



**Government of Union of Myanmar  
Ministry of Forestry  
Forest Department**



**Utilization Potential of Some Commercially  
Less Acceptable Species**

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1993

**စီးပွားရေးအရ ရောင်းတမ်းမဝင်သေးသည့် မြန်မာ့သစ် (၁၀) မျိုးတို့၏  
အသုံးချနိုင်မှုကို လေ့လာခြင်း။**

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သစ်တောသုတေသနဌာန

**စာတမ်းအကျဉ်းချုပ်**

မြန်မာနိုင်ငံတွင်ရှိသော သစ်တောများ၏ ပေါက်ရောက်မှု များပြားသော်လည်း ဈေးကွက်အရ ရောင်းတမ်း မဝင်သေးသော သစ် (၁၀)မျိုးကို စမ်းသပ်လေ့လာရန် ရွေးချယ်ခဲ့ပါသည်။ အဆိုပါသစ်မျိုးတို့၏ သစ်အင်္ဂါဗေဒ၊ သစ်အင်အားနှင့် ရူပဆိုင်ရာဂုဏ်သတ္တိများ၊ သစ်အခြောက်ခံမှု၊ သဘာဝအလျောက် ကြာရှည်ခံနိုင်မှု၊ ဆေးသွင်း လွယ်ကူမှုနှင့် လုပ်ကိုင်ရလွယ်ကူမှု စသည်တို့ကိုလေ့လာ၍ စုစည်းတင်ပြ ထားပါသည်။ တွေ့ရှိချက်များ အပေါ်တွင် အခြေခံလျက် ၄င်းသစ် (၁၀) မျိုးတို့၏ အသုံးချနိုင်မှု လုပ်ငန်းများနှင့် အလားအလာများကို အကြံပြု တင်ပြထားပါသည်။

## **Utilization Potential of Some Commercially Less Acceptable Species**

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### **Abstracts**

Ten species of wood were selected among the most abundant tree species which are commercially less acceptable. Anatomical features, physical and mechanical properties, drying behavior, durability, treat ability and working properties of these timbers were determined. Utilization potentials of species mentioned were recommended according to the research findings.

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## 1. Introduction

Forestry plays a major role in Myanmar because of financial and environmental reasons. During recent years timber trade overwhelms the other competitive trades to the extent that about one half the total export earning was covered by the timber trade alone ( Appendix 1). However, the number of tree species involved in the trade was barely a dozen-compared to hundreds of timber species in the forest. In fact, the number of total standing trees of commercially important timbers, including Teak, amounted to about 36.19 percent of the total ( Appendix 2). These include Kyun, Pyinkado, Padauk, Thitya, Ingyin, Tamalan, In, Kanyin, Thinwin, Taung-Thayet and Hnaw.

Yon, Taukkyan, Sagawa, Binga, Kokko, Tinyu and Yindaik sometimes appeared on the list of timber export. But the amount was so small that these timbers should be regarded as commercially non-acceptable species in this paper. The rest of the species, perhaps, be utilized locally or left intact in the Forest. Preliminary studies indicated that a number of timber species which are currently commercially unimportant were proved to be comparable to commercial species in many aspects.

Selective exploitation of only the high value species, leaving in the forest a majority of the species of currently non-market table, would eventually lead to the lowering of the value of the forest. Thus growing plantation of commercial species and improvement felling become necessary, from time to time, to compensate for such stock imbalances. However, such efforts solved only part of the problem, neglecting the proper utilization of yet unvaluable species.

According to the statistical data, timber export earnings contributed to 70 to 75 percent of the total value of timber production, through amounting to 40 percent of the volume produced. About 70 percent of the total export earnings were met by the Teak products alone (Ref .7).In fact, unit value of export in US dollars, is much more higher than the local values.

It is now perceived that exportation of commercially valuable species should continue to be, encouraged for the wellbeing of the country's economy. For the purpose of domestic consumption, it is quite probable, that suitable species be chosen among the rest of the species for particular end-use.

The objectives of this paper and the forthcoming ones are to find out the various properties of the commercially less-acceptable timbers and to give suggestions for proper utilization of such species. Recognizing the fact that not all the species might easily be available, priority is given to those species which are still abundant in the forest.

## 2. Materials and Methods

The following authenticated species were collected and their properties tested at FRI , Yezin.

1. Thabye (*Eugenia jambolana*, Lamk.)
2. Thadi (*Protium serrata*, Engler)
3. Nabe (*Lannea grandis* Engler.)
4. Yon (*Anogeissus acuminata* Wall)
5. Pyinma (*Lagerstroemia speciosa* Pers.)
6. Zaungbale (*Lagerstomeia villosa* Wall.)
7. Myauk-ngo (*Daubaga grandifolia* Roxb.)

- |     |        |   |
|-----|--------|---|
| 8.  | Leza   | ( <i>Lagerstroemia tomentosa</i> Presl.)        |
| 9.  | Kuthan | ( <i>Hymenodictyon excelsum</i> Wall.)          |
| 10. | Letpan | ( <i>Salmalia malabarica</i> (DC) Schott End 1) |

In this work, the microscopic sections of the wood samples were made according to the method given by Jeffrey, 1917. In the photomicrographic illustrations, three sectional view, namely (A) Transverse (B) Tangential longitudinal and (C) Radial longitudinal sections of each sample of wood were given. The overall magnification of the plates is 83.

For physical properties, shrinkage data were based on measurements taken from green to oven-dry condition.

For mechanical properties, the method of testing carried out was in accordance with the American Society for testing Material (ASTM).

Drying behaviour were based on the air drying tests which were tested in open-sided shed which was also being properly protected from rain and direct sunlight.

The information on natural durability of timber was based mainly on the laboratory decay tests.

Most of the data on treat ability of timber was obtained from the results of empty-cell process treatment using diesel oil. Retention of oil was used as the criterion for easiness of the treatment.

### 3. Observations

#### 3.1 Distribution

Distribution of the selected species was referred to the inventory data issued by the Forest Resources Division, FD ( Ref. 8) Thus it covers only the inventories regions. Detailed distribution of the tree species by forest type and region was shown in the appendix (4). The areas having the density of species concerned below 0.100 (2' g b h and above) per acre were omitted.

For simplicity reason, only the most abundant region and forest type were mentioned in the following text for each species. Dominant species were referred to those species the population of which was more than the species concerned. Major associates referred to those species which was less abundant than the said species, but more than 0.300 (2' g b h and above) trees per acre. Tree species having the girth less than 6 feet were again omitted here for it was believed to produce no timber of commercial size.

### **Thabye**

#### The Most abundant region

Sagaing division, upper Chindwin region; low indaing forests.

#### Dominant species

In

#### Major associates

Sagat, Thitya, Ingyin, Thitsi, Kanyin, Taunkkyan (*T. alata*),  
Tamalan, Pyinkado and Zinbyun.

## Thadi

### The most abundant region

Sagaing division, Katha region, dry hill forests.

### Dominant species

Kyun and Thit-e

### Major associates

Thabye, In, Ingyin, Tauksha, Zinbyun, Tamalan, Nabe, Pan-swele, Zaungbale-ywet-gyi, Kanyin, Thitsi, Panga, Bambwe, Gwe, Taukkyan (*T. alata*), Thabut-Thein, Sagat, Thitsein, Taung-thayet, Gyo and Thit-linda.

## Nabe

### The most abundant region

Magway division, DUMD Forest.

### Dominant species

Pyinkado, Kyun, Binga, Ingyin, Dahat, Thinwin and Than.

### Major associates

Taukkyan (*T. tomentosa*), Yon, Sha, Chinyok, Thitpagan, Didu, Taukkyan (*T. alata*), Zaungbale, Thitya, Hnaw, Zinbyun, Padauk, Yindaik, Te and Gwe.

## Zaungbale

### The most abundant region

Mandalay division, Meiktila region; MUDM Forests.

### Dominant species

Kyun, Pyinkado, Thinwin, Thadi, Leza and Binga .

### Major associates

Yon, Kyetyo, Thande, Thit-pagan, Ingyin, Chinyok, Gyo, Tayaw, Didu, Thitya, Nabe, Pethan and Taukkyan (*T. alata*).

## Yon

### The most abundant region

Magway division; Thorn forests.

### Major associates

Sagat, Binga, Thitya, Dahat, Hnaw, Thit-sanwin, Thit-payaung, Chinyok, Padauk, Nabe, Letpan and Thitsi.

## Pyinma

### The most abundant region

Rakhine state; LMD forests.

### Major associates

Nagye, Pyinkado, Zinbyun, Nabe, Gwe, Thitsein, Kyetyo, Kanyaung, Taung-thayet, Binga and Tauksha.

## Myauk -ngo

### The most abundant region

Rakhine state; riverine evergreen forests.

### Dominant species.

Taung-thayet, thitpyauk, Kanyaung, Kanyin, Nagye, Taung-thale.

Major associates

Taung-peinne, Thabye, Thitpok, Pyinkado, Pyinma, Thitpyu, Myaukchaw, Binga, Didu, Yengan-bok and Thit-ni.

**Leza**The most abundant region

Bago division; MUMD forests.

Dominant species.

Pyinkado, Kyun, Binga, Thit-pagan, Thadi, Thinwin, Pyinma, Chinyok, Zaungbale, Yon, Myaukchaw, Thande.

Major associates

Gwe, Didu, Myauk-ngo and Thetyingyi.

**Letpan**The most abundant region

Magway division; Thorn forests.

Dominant species.

Thit-e, Kyun, Pyinkado, Ingyin, Taukkyan (*T. alata*), Thinwin, Yon, Sagat, Binga, Thitya, Dahat, Hnaw, Thit-sanwin, Thit-payaung, Chinyok, Padauk and Nabe,

Major associates

Thitsi

**Kuthan**The most abundant region

Magway division; DUMD

Dominant species.

Pyinkado, Kyun, Ingyin, Dahat, Binga, Thinwin, Than, Nabe, Taukkyan (*T. tomentosa*), Yon, Sha, Chinyok, Thit-pagan, Didu, Taukkyan (*T. alata*), Zaungbale, Thitya, Hnaw, Zinbyun, Padauk, Yindaik, Te, Gwe.

**3.2 Results****3.2.1. Kuthan (*Hymenodictyon excelsum* Wall.)**

Rubiaceace

General Features

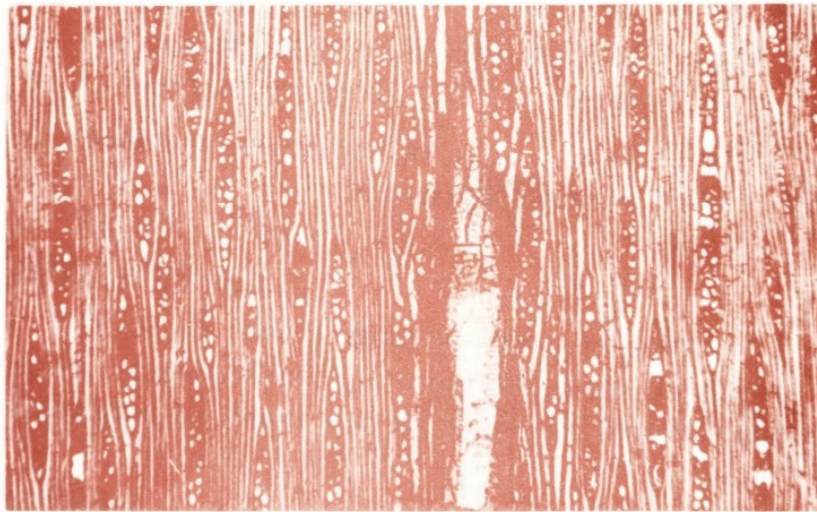
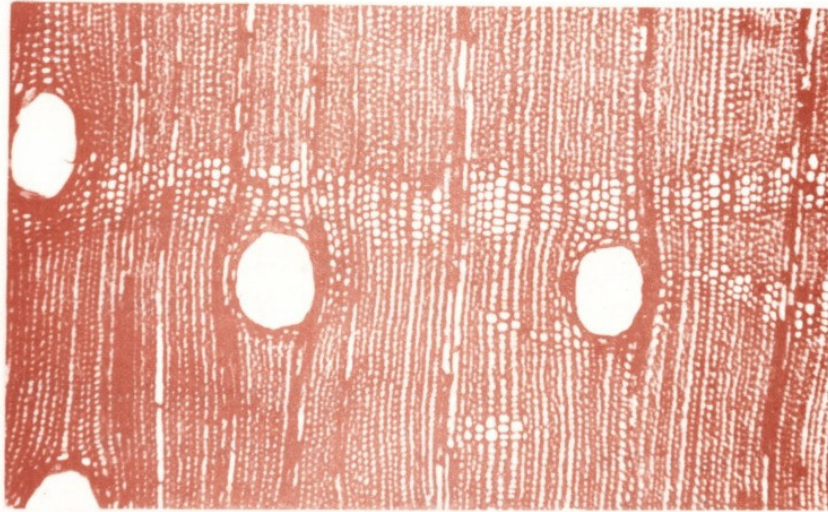
Growth rings distinct but inconspicuous; white to yellowish grey or brownish, straight grained. Texture medium-coarse and even textured.

Microscopic Features

Vessel diffuse, rarely solitary, in short radial multiples, moderately small to moderately large; number per sq. mm, ranges from 6-18 tangential diameter 65-250 um. Fibres non-libriform non-septate. Rays Uniseriate to triseriate, 1-3 cells wide, heterogeneous, number per mm ranges from 6-12. Parenchyma paratracheal, sparse, metatracheal parenchyma abundant.



PLATE I  
KUTHAN (*Hymenodictyon excelsum* Wall.)



Physical properties

Specific Gravity (green)	: 0.38
Density (oven-dried)	: 449 kg m <sup>-3</sup> (28 l b ft <sup>-3</sup> )
Shrinkage- Radial	: 3.9 %
- Tangential	: 6.9 %
Dimensional Stability	: 1.77

Mechanical Properties

Static Bending - MOE	: 9,887 N mm <sup>-2</sup>
- MOR	: 62 N mm <sup>-2</sup>
Compression Strength	
- Perpendicular to Grain	: 4.35 N mm <sup>-2</sup>
- Parallel to Grain	: 28.14 N mm <sup>-2</sup>
Shear Strength - Radial	: 6.01 N mm <sup>-2</sup>
- Tangential	: 6.19 N mm <sup>-2</sup>

Drying behavior

It is an easy timber to dry. No warping, splitting and checking occurred. Free from discoloration or decay and no signs of insect attack.

Durability

Perishable to not durable.

Treatability

Premeable to extremely permeable.

Working properties

It is easy to work in all processes. But the finished surface of boring process is slightly rough. The resistance to splitting when nailed is "good". It does not polish well but it goes well with paints.

**3.2.2. Letpan ( *Salmalia malabarica* (DC) Schoot & End 1.)**

## Bombacaceae

General Features

Growth rings fairly distinct, white, turning pale yellowish-brown, Straight-grained, even and very coarse-textured.

Microscopic Features

Vessel diffuse; solitary or in multiples, moderately large to very large, number per sq. mm ranges from 1-7, tangential diameter ranges from 287-369 um Fibres non-libriform, non-septate. Rays uniseriate to multiseriate, 1-6 cells wide, heterogeneous, number per mm ranges from 3-6. Parenchyma paratracheal, very abundant.

Physical properties

Specific Gravity (green)	: 0.33
Density (air-dried)	: 369 kg m <sup>-3</sup> (23 l b ft <sup>-3</sup> )
Shrinkage- Radial	: 2.3 %
- Tangential	: 5.1 %
Dimensional Stability	: 2.22

Mechanical properties

Static Bending - MOE	: 5,868 N mm <sup>-2</sup>
- MOR	: 42 N mm <sup>-2</sup>
Compression Strength	

- Perpendicular to Grain : 2.90 N mm<sup>-2</sup>
- Parallel to Grain : 24.13 N mm<sup>-2</sup>
- Shear Strength - Radial : 3.93 N mm<sup>-2</sup>
- Tangential : 5.38 N mm<sup>-2</sup>

#### Drying behavior

This timber is easy to dry. It is susceptible to stain and insects. Discoloration also occur in some boards.

The logs should be freshly cut and the lumber should be dried as soon as possible. To avoid the stain and discoloration either solar drying or kiln drying should be done.

The logs should be also debarked soon after felling and cutting to reduce the likelihood of insects attack.

#### Durability

Perishable to not durable, extremely durable under water.

#### Treat ability

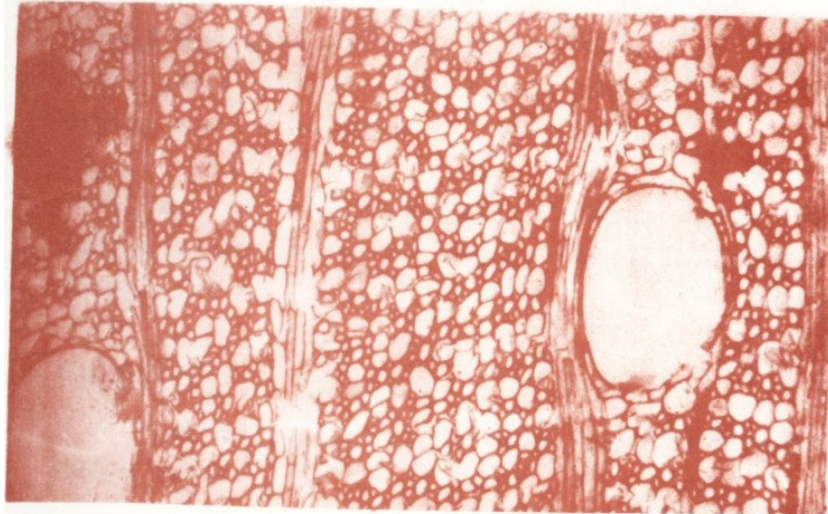
Moderately resistant to resistant.

#### Working properties

It is slightly difficult to saw. Saw teeth become tightly gripped in the wood. Cross cutting is not difficult. Planning, boring and turning processes are easy. The finished surfaces are rough. The resistance to splitting when nailed is " good". It does not polish well.



PLATE II  
LETPAN (*Salmalia malabarica* (D.C) Schott. & Endl.)



### 3.2.3 **Leza (*Lagerstroemia tomentosa* Presl.)**

Lythraceae

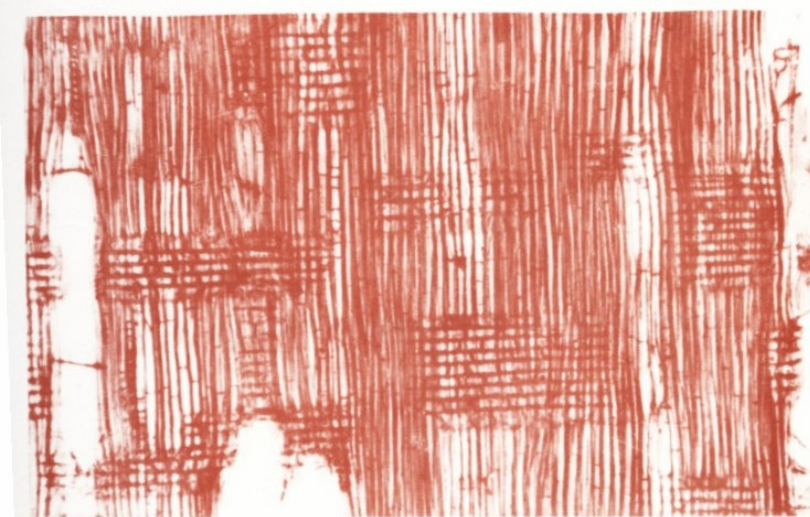
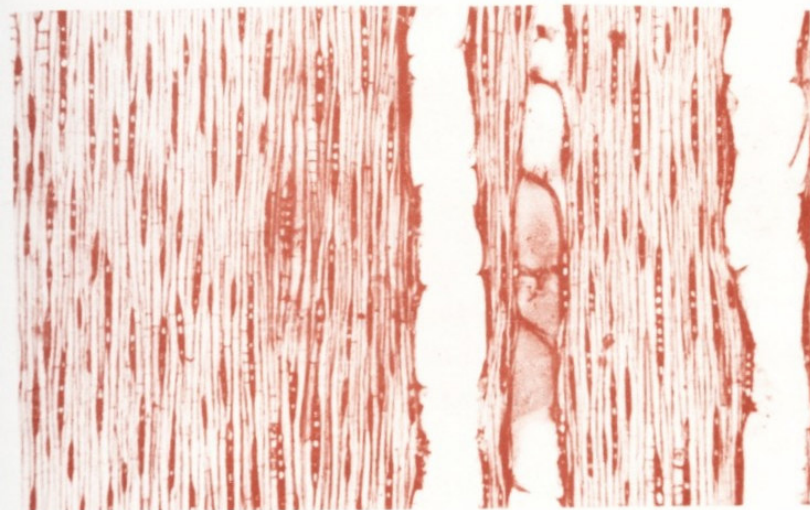
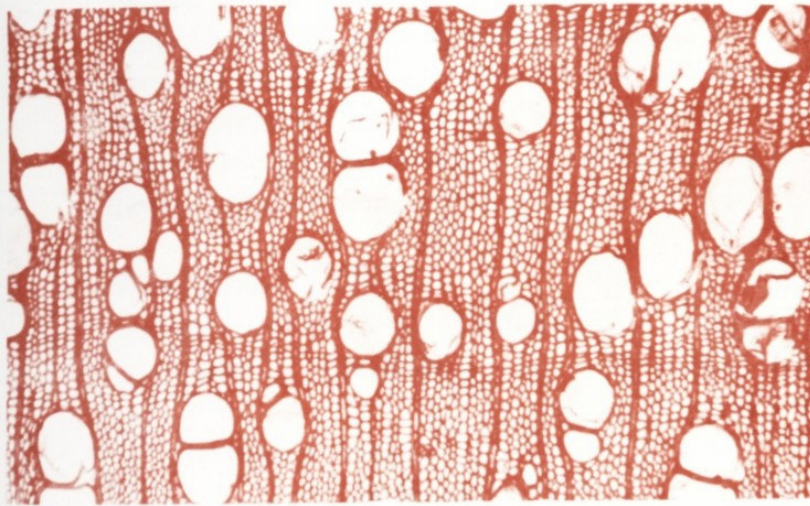
#### General Features

Growth rings distinct, but inconspicuous; sapwood yellowish-grey heartwood uniformly grey to brownish grey of light greyish brown; straight-grained; Even-textured. Pith flecks occasionally present.

#### Microscopic Features

Vessel diffuse, solitary, multiples and pore clusters; very small to medium-sized, number per sq. mm ranges from 8-23, tangential diameter ranges from 31-195  $\mu$ m. Fibres non-l libriform, non-septate. Rays uniseriate to tetraseriate, 1-4 cells wide, heterogeneous, number per mm range from 10-17. Parenchyma, paratracheal, confluent, 1-6 seriate bands unitary some of the vessels.

PLATE III  
LEZA (*Lagerstroemia tomentosa* Presl.)





Physical properties

Specific Gravity (green)	: 0.52
Density (air-dried)	: 673 kg m <sup>-3</sup> (42 l b ft <sup>-3</sup> )
Shrinkage- Radial	: 4.2 %
- Tangential	: 6.4 %
Dimensional Stability	: 1.52

Mechanical properties

Static Bending - MOE	: 13,376 N mm <sup>-2</sup>
- MOR	: 91 N mm <sup>-2</sup>
Compression Strength	
- Perpendicular to Grain	: 8.58 N mm <sup>-2</sup>
- Parallel to Grain	: 49.26 N mm <sup>-2</sup>
Shear Strength - Radial	: 9.07 N mm <sup>-2</sup>
- Tangential	: 9.14 N mm <sup>-2</sup>

Drying behavior

Only slight surface checking, splitting and warping. No signs of insect attack and free from discoloration or decay.

Durability

Fairly durable.

Treatability

Moderately resistant to resistant.

Working properties

It is easy to work in all aspects. The resulting surfaces of planning, boring and turning processes are smooth. The resistance to splitting when nailed is " slightly poor".

### 3.2.4. **Myauk-ngo ( *Duabanga grandiflora* ( Roxb )**

Lythraceae

General Features

Growth rings distinct, but inconspicuous; pale yellowish grey or grey often streaked or tinted with yellow to light brown, straight or shallowly interlocked-grained or many grained; very coarse-texture. Tyloses abundant.

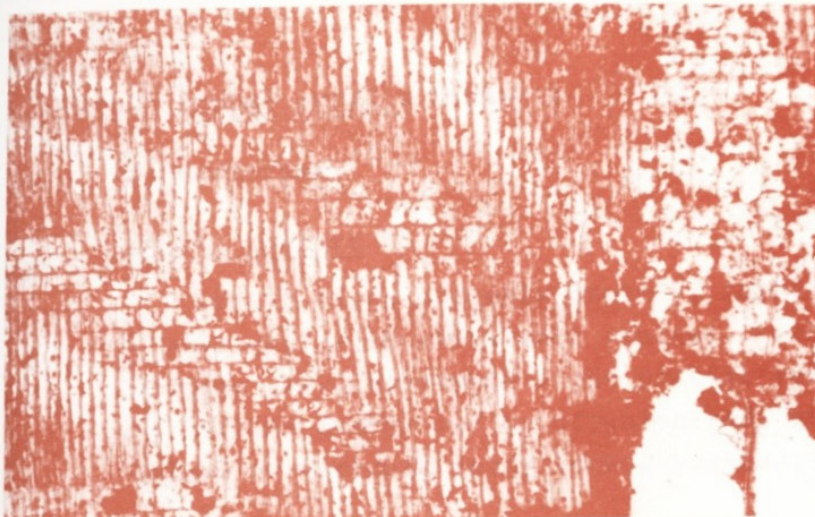
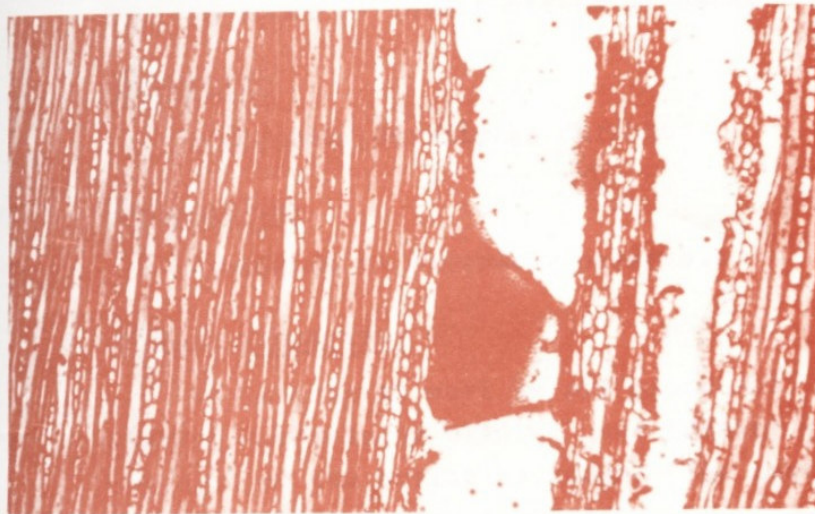
Microscopic Features

Vessel diffuse, solitary, in multiples or in clusters; moderately small to very large, number per sq. mm ranges from 2-10, tangential diameter ranges from 60-325 um. Fibres non-libriform, non-septate. Rays uniseriate to triseriate, 1-3 cells wide, heterogeneous, number per mm. ranges from 8-19. Parenchyma abundant, apotracheal parenchyma diffuse, scattered to continuous bands of 1-2 cells wide; paratracheal parenchyma typically vasicentric, scanty.

Physical properties

Specific Gravity (green)	: 0.43
Density (air-dried)	: 433 kg m <sup>-3</sup> (27 l b ft <sup>-3</sup> )
Shrinkage- Radial	: 3.7 %
- Tangential	: 6.6 %
Dimensional Stability	: 1.79

PLATE IV  
MYAUKNGO (*Duabanga grandiflora* (Roxb.) Walp.)





Mechanical properties

Static Bending - MOE	: 8,281 N mm <sup>-2</sup>
MOR	: 68 N mm <sup>-2</sup>
Compression Strength	
- Perpendicular to Grain	: 3.56 N mm <sup>-2</sup>
- Parallel to Grain	: 38.01 N mm <sup>-2</sup>
Shear Strength - Radial	: 6.43 N mm <sup>-2</sup>
- Tangential	: 8.53 N mm <sup>-2</sup>

Drying behavior

It is easy to dry. Slight splitting and checking at knots. Slight discoloration is occurred. No signs of insect attack or decay.

Durability

Moderately durable to durable

Treatability

Permeable to extremely permeable

Working properties

It is easy to work in all processes. The resulting surfaces of planing and turning are smooth but that of the boring is rough. The resistance to splitting when nailed is " good".

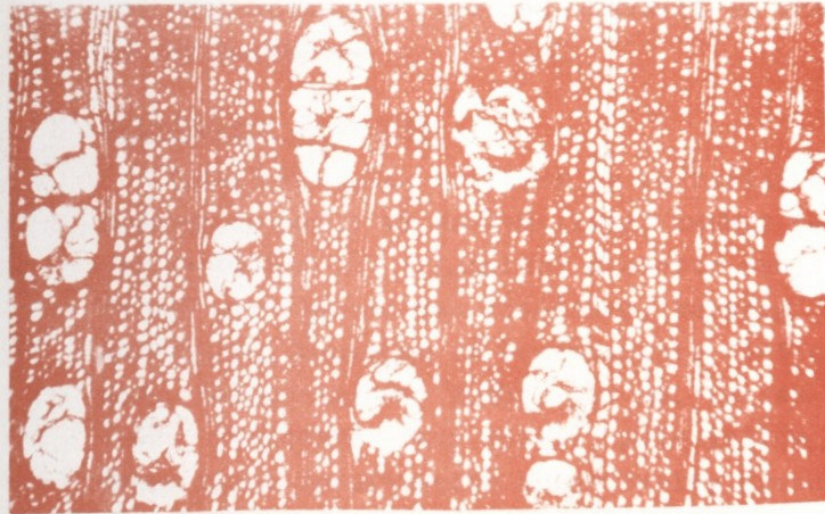
**3.2.5. Nabe (*Lannea grandis* Engler.)**

.....  
Anacardiaceae

General Feature

Growth rings scarcely present; sapwood white or pale yellowish-white when exposed, turning light brownish grey; heartwood light pinkish-red to light red turning darker-red or brownish-red; straight-grained or narrowly inter locked-grained; Medium and even-textured. Tyloses abundant in the vessels of the heartwood.

PLATE V  
NABE (*Lannea grandis* Engler.)



Microscopic Features

Vessel diffuse; solitary or in radial multiples; moderately small to medium-sized; number per sq. mm ranges from 6-15; tangential diameter ranges from 90-180  $\mu\text{m}$ . Fibres non-libriform, septate. Rays uniseriate, biseriate to pentaseriate, 1-5 cells wide, heterogeneous, number per mm. ranges from 4-12. Parenchyma very sparse, pale yellow or orange-brown gummy infiltration occasionally present in all types of parenchyma.

Physical properties

Specific Gravity (green)	: 0.50
Density (air-dried)	: $577 \text{ kg m}^{-3}$ ( $36 \text{ lb ft}^{-3}$ )
Shrinkage- Radial	: 3.0 %
- Tangential	: 5.4 %
Dimensional Stability	: 1.80

Mechanical properties

Static Bending - MOE	: $6,481 \text{ N mm}^{-2}$
- MOR	: $56 \text{ N mm}^{-2}$
Compression Strength	
- Perpendicular to Grain	: $5.83 \text{ N mm}^{-2}$
- Parallel to Grain	: $26.24 \text{ N mm}^{-2}$
Shear Strength - Radial	: $6.58 \text{ N mm}^{-2}$
- Tangential	: $8.10 \text{ N mm}^{-2}$

Drying behavior

This timber is very slow to dry, there is a great difficulty in drying. This is due to the presence of gummy infiltration in the parenchyma.

Durability

moderately durable to durable.

Treatability

Extremely resistant.

Working properties.

It is easy to saw and cross cut. Planing, boring and turning processes are also easy. The resulting surface smooth. The resistance to splitting when nailed is " poor".

**3.2.6. *Pyinma (Lagerstroemia speciosa Pers.)***LythraceaeGeneral Features

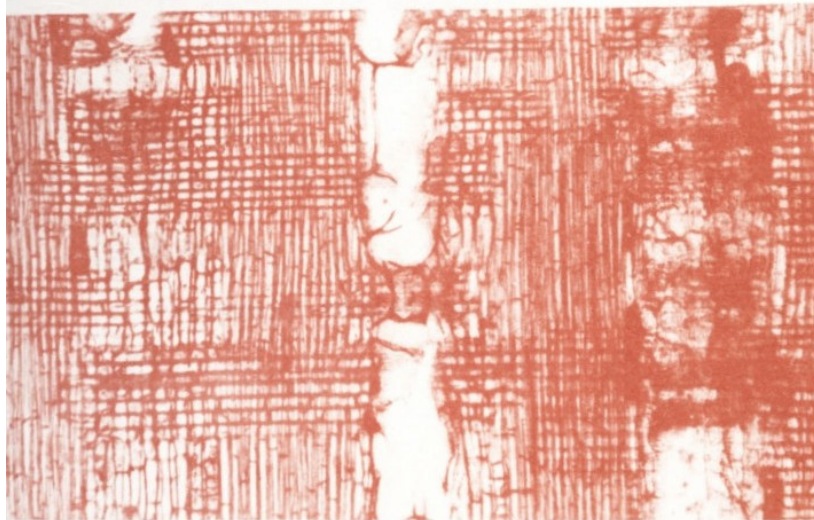
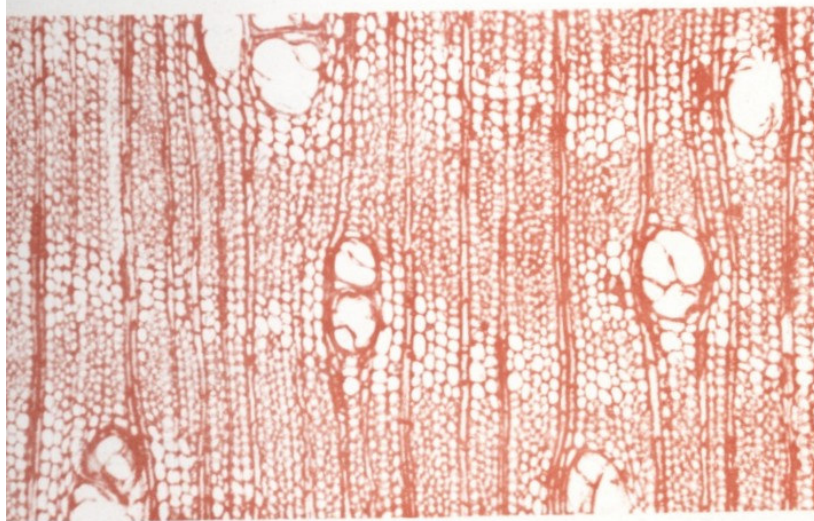
Growth rings generally distinct but inconspicuous; sapwood greyish white to pale roseate white; heartwood light red to reddish-brown, straight or occasionally wavy-grained, medium coarse-textured. High tylosic content, difficult to treat with preservatives.

Microscopic Features

Vessel diffuse; solitary and in radial multiples; medium sized to moderately large, number per sq. mm. ranges from 2-12, tangential diameter ranges from 105-300  $\mu\text{m}$ . Fibers non-libriform to semi-libriform, septate, the compartments frequently divided by 3-4 transverse septae into locules containing solitary crystals. Rays uniseriate to tetraseriate, 1-4 cells wide, homogeneous, number per mm. ranges from 4-12 parenchyma abundant, metatracheal or confluent- parenchyma from bands of 2 cells wide, expands in typical diagonal bands from pith to pore.



PLATE VI  
PYINMA (*Lagerstroemia speciosa* Pers.)



Physical properties

Specific Gravity (green)	: 0.52
Density (air-dried)	: 609 kg m <sup>-3</sup> (38 l b ft <sup>-3</sup> )
Shrinkage- Radial	: 4.4 %
- Tangential	: 6.8 %
Dimensional Stability	: 1.55

Mechanical properties

Static Bending - MOE	: 10,577 N mm <sup>-2</sup>
- MOR	: 91 N mm <sup>-2</sup>
Compression Strength	
- Perpendicular to Grain	: 9.55 N mm <sup>-2</sup>
- Parallel to Grain	: 49.98 N mm <sup>-2</sup>
Shear Strength - Radial	: 9.58 N mm <sup>-2</sup>
- Tangential	: 11.62 N mm <sup>-2</sup>

Drying behavior

Slight surface checking and splitting, but a marked tendency to warp and twist. No discoloration, insect attack or decay.

To reduce the warping and twisting, over-loading the lumber pile should be carefully done.

Durability

durable to very durable.

Treatability

Extremely resistant.

Working properties

This timber is slightly difficult to saw and cross-cut. Planning is also slightly difficult. The finished surface are smooth. The resistance to splitting when nailed is "poor". It does not polish well.

**3.2.7. Thabye (*Eugenia jambolana* Lamk.)**

Myrtaceae

General Features

Growth rings scarcely distinct, pale reddish grey to brownish grey, more or less irregular-grained and frequently interlocked-grained or wavy-grained; medium coarse-textures.

Microscopic Features

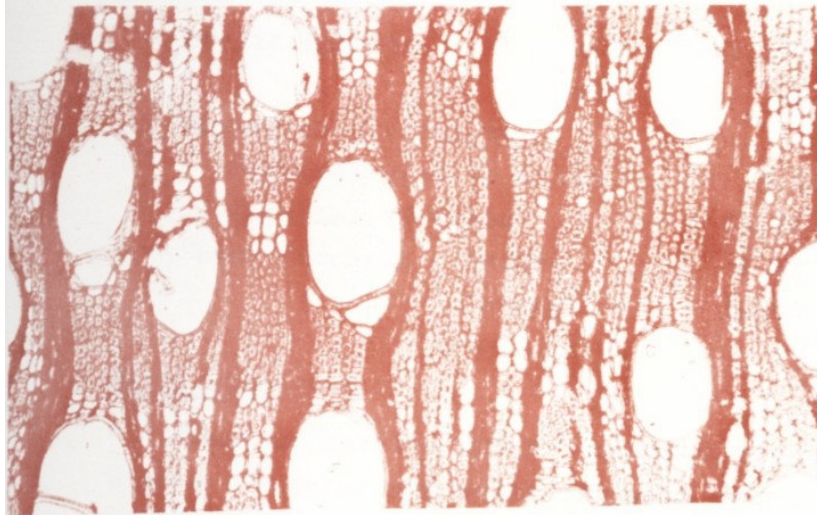
Vessel diffuse, solitary or in radial multiples; medium-sized to moderately large, number per sq. mm. ranges from 6-12, tangential diameter ranges from 105-275 um; Fibers semi-libriform, non-septate, rarely septate. Rays uniseriate to tetraseriate, 1- 4 cells wide, heterogeneous; number per mm. ranges from 8-14. Paratracheal parenchyma relatively sparse, metatracheal parenchyma fairly abundant; orange brown gummy infiltration fairly abundant in all types of parenchyma.

Physical properties

Specific Gravity (green)	: 0.68
Density (air-dried)	: 769 kg m <sup>-3</sup> (48 l b ft <sup>-3</sup> )
Shrinkage- Radial	: 4.5 %
- Tangential	: 7.8 %
Dimensional Stability	: 1.73



PLATE VII  
THABYE (*Eugenia jambolana* Lamk.)



Mechanical properties

Static Bending - MOE	: 12,597 N mm <sup>-2</sup>
- MOR	: 95 N mm <sup>-2</sup>
Compression Strength	
- Perpendicular to Grain	: 9.80 N mm <sup>-2</sup>
- Parallel to Grain	: 58.22 N mm <sup>-2</sup>
Shear Strength - Radial	: 9.62 N mm <sup>-2</sup>
- Tangential	: 11.48 N mm <sup>-2</sup>

Drying behavior

Numerous surface checks occurred during air-drying. Warping and splitting were found in some boards. Cup and twist not marked No discoloration, decay or insect attack.

Air-drying (under shed) during November to April is recommended. It should be Started in November to reduce the severe drying defects.

Durability

Not durable.

Treatability

Permeable to moderately resistant.

Working properties

This timber is not difficult to saw and crosscut . It is slightly difficult in planing and turning. The finished surface are not smooth. In boring it is not difficult and the resulting surfaces smooth. The resistance to splitting when nailed is "good".

**3.2.8. Thadi (*protium serrata* Engler.)**

Burseraceae

General Features

Growth rings distinct but inconspicuous; sap-wood light brown, heartwood bright red, turning brick-red or dull brown, interlocked-grained and frequently wavy-grained, even and medium-textured. Tyloses very abundant.

Microscopic Features

Vessel diffuse, solitary or in radial pore multiples of 2-6, moderately small to medium-sized, number per sq. mm. 14-28; tangential diameter ranges from 61-184 um. Fibres non-libriform, septate. Rays uniseriate to multiseriate, mostly uniseriate to biseriate, 1-2 cells wide, heterogeneous, number per mm. 5-10. Paratracheal parenchyma very sparse, reddish-brown organic infiltration copious, completely occluding some cells.

Physical properties

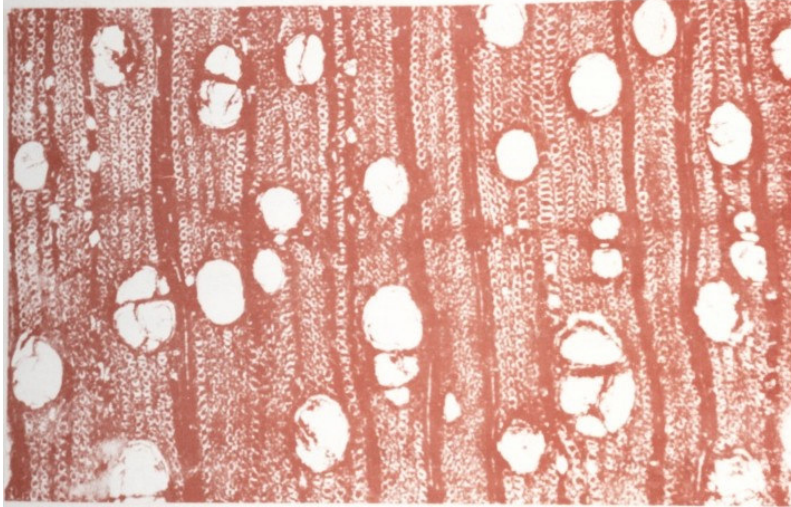
Specific Gravity (green)	: 0.71
Density (oven-dried)	: 817 kg m <sup>-3</sup> (51 lb ft <sup>-3</sup> )
Shrinkage- Radial	: 5.4 %
- Tangential	: 8.9 %
Dimensional Stability	: 1.65

Mechanical properties

Static Bending - MOE	: 11,749 N mm <sup>-2</sup>
- MOR	: 96 N mm <sup>-2</sup>
Compression Strength	
- Perpendicular to Grain	: 12.02 N mm <sup>-2</sup>
- Parallel to Grain	: 41.92 N mm <sup>-2</sup>
Shear Strength - Radial	: 9.49 N mm <sup>-2</sup>
- Tangential	: 10.60 N mm <sup>-2</sup>



PLATE VIII  
THADI (*Protium serrata* Engler.)





Drying behavior

Surface checks occurred during air drying and the cracks being numerous, small and inconspicuous. Although end-splitting was not prominent, generally this timber should be regarded as a refractory timber. The sapwood is found to be susceptible to insect attack.

Air- drying should be started at the beginning of the winter time (i.e Nov.) when the Restive Humidity (R.H) is not too low and it should be stopped at the end of summer (i.e April).

Durability

Moderately durable to durable.

Treatability

Extremely resistant

Working properties

Thadi is easy to saw and cross cut. Planning, boring and turning processes are not difficult and the result surface smooth. The resistance to splitting when nailed is "poor".

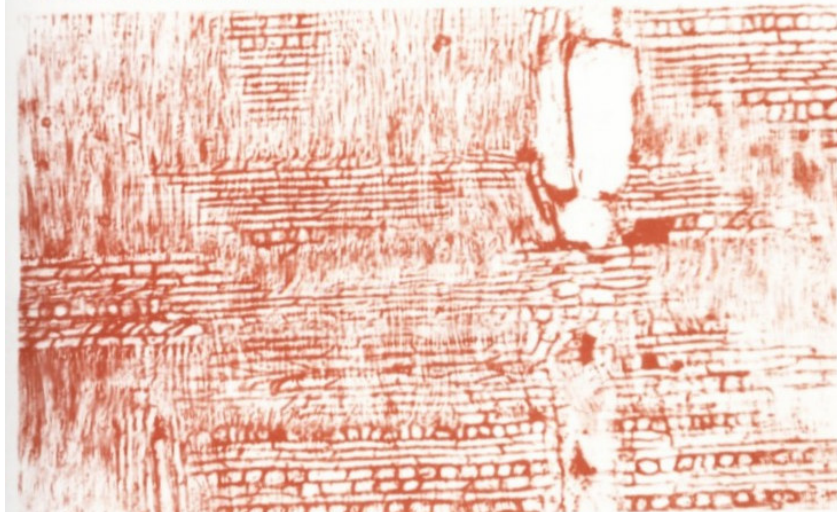
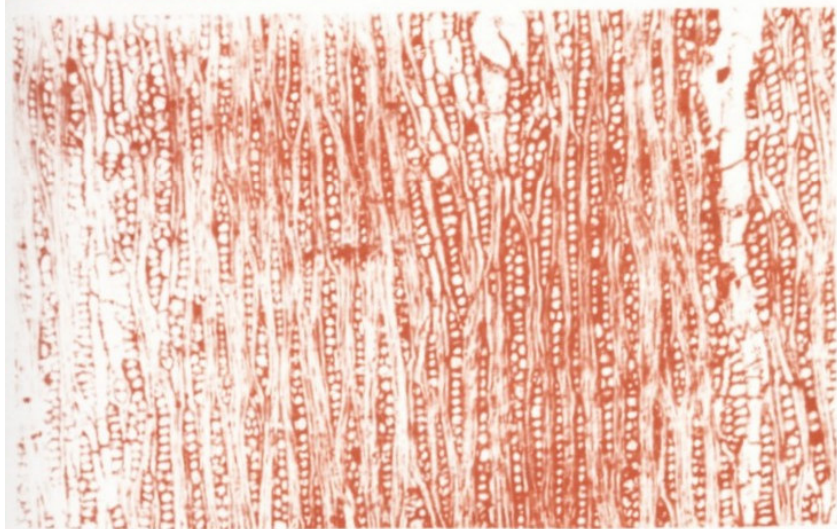
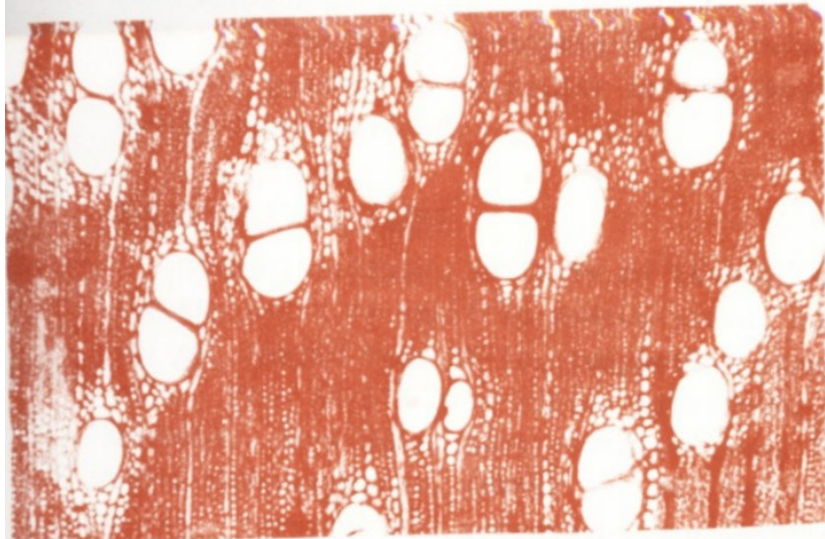
**3.2.9. Yon (*Anogeissus acuminata* Wall.)**

Comgbretaceae

General Features

Growth rings present but inconspicuous; sap-wood light whitish grey to pale greenish grey often with light grey bands, turning light greyish-brown with age; heartwood chocolate-brown; fairly straight grained to irregular interlocked-grained, medium fine-textured.

PLATE IX  
YON (*Anogeissus acuminata* Wall.)



Microscopic Features

Vessel diffuse, solitary or in multiples, extremely small or small to medium-sized, number per sq. mm. ranges from 13-40, tangential diameter ranges from 30-175  $\mu\text{m}$ . Fibres libriform, non-septate. Rays uniseriate to triseriate, 1-3 cells wide, heterogeneous, number per mm. ranges from 15-18. Paratracheal parenchyma abundant, confluent parenchyma uniting 2 several adjacent group of vessels but never forming definite tangential bands; terminal parenchyma inconspicuous, sometimes interrupted.

Physical properties

Specific Gravity (green)	: 0.74
Density (air-dried)	: $881 \text{ kg m}^{-3}$ (55 lb ft <sup>-3</sup> )
Shrinkage- Radial	: 4.2 %
- Tangential	: 8.1 %
Dimensional Stability	: 1.93

Mechanical properties

Static Bending - MOE	: $14,990 \text{ N mm}^{-2}$
- MOR	: $133 \text{ N mm}^{-2}$
Compression Strength	
- Perpendicular to Grain	: $15.41 \text{ N mm}^{-2}$
- Parallel to Grain	: $64.98 \text{ N mm}^{-2}$
Shear Strength - Radial	: $14.34 \text{ N mm}^{-2}$
- Tangential	: $17.41 \text{ N mm}^{-2}$

Drying behavior

Severe surface checking, splitting and warping. Surface checks and splits most pronounced in samples put down in the dry weather. No discoloration, decay or insect attack.

To reduce the severe drying defects, air-drying should be started during the rainy season when the relative humidity is high.

Air-drying proceeded by kiln-drying is full recommended.

Durability

Non-durable to moderately durable.

Permeability

Permeable to moderately resistant.

Working properties

Wood is difficult to saw and cross cut. It is difficult to plane but difficult to bore and turn. The resistant to splitting when nailed is "good".

**3.2.10. Zaungbale ( *Lagerstroemia villosa* Wall.)**

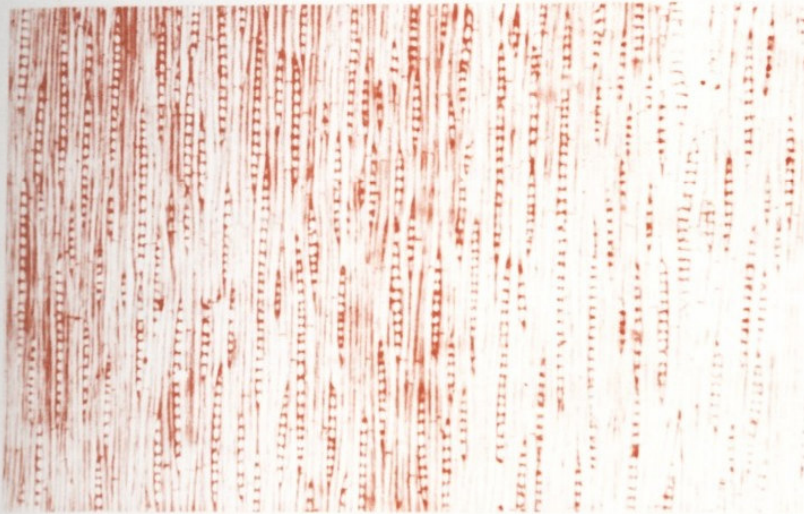
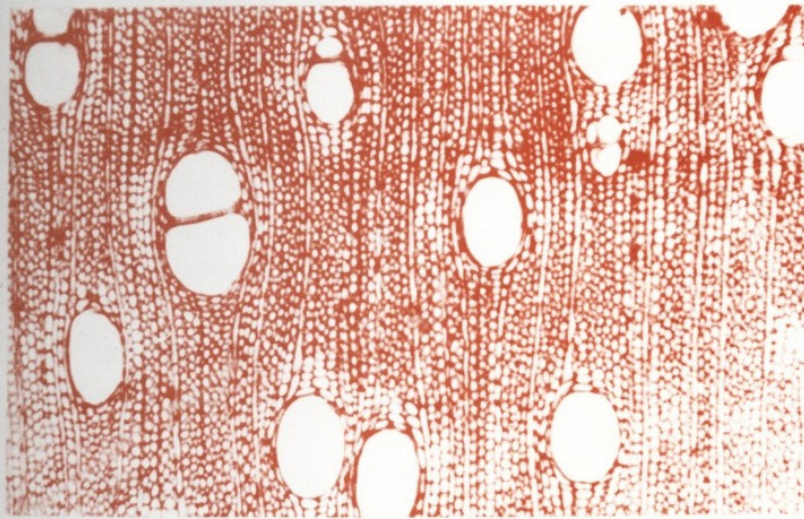
.....  
Lythraceae

General Features

Growth rings generally distinct but inconspicuous; pale brownish grey to brownish-grey; straight-grained; fine and even textured to medium coarse-textured.



PLATE X  
ZAUNGBALE (*Lagerstroemia villosa* Wall.)



Microscopic Features

Vessel diffuse, solitary or as radial pore multiples of 2-5 or clusters; extremely small to moderate-sized; number per sq. mm. ranges from 5-23; tangential diameter ranges from 21-154  $\mu\text{m}$ . Fibres non-libriform, non-septate. Rays uniseriate, cell wide homogeneous, number per mm. ranges from 3-5. Paratracheal parenchyma fairly abundant; 4-8 seriate bands uniting some of the vessels; occasionally interrupted bands.

Physical properties

Specific Gravity (green)	: 0.61
Density (air-dried)	: $721 \text{ kg m}^{-3}$ (45 l b ft <sup>-3</sup> )
Shrinkage- Radial	: 4.2 %
- Tangential	: 7.6 %
Dimensional Stability	: 1.81

Mechanical properties

Static Bending - MOE	: $13,776 \text{ N mm}^{-2}$
- MOR	: $99 \text{ N mm}^{-2}$
Compression Strength	
- Perpendicular to Grain	: $7.17 \text{ N mm}^{-2}$
- Parallel to Grain	: $53.68 \text{ N mm}^{-2}$
Shear Strength - Radial	: $9.69 \text{ N mm}^{-2}$
- Tangential	: $9.85 \text{ N mm}^{-2}$

Drying behavior

This timber is easy to dry. No surface checks and warps but easy to split. Free from discoloration or decay and no sings of insect attack.

Durability

Not durable to moderately durable.

Treatability

Moderately resistant to resistant.

Working properties

It is difficult to cross-cut. It is easy in planing and turning. It tends to split in boring. The resistance to splitting when nailed is "poor".

## 4. Discussion

For the purpose of compansion, physical and mechanical properties of some of the commercially accepted Myanmar species are given in Appendix (3). Out of the tested ten species, strength properties of Thabye, Thadi, Pyinma and Laza are almost similar to those of In and Kanyin which are already accepted as the construction timbers. Therefore, these timbers canbe used as construction timbers. It can also be seen that, properties of Yon are almost identical to Padauk where as properties of Zaungbale is superior to those of In, Kayyin and Kyun. Thus, Yon and Zaungbale can be used as heavy construction timbers when treated with preservative. According to their grain patterns and strength properties Yon, Thabye, Thadi and Pyinma can also be used as sleepers after preservative treatments. Yon is also very good for use as handless for hammer and tools.

Laze is also good for marking furniture because of its color and feature, dimensional stability and working properties.

Properties of Nabe; Myauk-ngo and Kuthan are similar to those of Yemane and Sagawa. Thus these timbers can be used as light construction timber such as

walling and ceiling. Because of low values of shrinkage and dimensional stability, these can also be suitable as low-cost furniture.

Table 1. Proposed end-uses of the ten commercially Less-acceptable species.

Proposed end-uses	Species	Remark
Construction	Thabye Thadi Pyima Leza	Preservative treatment required for external uses
Heavy Construction	Yon	
Light Construction	Nabe Myauk-ngo Kuthan Letpan	
Sleeper	Yon Thabye	Require preservative treatment
Veneer	Leza Nabe	
Veneer	Myauk-ngo Kuthan	
Packing cases & Furniture	Letpan Leza Nabe Myauk-ngo Kuthan	

These timbers are also good for making boxes. Painted by paints such as enamel paint, is preferable to polish. Kuthan is also good for carving. However, it is not as good as Yemane.

Leza, Nabe, Myauk-ngo and Kuthan will be also suitable for marking plywood.

According to its low strength values, letpan is only suitable for making cheep boxes and packing cases. It can also be suitable for ceiling and walling after treatment.

The following table show the summerized statement of the end-uses of the species concerned.

## 5. Conclusion

Although annual exploitation of teak is, more or less, equal to the annual allowable cut (AAC), production of hardwood is always far below the AAC. However, extraction of commercially important species might go beyond the prescribed capacity. The result is the accumulation of non-commercial species in the forest. In order to fully utilize the forest resources, every effort should be made to make these low value species marketable. The process of getting permission to extract such commercially less-acceptable species be made much easier.

Royalty levied on the extraction of such timber should be adjusted so as to make extraction of the low value timber feasible. Proper treatment be given so that the quality of timber become acceptable. More research work id yet to be done for the remaining non-commercial species having enough stock for regular consumption.

## Appendix (i)

Export earning by timber trade.

Year	Export earning by (Kyats in million)		Percent timber export
	Total	Timber	
1981-82	3462.9	805.8	23.3
1982-83	3036.3	729.6	24.0
1983-84	3419.5	980.4	28.7
1984-85	3194.5	1016.7	31.8
1985-86	2653.9	1070.0	40.3
1986-87	2513.9	851.2	33.9
1987-88	1679.4	883.1	52.6

## Appendix (ii)

percentage of standing trees(2' gbh &amp; above) of commercially important timbers 8

Species	(%)
Kyun	6.21
pyinkado	5.65
Padauk	0.57
Thitya	3.50
Ingyin	4.92
Tamalan	0.85
In	8.77
Kanyin	2.84
Thinwin	1.72
Taung-thyet	0.65
Hnaw	0.51
Total	36.19

## Physical and mechanical properties (Air-Dried) of Some Commercial Myanmar Timbers.

Sr. No.	Species	Botanical Name	Sp. Gr (green)	Shrinkage green to oven dry		Static Bending		Compression Strength		Shear Strength	
				Radial (%)	Tangential (%)	MOE	MOR	Perpendicular (N/ mm <sup>2</sup> )	Parallel (N/ mm <sup>2</sup> )	Radial (N/ mm <sup>2</sup> )	Tangential (N/ mm <sup>2</sup> )
1.	Thitya	<i>Shorea oblongitolia</i>	0.858	5.4	9.7	19416	158	18.49	76	14.96	13.76
2.	Pyinkado	<i>Xylia dolabriformis</i>	0.779	3.3	6.7	17444	142	15.24	79	14.69	16.00
3.	Ingyin	<i>Pentacme siamensis</i>	0.779	4.8	8.9	15707	111	10.41	54	12.10	12.65
4.	Padauk	<i>Pterocarpus macrocarpus</i>	0.752	3.4	5.1	14321	142	19.20	75	12.48	11.31
5.	In	<i>Dipterocarpus tuberculatus</i>	0.726	4.4	9.1	13542	96	6.21	47	9.52	11.03
6.	Kyun	<i>Tectona grandis</i>	0.598	2.3	4.2	12535	96	9.69	54	8.41	9.76
7.	Kanyin	<i>Dipterocarpus alatus</i>	0.574	3.6	8.6	13073	86	6.07	45	8.69	10.24
8.	Yemane	<i>Gmelina arborea</i>	0.419	-	-	8874	65	4.72	33	7.14	7.24
9.	Sagawa	<i>Michelia champaca</i>	0.426	3.2	5.2	9563	64	6.79	44	7.38	8.45



## Distribution of Tree Species by Forest Types and Regions

Species	Region	Forest Type	Average number of trees/acre
Thabye	Sagaing division Upper Chindwin Region Rakine	Low indaing	4.734
		High indaing	2.980
		MUMD	2.289
		Typical evergreen	4.072
		Giant evergreen	1.075
		Riverine evergreen	0.916
		MUMD	0.462
		DUMD	0.430
		LMD	0.294
		Bamboo	0.100
	Sagaing division Lower Chindwin region	Hill evergreen	3.392
		High indaing	1.410
		MUMD	1.119
		LUD	1.077
		Low indiang	0.875
	Sagaing division Katha region	DUMD	0.521
		Hill evergreen	2.187
		Dry hill	1.977
		Typical evergreen	1.682
		DUMD	1.535
		High indaing	1.108
		MUMD	0.994
		LMD	0.777

Species	Region	Forest Type	Average number of trees/acre
Thadi	Sagaing division Katha Region	Dry hill	2.116
		DUMD	1.951
		MUMD	1.839
		LMD	1.519
		Typical evergreen	1.031
		High indaing	0.672
	Sagaing division Upper Chindwin region	MUMD	1.359
		iant evergreen	0.967
		LMD	0.744
	Chindwin region	DUMD	0.717
		Riverine evergreen	0.449
		High indiang	0.240
		Low indiang	0.172
		MUMD	1.283
	Sagaiong division Lower Chindwin region	LMD	0.881
		DUMD	0.513
	Madalay division Pyin-Oo-Lwin region	MUMD	1.142
		LMD	0.589
	Pyin-Oo-Lwin region	DUMD	0.436
		High indaing	0.265
		Hill evergreen	0.211
		Low indaing	0.149
		MUMD	0.768
		DUMD	0.493
		LMD	0.366
	Mandalay division Meiktila region	High indaing	0.240
		MUMD	0.647
		LMD	0.373
	Bago division	Typical evergreen	0.208
		DUMD	0.197

Species	Region	Forest Type	Average number of trees/acre
Nabe	Magway division	DUMD	0.880
		LMD	0.558
		Than-dahat	0.529
		Thorn	0.436
		High indaing	0.420
	Bago division	DUMD	0.716
		MUMD	0.295
		LMD	0.259
	Ayeyarwaddy division	DUMD	0.489
		MUMD	0.418
Yon	Magway division	Thron	0.873
		MUMD	0.854
		DUMD	0.803
		LMD	0.654
		Than-dahat	0.469
		Low indaing	0.166
		LMD	0.794
	Mandalay division	MUMD	0.631
		DUMD	0.529
	Meiktila region		
	Mandalay division	LMD	0.791
Yon	Bago division	MUMD	0.754
		DUMD	0.472
Yon	Bago division	DUMD	0.606
		MUMD	0.488
Pyinma	Rakhine state	LMD	1.612
		Giant evergreen	1.085
		MUMD	0.782
		Riverine	0.651
		evergreen	

Species	Region	Forest Type	Average number of trees/acre
	Bago division	DUMD	0.511
		Typical evergreen	0.369
		Bamboo Forests	1.323
		Typical evergreen	0.716
		LMD	0.639
		MUMD	0.619
	Yangon division	DUMD	0.412
		MUMD	1.142
		DUMD	0.878
		Typical evergreen	0.588
		LMD	0.405
Zaungbale	Mandalay division	MUMD	0.657
		LMD	0.489
		DUMD	0.268
	Meiktila region		
	Bago division	MUMD	0.518
		LMD	0.332
		DUMD	0.320
		Typical evergreen	0.203
	Magway division	UMD	0.474
		DUMD	0.453
		LMD	0.252
	Mandalay division	MUMD	0.381
		DUMD	0.361
	Pyin- Oo- Lwin region		

Species	Region	Forest Type	Average number of trees/acre
Myauk-ngo	Rakhine state	Riverine evergreen	1.136
		MUMD	0.388
		LMD	0.195
		Typical evergreen	0.127
	Sagaing division Katha region Bago division	Typical evergreen	0.451
		MUMD	0.333
		LMD	0.219
		Typical evergreen	0.141
Leza	Bago division	MUMD	0.419
		LMD	0.334
		Typical evergreen	0.146
Letpan	Magway division	Thorn	0.393
		DUMD	0.167
		MUMD	0.161
		LMD	0.139
Kuthan	Magway division	DUMD	0.205
		Thorn	0.171
		MUMD	0.150
	Mandalay division Meiktila region	MUMD	0.176
		DUMD	0.137

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