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**COMPARATIVE MORPHOLOGY and WOOD ANATOMY of
Acacia arabica (Lam.) Willd. and TWO VARIETIES of
A. leucophloea (Roxb.) Willd.**

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Summary

A study on morphology and wood anatomy of *Acacia arabica* (Lam.) Willd. and two varieties of *A. leucophloea* (Roxb.) Willd. growing wild throughout central Myanmar has been made. Morphology of the vegetative and reproductive organs, and anatomy of the sapwood of these species have been studied.

The species studied in this research are :

1. *A. arabica* (Lam.) Willd. (Subyu), and
2. *A. Leucophloea* (Roxb.) Willd. var. (1) and (2) (Hta-naung),

The outstanding characteristics of the species, important botanical observation and their uses are described, compared and discussed.

ဆူးဖြူပင်နှင့်ထနောင်းပင်မျိုးပြား(၂)မျိုးတို့၏ပြင်ပရုပ်သွင်နှင့်သစ်အင်္ဂါဗေဒကို
နှိုင်းယှဉ်လေ့လာခြင်း

ဒေါ်ခင်နီလာစန်း M.Sc (Mdy.)
သရုပ်ပြ၊ ရုက္ခဗေဒဌာန၊ ရတနာပုံတက္ကသိုလ်၊ မန္တလေး
နှင့်
ဦးစိုးမြင့် M.Sc (Rgn.)
ဒုတိယပါမောက္ခချုပ်၊ ပခုက္ကူတက္ကသိုလ်၊ ပခုက္ကူ

စာတမ်းအကျဉ်း

မြန်မာနိုင်ငံအလယ်ပိုင်းတွင်ပေါက်ရောက်သောဆူးဖြူပင် (*Acacia arabica* (Lam.) Willd.နှင့်ထနောင်းပင် (*A.leucophloea* (Roxb.) Willd.)၏ မျိုးပြား(၂)မျိုးတို့၏ ပြင်ပရုပ်သွင်နှင့်ခန္ဓာဗေဒတို့ကိုလေ့လာတင်ပြထားပါသည်။ ပင်ပိုင်းနှင့်မျိုးပွားအင်္ဂါပိုင်းတို့၏ ပြင်ပလက္ခဏာနှင့်သစ်အင်္ဂါပိုင်း၏သစ်အင်္ဂါဗေဒတို့ကို လေ့လာ၍ ထင်ရှားသောလက္ခဏာများနှင့် အရေးပါသောအချက်အလက်တို့ကို တင်ပြနှိုင်းယှဉ်ဆွေးနွေး ထားပါသည်။

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1. INTRODUCTION

The genus *Acacia* is widely and abundantly distributed especially in central Myanmar and its many species are well known for their gums and some are used in medicine. Cutch, the source of a dye, is the most important gum and a lot of tons of its wood had been exploited annually by the factory of central Myanmar in the pre-war time.

A few available literature showed that morphology of some species of the genus *Acacia* had been described by many researchers in their studies on regional flora of Myanmar, and anatomy of their heartwood of the stems of some species had also been recently studied by some workers. However, the varieties of *Acacia leucophloea* (Roxb.) Willd. had not been described in their studies except in a few case.

In this work, *A. arabica* (Lam.) Willd. (Su-byu) and the two varieties of *A. leucophloea* (Roxb.) Willd. (Hta-naung) had been studied. Their inflorescences are of globose type. The comparative study on morphological characteristics of their vegetative and reproductive organs, and anatomy of their sapwoods of the stems are carried out, described and discussed.

2. REVIEW OF THE LITERATURE

Lawrence (1951) divided the family Leguminosae into the sub-family Mimosoideae, Caesalpinoideae and Lotoideae. He also stated that these sub-families were treated as distinct families viz. Mimosaceae, Caesalpiniaceae and Papilionaceae respectively by many botanists. He placed the genus *Acacia* of about 350 species under the sub-family Mimosoideae. The sub-family Mimosoideae consisted of about 40 genera divided among the five tribes.

He accepted Mimosoideae to be the most primitive one of the three sub-families, and Lotoideae (Papilionaceae) to be the most advanced.

Lawrence (1951) stated that the placentation in the family Leguminosae was parietal along ventral suture with two to many ovules in two alternating rows on a single placenta and the style and stigma one in number, fruit usually legume or loment sometimes follicular, or dehiscent or tardily so.

Rendle (1967) placed the single large genus *Acacia* under the tribe Acacieae of the sub-family Mimosoideae that was the smallest one of the three sub-families of the family Leguminosae, the second largest family of the seed plants. He also classified the family Leguminosae under the order Rosales of the grade Dialypetalae. He described that *Acacia* was one of the two largest genera of Mimosoideae and it contained about 500 species.

According to Vassal (1972), the genus *Acacia* could be divided into three sub-genera that were based mainly on the morphology of the stipules, the primary leaves, pollen and seeds. The two sub-genera viz. *Acacia* and *Aculeiferum* Vassal were indigenous to Thailand (Nielsen, 1985).

Hooker (1879) divided the genus *Acacia* into three series as follow.

- (1) *Gummiferae globiferae* which included *A. arabica*, *A. leucophloea* and other five species,
- (2) *Gummiferae spicatae* which contained *A. catechu*, *A. sundra*, *A. modesta* and other six species. and
- (3) *Vulgares* which consisted of three species.

According to Nielsen (1984, 1992), the genus *Acacia* was placed under the tribe (tribus) *Acacieae* of the family *Mimosaceae* and it was divided into three sub-genera viz. *Aculeiferum*, *Acacia* and *Phyllodineae*.

Nielsen (1992) mentioned three species of the sub-genus *Acacia*, 14 species of the sub-genus *Aculeiferum* and three species of the sub-genus *Phyllodineae* of the globose inflorescence type among the members of the genus *Acacia* in his Flora Malesiana.

Pearson and Brown (1932) mentioned that the genus *Acacia* consisted of over 400 species of unarmed and armed trees and shrubs, widely scattered over the tropic and sub-tropic of the old and the new world.

Rendle (1967) described that the genus *Acacia* was distributed throughout the warmer part of the world and it more especially developed in Africa and Australia.

The genus *Acacia* consisted of more than 1300 species. Most of the species were tropical and sub-tropical, and mainly in the southern Hemisphere (Nielsen, 1984).

Nielsen (1992) stated that about 60 genera and some 3000 species of *Mimosaceae* were distributed in the tropics and sub-tropics, but some genera such as *Acacia* and *Albizia* extending into the warm temperate zone.

Nielsen (1992) also stated that the genus *Acacia* were distributed in tropical and sub-tropical areas of the world, mainly in the Southern Hemisphere, Africa (more than 130 species), Madagascar (about 100 species), and America (about 270 species), Australia and the Pacific area (more than 900), and Asia (more than 55 species), more than 1300 species in all.

According to Nielsen (1992), the sub-genus *Acacia* was characterized by trees or shrubs, stipules spinescent, internodes unarmed, leaves of mature plants bipinnate, petiole and rachis with extrafloral nectaries, the diploid number of chromosomes 26 or 52, and polyploidy frequent. In the genus *Acacia*, the flower gromerulès were protogynous. A remarkable feature of *Acacia* was the apparent correlation between the number of grains in polyad and the number of ovules per ovary. He also mentioned that seeds with hard seed coats were found in the tribe *Acacieae*, *Ingeae*, *Momoseae*, *Mimozyantheae* and *Parkieae*.

Nielsen (1992) described that polyads arose through one or several mitotic divisions of the sporogenous cells prior to meiosis. They usually contained 8, 16 or 32 grains in the *Mimosaceae*. Their size was up to 350 µm.

He also mentioned that stipular spines were found in all species of the sub-genus *Acacia*. The species of the sub - genus *Acacia* and *Phyllodineae* had sessile or sub-sessile ovaries. The glandular appendages of the anthers were found in most species of the sub-genus *Aculeiferum* and in several species of the sub-genus

Acacia (eg. in *A. leucophloea* and *A. tomentosa*). The stamens were free in all Asian and Australian *Acacia* species.

According to Brandis (1874), *A. arabica* flowered from July to September in Panjab and the height of the tree was 50 - 60 feet and of the trunk 10 - 15 feet long with the largest girth recorded being 16.7 feet. The bark was thick, dark brown, nearly black; with deep, narrow, regular longitudinal fissures, joined by short cross-cracks and inner bark reddish brown, very fibrous.

Hooker (1879) stated that *A. arabica* was a shrub or tree with straight finely grey-downy branchlets with long, large and white spines.

Watt (1889) mentioned that the pods of *A. arabica* were stalked, straight, sub-indehiscent, persistently grey-downy, with sutures deeply indented between the seeds, and seeds 8 - 12 in number.

Talbot (1902) described that the pods of *A. arabica* were ligulate-falcate with straight edges, and stipular spines short, hooked, tomentose and not winged.

Bor (1953) stated that the pods of *A. arabica* were 3 - 6 inches long, stipitate, moniliform, densely grey tomentose, downy, dented on both sides between the seeds.

The young leaves of *A. leucophloea* appeared in April and it flowered from August to November, sometimes in May. Its fruits appeared from November to April. The size of the tree was recorded to be six feet in girth and 80 feet high (Brandis, 1874).

The bark was thin, cinereous, yellowish, or light brown, with few deep narrow, longitudinal fissures and short shallow cross-cracks, and smooth between (Brandis, 1874).

Hooker (1879) recorded that *A. leucophloea* was distributed in North-West provinces of Ceylon and Burma, Malay isles and Timor. He also described the morphological characters of *A. leucophloea* and its variety *miocrocephala* Grah. in Wall. cat. 5263; 1832 (Synonym; *A. densa* Wall. cat. 5262; 1832.). In *A. leucophloea* Willd. var. *miocrocephala* Grah., the leaf rachis was glabrous and the leaflets much larger, 1/4 - 3/8 inch long.

According to Morehead (1944), thorn forest characteristically contained a number of thorny species which included *A. leucophloea* (Hta-nuung) and this type of forest was found where the annual rainfall was less than 40 inches.

Nielsen (1992) stated that *Acacia leucophloea* (Roxb). Willd. was distributed in India, Myanmar, Thailand, South Vietnam and Malesia. It was found in Savana, scrub, dry sclerophyll forest, teak forest and brushwood. The flowering period was from January to June and the fruiting from April to July.

According to Nielsen (1992), *Acacia leucophloea* was included in the sub-genus *Acacia*.

The key characters of *A. leucophloea* (under the sub-genus *Acacia*) were the flower in glomerules (Nielsen, 1992), involucre in the lower half or near the middle of the peduncle, more or less compressed pods, lower surface of leaflets pinnately veined, without lateral veins ascending from the base, peduncles panicle, axillary or terminal, calyx and corolla densely puberulous, corolla 1.5 - 2.0 mm long, ovary faintly puberulous, pod legulate-falcate, 0.95 - 1.00 cm broad. The flowering glomerules are light yellow to cream (Nielsen, 1985, 1992).

4. *Leucophloea* with 20 - 25 stamens and glandular anthers could belong to the oldest part of sub-genus *Acacia* (Nielsen, 1992). Goldblatt (1981) reviewed the chromosome number of *A. leucophloea* as $2n = 52$ (Nielsen, 1992).

The morphological characteristics of *A. arabica* and *A. leucophloea* grown in Myanmar were also studied and described by Khin Maung Tin (1974), Aung Kyaw (1976), Aung Moe (1977), Myint (1977), Hnin Hnin Mya (1977), Tin Tin Nwe (1977), Ah Mar Sein (1991), Myint Myint Lay (1991) and Aung Naing Oo (1994).

According to the Myanmar forest inventory's record (1983-84), the total number of *A. arabica* trees (over 2 feet in girth) was found to be 14937, and that of *A. Leucophloea* trees (over 2 feet in girth) 359072 throughout the whole Myanmar.

Lawrence (1951) mentioned that Senn (1943) pointed out that there were no sharp lines separating the sub-families from comparative studies of wood anatomy.

Brandis (1874) described that the wood of *A. arabica* was tough and close-grained, very durable if it was water-seasoned. It was used extensively for implement such as wheels, sugar-rollers, oil presses, rice-powders, agricultural implements, handles, and tent pegs. It was much employed in boat building and as railway-sleepers. It was an excellent fuel. The gum was used in native medicine, dyes and cloth printing. It was similar to gum arabic. It had many varieties and the most important one was var. *cupressiformis*, a tall broom-like tree, with close ascending branches.

The bark was used in the preparation of spirits from sugar and palm-juice. The fibres could be extracted from the bark to use for making nets and coarse cordage. Young pods were used as vegetables and the seeds were ground and mixed with flour (Brandis, 1874)

The genus *Acacia* was economically important for the timber of certain species, for ornamental purposes, as the source of tannin from its barks, and for gum arabic. At least five species were timber trees of varying importance. They were *A. arabica* Willd., *A. Leucophloea* Willd., *A. catechu* Willd., *A. ferruginea* DC. and *A. modesta* Willd. (Pearson and Brown, 1932).

The calcium oxalate crystals were commonly present in woody tissue and the size, quantity and distribution of the crystals might be used in wood anatomical identification and classification (Chattaway, 1937; Metcalfe and Chalk, 1950, IAWA Committee, 1989).

The sapwood of *A. arabica* was large and generally occupied the fifth or sixth part of the radius and it was whitish, coarse-grained, and soft. The heartwood was pale red, nearly colourless when fresh-cut, but on exposure to the air it turned red or dark reddish brown, often with blackish streaks. The pores were uniformly distributed

and numerous, generally surrounded by a small rounded patch of lighter-coloured tissue, often close together in the inner belt of each of annual ring, the outer belt having fewer pores (Brandis, 1874).

Numerous medullary rays were present and the pores and the shining plates or bands of the medullary rays were very prominent in longitudinal section (Brandis, 1874).

The sapwood was whitish, porous and coarse-grained. The heartwood was small, reddish or dark purple, with darker wavy concentric streaks, close and fine-grained. It could be seasoned well and takes a fine polish, but it was somewhat brittle. The wood was strong and tough, but the insects could eat it (Brandis, 1874).

Gamble (1922) stated that the wood of *A. arabica* was hard, sapwood large, whitish; heartwood pinkish-white, turning reddish-brown on exposure, mottled with dark streaks and pores moderate-sized. The wood was very durable if well seasoned. The wood of *A. leucophloea* was hard, sapwood large; heartwood reddish-brown or nearly brick red, with lighter and darker streaks and pores moderate sized, uniformly distributed.

Pearson and Brown (1932) generally described the anatomical structure of the wood of five timber species of commercial importance in India including *A. arabica*, *A. leucophloea*, *A. catechu*, *A. ferruginea* and *A. modesta*.

Pearson and Brown (1932) described macroscopic key characters of *A. arabica*, and *A. leucophloea*. In *A. arabica*, growth rings were not delimited by terminal parenchyma. In *A. leucophloea*, growth ring were delimited by narrow, sharp line of terminal parenchyma, pores at least in part united by more or less continuous tangential bands of parenchyma, bands of parenchyma broad, occupying more than half the space between the pores rays.

Pearson and Brown (1932) also stated the microscopic key characters of *A. arabica* and *A. leucophloea* that tangential diameters of largest vessels showed more than 220 μm and largest rays more than 80 μm in width. In *A. leucophloea*, vessels were united by broad tangential bands of parenchyma, and terminal parenchyma forming a sharp 1 - 3 seriate line. But in *A. arabica*, the vessels were not united by broad tangential bands of parenchyma and terminal parenchyma were absent or sporadic.

The wood of *A. arabica* was heavy, somewhat twisted-grained and coarse-textured, reddish brown in age, and non-ornamental. It was one of the best of the Indian *Acacia* species and anatomically featured by large vessels containing deposits of reddish-brown gum and encircled by parenchyma, extensive dense tracts of the fine libriform fibres, and conspicuous rays which formed a cherry-like fleck on the radial surface (Pearson and Brown, 1932).

The timber was probably stronger than Burma teak and very durable if well seasoned, both in exposed positions and in contact with water. The timber was hard and tough when seasoned and somewhat difficult to saw. It was probably the best hardwood timber of the close-grained type in India (Pearson and Brown, 1932).

Pearson and Brown (1932) mentioned that the wood of *A. leucophloea* was moderately heavy, non-ornamental, red or reddish-brown, irregularly interlocked-grained and coarse-textured; anatomically featured by large vessels which were frequently occluded with gum, broad, ragged, tangential and usually oblique bands of paratracheal-zonate parenchyma alternating with narrow bands of dense fibrous tissue, and rather narrow rays which formed an inconspicuous fleck on the radial surface.

It was a hard, strong, and very tough timber. It was not a really durable timber, especially in exposed positions. The timber was somewhat difficult to saw, especially when dry (Pearson and Brown, 1932).

Kribs (1959) stated the general properties of *A. leucophloea* wood. The colour was pinkish to light red turning reddish brown with darker streaks. The odour and taste were not distinct. The wood was moderately hard and heavy and straight to irregular or interlocked-grained, coarse-textured. The growth rings was usually indistinct, vessels visible without lens; numerous, evenly distributed with a tendency to become ring-porous. Fibres were libriform with simple pits. Parenchyma was distinct with lens. Rays were visible without lens in transverse section and homogeneous. Gum ducts were absent.

3. MATERIALS AND METHODS

3.1 Collection

The specimens of *Acacia leucophloea* var. (1) and var. (2) were taken from the front of two-storied academic building, Mandalay University, Mandalay and those of *A. arabica* were also collected from near the main building of the same University, and roadside of Mandalay Hill, during the flowering and fruiting period of the year 1995 - 1997.

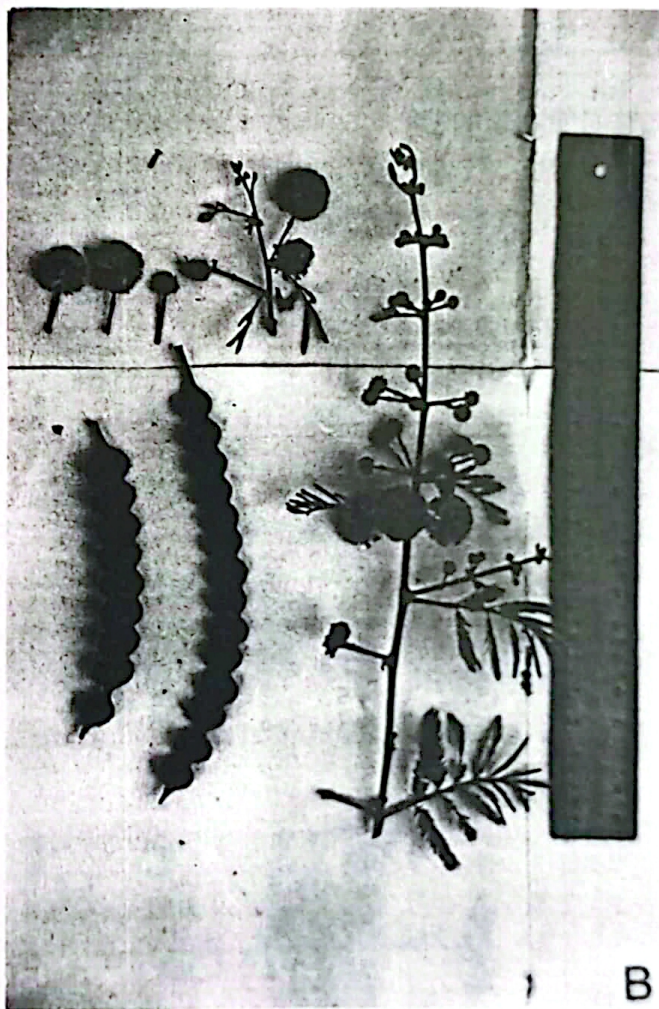
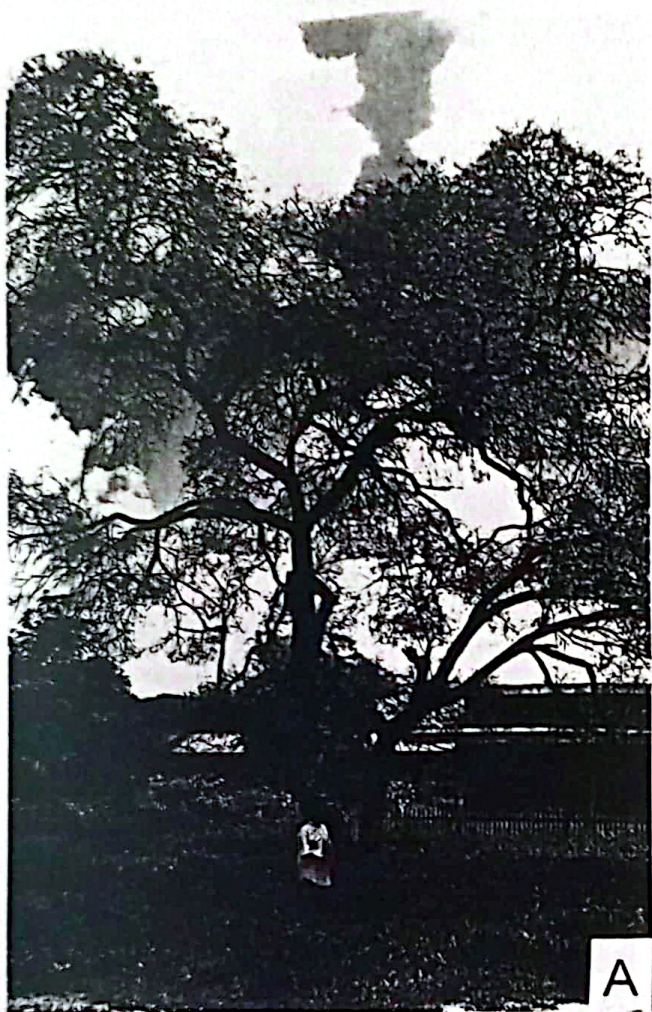
Some of the vegetative and reproductive parts were pressed, dried and kept on herbarium sheets with a label of specified short notes, and some were preserved for morphological, taxonomic and anatomical studies.

All of the pressed, preserved and fresh specimens were used to identify.

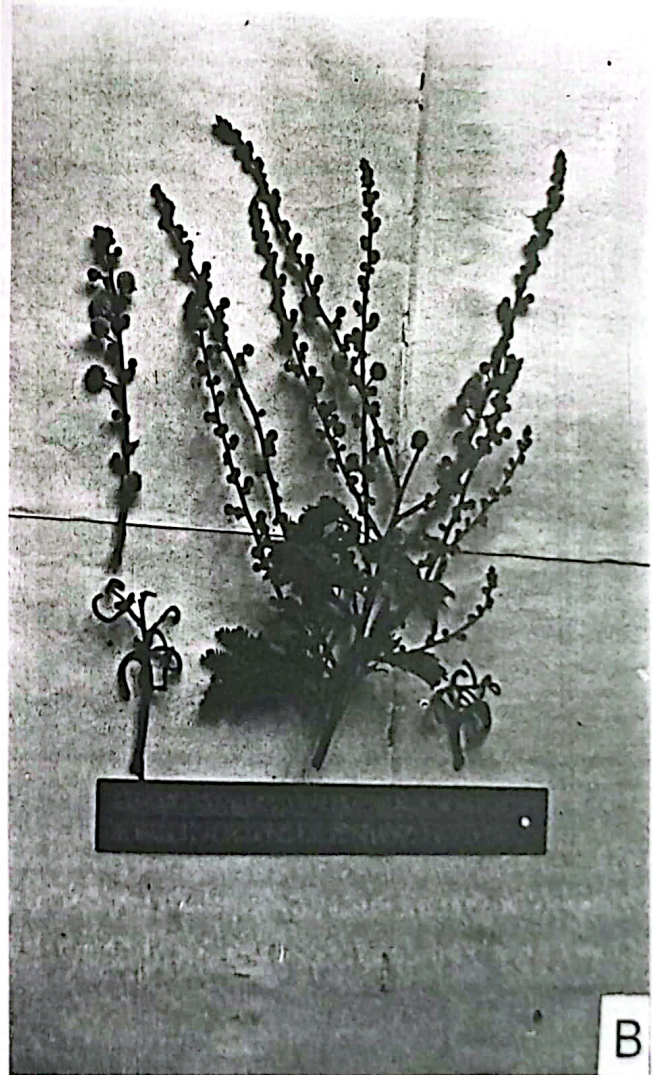
A small block of the sapwood with bark attached measured 5 cm x 5 cm x 3 cm, from each tree studied, was also cut from 4 feet height level for microscopic study.

3.2 Killing and fixation

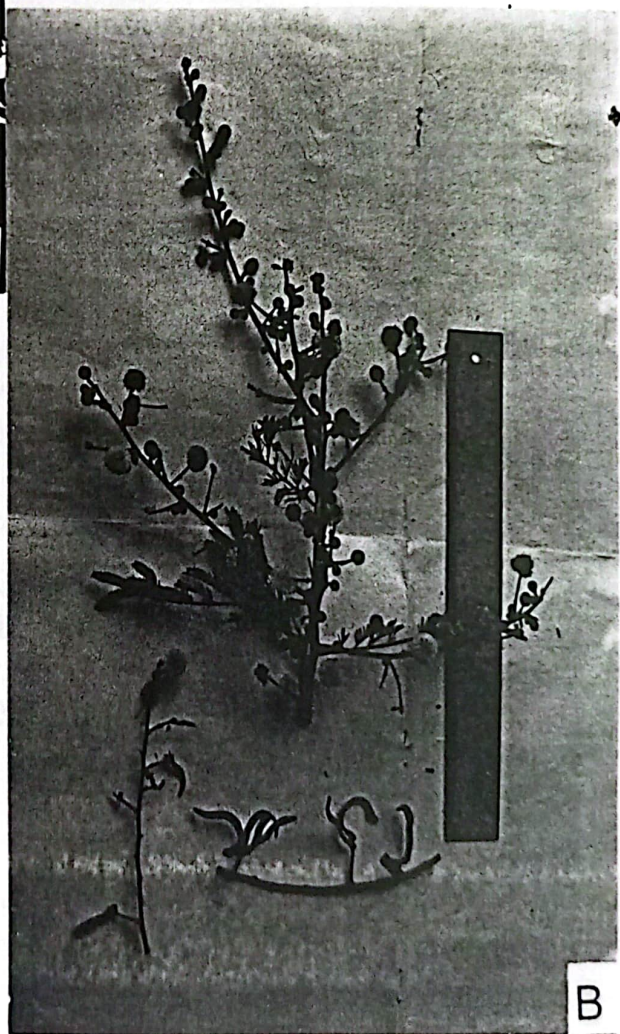
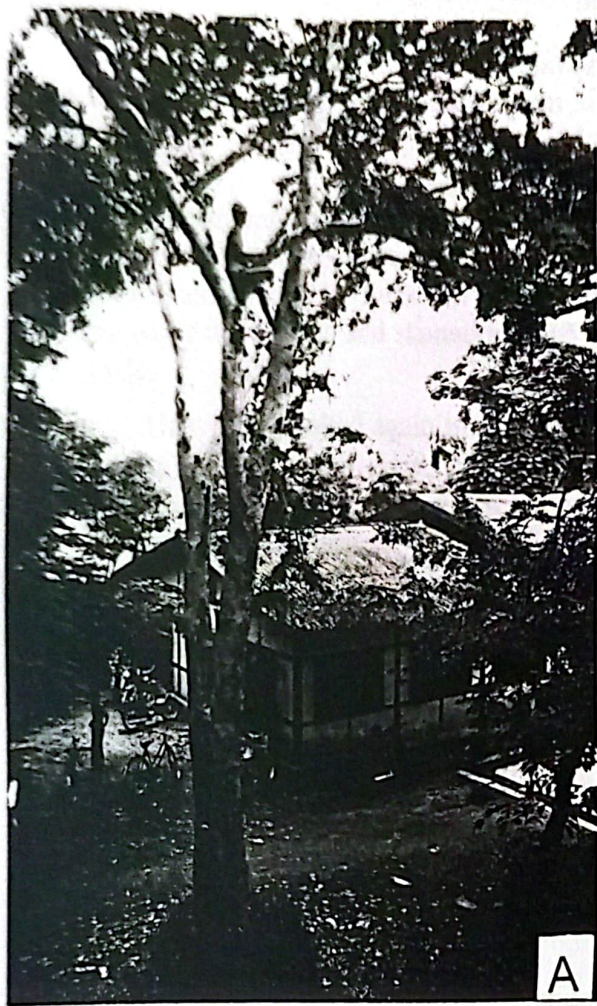
Some of the vegetative and reproductive parts were killed and fixed in 50% of ethyl alcohol solution.



Acacia arabica (Lam.) Willd.; (Su-byu)
 A. A flowering tree B. A flowering branchlet and mature fruits



Acacia leucophloea (Roxb .) Willd. var. (1); (Hta-naung)
 A. A flowering tree B. A flowering branchlet and young fruits



Acacia leucophloea (Roxb .) Willd. var. (2); (Hta-naung)
 A. A flowering tree B. A flowering branchlet and young fruits

3.3 Infiltration, embedding, microtoming and staining

For anatomical study, the sapwood of 1 cm x 1 cm x 2 cm blocks were boiled in water for about 24 hours to soften them in microtoming. These wood blocks were cut by use of a sliding microtome at a thickness of 18 - 35 μ m.

These sections were stored in 50% ethyl alcohol-glycerine solution before staining, and the sections were washed in tap water and immersed in 3% solution of ferric ammonium sulfate for about 30 seconds, for staining. They were then washed in the water three times and stained in a 0.5% solution of haematoxylin for about 30 seconds.

They were washed again in water twice and stained in dilute safranin solution overnight. The sections were then destained and dehydrated through a series of 50%, 70%, 90% and absolute ethyl alcohol solution. The sections were then cleared in xylol and clove oil separately.

The above sections were mounted in Canada balsam dissolved in xylol on already cleared glass slides.

The transverse, tangential and radial longitudinal sections of each species or varieties were mounted on the same slides and dried in open air for a few days.

4. OBSERVATIONS

4.1 Morphology

A. arabica, *A. leucophloea* var. (1) and var. (2) studied in this work are deciduous and aculeate trees. *A. leucophloea* var. (1) and var. (2) are medium- to large-sized, but *A. arabica* is small to medium-sized. All of them are umbelliform-crowned and gummiferous.

The barks of *A. leucophloea* var. (1) and var. (2) are pale yellow or whitish green, occasionally covered with old and black bark flecks, but those of *A. arabica* are darkish grey to black, longitudinally and deeply fissured.

The branchlets of *A. arabica* are softly tomentose and those of *A. leucophloea* var. (1) and var. (2) are grayish-pubescent.

The leaves are bipinnately compound, paripinnate and stipulate in all of them.

The stipules of *A. arabica* are spinous, straight, paired; quite sharp at the tip, white, apparent and long on seedlings; short on young branchlets; and those of *A. leucophloea* var. (1) and var. (2) are spinous, straight, paired, and reddish brown on seedlings.

In *A. arabica* the leaflets are 5 to 26 pairs in number per leaf and linear-oblong with entire and ciliate margin, oblique base and rounded tip, and they are rigidly coriaceous, green and downy on both surfaces.

In *A. leucophloea* var. (1) and var. (2), the leaflets are 16- to 22-paired, linear-oblong, slightly falcate with entire margin on which with a very few cilia, abruptly oblique base and acute tip, and they are green and glabrous on both surfaces.

The number of secondary rachae and leaflets, the length of petiole, primary rachis and secondary rachis are found as shown in table 4.1.

A minute elliptic cup-shaped gland is found on the petiole, just below the first basal pair of secondary rachis in these three species. The petioles are found to be tomentose. In *A. arabica* a minute oval gland is also found between the topmost pair of the secondary rachis.

Table 4.1 The number of secondary rachis, leaflets and the length of petiole, primary rachis and secondary rachis.

No	Species	No. of secondary rachis pairs	No. of leaflet pairs	length of petiole (cm)	length of primary rachis (cm)	length of secondary rachis(cm)
1	<i>A. arabica</i>	2 - 6	5 - 26	1.1 - 2.1	1.9 - 6.5	1.2 - 3.5
2	<i>A. leucophloea</i> var. (1)	5 - 11	16 - 22	0.5 - 2.2	4 - 10	2.8 - 7.0
3	<i>A. leucophloea</i> var. (2)	5 - 12	10 - 19	0.6 - 2.7	6.0 - 11.8	2 - 5

In *A. leucophloea* var. (1), 2 - 4 minute glands are usually found on the terminal portion of primary rachis, each gland on each junction of 2 - 4 uppermost pairs of secondary rachae. In *A. leucophloea* var. (2), 1 - 5 minute glands are borne on the terminal portion of primary rachis, each gland on each junction of 1 - 5 uppermost pairs of secondary rachae.

The above terminal glands are rounded or oval cup-shaped.

The petioles are sub-terete in *A. arabica*, but more or less angular in *A. leucophloea* var. (1) and var. (2).

The primary rachae of all the three species are angular, shallowly canaliculate at adaxial side and terminating with a short mucro.

The primary rachae of *A. arabica* are tomentose, but those of *A. leucophloea* var. (1) and var. (2) are shortly pubescent.

The secondary rachae are angular and pubescent in all the three species.

The inflorescences are axillary and terminal, paniculate small globose head in all the three species, but axillary fasciculate heads are also found in *A. arabica*. In all the three species, the bracts are borne on the middle of the stalk forming an annulus.

The globose heads are yellowish white in *A. leucophloea* var. (1) and var. (2), but bright yellow in *A. arabica*.

The flowers are minute, bisexual, regular, complete and sessile in these three species and bright yellows in *A. arabica* and yellowish white in *A. leucophloea* var. (1) and var. (2).

In these three species, the calyces are campanulate, yellowish green, 5-lobed and toothed.

The calyces are tomentose in *A. arabica* and densely tomentose in the rest two varieties of *A. leucophloea*.

The corollas are tubular-campanulate and 5-lobed and the lobes are triangular and tomentose without in *A. arabica*, but pubescent without in *A. leucophloea* var. (1) and var.(2).

The stamens are numerous in a flower and free. the filaments are filiform and white in *A. arabica*, and pale yellow in *A. leucophloea* var. (1) and var. (2). The anthers are ditheous, dorsifixed, introrse, dehiscing longitudinally in all of the three species, although the shape of anthers is rhomboid in *A. arabica* and ovoid in *A. leucophloea* var. (1) and var. (2).

Gynoecia are monocarpellary, unilocular with many ovules on 2 rows of marginal placentae, ovary oblongoid, superior and thinly tomentose in *A. arabica*, and shortly tomentose in *A. leucophloea* var. (1) and var. (2). The styles are filiform and glabrous and the stigmas are simple in all of the three species.

The size and shape of the fruits are varied as shown in Table 4.2.

Table 4.2 The size and shape of the fruits.

No	Species	length	width	shape
1	<i>A.leucophleoa</i> var. (1)	3.5 - 14.7 cm	0.6 - 0.7 cm	linear-falcate slightly and laterally curved, sometimes extremely curved, dorsiventrally compressed
2	<i>A.leucophleoa</i> var. (2)	6.5 - 13.8 cm	0.8 - 1.1 cm	dorsi-ventrally spiral or deeply and dorsiventrally curved, sometimes sigmoid, dorsiventrally compressed
3	<i>A. arabica</i>	4 - 21 cm	1.0 - 1.6 cm	lomentaceous-linear, laterally compressed, straight or slightly curved, deeply indented with thick sutures between the seeds, distinctly beaked.

The seeds are ovoid in *A. arabica*, although oblongoid to ovoid in *A. leucophloea* var. (1) and irregularly oblongoid as in *A. leucophloea* var. (2).

4.1.1 Artificial key to the species and variety

1. Trunks with darkish grey to black bark; barks longitudinally and deeply fissured; branchlets softly tomentose; stipules spinous, white, apparent and long on seedling; leaflets with ciliate margin; globose heads bright yellow, number of flowers per head less than 50, flowers 5 - 7 mm long; legume lomentaceous-linear *A. arabica*
1. Trunks with pale yellow or whitish green, occasionally covered with old and black bark flecks; barks rather smooth; branchlets greyish pubescent; stipules spinous, dark brown on seedlings; leaflets with almost entire margin or the entire margin with a very few of cilia; globose heads greyish white, number of flowers per head more than 50; flower 2.5 - 4.5 mm long; legumes not lomentaceous-linear.....2
 2. Number of flowers per head 62-84; flowers 2.5-3.5 mm long; legumes slightly and laterally curved..... *A. leucophloea* var. (1)
 2. Number of flowers per head 97 - 106; flowers 4.0 - 4.5 mm long; legumes dorsi-ventrally spiral or deeply and dorsi-ventrally curved..... *A. leucophloea* var. (2)

4.2 Anatomy

4.2.1 Sapwood of the stem

4.2.1.1 Key to the species and variety

1. Heartwood reddish brown; wood medium-textured; irregularly interlocked-grained; average solitary pores 73 - 81 % mean length of vessel elements 118 - 121 μm ; mean length of fibres 843 - 980 μm ; Ray cells homocellular and heterocellular, crystals present in ray cells.....2.
2. Odour of the wood not distinct; pores medium-sized to very large, with mean tangential diameter 231 μm , average solitary pores 73%, vessel elements extremely short with mean length 118 μm ; mean length of fiber 980 μm ; mean width of rays 53 μm ; mean height of uniseriate ray 136 μm ; axial parenchyma forming a band with 7 -22 series.....*Acacia leucophloea* var. (1)
2. Odour of the wood distinct; pores medium-sized to moderately large, with mean tangential diameter 156 μm , average solitary pores 81%, vessel elements extremely short to moderately short with mean length 121 μm ; mean length of fibres 843 μm ; mean width of rays 38 μm ; mean height of uniseriate ray 76 μm ; axial parenchyma not banded.....*Acacia leucophloea* var. (2)
- 1 Heartwood pinkish brown with blackish streaks; wood coarse- textured; some-what twisted grained; average solitary pores 49%; mean length of vessel elements 194 μm ; mean length of fibres 1054 μm ; Ray cells homocellular, crystals absent in ray cells..... *Acacia arabica*

4.2.1.2 *Acacia arabica* (Lam.) Willd.

General Characteristics and Properties of the Wood

Sapwood yellowish white, heartwood pinkish brown with blackish streaks, odour and taste not distinct; heavy, hard, coarse-textured, somewhat twisted grained; diffuse porous; growth ring not distinct.

Microscopic Characteristics

Vessel elements: Diffuse porous; pores moderately small to moderately large, mean tangential diameter 190 μm (range 51 - 246 μm); number per square millimeter few to moderately numerous (range 3 - 12); average solitary pores 49% (range 9 - 100); pore solitary or pore multiple of 2 - 7 or rarely pore cluster; circular or oval in cross section; thin-walled; tyloses absent; perforation plates simple, end walls of elements oblique or transverse, tailed at one end or both ends; intervacular pitting alternate, crowded, oval, with mean tangential diameter of the chambers 5 μm (range 3 - 7 μm); vessel element extremely short to moderately short, mean length 194.4 μm (range 102 - 307 μm).

Fibres: Libriform, very short to medium-sized, mean length 1054 μm (range 512 - 1127 μm), non-septate; interfibre pits simple, slit-like, minute.

Rays: Homocellular, uniseriate to multiseriate (2- to 7-seriate), 9 - 16 per millimeter tangentially, moderately numerous to very numerous, extremely fine to medium-sized, mean width 33.3 μm (range 5 - 70 μm); mean height of the uniseriate rays 192 μm (range 25 - 137 μm), 2 - 11 cells high; mean height of the multiseriate rays 353 μm (range 71 - 604 μm), 5 - 41 cells high; ray-vessel pitting alternate, oval in shape, 5 - 8 μm in diameter; gum deposits present, crystals present.

Axial parenchyma: Abundant; paratracheal, vasicentric, aliform, aliform confluent connecting 2 - 4 vessel pores; apotracheal diffuse in aggregate; crystals frequently present in 2 to 6 chambered axial parenchyma.

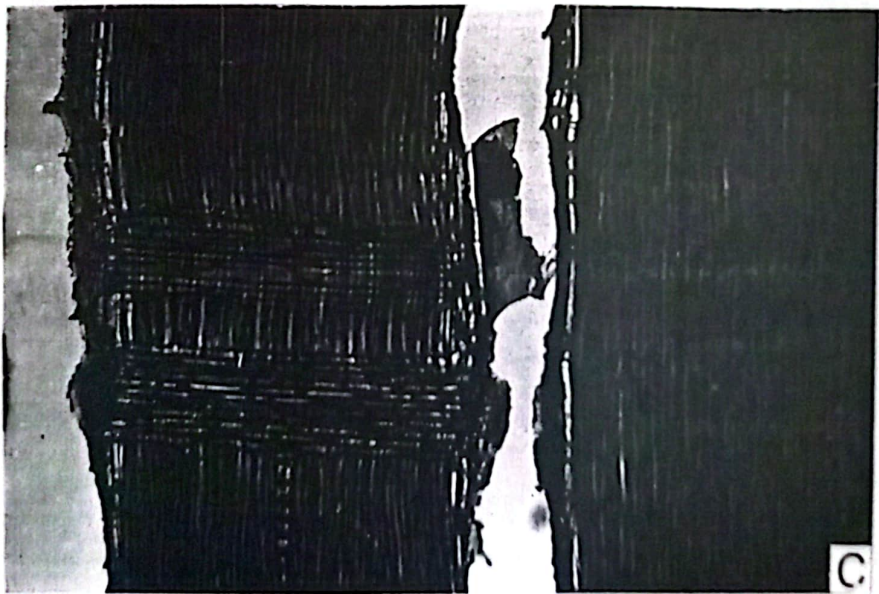
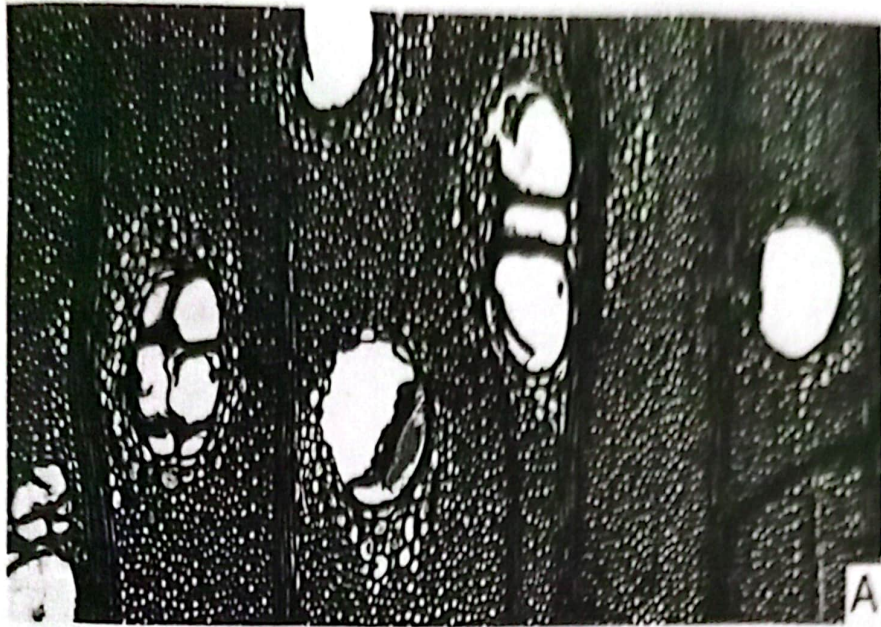
4.2.1.3 *Acacia leucophloea* (Roxb.) Willd. var. (1)

General Characteristics and Properties of the Wood

Sapwood pale yellowish white, heartwood reddish brown, with darker streaks; odour and taste not distinct, moderately heavy; moderately hard; irregular interlocked-grained; medium textured; diffuse porous; growth rings not distinct.

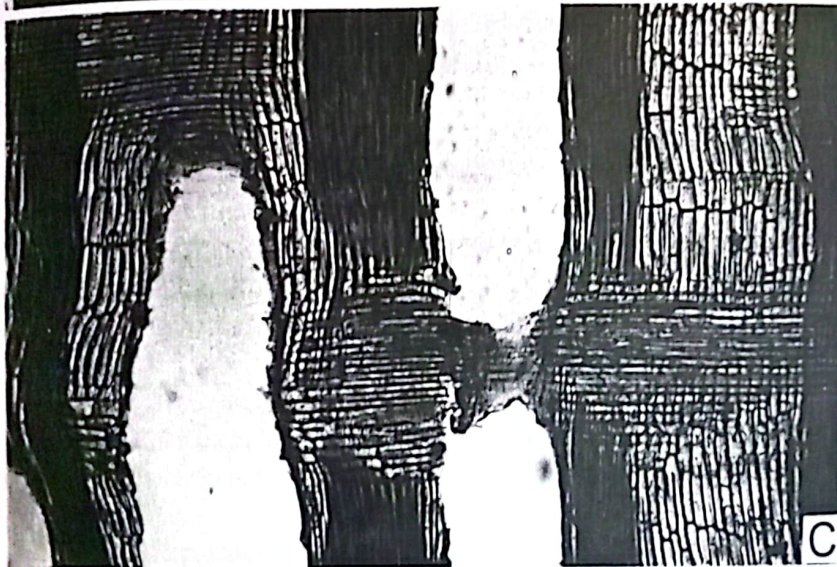
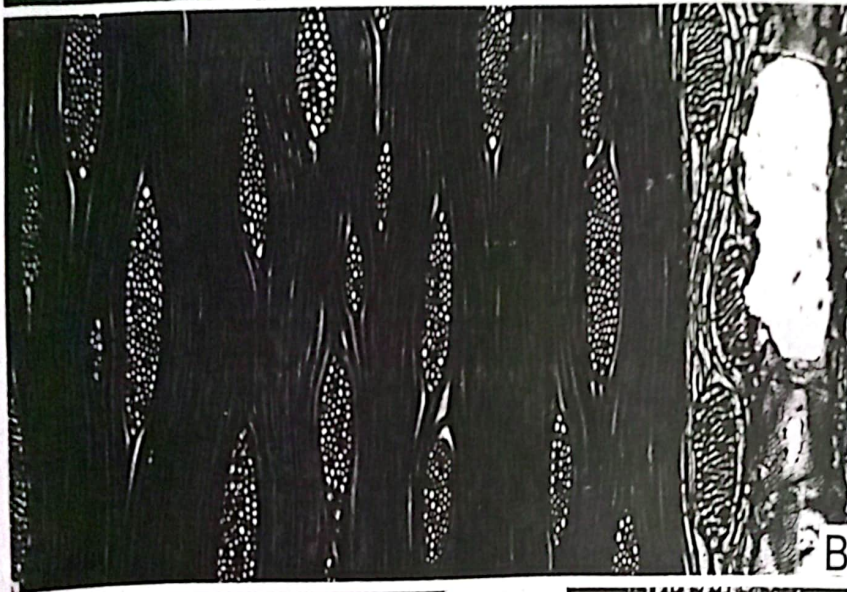
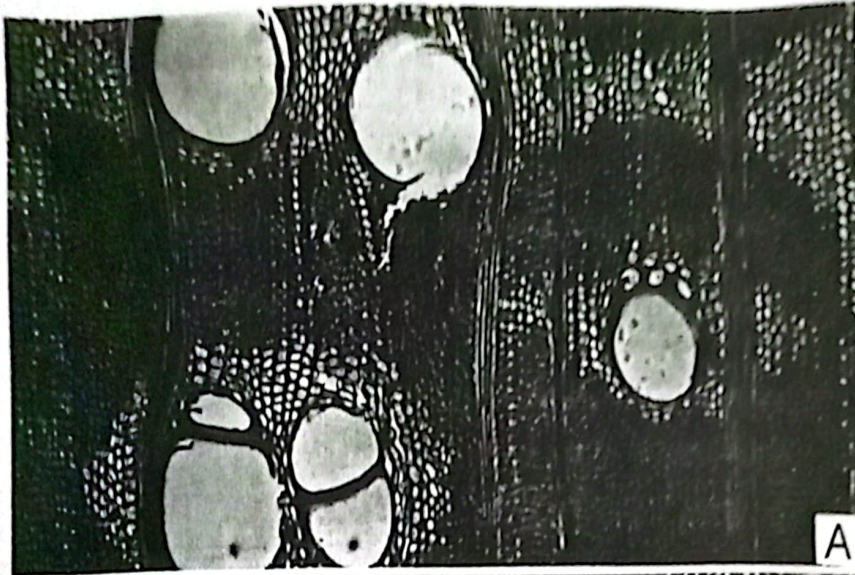
Microscopic Characteristics

Vessel elements: Diffuse porous; pores medium-sized to very large, mean tangential diameter 231 μm (range 153 - 338 μm); number per square millimeter few to moderately few (range 3 - 8); average solitary pores 73% (range 50 - 100); pore solitary or pore multiple of 2 - 4 (mostly 2 - 3); circular or oval in cross section; thin-walled; tyloses absent; perforation plates simple, end walls of elements oblique or



Acacia arabica (Lam.) Willd.; (Su-hyu)

- A. T.S of a portion of sapwood (x 121) B. T.L.S of a portion of sapwood (x 121)
C. R.L.S of a portion of sapwood (x 121)



Acacia leucophloea (Roxb.) Willd. var. (1); (Hta-naung)

A. T.S of a portion of sapwood (x 121) B. T.L.S of a portion of sapwood (x 121)

C. R.L.S of a portion of sapwood (x 121)

transverse, tailed at one end or both ends or truncate; intervascular pitting alternate, crowded, oval or elliptic, with mean tangential diameter of the chambers $8.7\ \mu\text{m}$ (range $6 - 10\ \mu\text{m}$); vessel elements extremely short, mean length $118\ \mu\text{m}$ (range $51 - 153\ \mu\text{m}$).

Fibres: Libriform, extremely short to medium-sized, mean length $980\ \mu\text{m}$ (range $348 - 1537\ \mu\text{m}$), non-septate; interfibre pits simple, slit-like, minute.

Rays: Heterocellular, uniseriate to multiseriate (3- to 8-seriate), 5 - 18 per millimeter tangentially, moderately numerous to very numerous, very fine to medium-sized, mean width $53\ \mu\text{m}$ (range $20 - 82\ \mu\text{m}$); mean height of the uniseriate rays $136\ \mu\text{m}$ (range $42 - 275\ \mu\text{m}$), 3 - 14 cells high; mean height of the multiseriate rays $349\ \mu\text{m}$ (range $90 - 512\ \mu\text{m}$), 6 - 51 cells high; ray vessel pitting opposite to alternate, oval or rounded in shape, $5 - 7\ \mu\text{m}$ in diameter; gum deposits present; crystals present in upright cells.

Axial parenchyma : Abundant; paratracheal vasicentric, aliform, aliform confluent connecting 3 - 8 vessel pores; banded with 7 - 22 series; apotracheal diffuse in aggregate; crystals frequently present in 3- to 14-chambered axial parenchyma.

4.2.1.4 *Acacia leucophloea* (Roxb.) Willd. Var. (2)

General Characteristics and Properties of the Wood

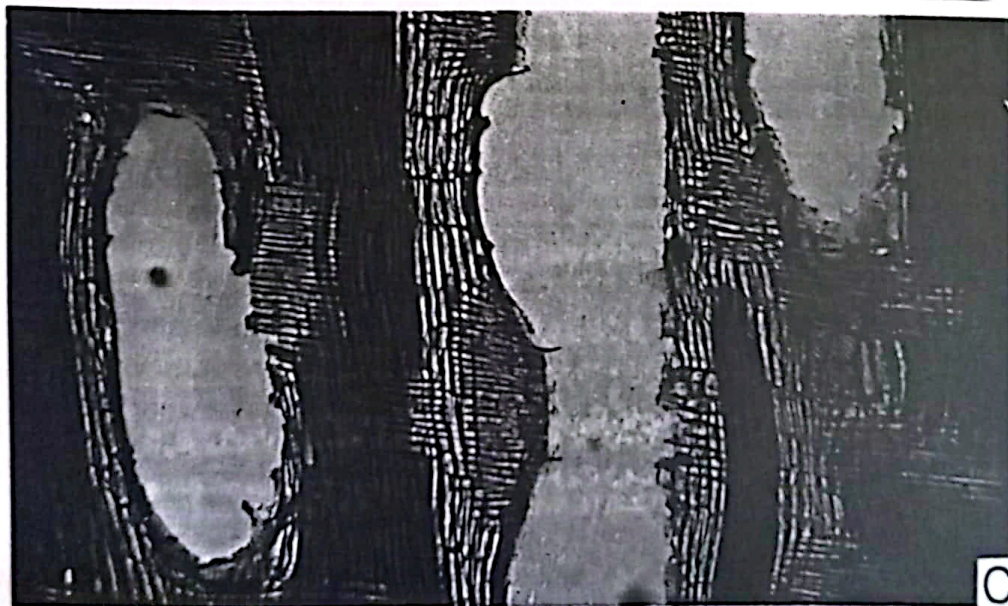
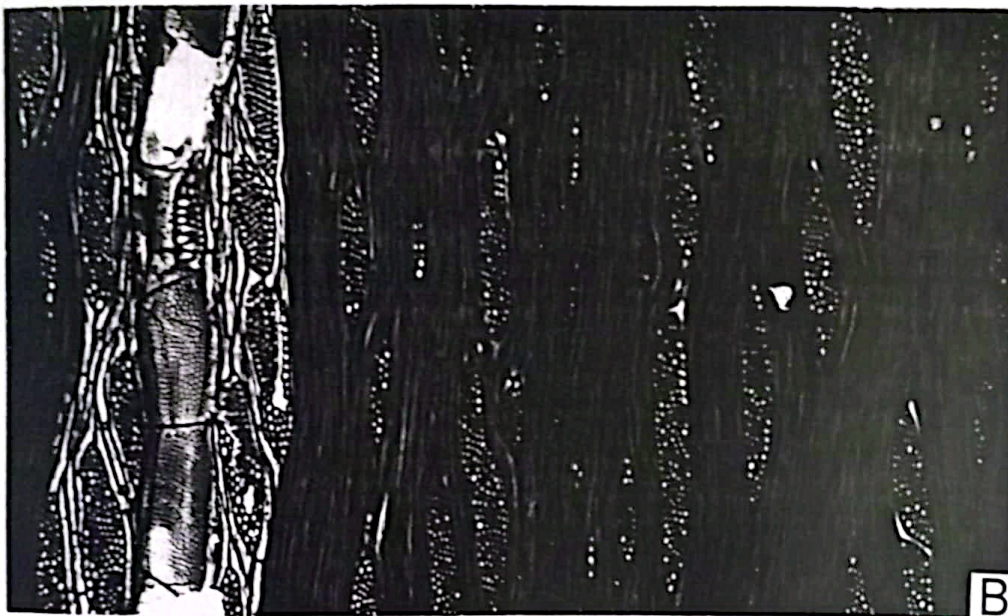
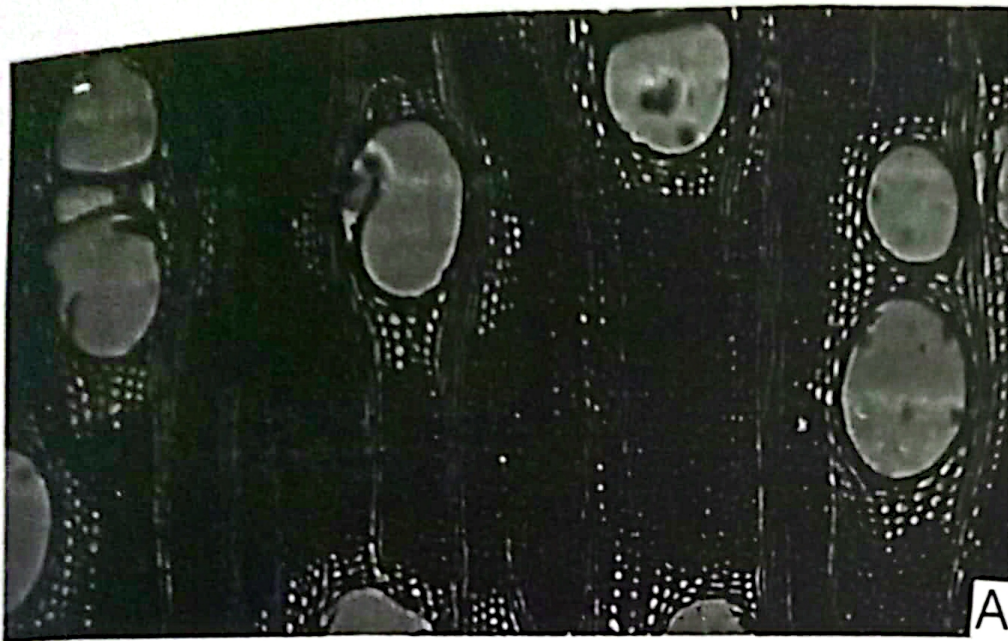
Sapwood pale yellowish white, heartwood reddish brown, with darker streaks; odour and taste distinct, moderately heavy; moderately hard; irregularly interlocked-grained; medium textured; diffuse porous; growth rings not distinct.

Microscopic Characteristics

Vessel elements: Diffuse porous; pores medium-sized to moderately large, mean tangential diameter $156\ \mu\text{m}$ (range $102 - 287\ \mu\text{m}$); number per square millimeter few to moderately few (range 4 - 8); average solitary pores 81% (range 50 - 100); pore solitary or pore multiple of 2 - 3; circular or oval in cross section; thin-walled; tyloses absent; perforation plates simple, end walls of elements oblique or transverse, tailed at one end or both ends or truncate; intervascular pitting alternate or opposite, crowded, oval or elliptic, with mean tangential diameter of the chambers $10\ \mu\text{m}$ (range $5 - 12\ \mu\text{m}$); vessel elements extremely short to moderately short, mean length $121\ \mu\text{m}$ (range $61 - 287\ \mu\text{m}$).

Fibres: Libriform, extremely short to medium-sized, mean length $843\ \mu\text{m}$ (range $410 - 1332\ \mu\text{m}$), non-septate; interfibre pits simple, slit-like, minute.

Rays: Heterocellular, uniseriate to multiseriate (2- to 9-seriate), 9 - 16 per millimeter tangentially, numerous to very numerous, extremely fine to medium-sized, mean width $38\ \mu\text{m}$ (range $5 - 75\ \mu\text{m}$); mean height of the uniseriate rays $76\ \mu\text{m}$ (range $25 - 175\ \mu\text{m}$), 2 - 11 cells high; mean height of the multiseriate rays $332\ \mu\text{m}$ (range $71 - 594\ \mu\text{m}$), 5 - 41 cells high; ray vessel pitting alternate, oval in shape, $5 - 10\ \mu\text{m}$ in diameter; gum deposits present; crystal absent.



Acacia leucophloea (Roxb .) Willd. var. (2); (Hta-naung)

- A. T.S of a portion of sapwood (x 121) B. T.L.S of a portion of sapwood (x 121)
C. R.L.S of a portion of sapwood (x 121)

Axial parenchyma : Abundant; paratracheal, vasicentric, aliform, aliform confluent connecting 2 - 10 vessel pores; apotracheal diffuse in aggregate; crystals frequently present in 2- to 6-chambered axial parenchyma.

5. DISCUSSION

5.1 Morphology

From Hooker's (1879) days of floristic study to now, many workers recorded morphology of the species of the genus *Acacia* in their literature.

According to the available literature, no one had distinguished *A. leucophloea* at the level of varieties, however Hooker (1879) described *A. leucophloea* and its variety *microcephala* Grah.

Brandis (1874) described *A. arabica* and its variety *cupressiformis* among many other varieties. In Myanmar, Khin Maung Tin (1974), Aung Kyaw (1976), Aung Moe (1977), Myint (1977), Hnin Hnin Mya (1977), Tin Tin Nwe (1977) and Ah Mar Sein (1991) had studied and described the morphology and distribution of *A. leucophloea* and *A. arabica* in their regional flora.

Myint Myint Lay (1991) and Aung Naing Oo (1994) also investigated the morphology and wood anatomy of some Myanmar *Acacia* species. However, they did not mention *A. leucophloea* of central Myanmar at the level of sub-species or varieties or forms on the basis of morphology or anatomy.

In this research, two varieties of *A. leucophloea* were studied and described their distinguishing characters but any one of them does not resemble *A. leucophloe* var. *microcephala* Grah. of Hooker (1879) in the hairy characters of leaf rachis and the length of leaflets as shown in Table 5.1.

Table 5.1 The hairy characters of leaf rachis and the length of leaflets of the varieties of *A. leucophloea*.

No.	Species	leaf rachis	leaflets
1	<i>A. leucophloea</i> (Roxb.) Willd. var. (1)	primary rachis shortly pubescent, secondary one pubescent	2 - 15 mm long
2	<i>A. leucophloea</i> (Roxb.) Willd. var. (2)	primary rachis shortly pubescent, secondary one tomentose	2.5 - 11.0 mm long
3	<i>A. leucophloea</i> Willd. var. <i>microcephala</i> Grah.	glabrous	1/4 - 3/8 inch (6.3 - 9.5 mm long)

These two varieties of *A. leucophloea* grow healthy just at the front of the two-storied academic building in the campus of Mandalay University. They have different form and shape of pods. However, these characters have not been recorded until a few years ago.

The morphological features of the leaves of two varieties of *Acacia leucophloea* and *A. arabica* are compared and described in Table 5.2.

According to Table 5.2, the whole compound leaves of the variety (2) are found to be slightly longer than those of the variety (1) of *A. leucophloea* and considerably larger than those of *A. arabica*.

The breadth of the whole compound leaf of *A. leucophloea* var. (1) is found to be slightly broader than that of *A. leucophloea* var. (2), and that of *A. arabica* is the least.

Among the varieties of *A. leucophloea* and *A. arabica*, the number of leaflets per secondary rachis slightly differs from each other and the lowest and highest limits are found in *A. arabica* as shown in Table 5.3.

The number of secondary rachis and leaflets of *A. leucophloea* and *A. arabica* observed by the other workers are shown in Table 5.3 and 5.4.

The number of secondary rachis of *A. leucophloea* var. (1) and var. (2) and *A. arabica* observed in this work is approximately same as had been described by the previous workers. However, the number of secondary rachis of *A. arabica* is found to be slightly different, that is 5 - 6 (Talbot, 1902), instead of 2 - 6 as obtained in this research.

Table 5.2 Comparison of the characters of the leaves of two varieties of *Acacia leucophloea* and *A. arabica*.

Species	<i>A. leucophloea</i> var. (1)	<i>A. leucophloea</i> var. (2)	<i>A. arabica</i>
Leaf characters			
Length of petiole (cm)	0.5 - 2.2	0.6 - 2.7	1.1 - 2.1
Length of primary rachis (cm)	4 - 10	6.0 - 11.8	1.9 - 6.5
Length of secondary rachis (cm)	2.8 - 7.0	2.0 - 5.0	1.2 - 3.5
No. of secondary rachis pairs per primary rachis one	5 - 11	5 - 12	2 - 6
No. of leaflet pairs per secondary rachis	16 - 22	10 - 19	5 - 26
No. of glands found on the petiole	1	1	1
No. of glands found on the primary rachis	2 - 4	1 - 5	1
Shape of leaflets	linear-oblong	linear-oblong	linear-oblong
Shape of leaf base	abruptly oblique	abruptly oblique	oblique
Shape of leaf margin	entire with very few cilia	entire with very few cilia	margin ciliate
Shape of leaf tips	acute	acute	rounded
Length of leaflets (mm)	2 - 15	2.5 - 11.0	1.5 - 7.5
Hairy character of primary rachis	pubescent	pubescent	tomentose

In the case of *A. leucophloea*, the maximum number of the leaflets per secondary rachis is also found to be higher in the results of Brandis (1874), Hooker (1879), and Khin Maung Tin (1974) than in those of this research.

The number of leaflets per secondary rachis of *A. arabica* in this work is slightly different in comparison to that of the previous workers as shown in Table 5.4.

The stipule of *A. leucophloea* var. (1), var. (2) and *A. arabica* are modified into straight spines. Their spinous stipules are apparent in seeding stage or while very young.

Table 5.3 The number of secondary rachis per primary one of *A. leucophloea* and *A. arabica* observed by other workers and in this research.

No.	author	<i>A. leucophloea</i>	<i>A. arabica</i>
1	Brandis (1874)	5 - 12 pairs	3 - 6 pairs
2	Hooker (1879)	6 - 12 pairs	3 - 6 pairs
3	Watt (1889)	-	3 - 6 pairs
4	Talbot (1902)	-	5 - 6 pairs
5	Khin Maung Tin (1974)	4 - 13 pairs	2 - 6 pairs
6	Nielsen (1992)	6 - 13 pairs	-
7	Aung Naing Oo (1994)	4 - 12 pairs	2 - 8 pairs
8	In this research	5 - 11 pairs in var. (1) 5 - 12 pairs in var. (2)	2 - 6 pairs

Table 5.4 The number of leaflets per secondary rachis of *A. leucophloea* and *A. arabica* observed by other authors and in this research.

No.	author	<i>A. leucophloea</i>	<i>A. arabica</i>
1	Brandis (1874)	12 - 30 pairs	10 - 20 pairs
2	Hooker (1879)	15 - 30 pairs	10 - 20 pairs
3	Watt (1889)	-	10 - 20 pairs
4	Talbot (1902)	-	15 - 25 pairs
5	Khin Maung Tin (1974)	10 - 30pairs	10 - 20 pairs
6	Nielsen (1992)	6 - 25 pairs	-
7	Aung Naing Oo (1994)	9 - 21 pairs	10 - 20 pairs
8	In this research	16 - 22 pairs in var. (1) 10 - 19 pairs in var. (2)	5 - 26 pairs

Although the spinous stipules of *A. arabica* are found to be distinctly long (i.e. 1.2 - 7.5 cm) and white, those of the two varieties of *A. leucophloea* are short (i.e. 1.5 - 3.5 mm) and dark brown.

The number of flowers found in a globose head is not recorded yet by the previous authors, but in this work, it is observed as shown in Table 5.4. It shows that the number of flowers is much greater in *A. leucophloea* var. (2) than in that of var. (1).

In *A. leucophloea* var. (2), the size of each flower is also slightly larger than that of *A. leucophloea* var. (1) as shown in Table 5.4. However, the size of the flower is found to be largest in *A. arabica*.

The number of the stamens of the three species studied in this research is variously recorded as shown in Table 5.5.

Table 5.5 Number of flowers per head, size of the flower and number of stamens

No	Species	number of flowers per head	size of flower		number of stamens per flower
			length (mm)	width (mm)	
1	<i>A. leucophloea</i> var. (1)	62 - 84	2.5 - 3.5	1.0 - 1.5	31 - 43
2	<i>A. leucophloea</i> var. (2)	97 - 106	4.0 - 4.5	2.5 - 3.5	35 - 48
3	<i>A. arabica</i>	30 - 40	5 - 7	3 - 4	95 - 110

Table 5.6 The size of pods found in *A. leucophloea* and *A. arabica*

No	Author	<i>A. leucophloea</i>		<i>A. arabica</i>	
		Length	Width	Length	Width
1	Brandis (1874)	4 - 6"	1/3"	6"	-
2	Hooker (1879)	4 - 8"	1/4 - 1/3"	3 - 6"	1/2 - 5/8"
3	Myint Myint Lay (1991)	9 - 15 cm	0.7 - 0.8 cm	14 - 22 cm	1.0 - 1.5 cm
4	Aung Naing Oo (1994)	4.5 - 12.5 cm	0.8 - 1.0 cm	5 - 22 cm	1.2 - 1.8 cm
5	In this research	var. (1)	var. (1)	4 - 21 cm	1.0 - 1.6 cm
		3.5 - 14.7 cm	0.6 - 0.7 cm		
		var. (2)	var. (1)		
		6.5 - 13.8 cm	0.8 - 1.1 cm		

These differences in size and number of the flowers and the number of stamens are also significant to distinguish *A. leucophloea* from *A. arabica*, and it is not clearly sharp to differentiate between the two varieties of *A. leucophloea*.

In *A. leucophloea*, Myint Myint Lay (1991) and Aung Naing Oo (1994) stated that the flowers consisted of numerous stamens: Nielsen (1992) also mentioned that the number of stamens is 20 - 25 per flower in his Flora Malesiana. But, in this research, the number of stamens is found to be 32 - 43 in *A. leucophloea* var. (1) and 35 - 48 in *A. leucophloea* var. (2).

The colour of globose head is also useful in identifying *A. leucophloea* and *A. arabica*, since *A. arabica* being bright yellow, and the rest yellowish white.

The size of the pods found in this work is compared to that observed by other workers as shown in Table 5.6. The shape of pods found in this work is shown in Table 4.2. The size and shape of the pods of *A. arabica* distinctly differ from those of the two varieties of *A. leucophloea*.

The shape and size of the pods are also different between the two varieties of *A. leucophloea*. This characteristics is significant for distinguishing the two varieties of *A. leucophloea* and *A. arabica*.

5.2 Anatomy

Many workers mentioned the general characteristics of the sapwood of *Acacia leucophloea*. The sapwood is whitish, open, porous, coarse-grained (Brandis, 1874); wide, pale yellowish-white (Pearson and Brown, 1932); large (Gamble, 1922); wide, pale yellowish-white (Aung Naing Oo, 1994). In this research, the sapwood of *A. leucophloea* var. (1) and var (2) is found to be pale yellowish-white.

The heartwood of *A. leucophloea* is reddish or dark purple, with darker wavy, concentric streaks, close and fine-grained (Brandis, 1874); reddish-brown or nearly brick-red, with lighter and darker streaks, pores moderate-sized (Gamble, 1922); light red to brick, ageing to reddish- brown with darker streaks (Person and Brown, 1932); brown to reddish-brown (Myint Myint Lay, 1991); and reddish-brown with darker streaks (Aung Naing Oo, 1994).

In this research, the heart wood of *A. leucophloea* var. (1) and var. (2) is observed as reddish-brown.

The sapwood of *A. arabica* is large, whitish, coarse-grained and soft (Brandis, 1874); large, whitish (Gamble, 1922); wide, whitish (Myint Myint Lay, 1991); and yellowish-white (Aung Naing Oo, 1994). In this research, the sapwood of *A. arabica* is found to be yellowish- white.

The heartwood of *A. arabica* is dark reddish brown, with blackish streaks, pores numerous, generally surrounded by a small rounded patch of lighter coloured tissue (Brandis, 1874); pinkish- white turning reddish-brown on exposure, with dark streaks, pores moderate-sized (Gamble, 1922); pinkish-white to light red when first exposed, turning reddish-brown with age, with darker streaks (Pearson and Brown, 1932); reddish-brown (Myint Myint Lay, 1991); and pinkish brown with blackish

streaks (Aung Naing Oo, 1994). In this work it is observed to be pinkish brown with blackish streaks.

The size of pores found in the wood of *A. leucophloea* and *A. arabica* by Gamble (1922), Pearson and Brown (1932), Myint Myint Lay (1991), and Aung Naing Oo (1994) are compared with those found in the sapwood in this research as shown in Table 5.7.

The fibre types found in the wood of *A. leucophloea* and *A. arabica* by Pearson and Brown (1932), Myint Myint Lay (1991), and Aung Naing Oo (1994) are also compared with those found in the sapwood in this research as mentioned in Table 5.8.

Table 5.7 Comparison of size of pores in the wood of *A. leucophloea* and *A. arabica* observed by other workers and in this research.

No.	author	<i>A. leucophloea</i>	<i>A. arabica</i>
1	Gamble (1922)	Moderate-sized	very large to medium-sized
2	Pearson and Brown (1932)	large to medium or small	very large to medium-sized
3	Myint Myint Lay (1991)	Moderately small to medium-sized	small to medium-sized
4	Aung Naing Oo (1994)	very small to moderately large	moderately small to moderately large
5	In this research	var.(1) medium-sized to very large var.(2) medium-sized to moderately large	moderately small to moderately large

Table 5.8 Comparison of fibre types of *A. leucophloea* and *A. arabica*.

No.	author	<i>A. leuco phloea</i>	<i>A. arabica</i>
1	Person and Brown (1932)	libriform, septate	libriform, septate
2	Myint Myint Lay (1991)	libriform, septate	libriform, non-septate
3	Aung Naing Oo (1994)	libriform, non-septate	libriform, non-septate
4	In this research	var.(1) libriform, non-septate var.(2) libriform, non-septate	libriform, non-septate

Table 5.9 Comparison of the quantitative characteristics of microscopic wood structure.

No.	Species observed	<i>A. Leucophloea</i> var.(1)	<i>A. leucophloea</i> var.(2)	<i>A. arabica</i>
	Characteristics			
1	Mean pores frequency (per sq mm)	5	6	7
2	Mean vessel diameter (μm)	231	156	190
3	Mean vessel length (μm)	118	121	194
4	Mean fibre length (μm)	980	843	1054
5	Mean uniseriate ray height (cells)	7	5	5
6	Mean uniseriate ray height (μm)	136	76	192
7	Mean ray width (μm)	53	38	33
8	Mean multiseriate ray height (cells)	21	18	21
9	Mean multiseriate ray height (μm)	349	332	353

In this work, vessel distribution is found to be diffuse-porous in both of the two varieties of *A. leucophloea* and *A. arabica*.

Myint Myint Lay (1991), and Aung Naing Oo (1994) also stated that the wood of *A. leucophloea* and *A. arabica* is diffuse-porous.

However, Metcalf and Chalk (1950) described that the vessels are ring porous or semi- ring porous in a few species of family Mimosaceae.

In Table 5.9, the quantitative characteristics of microscopic wood structure of *A. leucophloea* var. (1) and var. (2) and *A. arabica* are mentioned comparatively. According to this table the two varieties of *A. leucophloea* are not much different from each other except in the case of mean vessel diameter, mean fibre length and mean uniseriate ray height. This difference in measurement of vessel diameter, fibre length and uniseriate ray height could be useful to identify the wood of *A. leucophloea* var. (1) and var. (2).

As shown in Table 5.9, mean vessel diameter, mean vessel length, mean fibre length, mean uniseriate ray height (in μm), mean ray width are very significant as key characters to distinguish the two varieties of *A. leucophloea*. Vessel length and fibre length are also useful key characters to distinguish *A. leucophloea* and *A. arabica*.

Table 5.10 The ray distribution among the *A. leucophloea* var. (1) and var. (2) and *A. arabica*.

No.	Species	ray
1	<i>A. leucophloea</i> var.(1)	heterocellular, uniseriate to multiseriate, moderately numerous to very numerous, very fine to medium-sized.
2	<i>A. leucophloea</i> var.(2)	heterocellular, uniseriate to multiseriate, numerous to very numerous, extremely fine to medium-sized.
3	<i>A. arabica</i>	homocellular, uniseriate to multiseriate, moderately numerous to very numerous, extremely fine to medium-sized.

The ray distribution in the sapwood is observed as shown in Table 5.10.

Axial parenchyma found in the sapwood of *A. leucophloea* and *A. arabica* are abundant, paratracheal vasicentric, aliform confluent connecting 3 - 8 vessel pores, banded with 7 - 22 series in *A. leucophloea* var.(1); aliform confluent connecting 2 - 10 vessels pores in *A. leucophloea* var. (2); and aliform confluent connecting 2 - 4 vessel pores in *A. arabica*. However, apotracheal parenchyma are found to be diffuse in aggregate in the two varieties of *A. leucophloea* and *A. arabica*.

Crystals are frequently present in these three trees studied, but showing 3- to 6-chambered parenchyma in *A. leucophloea* var. (1). 3- to 14-chambered in *A. leucophloea* var. (2), and 2- to 6-chambered in *A. arabica*.

In this research, the varieties of *A. leucophloea* could not be identified by proper name due to lacking available literature and hence they are tentatively described as var. (1) and var. (2). The further study for proper identification of the two varieties of *A. leucophloea* is called for.

6. CONCLUSION

The morphological characteristics of both of the reproductive and vegetative organs and the anatomical characteristics of the sapwood of the stems of *A. leucophloea* var. (1) and var. (2), and *A. arabica* collected from central Myanmar have been studied, described, compared and discussed.

Their distinct morphological characteristics are:

- (1) the medium-sized, deciduous armed trees.
- (2) bipinnately compound leaves which vary in the number of secondary rachaeae and leaflets.
- (3) the spinous stipules straight and paired.
- (4) the presence of the basal gland on the petiole, and 1 - 5 terminal glands, one on each junction of the uppermost secondary rachis pairs.
- (5) the paniculate small globose heads bearing yellowish white or bright yellow flowers.
- (6) the sessile, minute, bisexual and hypogynous flowers with campanulate and 5-lobed calyx, tubular-campanulate and 5-lobed corolla and numerous free exserted stamens.
- (7) the pistils monocarpellary, unilocular with two rows of alternating ovules on the marginal adjacent placentae, with distinct gynophore.
- (8) the styles filiform, glabrous and terminal, and the stigmas simple.
- (9) the ovaries oblongoid, hairy, and shortly stalked.
- (10) the ovules anatropous.
- (11) the pods lomentaceous-liner or strap-shaped, deliscent and yellowish brown or dark brown when maturity.

The sapwood shows diffuse porous; tangential pore diameter moderately small to very large and number per sq. mm. few to moderately numerous; vessel pores solitary or occasionally in radial multiples; perforation plate of the vessel elements simple; the fibres libriform, non-septate; the rays homocellular and heterocellular, uniseriate to multiseriate, number of rays per mm 5 - 18; axial parenchyma paratracheal and apotracheal, vasicentric, aliform, aliform confluent; the gum deposits present; crystals present or absent.

In conclusion, the morphological and anatomical characteristics of these three Myanmar *Acacia* species studied in this research are very usefully informative for identification, classification and their proper and effective utilization in near future.

It is also suggested for further investigation in many other aspects to promote knowledge of *Acacia* species and especially to identify and classify the species at the level of variety or form.

7. LITERATURE CITED

- Aung Kyaw (1976). *Angiosperm Flora of Nyain Baw and Its Surrounding Area (Along Mandalay -Lashio road)*; M.Sc. Thesis, Mandalay University.
- Aung Moe (1977). *Angiosperm Flora of the Bilin and Letpan Area*; M.Sc.Thesis, Mandalay University.
- Ah Mar Sein (1991). *Angiosperm Flora of the Area between Surrounding Madaya and Ta Nga Tha Village*. M.Sc. Thesis, Mandalay University.
- Auning Naing Oo (1994). *An Investigation on Morphological and Anatomical Characteristics of some Myanmar Fuelwood Timber Species*. M.Sc. Thesis, Mandalay University
- Bor, N.L. (1953). *Manual of Indian Forest Botany*. Geaffcey Cunnerlege, Oxford University Press, Bombay.
- Brandis,D. (1874). *The Forest Flora of North-West and Central India* . Bishen Singh and Mahendra, Pal Singh, Dehra Dun.
- Chattaway, M.M.(1956). *Crystals in Woods Tissues*. Part II. Tropical Woods. 104, Yale University: 100 – 124.
- Core, H. A; W.A. Cote & A.C. Day (1979). *Wood Structure and Identification*. 2nd Ed. Syracuse University Press.
- Easu, K. (1953). *Plant Anatomy*. John Wiley and Sons Inc., New York and London.
- Easu, K. (1961). *Anatomy of Seed Plants*. John Wiley and Sons Inc., Wiley International Edition, New York.
- Gamble. J.S (1922). *A Manual of Indian Timbers*. Sampson Low, Marston and Indian Company Limited, London.
- Hooker, J.D. (1879). *Flora of British India*, Vol. II and Vol. III L.Reeve and Company, London.
- Hnin Hnin Mya (1977). *Angiosperm Flora of Yankin Hill and its Surrounding Area*. M.Sc. Thesis, Mandalay University.
- Junikka, Leo (1994). *Survey of English Macroscopic Bark Terminology*. LAWA journal. Vol. 15 (1), 1994: 3 – 45.
- Kribs, David A. (1959). *Commercial Foreign Woods on the American Market*. The Pennsylvania State University. University Park, Pennsylvania.

- Khin Maung Tin (1974). *Angiosperm Flora of Taung-tha-man-inn and Tet-the-inn*. M.Sc. Thesis, University of Mandalay.
- Lawrence, George H.M. (1951). *Taxonomy of Vascular Plants*. The Macmillan Company: New York.
- Morehead F.T. (1944). *The Forests of Burma*, Burma Pamphlets No. 5., Longmans, Green & Co. Ltd.
- Metcalf, C.R and L. Chalk. (1950). *Anatomy of the Dicotyledons*, Vol. II Oxford at the Calrendon Press.
- Myint, Maung (1977). *Angiosperm Flora of Sedawlay Area*. M.Sc. Thesis, Mandalay University.
- Myint Myint Lay (1991). *A Comparative Morphology and Anatomy of Some Myanmar Species of the genus Acacia*. M.Sc. Thesis, Yangon University.
- Nielsen I.C (1984). *Leguminosae - Mimosoideae in Flora of Thailand*. Vol. IV, Part 2. 131 - 222. 1985, The forest Herbarium, Royal Forest Department, Bangkok.
- Nielsen I.C (1992). *Flora Malesiana. Series I - Spermatophyta*, Volume II, Part 1. Mimosaceae (Leguminosae - Mimosoideae) Published for foundation Flora Malesiana by Rijksherbarium/Hortus Botanicus Leiden University. The Netherlands.
- Pearson, R.S and Brown, H.P. (1932). *Commercial Timbers of India*. Vol. II Government of India Central Publication Branch. Calcutta.
- Rendle, Alfred Barton (1967). *The Classification of Flowering Plants*. Vol. II, Dicotyledons. Cambridge at the University Press
- Talbot, W. A (1902). *The Trees, Shrubs, and Woody Climbers of the Bombay Presidency*. 2nd Ed. Printed at the Government Central Press, Bombay.
- Tin Tin Nwe (1977). *Angiosperm Flora of the Southern Sagaing Hill*. M.Sc. Thesis, Mandalay University.
- Watt, George (1889). *A Dictionary of the Economic Products of India*. Vol. I. International Book Distributors, Dehra Dun.
- Wheeler, E. A; P. Bass and P.E. Gasson (1989). IAWA List of Microscopic Features for Hardwood Identification. *IAWA Bulletin* n.s. 10 (3):219 - 332; IAWA Committee. Leiden. The Netherlands.

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