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**An Investigation on the Morphological, Anatomical
Characteristics and Uses of Some Myanmar
Lesser Known Heavy Wood Species**

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လူသိနည်းသေးသည့် သိပ်သည်းခြင်းများသော မြန်မာ့သစ်အချို့၏ပြင်ပရုပ်သွင်နှင့် အင်္ဂါဗေဒ လက္ခဏာရပ်ကို လေ့လာခြင်း

ဦးစိုးမြင့်၊ M.Sc. (Rgn.) ၊ ကထိက၊ ရုက္ခဗေဒဌာန၊
ပဲခူးဒီဂရီကောလိပ်၊ ပဲခူး။
ဒေါ်ကြူကြူသင်း၊ M.Sc. (Mdy.) ၊ သုတေသနလက်ထောက်
ဒေါ်ရီရီဟန်၊ M.Sc. (Rgn.) ၊ လက်ထောက်သုတေသနအရာရှိ
နှင့်
ဦးသိန်းကြွယ်၊ M.Sc. (Rgn.) , M.S. (SUNY, CESF)
လက်ထောက်ညွှန်ကြားရေးမှူး၊ သစ်တောသုတေသနဌာန၊ ရေဆင်း။

စာတမ်းအကျဉ်းချုပ်

မြန်မာနိုင်ငံအလယ်ပိုင်းတွင် တွေ့ရသော လူသိနည်းသေးသည့် သစ် (၉)မျိုးကို ပျဉ်းမနား မြို့နယ်
နှင့်အနီးတစ်ဝိုက်မှ စုဆောင်း၍ ၎င်းတို့၏ ပြင်ပရုပ်သွင်နှင့် သစ်အင်္ဂါဗေဒ လက္ခဏာများကို လေ့လာ
ထားပါသည်။ ၎င်းတို့၏ ပင်ပိုးနှင့် မျိုးပွားပိုင်းတို့၏ ပြင်ပရုပ်သွင်၊ ပင်စည်မှ ထွက်သော သစ်သားတို့၏
အင်္ဂါဗေဒ လက္ခဏာများနှင့် သစ်သား အသုံးဝင်ပုံတို့ကို ဖော်ပြထားပါသည်။ လေ့လာဖော်ပြထားသော
အပင် (၉)မျိုးမှာ

- ၁။ တောင်သရက် (*Swintonia floribunda* Griff.)
- ၂။ ဖက်သန်း (*Haplophragma adenophyllum* Dop.)
- ၃။ သံတေ (*Stereospermum personatum* (Hassk) Chatt.)
- ၄။ သဒီ (*Protium serratum* Engl.)
- ၅။ ငှုဝါ (*Cassia fistula* Linn.)
- ၆။ ရုံး (*Anogeissus acuminata* Wall.)
- ၇။ လိမ္မော် (*Terminalia pyrifolia* Kz.)
- ၈။ မျောက်ချော (*Homalium tomentosum* Benth)
- ၉။ ယင်းမာ (*Chukrasia tabularis* A. Juss.) တို့ဖြစ်ပါသည်။

ထူးခြားသော ပြင်ပရုပ်သွင်လက္ခဏာများနှင့် အရေးကြီးသော သစ်အင်္ဂါဗေဒ လက္ခဏာများကို ဆွေးနွေး
တင်ပြ ထားပါသည်။

An Investigation on the Morphological, Anatomical Characteristics and Uses of Some Myanmar Lesser Known Heavy Wood Species

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Abstracts

Morphology and Anatomy of the nine lesser known timber species, found in central Myanmar, taken from Pyinmana Township surrounding area and have been studied. Morphology of vegetative and reproductive part, anatomy of the wood of the stems and have been described. The species studied in this research are as follows:

1. Taung theyet (*Swintonia floribunda* Griff.)
2. Petthan (*Haplophragma adenophyllum* Dop.)
3. Thande (*Stereospermum personatum* (Hassk) Chatt.)
4. Thadi (*Protium serratum* Engl.)
5. Ngu-shwe (*Cassia fistula* Linn.)
6. Yon (*Anogeissus acuminata* Wall.)
7. Lein (*Terminalia pyrifolia* Kz.)
8. Myauk - chaw (*Homalium tomentosum* Benth)
9. Yinma (*Chukrasia tabularis* A. Juss.)

The outstanding morphological features and important anatomical characteristics in reference to their wood have been discussed.

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1. Introduction

By providing employment opportunities and earning a major portion of income from export, forestry function as one of the major contributors of Myanmar's economy. During recent years timber trade overwhelms the other competitive ones to the extent that about one half the total export earning was covered by the timber trade alone (Win Kyi (1) and et. al. 1993). So, there is an urgent need to capture the opportunities offered by specialised high end-use sectors, marked for value added products and for products made of lesser known or lesser used species.

Actually there exists about a thousand tree species in Myanmar, of which forty to fifty species are in used and are commercially extracted from the forest at the moment. The rest are unused or little used. Thus commercially important timbers become scarce due to development of wood-based industries and domestic and international timber trade increases. Therefore people in the forestry sector become considered that commercially important timbers are substituted by other appropriate woody species. As a matter of fact lack of sufficient quality of each species in a particular area is the main obstacle for the economically viable use of lesser used species. As long term supply is not assured, lesser used species are not introduced to the market at all. However some of them possessed properties equal or superior to known commercial species. Apart from that, the wood of lesser used species could be promoted by developing management, proper drying and supporting preservative treatment.

In view of the improved utilization of lesser used species, it is necessary to study these species first. Many researcher studied on strength, physical and mechanical properties, in relation to its structure and durability. Some workers investigation on their properties and utilization according to their weight. Depending upon their weight, the timber species are grouped as heavy hardwoods, medium or moderately heavy hardwoods and light hardwoods. It included heavy hardwoods, ranging in density from about 816 to 1124 Kg per cu. m, moderately heavy hardwood ranging in density from about 656 to 816 kg per cu. m, and light hardwood ranging in density from about 352 to 656 kg. per cu. m, (air dry density) (Thein Kywe, 1994). All species included in this study are heavy hardwoods.

A review of literature has mentioned that very little work on wood anatomy of these species has been done in Myanmar and then this types of comparative study is totally lacking.

It is hoped that by exploring the suitability of these commercially secondary important species, in the near future, their export can be increased like the famed teak, pyinkado and padauk.

2. Literature Review

In Myanmar forests, there are most abundant tree species which are termed Lesser Known Species (L K S) or Lesser Used Species and Commercially important species are becoming scarcity.

Kyaw Lwin (1995) mentioned that during the years 1990 S, as wood -based industry developed and due to growing scarcity of the more desired timber species starts to gain acceptance in the international market. In the case of Myanmar, there is a vast resource of LKS which account for 75-80 % of the total growing stock.

As the classification of Hutchinson (1961), the genus *Swintonia* belongs to the family Anacardiaceae and the genera *Haplophragma* and *Stereospermum* to

the family Bignoniaceae, the genus *Protium* to the family Burseraceae and the genus *Cassia* to the family Caesalpiniaceae. But Lawrance (1969) classified the genus *Cassia* under subfamily Caesalpinioideae of the family Leguminosae. The genera *Anogeissus* and *Terminalia* were included in the family Combretaceae according to Hutchinson (1961) and Lawrance (1969). Hutchinson (1961) placed the genus *Homalium* under the family Flacoutiaceae and the genus *Chukrasia* under the family Meliaceae.

The morphological characteristics of all species included in this work are mentioned by Kurz (1877), Hooker (1885), Bor (1953) and Brandis (1906). Among them some species are revealed in taxonomic study of regional flora by many myanmar workers.

Pearson & Brown (1932) and Saw C. Doo et. al (1989) stated that medium sized to large vessel pores with or without tyloses are found in *Swintonia floribunda*. Gamble (1922) described that vessel pores of *Haplophragma adenophyllum* are moderate-sized and filled with yellowish resinous materials. In *Protium serratum*, moderately small to medium-sized vessel pore with abundant tyloses are found by Win ky (1) et. al (1993) and medium-sized to large ones with abundant tyloses are found by Pearson & Brown (1932). According to Pearsin & Brown (1932) and Gamble (1922), the vessel pores of *Cassia fistula* are medium-sized to large and occluded with pale yellowish brown gum. Pearson & Brown (1932) stated that small or very small to medium sized vessel pores are found in *Anogeissus acuminata* and medium sized to very large ones are found in *Terminalia pyrifolia*. The vessel pores of *Homalium tomentosum* are very small to small with yellow or yellowish gummy inclusion, and those of *Chukrasia tabularis* are small to medium sized with yellowish white deposits according to Pearson & Brown (1932).

Pearson & Brown (1932) stated that 1-to 3-seriate heterogeneous rays which containing reddish brown gummy infiltration in some cells are found in *Swintonia floribunda*. The rays of *Protium serratum*, *Cassia fistula* and *Anogeissus acuminata* are heterogeneous 1-to 3-seriate. Crystals and gum infiltration are found in the ray of *Protium serratum* and especially in upright cells of *Anogeissus acuminata*. In *Chukrasia tabularis*, 1-to 6-seriate ray cells are homogeneous or nearly so and contain yellowish brown gummy infiltration. However, Kribs (1959) described that 1-to 6- (mostly 3- to 4-) seriate ray cells of *C. tabularis* are heterogeneous to homogeneous and occluded with brown gum. According to Thein Kywe and Kyaw Soe (1983), they are homogeneous type II and some of them show tendency to be homogeneous type I and they are 1-5 cells wide.

According to Pearson & Brown (1932), the fibers of *Swintonia floribunda* are libriform and non-septate and those of *Protium serratum* are non-libriform to libriform, septate and found to be occluded with reddish brown gummy deposits. The fibers of *P. serratum* are non-libriform and septate as had been described by Win Kyi (1) et. al (1993). According to Pearson & Brown (1932) in *Cassia fistula* libriform and in part septate fibers contained minute globose yellow or yellowish brown gum and those of *Anogeissus acuminata* are occasionally septate and libriform. However, Thein Kywe & Kyaw Soe (1983) found the non-libriform to libriform and non-septate fibers in *A. acuminata*. According to Pearson & Brown (1932), fibers of *Terminalia pyrifolia* are non-libriform to semilibriform and in part septate, but they are observed to be non-libriform and non-septate by Soe Tint & Thein Kywe (1984). Semilibriform to libriform and septate fibers are found in *Homalium tomentosum* and non-libriform fibers of *Chukrasia tabularis* are occasionally septate Pearson & Brown (1932).

However, Kribs (1959) and Thein Kywe & Kyaw Soe (1983) stated that the fibers of *Chukrasia tabularis* are libriform and rarely septate.

The axial parenchyma of *Swintonia floribunda* are found to be very sparse paratracheal, terminal and metatracheal, and no crystals are observed by Pearson & Brown (1932). However Saw C. Doo et. al (1989) mentioned that paratracheal parenchyma are sparse and apotracheal parenchyma diffuse or short or relatively long bands with 3- or 4- seriate in *S. floribunda*. Pearson & Brown (1932) described that very sparse paratracheal parenchyma contained reddish infiltration in *Protium serratum*. The axial parenchyma of *Cassia fistula* are terminal, paratracheal and metatracheal, and contain crystals. In *Anogeissus acuminata*, the axial parenchyma are paratracheal zonate and never form definite tangential bands. Scattered metatracheal and inconspicuous terminal parenchyma are also found in this species. The paratracheal parenchyma of *Terminalia pyrifolia* are broad, conspicuous and wavy bands occasionally forked. In this species, terminal and metatracheal parenchyma are also found. The axial parenchyma of *Homalium tomentosum* are very sparse and in *Chukrasia tabularis*, terminal, metatracheal and paratracheal parenchyma are observed. In the axial parenchyma of this species, light yellowish brown gummy deposits are common and crystals are rare. However, Thein Kywe & Kyaw Soe (1983) observed sparse paratracheal, diffuse and scattered apotracheal and terminal parenchyma in *C. tabularis*. Kribs (1959) also found the scanty to vasicentric paratracheal, terminal and diffuse apotracheal parenchyma in *C. tabularis*. Crystal and brown gums are also common in this species.

3. Materials and Methods

All the included in this study were collected from Pyinmana and Tatkon Township in Mandalay Division. They were taken during the flowering and fruiting periods.

Both fresh and preserved vegetative and reproductive parts are used for the identification and morphological study.

For anatomical studies on wood, a portion of the stem with the bark measured 8" X 6" X 1" was taken between 4 and 5 feet from the base of the stem.

For microscopic investigations, the method of Jeffery (1917) was employed in the preparation of microscopic sections of the wood sample with slight modification.

The wood specimens were macerated by Franklins's method (1946).

Photomicrographs were taken by use of the Olympus Universal Research Microscope, Vanox model.

4. Observation

4.1 Morphology

All of the species studied in the presented research are deciduous trees except *Swintonia floribunda* which is evergreen.

The leaves of *Swintonia floribunda*, *Anogeissus acuminata*, *Terminalia pyrifolia* and *Homalium tomentosum* are simple while those of the rest species are unipinnately compound. However the leaves of *Chukrasia tabularis* are not only unipinnate but sometimes bipinnate near the tip. In all species observed in this study,

the leaves are found to be exstipulate except in *Cassia fistula*. Although the leaves of *Haplophragma adenophyllum* and *Stereospermum personatum* are opposite and decussate, the rest are found to be alternate. The shape, margins, tips and bases of the leaves or leaflets are revealed in Table(1).

The inflorescences are mostly panicle but drooping raceme in *Cassia fistula*, globose head in *Anogeissus acuminata*, and spike in *Terminalia pyrifolia* and *Homalium tomentosum*. The flowers are found to be bisexual and unisexual in *Swintonia floribunda* but those of the remaining species bisexual. Although the sessile flowers are found in *Anogeissus acuminata*, *Terminalia pyrifolia* and *Homalium tomentosum*, the pedicellate ones are found in the rest.

Table (1)

No.	Species Observed	shape	margin	base	tip
1.	<i>Swintonia floribunda</i>	Lanceolate or oblong lanceolate	entire	obtuse to cuneate	acute to acuminate
2.	<i>Haplophragma adenophyllum</i>	obovate to elliptic-oblong	entire	obtuse to slightly oblique	acute
3.	<i>Stereospermum personatum</i>	elliptic to elliptic-oblong	entire	cuneate	cuspidate to acuminate
4.	<i>Protium serratum</i>	oblong to elliptic-oblong	more or less serrate to almost entire	obtuse	cuspidate with wide and blunt end
5.	<i>Cassia fistula</i>	ovate-oblong to elliptic-oblong	entire	obtuse or acuminate	acute to acuminate
6.	<i>Anogeissus acuminata</i>	narrowly lanceolate to elliptic	entire	acute	acuminate
7.	<i>Terminalia pyrifolia</i>	broadly lanceolate	entire or slightly wavy	auneate to attenuate	acute or acuminate
8.	<i>Homalium tomentosum</i>	obovate to abovate-oblong	glandular crenate	cuneate or obtuse	apiculate or acuminate
9.	<i>Chukrasia tabularis</i>	ovate to elliptic	entire to slightly undulate	oblique	acuminate

Table (2)

No.	Species	hairy character of calyx	shape of calyx	hairy characters of corolla	shape of corolla
1.	<i>Swintonia floribunda</i>	glabrous	cup-shaped	glabrous	obovate
2.	<i>Haplophragma adenophyllum</i>	brown stellate tomentose without; glabrous within	tubular-campanulate	densely brown stellate tomentose without; glabrous within	tubular-campanulate and ventricose
3.	<i>Stereospermum personatum</i>	pubescent without; glabrous within	campanulate and slightly curved	glabrous without; long hairs brone inside at the posterior side of the throat of the corolla tube	tubular-ventricose and bilabiate
4.	<i>Protium serratum</i>	tomentose without; glabrous within	cup-shaped	pubescent without; glabrous within	oblong
5.	<i>Cassia fistula</i>	glabrous	ovate	glabrous	obovate with distinct claw
6.	<i>Anogeissus acuminata</i>	tomentose without; long hair within	tubular-campanulate	-	-
7.	<i>Terminalia pyrifolia</i>	tomentose without; tomentose within	funnel-shaped	-	-
8.	<i>Homalium tomentosum</i>	tomentose without; glabrous within	linear-obolong to lanceolate	tomentose without; glabrous within	triangular
9.	<i>Chukrasia tabularis</i>	tomentose without; glabrous within	cup-shaped	glabrous	obovate-oblong

Table (3)

No.	Species observed	number		colour	fixation	dehiscence
		fertile stamens	staminodia			
1.	<i>Swintonia floribunda</i>	5	-	creamy white	dorsifixed	longitudinal slit
2.	<i>Haplophragma adenophyllum</i>	4	1	pale yellow	dorsifixed	longitudinal slit
3.	<i>Stereospermum personatum</i>	4	1	pale yellow	dorsifixed	longitudinal slit
4.	<i>Protium serratum</i>	10	-	pale yellow	dorsifixed	longitudinal slit
5.	<i>Cassia fistula</i>	3 +4 + 3	-	brown and pale yellow	dorsifixed and basifixed	longitudinal slit and apical pores
6.	<i>Anogeissus acuminata</i>	10	-	pale yellow	dorsifixed	longitudinal slit
7.	<i>Terminalia pyrifolia</i>	10	-	pale yellow	dorsifixed	longitudinal slit
8.	<i>Homalium tomentosum</i>	5	5	dark purple	dorsifixed	longitudinal slit
9.	<i>Chukrasia tabularis</i>	10	-	pale yellow	basifixed	longitudinal slit

Table (4)

No.	Species	number of		number of ovules per placenta	type of placentation	number of style	type of stigma
		carple	locule				
1.	<i>Swintonia floribunda</i>	1	1	1	basal	1	discoïd
2.	<i>Haplophragma adenophyllum</i>	2	2	many	axile	1	bifid
3.	<i>Stereospermum personatum</i>	2	2	many	axile	1	bifid
4.	<i>Protium serratum</i>	5	5	2	axile	subsessile or absent	5-lobed
5.	<i>Cassia fistula</i>	1	1	many	marginal	1	simple
6.	<i>Anogeissus acuminata</i>	1	1	2	pendulous	1	simple
7.	<i>Terminalia pyrifolia</i>	1	1	2	pendulous	1	simple
8.	<i>Homalium tomentosum</i>	2 (or) 3	1	2 (or) 3	parietal	2 (or) 3	simple
9.	<i>Chukrasia tabularis</i>	3	3	many	axile	1	discoïd

Table (5)

No.	Species	position	shape	hairy character
1.	<i>Swintonia floribunda</i>	superior	ovoid and oblique	glabrous
2.	<i>Haplophragma adenophyllum</i>	superior	oblong with 6 ridges	densely brown stellate tomentose
3.	<i>Stereospermum personatum</i>	superior	quadrangular	glabrous
4.	<i>Protium serratum</i>	superior	ovoid	tomentose
5.	<i>Cassia fistula</i>	superior	linear-falcate	sparsely puberulous
6.	<i>Anogeissus acuminata</i>	inferior	oblong with 2 lateral wings	tomentose at tip and glabrous at base
7.	<i>Terminalia pyrifolia</i>	inferior	ovoid or slightly triangular	densely pubescent
8.	<i>Homalium tomentosum</i>	half inferior	ovoid	villous
9.	<i>Chukrasia tabularis</i>	superior	oblongoid	velvety tomentose

Table (6)

No.	Species observed	type of fruit	shape of fruit	shape of seed	colour of seed coats
1.	<i>Swintonia floribunda</i>	samaroid	oblong	oblong	creamy white to pale yellow
2.	<i>Haplophragma adenophyllum</i>	capsule	spiral	orbicular with wings	light brown to yellowish brown
3.	<i>Stereospermum personatum</i>	capsule	slightly twisted or curved	oblong with 2 lateral wings	greyish white
4.	<i>Protium serratum</i>	drupe	globose or 2- or 3- lobed	oblong	light brown
5.	<i>Cassia fistula</i>	pod	cylindrical	ovoid	brownish yellow
6.	<i>Anogeissus acuminata</i>	drupe	oblong with 2 lateral wings	ovate-oblong	dark brown
7.	<i>Terminalia pyrifolia</i>	drupe	oblong with 2 lateral wings	oblongoid	yellowish brown to brown
8.	<i>Homalium tomentosum</i>		ovoid	ovoid	greenish white
9.	<i>Chukrasia tabularis</i>	loculicidal capsule	ovoid	obovate with wings at the top	light brown to reddish brown

The flowers of *Swintonia floribunda* and *Protium serratum* are bracteate, and those of the remaining species are bracteate. The bracteoles are absent in all species except in *Stereospermum personatum* and *Chukrasia tabularies*. The shape and hairy character of calyx and corolla are stated in Table (2).

The number of stamen and staminode, colour, fixation and dehiscence of anthers of all species are mentioned in Table (3).

The gynoecia vary widely in number of carpels, locules, types of placentation, number of ovules per placenta, number of style and types of stigma as shown in Table(4).

In the species studied in this research, the ovaries are in different position and have various shape and types of hairs are shown I Table (5).

In *Homalium tomentosum*, the base of the ovary fused with the hypanthium.

The disc in the flowers of *Haplophragma adenophyllum*, *Swintonia floribunda* and *Stereospermum personatum* are found at the base of the ovary, but those of *Protium serratum* is found to be annular, surrounding the ovary. In *Terminalia pyrifolia*, the disc surrounded at the base of style above the inferior ovary and fused with the calyx tube.

The type of fruits, shape of seeds, and colour and type of seed coat vary as mentioned in Table (6).

4.2 Anatomy

4.2.1 Key to the species.

- | | |
|---|-----------------------------|
| 1. Wood diffuse porous; growth rings fairly distinct or faint; tyloses present or absent; ray 1-3 cells wide— | 2 |
| 1. Wood semining porous; growth rings distinct; tyloses absent; rays 1-4 cells wide— | <i>Chukrasia tabularis</i> |
| 2. Paratracheal parenchyma scarce or vasicentric; apotracheal parenchyma absent or scarce; fiber septate— | 3 |
| 2. paratracheal parenchyma abundant or vasicentric, aliform or confluent connection 2- numerous vessel pores; apotracheal parenchyma absent or diffuse, banded; fiber non-septate or septation very rare— | 4 |
| 3. Heart wood distinct; grain fairly straight; pores with abundant tyloses; layers of stratification absent in fiber— | <i>Protium serratum</i> |
| 3. Heart wood not distinct grain twisted; pores without tyloses; layers of stratification present in fiber— | <i>Homalium tomentosum</i> |
| 4. Pores with tyloses; gum canals and silica bodies present in ray cells; fiber non-libriform; apotracheal parenchyma shortly banded— | <i>Swintonia floribunda</i> |
| 4. Pores without tyloses; gum canals and silica bodies absent in ray cells; fiber libriform; apotracheal parenchyma diffuse or diffuse in aggregate— | |

5.	Maximum pore diameter less than 160 μm ; rays heterogeneous; crystal common grain irregularly interlocked	5	
5.	Maximum pore diameter more than 170 μm ; rays heterogeneous; crystal absent; grain straight		<i>Anogeissus acuminata</i>
6.	Confluent parenchyma forming long wavy tangential bands; crystals present in axial parenchyma; height of uniseriate ray more than 270 μm	6	
6.	Confluent parenchyma connecting 2-7 pores; does not form long wavy tangential bands; crystals absent in axial parenchyma; height of uniseriate ray less than 200 μm	7	
7.	Pores with gum deposits; maximum height of multiseriate ray less than 500 μm ; rays 1-3 cells wide, mostly biseriate; axial parenchyma without elongate crystal	8	
7.	Pores with gum deposits; maximum height of multiseriate ray more than 800 μm ; rays 1-2 cells wide, mostly uniseriate; axial parenchyma with elongate crystal		<i>Cassia fistula</i>
8.	Wood greyish-white, pores solitary or multiples; very few to moderately numerous; averages solitary pores percentage more than 80; maximum height of uniseriate ray more than 160 μm		<i>Terminalia pyrifolia</i>
8.	Wood pale yellow; pores solitary, multiples or clusters; moderately few to numerous; average solitary pores percentage less than 70; maximum height of uniseriate ray less than 150 μm		<i>Stereospermum personatum</i>
			Haplophragma adenophyllum

Plate I



Swintonia floribunda Griff.

- A. A plant in natural habit.
- B. Terminal and axillary inflorescence.
- C. Portion of wood.
- D. Cross section of wood.
- E. Tangential longitudinal section of wood.

1. ***Swintonia floribunda* Griff.**
 Synonym : *S. Griffithii* Kurz.
 Family : Anacardiaceae
 Local name : Taung-thayet
 Trade name : Taung-thayet

General Features

Growth ring faint, Heartwood not distinct, sapwood greyish or pinkish white. Texture medium, straight-grained.

Microscopic Features

Vessel elements

Wood diffuse porous, average solitary pores 61 % radial multiples of 2-12, 2-17 pores per sq. mm., circular or oval in cross section moderately small to moderately large, mean tangential diameter 162 μm (range 51-297 μm); perforation simple, end walls oblique or transverse, tailed at one or both ends thin-walled, tyloses present; intervacular pits alternate to opposite, crowded, oval or rounded or elliptical, 5-38 μm in diameters; vessel elements medium-sized to moderately long, mean length 633 μm (range 369-892 μm).

Fibers

Non-libriform and non-septate, walls 2.5-6.0 μm thick, lumen 18 μm wide mean length 1048 μm (738-1292 μm); F/V ratio 1.7 (range 1.1 - 3.0).

Rays

Uniseriate to triseriate, heterogeneous, 5-12 per mm. tangentially; uniseriate rays 1-17 cells (51-636 μm) high; multiseriate rays 5-30 cells (123-892 μm) high and composed of gum canal the middle; silica present in ray cells; rays vessel pits opposite to alternate, oval or elliptical.

Axial parenchyma

Paratracheal parenchyma scanty, confluent forming 2-8 seriate bands, apotracheal parenchyma diffuse in aggregate and frequently forming short tangential bands containing 2-4 seriate; gum deposits and crystal present.

Plate II



Hoplophragma adenophyllum Dop.

- A. A plant in natural habit.
- B. A terminal inflorescence.
- C. Portion of wood.
- D. Cross section of wood.
- E. Tangential longitudinal section of wood.

2. ***Hapliophra Adenophyllum* Dop.**

Synonym : *Bignonia adenophyllum* Wall.
Heterophragma adenophyllum Seem.
Spathodea adenophyllum A. DC.

Family : Bignoniaceae

Local name : Petthan

Trade name : Petthan, Karen wood.

General Features

Growth ring faint; heartwood brownish yellow; sapwood pale yellow.
 Texture fine; straight-grained.

Microscopic Features

Vessel elements

Wood diffuse porous: average solitary pores 67 % and radial multiples of 2-8 and occasionally pore clusters; 9-22 pores per sq. mm, circular or oval in cross section, very small to medium-sized, mean tangential 117 μm (range 31-185 μm); perforation simple, end walls transverse or oblique, tailed at one end, thin-walled; intervascular pits alternate, crowded, rounded, vessel elements extremely short to medium-sized, mean length 307 μm (range 153-502 μm).

Fibers

Libriform, non-septate; walls 2.5-8.0 μm thick, lumen 15 μm wide, mean length 1285 μm (range 707-1579 μm); F/V ratio 4.5 (range 1.6-9.4 μm).

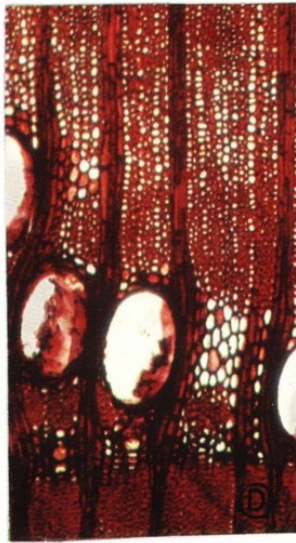
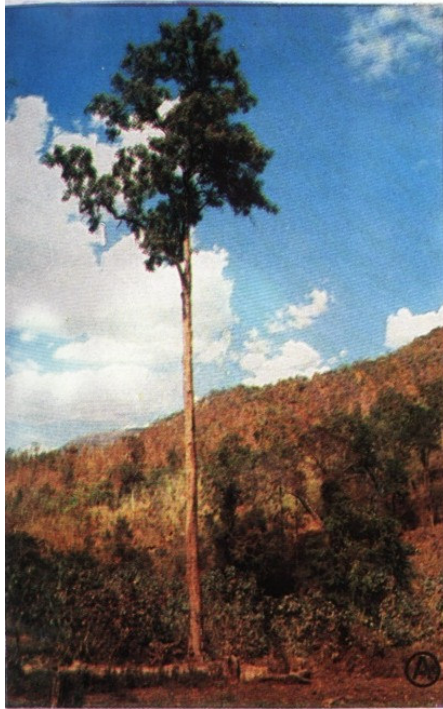
Rays

Uniseriate to triseriate, rarely uniseriate, homogeneous, 6-10 per mm tangentially, uniseriate rays 1-6 cells (41-133 μm) high; multiseriate rays 6-24 cells (range 72-472 μm) high; ray vessel pits similar to intervascular pits.

Axial parenchyma

Vasicentric, aliform, aliform confluent paratracheal, diffuse apotracheal and uniseriate terminal bands.

Plate III



Stereospermum personatum (Hassk.) Chatt.

- A. A plant in natural habit.
- B. A terminal inflorescence.
- C. Portion of wood.
- D. Cross section of wood.
- E. Tangential longitudinal section of wood.

3. *Stereospermum Peronatum* (Hassk) Chatt.

Synonym	: <i>Bignonia chelonoides</i> Linn. <i>Stereospermum chelonoides</i> Kurz. <i>Dipterosperma personatum</i> Hassk.
Family	: Bignoniaceae
Local name	: Thande
Trade name	Nil

General Features

Growth ring fairly distinct, heartwood not distinct, sapwood greyish white. Texture fine, straight-grained.

Microscopic Features

Vessel elements

Wood diffuse porous, average solitary pores 83 %, radial multiples of 2-4, 1-12 pores per sq. mm , circular or oval in cross section, very small to medium-sized, mean tangential diameter 118 um (range 30-184 um); perforation simple, end walls oblique to transverse, tailed at one or both ends, thin-walled; intervascular pits alternate, crowded, rounded or oval, 2.5-5.0 um in diameter, vessel elements very short to medium-sized, mean length 283 um (range 195-359 um).

Fibers

Libriform, non-septate, walls 2.5-5.0 um thick, lumen 20 um wide, mean length 1123 um (range 595-1456 um); F/V ratio 4.1 (range 1.8-6.2).

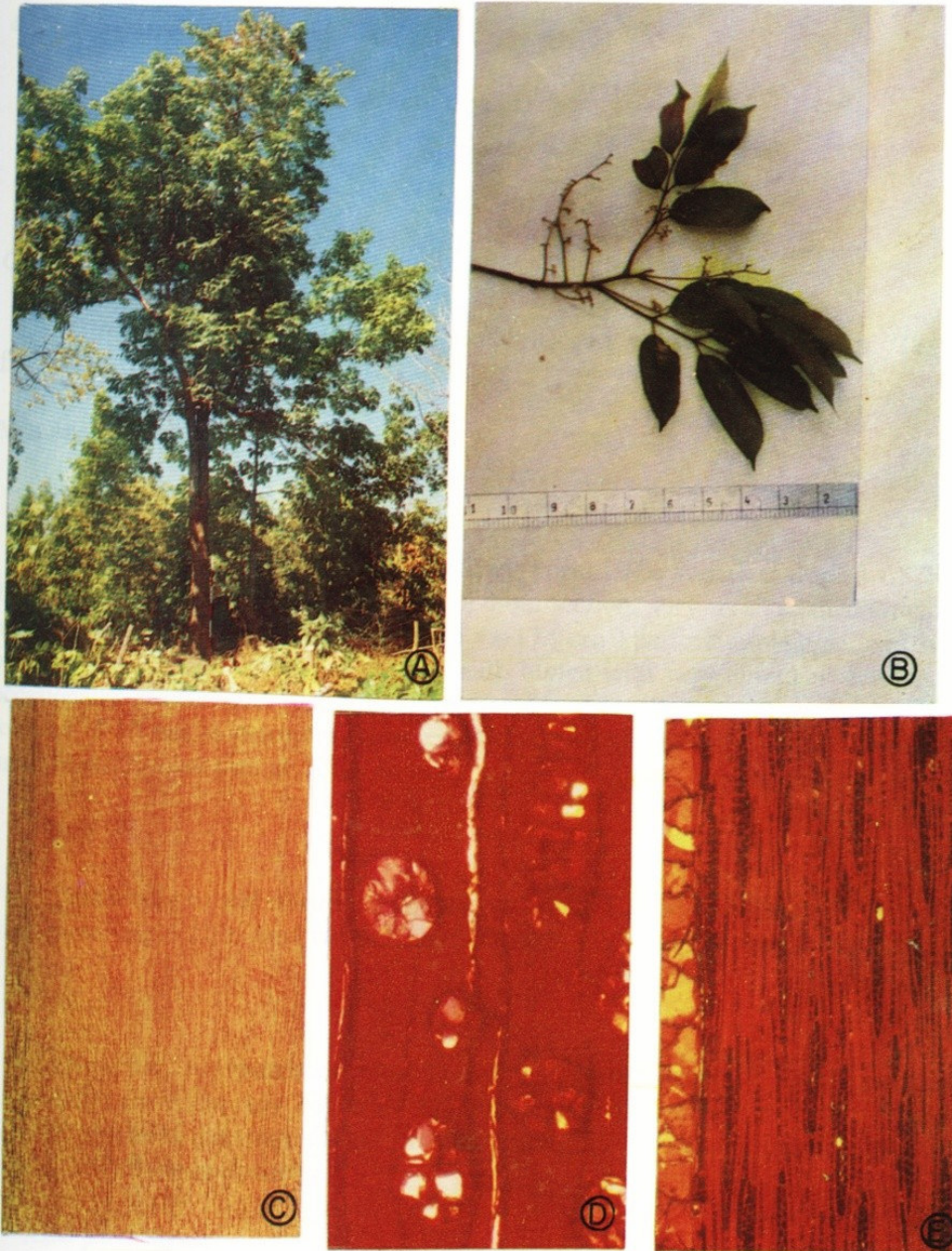
Rays

Uniseriate to triseriate, rarely uniseriate, homogeneous, 5-11 per mm tangentially; uniseriate rays 2-9 cells (31-185um) high; multiseriate rays 3-31 cells (62-574 um) high; ray vessel pits similar to intervascular pits.

Axial parenchyma

Aliform, aliform confluent paratracheal connecting 2-7 vessel pores forming oblique and occasionally wavy bands containing 2-9 seriate; diffuse in aggregate apotracheal and terminal bands containing 2-7 seriate; gum deposits in some parenchyma.

Plate IV



Protium serratum Engler.

- A. A plant in natural habit.
- B. Terminal and axillary inflorescence.
- C. Portion of wood.
- D. Cross section of wood.
- E. Tangential longitudinal section of wood.

4. ***Protium Serratum* Enel.**

Synonym : *Bursera serrata* Colebr.
 Family : Burseraceae
 Local name : Thadi, Kati
 Trade name Thadi

General Features

Growth ring fairly distinct, heartwood brick red, sapwood light brown.
 Texture fine, fairly straight-grained.

Microscopic Features

Vessel elements

Wood diffuse porous, average solitary pores 58% radial multiples of 2-10, 11-31 pores per sq. mm., circular or oval in cross section, very small to medium-sized, mean tangential diameter 123 μ m (range 41-174 μ m); perforation simple, end walls oblique, tailed at one or both ends, thin-wall, lumen with very abundant tyloses and occasionally reddish-gum deposits; intervascular pits alternate, crowded, oval or rounded, 5-10 μ m in diameter, vessel elements moderately shorts, to medium-sized, mean length 546 μ m (range 338-738 μ m).

Fibers

Non-libriform and libriform, septate, walls 2.5-8.0 μ m thick, lumen 20 μ m in wide, mean length 1206 μ m (range 502-1620 μ m); F/V ratio 2.2 (range 0.8-4.5).

Rays

Uniseriate to triseriate, mostly biseriate, heterogeneous, 6-12 per mm tangentially; uniseriate rays 2-9 cells (51-25.6 μ m) high; multiseriate rays 5-25 cells (62-410 μ m) high; gum deposits and crystals present; ray vessel pits alternate, rounded or oval, 2.5-8.0 μ m in diameter.

Axial parenchyma

Very sparse, vasicentric paratracheal with uniseriate sheath, with abundant gum deposits.

Plate V



Cassia fistula Linn.

- A. A plant in natural habit.
- B. An axillary drooping inflorescence.
- C. Portion of wood.
- D. Cross section of wood.
- E. Tangential longitudinal section of wood.

5. *Cssila Fistula* Linn.

Synonym : *C.fistuloides* Collad.
C.rhombifolia Roxb.
Bactrylobium fistula Willd.
Cathartocarpus fistula Pers.

Family : Caesalpiniaceae

Local name : Ngu-shwe, Ngu-shwe-wa, Ngu-gyi,
: Pwa-bet

Trade name : Indian Laburnum

General Features

Growth ring not distinct, heartwood yellowish red, sapwood greyish red. Texture medium, straight-grained.

Microscopic Features

Vessel elements

Wood diffuse porous, average solitary pores 64 % radial multiples of 2-4, 3-10 pores per sq. mm., circular or oval in cross section, moderately small to moderately large, mean tangential diameter 161 μ m (range 82-236 μ m); perforation simple, end walls transverse or oblique, truncate or tailed at one end, thin-walled, lumen with frequently gum deposits; intervascular pits alternate, crowded, oval or elliptic, occasionally vested, 5-15 μ m in diameter, vessel elements extremely short to medium-sized, mean length 309 μ m (range 174-420 μ m).

Fibers

Libriform, occasionally septate, walls 2.5-10.0 μ m thick, lumen 18 μ m wide, mean length 1147 μ m (range 851-1476 μ m); F/V ratio 3.9 (range 2.1-6.9).

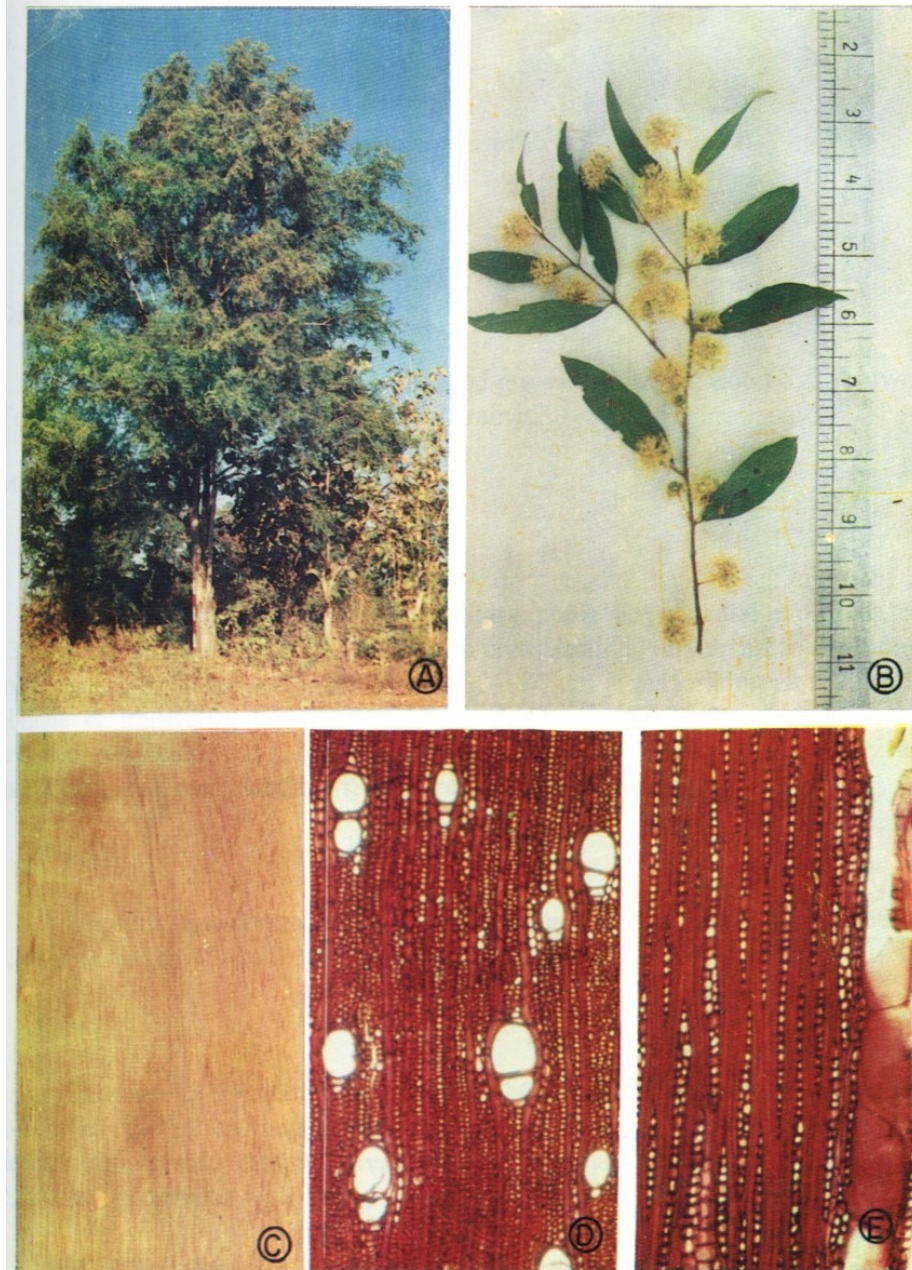
Rays

Uniseriate to triseriate, mostly biseriate, homogeneous, 9-15 per mm tangentially; uniseriate rays 3-17 cells (62-277 μ m) high; multiseriate rays 6-28 cells (41-482 μ m) high; gum deposits present; ray vessel pits alternate, rounded or oval. 4-8 μ m in diameter.

Axial parenchyma

Vasicentric, aliform and aliform confluent paratracheal connecting 2-5 vessel pores forming 4-14 seriated bands, diffuse in aggregate apotracheal and terminal band containing 1-4 (mostly 2-3) seriate; reddish brown gum deposits in some parenchyma; prismatic crystals frequently in 4-14 chambered some axial parenchyma.

Plate VI



Anogeissus acuminata Wall.

- A. A plant in natural habit.
- B. Axillary globose heads.
- C. Portion of wood.
- D. Cross section of wood.
- E. Tangential longitudinal section of wood.

6. *Anogeissus Acuminata* Wall.

Synonym : *A. hirta* Wall.
Conocarpus acuminata Roxb.

Family : Combretaceae

Local name : Yon

Trade name : Yon

General Features

Growth ring fairly distinct, heartwood greyish white, sapwood light brown
 Grey Texture very fine, irregularly interlocked grained.

Microscopic Features**Vassel elements**

Wood diffuse porous, average soliated pores 63% radial multiples of 2-4, 13-32 pores per sq. mm., circular or oval in cross section, very small to medium-sized, mean tangential diameter 96 μm (range 30-154 μm); perforation simple, end walls oblique or transverse, tailed at one end, thin-walled; intervascular pits alternate, crowded, rounded or oval, 10-13 μm in diameter, vessel elements extremely short to moderately long, mean length 348 μm (range 174-994 μm).

Fibers

Libriform, non-septate, walls 2.5-8.0 μm thick, lumen 14 μm wide, mean length 1288 μm (range 625-1640 μm); F/V ratio 4.1 (range 1.4-7.4).

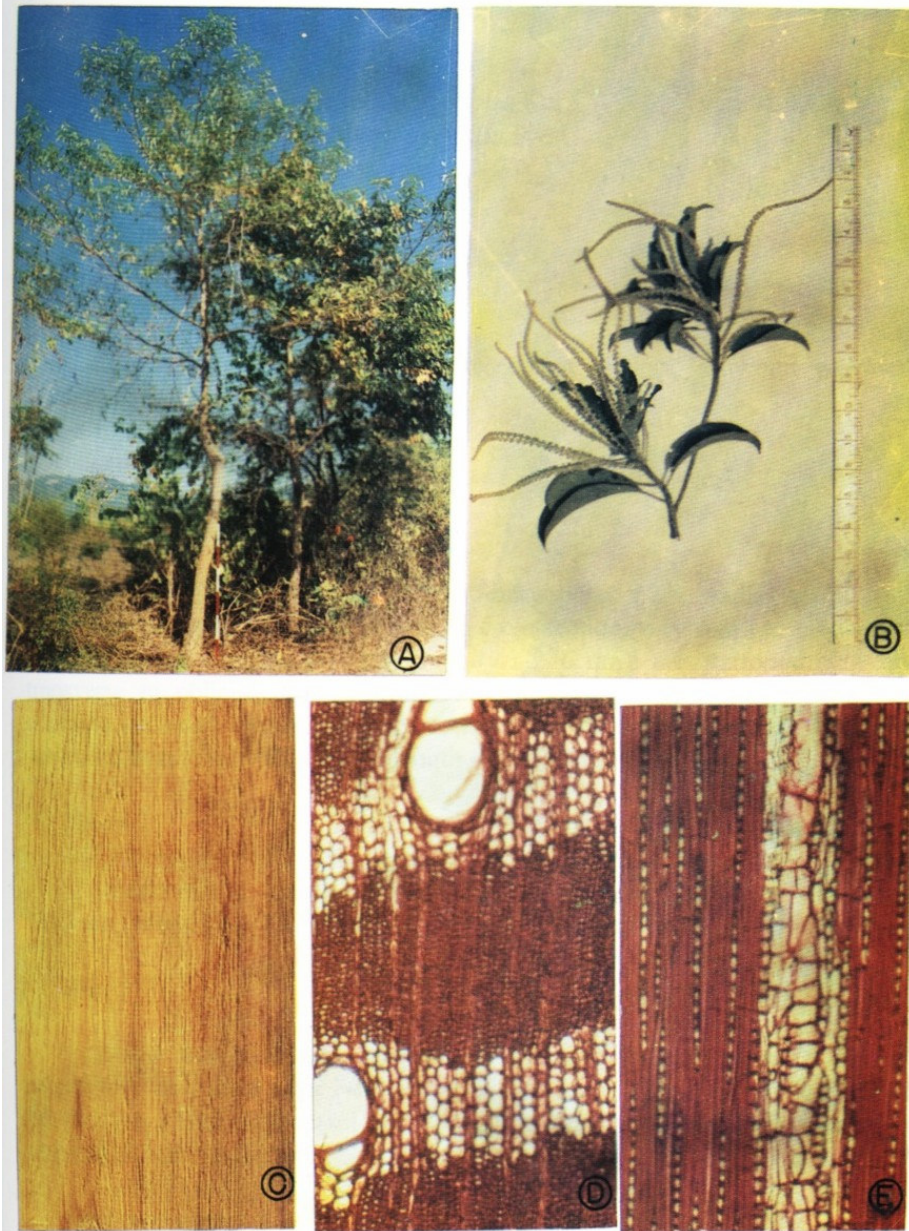
Rays

Uniseriate to biseriate, heterogeneous, 9-26 per mm tangentially, uniseriate rays 2-42 cells (51-964 μm) high; multiseriate rays 6-67 cells (123-1415 μm) high; gum deposits and crystals present; ray vessel pits alternate, crowded, rounded or oval, 2.5-8.0 μm in diameter.

Axial parenchyma

Unilateral, confluent paratracheal containing 2-5 pores forming inconspicuous obliquely bands, and diffuse apotracheal; gum deposits in some parenchyma.

Plate VII



Terminalia pyrifolia Kurz.

- A. A plant in natural habit.
- B. Axillary spikes.
- C. Portion of wood.
- D. Cross section of wood.
- E. Tangential longitudinal section of wood.

7. *Terminalla Pyrifolia* Kurz

Synonym	: <i>Combretum pyrifolia</i> Kurz. <i>Pentapetera pyrifolia</i> Persl.
Family	: Combretaceae
Local name	: Lein
Trade name	: Lein

General Features

Growth ring not distinct, heartwood not distinct, sapwood yellowish grey. Texture fine, straight-grained.

Microscopic Features**Vessel elements**

Wood diffuse porous, average solitary pores 62 %, radial multiples of 2-6, 1-11 pores per sq. mm, circular or oval in cross section, very small to moderately large, mean tangential diameter 147 μ m (range 41-236 μ m); perforation simple, end walls transverse to oblique, tailed at one or both ends, thin-walled; intervacular pits alternate, crowded, oval or elliptic, vestured, 5-15 μ m in diameter, vessel elements very short to medium-sized, mean length 445 μ m (range 205-615 μ m).

Fibers

Libriform, non-septate, walls 2.5-8.0 μ m thick, lumen 22 μ m wide, mean length 1452 μ m (range 625-1749 μ m); F/V ratio 3.3 (range 1.3-6.4).

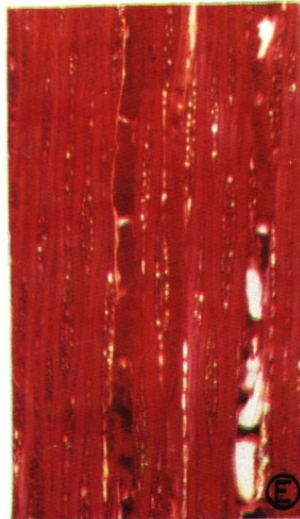
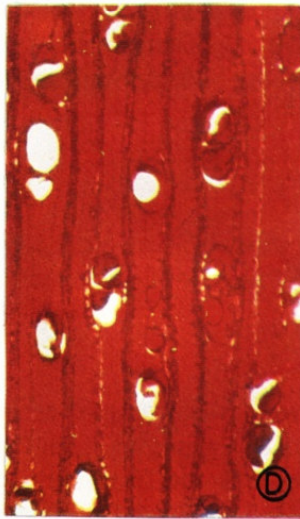
Rays

Mostly uniseriate and occasionally biseriate, homogeneous, 12-22 per mm tangentially; uniseriate rays 1-67 cells (31-2091 μ m) high; biseriate rays 3-29 cells (72-861 μ m) high; ray vessel pits opposite to alternate, crowded, rounded or oval, vestured, 5-9 μ m in diameter.

Axial parenchyma

Confluent paratracheal connecting vessel pores forming wavy and occasionally forked bands containing 2-10 (mostly 5-8) seriate, elongate crystals frequently present.

Plate VIII

*Homalium tomentosum* Benth.

- A. A plant in natural habit.
- B. Axillary spikes.
- C. Portion of wood.
- D. Cross section of wood.
- E. Tangential longitudinal section of wood.

8. *Homalium Tomentosum* Benth.

Synonym	: <i>Blackwellia tomentosa</i> Vent. <i>B.spiralis</i> Wall.
Family	: Flacourtiaceae
Local name	: Myauk-chaw
Trade name	: Muauk-chaw

General Features

Growth ring not distinct, heartwood not distinct, sapwood greyish brown. Texture very fine, twisted-grained.

Microscopic Features

Vessel elements

Wood diffuse porous, average solitary pores 49%, radial multiples of 2-5 (mostly 2-3), 36-60 pores per sq. mm., circular or oval section, very small to medium-sized, mean tangential diameter 74 μ m (range 31-102 μ m); perforation simple, end walls oblique, tailed at one or both ends, thin-walled, lumen with abundant dark red gum deposits; intervascular pit alternate, crowded, rounded or oval, 2.5-5 μ m in diameters; vessel elements medium-sized to moderately long, mean length 776 μ m (range 513-1103 μ m).

Fibers

Libriform, septate; walls 2.5-8 μ m thick, with stratification layer, lumen 21 μ m wide, mean length 1395 μ m (range 984-1948 μ m); F.V ratio 1.8 (range 1.0-3.2).

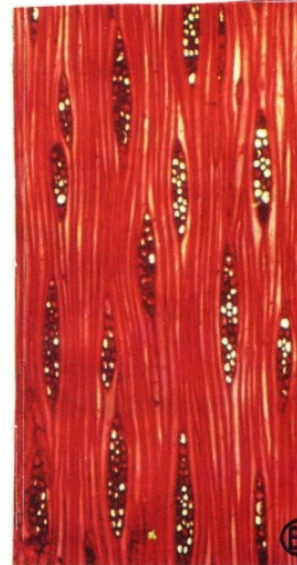
Rays

Uniseriate to triseriate, heterogeneous 7-23 per mm tangentially; uniseriate rays 3-20 cells (92-718 μ m) high; multiseriate rays 7-83 cells (102-1322 μ m) high; gum deposits and crystals present; ray vessel pits alternate to opposite, crowded, oval or rounded, 2.5-5.0 μ m in diameter.

Axial parenchyma

Very sparse, scanty paratracheal, scattered and sparse apotracheal; gum deposits present.

Plate IX

*Chukrasia tabularis* A. Juss.

- A. A plant in natural habit.
- B. Terminal and axillary inflorescences.
- C. Portion of wood.
- D. Cross section of wood.
- E. Tangential longitudinal section of wood.

9. *Chukrasla Tabularis* A. Juss.

Synonym : *Chukrasia velutina* Wight & Arn.
Chickrasia tabularis A. Juss.
 Local name : Yin-ma
 Trade name : Golden Mahogany, chittagong wood.

General Features

Growth ring distinct, heartwood yellowish brown, sapwood pale yellowish brown. Texture very fine, fairly interlocked grained.

Microscopic Features

Vessel elements

Wood semi-ring porous, average solitary pores 42 %, radial multiples of 2-4, 12-29 pores per sq. mm., circular or oval in cross section, very small to medium-sized, mean tangential diameter 93 μ m (range 30-133 μ m); perforation simple, and walls oblique or transverse, tailed at both end; thin-walled, lumen with dark red gum deposits; intervascular pits alternate pits alternate, crowded, oval or rounded, 2.5-10.0 μ m in diameter, vessel elements extremely short to medium-sized, mean length 404 μ m (range 144-646 μ m).

Fibers

Libriform, non-septate, walls 2.5-8.0 μ m thick, lumen 18 μ m wide, mean length 1065 μ m (range 666-1353 μ m); F/V ratio 2.9 (range 1.0-6.3).

Rays

Uniseriate to tetraseriate, mostly triseriate, heterogeneous, 7-11 per mm tangentially, uniseriate rays 1-11 cells (21-256 μ m) high; multiseriate rays 6-40 cells (113-738 μ m) high; gum deposits present; ray vessel pits opposite to alternate, rounded or oval 2.5-5.0 μ m in diameter.

Axial parenchyma

Scanty, vascentric paratracheal with 1-2 seriate, scattered apotracheal and terminal band with 2-6 (mostly 3-4) seriate; gum deposits present; crystals frequently in 4-18 chambered parenchyma.

5. Discussion

5.1 Morphology

The leaves of *Swintonia floribunda*, *Anogeissus acuminata*, *Terminalia pyrifolia* and *Homalium tomentosum* are simple and those of the remaining 5 species are unipinnate compound. The basal pairs of auricle-like leaflets are found in the leaves of *Haplophragma adenophyllum* which agrees with Kurz. (1877).

The flowers are bisexual in all species except in those of *Swintonia floribunda* which are both of unisexual and bisexual. Those characters agree with those described by Kurz. (1877) and Hooker (1885).

The free calyces are found in *Cassia fistula* and *Homalium tomentosum*, but they are gamoseplous in the remaining species. Among them, calyces of *Haplophragma adenophyllum* and *Stereospermum personatum* are persistent and those of the remaining species are deciduous. These characteristics are agreed with those mentioned by Hooker (1885), Brandis (1906), Van Steenis (1955) and Khin Maung Tin (1974). The Calyx tubes of *Anogeissus acuminata* are attenuated to the ovaries and persistent.

The corolla are absent in *Anogeissus acuminata* and *Terminalia pyrifolia* which agree with Kurz (1877), Hooker (1885), Aung Kyaw (1976) and Myint (1977). In this research the petals of *Swintonia floribunda* are found to be persistent. Moreover they become enlarged and mortified into the wings of fruits as had been mentioned by Kurz (1877) and Brandis (1906).

The flowers of *Haplophragma adenophyllum* and *Stereospermum personatum* contained 2 pairs of didynous fertile stamens and one staminode as had been described by Kurz (1877), Van, Steeris (1977), Soe (1977) and Myint (1977).

In *Cassia fistula*, the stamens are not equal in shape and size, and among the total of 10, 3 posterior are largest and strongly sigmoid, 4 middle ones stout, and 3 anterior ones smallest and straight.

The stamens of *Anogeissus acuminata*, *Terminalia pyrifolia* and *Protium serratum* are biseriate. Those of *Homalium tomentosum* consists of 5 fertile stamen with purplish anther and 5 orange glandular staminode. In *Chukrasia tabularis* the stamen fused at the base to form a staminal tube.

In this research, ovary is found to be oblique and glabrous in *Swintonia floribunda* as had been stated by Kurz (1877), Hooker (1885) and Brandis (1906). The densely brown stellate hairs are found on the surface of ovaries of *Haplophragma adenophyllum* which agree with Hla Aye (1977). However Myint (1977) mentioned that the hairs on the ovaries are long and brown in this species. The style found in the pistils of *Cassia fistula* contain are very short. The pistils of *Homalium tomentosum* consist of 3-5 styles and this character agrees with Van Steenis (1955). The ovaries of *Anogeissus acuminata* are observed to be covered with tomentose hairs at the tip and glabrous at the base in this work. But, Aung Kyaw (1976) and Myint (1977) stated that the ovaries are covered with pubescent hairs.

The fruits are found to be samaroid in *Swintonia floribunda* which agree with Kurz. (1877) and Brandis (1906). In *Haplophragma adenophyllum* and *Stereospermum personatum* the fruits are found to be capsules. In *Stereospermum personatum* the capsules contained hard septum, although Myint (1977) stated that the septa of capsules are spongy. The fruits of *Cassia fistula* are indehiscent pod and those of *Protium serratum* are 2-to-3-lobed drupes and edible. In *Anogeissus acuminata* and *Terminalia pyrifolia* the fruits consists of 2 lateral wings. In *Chukrasia*

tabularis the fruits are loculicidal capsules which agree with Khin Maung Tin (1974), Aung Kyaw (1976), Hla Aye (1977), Hnin Hnin Mya (1977), Myit (1977) and Soe (1977).

5.2 Anatomy

All the general characteristics such as colour, grain and texture of the species studied are observed to differ from each other. The relative differences in general characteristics of the nine commercially less acceptable species are stated as shown in the table 5.1.

The sapwood of *Swintonia floribunda* is found to be greyish-white in colour and without distinct heartwood which agrees with Pearson & Brown (1932), Rodger (1963), and Saw C. Doo & et. al (1989).

The wood colour of *Haplophragma adenophyllum* is found to be pale yellow to brownish yellow in this study. However, Gamble (1922) stated that the wood colour of *H. adenophyllum* was light yellow to orange yellow with occasionally darker streaks, Watt (1890) and Rodger (1963) also described as yellowish white and orange or yellow in colour respectively.

The wood of *Stereospermum personatum* is geryish white in colour and not differentiated into sapwood and heartwood which agrees with Bor (1953) and Burkill (1966).

In this study the wood colour of *Portium serratum* is found to be light brown to brick red which agrees with the description of Pearson & Brown (1932), Anon (1956), and Win Kyi (1) et. al (1933). But according to Watt (1899) it was red in colour.

The sapwood colour of *Cassia fistula* is greyish red in this study. However Kurz (1877) stated that it was pale reddish brown in colour and Pearson & Brown (1932) revealed that it was pale dirty white. The heartwood colour of *Cassia fistula* is found to be yellowish red which generally in agreement with the description of Watt (1899), Gamble (1922), and Pearson & Brown (1932), Kurz. (1877) also described that it was dark brown.

The sapwood colour of *Cassia fistula* is greyish red in this study. However Kurz (1877) stated that it was pale reddish brown in colour and Pearson & Brown (1932) revealed that it was pale dirty white. The heartwood colour of *Cassia fistula* is found to be yellowish red which generally in agreement with the description of Watt (1899), Gamble (1922), and Pearson & Brown (1932). Kurz. (1877) also described that it was dark brown.

The sapwood colour observed in *Anogeissua acuminata* is found to be light brownish grey in this study. But according to Pearson & Brown (1932), and Win Kyi (1) & et. al (1993), it was light whitish grey to pale greenish grey, often with light grey bands. The colour of heartwood is found to be greyish white in this work. Although, it was chocolate-brown according to Pearson & Brown (1932), and Win Kyi (1) & et. al (1993).

The sapwood of *Terminalia phrifolia* in this work is yellowish grey and without distinct heartwood which agrees with Pearson & Brown (1932), But according to Rodger (1963) it was grey.

In this study the sapwood colour of *Homalium tomentosum* is greyish brown and without distinct heartwood which agrees with Pearson & Brown (1932), However, Gamble (1922) stated that the heartwood was dark-coloured. According to Titmuss (1948), the heartwood was light red-brown in colour.

The sapwood of *Chukrasia tabularis* is found to be pale yellowish in colour, but Pearson & Brown (1932), and Thein Kywe & Kyaw Soe (1983) stated that it was pale yellowish or brown white. In the present study the colour of the heartwood of *C. tabularis* was yellowish brown which generally agrees with Watt (1889), Gamble (1922) and Pearson & Brown (1932). However Titmuss (1948) stated that it was golden-mahogany or reddish brown in colour.

In the present study, the wood of these species are straight-grained, irregularly interlocked-grained and twisted grained. The wood of *Swintonia floribunda* is straight-grained which agrees with Pearson & Brown (1932), Rodger (1963), and Saw C. Doo & et. al (1989). *Haplophragma adenophyllum* and *Stereospermum personatum* are straight grained. The wood of *Protium serratum* is fairly straight grained. However according to Pearson & Brown (1932) it was narrowly interlocked grained and frequently wavy grained, Kurz (1877) also stated that it was closed-grained.

The wood of *Cassia fistula* is straight-grained which agrees with Pearson & Brown (1932). But Kurz (1877) stated that it was closed-grained. The wood of *Anogeissus acuminata* is seen to be irregularly interlocked grained in this work. However according to Pearson & Brown (1932), it was fairly straight-grained to irregularly interlocked grained. The wood of *Terminalia pyrifolia* is straight grained which agrees with Pearson & Brown (1932).

The wood of *Homalium tomentosum* is twisted grained, although Pearson & Brown (1932) stated that it was straight-grained. The wood of *Chukrasia tabularis* is fairly interlocked grained which agrees with the description of Pearson & Brown (1932).

As observed in this study the wood of *Swintonia floribunda* is medium textured which agrees with Saw C. Doo & et. al (1989). However Pearson & Brown (1932) mentioned that it was coarse textured. The wood of *Haplophragma adenophyllum* and *Stereospermum personatum* are found to be fine textured in this work.

The wood of *Protium serratum* is fine textured. However it was medium textured as given by Pearson & Brown (1932), and Win Kyi (1) et. al (1993). The wood of *Cassia fistula* is medium-textured, but according to Pearson & Brown it was medium coarse textured. The wood of *Anogeissus acuminata* is very fine-textured however Pearson & Brown (1932) described that it was medium fine textured.

The wood of *Terminalia pyrifolia* is fine textured. However, it was coarse-textured as mentioned as mentioned by Pearson & Brown (1932). The wood of *Homalium tomentosum* is very fine textured but it was fine to very fine textured according to Pearson & Brown (1932). The wood of *Chukrasia tabularis* is found to be very fine textured, although Kribs (1959) stated that it was fine textured, and it was medium textured according to Pearson & Brown (1932).

The anatomical characteristics of the wood studied in the present research are in accordance with the description of the species given in the literature and secondary xylem characteristics observed for all the species are shown in the table 5.2. Growth rings are fairly distinct to distinct or not distinct in all species studied.

All the species studied have diffuse porous wood except *Chukrasia tabularis* which is semi-ring porous. The vessels are solitary as well radial multiples and occasionally in clusters which agrees with Pearson & Brown (1932).

The pores of *Swintonia floribunda* are found to be moderately small to moderately large. However according to Pearson & Brown (1932) the pores were very large to medium-sized while those were large to very small as given by Saw C. Doo & et. al (1989).

The pores of *Haplophragma adenophyllum* are found to be very small to medium sized but those were moderate-sized according to Gamble (1932).

The pores found in *Stereospermum personatum* are very small to medium-sized. The pores of *Protium serratum* are found to be very small to medium-sized. Although Pearson &

Brown (1932) stated that those were medium-sized to large and the pores were moderately small to medium-sized as mentioned by Win Kyi (1) & et. al (1993).

The pores observed in *Cassia fistula* are moderately small to moderately large but according to Gamble (1922) the pores were moderate-sized to large and those were small or medium sized to large as mentioned by Pearson & Brown (1932).

The pores found in *Anogeissus acuminata* are very small to medium-sized which agrees with Pearson & Brown (1932). However according to Gamble (1992), the pores were considerably large and those were small according to Brandis (1953).

The pores of *Terminalia pyrifolia* are found to be very small to moderately large in this study. However, those were very large to medium-sized as described by Pearson & Brown (1932).

The pores of *Homalium tomentosum* are found to be very small to medium-sized but according to Pearson and Brown (1932), those were very small to small.

The pores found in *Chukrasia tabularis* are very small to medium-sized. However, those were small to medium-sized as given by Pearson & Brown (1932).

Vessel elements of *Swintonia floribunda* and *Homalium tomentosum* are found to be medium-sized to moderately long, Those of *Haplophragma adenophyllum*, *Cassia fistula* and *Chukrasia tabularis* are extremely short to medium sized. Vessel elements found in *Stereospermum personatum* and *Terminalia pyrifolia* are very short to medium-sized. Those of *Protium serratum* are moderately short to medium-sized and those of *Anogeissus acuminata* are extremely short to moderately long.

Average length of vessel elements of those nine species are shown in the Table 5.2. Their tangential pores diameter reveal the wide range, but the maximum mean diameter is observed in *Swintonia floribunda* and the maximum mean diameter in *Homalium tomentosum* as shown in the Diagram 5.1.

Wall thickness of vessel elements of all of the species studied are thin-walled. *Perforation plates* are simple in all of the species studied. Intervascular pittings are found to be alternate except *Swintonia floribunda* in which those are opposite to alternate. Vestured pittings are found in *Terminalia pyrifolia* and occasionally found in *Cassia fistula*.

The number of pores per square millimeter is varied among the species and their frequency and range are also mentioned in the Diagram 5.2.

In the present study, the fibers of all of the species are libriform except *Swintonia floribunda* and *Portium serratum*. In *Swintonia floribunda* non-libriform fiber are found in this study and *Protium serratum* possesses non-libriform to, libriform fiber which agrees with Pearson & Brown (1932). *Chukrasia tabularis* shown non-libriform to semi-libriform, *Terminalia pyrifolia* possesses non-libriform fiber and *Homalium tomentosum* show semi-libriform to libriform, according to Pearson & Brown (1932). Interfiber pittings are inconspicuous, minute, simple, slit-like which agree with Pearson & Brown (1932). *Protium serratum* and *Homalium tomentosum* possess septate fibers and in *Cassia fistula* septate fibers are occasionally found which agree with Pearson and Brown (1932). The fibers found in all remaining species are non-septate. Moreover the stratification layers are observed in the fibers of *Homalium tomentosum* which is in agreement with the description of Pearson & Brown (1932). However according to Pearson & Brown (1932), *anogeissus acuminata*, *Terminalia pyrifolia* and *Chukrasia tabularis* occasionally exhibit septate fibers.

In this study, the length of vessel to fiber ratio is calculated and presented in the Diagram 5.3. The maximum mean is found in *Haplophragma adenophyllum* and minimum mean in *Swintonia floribunda*.

Axial parenchyma as seen in transverse sections are found to be variable and they are regarded as reliable diagnostic features for identification of the species.

The axial parenchyma of *Swintonia floribunda* are scanty paratracheal or confluent forming 2-8 seriate bands and apotracheal parenchyma diffuse in aggregate forming short tangential bands which agree with Pearson & Brown (1932) and Saw C. Doo & et. al (1989).

The axial parenchyma of *Haplophragma adenophyllum* are paratracheal vasicentric, aliform or aliform confluent and apotracheal diffus. Moreover uniseriate terminal bands are observed in the present study.

The axial parenchyma found in *Stereospermum personatum* are paratracheal aliform to aliform confluent and apotracheal diffuse in aggregate. In this work 2-7 seriate terminal bands are also observed.

The paratracheal parenchyma of *Protium serratum* are vasicentric with uniseriate sheath which agree with Pearson & Brown (1932), and Win Kyi (1) & et. al (1993).

The axial parenchyma observed in *Cassia fistula* are paratracheal vasicentric, aliform to aliform confluent forming 4-14 seriate bands and apotracheal diffuse in aggregate and 1-4 seriate terminal bands.

The paratracheal parenchyma of *Anogeissus acuminata* are unilaterally and confluent forming inconspicuous bands and apotracheal diffuse, which agree with Pearson & Brown (1932), and Thein Kywe & Kyaw Soe (1983).

The paratracheal parenchyma of *Terminalia pyrifolia* are found to be wavy and occasionally forked bands which is in agreement with the description of Pearson & Brown (1932), and Soe Tint & Thein Kywe (1984).

The paratracheal parenchyma observed in *Homalium tomentosum* are scanty which agree with Pearson & Brown (1932). Moreover scattered and sparse apotracheal parenchyma are also found in this work.

The axial parenchyma of *Chukrasia tabularis* are paratracheal sparse, apotracheal scattered in solitary and 2-6 seriate terminal bands which agree with Pearson & Brown (1932), and Thein Kywe & Kyaw Soe (1983). Moreover, paratracheal vasicentric parenchyma with 1-2 seriate are also observed in this study which agree with Kribs (1959).

Axial parenchyma cells are often with transverse septation, resulting in multiple crystal chambers in *Swintonia floribunda*, *Cassia fistula* and *Chukrasia tabularis*. Elongated solitary crystals are found in the axial parenchyma of *Terminalia pyrifolia*.

Rays vary from low to high and uniseriate to multiseriate, the minimum mean of rays per millimeter tangentially occur in *Haplophragma adenophyllum* and maximum mean in *Anogeissus acuminata* and variation within species studied are shown in diagram 5.4.

The rays are homogeneous and heterogeneous. Homogeneous rays are found in *Haplophragma adenophyllum*, *Stereospermum personatum*, *Cassia fistula* and *Terminalia pyrifolia*, but Pearson & Brown (1932) stated that the rays of *Cassia fistula* are heterogeneous. *Swintonia floribunda*, *Protium serratum*, *Anogeissus acuminata* and *Homalium tomentosum* show heterogeneous rays which agree with Pearson & Brown (1932). The rays of *Chukrasia tabularis* are heterogeneous. However according to Pearson & Brown (1932), the rays of *Chukrasia tabularis* were homogeneous those were homogeneous to heterocellular as given by Kribs (1959). The rays are commonly uniseriate to triseriate and *Anogeissus acuminata* they are found to be uniseriate to biseriate. The rays of *Terminalia pyrifolia* were mostly uniseriate and occasionally biseriate and the ray of *Chukrasia tabularis* were uniseriate to tetraseriate.

The Presence of gum deposits are observed in *Swintonia floribunda*, *Protium serratum*, *Cassia fistula*, *Anogeissus acuminata*, *Homalium tomentosum* and *Chukrasia tabularis* while the gum deposits are absent in *Haplophragma adenophyllum*, *Stereospermum personatum* and *Terminalia pyrifolia*. Crystals are present in the rays of *Protium serratum*, *Homalium tomentosum* and *Anogeissus acuminata* which agree with Pearson & Brown

(1932). Gum canals and silica bodies are found in the rays *Swintonia floribunda*. But Pearson & Brown (1932) described that gum canals were found in the rays.

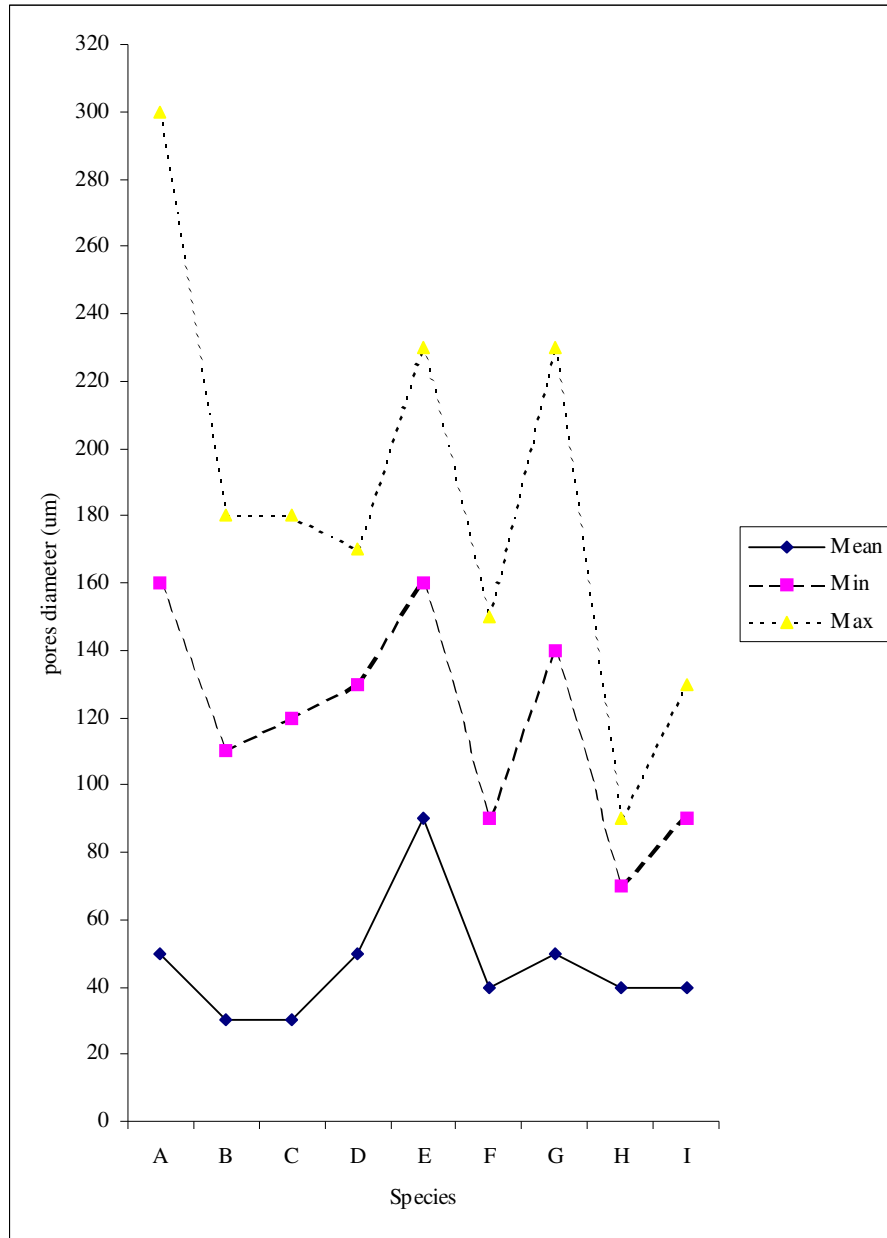
5.1. Quantitative characteristics of microscopic wood structures for nine commercially less acceptable species

Species observed	Swintoina floribunda	Haplophragma adenophyllum	Stereospermum personatum	Protium serratum	Cassia Fistula	Anogeissus acuminata	Terminalia pyrifolia	Homalium tomentosum	chukrasia tabularis
mean pores frequency (per sq mm)	6.0	16.0	5.0	20.0	6.0	21.0	4.0	49.0	21.0
mean vessel diameter (um)	162.0	117.0	118.0	123.0	161.0	96.0	147.0	74.0	93.0
mean vessel length (um)	633.0	307.0	288.0	546.0	309.0	348.0	445.0	776.0	404.0
mean fiber diameter (um)	18.0	15.0	20.0	20.0	18.0	14.0	22.0	21.0	18.0
mean fiber length (um)	1048.0	1285.0	1123.0	1206.0	1147.0	1288.0	1452.0	1395.0	1065.0
mean fiber thickness (um)	1.6	4.1	3.7	4.7	5.6	5.7	2.4	6.1	2.3
mean uniseriate ray height (cells)	7.0	3.0	4.0	4.0	9.0	14.0	15.0	7.0	6.0
mean uniseriate ray height (um)	325.0	91.0	80.0	122.0	153.0	325.0	419.0	539.0	127.0
mean uniseriate ray width (um)	24.0	12.0	8.0	13.0	12.0	13.0	15.0	12.0	19.0
mean ray frequency (permm)	8.0	7.0	8.0	9.0	11.0	19.0	17.0	15.0	11.0
mean multiseriate ray height (cells)	16.0	15.0	8.0	12.0	18.0	24.0	14.0	35.0	20.0
mean multiseriate ray height (um)	506.0	298.0	303.0	283.0	247.0	503.0	407.0	610.0	375.0
mean multiseriate ray width (um)	47.0	32.0	30.0	26.0	27.0	26.0	29.0	25.0	38.0

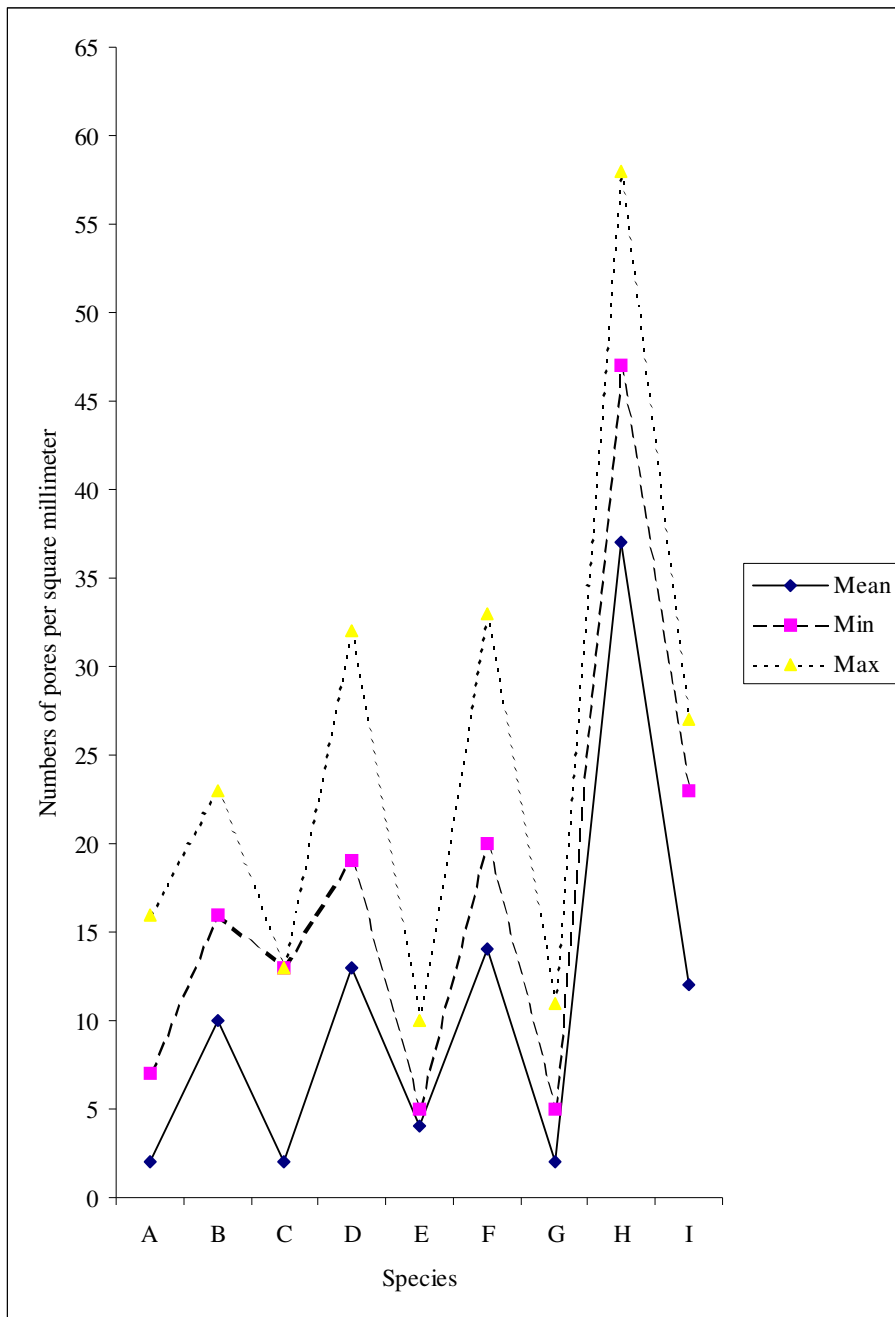
5.2 Comparisons of macroscopics characteristics of wood

Species observed	Colour	Odour and taste	Grain	Texture
<i>Swintonia floribunda</i>	grayish or pinkish white	not distinct	straight - grained	medium - textured
<i>Haplophragma adenophyllum</i>	pale yellow to brownish yellow	not distinct	straight - grained	fine-textured
<i>Stereospermum personatum</i>	grayish white	not distinct	straight - grained	fine-textured
<i>Bursera serrta</i>	Light brown to brick red	not distinct	fairly straight-grained	fine-textured
<i>Cassia fistula</i>	Grayish red to yellow red	not distinct	straight - grained	medium - textured
<i>Anogeissus acuminata</i>	Light brownish gray to grayish white	not distinct	irregularly interlocked grained	very fine textured
<i>Terminalia pyrifolia</i>	yellowish gray	not distinct	straight - grained	fine - textured
<i>Homalium tomentoum</i>	grayish brown	not distinct	twisted grained	very fine textured
<i>Chukrasia tabularis</i>	pale yellowish brown to yellowish brown	not distinct	fairly interlocked grained	very fine textured

5.1 Diagram showing
Comparison of vessle pores diameter among
the nine comercially less acceptable species



- A. *Swintonia floribunda* B. *Haplohragma adenophyllum* C. *Stereospermum personatum*
D. *Protium serratum* E. *Cassia fistula* F. *Anogeissus acuminata*
G. *Terminalia pyrifolia* H. *Homalium tomentosa* I. *Chukrasia tabularsis*



5.2 Diagram Showing Comparison of Pores Per Square Millimeter

A. *Swintonia floribunda*

B. *Heplophragma adenophyllum*

C. *stereospermum personatum*

D. *Protium serratum*

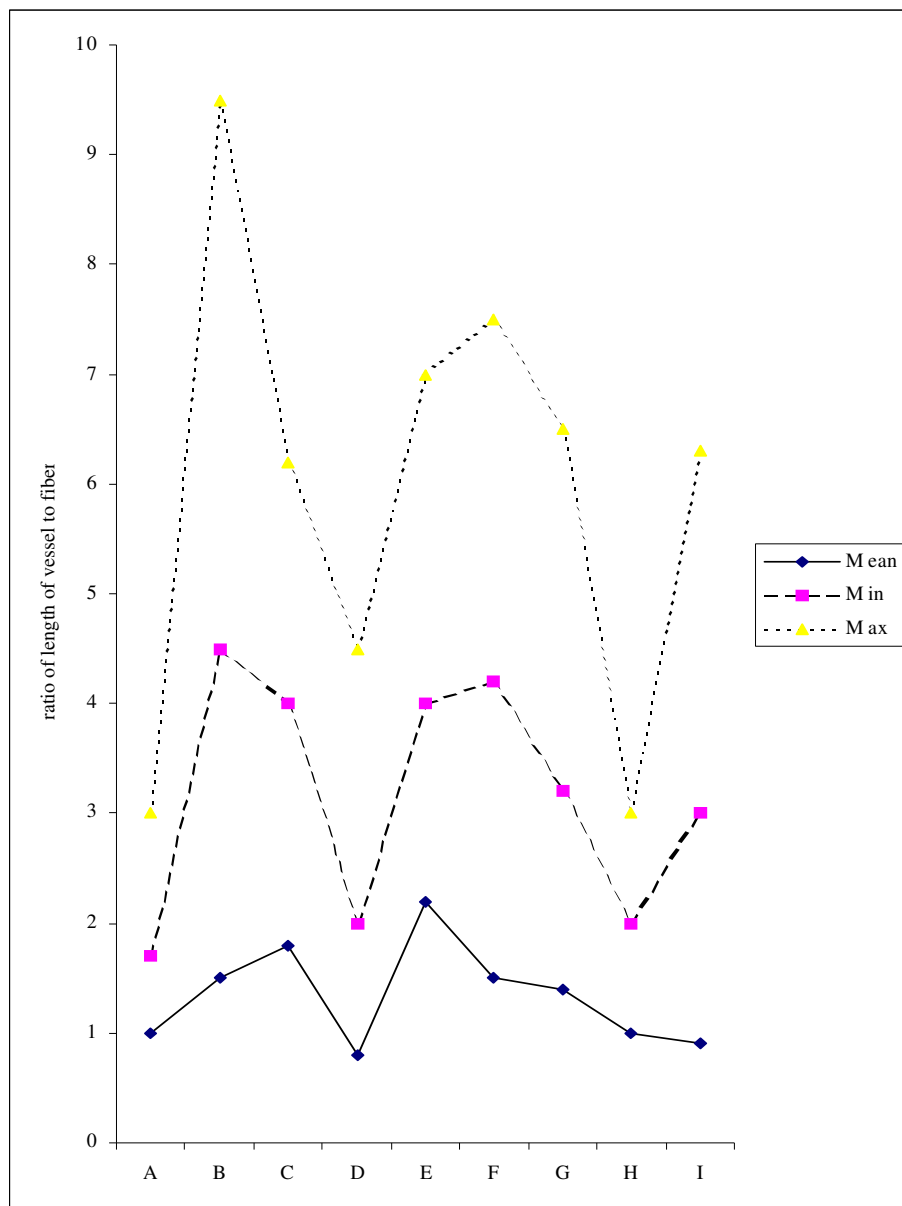
E. *Cassia fistula*

F. *Anogeissus acuminata*

G. *Terminalia pyrifolia*

H. *Homalium*

I. *Chukrasia tabularis*



5.3 Diagram showing Expression of fiber length and vessel length ratio

A. *Swintonia floribunda*

B. *Hapalophragma adenophyllum*

C. *Stereospermum personatum*

D. *Protium serratum*

E. *Cassia fistula*

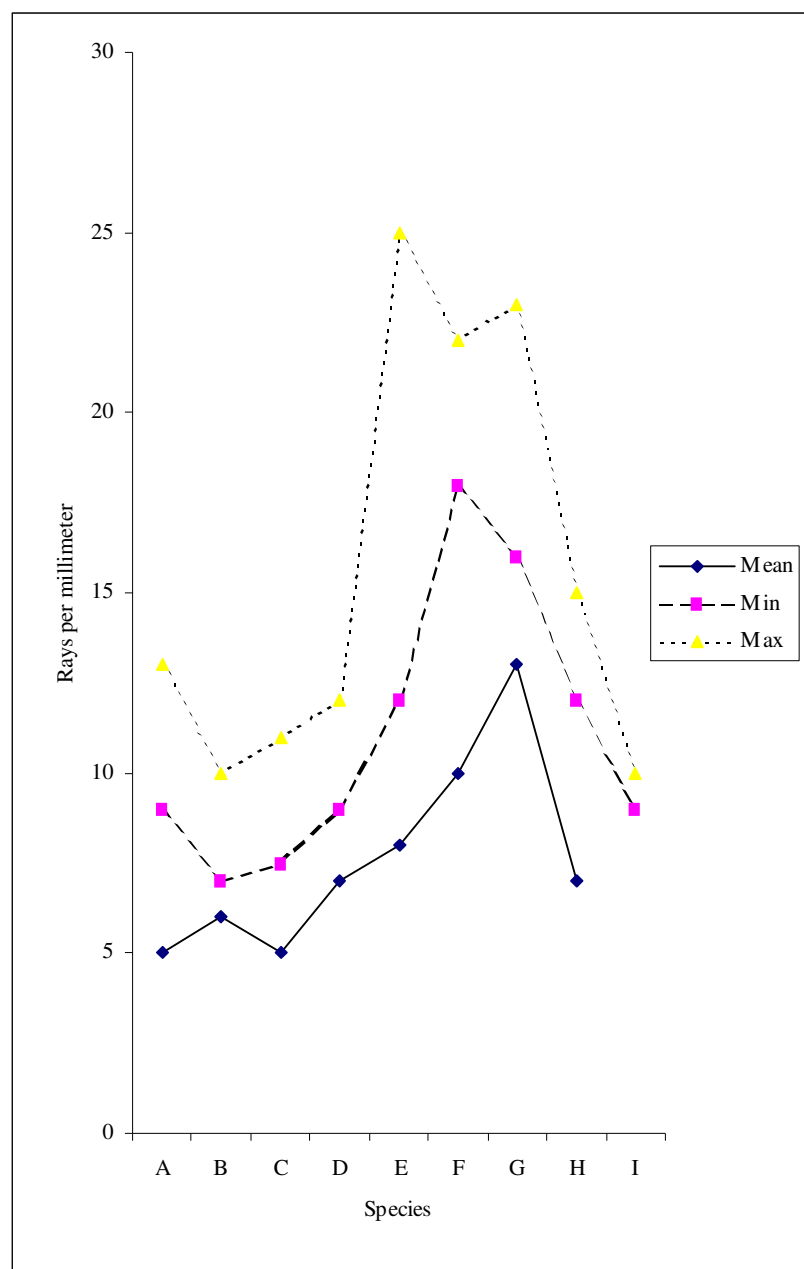
F. *Anogeissus acuminata*

G. *Terminalia pyrifolia*

H. *Homalium tomentosa*

I. *Chukrasia tabularsis*

5.4 Diagram showing Comparison of rays number millimeter for nine commercially less acceptable species



A. *Swintonia floribunda*

B. *Haplohragma adenophyllum*

C. *Stereospermum personatum*

D. *Protium serratum*

E. *Cassia fistula*

F. *Anogeissus acuminata*

G. *Terminalia pyrifolia*

H. *Homalium tomentosa*

I. *Chukrasia tabularis*

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