanachi	233
Karang-kunthrikam	74
Karangkunthrikkam	74
Karanphal	27
Karapincha	41
Karapu dammar	74
Karapu kongiliam	74
Kardai	10
Karelu	176
Karendera	244
Karepak	41
Kare paku	41
Kargil	95
Karhi-nimb	41
Kariar	71
Kari-beyu	41
Karigeru	313
Karikkuvaggai	192
Karingota	59
Karis	256
Karivappilei	27
Kari-vempu	41
Kari-vepa	41
Kari-vepa-chettu	41
Kariveppila	29
Kariyan	285
Karkalla	203
Karkar	303
Karkat	203
Karkataka-shringi	309
Karkata-sringi	309
Karkava	181

Name	Page
K—(*contd.*)	
Karkkara-sringi	309
Karkon	260
Karmal	10
Karmavu	268
Karolu	77
Karomonga	11
Karonda	71
Karre vemba	77
Karre vembu	77
Karru	163
Karsepak	41
Karui	58
Karuka	189
Karukara	202
Karukava	202
Karukkati	130
Karum	74, 183
Karumiraka	181
Karunjarai	282
Karunkarai	282
Karunkungiliam	74
Karur	77
Karuttukungiliyam	74
Karuvali	192
Karuvati	181
Karuvembu	41
Karveppilai	41
Karvambu	77
Kasabally	214
Kasai	209, 228, 230
—— Malayan	229, 230
Kashbar	58
Kashmala	285
Kashu-mavu	268
Kasma	233
Kasrukuva	181
Kasshok	127
Kasuri	183
Katambalam	316
Kata narunga	20
Katangai	110
Kataw-chying-krang	251
Katbel	33
Kat-ber	203
Katbo	189
Katebel	283
Kateru	176
Kathai	59
Katha-shengkotta	314
Kathbel	33, 36
Kathbhalai	309
Kathbhilawa	272
Kathe-elumichcham-param	20
Katheru	198
Kathi kilavi	260
Kathitsu	44
Kath-lechi	225
Katila	77
Katimango	272
Kat kitchillee	36
Katli	117
Katli-tun	123
Katmaa	272
Katma-maram	272
Katmanna	77
Katnim	41
Katori	18
Kattambate	316
Kattam-bolam	316
Kattam palam	316
Katta murakku	45
Katta-naragam	20
Katta-vappilu	41
Katta vekkali	163
Kattuchampakam	32
Kattu-chera	282
Kattu cheru	282
Kattu cherum	282
Kattuchrai	282
Kattuk kariveppilai	29
Kattuma	272
Kattumavu	316
Kattunelli	219
Kattupuvam	225
Kattu shenkottai	314
Kattuveppu	135, 136
Katugeri	282
Katu kina	45
Katula	77
Katum sing	127
Katupuveras	219
Katur	292
Katuvela	36
Kat vepillei	29
Katyalu	20
Kaunggalo	306
Kauri	242
Kauth	33
Kavadi-pungai	231
Kavaga	313
Kavat	33
Kavit	33
Kavith	33
Kavitha	33
Kawat	33, 36
Kay-bevu	101
Kaype-bivu	101
Kechechi	77
Keevi	181
Keidi-asing	290
Kekar	77
Kekara	77
Kekda	77
Kekked	77
Kekra	77
Kembel	285
Kempugandapheri	110
Kempu geru	268
Kempu-gerubija	268
Kemuning	39, 40
Keotai	123
Kerepaku	39
Kering-phong	97, 123
Keru	313
Kerubija	313
Ketenggah	14
Khag-men-chhi	131
Khakkar	303
Khami	242
Khamoli-mola	316
Khamoli-sali	316
Khankhri-wakbuk	202

Name	Page
K—(*contd.*)	
Khankpa	30
Khansing	242
Kharai	185
Kharang	127
Kharang-kelok-arong	123
Kharas	260
Kharasa	185
Kharpat	77
Kharri	154
Kharwar	22
Khatalimbu	25
Khati	277
Khatimai-phang	108
Khattanibmu	26
Kherai	283
Khetma	308
Kheu	296
Khimdabeng	62
Khi-si	313
Khitma	308
Khoirao	236
Khong-khani-makbul	202
Khonki	309
Khrang	90
Khrang arong	257
Khonki	309
Khrankerarong	116
Khrauchi	155
Khri	296
Khunkia	308
Khuranchi	236
Khusing	111
Kichejanthar	71
Kilamari	257
Kili	160
Kilmira	77
Kilpattar	243, 244
Kilu	242
Kimia	242
Kimul	285
Kingaro	185
King wood	265
Kinji	101
Kinthat-putgyi	30
Kioch	183
Kiranelli	10
Kiri	181
Kirmira	35
Kirmola	243
Kirmoli	243
Kishing	251
Kisianthor-arong	71
Kitchli	25
Kithale	25
Kitla	243
Kitmira	77
Kitmirria	77
Kittali	25
Koasa	260
Kobbe	214
Kochbel	33
Kodamankattu maram	272
Kodambada	316
Kodivirai	2
Kodsa	173
Koeta	33
Kogema-iaopa-phang	16
Kohaka	313
Kohan	233
Kohka	313
Kohumba	101
Koito	33
Kokan ber	202
Kokha-marra	313
Kokli	45
Koko	260
Kok-aru	163
Kokoh	260
Kola mavu	269, 272
Kolamma	316
Kolegeru	272
Kolemavu	272
Koliori	188
Kolliceru	272
Kolong-asing	39
Kolumichangai	26
Komal-siuli	130
Komker-asing	74
Komur	233
Kon	233
Kondamamidi	316
Kondanakkera	167
Konghi	313
Kongki	313
Kongsung kung	37
Koniari	62
Konji	39
Konshikaha	66
Kontakura	214
Koon	233
Kop-kwai	165
Kora	130
Korakadi	130
Korali	217
Koranga	53
Korivi	222
Korna-nebu	25
Koroiphula	37
Kosam	233
Kosham	292
Koshru	260
Kosomara	77
Kosomera	77
Kosramba	77
Kosromba	77
Kosru	260
Kothamari	257
Kotoki	177
Kotta	203
Kottai mundi	269
Kottei	202, 203
Kotti	269
Kovit	33
Kowa-tuti	35
Krali	215
Krerk	290
Krimugi	313
Krucho	176
Kruk	290
Kuccavir	260
Kuchni	198
Kudak	77
Kudia-nim	41

Name	Page
K—(*contd.*)	
Kuhamathi	222
Kuhimala	285
Kuhumb	233
Kujya	111
Kukandra	243
Kukei	198
Kuki	201
Kukulman	257
Kul	201, 202
Kula	233
Kula-pannai	35
Kulkili	68
Kuma	111
Kum-kum	183
Kumla-nebu	25
Kundrikam	68, 74
Kundrikam-morada	68
Kundro	68
Kundruk-kampishin	68
Kundur	68
Kunduru	68
Kundurukka-maram	68
Kunghi	243
Kungiliam	68, 71
Kungku	183
Kungli	68
Kungli-parangisambrani	68
Kunji	198
Kunkudu	231
Kunthirikka-payin	74
Kuntichintha	192
Kura	185
Kurak	77
Kuranga	36
Kuriaput	136
Kuri-bevu	41
Kuriya	130
Kurku	18, 183
Kurkuvu	181
Kurpa	222
Kurpah	222
Kurpodur	163
Kuruk	77, 110
Kuruntu	20
Kusamo	233
Kusavi	259
Kusimb	77
Kusum	209, 220, 233, 235
Kusumb	233
Kutigheri	282
Kutimba	77
Kutla	25
Kuttegreu	282
Kuvalam	18
Kuvalap-pazham	18
Kwet	33
Kwik	296
Kyana	105
Kyatnan	105
Kyaungthwe	41
Kyelthatun	326
Kyetmack	30
Kyetmauk	225
Kyoroe	316
Kyoung	296
Kywegaw	25

Name	Page
L	
Labshi	316
Lacquer tree	306
Lahanlokhandi	216
Lahara kapasi	243, 244
Lahara timur	44
Lahasune	95
Lahkra-la	257
Lahripoma	117
Lahsune	123, 127
Lakhandi	222
Lakhar	309
Lakshmi-am	292
Lalang-baiong	53
Lalay	260
Lalchini	97
Lal devdari	117
Lali	97, 127, 155
Lalkabashi	243
Lalkapasi	243
Lamboben	272
Lamote	290
Lamu	215
Lamung	290
Lanchu	183
Lanka ambo	269
Lapshi	136
Larga	306
Large leaved mahogany	147
Larubandha	260
Lasmani	37
Lasumi	176
Latang	285
Latmi	94
Latsai	110
Laur	244
Law-gaw-pan	236
Lawihkri	25
Lawihpaw-ma	25
Lebu	25
Lei	185
Lein	296
Lienmaw	25
Lekh kapasi	242
Lelaw	163
Lelu	163
Lemon	26
Lesi	225
Letauk	89
Libado	101
Lichhoi	183
Lichu	225
Lignum-vitae	7
Lilac, Indian	101
Lilac, Persian	135
Lim	110
Limba	101
Limbado	53, 101
Limbara	135, 136
Limbe	25
Limbo	101
Limbra	101
Limbru	71
Limbu	25, 26
Limburnyok	42
Limun	25

Name	Page
L—(*contd.*)	
Lindwi	71
Ling-kun	39
Lisay	176
Lise	176
Lisi	225
Litchi	225, 227
Litzaklo	324
Loajan	16
Lohagasi	18
Lohar	285
Lohasa	309
Lokaneli	222
Lokar bhadi	285
Lombo	272
Loneopomoa	272
Lonepho	272
Longan	225
Long-lephuphang	97
Lonka-bhollia	269
Lonpo	272
Loonia	181
Loso	313
Lota amari	95
Luban	68
Luhish	198
Lumbo	25
Lunbo	272
Lunu-ankonda	32
Lutchmi	216
M	
Ma	291
Maa	291
Macheru	299
Machli-poma	30
Madabai	285
Madagari vembu	117
Madagiri vembu	110, 117
Madala	25
Madalkura	163
Madanay	29
Maddi	68
Maddipalu	53
Madhuduta	290
Madhu-kartika	26
Madi	68
Madrasada	94
Madukarai	167
Magyibauk	231
Mahadebava	201
Mahaka	18
Mahaka-dibur	18
Mahala	53
Mahalimbu	111, 136
Mahamilvam	36
Mahanim	53, 110, 135
Mahanimbu	25
Mahaphala	25
Maharukh	53
Maharukha	53
Maharut	77
Mahi-sakrh	66
Mahi-saksh-gugal	66

Name	Page
Mahogany	14, 81, 82, 144, 145, 146, 147, 151, 153, 277
Mahogany African	82, 146
—— American	145
—— Australian	82, 146
—— Birch	146
—— Brazilian	145, 146, 147
—— Burma	146
—— Central American	151
—— Cherry	146
—— Colombian	145, 147
—— Costa Rican	145
—— Cuban	145, 147
—— Gaboon	64, 146
—— Guatemalan	145
—— Honduras	145, 147
—— Jamaica	145, 147
—— Large leaved	147
—— Mexican	145, 147
—— Panama	145
—— Para	146
—— Peruvian	145, 147
—— Philippine	146
—— Porto Rico	145, 147
—— Rose	82, 146
—— San Domingo	145, 147
—— Sapele	82, 146
—— Spanish	145, 147
—— West Indian	145, 147
Mahrukh	53
Mahua	273
Mahura-naranna	25
Maihakhpu	272
Maihat	296
Mai-hki	55
Mai-hun	296
Maika	18
Mai-ka-aung	313
Mai-kasan	236
Maikawk	316
Mai-kham	285
Mai-khaw	233
Maikyang	233
Mai-mak-kauk	316
Maiphak	30
Maisachi	66
Maisakshi	66
Maishkshi	66
Maishakshi-gukkal	66
Mai-si	55
Maiyum	110
Maja	285
Makad-limbu	20
Makai	201
Makaudamu	291
Makhaibo	116, 127
Mak-hpiig	10
Makkhaibo	116
Mak-mong	290
Mak-mong-sang-yin	292
Mak-mong-si-ho	268
Makoh	201
Makola	324
Makpyen-sum	33
Mak-pyin	18
Makranda	35

Name	Page
M—(*contd.*)	
Maksawk	25
Mak-sun-ting	25
Makur limbu	20
Malabar neem	136
Malai lakri	39
Malai-vembu	135, 136
Malaivirali	155
Malamavu	272
Malam Kara	163
Malampulavum	95
Malancera	314
Malaphang	45
Malar-veppu	110
Malayan Kasai	229, 230
Maldid	77
Malei vembu	117
Mal-kera	62
Malla	202
Mallei vapu	117
Mallikanarangi	25
Mal naranga	20
Malugam	101
Malurainu	18
Mamadi	291
Mamaram	291
Mamid	291
Ma-monton	290
Mampuli	316
Mampulichi	316
Mamral	198
Mamri	181
Ma-mung	290
Mana	183
Mancharei	313
Manda-dhup	74
Mandamai	285
Mandar	242
Manderikke	110
Mandra	244
Mandraj	37
Manga	291
Mangas	291
Mango	277, 290, 292, 293, 294, 295
Mango, Ceylon	269
Manichal	231
Manikyan	35
Mani-pungam	217
Manna	290
Manu	306
Manwood	162
Manwood, Black	162
Maple	47, 241, 242, 243, 244
—— American, rock	245
—— Big leaf	241
—— Black	240
—— Hard	241, 246
—— Indian	245, 246
—— Japanese	241
—— Norway	241
—— Oregon	241, 246
—— Pacific	241, 246
—— rock, American	245
—— Soft	241, 246, 247
Maple, Sugar	240, 246
Mara	183
Maram	181
Marat	18
Marchob	256
Marchula	39
Marchulu	38
Maredu	18
Mareila	185
Margosa	101
Marka	290
Marka marra	290
Markaria char	272
Marking nut tree	265, 313
Marli-thing	225
Marmakoul	183
Marukh	53
Marum	272
Masa veppu	136
Mashwal	21
Masispel	123
Masna	303
Masru siphel	116
Massan	201
Massivara	259
Masuala	260
Masula	21
Masun	201
Masuri	324
Matalanarakam	25
Mathagiri vembu	110
Mathe	260
Mathu	58
Matkhila	35
Mattigar	299
Mattipal	53
Matu-lunga	26
Mauhidal	123
Maukti	35
Mavedi	285
Mavena	290
Mavi	291
Mavina mara	290
Mavu	290
Mawu	290
May	233
Mayan	270
Mayamn	44
Mayamn-kyetsu	44
Mayini	285
Mechia sag	41
Meke	38
Mekadik-kuruntu	33
Melo-kapasi	244
Mendru	216
Metahmbu	25
Metkur	181
Metyun	30
Mewa	285
Mexican mahogany	145, 147
Mezenga	44
Midauma-baphang	32
Midoubri-doukha	197
Migliok-kung	130
Mikachhak	177
Mimarari	198
Mindiri	269

Name	Page
M—(*contd.*)	
Mipak	30
Mirandu	181
Mirga	181
Mirgach	225
Miri	181
Miriam	270
Mirimah	71
Mirtenga	71
Misai-athep	39
Mishta-nimb	41
Misser	26
Mitha	25
Moakurra	160
Modama	272
Moda mavu	272
Modhal	285
Modirakanni	2
Modwa	272
Moee	285
Mogchauphong	155
Mohara	216
Mohdi	77
Mohi	71, 77, 285
Mohin	285
Mohwai	285
Moi	285
Moja	285
Mokha-pisi-tondora	181
Mokkamamidi	269
Moksongayok	38
Momai lateku	90
Mondaing	189
Monia	285
Montamamidi-vittu	269
Mooi	285
Mookurichi	181
Mooltaga	222
Moonga	326
Moorghu	272
Mora	225, 272
Morada	68
Morai	45
Morala	272
Moralai	272
Morala sirtik	272
Morale	272
Morallu	272
Morave	272
Mori	191
Morindu	181
Morli	272
Morlimorlu banka	272
Morli sara	272
Morlu	272
Morlu chettu	272
Morphai torelka	36
Morunga	326
Morvel	214
Mosroi	324
Mota amari	257
Mota char	272
Motirakodi	2
Moto aduso	53
Mottakayadi	163
Motunimbu	25
Mouksa-khislam-phang	95
Movurdonn	181
Mowai	285
Mowen	285
Moya	260
Moyal	285
Moyee	285
Moyini	285
Moyna	285
Mudah	62
Mudaima	272
Mudamah	272
Mudma	272
Mududad	22
Mugila	243
Muka-asing	30
Mukarive	181
Mukarti	181
Mukkannan-peru	214
Mukkarite	181
Muktamanji	231
Muktamaya	231
Mukti-moya	217
Mukul	66
Mukul sali	68
Mulaka	326
Mulei	225
Mulgia	326
Mulillam	45
Mullankode	2
Mullilam	45
Mullukare	203
Mullu-muttaga	95
Munaga	326
Munagha	326
Mundika	155
Mundiri-kottai	269
Munga	326
Munga ara	326
Mungapara	272
Mungaperlu	272
Mungidi	269
Munnuthikaraka	136
Muntha-mamidi	269
Munthri	269
Munthri-kottei	269
Mural	272
Murangai	326
Murele bhendy	214
Murgut	257
Muria	272
Muri chetu	272
Muringa	326
Muringo	326
Murkalu	272
Murki malle	164
Murtenga	71
Murthiga	316
Murukali	272
Murukalu	272
Murukalu muruku	272
Muruku	272
Mutirai	22
Mutmur	181
Mutta-nari	16
Muvalneeli	214
Myank zi	202

Name	Page
M—(*contd.*)	
Myauk-okshit	193
Myrtle, Chinese	14
N	
Nabe	285
Naga	183
Naga-golunga	39
Naga-lichi	225
Nagaragandanam	167
Naga-tenga	308
Nagdaun	256
Naggiri	167
Nagpat	257
Nahi	285
Nah-pui	260
Nai-bel	36
Naibela	36
Naibullal	36
Naicheru	282
Naikottai	231
Naimarom	214
Na-imbul	220, 228
Nai-vela	36
Najor	71
Nakaling-arong	197
Nakkarai	167
Nakkhaibo	122
Nal-bila	121
Nalla-jidi	313
Nallarojan	74
Nalla rojanamu	74
Namilikalu	214
Nanam	285
Nandichettu	111
Nange timur	47
Nangryupat tembar	14
Nanjunda	8
Nar	198
Naradabba	26
Narangam	25
Naranga-pandu	25
Narangi	25
Nara singha	28
Narattai	25
Nargan	39
Narguni	20
Nari-ilantai	203
Narockpa	74
Narole	62
Narpati	42
Narsingha	41
Nartham pazham	26
Narup	53
Naruvi	272
Natmi	94
Natu-sengote	314
Nava lung	26
Navi-bel	36
Naya-changney	25
Nebede	32
Nebu	25
Neeb	101
Neem	81, 101, 135
Neem, Malabar	136
Neikottei	220
Nekota	222
Nekri	167
Neoli	71
Neonri	181
Nepali-dhanua	44
Ner	42
Neradi	181
Nerebi	74
Nereri	74
Neridi	181
Nerosi	181
Newar	183
Ngabauk	275
Ngraurau	251
Nia-jowa	77
Nib	101
Nibam	59
Nibu	25
Nibua	25
Nichu	225
Nihor	71, 316
Nikadawulu	259
Nikki kander	198
Nila	257
Nilbhadi	77
Nilbhodi	77
Nim	101
Nimb	101
Nimba	101
Nimbainara	36
Nimbamu	101
Nimban	101
Nimba-olle-behu	101
Nimbara	136
Nimbay	101
Nimbe-hanu	25
Nimbu	25, 26, 101
Nimburu	71
Nimkathia	41
Nimma	36
Nimmapandu	25, 26
Nimo	101
Nimtita	57
Nimuri	101
Ninas	308
Ninawa	308
Ninb	101
Ningal	219
Nior	198
Nirija	181
Niriyasam	101
Niroli	219
Nirvoli	219
Nitak-asing	260
Nithavanji	231
Niuri	181
Niutni	198
Nobunisero	62
Nolla-jidi	313
Noogay	326
Nor-hing	41
Norway maple	241
Nugge	326
Nuggi-mara	326
Nundo-jangro	202
Nunewalai	261

Name	Page
N—(*contd.*)	
Nunga	217
Nungha	326
Nurai	225
Nurchilla	272
Nurkal	272
Nuruke	272
Nuruvei	272
Nuskul	272
Nyngdong	44
O	
Oak	297, 309
Obakotru	25
Obok	35
Odai manu	286
Odia	286
Odiyamaram	286
Okshit	18
Olo-jem	313
Onger-asing	45
Ongret	45
Oorgero	313
Ope-sheet	18
Oregon maple	241, 246
Otali	39
Ote armu	28
Owebaung	316
P	
Paan	306
Pabba	117
Pacific maple	241, 246
Padara kawat	36
Padragota	37
Padrium	181
Pagadapu-katta	5
Paharijiga	77
Pahari kaghzi	25
Pahari-nimbu	25
Paira	272
Pajerra	324
Palai	308
Palami	154
Palara	142
Pale	243
Pale-kung	243
Paling-changne	16
Palit kung	90
Pallam	313
Pallikkai	313
Pal vidiyan	282
Pambalimasu	25
Pambavettu	257
Pamburu	20
Pampala masam	25
Pampali	202
Pampara masam	25
Panaka	192
Panal	35
Panalai	231
Panama mahogany	145
Pandry	39
Pangar	251
Pangoi	243
Pangyala	243
Paniala	181
Pani-amora	77
Panikusum	222
Pani-let-ku	257
Paniphul	215
Pan-kafur	27
Pantappayan	74
Pantham	74
Paorki	216
Paowlay	16
Papar	183
Papnassa	25
Paragi	202
Para mahogany	146
Paranga	243
Parangi	68
Parangi mavu	268
Parangi-sambrani	68
Parangi-shambi-rani	68
Paranki-mavakuru	268
Parenga	260
Paribadhra	41
Pariyacceran	314
Parmium	185
Parop	272
Parpailigidda	202
Parpar timur	44
Parpat	243
Paruh	117
Paruppusedi	272
Pasakotta	225, 231
Pash	183
Passur	105
Pata	244
Pata-champa	62
Pataki	185
Patmebu	25
Patir	18
Patiri mavu	268
Patmoya	260
Patrang	42
Paudama	135
Pauh-kijang	56
Pavirimulei	225
Payakoson	275
Payala	272
Payan	198
Pedda chintu	185
Peddamanpata	53
Peddamanu	53
Pedda-morali	272
Pedda sara	272
Pedu	53
Peduman	233
Peenari	53, 173
Peetherai	53
Pehimbiya	219
Peimota sara	272
Peju	30
Penela	321
Peng-lay-oang	105
Pepuli	45
Pepull	45
Periamaram	53
Perilla picha	155
Periyaelumichcham-pazham	26

Name	Page
P—(*contd.*)	
Perrakudikai	214
Persian lilac	135
Persimmon	115
Peru	53
Perumarium	53
Perumarum	53
Perumaruthe	53
Perunkuruntu	20
Peruppi	53
Peruvian mahogany	145, 147
Pesho	58
Pet-taung-gyaing	260
Peykuruntu	20
Phaglan-jan-arong	260
Phaklang-jan-arong	251
Phalapura	26
Phan	306
Phandgao	243
Pharbanj	243
Phatgab	243
Phatgal	243
Philippine alupag	226
Philippine mahogany	146
Philli	260
Phipai	198
Phirphiri	243
Phish	198
Phitniber	203
Phoko	260
Phol-hoi	283
Pholoi-kung	283
Phrado-buphang	251
Phulla	198
Phul-rata	97
Phupari	185
Phuwathai	231
Pial	272
Pichola	260
Pilrupotala	35
Pimaran	53
Pinari	53
Pincho	183
Pine	309
Pinle-kayin	167
Pinle-on	105
Pinleon	105
Pinlezi	167
Pinna	183
Pinni	183
Pirai	181
Pira mattipala	89
Pisidam	101
Pisumarddam	101
Pitha	231
Pitni	201
Pitondi	39
Pitraj	95
Piyal	272
Piyar	272
Piyari	181, 192
Piyu-nekphi	257
Pleg-ik-arong	35
Plum, Hog	264, 316, 317
Poison Ivy	306
—— Sumac	306
Poma	110
Poma arong	110
Poma-khatmai	110
Pongilyam	53
Ponnaeceran	314
Ponthikechauphang	94
Poonjara	89
Poospala	41
Porasu	22
Porda	260
Poripuna	225
Porto Rico mahogany	145, 147
Portugi mavu	268
Potai	243
Potali	35
Potla	35
Potli	244
Potti	29
Pounanga	231
Pritikannavu	268
Proth-arong	176
Pu	251
Puanle	16
Pucha	231
Puchankottai	231
Pudanashanam	313
Pulichi	11, 233
Pulima	272
Pulipilai	316
Pulusari	233
Pumaratha	233
Pumelo	25
Pundalu	220
Pungankottai	231
Punil	285
Punna-charei	314
Punpan	251
Punyava	90
Pural	272
Purpuray timur	44
Pursho-bhola	313
Purudona	121
Purush	22
Puska	233
Pusku	233
Pussur	105
Puthorin	58
Putuchal	57
Putli	243
Puvam	233
Puvamkottai	231
Puvan	233
Puvathi	233
Puvatti	225
Puvela	231
Puvilagil	128
Puvu	233
Pyal-char	272
Pyindawthem	27, 28
Pyinmana	38
Pyizin	306
Q	
Quebracho	265
Queensland maple	14
Quince, Wild	209

Name	Page
R	
Rainyi	142
Raitung	308
Raja-veppu	101
Raj-jehul	181
Rakat-berar	39
Raktan	189
Rakta rohida	199
Rakta zorar	199
Ral dhup	74
Raldhupada	74
Raman bih	251
Ramanchi	5
Rambutan pachat	236
Ramon asing	251
Ramser	20
Ranabili	121
Ranai	183
Ranggach	35
Ranghan	66
Ranghan-turb	66
Rangrek	198
Raniwalai	309
Ranlimbu	20
Rannel	308
Rasala	290
Raselwa	324
Rashtu	308
Rasi	181
Rata	116, 123
Ratadummula	66
Ratanjot	27
Ratapangpa	116
Ratasahatta	127
Ratatuni	117
Rath-kanchula	242
Ratu kina	45
Rau	324
Rebab-tenga	25
Red dhup	300
Reddi	45
Rega panda	201
Rege	201
Regi	201
Regorea	8
Renga	201
Rangas	296
Rangha	201
Rantha	231
Reteon	198
Rhetsa	45
Rhetsaman	45
Ribo-sing-king	25
Rihali	309
Rikam-ruibi	44
Rikhul	309
Rimmel	163
Rimot	251
Ring	53
Ringa	201
Ring-kang-akikarong	197
Ringok-me	97
Ritha	217, 231
Rithu	183
Roatanga	233
Rohada	95
Rohi	181
Rohimala	77
Rhimola	77
Rohina	95, 142
Rohini	142
Rohitaka	95
Rohituka	95
Rohun	142
Rokpoletak	160
Rolang-phang	130
Rolla mavu	269
Rom	77
Romusk	198
Ronchilling	316
Rongi-rata	97
Roni	183
Rothang-phang	130
Roum poma	77
Ruglim	191
Ruhimala	285
Rukh baer	202
Rumin	189
Rusaka	25
Ruskam	25
S	
Sablata	256
Sadaphal	25
Sagada	233
Sagadi	233
Sagladi	37
Sagra	202
Sagyaw	290
Sahatchakung	97
Saihan	326
Saiphra	117
Sajina	326
Sajuna	326
Sakar nimbu	26
Sakkota	25
Sakotra hannu	25
Sal	128, 234, 273
Salai	68, 70
Salaia	68
Salai-dhup	68
Salai-guggar	68
Salar	68
Salasi-niryasa	68
Salaya-dhup	68
Salei	68
Saleh	68
Saler	68
Saleya	68
Salga	68
Salhe	68
Sali	21, 68
Salikukudu	214
Salima	242
Saliya	68
Salla	68
Sallaki	68
Salpe	68
Salphali	68
Salphullia	68
Salphullie	68
Samak	308
Samdaukhi	28

Name	Page
S—(*contd.*)	
Sami	181
Sam-khatsi	41
Samphal	97
Samphal-bol	225
Sam-sweng	28
San	296
Sanatta	215, 216
Sandal, Bastard	5
Sandalwood	133, 162, 168
Sandani vembu	110
San Domingo mahogany	145, 147
Sangatrani	25
Sangkatra	25
Sanjna	326
San-mani	37
Santala	25
Santara	25
Santha	257
Santhana vembu	111
Santhanaviri	132
Sanu lahasune	90
Sapele mahogany	82, 146
Sapochi-kuing	77
Sappula	308
Sara	272
Sara chettu	272
Saradi	71
Saragphula	53
Sarai	272
Saraiparuppu	272
Saraka	272
Sarawau	303
Sarekha	272
Sarlokasing	251
Sarmon-blai	16
Sarota	77
Sarrota	77
Saslendi	243
Satinwood	21
Satinwood, Andaman	39
—— East Indian	14, 24
—— West Indian	14, 43
Satpate	251
Satrai-phang	74
Sat-ta-mane	257
Saungya	10
Saunygga	10
Se	313
Segabin	251
Sehr-kung	308
Seiknan	28
Seingangaw	223
Seitnan	28
Sejan	326
Sekra	202
Selbal	2
Selga	68
Sel-gond	68
Sembulichan	5
Sengel	21
Sengkung	275
Sengumaru	101
Senkurunji	280
Seram	269
Seran	313

Name	Page
Serebilijira	35
Serhnyok	309
Sessal	45
Setapajja	198
Sevai	140
Sevamanu	140
Shaddock	25
Shagyaw	290
Shaing	313
Shaing-jiri	313
Shajna	326
Shala	324
Shalangli	42
Shalawi	25
Shamabairangi	58
Shangala	176
Shankonaro	260
Shankthakwa	25
Shanpi	236
Shanriya	181
Shapra	260
Shashni jamir	26
Shashra	42
Shashri	42
Shaukpan	25
Shaukton	25
Shaukvaing	20
Shaukwaing	25
Shayrang	313
She-che	283
Shem	142
Shemanathi	5
Shembiri	313
Shemmarom	142
Shemmuna	5
Shempuna	225
Shempuvan	225
Shenchanthanam	280
Shengotta	313
Shenkarai	167
Shenkararu	280
Shenkottai	313
Shenkuram	280
Shenkurani	280
Shenkuranthi	280
Shenkuravi	280
Sherankottai	313
Sherbili-phang	18
Shilkoi	188
Shimbat	285
Shimti	285
Shitkale	268
Shitzam	39
Shne	303
Shobhanjan	326
Sholapuvam	225
Shomfol	198
Shouk-ta-kwah	25
Shouk-ton-oh	25
Shumanjra	242
Shumi-chheng	45
Si	296
Siamunu	260
Sibon-asing	77
Sicilian Sumach	264
Sidemnyok	29
Sidhera	183

Name	Page
S—(*contd.*)	
Sidisale	214
Sidugoli	121
Siduguli	214
Sidumbulli-asing	257
Sigidima	269
Sigru	326
Sihosayesi	268
Siki	183
Sikru	95
Silai	68
Sileng-asing	53
Silot-kung	136
Silum-kung	25
Silver ash	14
Simal	110
Simali	39
Simli	203
Simnabat	260
Sind-gum-gugal	66
Sindrol	198
Sinduram	313
Sindure dabdabe	260
Sinduri debdabbi	260
Singi	183
Sing-i-te	44
Singjo	18
Singka-asing	57
Sinin-thayet	290, 292
Sinjli	203
Sinninthayet	290
Sinsri-kanthou	39
Sinwe	62
Sinyok	77
Siposhi kung	123, 127
Siriphal	18
Sirıtakdangji	44
Sirusalle	214
Siruyilandai	167
Sish	303
Sitaber	203
Sitha	308
Situk-payu	123
Sivit	272
Skioch	183
Smoke-tree	306
Soft maple	241, 246, 247
Sohaga	95
Sohan	142
Sohanjna	326
Soh-bel	18
Soh-dieng-lang	136
Soh-jing-buin	44
Sohjna	326
Soh-lapeit-synrang	285
Soh-ma	309
Soh-manong	25
Soh-mrit	44
Soh-umiuw	44
Soimi	142
Soitani	37
Sojna	326
So-kymphurkhlaw	165
Somadanam	142
Sombalam	313
Sombupattai	142
Some	142
Somepotri dope	77
Somida	142
Sompotri	77
Sompotri do dope	77
Somunthiri	105
Son	177, 296
Sona-mahanga	217
Sondna	326
Sonemau	16, 299
Songsun-kung	133
Soogyin	55
Soothan	296
Sorapalai	299
Sorupotri	285
Soso	313
Spanish mahogany	145, 147
Spite	198
Sri-amla	77
Su	296
Sudrabilo	282
Sugar maple	240, 246
Sukung	313
Sumac, Poison	306
Sumach, Elm leaved	306
Sumach, Indian	306
Sumach, Sicilian	264
Sumach, Venetian	307
Sumbi	142
Sumet-chheng	44
Sumi	142
Suming-arong	316
Sumusram	202
Sunari	62
Sundri	105
Sungru	44
Sungrukung	44
Sunjna	326
Sura	202
Surabhi-nimbu	41
Suraghzai	185
Surajmukha	27
Suram	202
Surja poma	111
Surkhi	256
Suruj-bed	111
Suru-potrimoi	71
Swad	233
Swanjera	326
Sweet lime	26
Sycamore	241, 246, 247
Synrang	77
T	
Tabu	55
Tadra	198
Tadrelu	324
Tadru	198
Tagari	259, 260
Tagat-kwedaung	220
Tagatni	122
Tagat-pyn	116
Tagat-thitto	94
Tagilima	313
Tagong-asing	225
Tairel	110
Taireny	110
Takau	290

Name	Page
T—(*contd.*)	
Takhril	309
Takku-asing	257
Takre-changne	257
Takta	130
Taktaraj	95
Talkar	185
Tallidhar	185
Tamabin	101
Tamaka	135
Tamarak	10
Tamarata	11
Tamarathai	11
Tamarat-tuka	11
Tamarta-kaya	11
Tamruj	181
Tamsung-kung	37, 117
Tamzen	316
Tang	308
Tangar champa	62
Tangaruk	95, 133
Ta-nyeng-hpo	37
Tanyinbo	37
Tarkhana	242, 244
Tarop	272
Tarub	272
Taruka	101
Tarum	272
Tasungchangpe	35
Tatri	309
Tauhari	303
Tauling-asi-kur	202
Taungdama	109
Taungkamaka	57
Taungsagaing	223
Taungtama	135
Taung-thayet	56, 319
Taung thitsi	277
Taw-ngayok	38
Taw-petsut	257
Taw shauk	20, 25, 35
Tawtama	108, 110
Taw-thamaka	135
Tawthanbya thee	20
Tawthayet	225, 290, 292
Tawthitcha	275
Taw-yeng-ma	117
Tawyinma	117
Tayokzi	225
Teak, Brush	209
Tejbel	44
Tejhi-arong	77
Tejmaibih	44
Tejmal	44
Teju	57
Tekreng	74
Telsur	277
Tembarai	313
Tempor	16
Temprakku	313
Tencera	314
Tendalake	74
Tengkhimakbil	202
Teon	243
Terebinth tree	304
Terhilnvok	29
Tessul	45
Tetar	308
Tew-kalong	47
Teyrar	27
Tezbal	44
Tezmal	44
Tezmoi	44
Tezmuri	44
Thabi-ben	68
Thabyay	228
Thagari	259
Thai-daw-ing	95
Thaidubriki-buphang	90
Thai ganggi	201
Thai gangni-hogra	202
Thaiguja baphang	290
Thaikhuokisin-bapang	116
Thaisram-phang	257
Thaisudi-phang	316
Thakabti	233
Thakhauphang	127
Thakri arong	201
Thali	231, 257
Thali kabashi	243
Thamaka	101
Thamaroja	181
Thanatka	36, 38
Thanbaya	25
Thanki	181
Thanthatkyi	95
Tharbi-arong	290
Thaukhu-khokhra	260
Thauthow	198
Thawka	283
Thawk-apo	227
Thawkat	227
Thayet	268, 290
Thayet-kan	319
Thayet-kin	319
Thayet-kin-san	319
Thayetle	319
Thayet-pya	290
Thayet san	319
Thayet-thee-nee	291
Thayet-thini	291
Thayetthitsi	280
Thee-hoh-thayet	268
Thee-hon-thayet	268
Thee hot	268
Thee-noh	268
Theibar	2
Thei-rhei ol	11
Thekachu	290
Thekejoy	257
Thekjoai	257
Thelli	74
Thelurikang	197
Theng-are-arong	130
Theng khi	201
Theng-kippi	116
Theng-lokso-arong	35
Theng-ngoitheh	176
Theng-pisumi	177
Thengpitungmeng	35
Theng-rali	155
Theng-sah-soh-arong	28
Thengsakso	41
Theng-sang	176

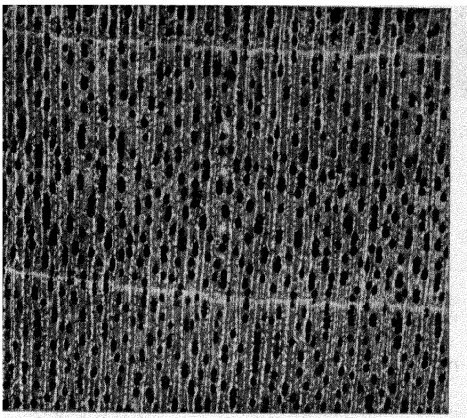
Name	Page
T—(*contd.*)	
Theng turni	176
Thenkotta	313
Thenthe-lau-phang	45
Theseli-arong	316
Thevetharam	111
Thi	33
Thibin	33
Thidak-dak-arong	231
Thigisin	57
Thihaza	36
Thihon thayet	268
Thihothayet	268
Thikring	71
Thin	101
Thinbaung	272, 319
Thin-boro-tamakha	101
Thing-buphai	2
Thing-erkum	260
Thing-hanse	37
Thing-nang-arong	45
Thing-poi	117
Thing-ril-char	90, 95
Thing-rot	77
Thing-tupui	127
Thinkiyo	176
Thin-saphu	123
Thitkado	110
Thitkandu	209, 228, 229
Thitni	94, 95
Thit-say-pen	296
Thitsi	296, 298
Thitsibo	272, 277, 313
Thitto	140
Thittwet	272
Thitya	296
Thodappei	280
Thoddali	202
Tholu-velaga	36
Thong-rong	316
Thoomay	280
Thora-limbu	26
Thotmela	77
Thotmola	77
Thowlhowa	260
Thriphal	45
Thu	296
Thu-asaw	296
Thudai	176
Thu-huya-za	36
Thulo khanakpa	30
Thurakayepa	135
Thu-saw	296
Thutu	296
Tian	243, 244
Tibri	308
Tigenaku	164
Tihotiva-si	268
Tiji-arong	285
Tikta	244
Tilavi	244
Tilmadi	77
Tilpattar	242
Tilpatto	243
Timbur	44
Timburnyok	42
Timur	44, 45
Tingang-arong	45
Tinn	77
Tipani	214
Tiri	308
Tirigai	269
Tirphal	45
Tirsam	176
Tisul	45
Titar	309
Titari	308
Tithai	58
Titmer	77
Titrai	308
Titri	306, 308, 309
Titroi	308
Tituri	308
Titwi	214
Toddali	202
Tochi-no-ki	250
Tode	260
Todu	110
Toisim-taito	77
Toi-sing-taite	286
Tokra	225
Tolao	260
Tolmori	272
Tondsha	36
Tonglong kung	176
Toon	82, 108, 110, 113, 114, 115, 121, 252
Tor-elaga	36
Tori-elaga	36
Torrayellaka	36
Touk-sha-ma	257
Toykhati	191
Trekhan	242, 243, 244
Trita	58
Tseik-chay	217
Tudhi	198
Tuga	303
Tugang	306
Tulip wood	209, 221
Tulli	183
Tultha-poka	35
Tum	77
Tumbaru	44
Tume han-thor	25
Tummeda-mamidi	313
Tumpat-kurundu	36
Tumra	308
Tumsung-kung	117
Tun	108, 110
Tunani	198
Tundu	110
Tung	306, 308
Tunga	306, 308
Tungchir-kung	57
Tungla	308
Tungnyok	243
Tungoi	306
Tungu	303
Tunhat	296
Tuni	108, 110, 111
Tun-mapa	25
Tunser	188

Name	Page
T—(*contd.*)	
Tunumaranı	111
Turaka gerı	268
Tural	130
Turan	202
Turanj	25
Turkavepa	164
Tutai	58
U	
U-da	290
Udi	285, 286
Udia	286
Ukkargandam	101
Ul	290
Ulagera	299
Uli	290
Ulkhuru	309
Umung	290
Unatharvai	220
Undurugu	217
Ungaralapedmi	2
Uranakkera	167
Uranechra	167
Urchiri	163
Urıam	270
Urisa	286
Urkur	309
Urmu	71
Uruangi	231
Uruk	309
Urulı	117
Urulinji	231
Ushan	326
Uthi	285, 286
Uttumabalam	269
Uugar	66
V	
Vadamalai-checkku	142
Vadari	201
Vaidraj	95
Vakinaran	20
Valiyaccera	283
Vallanga	33
Valmurichha	219
Vambu	101
Vandakamin	132
Vappa	101
Varul	53
Vavaneshta	101
Vedi vembu	110, 117
Vegula chokla	90
Vela	33
Velaga	33
Velama	313
Velasura	155
Vellagil	124
Vellakongu	95
Vella-kundirukkam	68
Vellam	33
Vellanga	33
Vellei-charei	313
Vellodai	177
Velloday	177
Vemu	101
Venetian sumach	307
Vengul	95
Vengurla	45
Venkadavan	189
Venkatava	189
Venkotta	189
Venkottei	189
Vepillei	27
Veppa	101
Veppam	101
Veppu	101
Verra oryewa aduga	90
Veruttam	101
Vijapura	26
Vila	33
Vilam	33
Vilatti	33
Vilayati-nimb	135
Vilva	18, 33
Vilvam	18
Vilva-pazham	18
Vingi	313
Vinma	117
Vinma bin	117
Virali	216
Virasagi	313
Vishirnaparana	101
Vittulu	313
Vrali	215
Varanasodhakari	101
W	
Wakek-turang	95
Walayati mehndi	215
Wal-karapincha	37
Walnut	14, 257, 277
Walnut, African	82
Walurasi	155
Wang-la-bei	97
Wansh	309
Watal	183
Weda-pana	29
Werella	216
Wesinni	251
West Indian mahogany	145, 147
West Indian satinwood	14, 43
Wet kyut	209
White cedar	82, 124
White dhup	74
Wig-plant	306
Wild quince	209
Wo-chora-a-anarong	35
Wodier	286
Woibaw	193
Workner	202
Wude	286
Wumb	225
Wun-the-che	164
Wun-the-gye	164

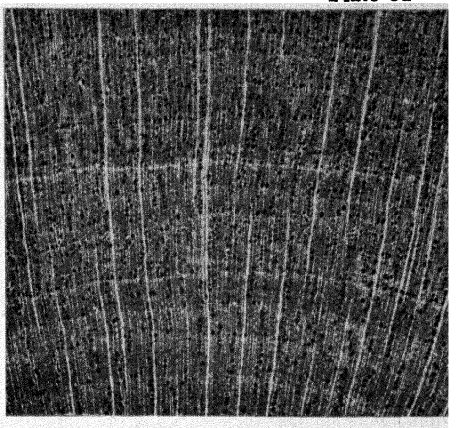
Name	Page
Y	
Yadama	135
Yakushi	130
Yali	242
Yalishin	242
Yang-ma	118
Yatli-kung	242
Yelchi	201
Yellandai	201
Yellande	201
Yellow wood	17
Yemyaw	251
Yeng-ma	117
Yenkul	185
Yeppa	101
Yerra-juvi	62
Yerra monukudu	20
Yinma	118
Yo-da-yah	62
Z	
Ziben zi	201
Zebra wood	265

M.P.—P.O.—J.S. 498—11-11-60—990

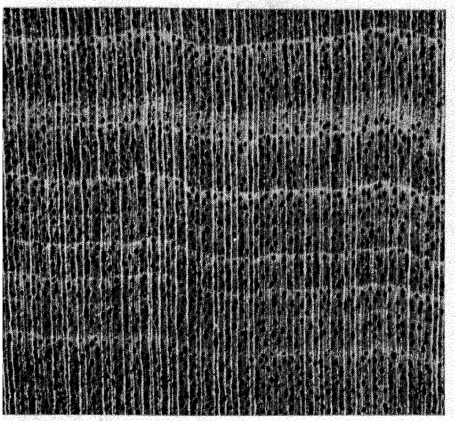
PLATES



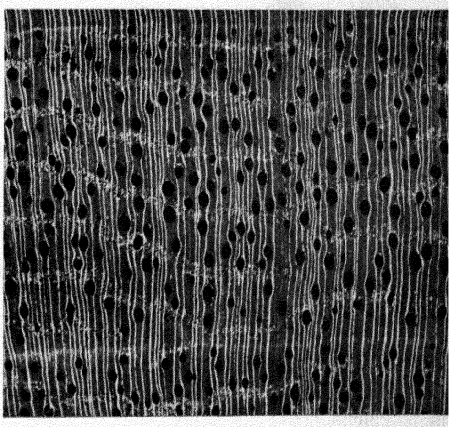
181. Erythroxylon burmanicum Griff.
(E. cuneatum (Wall.) Kurz)



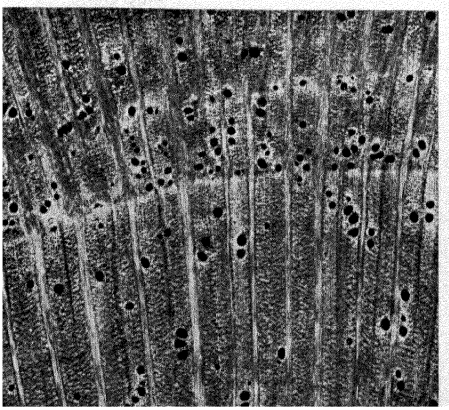
182. Erythroxylon kunthianum (Wall.) Kurz



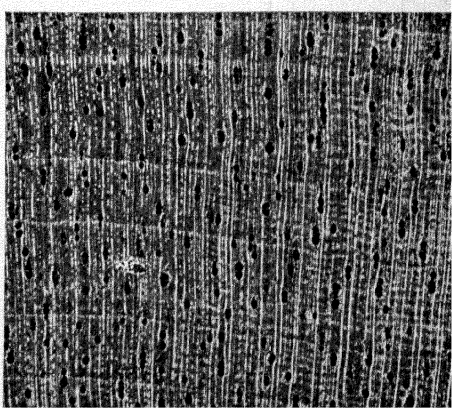
183. Erythroxylon monogynum Roxb.



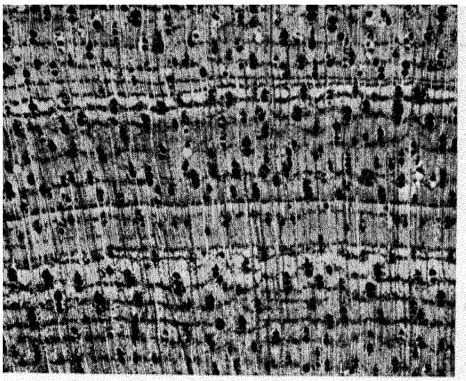
184. Ixonanthes khasiana Hk. f.



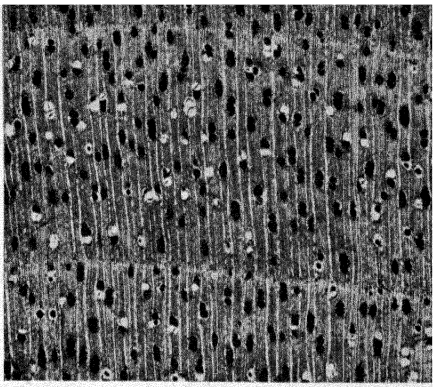
185. Balanites roxburghii (L.) Delile
(B. aegyptiaca (L.) Delile)



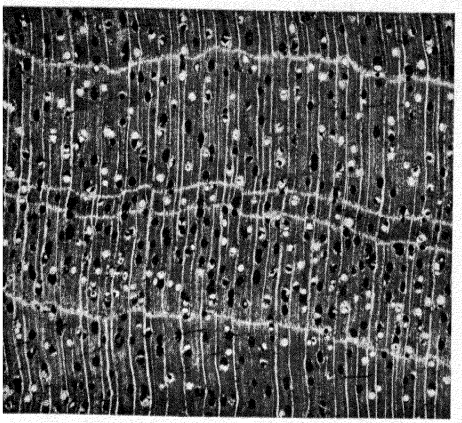
186. Averrhoa carambola L.



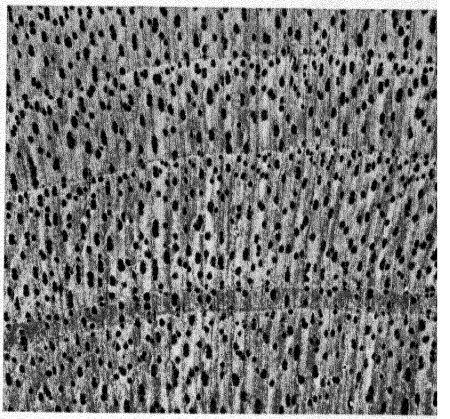
187. Acronychia laurifolia Blume
(A. pedunculata (L.) Miq.)



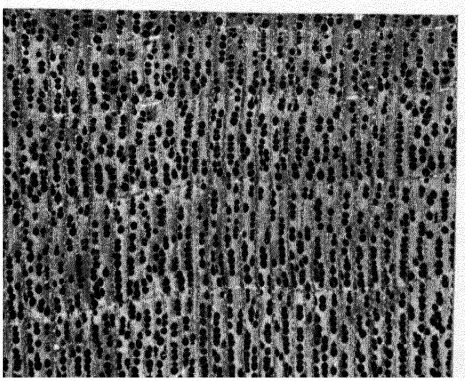
188. Aegle marmelos (L.) Correa



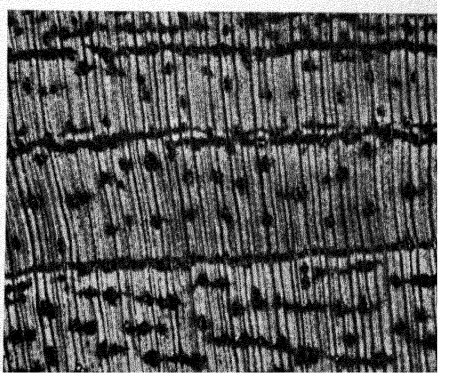
189. Atalantia missionis Oliver
(Pamburus missionis (Wt.) Swingle)



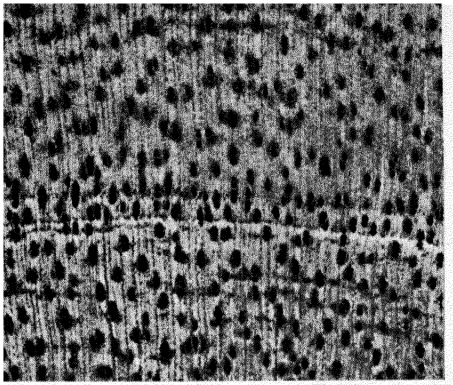
190. Atalantia monophylla DC.



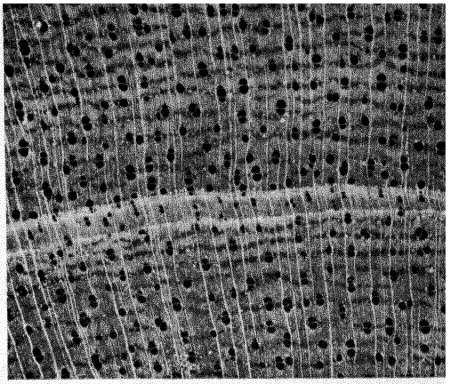
191. Chloroxylon swietenia DC.



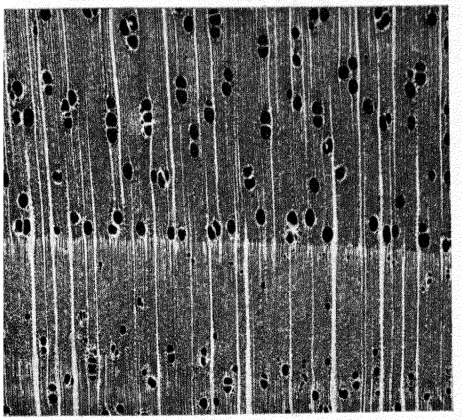
192. Citrus aurantium L.



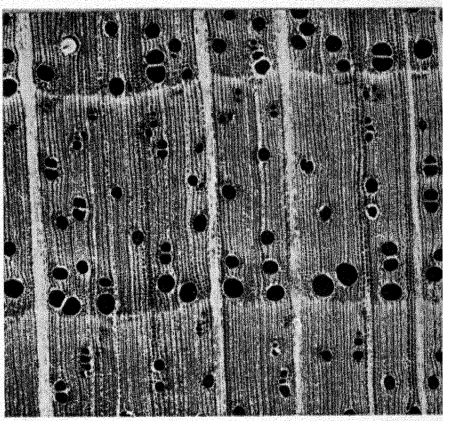
193. Citrus medica L.



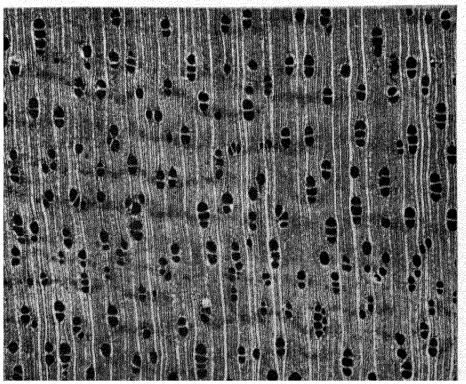
194. Clausena excavata Burm. f.



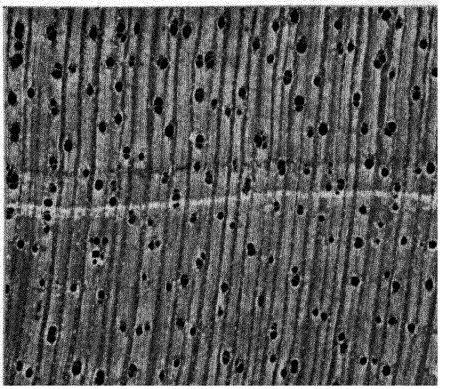
195. Evodia fraxinifolia Hk. f.



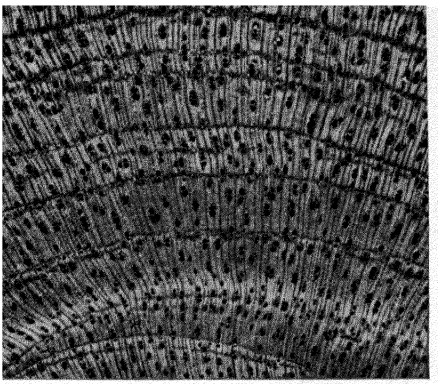
196. Evodia meliaefolia Benth.



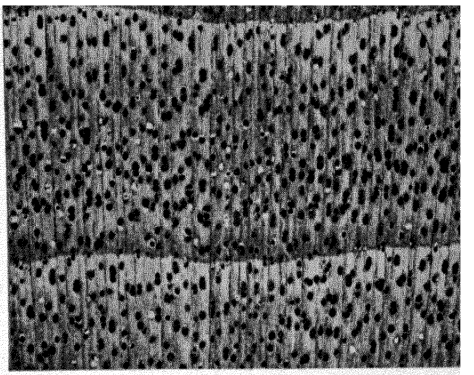
197. Evodia roxburghiana Benth.
(E. lunu-ankenda (Gaertn.) Merr.)



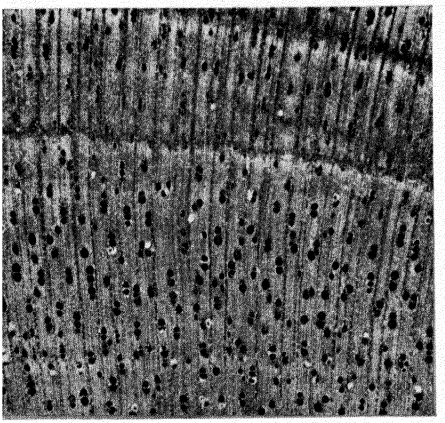
198. Feronia elephantum Correa
(F. limonia (L.) Swingle)



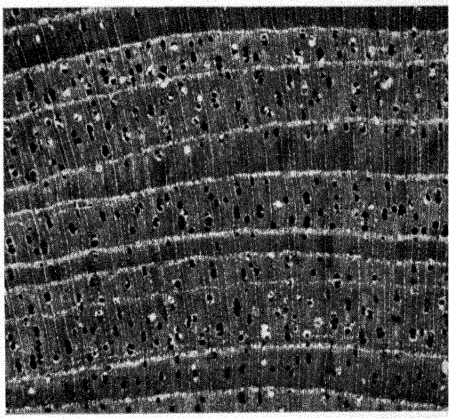
9. Glycosmis pentaphylla (Retz.) Correa



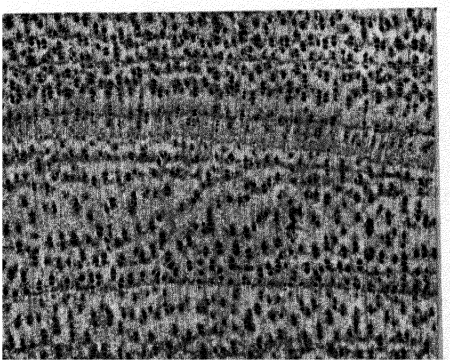
200. Limonia acidissima Auct. (non Linn.)
(Hesperethusa crenulata (Roxb.) Roem.)



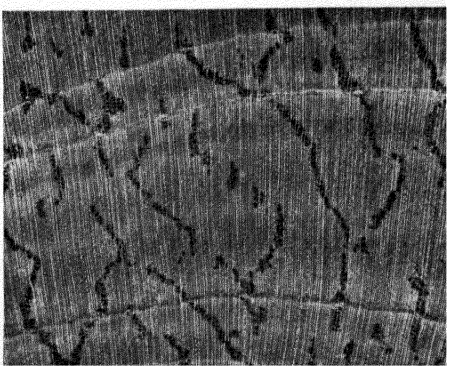
201. Micromelum pubescens Blume
(M. integerrimum (Buch.-Ham.) Roem.)



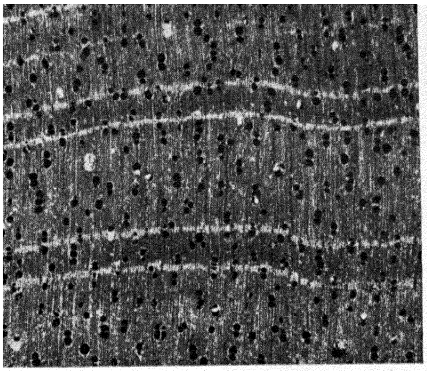
202. Murraya exotica L.
(M. paniculata (L.) Jack.)



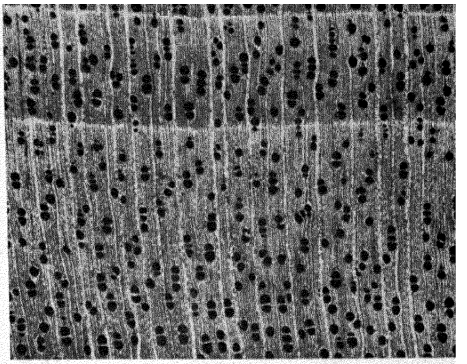
203. Murraya koenigii (L.) Spr.



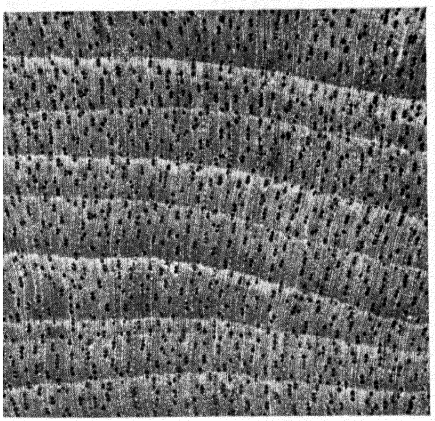
204. Skimmia laureola Sieb. & Zucc.



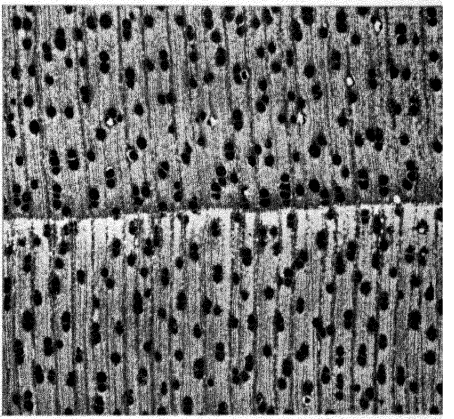
205. Vepris bilocularis Engl.



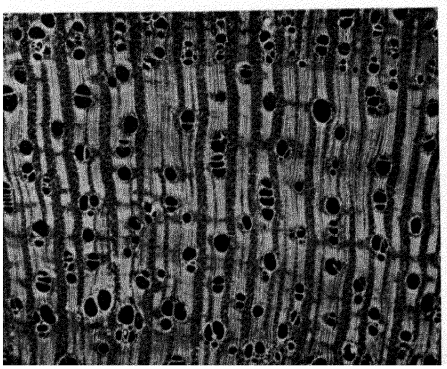
206. Zanthoxylum budrunga Wall.



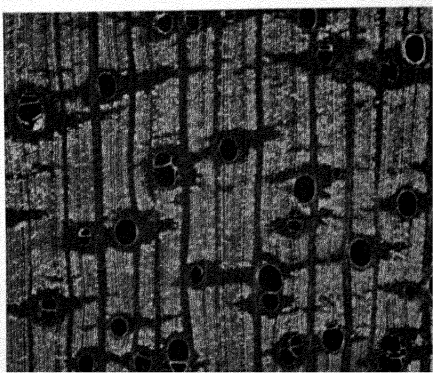
207. Zanthoxylum ovalifolium Wight



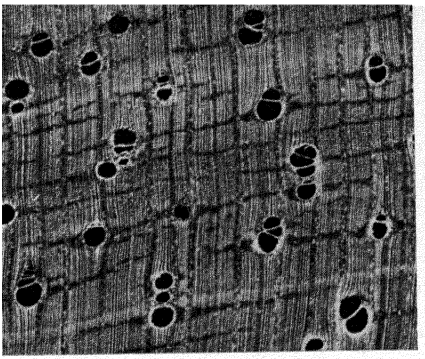
208. Zanthoxylum rhetsa DC.



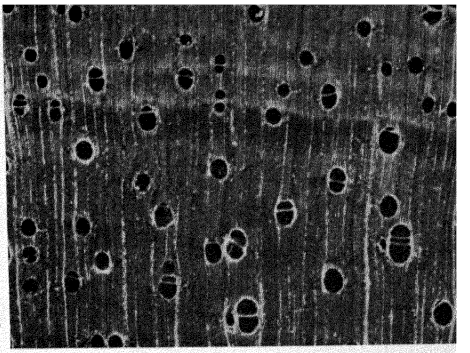
209. Ailanthus excelsa Roxb.



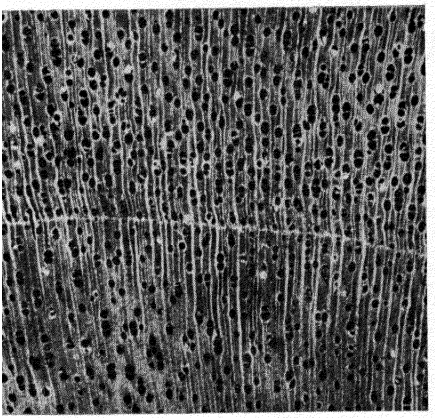
210. Ailanthus excelsa Roxb.



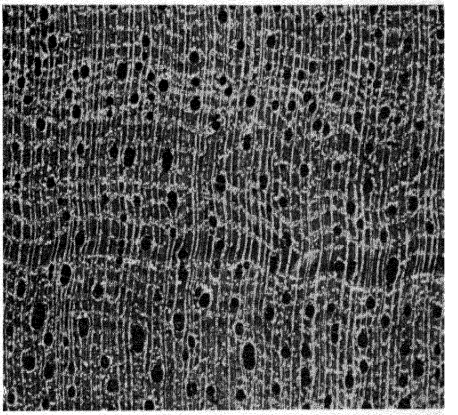
211. Ailanthus grandis Prain



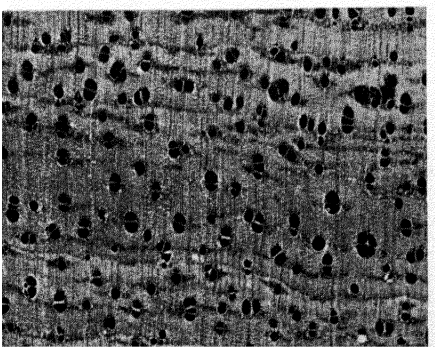
212. Ailanthus malabarica DC.



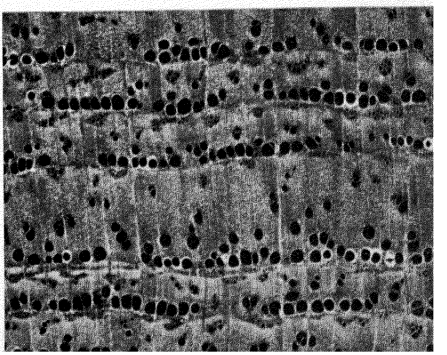
213. Harrisonia benettii Hk. f.



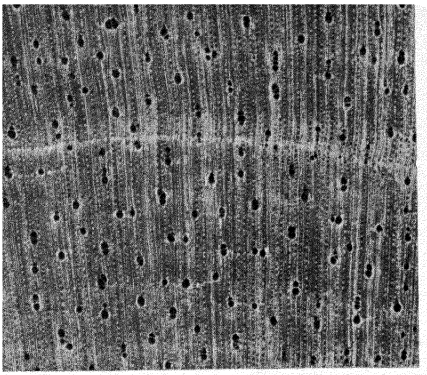
214. Irvingia malayana Oliver



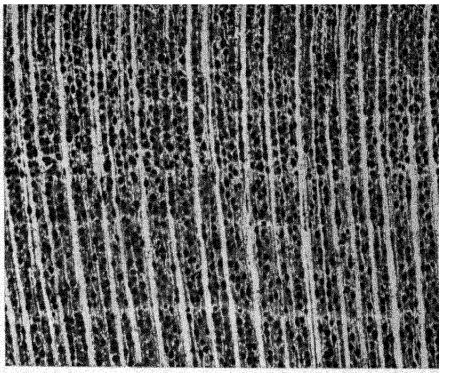
215. Picrasma javanica Blume



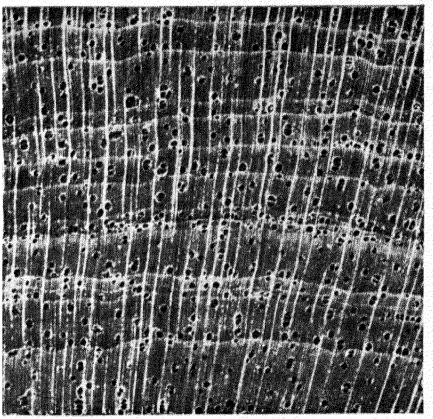
216. Picrasma quassioides Bennett



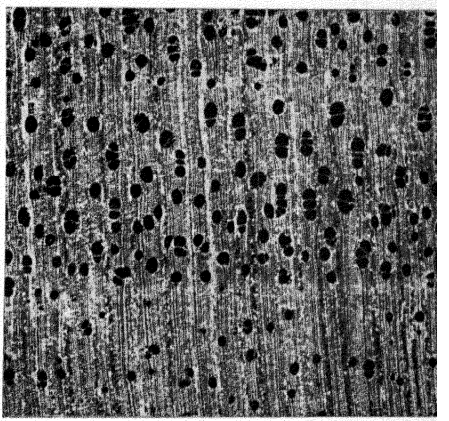
217. Samadera indica Gaertn.



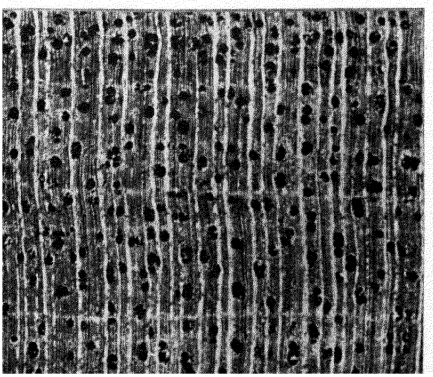
218. Ochna wallichii Planchon



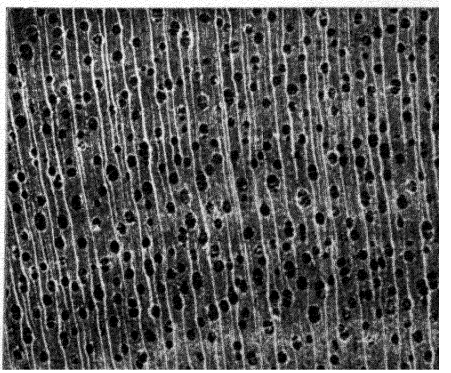
219. Balsamodendron mukul Hk.
ommiphora mukul (Hk. ex Stocks) Engl.)



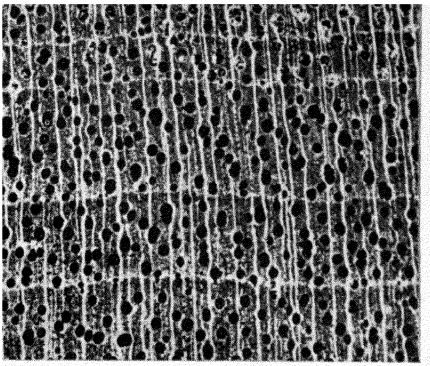
220. Boswellia serrata Roxb.



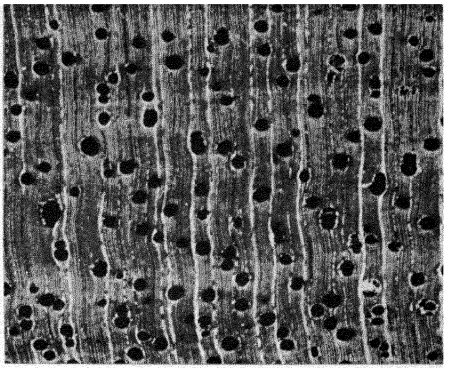
221. Boswellia serrata Roxb.



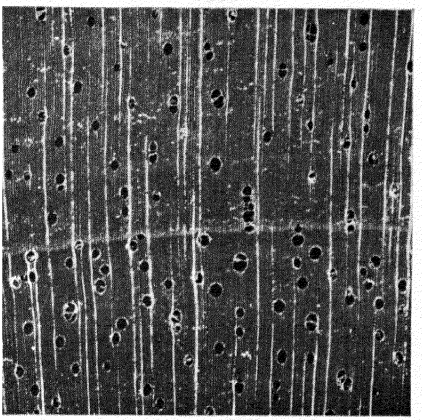
222. Bursera serrata Wall. ex Colebr.



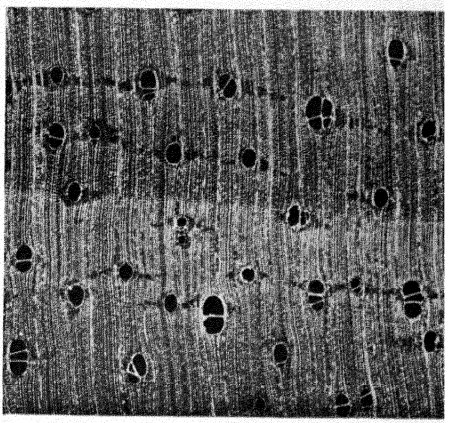
. Bursera serrata Wall. ex Colebr.



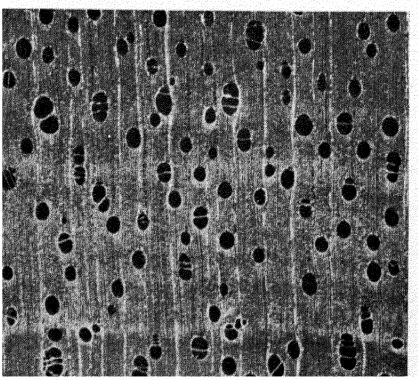
224. Canarium bengalense Roxb.



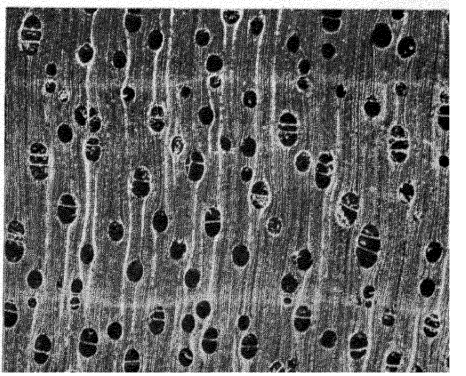
225. Canarium euphyllum Kurz



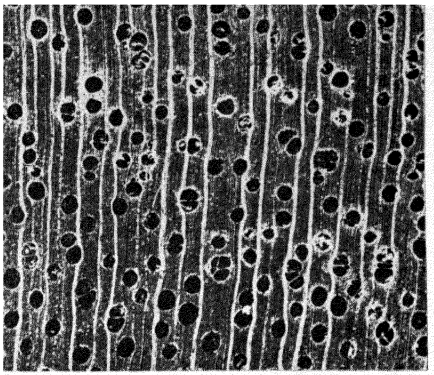
226. Canarium sikkimense King



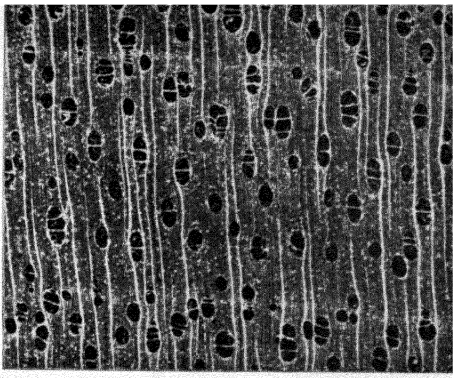
227. Canarium strictum Roxb.



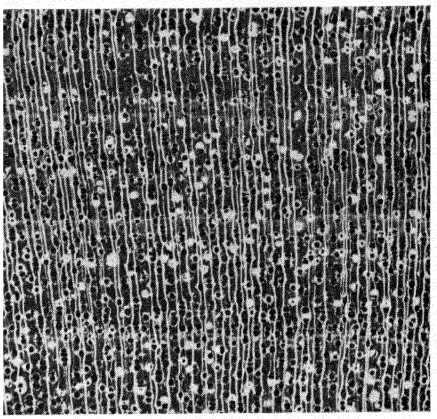
228. Garuga gamblie King



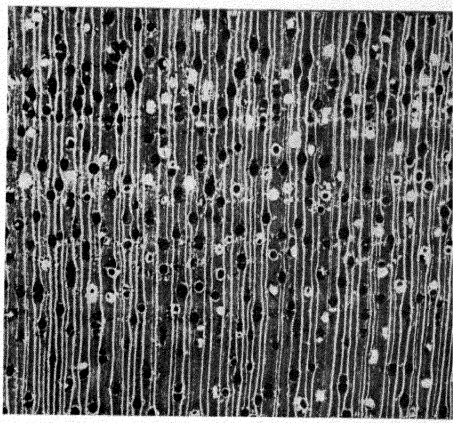
229. Garuga pinnata Roxb.



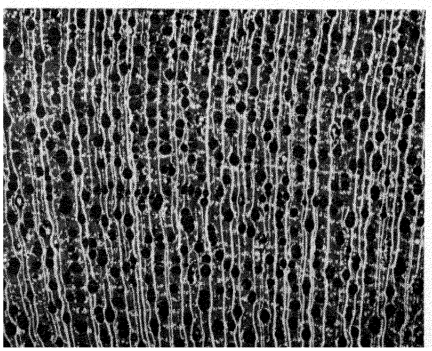
230. Garuga pinnata Roxb.



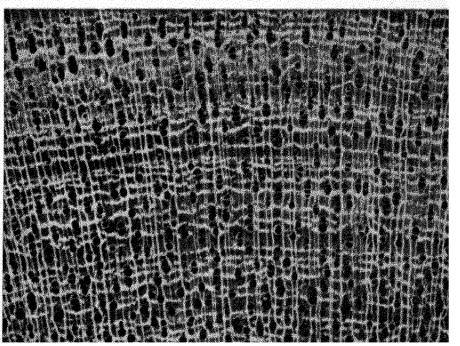
231. Aglaia andamanica Hiern



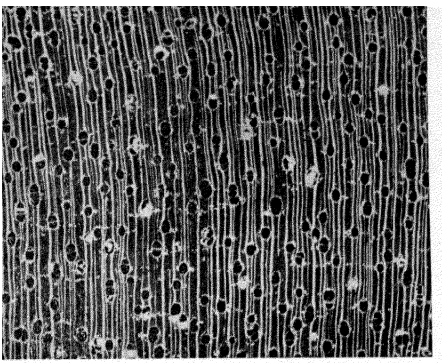
232. Aglaia edulis A. Gray



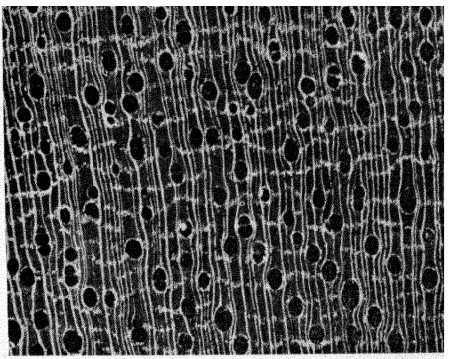
233. Aglaia odoratissima Blume



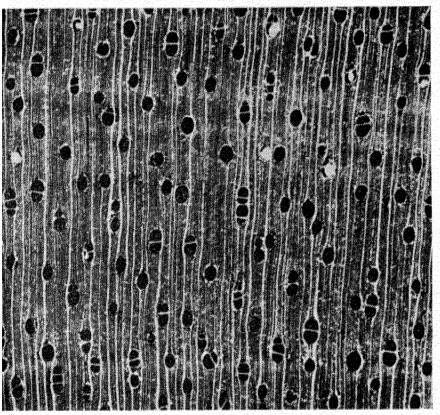
234. Aglaia odoratissima Blume



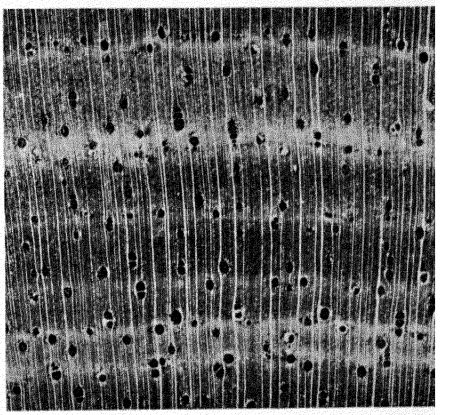
235. Amoora cucullata Roxb.



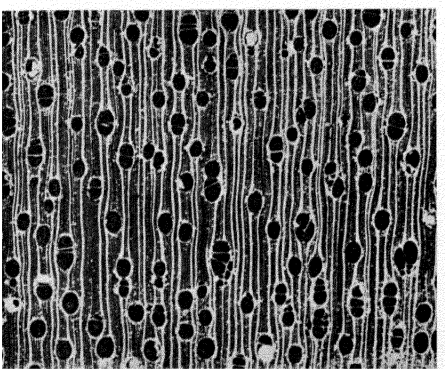
236. Amoora rohituka W. & A.
(Aphanamixis polystachya (Wall.) Parker)



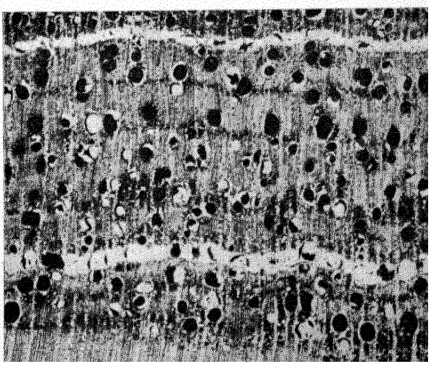
237. Amoora wallichii King



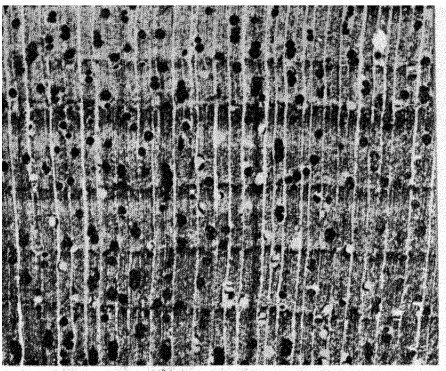
238. Amoora wallichii King



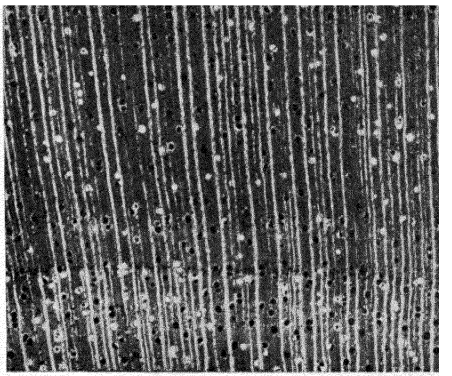
239. Amoora wallichii King



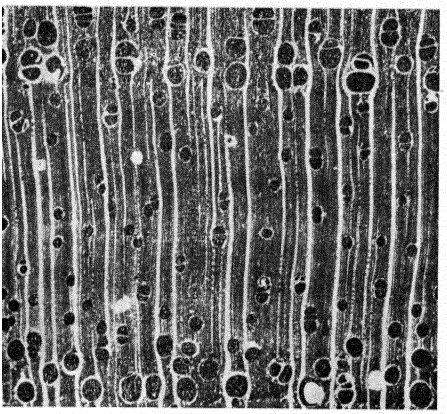
240. Azadirachta indica A. Juss.



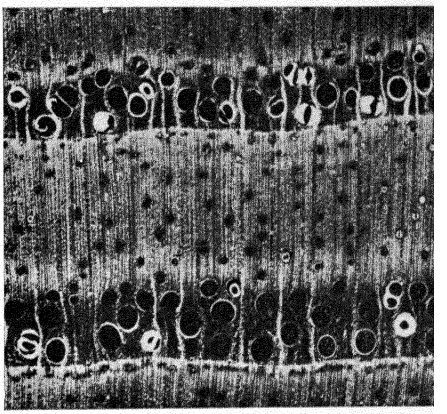
241. Carapa moluccensis Lam.



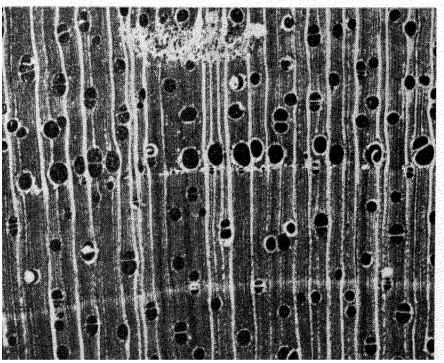
242. Carapa obovata Blume



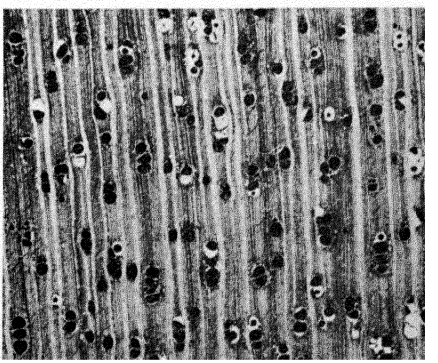
243. Cedrela microcarpa C. DC.



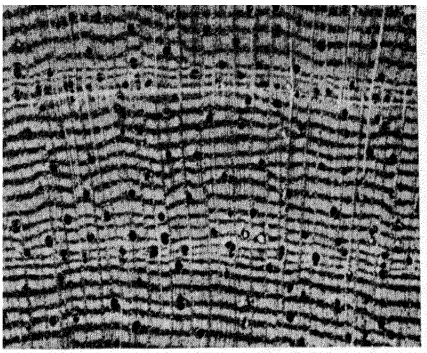
244. Cedrela serrata Royle



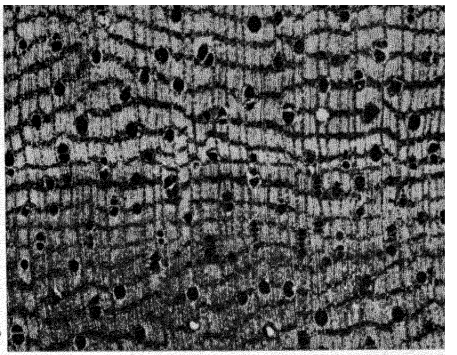
245. Cedrela toona Roxb.



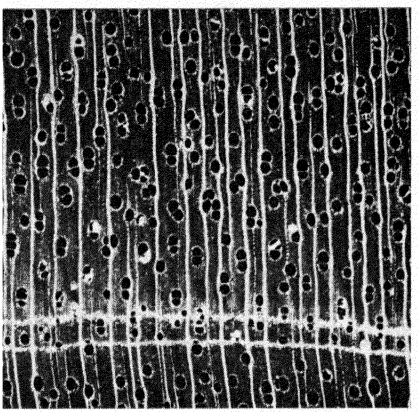
246. Cedrela toona Roxb.



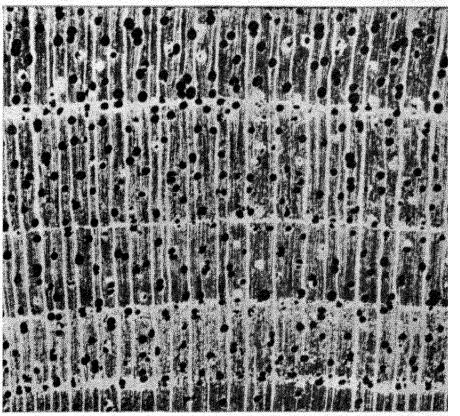
247. Chisocheton grandiflorus Kurz



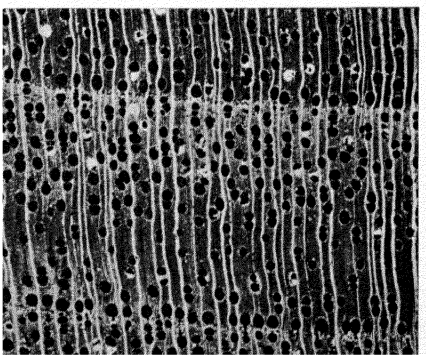
248. Chisocheton paniculatus Hiern



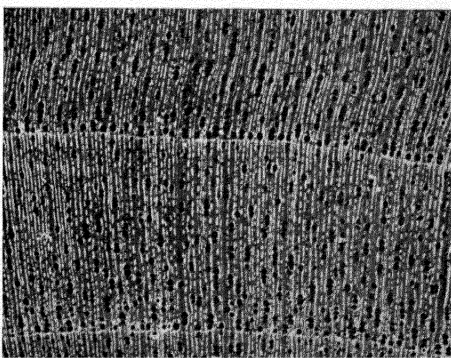
249. Chukrasia tabularis A. Juss.



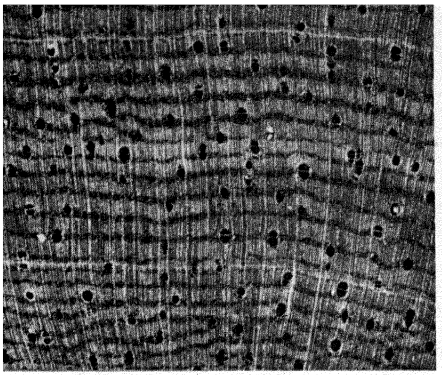
250. Chukrasia tabularis A. Juss.



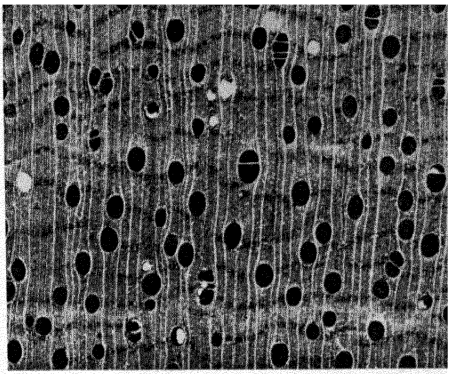
251. Chukrasia velutina Roemer



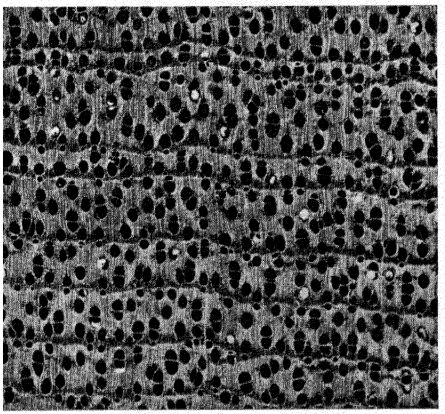
252. Cipadessa fruticosa Blume



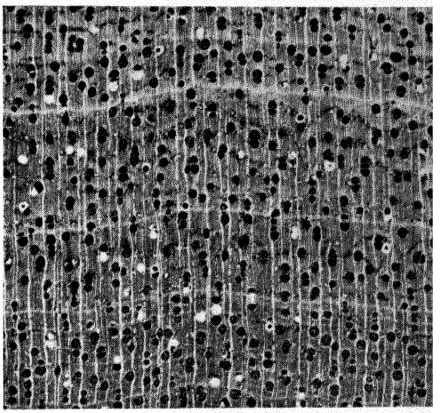
253. Dysoxylum binectariferum Hk. f.



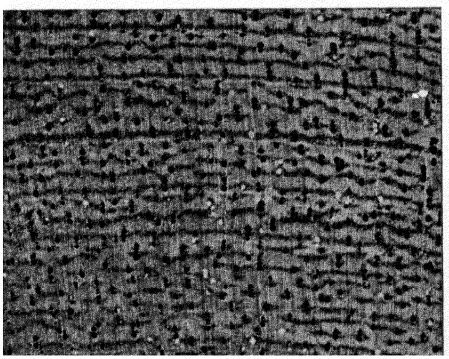
254. Dysoxylum hamiltonii Hiern



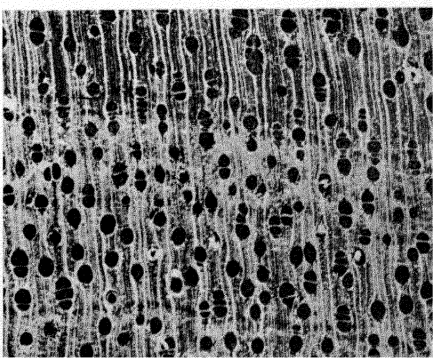
255. Dysoxylum malabaricum Bedd.



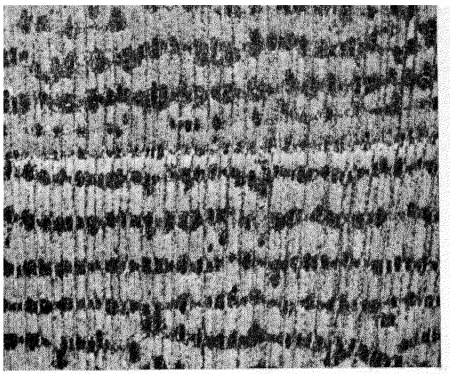
256. Dysoxylum malabaricum Bedd.



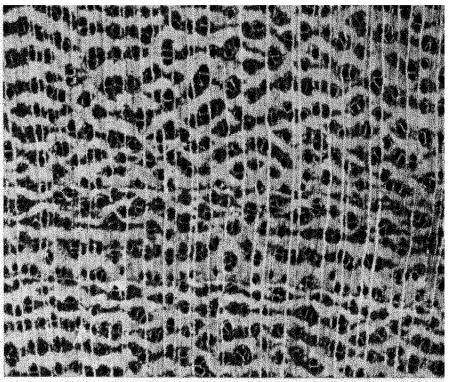
257. Dysoxylum malabaricum Bedd.



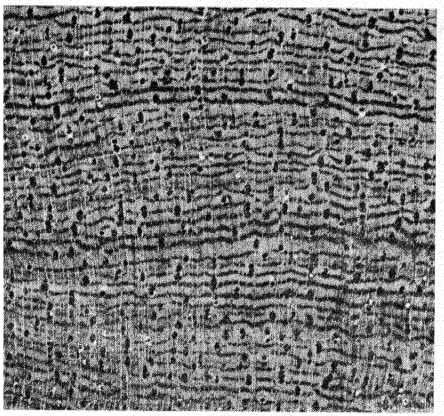
258. Dysoxylum procerum Hiern



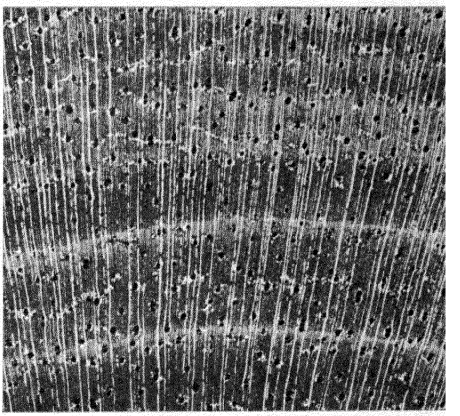
259. Heynea trijuga Roxb.



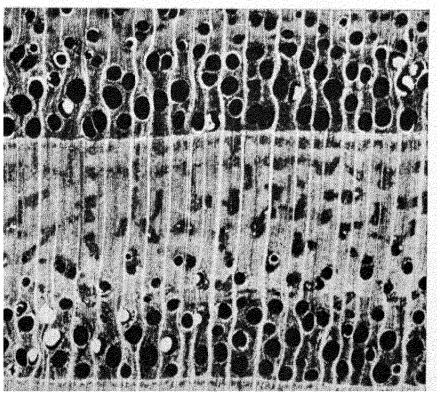
260. Heynea trijuga Roxb.



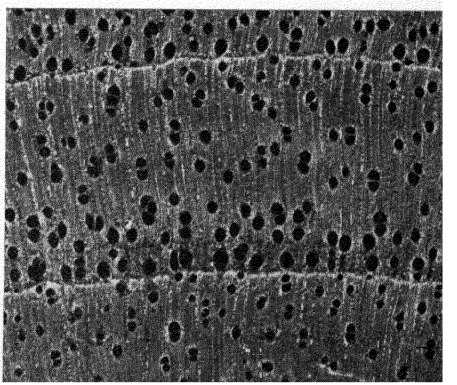
261. Lansium anamalayanum Bedd.



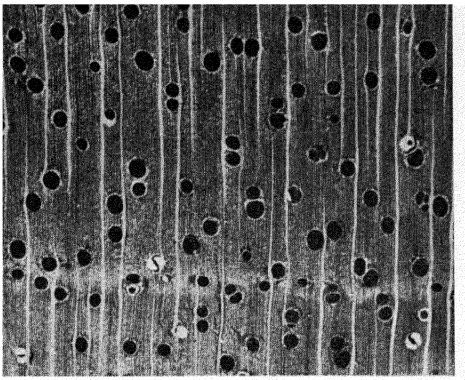
262. Lansium decandrum King



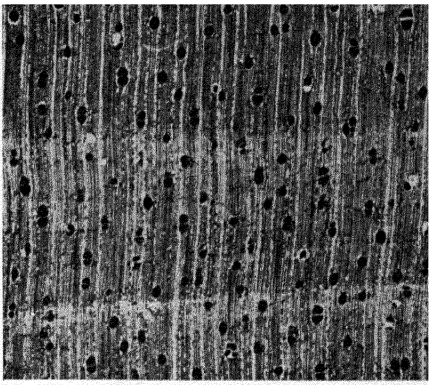
263. Melia azedarach L.



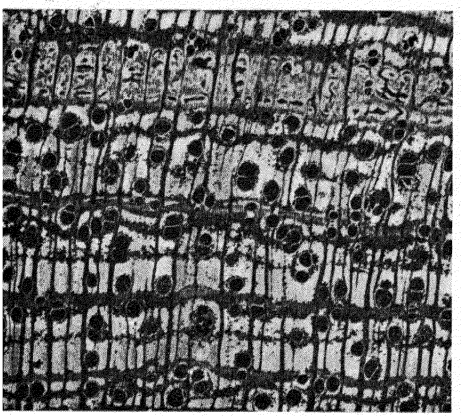
264. Melia birmanica Kurz



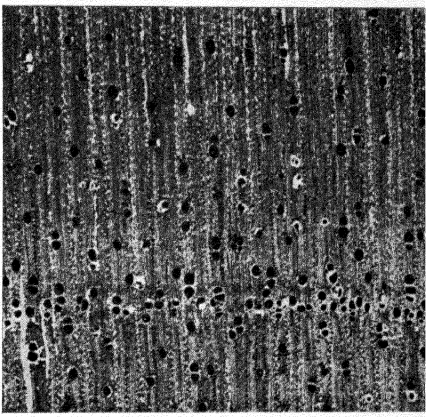
265. Melia composita Willd.



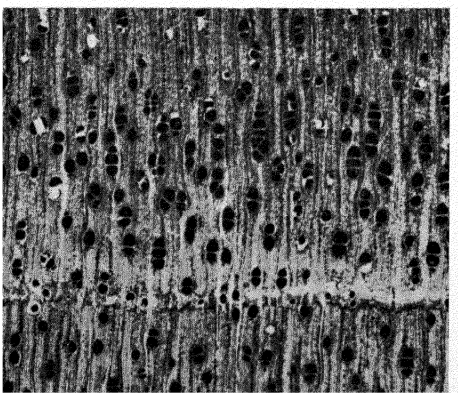
266. Sandoricum indicum Cav.



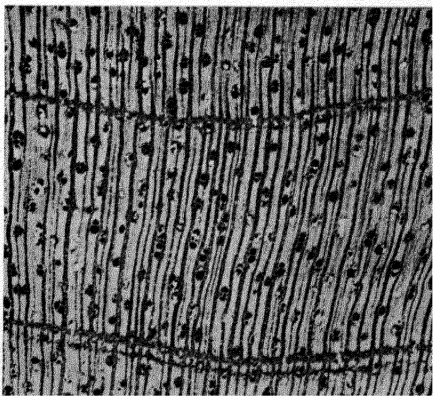
267. Soymida febrifuga A. Juss.



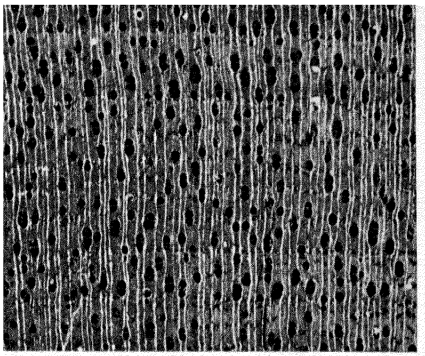
268. Swietenia macrophylla King



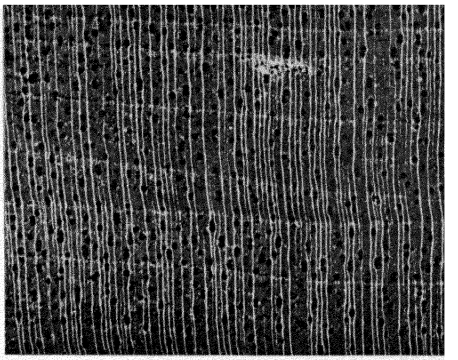
269. Swietenia mahagoni Jacq.



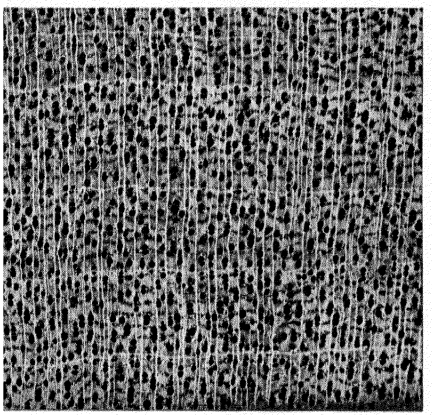
270. Swietenia mahagoni Jacq.



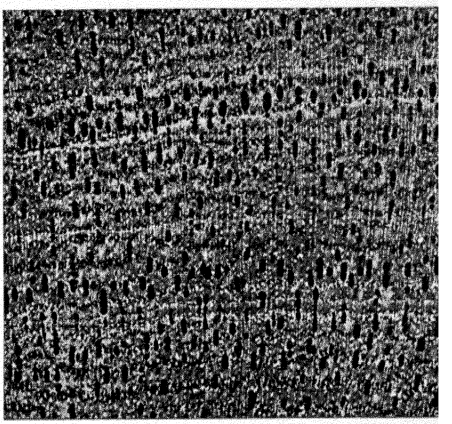
71. Walsura glauca C. E. C. Fischer



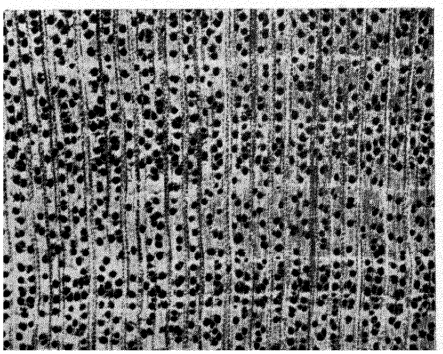
272. Walsura piscidia Roxb.



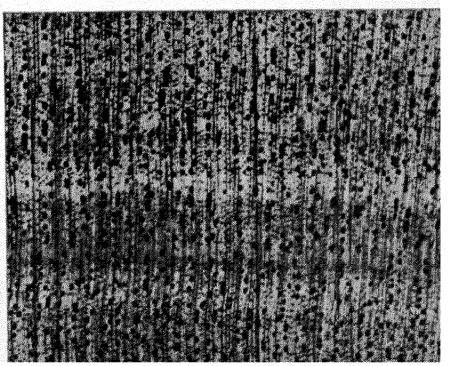
273. Walsura robusta Roxb.



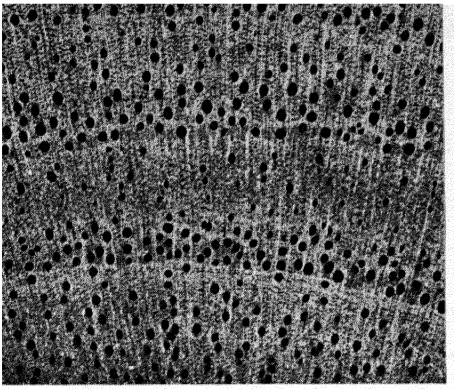
274. Walsura villosa Wall.



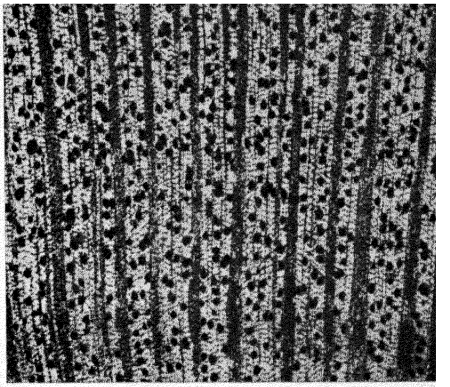
275. Chailletia gelonioides Hk. f.
(Dichapetalum gelonioides Engl.)



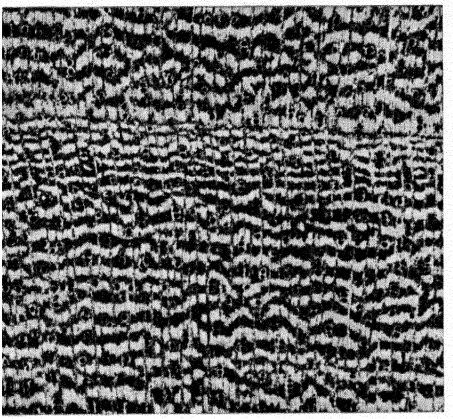
276. Anacolosa densiflora Bedd.



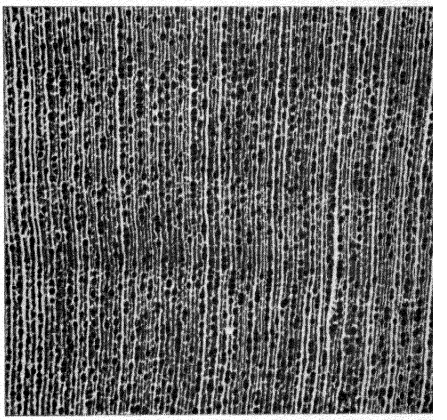
277. Olax scandens Roxb.



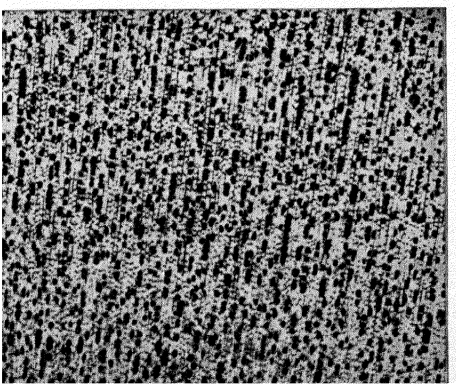
278. Phlebocalymna griffithiana Mast.



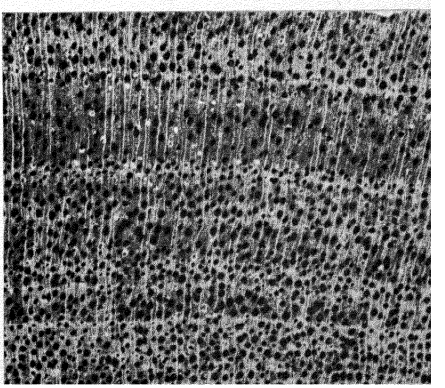
279. Schoepfia fragrans Wall.



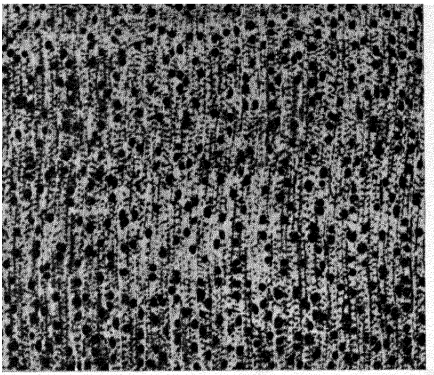
280. Strombosia ceylanica Gardner



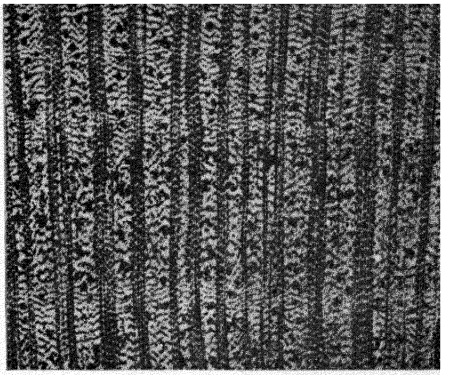
281. Strombosia javanica Blume



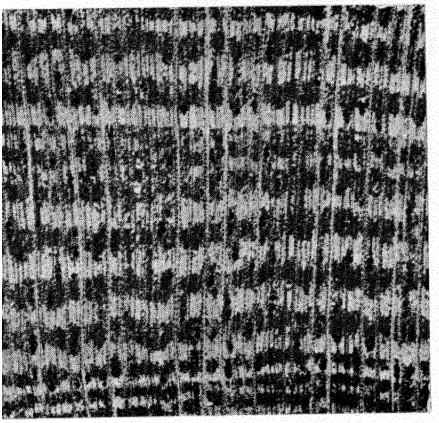
282. Ximenia americana L.



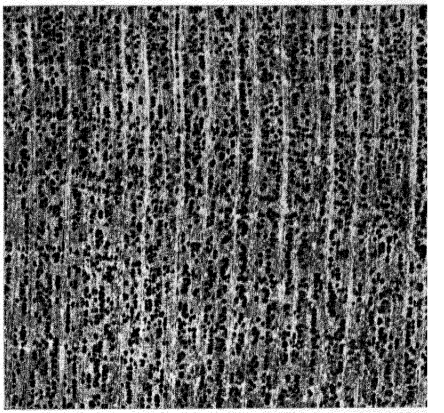
283. Apodytes cambodiana Pierre



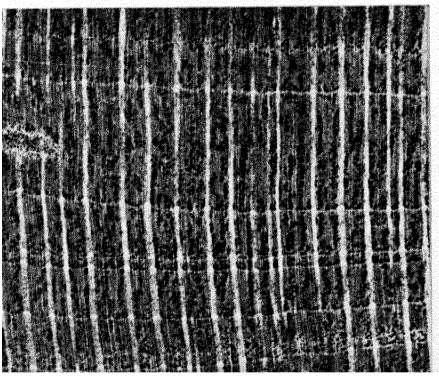
284. Gomphandra polymorpha Wight



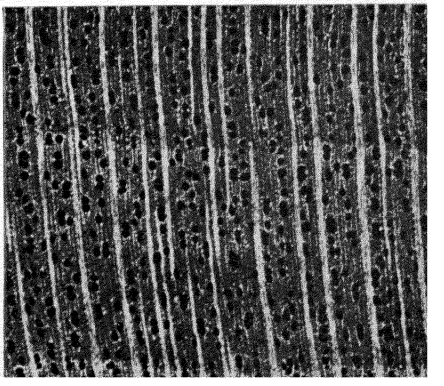
285. Mappia foetida Miers



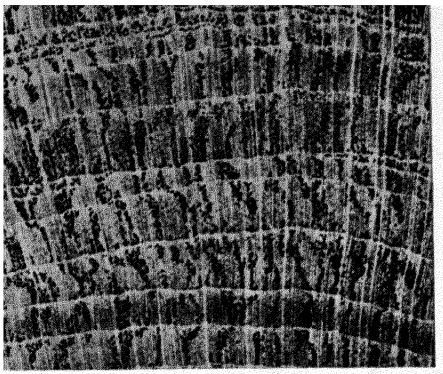
286. Ilex denticulata Wall.



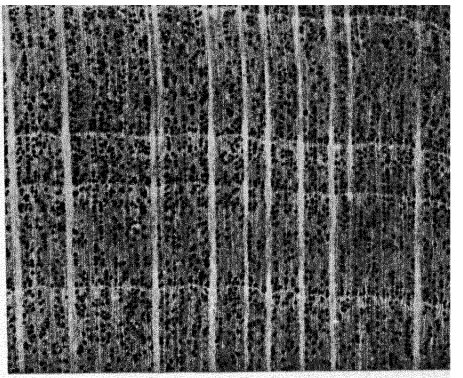
287. Ilex dipyrena Wall.



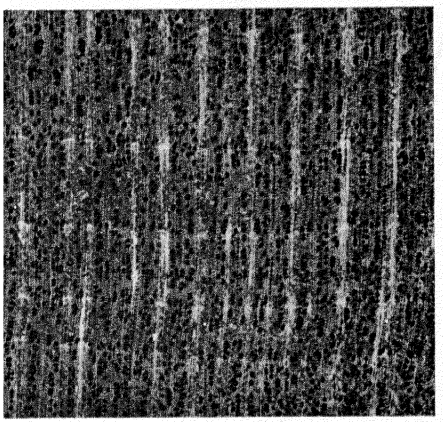
288. Ilex godajam Colebr.



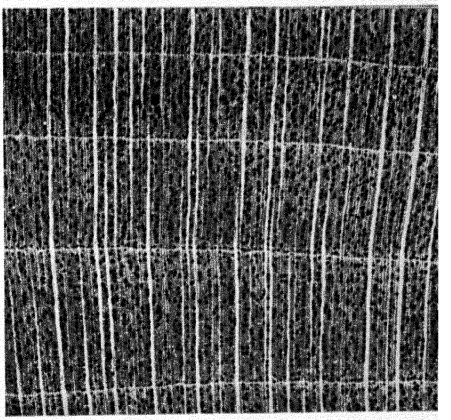
289. Ilex hookeri King



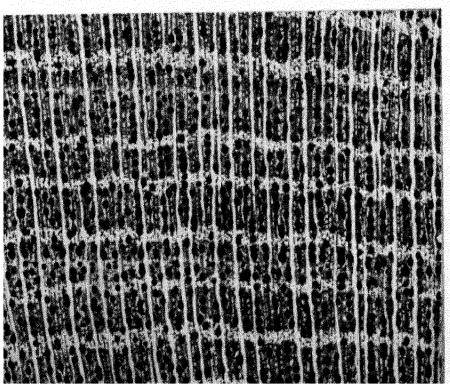
290. Ilex insignis Hk. f.



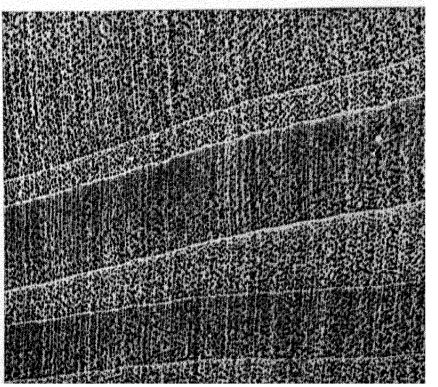
291. Ilex odorata Buch. Ham.



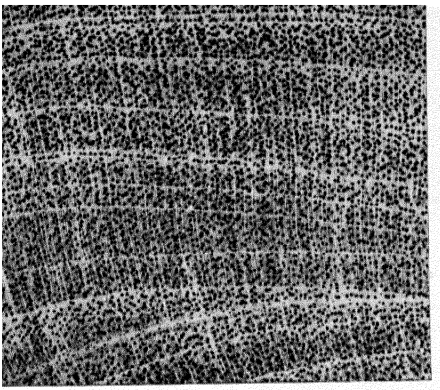
292. Ilex venulosa Hk. f.



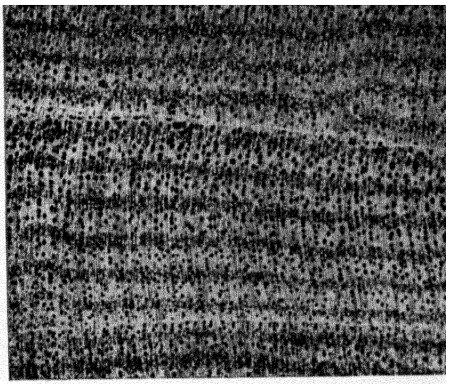
293. Elaeodendron glaucum Pers.



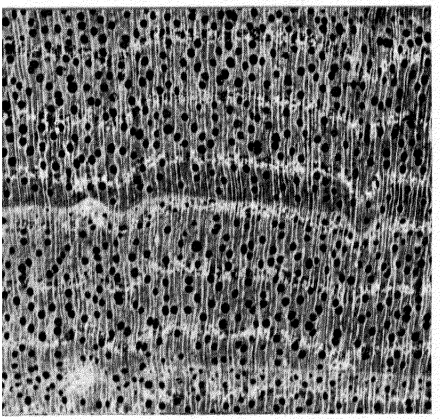
294. Euonymus hamiltonianus Wall.



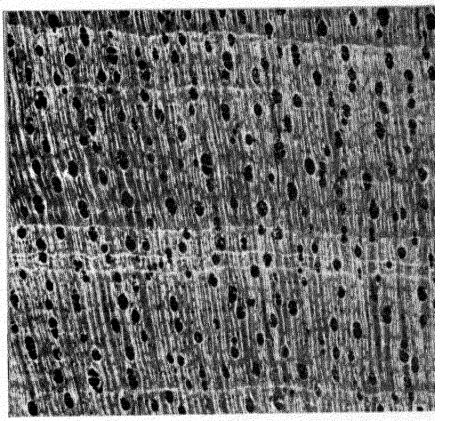
295. Euonymus javanicus Blume



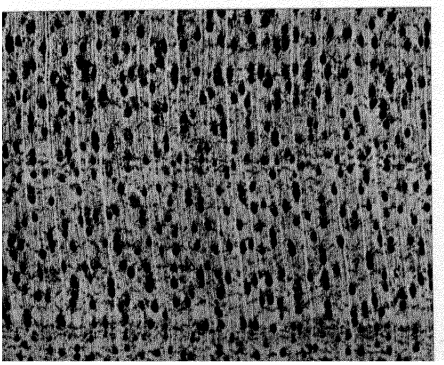
296. Gymnosporia montana Lawson



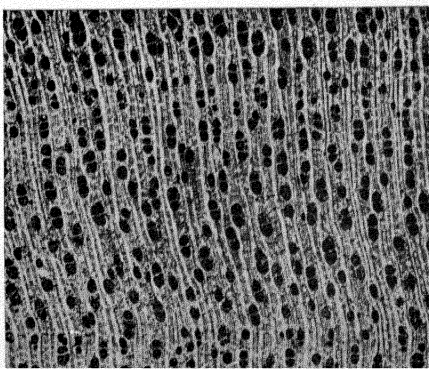
297. Kokoona filiformis C. E. C. Fischer



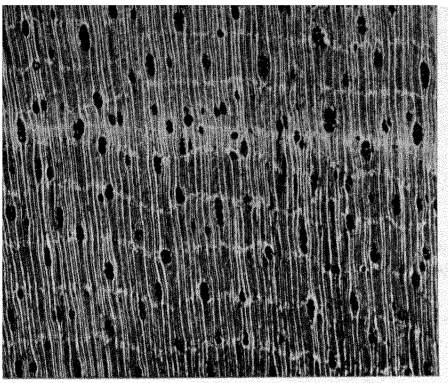
298. Kokoona littoralis Lawson



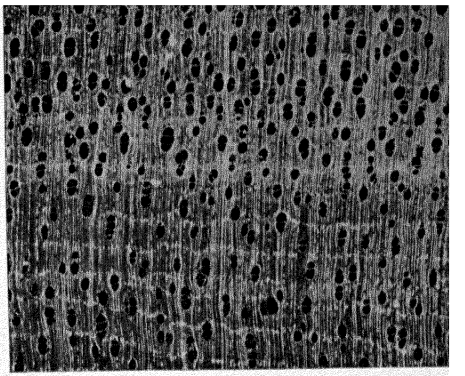
299. Kurrimia paniculata Wall.



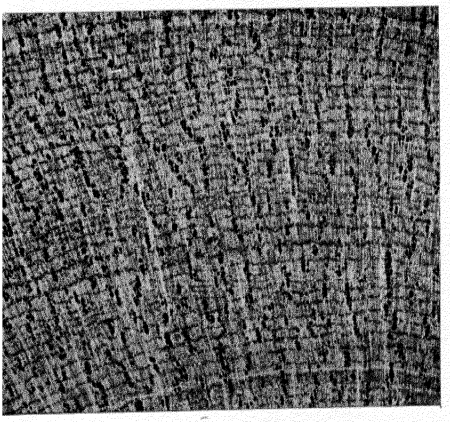
300. Kurrimia pulcherrima Wall.
(K. robusta Kurz)



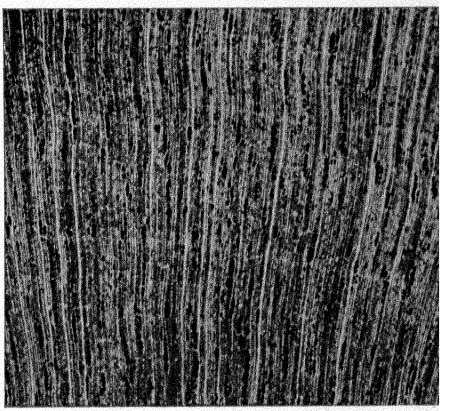
301. Lophopetalum fimbriatum Wight



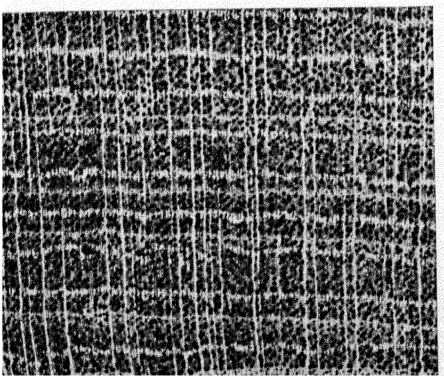
302. Lophopetalum wightianum Arn.



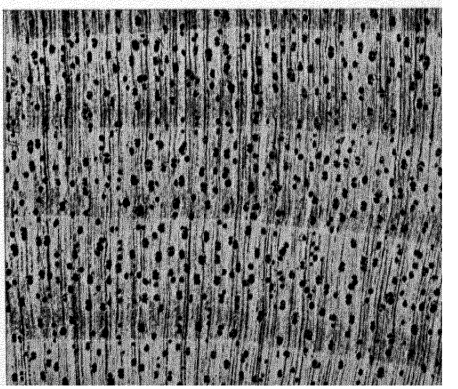
303. Microtropis microcarpa Wight



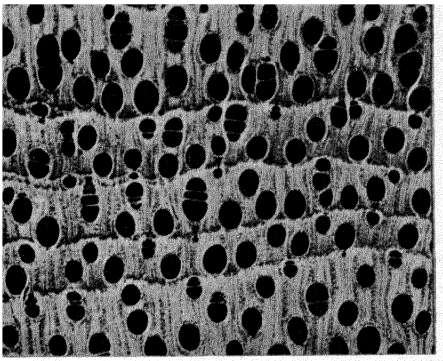
304. Microtropis ovalifolia Wight



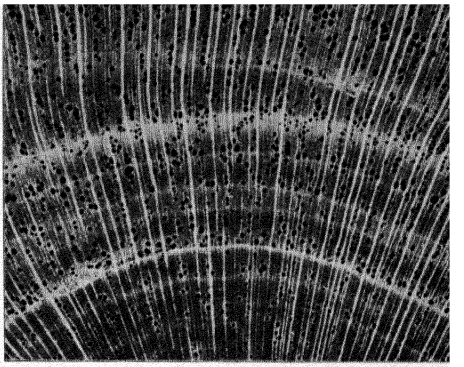
305. Pleurostylia wightii W. & A.



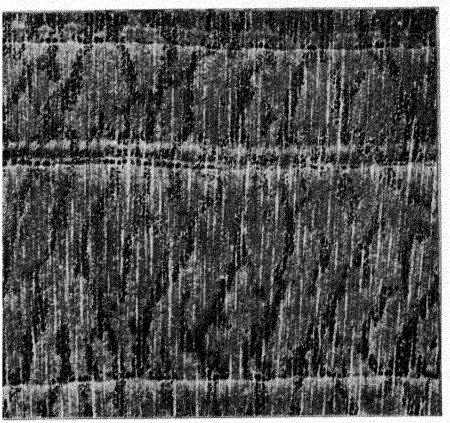
306. Siphonodon celastrineus Griff.



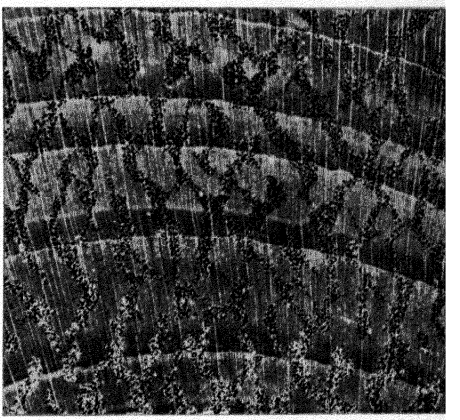
307. Gouania leptostachya DC.



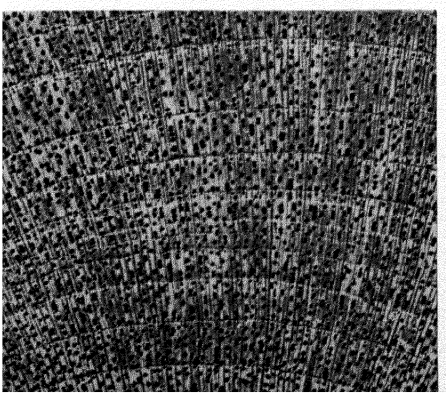
308. Rhamnus nepalensis Wall.



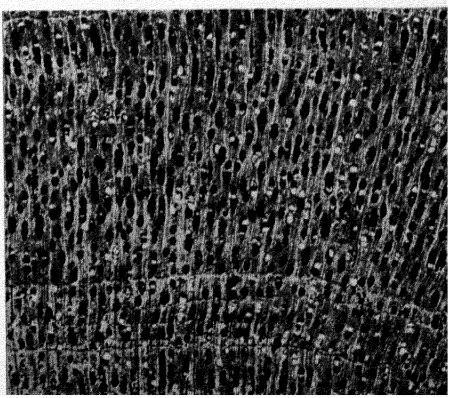
309. Rhamnus purpureus Edgew.



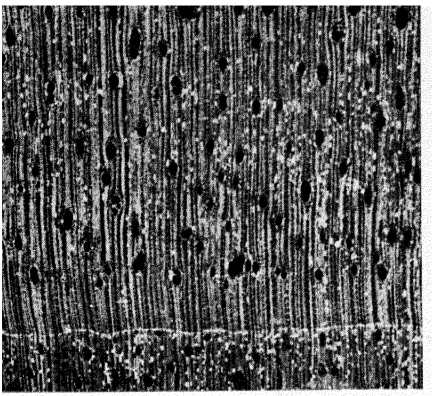
310. Rhamnus virgatus Roxb.



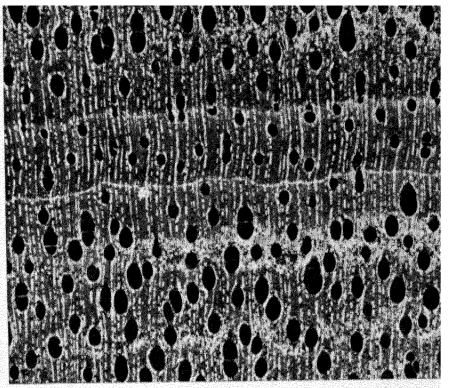
311. Sageretia brandrethiana Aitchison



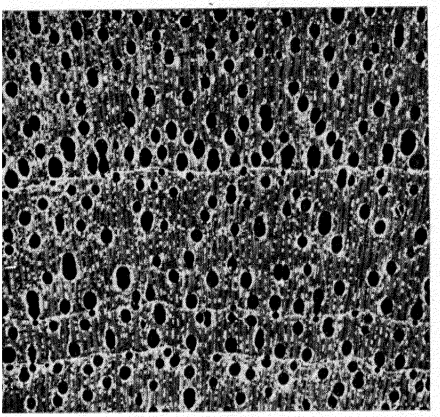
312. Scutia indica Brongn.



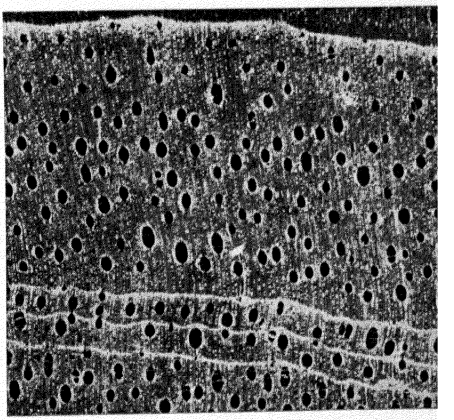
313. Zizyphus jujuba Lam.



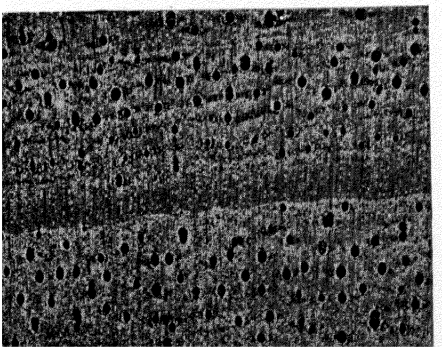
314. Zizyphus jujuba Lam.



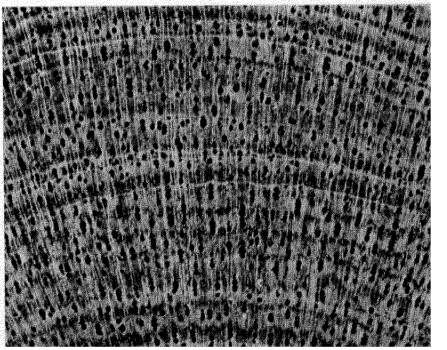
315. Zizyphus nummularia W. & A.



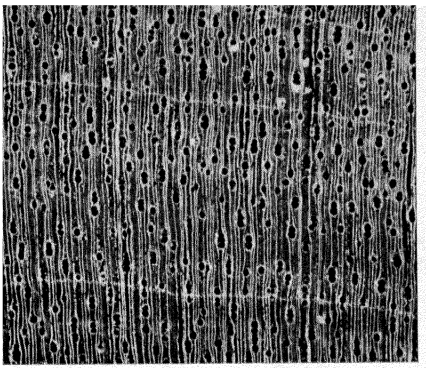
316. Zizyphus xylopyrus Willd.



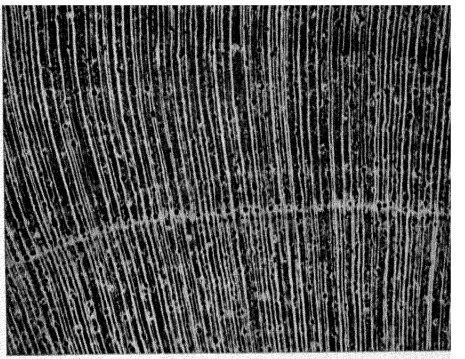
317. Zizyphus xylopyrus Willd.



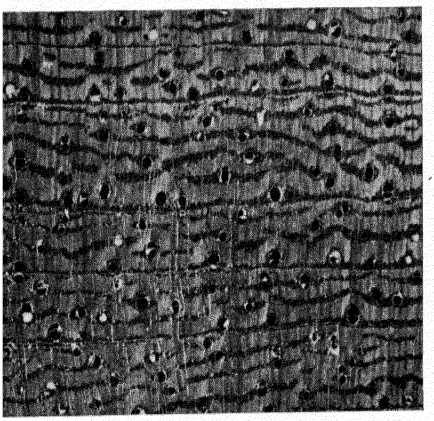
318. Allophyllus cobbe Blume



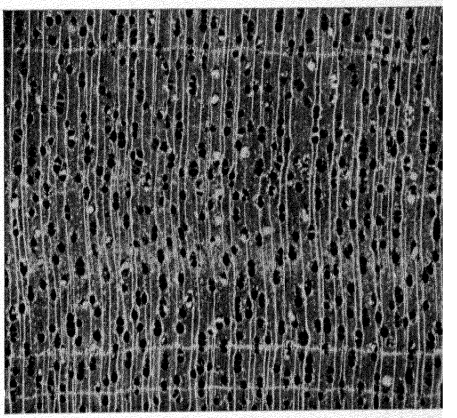
319. Arytera littoralis Blume



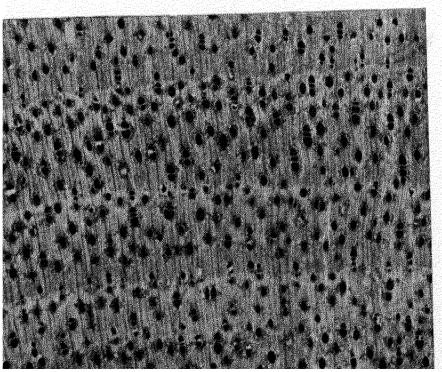
320. Dodonea viscosa (L.) Jacq.



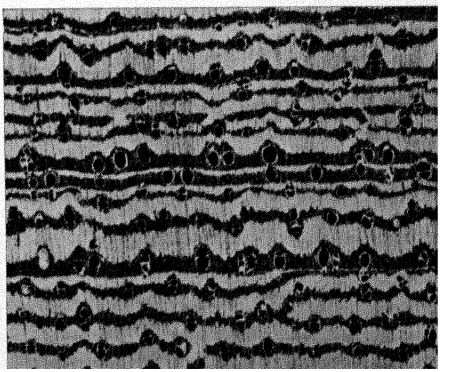
321. Erioglossum rubiginosum Blume



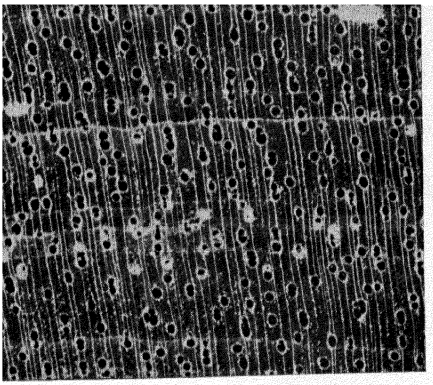
322. Filicium decipiens Thw.



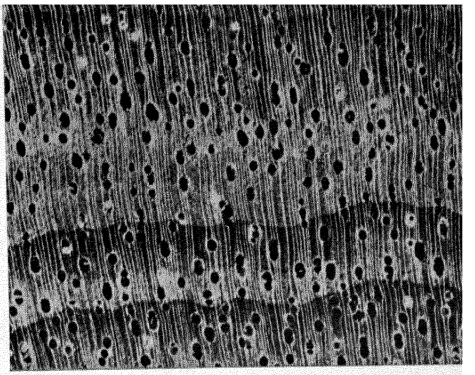
323. Harpullia cupanioides Roxb.



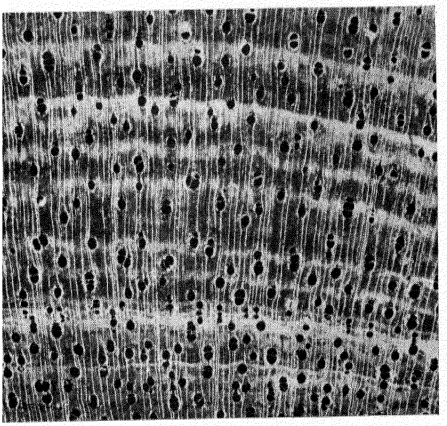
324. Lepisanthes tetraphylla Radlk.



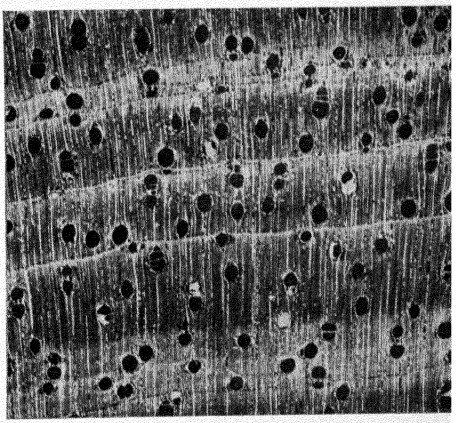
325. Mischocarpus fuscescens Blume



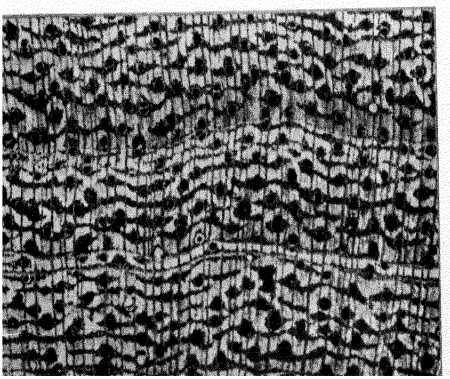
326. Nephelium longana Cambess



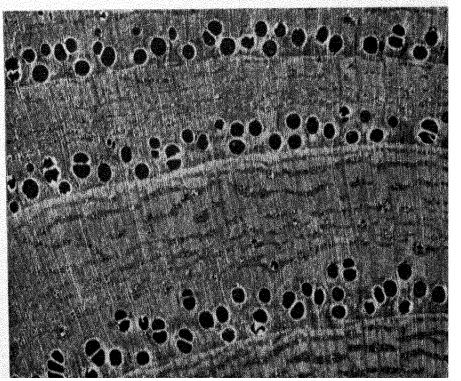
327. Paranephelium hystrix W. W. Smith



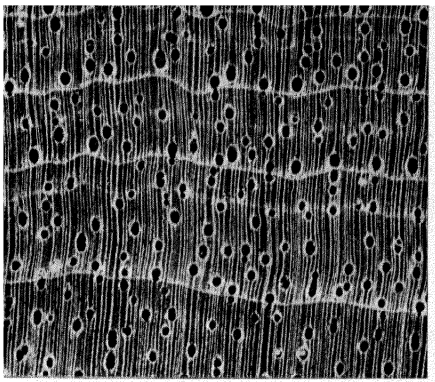
328. Pometia pinnata Forst.



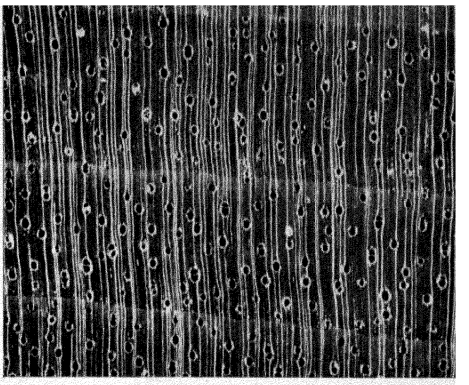
329. Sapindus laurifolius Vahl



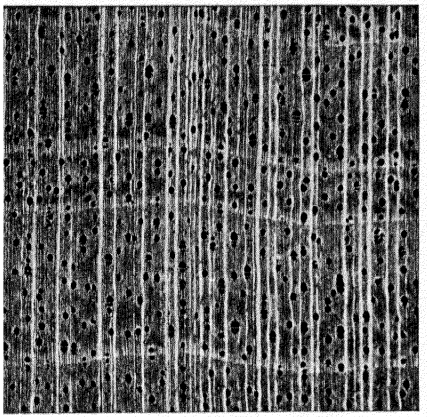
330. Sapindus mukorossi Gaertn.



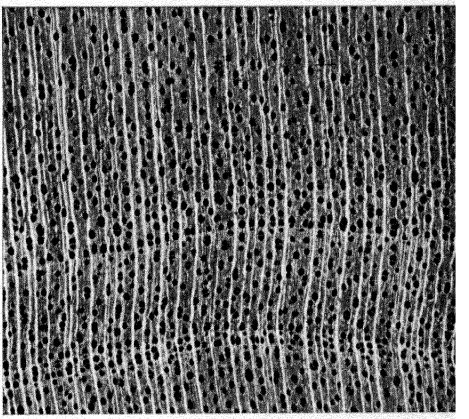
331. Schleichera trijuga Willd.



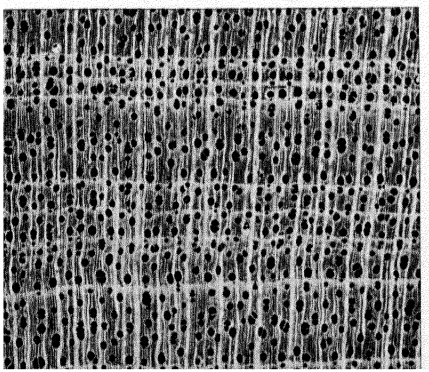
332. Xerospermum glabratum C. E. C. Fischer



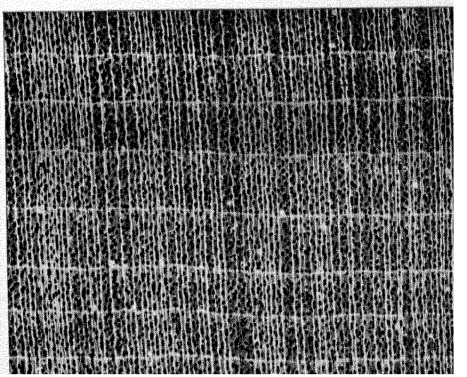
333. Acer campbellii Hk. f. & Th.



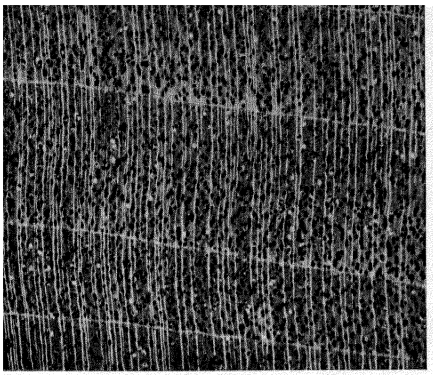
334. Acer oblongum Wall.



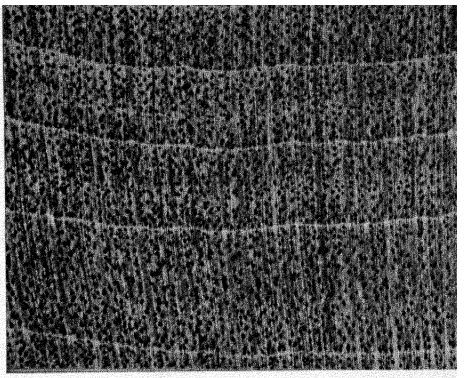
335. Acer thomsoni Miq.



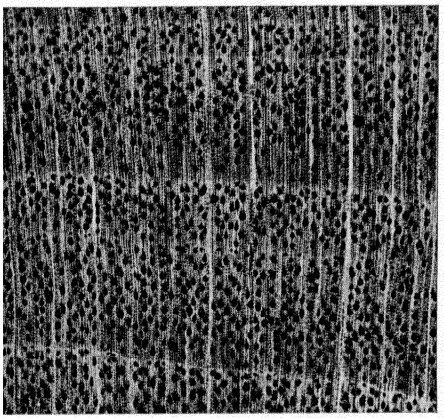
336. Aesculus indica Colebr.



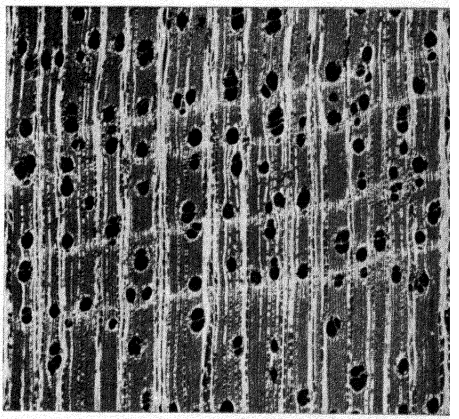
337. Aesculus indica Colebr.



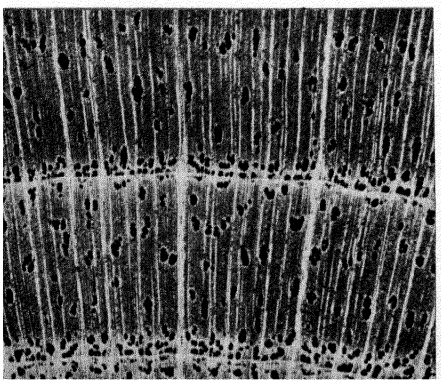
338. Staphylea emodi Wall.



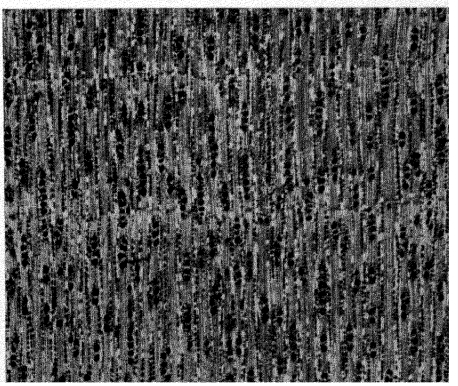
339. Turpinia pomifera DC.



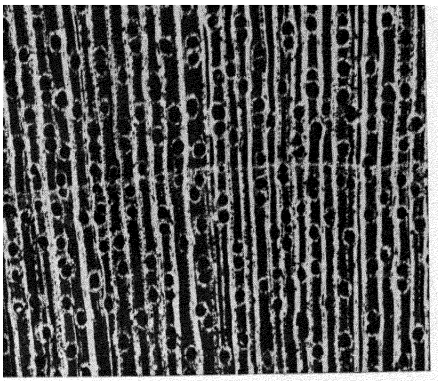
340. Meliosma arnottiana Wight



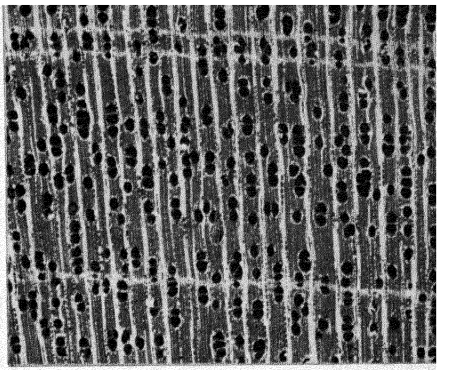
341. Meliosma dilleniaefolia Blume



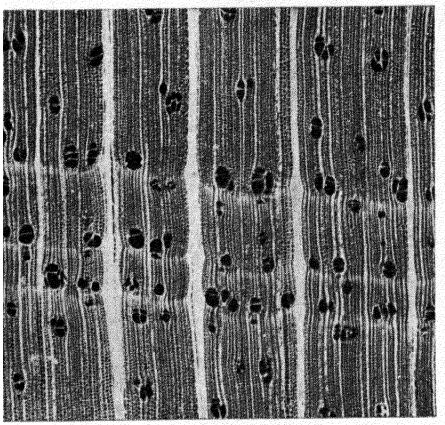
342. Meliosma pungens Walpers



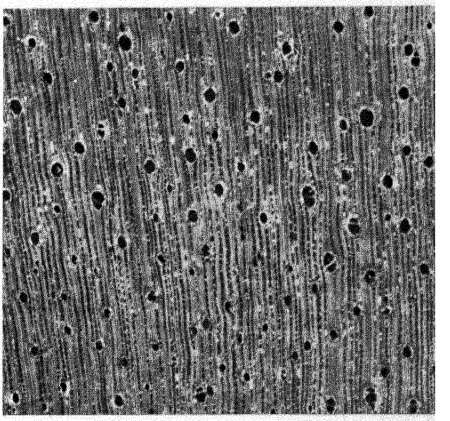
343. Meliosma simplicifolia Roxb.



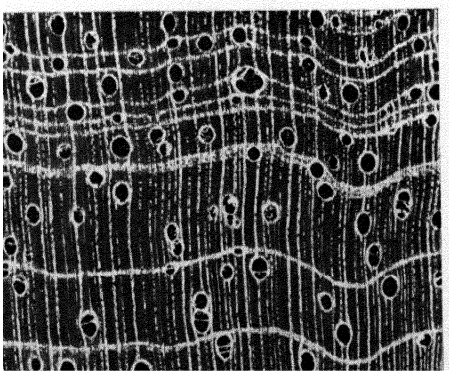
344. Meliosma thomsoni King



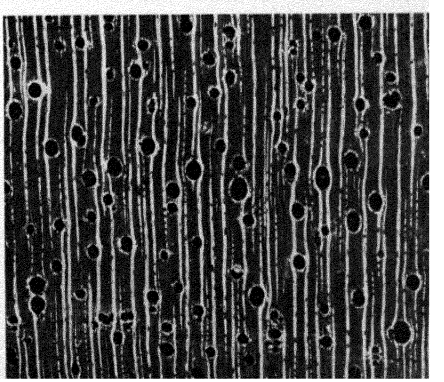
345. Meliosma wallichii Planchon



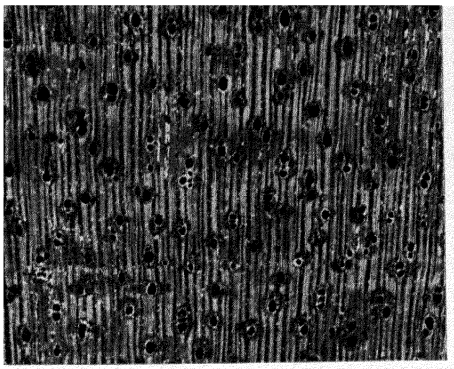
346. Anacardium occidentale L.



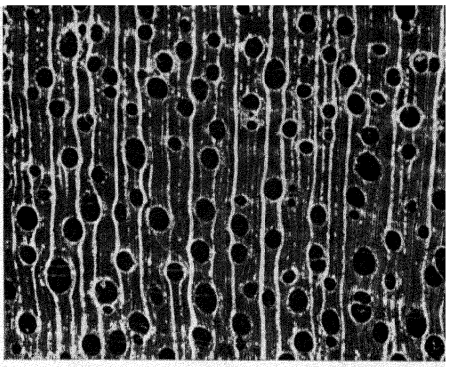
347. Bouea burmanica Griff.



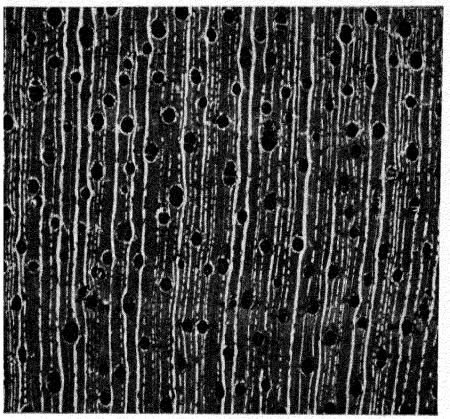
348. Buchanania lancifolia Roxb.



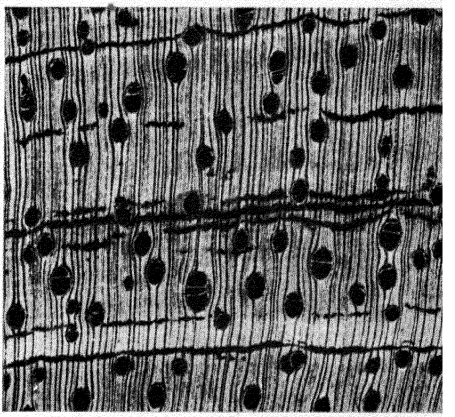
349. Buchanania latifolia Roxb. (B. lanzan Spreng.)



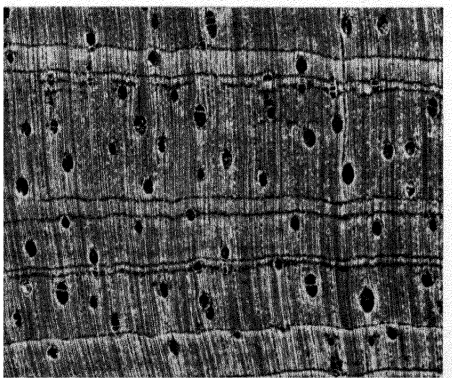
350. Dracontomelum mangiferum Blume



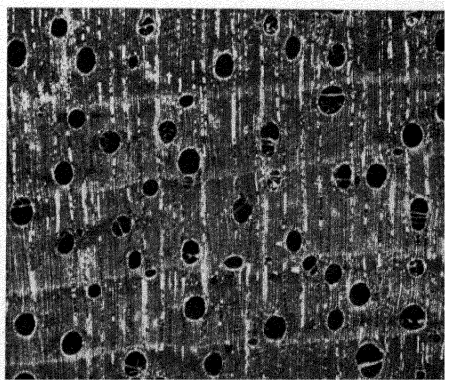
351. Drimycarpus racemosus Hk. f.



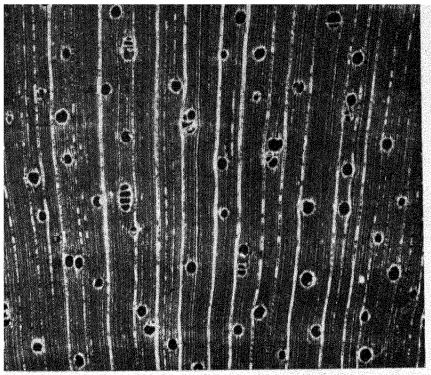
352. Gluta tavoyana Hk. f.



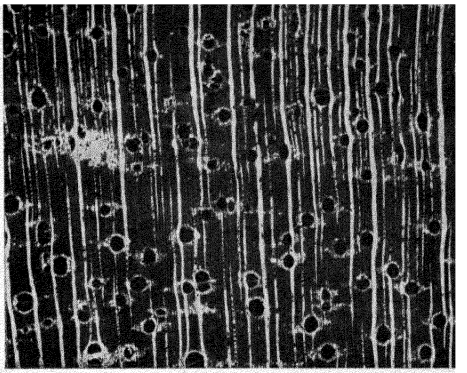
353. Gluta travancorica Bedd.



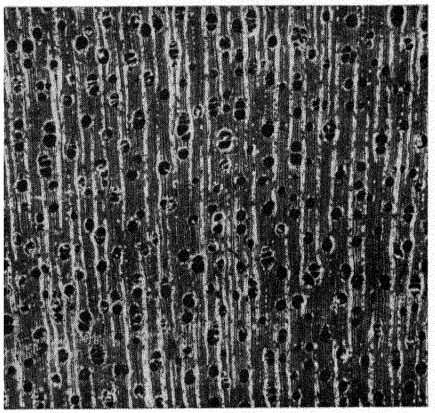
354. Holigarna grahamii Hk. f.



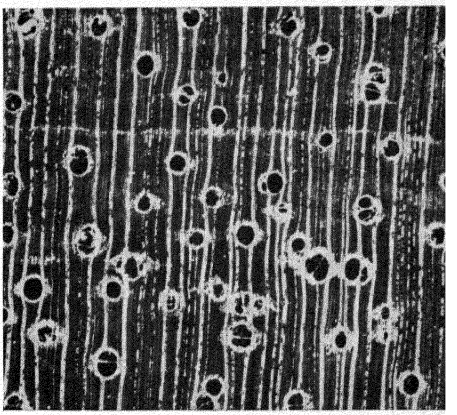
355. Holigarna helferi Hk. f.



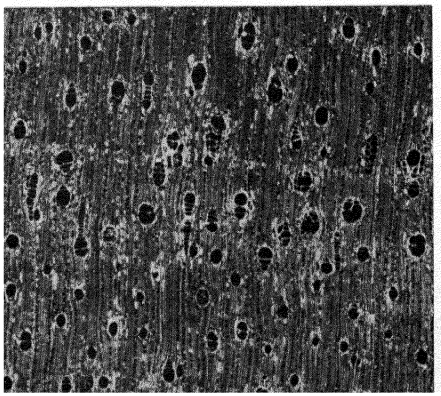
356. Holigarna longifolia Roxb.



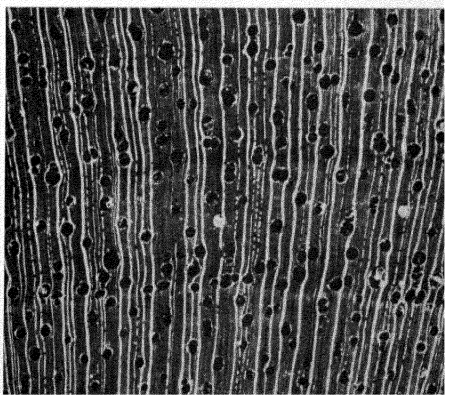
357. Lannea grandis Engl.



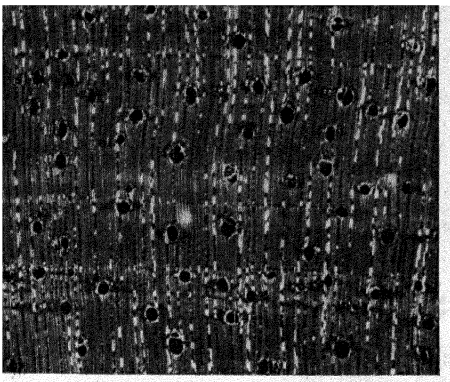
358. Mangifera indica L.



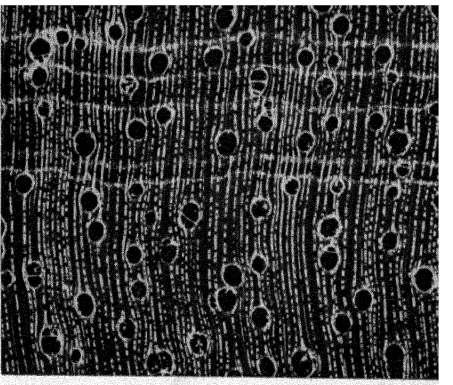
359. Mangifera indica L.



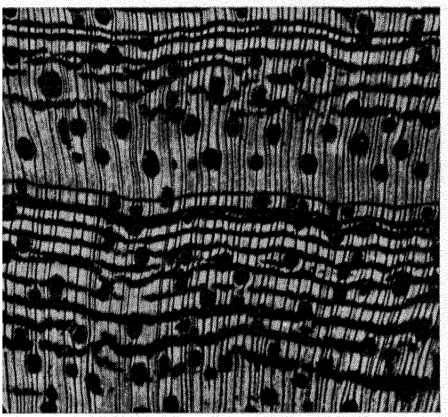
360. Mangifera longipes Griff.



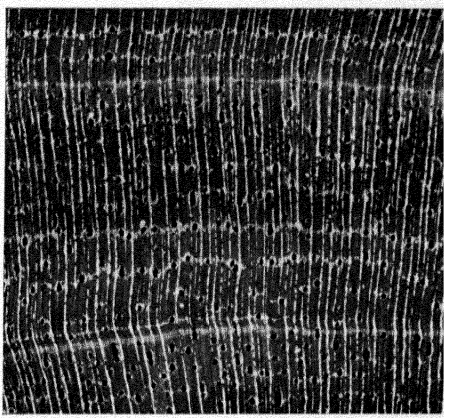
361. Mangifera sylvatica Roxb.



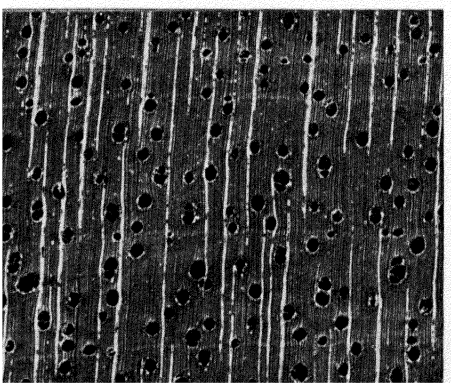
362. Melanorrhoea glabra Wall.



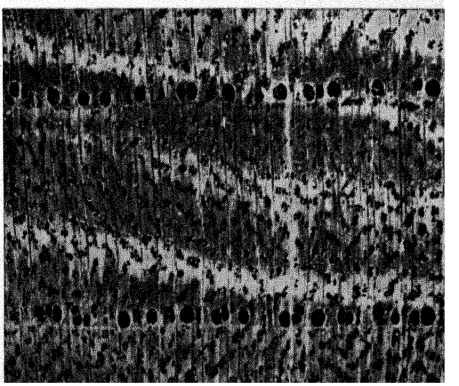
363. Melanorrhoea usitata Wall.



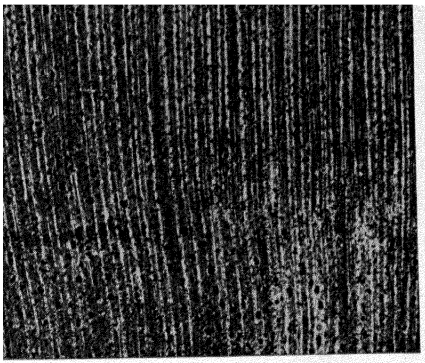
364. Nothopegia colebrookiana Blume



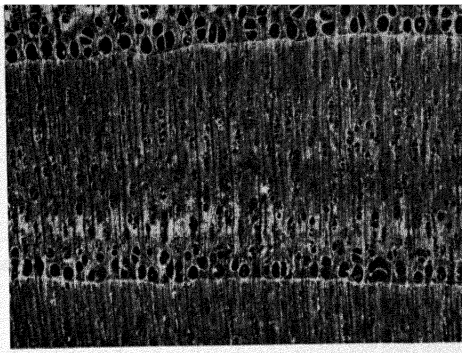
365. Parishia insignis Hk. f.



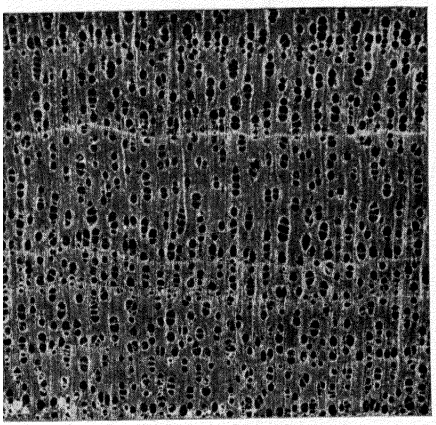
366. Pistacia integerrima Stewart



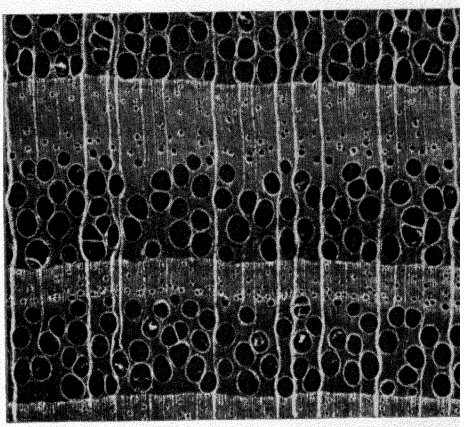
367. Pistacia terebinthus L.



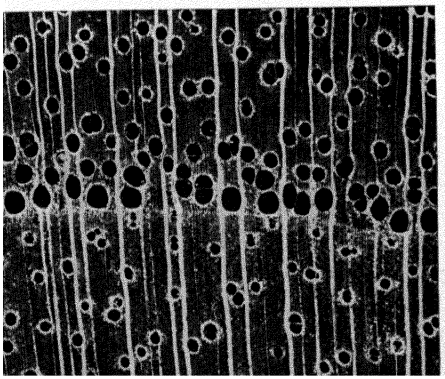
368. Rhus continus L.



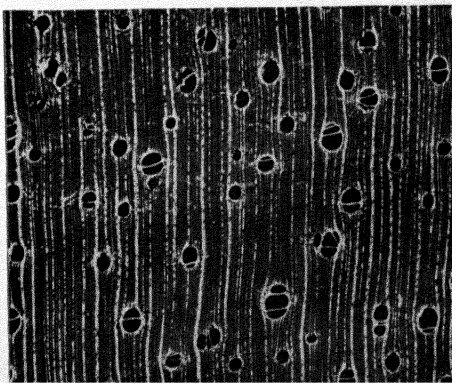
369. Rhus parviflora Roxb.



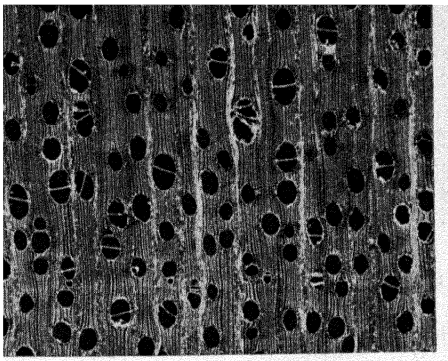
370. Rhus punjabensis J. L. Stewart



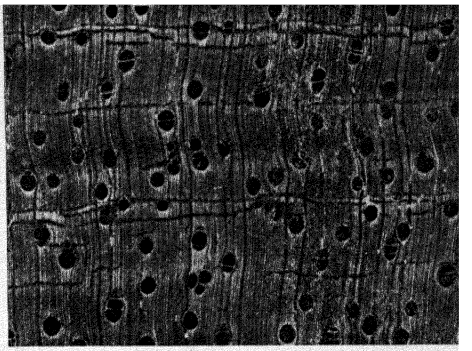
371. Rhus succedanea L.



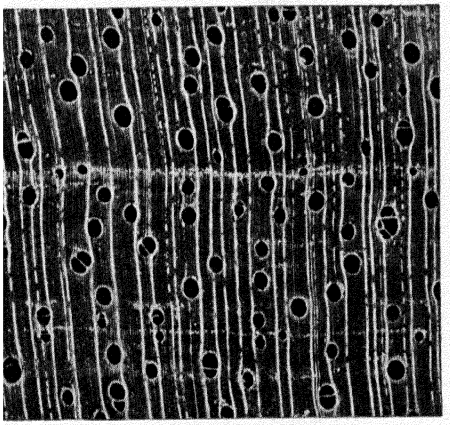
372. Semecarpus auriculata Bedd.



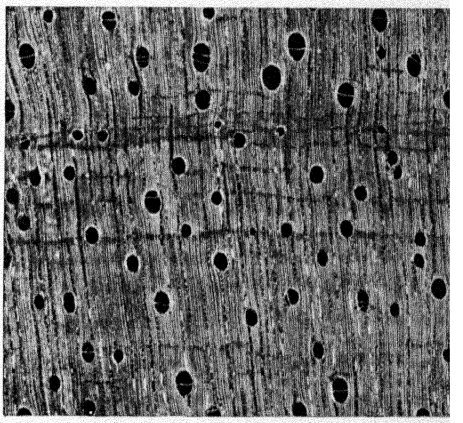
373. Spondias mangifera Willd.
(S. pinnata (L. f.) Kurz)



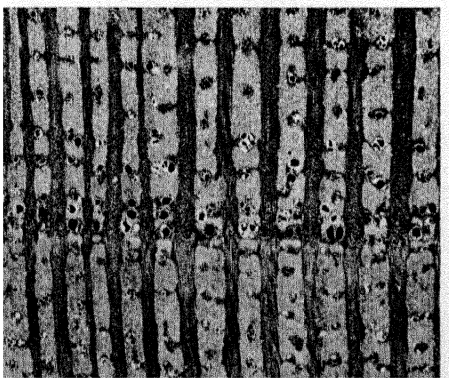
374. Swintonia floribunda Griff.



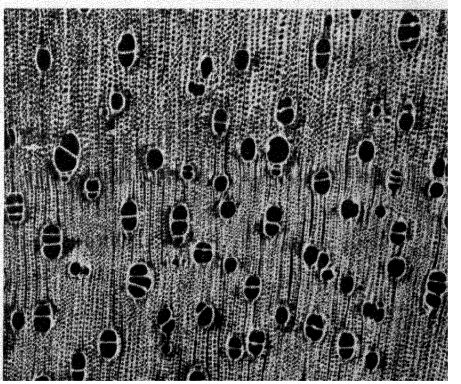
375. Swintonia floribunda Griff.



376. Swintonia schwenckii Kurz



377. Coriaria nepalensis Wall.



378. Moringa pterygosperma Gaertn.
(M. oleifera Lam.)