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Morphology and Anatomy of Four Myanmar Species of the Genus *Acacia* from Dry Zone

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မြန်မာနိုင်ငံအပူပိုင်းဇုံမှ Acacia မျိုးစုဝင် မျိုးစိတ်လေးမျိုးတို့၏ပြင်ပရုပ်သွင်နှင့်ခန္ဓာဗေဒ

ရီရီဟန်၊ သုတေသနအရာရှိ

ကျော်ဝင်းမောင်၊ လက်ထောက်သုတေသနအရာရှိ
ကြည်ကြည်ရိုင်၊ သုတေသနလက်ထောက် (၃)
သစ်တောသုတေသနဌာန၊ ရေဆင်း
စိုးမြင့်၊ ပါမောက္ခချုပ် (အငြိမ်းစား)၊ ပခုက္ကူတက္ကသိုလ်

စာတမ်းအကျဉ်း

မြန်မာနိုင်ငံအပူပိုင်းဇုံမှ ရှား ထနောင်း မျိုးစုဝင် မျိုးစိတ်လေးမျိုး တို့ကို ကျောက်ပန်း တောင်း၊ မိတ္တီလာ၊ ပခုက္ကူ၊ ရေစကြို နှင့် မုံရွာမြို့နယ်တို့မှ စုဆောင်း၍ မျိုးမည်ဖော်ပြီး လေ့လာပါသည်။ ၄င်းတို့၏ပင်ပိုင်းနှင့်မျိုးပွါးပိုင်းတို့၏ ပြင်ပရုပ်သွင်နှင့် ပင်စည်၊ အမြစ်တို့၏ အပင်ခန္ဓာဗေဒတို့ကို နှိုင်းယှဉ်ဆွေးနွေး တင်ပြထားပါသည်။ ဤပြင်ပရုပ်သွင် လက္ခဏာများသည် အပူပိုင်းဒေသရှိ မျိုးစု Acacia ဝင် မျိုးစိတ်များကို မျိုးမည်ဖော်ရာ၌ အသုံးဝင်ပါသည်။ အပင်ခန္ဓာဗေဒ လက္ခဏာများသည် လည်း မျိုးမည်ဖော်ရာတွင် အထောက်အကူပြုပါသည်။

Morphology and anatomy of four species of the genus *Acacia* from dry zone of Myanmar

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Abstract

Specimens of four species of the genus *Acacia* were collected from Kyaukpadaung, Meiktila, Pakokku, Yezagyo and Monywa Townships, identified and studied. The morphological characteristics of their vegetative and reproductive parts and anatomical characteristics of stems and roots were described, compared, discussed, and presented with their photographs and photomicrographs. The morphological characteristics of the species are useful in identifying the *Acacia* species of dry zone, and anatomical characteristics of stems and roots also may help in identification.

Acknowledgement

We acknowledge the Directors of Forest Research Institute, Yezin who allowed us to conduct this research and providing the research grants. We are also thankful friends and local people who helped in various ways in the specimen collections.

Contents

1. INTRODUCTION

The genus *Acacia*, belongs to the family Mimosaceae, is generally much tolerable to drought and well distributed in arid zones of the world and it is also vigorously growing in dry zone of central Myanmar. Some of them are economically important for their contents such as tannin from their barks, dye from their gum; their stems can be used as poles, posts, and fence, and their timber used to make clubs, spears, and shields. Some species are used in making fine furniture and some are widely used as fuel wood.

The seeds from some specific ***Acacia*** species are a source of valuable food. Various extracts from the bark and leaves are used for medicinal purposes such as relieving tooth ache, colds, astringent, and to treat wounds and burns. Since nineteenth century Ethiopian species of *Acacia* (known as *grar*) was used as folk medicine for rabies.

The usefulness of a species depends very much on availability in terms of abundance and, as a food and fodder resource, seasonal availability, as well as the relative merits of other alternatives (Wickens 1995). Some of *Acacia* species could be potentially utilized as timbers of lesser known species. *Acacia* can be planted on a large scale to control erosion, especially after mining or construction damage.

Desertification, the consequences of over-cultivation, over-grazing and deforestation, is an insidious process and resulted in a degradation of the environment (Wickens 1995). The enormous scale of environmental degradation in recent decades might be cured by systematic management of maintaining and continuously growing of *Acacia* community together with other species of trees, shrubs and herbs.

It might be stressed that the most important role of *Acacia* and other tree and shrub species is to stabilize the environment and thus prevent desertification, a role that safeguards both the national and rural economy. Any future afforestation schemes should be designed for maximum protection against desertification (Wickens 1995).

The genus *Acacia* is distributed in Australia, Africa, Madagascar, throughout the Asia-Pacific region and in Americas (Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. (2012). The genus *Acacia* is also widely distributed in Myanmar, especially in dry zone of Central Myanmar. Among them 36 species are recorded by Kress *et al*. (2003).

Acacia communities have probably well established in dry zone of Myanmar before British invasion in Upper Myanmar. However, the community have been deteriorated to scarcity as observed as today in dry forests. Demands for fuel are undoubtedly the major cause of the scarcity of trees. It seemed that Irrawaddy Flotilla Company was one of the most consumers of *Acacia chundra* and *A. catechu* wood for inland steam-boat ferries along the Ayeyarwadi river, and many fuel wood suppliers to the company had been established on both sides of Ayeyarwadi river according to the local aged eye-witnesses.

The local aged remarked that the hill forest of Tant-kyi-taung which lying at the opposite side of Bagan on the west bank of Ayeyarwadi was being wildlife habitat including tiger at that time. Consequently, it still needs a system for managing the *Acacia* communities for the benefit of the rural people in order to meet their various needs as well as to maintain the environment and its associated wildlife.

Nowadays, local people in Myanmar encounter a shortage of fuel-wood because of over extraction of fuel-wood trees for their daily use. The population in rural area as well as in urban one is still growing and fuel consumption is also greater than ever. In dry zone of Myanmar,

although *Acacia* species are enormously growing, some of them are felled by local people for fuel-wood and other purposes and becoming smaller in number.

The *Acacia* trees are used mostly as fuel wood by local people in rural area. Hence, fuel demands of the urban populations also have a large impact on the tree resources of the rural areas, affecting not only the local people but also the natural environment conservation. It is required that the trees including *Acacia* community which are utilized in fuel, medicinal, fodder, and other purposes have to be sustainable to meet local needs.

The systematic management of the Acacia communities provides the benefit of the rural people in order to meet their needs for fuel, fodder, medicinal, etc. as well as to maintain the environment and its associated wildlife (Wickens 1995).

This research on four species of the genus *Acacia* is conducted with the aims and objectives of providing information of morphological and anatomical characteristics of the species, supporting in specific identification in *Acacia*, and motivating the local people and responsible persons in conserving dry forest of Myanmar and preventing desertification by systematic management of maintaining and continuously growing of *Acacia* community together with other species.

2. LITERATURE REVIEW

The genus *Acacia* was distributed in Australia, Africa, Madagascar, throughout the Asia-Pacific region and in Americas (Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. (2012).

Old *et al.* (2002) described that Acacias (*Acacia* Mill.) were woody legumes of the Mimosaceae family, occurring naturally in all the inhabited continents except Europe. There were more than 1500 species, worldwide, with around 1200 of these endemic to Australia. Many were pioneer species in their natural environments and consequently, they usually display very vigorous growth in cultivation ranging in size from small shrubs to large forest trees. Acacias were suitable for a wide range of wood and non-wood uses. Like other legumes, they formed symbiotic associations with soil bacteria to fix atmospheric nitrogen, making them suitable for poor quality sites.

Hundley and Chit Ko Ko (1987) listed a total of 26 species of the genus *Acacia* in Myanmar. Kress *et al*. (2003) stated that the genus *Acacia* is widely distributed in Myanmar containing 36 species.

The genus *Acacia*, commonly known as Wattle, belonged to the family Mimosaceae and some 1350 species of *Acacia* were found throughout the world. About 1000 species were found in Australia. Australia's national floral emblem was *Acacia pycnantha*, the Golden Wattle and Wattle Day was celebrated on the first of September each year (Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. (2012).

Rafting Masti (2008) described that *Acacia chundra* was the moderate sized deciduous tree. The leaves were 8 – 10 cm long and it had short curved stipular spines and rough grayish brown bark. The flowers were pale yellow in colour. Fruits were ripened in January to March and remaining in the tree for long.

Kshirsagar (2012) stated that *Acacia* was a cosmopolitan genus containing about 1350 species (Orchard & Maslin, 2003) and the second largest genus in the Leguminosae. *Acacia* had had a complex nomenclatural history. Synonym of *A. chundra* (Roxb. ex Rottler) Willd. was *Mimosa chundra* Roxb. ex Rottler; *Acacia sundra* DC.; and *A. catechu* Willd. var. *sundra* Prain. It was a tree, bark dark brown, deeply fissured; stem unarmed; branches prickled, prickles hooked, in pairs. Leaves were bipinnate, about 9 – 12 cm long; pinnae pairs about 12 or 13,

pinna about 3 cm long; leaflets about 24 – 26 pairs, about 4 mm long, acute or obtuse at apex, puberulous; main rhachis puberulous; glands between upper 3 or 4 pairs of pinnae; fistular, depressed, rounded to elliptic rhachis gland in between or near the lowest pair of pinnae. Inflorescence was axillary, solitary, or in 2 or 3 spikes per axial, about 11.5 cm long. Flowers were creamy white, sepals 5, united entirely into a tube, completely glabrous, 0.4 – 0.5 mm long, petals 5, free, glabrous, 2 – 2.5 mm long (2 mm exceeding glabrous calyx), linear, acute at apex, scarious at margin. Stamens were numerous, filaments creamy-white, pellucid; ovary green, oblique, style pellucid; stigma terminal. Pods were about 4.5 – 7.2 long and 1.5 – 1.7 cm wide, acute at apex, attenuate at base. Flowers appeared in June to August and fruiting was in August to January.

Kshirsagar (2012) also discussed that in *A. catechu* and *A. chundra*, the rachises were never completely glabrous. Bark was brown to dark brown; flowers creamy-white; corolla 2 – 3 times exceeding the calyx; pinnae more than 20. Calyx, corolla and rhachises were densely pubescent in *A. catechu* and calyx, corolla glabrous and rhachises puberulous to pubescent in *A. chundra.*

Acacia seeds such as *Acacia dealbata* were often used for food and a variety of other products. In Myanmar, Laos and Thailand, the feathery shoots of *A. pennata* (common name cha-om, and su pout ywet in Myanmar) were used in soups, curries, omelettes, and stir-fries (Wikipedia. (2013).

Various species of Acacia yielded gum. True gum arabic was the product of *Acacia senegal*, abundant in dry tropical West Africa from Senegal to northern Nigeria.(Wikipedia 2013).

Acacia chundra was a perennial, deciduous tree found in Asia, India and in the Indian Ocean area. It grew 12 m to 15 m in height. Common names for it included Karangali, Kodalimurunkai, Lal Khair, Rat Kihiriya and Red Cutch. Its uses included chemical and wood products (Wikipedia 2013).

Acacia senegal was a small deciduous Acacia tree, known by the common names Rfaudraksha, Gum Acacia, Gum Arabic Tree, or Gum Senegal Tree. It was native to semi-desert regions of Sub-Saharan Africa, as well as Oman, Pakistan, and northwestern India. It grew to a height of 5 – 12 m, with a trunk up to 30 cm in diameter. It was the source of the world's highest quality gum arabic, known locally as hashab gum (Wikipedia 2013).

Gaikwad *et al.* (2012) described that *Acacia planifrons* were small armed trees with spreading branches. Leaves were bipinnate and stipular spines were of two kinds. Flowers were in globose heads in axillary fascicles and pods were subcylindric, turgid, and circinate. This species was readily distinguished from others in having an umbrella like canopy, stipular spines of two kinds and circinate pods. Gaikwad *et al.* (2012) stated that *A. senegal* were small trees, and stems prickly. Leaves were bipinnate and stipular spines usually ternate. Flowers were white in spikes and pods were linear-oblong, flat, 5 – 6 seeded. The species could be easily identified by its ternate stipular spines, and the two lateral spines were nearly straight or slightly curved upwards and the middle one was curved downwards.

Khin Ni Lar San and Soe Myint (2002) stated morphological and anatomical characteristics of two varieties of *A. leucophloea* and *A. arabica* of Myanmar.

Pearson and Brown (1932) stated that the wood of *A. leucophloea* was a moderately heavy, non-ornamental, red or reddish-brown, irregularly interlocked-grained and coarse-textured; featured anatomically 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.

Pearson and Brown (1932) mentioned that the wood of *A. leucophloea* was used for agricultural implements and especially for ploughs, as also for oil-mills. It was used to a limited extent for cart wheels, for verandah posts and beams, carts, wheels, ploughs, and for turnery. It was used for tool handles and everywhere used as fuel.

3. MATERIALS AND METHODS

The samples of reproductive and vegetative parts of *Acacia* species were collected from Pakokku (21° 9′ North Latitude; 95° 05′ East Longitude) and Yezagyo (21°38′ North Latitude, 95° 14′ East Longitude), Magway Region, Monywa (21° 9′ North Latitude, 95° 05′ East Longitude), Sagaing Region; Letpabya (20° 48′ North Latitude, 95° 24′ East Longitude), Kyaukpadaung Township, and Meiktila (20° 52′ North Latitude, 95° 51′ East Longitude), Mandalay Region, in the year of 2010 to 2012. Small portions of stem near at the breast height level and small portions of the tap roots were also taken. Some of the specimens are dried to make herbarium sheets and some of them are killed and fixed in 50% or 70% ethyl alcohol for further study. The collected specimens are authenticated by Tree improvement Section (Herbarium voucher)

The barks, stems, lateral roots, as well as the plants in natural habit in flowering and fruiting seasons, were studied and described, compared, discussed and presented.

The small portions of petioles, leaf blades, fruits, seeds, stem and tap roots which were previously killed and fixed were washed in the running water for overnight and the specimens were dehydrated through a series of tertiary butyl alcohol solutions. Then the totally dehydrated specimens were infiltrated in a series of paraffin wax of which melting points were 49° C, 55° C and 60° C respectively. The specimens were then embedded in the 60° C paraffin wax and cut into 16 – 19 µm thick sections by using a rotary microtome, model AO 820.

These thin sections were mounted on a clean glass slide by Mryer's albumen and immersed in xylol solution to remove paraffin. Then they were double-stained in the combination of safranin and fast green solutions according to Johenson (1940). After staining, the sections were permanently mounted under a cover slip by using Canada balsam in xylene and kept dried for a few days on a slide tray in the room temperature. The killing and fixation, dehydration, infiltration, embedding, staining and mounting were made according to Johansen's (1940) Method.

Some of the stem blocks and root blocks were boiled in water for 12 hours and cut into 25 – 30 µm thick sections by using a sliding microtome. These sections were stained haematoxilin and safranin combination according to Johansen (1940). After staining, the sections were dehydrated and permanently mounted under a cover slip with Canada balsam in xylene and kept dried for a few days on a slide tray.

The parts of leaves, fruits, seeds, stem bark, stem wood, root bark and root wood were macerated separately by warming in a mixture of two parts of 30% hydrogen peroxide solution and one part of glacial acetic acid solution according to Franklin's method (modified) (Berlyn and Mikshe 1976). The macerated elements were studied under research microscope and the vessel elements and fibers were measured and recorded by a digital camera.

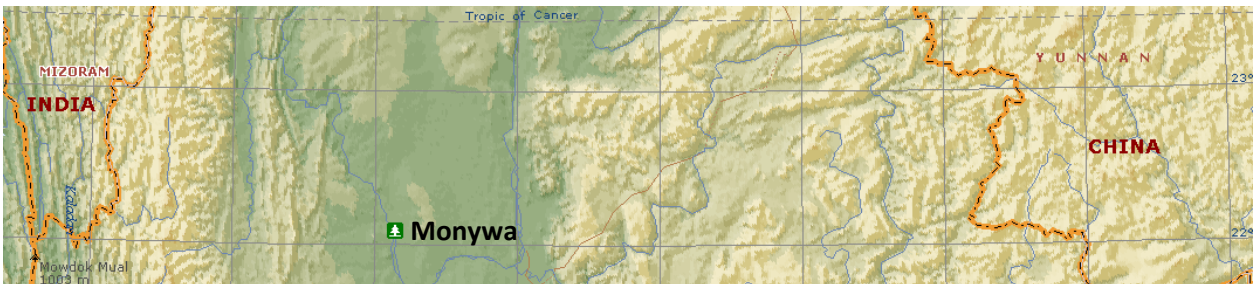


Figure 3.1 Location map of collection site of *Acacia* species.

4. RESULTS

4.1. Morphology

All of the four species of the genus *Acacia* are armed trees. However the trees of *Acacia planiferon* and *A. senegal* are smaller than those of the rest two species. Among them, *A. planifrons* are baring white and long thorns on the branches while young whereas *A. leucophloea* baring brown and long thorns on the branches while young.

The inflorescences of *A. planifrons* and *A. leucophloea* are globosed heads and those of *A. chundra* and *A. senegal* are spikes. The flowers of *A. planifrons* and *A. leucophloea* are smaller than those of *A. sundra* and *A. senegal*. The flowers of all of the four species are actinomorphic, regular, penta-merous, bisexual and hypogynous.

The calyxes are campanulate and calyx lobes are toothed and small. The corollas are gamopetalous and tubular in shape. Stamens are many in number and apostemonous. Filaments are slender and long. The anther lobes are dithecous, dehisced longitudinally and usually they bare glands at their tips. Their pollen grains are pollinia. Pistils are monocarpellary, marginal placentation with two rows of alternating ovules on the same placenta.

Fruits are pods or legumes and indehiscent in *A. senegal* and dehiscent in the rest three species.

4.1.1 Generic characters of *Acacia*

***Acacia* Willd; Fl. Brit. Ind. ii. 292**

Synonym: *Acaciella* Britton & Rose;
Racosperma Martius
Senegalia Rafinesque
Vachellia Wight & Arnott.

Trees, shrubs and climbers, armed with stipular, infra-stipular or scattered. Leaves by bipinnate, pinnae and leaflets opposite. Flowers yellow or white, in globase heads or cylindrical spikes; numerous scaly bracteoles between the flowers. Calyx and corolla 4 – 5 merous. Stamens free, generally very numerous. Fruits dehiscent or indehiscent. Trees or shrubs; stipules spinescent; flowers in globase heads or spikes.

4.1.2 Synoptic key to the species of the genus *Acacia*.

1. Inflorescences are cylindrical spikes …….2
   2. Number of secondary rachis 11 – 14 pairs per leaf and number of leaflet 21 – 34 pairs per secondary rachis and leaflet glabrous, pod dehiscent ……..
   ……***Acacia chundra***
   2. Number of secondary rachis 3 – 5 pairs per leaf and number of leaflet 5 – 14 pairs per secondary rachis and leaflet sparcely pubescent, pod indehiscent **……**
   ……*Acacia senegal*
1. Inflorescences are globose heads ……..3

3. Number of flowers 77 – 97 per head; flowers pale yellow,brown and long spines present on the branch while young …….***Acacia Leucophloea***
3. Number of flowers 20 – 24 per head; flowers white, white and long spines present on the branch while young …….. ***Acacia planifrons***

4.1.3 ***Acacia chundra Willd.***

***Acacia chundra* Willd.** Sp. Pl., ed. 4 [Willdenow] 4(2): 1078. 1806 [Apr 1806] (IK)
Synonym: *Acacia sundra* DC**.** Prodr.[A.P.de Candolle] 2:458. 1825[mid Nov1825](IK)
A. sundra Roxb. Numer. List [Wallich] n.5227.[1831-32](IK)
A. catechuoides Wall. Cat. 5229 A, parte.
A. catechu Brand. For. Flor. 186, et Benth, in Trans. Linn. Soc. xxx. 519, in part.
A. catechu Willd. var. *sundra* Prain in J. Asiat. Soc. Bengal, 66: 508-510. 1898; Cooke, Fl. Pres. Bombay 1: 448. 1958 (Repr.ed.).
A. catechu var. *sundra* (Roxb.) Duthie
Mimosa sundra. Roxb. Cor. Pl. t. 225; Hort. Beng. 41; Fl. Ind. ii. 562.
M. chundra Roxb. ex Rottler, Ges. Naturf. Freunde Berlin Neue Shriften 4: 207. 1803.

Local name: Sha, Shar-pin.
Trade name: Cutch, Sha, Shasi;
(Red Cutch, Sundra, Sadra, and Lal khair, Kaiger Kher in India).
Family: Mimosaceae.
Localit: Pakokku University campus, Pakokku.
Specimen examined: Yi Yi Han *et al*., 30-7-2011; Herbarium Voucher No. 2444/12.
Flowering period: April to September.
Fruiting period: May to September, ripe fruits observed round the year in some plants.

Taxonomic Description

Armed trees with laxly cylindrical crown, bushy while young with usually brown spines.

Stem straight, terete; 6 – 8 meter high, 3 meter to the first branch from the ground level; main trunk with spines while young; stipular spines paired, 3 – 6 mm long and 2 – 9 mm wide at the base on the young branches, usually brown, slightly curve and pointed,

A. A tree grown in natural habit. **B.** A portion of stem showing bark. **C.** A flowering branchlet and young fruits.

D. Inflorescences and ripen dry fruits on a tree. **E.** A fruiting branchlet showing young and ripe dry fruits. **F.** A very young fruit on a branchlet.

Figure 4.1 Habit of *Acacia chundra*.

stipular spines 2.5 – 3.0 mm long and 2.5 mm wide at the base on the flowering branchlets, glabrous.

Barks grayish brown, 4 – 13 mm thick, with longitudinal, variously deep and wide furrows and long ridges, short horizontal cracks present; 3 – 5 whitish rings in transverse section, inner bark 2 – 5 mm thick.

Leaves bipinnately compound, 11.5 – 13.5 cm long and 2.5 – 4.5 cm wide, alternate, petiolate, petiole pulvinate, 2.0 – 2.5 mm in length, cylindrical, sparsely pubescent, an elliptical gland present on the upper surface at about three fourths of the petiole from its base, gland glabrous; primary rachis 6.0 – 9.5 cm long, cylindrical, sparsely pubescent, a small discoid gland present below the tip, tip pointed, 11 – 14 pairs of secondary rachae per primary rachis; secondary rachis 2.1 – 3.1 cm long, pubescent, with 21 – 34 pairs of leaflets; leaflets petiolutate; petiolule very short, terete, very small discoid glands present on the margin and surfaces, green above and slightly paler beneath, oblong, 2 – 4 mm long and 1 mm wide, tip cuspidate, margin entire, base oblique.

Inflorescences spikes, cylindrical in shape, axillary, 1 or 2 in number per axil, white, turn milky in older stage green, pubescent, flowering portion of the spike 4.5 – 7.0 cm in length and 1.0 – 1.2 cm in diameter; 55 – 78 flowers per head, white, turn milky when older.

Flower ebractate, sessile, ebracteolate, complete, bisporangiate, regular, actinomorphic, cyclic, pentamerous, hypogynous. Calyx gamosepalous, infundibuliform, 5-lobed, whitish green, glabrous; calyx tube 0.5 – 0.6 mm long, toothed, glabrous, whitish, valvate. Corolla gamopetalous, tubular, tube 1.5 – 1.7 mm long, whitish green, glabrous, 5-lobed, corolla lobes triangular, about 0.7 – 0.9 mm long, greenish white, glabrous, valvate.

Androecium numerous, apostemonous, filaments white, about 2 – 3 mm long, glabrous, anthers dithecous, yellow, dehiscence longitudinal, pollens forming pollinia, dorsifixed. Gynoecium monocarpellary, unilocular, placentation marginal, with two rows of alternating ovules on a single placenta. Ovary slightly yellowish green, glabrous, gynophores very short; style slender, stigma simple, ovary superior.

Pods or legumes 6.5 – 10.8 cm long and 1.2 – 2.2 cm wide, 3 – 7 seeded, purple in colour while very young and turn purplish green while older, then black when dry. Seeds discoid, germination epiginal, non-endospermic.

Floral formula: ⊕ ♀ **$K_{(5)}$ $C_{(5)}$ A_{∞} $G_{\underline{1}}$**

Distinguishing characters

(1) Trees are armed with laxly cylindrical crown, bushy while young with usually brown spines.

(2) Barks are grayish brown, 4 – 13 mm thick, with variously deep and wide longitudinal furrows and long ridges and shallow horizontal cracks; 3 – 5 whitish rings in transverse section.

(3) Leaves are bipinnately compound, sparsely pubescent, an elliptical gland present on the upper surface at about three fourths of the petiole from its base.

(4) Primary rachis is sparsely pubescent, a small discoid gland present below the tip, tip pointed; and bearing usually 7 – 18 pairs of secondary racheae.

(5) Secondary rachis is pubescent, and bearing 21 – 34 pairs of leaflets.

(6) Very small discoid glands present on the margin and surfaces of the leaflets, tip cuspidate, base oblique.

(7) Inflorescences are spikes, cylindrical in shape, axillary, 1 or 2 in number per axil, white, turn milky in older stage, and pubescent.

(8) Flowers are sessile, actinomorphic, pentamerous, and hypogynous.

(9) Calyxes are gamosepalous, infundibuliform, whitish green, and glabrous;

(10) Corollas are gamopetalous, tubular, whitish green, and glabrous.

(11) Stamens are numerous in number, apostemonous, and dorsifixed.

(12) Pistils are monocarpellary, unilocular, placentation marginal, and with two rows of alternating ovules on a single placenta.

(13) Ovaries are glabrous, and gynophores very short.

(14) Pods or legumes are 3 – 7 seeded, and purple in colour while very young and turn purplish green while older, then black when dry.

Uses

The wood was used in shipbuilding. The tree was used for timber, for cutch from its wood and for tannin. It was also used as food for bees. Cutch was used as a dye and to preserve fabrics from weather, mildew and marine exposure (Wikipedia 2013).

The tree is very useful in the dental problems. It also used in dry cough, in stomatis, anaemia, leprosy, bronchitis, pruritus, diarrhoea, polyuria. Catechin, catechutanic acid and tannin of the wood are used externally for ulcers, boils and eruption of the skin. The juice of the fresh bark is used in haemoptysis and to treat painful throat and cough. The mucilaginous gum exudes from the tree yield one of the beast substitutes for true gum arabic. The wood extracts are used for tanning and dying Khaki. Its wood is used as the raw material in the raw industry. It is used in making the plough and the pounding log for rice (Rafting Masti 2008).

4.1.4 *Acacia leucophloea* Willd.

Acacia leucophloea **Willd.** Sp. Pl. ed. 4 [Willdenow] 4(2): 1083. 1806 [Apr 1806] (IK) Synonym: *Acacia alba* Willd. DC. loc. cit.

A. arcuata Decaisne Herb. Timor. Descr. 133.

Mimosa leucophloea Roxb. Cor. Pl. t. 150. 1798; Fl. Ind. ii. 558. 1832.
M. alba Rottl. in Nov. Act. Ber. 1803

Local Name: Hta-naung
Trade Name: White-barked acacia, Hta-naung
Family: Mimosaceae
Locality: Letpabya, Kyaukpadaung Township; Pakokku University campus, Pakokku;
Specimen examined: Yi Yi Han *et al*., 4-1-2011, Letpabya, Kyaukpadaung Township; 26-6-2011, 3-9-2011, Pakokku University campus. Herbarium Voucher No. 2445/12.
Flowering period: June to November.
Fruiting period: December to May.

Taxonomic Description

Armed trees with umbelliform crown, bushy while young with brownish long thorns.

Stem straight, terete; 8 – 10 m to the first branch from the ground level; main trunk with spines while very young; lateral branches with long spines while young, the spines 2 – 3 mm long, pointed; the spines brown in colour in lateral branches of mature tree, the stipular spines paired, 1 – 4 mm long and 2 mm wide in flowering branchlets, sometimes spine 1.2 – 2.0 cm long, pubescent.

Barks gray, thick, with longitudinal deep furrows and vertical and horizontal cracks, older barks turned brownish black, and usually damaged and detached so that inner barks exposed, inner barks greenish white.

Leaves bipinnately compound, 5.0 – 16.0 cm long and 2.0 – 8.0 cm wide, alternate, petiolate, petiole pulvinate, 2.1 – 0.9 cm in length, cylindrical, pubescent;

A. A tree grown in natural habit. **B**. A portion of stem showing bark. **C.** A branchlet bearing an inflorescence of globose heads.

D. A portion of stem showing bark exposing inner barks. **E**. A portion of inflorescence showing globose heads and paired spines. **F.** Globose heads, floral buds, and flowers.

G. An inflorescence on a tree.

Figure 4.2 Habit of *Acacia leucophloea*.

primary rachis 4.0 – 9.5 cm long, cylindrical, pubescent, with 2 – 8 pairs of secondary rachae; an small oval gland present on the primary rachis at the point of attachment of lowermost pair of secondary rachis, deep brown in colour; two glands also present on the terminal portion of primary rachis, one at each point of attachment of uppermost and to next to uppermost pair of secondary rachis; a mucro present at the top of secondary rachis.

secondary rachis 4.0 – 5.6 cm long, pubescent, with 16 – 24 pairs of leaflets; leaflets sub-sessile; lamina green above and slightly paler beneath, oblong, 4 – 8 mm long and 1.0 – 2.0 mm wide, tip acute, margin entire and pubescent, base oblique.

Inflorescences globose heads, terminal 8 – 24 in number per axil, yellow, stalk jointed at the middle portion, cylindrical, green, pubescent, head 5 – 7 mm in diameter; 77 – 97 flowers per head, yellow; four bracts present on the joint of the stalk, triangular, green, pubescent.

Flower bractate, bracts present at the base of flower, triangular, whitish; sessile, ebracteolate, complete, bisporangiate, regular, actinomorphic, cyclic, pentamerous, hypogynous. Calyx gamosepalous, infundibuliform, 5-lobed, whitish, pubescent; calyx tube 1.0 – 1.5 mm long, toothed, pubescent, whitish, valvate. Corolla gamopetalous, tubular, tube 2 mm long, whitish, pubescent; 5-lobed, corolla lobes triangular, about 1 mm long, greenish white, pubescent, valvate.

Androecium numerous, apostemonous, filaments young white, 6 – 7 mm long, glabrous, anthers dithecous, yellow, dehiscence longitudinal, pollens forming pollinia, dorsifixed. Gynoecium monocarpellary, unilocular, placentation marginal, with two rows of alternating

ovules in transverse section on a single placenter. Ovary slightly yellowish green, glabrous, rarely pubescent, gynophores very short; style slender, stigma simple, ovary superior.

Pods or legumes 5.9 – 7.0 cm long and 0.4 – 0.8 cm, 4 – 12 seeded, dehiscent, greenish gray in colour. Seeds discoid, non-endospermic.

Floral formula: ⊕ ♀ $K_{(5)}$ $C_{(5)}$ A_{∞} $\underline{G_1}$

Distinguishing characters.

(1) Trees are armed with umbelliform crown, bushy while young with brownish long thorns.
(2) Barks are gray, thick, with longitudinal deep furrows and vertical and horizontal cracks, older barks usually damaged and detached, inner barks greenish white.
(3) Leaves are bipinnately compound, petioles cylindrical, pubescent.
(4) Primary rachis is pubescent, with 2 – 8 pairs of secondary racheae.
(5) secondary rachis is pubescent bearing 16 – 24 pairs of leaflets;.
(6) Inflorescences are globose heads, terminal, 77 – 97 flowers per head, yellow; four bracts present on the joint of the stalk,.
(7) Flowers are bracteate, bracts triangular, whitish; flowers sessile, ebracteolate, complete, actinomorphic, pentamerous and hypogynous.
(8) Calyxes are gamosepalous, infundibuliform, toothed, whitish, and pubescent.
(9) Corollas are gamopetalous, tubular, whitish, pubescent; 5-lobed,
(10) Stamens are numerous, apostemonous, and dorsifixed.
(11) Pistils are monocarpellary, unilocular, placentation marginal, and with two rows of alternating ovules on a single placenta.
(12) Ovaries are glabrous, rarely pubescent, gynophores very short.
(13) Pods or legumes are 4 – 12 seeded, greenish gray in colour.

Uses

The barks are used in Pakistan traditional medicine as an astringent, a bitter, a thermogenic, a styptic, a preventive of infections, an anthelmintic, a vulnery, a demulcent, an expectorant, an antipyretic, an antidote for snake bites and in the treatment of bronchitis, cough, vomiting, wounds, ulcers, diarrhea, dysentery, internal and external hemorrhages, dental caries, stomatitis, and intermittent fevers and skin diseases (Wikipedia 2013).

4.1.5 *Acacia planifron*s Wight & Arn.

***Acacia planifron*s Wight & Arn.** Prodr. Fl. Ind. Orient. 1: 276. 1834. [10 Oct. 1834](IK).

Synonym: *Acacia Farnesiana* Wall. Cat. 5264 I.
A. roxburghii W. & A. Prodr. 276.
A. campbellii Arn. Pug. 15
Mimosa eburnea Roxb. Cor. Pl. t. 199; Fl. Ind. ii. 558, non Linn.
M. horrid Sm. In Rees Cyclop.
M. planifrons Koenig ex W. & A., l.c. Type: Ceylon, *s.n.* (LUND).

Local Name: Subyu
Family: Mimosaceae
Trade Name: Subyu, Umbrella-thorn
Locality: Roadside of Taung-phila Monastery, Shweguni Village, Monywa Township; Singyo-shwegu Road, Yezagyo Township; Roadside in front of compound of Aged, Meiktila.

Specimen examined: Yi Yi Han *et al.,* 18-6-2011, Shweguni Village, Monywa Township; 3-9-2011, Singyo-shwegu Road, Yezagyo Township; 31-8-2011, Roadside in front of compound of Aged, Meiktila. Herbarium Voucher No. 2446/12.

Flowering period: May to November.

Fruiting period: December to May.

Taxonomic Description

Armed trees with umbelliform crown, bushy while young with white and long thorns.

Stem straight, terete; 4 – 6 m to the first branch from the ground level; main trunk with spines while very young; lateral branches with long white spines while young, the spines 1.7 – 2.8 cm long, white and pointed; the spines not white in colour in lateral

A. A tree showing umbelliform crown. **B.** A flowering branchlet and dry fruits.

C. A fully blossomed tree. **D.** Branches bearing white and long thorns on a young plant.

E. A portion of stem showing bark. **F.** Heads showing floral buds and flowers.

Figure 4.3 Tree, flowering branches,white thorns, and heads of *Acacia planifrons.*

A. A flowering branchlets on a tree showing globose head with white flowers.

B. Branchlets on a tree bearing white and long thorns. **C.** A fruiting branchlet showing a curve pod.

Figure 4.4 Flowering branch, white thorns and a fruit of *Acacia planifrons.*

branches of mature tree, the stipular spines paired, 1 – 4 mm long and 2 mm wide in flowering branchlets, sometimes long spine present, 12 mm long, pubescent.

Barks blackish gray, thick, brittle, with longitudinal fissures and vertical and horizontal cracks, fissures deep in older barks.

Leaves bipinnately compound, 5.0 – 9.5 cm long and 2.5 – 5.5 cm wide, alternate, petiolate, petiole pulvinate, 5 – 12 mm in length, cylindrical, pubescent; primary rachis 3.0 – 7.5 cm long, cylindrical, pubescent, with 7 – 14 pairs of secondary rachae; secondary rachis 1.5 – 2.6

cm long, pubescent, with 10 – 22 pairs of leaflets; leaflets petiolutate; petiolule very short, terete, pubescent, green above and slightly paler beneath, oblong, 4 – 6 mm long and 0.5 – 2.0 mm wide, tip cuspidate, margin entire and pubescent, base oblique.

Inflorescences globose heads, axillary, 1 – 7 in number per axil, white, turn milky in older stage, stalk jointed at the middle portion, cylindrical, green, pubescent, head 1.4 – 1.8 cm in diameter; 20 – 24 flowers per head, white, turn milky when older; two small bracts present on the joint of the stalk, triangular, brownish green, pubescent.

Flower bractate, bracts present at the base of flower, triangular, whitish; sessile, ebracteolate, complete, bisporangiate, regular, actinomorphic, cyclic, pentamerous, hypogynous. Calyx gamosepalous, infundibuliform, 5-lobed, whitish, pubescent; calyx tube 0.7 – 1.0 mm long, toothed, pubescent, whitish, valvate. Corolla gamopetalous, tubular, tube 2 mm long, whitish, pubescent; 5-lobed, corolla lobes triangular, about 1 mm long, greenish white, pubescent, valvate.

Androecium numerous, 97 – 102 in number, apostemonous, filaments white, 6 – 7 mm long, glabrous, anthers dithecous, yellow, dehiscence longitudinal, pollens forming pollinia, dorsifixed. Gynoecium monocarpellary, unilocular, placentation marginal, with two rows of alternating ovules in transverse section on a single placenter. Ovary slightly yellowish green, glabrous, rarely pubescent, gynophores very short; style slender, stigma simple, ovary superior.

Pods or legumes 2.5 – 5.5 cm long and 3 – 7 mm wide, 3 or 4 seeded, slightly purple in colour and turn black when dry. Seeds discoid, germination epiginal, non-endospermic.

Floral formula: ⊕ ♀ $K_{(5)}$ $C_{(5)}$ A_{∞} $\underline{G_1}$

Distinguishing characters

(1) Trees are armed with umbelliform crown, bushy while young with white and long thorns.
(2) Barks are blackish gray, thick, with longitudinal fissures and vertical and horizontal cracks, fissures deep in older barks.
(3) Leaves are bipinnately compound, 5.0 – 9.5 cm long and 2.5 – 5.5 cm wide, petioles cylindrical, pubescent.
(4) primary rachis pubescent, with 7 – 14 pairs of secondary racheae.
(5) secondary rachis is pubescent bearing 10 – 22 pairs of leaflets.
(6) Inflorescences are globose heads, axillary, 1 – 7 in number per axil, 20 – 24 flowers per head, white, turn milky when older; two small bracts present on the joint of the stalk.
(7) Flowers are bracteate, bracts triangular, whitish; actinomorphic, pentamerous and hypogynous.
(8) Calyxes are gamosepalous, infundibuliform, 5-lobed, whitish, pubescent.
(9) Corollas are gamopetalous, tubular, whitish, pubescent; 5-lobed.
(10) Stamens are numerous, 97 – 102 in number, apostemonous, and dorsifixed.
(11) Pistils are monocarpellary, unilocular, placentation marginal, and with two rows of alternating ovules on a single placenta.
(12) Ovaries are glabrous, rarely pubescent, gynophores very short.
(13) Pods or legumes are 4 – 12 seeded, greenish gray in colour.

Uses

Local people used for poles, posts, and fuelwood.

4.1.6 *Acacia senegal* Willd.

***Acacia senegal* Willd.** Sp. Pl., ed. 4 [Willdenow] 4(2): 1077. 1806 [Apr 1806] (IK)
DC. Prodr. ii. 459 in part.

Synonym: *Mimosa senegal* L. Sp. Pl. 521. 1753.
Senegalia senegal (L.) Britton (1930)
Acacia verek Guill. & Per. Fl. Seneg. i. 245, t 56.
A. rupestris Stock. Boiss. Fl. Orient. ii. 638.; Stock. Brandis F. Fl. 184.
Local Name: Senegal-sha
Trade Name: Gum tree, gum arabic tree, three-thorned acacia, gum acacia, hashab (Arabic).
Family: Mimosaceae
Locality: Roadside of Meiktila-Kyaukpadaung Road, Near Letpanphya Village.
Specimen examined: Yi Yi Han *et al*., 1-2-2011, 31-8-2011; Roadside of Meiktila-Kyaukpadaung Road, Near Letpanphya Village. Herbarium Voucher No. 2447/12.
Flowering period: May to September.
Fruiting period: May to September, dry fruits observed on the trees round the year.

Taxonomic Description

Armed, deciduous trees with laxly cylindrical crown, triple brownish black spines present at the nodes.

Stem straight, terete; 4 – 8 meter high, 2 meter to the first branch from the ground level; lateral branches with three stipular spines at the base of petiole on the node, two lateral ones curved upward, the central spine curved downward, the spines 3 – 4.5 mm long and 2.5 – 3.0 mm wide at the base, brownish black, glabrous.

Barks whitish gray with longitudinal, long and deep cracks and short, shallow or deep vertical cracks, with many warts, 7 – 9 mm thick.

Leaves bipinnately compound, 3.0 – 6.5 cm long and 2.5 – 5.5 cm wide, alternate, petiolate; petiole pulvinate, 5 – 8 mm in length, cylindrical, sparsely pubescent, a small gland

A. A tree growing at natural habit. **B.** A portion of stem showing bark. **C.** Spikes on the branchlet of a tree.

D. Developmental stages of floral bud to dry fruit. **E.** Floral buds, flower, pistil and calyx.

Figure 4.5 Habit of *Acacia senegal*.

present on the upper surface at about one third of the petiole from its base, gland glabrous; primary rachis 1.5 – 2.6 cm long, cylindrical, sparsely pubescent, tip pointed, 3 – 5 pairs of secondary racheae per primary rachis; secondary rachis 1.3 – 3.7 cm long, sparsely pubescent, with 5 – 14 pairs of leaflets; leaflets petiolutate, petiolule very short, terete, green above and slightly paler beneath, oblong, 2 – 3 mm long and 1 mm wide, tip acute, margin entire occasionally with a few hairs, base oblique, sparsely pubescent.

Inflorescences spikes, cylindrical in shape, axillary, 1 or 2 in number per axil, white, peduncle pubescent, flowering portion of the spike 6 – 9 cm in length and 1.3 – 1.5 cm in diameter; 67 – 135 flowers per head, white.

Flower ebractate, sessile, ebracteolate, complete, bisporangiate, regular, actinomorphic, cyclic, pentamerous, hypogynous. Calyx gamosepalous, campanulate, 5-lobed, 0.9 – 1.0 mm long, very small gland present on the margin of calyx lobe, a few hairs present on the calyx lobe, whitish green, valvate. Corolla gamopetalous, tubular, tube 1.5 – 2.0 mm long, whitish green, glabrous, 5-lobed, corolla lobes triangular, 0.9 – 1.2 mm long, greenish white, glabrous, valvate.

Androecium numerous, apostemonous, filaments white, 7 – 9 mm long, glabrous, anthers dithecous, whitish, gland-tipped, dehiscence longitudinal, pollens forming pollinia, dorsifixed. Gynoecium monocarpellary, unilocular, placentation marginal, with one row of ovules on a single placenta. Ovary whitish, glabrous, gynophores very short; style slender, stigma simple, ovary superior.

Pods or legumes indehiscent, 6.5 – 8.5 cm long and 1.8 – 2.0 cm wide, with distinct network of veins, 3 – 5 seeded, green in colour while young, grayish when dry. Seeds discoid, germination epiginal, non-endospermic.

Floral Formula: $K_{(5)}\ C_{(5)}\ A_{\infty}\ \underline{G_1}$

Distinguishing characters

(1) Trees are armed with laxly cylindrical crown, triple brownish black spines present at the nodes.

(2) Barks whitish gray with longitudinal, long and deep cracks and short, shallow or deep vertical cracks, with many warts.

(3) Leaves bipinnately compound, 3.0 – 6.5 cm long and 2.5 – 5.5 cm wide, petiole cylindrical, sparsely pubescent.

(4) Primary racheae are sparsely pubescent, bearing 7 – 14 pairs of secondary racheae.

(5) Secondary rachis is sparsely pubescent, bearing 5 – 14 pairs of leaflets.

(6) Inflorescences are spikes, axillary, 1 or 2 in number per axil, white, 67 – 135 flowers per spike.

(7) Flowers are bracteate, actinomorphic, pentamerous and hypogynous.

(8) Calyxes are gamosepalous, campanulate, a few hairs present on the calyx lobe, whitish green.

(9) Corollas are gamopetalous, tubular, whitish green, glabrous.

(10) Stamens are numerous, apostemonous, and dorsifixed.

(11) Pistils are monocarpellary, unilocular, placentation marginal, and with two rows of alternating ovules on a single placenta.

(12) Ovaries are glabrous, gynophores very short.

(13) Pods or legumes are indehiscent, 3 – 5 seeded, green in colour while young, grayish when dry.

Uses

The gum arabic is used as a food additive, in crafts, and as a cosmetic. New foliage is very useful as forage. Dried seeds are used as food by humans. It fixes nitrogen within *Rhizobia* or nitrogen-fixing bacteria living in root nodules and enriches the poor soils. It is used as for its astringent properties, to treat bleeding, bronchitis, diarrhea, gonorrhea, leprosy, typhoid fever and upper respiratory tract infections. Roots near the surface of the ground are quite useful in making all kinds of very strong ropes and cords. The tree bark is also used to make rope. Wood is used as handles for tools, parts for weaving looms (Wikipedia 2012)

Table 4.1 Size of leaves, number ofsecondary recheae and leaflets.

No.	Species	Leaf		Number of secondary rachis pairs	Number of leaflet pairs	Petiole and leaflet hairs
		Length (cm)	Width (cm)			
1	***Acacia chundra***	11.5 – 13.5	2.5 – 4.5	11 – 14	21 – 34	petiole pubescent, leaflet glabrous
2	***A. Leucophloea***	5.0 – 16.0	2.0 – 8.0	2 – 8	16 – 24	pubescent
3	***A. planifrons***	5.0 – 9.5	2.5 – 5.5	7 – 14	10 – 22	pubescent
4	***A. senegal***	3.0 – 6.5	2.5 – 5.5	3 – 5	5 – 14	sparely pubescent

Table 4.2 Type of inflorescences, number and colour of flowers, and colour of spine

No.	Species	Inflorescences	Flowers per head	Flower colour	Branch spines
1	***Acacia chundra***	spike	55 – 78	white	brown
2	***A. leucophloea***	head	77 – 97	pale yellow	brown
3	***A. planifrons***	head	20 – 24	white	white
4	***A. senegal***	spike	67 – 135	white	brownish black

Table 4.3 Size and colour of fruits, and number of seeds.

No.	Species	Pods		Colour	Number of seeds
		Length (cm)	Width (cm)		
1	***Acacia chundra***	6.5 – 10.8	1.2 – 2.2	purple while very young, purplish green while older, black when dry	3 – 7
2	***A. leucophloea***	5.9 – 7.0	0.4 – 0.8	greenish gray	4 – 12

3	***A. planifrons***	2.5 – 5.5	0.3 – 0.7	slightly purple, black when dry	3 or 4
4	***A. senegal***	6.5 – 8.5	1.8 – 2.0	green while young, grayish when dry	3 – 5

4.2 Anatomy

4.2.1 *Acacia chundra*

4.2.1.1 Wood of stem

General characteristics and properties of the wood

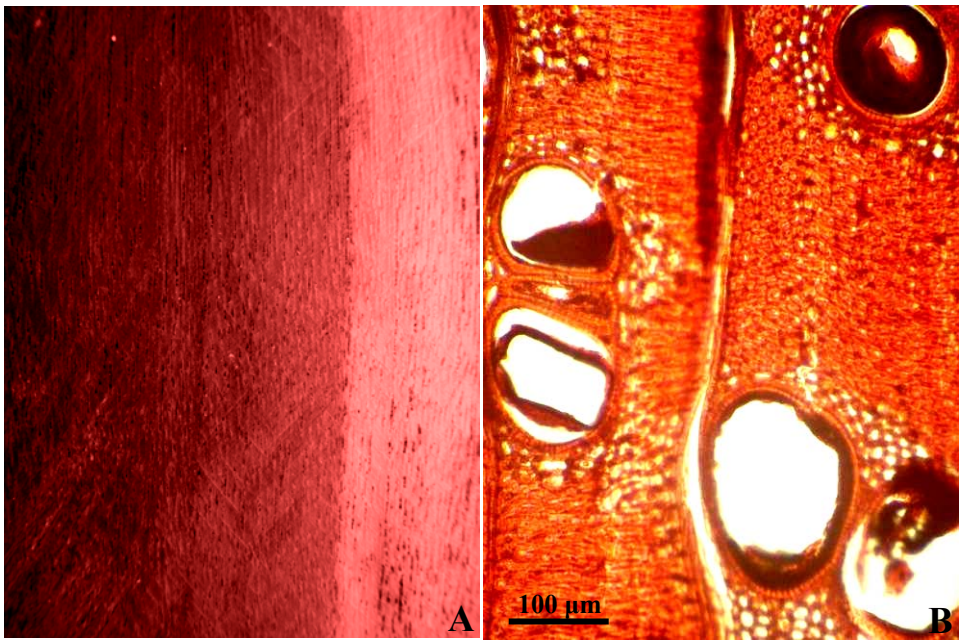
Sapwood of stem of *Acacia chundra* studied is pale yellow and heartwood reddish-brown, its odour and taste not distinct. It is hard, straight- or slightly interlock-grained, and fine-textured. The wood is diffuse-porous and its growth ring is not distinct.

Microscopic characteristics

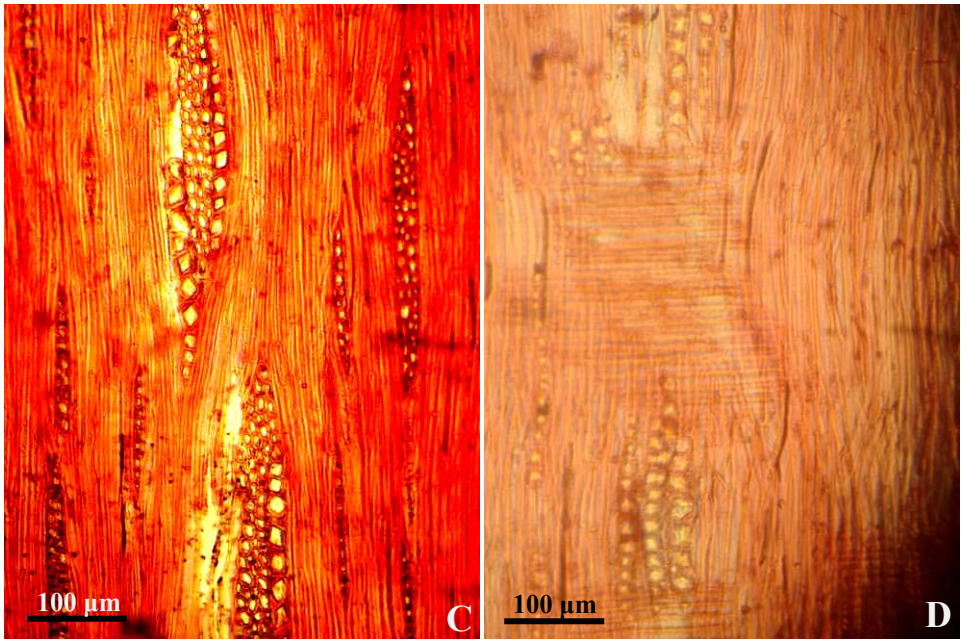
Vessel elements: Diffuse-porous, pores very small to moderately large, tangential diameter 30.8 – 205.0 µm (mean 101 µm), fine-textured; number per square mm few to moderately numerous (range 5 – 20); pore solitary or as radial multiples of 1 – 6 (mostly 1 or 2), solitary pores 70% (range 50 – 90%); pore circular or oval in cross section; perforation plate simple; end walls of element transverse or oblique, tailed one end, truncate; intervessel pits alternate, circular or coal, very small to small; vessel element extremely short to medium-sized; 92.3 – 358.8 µm (mean 207.4 µm) long, tyloses absent; gum deposit dark reddish-brown; crystals absent.

Fibres : Libriform, extremely short to medium-sized, 358.8 – 1527.3 µm (mean 1025.4 µm) long and 10 – 20 µm (mean 14.5 µm) wide, wall 2.5 – 6.3 µm (mean 4.9 µm) thick, non-septate, with tapering ends; interfibre pits minute, simple, slit-like; chain of prismatic crystals present between the fiber cells, silica bodies absent.

Rays: Heterogeneous, 1- to 4-seriate, 10 – 15 per mm tangentially, numerous to very numerous, fairly close to close; uniseriate rays, 51.3 – 164.0 µm (mean 102.5 µm) in height, 4 – 13 cells high; extremely fine to very fine, 5.1 – 15.4 µm (mean 10.8 µm) in width; multiseriate rays, 92.3 – 768.3 µm (mean 304.6 µm) in height, 3 – 57 cells high; extremely fine to medium-sized, 10.3 – 51.3 µm (mean 27.7 µm) in width; ray vessel pitting alternate, circular or oval in shape; gum deposits dark reddish-brown.



A. Wood of stem as seen. **B.** T. S of stem wood showing solitary and group of vessel, and gum deposits in vessels and some parenchyma cells.



C.T. L. S of stem wood showing uniseriate rays, multiseriate rays, crystals chain in parenchyma, and gums in some parenchyma cells. **D.** R. L. S of stem wood showing multiseriate rays and crystals chamber in parenchyma cells.

Figure 4.6 Internal structure of stem wood of *Acacia chundra.*

Axial parenchyma : Abundant, paratracheal parenchyma diffuse and aggregate, vasicentric, apotracheal parenchyma diffuse; prismatic crystals present.

4.2.1.2 Bark of stem

General characteristics and properties of the bark

Bark of stem of *Acacia chundra* studied is grayish brown, 3 – 12 mm thick, with longitudinal, deep and wide furrows and long ridges, deep and shallow horizontal cracks present, old barks very hard and partially broken and leaving deep furrow; three yellowish white rings of fibers clearly observed in transverse section; inner bark 1.5 – 2.0 mm thick; pale yellow, fibrous, soft; odour and taste not distinct.

Microscopic characteristics

Primary body of the stem

Dermal tissue system: Epidermal cells damaged and no trace of cells left.

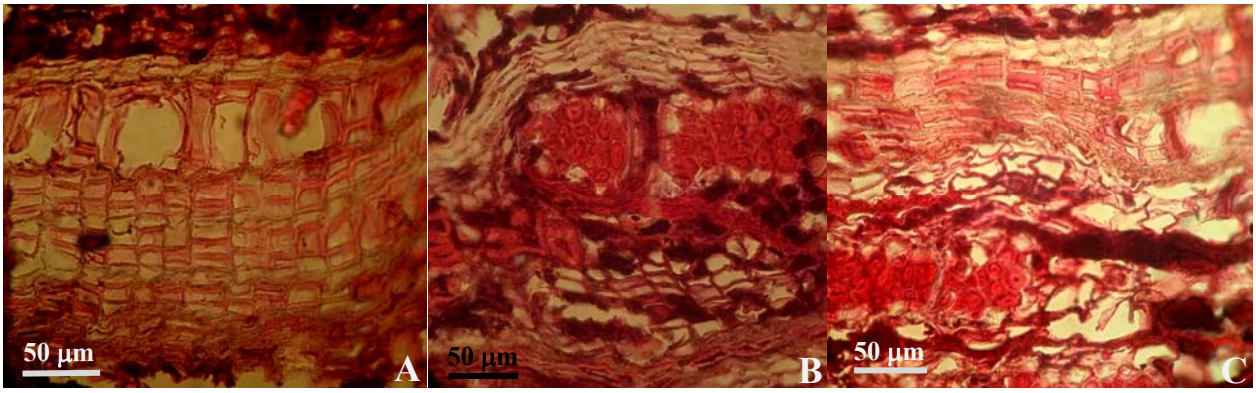
Ground tissue system: Primary cortex outermost in position, most of the cells damaged, periderm formed up to three times in the peripheral and inner regions, some of cortical cells forming column of sclereids and cortical fibers; parenchymatous cells rectangular, polygonal, or irregular shape, sclereids thick-walled and with narrow lumin.

Vascular tissue system: Primary phloem located outward, and overlapped the cortex, forming groups of phloem fiber of continuous ring, alternating with groups of sieve tube, companion cell,

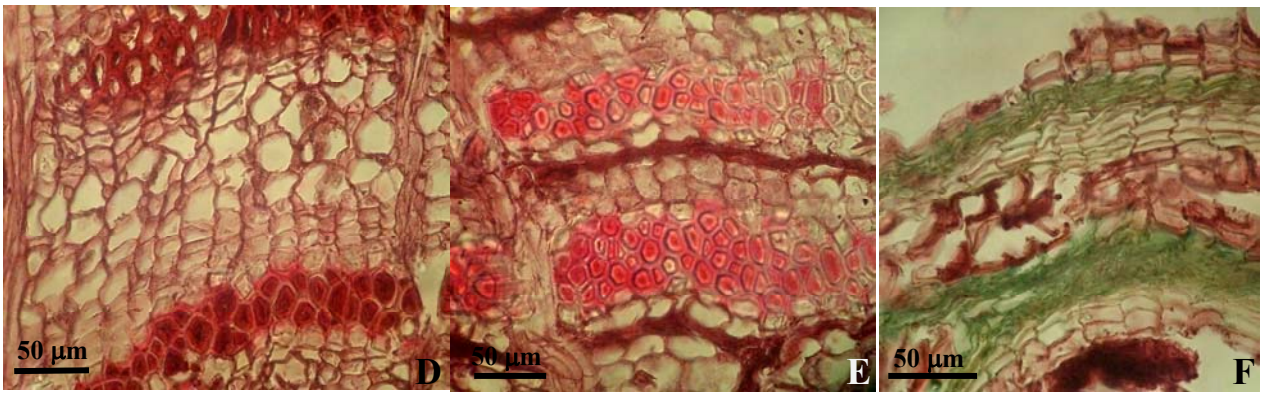
and phloem parenchyma; phloem fibers thick-walled; phloem ray cells distinct and thin-walled, many ring-like structure containing deeply stained materials present.

Secondary body

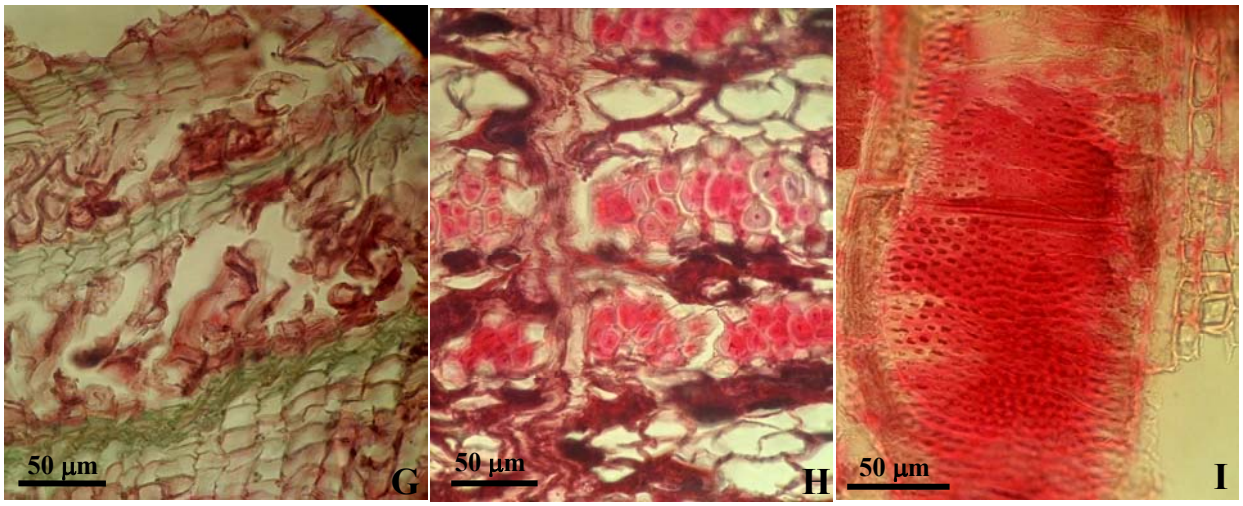
Periderm: Situated in primary phloem and secondary phloem, forming a discontinuous ring, periderm repeatedly formed and up to 4 times in the phloem tissues, individual periderm 117 – 320 µm thick, each periderm composed of phellogen or cork cambium, phellen or cork



A.T. S of a portion of stem bark showing innermost periderm. **B.** T. S of a portion of stem bark showing inner periderm. **C.** T. S of a portion of stem bark showing outer periderm.



D. T. S of a portion of stem bark showing secondary phloem near vascular cambium. **E.** T. S of a portion of stem bark showing phloem away from vascular cambium. **F.** T. S of a portion of root bark showing outer double periderm.



G. T. S of a portion of root bark showing outer triple periderm. **H.** T. S of a portion of root bark showing phloem fibers and phloem rays. **I.** R. L. S of a portion of root bark showing vessel with bordered pits.

Figure 4.7 Internal structure of stem and root of *Acacia sundra.*

and phelloderm. Phellogen or cork cambium compactly arranged and tangentially flattened, 1 – 3 layered with its immediately derived cells, rectangular in shape, thin-walled, pale-yellowish, sometime deeply stained brown due to the presence of tanniferous or resinous materials, initiation of cork cambium 1 to 4 times in the same phloem tissues; cork cells or phellem which was derived from phellogen outward, many layered, parenchymatous, colourless, rectangular in shape, a few layer of cells radially elongated and air cavity formed between the cells, thin-walled, not distinctly suberised, usually many layers flattened and compact; phelloderm inward, parenchymatous, 1 to many layers of cells, cells tangentially elongated, some layers flattened and compact.

Vascular cambium: One-layered**,** parenchymatous, tangentially flattened, slightly shrunk in some cells, a few layered and compactly arranged together with its immediate derivatives, differentiated into ray initial and fusiform initials, thin-walled.

Secondary phloem: Many-layered, composed of sieve tubes, companion cells, phloem parenchyma, phloem fibers and sclereids; phloem fibers of continuous rings alternating with layers of a mass of sieve tubes, companion cells and phloem fibers, phloem fibers per ring 1- to 4-layered, thick-walled, wall thicker than that of xylem fiber, 800 – 1380 μm (mean 1034.6 μm) long and 10 – 20 μm (mean 10.4 μm) wide; sieve tube thin-walled, polygonal in shape, companion cells distinct in active phloem but not distinct in old layers of phloem; phloem parenchyma oval, rounded , elongate, or irregular in shape; sclereids appeared in many groups, , lumen very narrow, pits very small, many ring-like structure containing deeply stained materials present.

4.2.1.3 Roots

Macroscopic Characters

The roots of *Acacia chundra* studied are grey in colour.

Microscopic Characters

Primary body of the root

The lateral root studied was 22 – 28 mm in diameter, more or less circular in outline in transverse section.

Dermal tissue system: Epidermal cells (epiblema) one layered, ruptured, no trace of cells left in old bark.

Ground tissue system: Cortex lying outermost in position and internal to the outermost periderm due to the demage of epiblema cells, cells parenchymatous, thin-walled, many-layered, mostly tangentially elongated, some cells polygonal, oval, or irregular in shape, some cells filled with deeply stained tannin-like materials. Groups of sclereids formed in the cortex, prismatic crystals present in some sclereids.

Vascular tissue system: Primary phloem lying outward and internal to cortex, old phloem contained patches of phloem fibers and phloem parenchyma cells; groups of sclereids formed between phloem cells.

Secondary body of the root

Periderm initiation observed four times, one lying outermost in position due to the damage of epiblema cells and surrounding the cortex, the rest periderms lying between the

phloem cells; periderm consisted of phellogen or cork cambium, phellem or cork lying outward, and phelloderm inward. In transverse section, phellogen or cork cambium compactly arranged, tangentially flattened, 1 – 3 layered with its immediately derived cells, rectangular in shape, thin-walled, brownish due to the presence of tanniferous or resinous materials; cork cells or phellem derived from phellogen and lying outward, many layered, parenchymatous, thin-walled, cork cells rectangular in shape, flattened and radially arranged, some cells in the phellem larger and radially elongated in periderm, air cavities present between the cells; phelloderm 2 – 8 layered, parenchymatous, thin-walled, slightly elongated, polygonal or irregular in shape, some filled with coloured materials, sclerenchymatous cells sometimes formed in phelloderms, prismatic crystals or gums present in some sclereids.

Secondary phloem lying outside the vascular cambium, many-layered, composed of sieve tubes, companion cells, phloem parenchyma, phloem fibers and phloem ray cells; phloem fibers forming discontinuous rings, alternating with sieve tubes and phloem parenchyma cells, interrupted by phloem ray cells, sieve tube thin-walled; ring-like structure of tannin materials alternate with phloem, discontinuous.

Vascular cambium and its derivatives lying between secondary phloem and secondary xylem, cells together with immediate derivatives compactly arranged, parenchymatous, tangentially flattened, thin-walled.

4.2.2 *Acacia leucophloea*

4.2.2.1 Wood of stem

General characteristics and properties of the wood

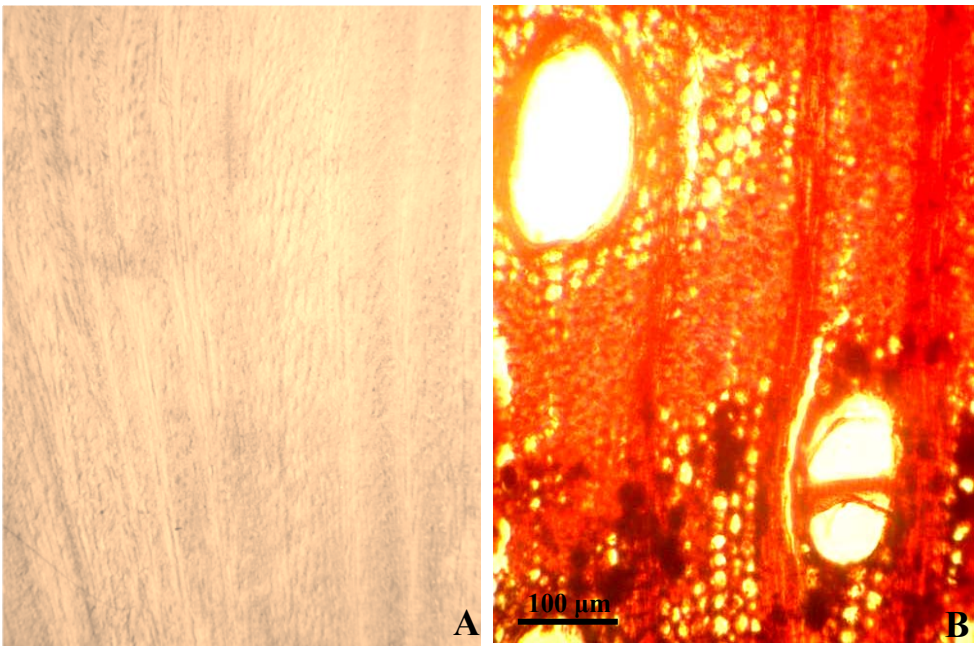
The sapwood of stem of *Acacia leucophloea* is whitish-yellow, heartwood pale yellowish-brown, odour and taste not distinct. The wood is hard, straight-grained or slightly interlock grained and fine-textured. . The wood is diffuse-porous and its growth ring is not distinct.

Microscopic characteristics

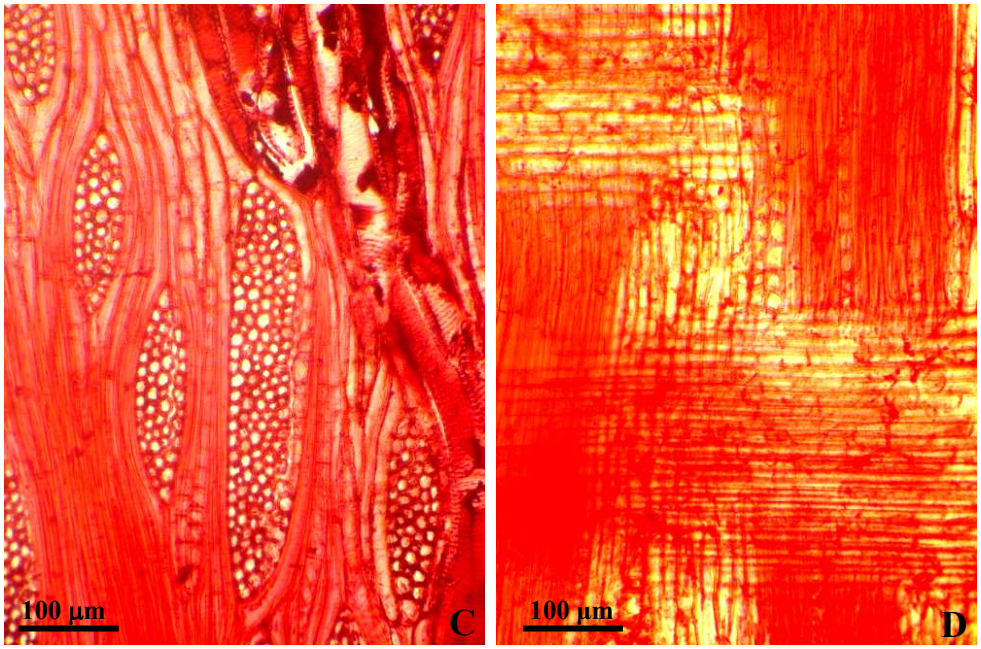
Vessels: Diffuse-porous, pores very small to moderately large, tangential diameter 30.75 – 235.75 μm (mean 127.69 μm); number per square mm few to moderately few (range 3 – 10); solitary pore 66% – 80% (mean 75%); pore solitary or as radial multiples of 2 – 3, circular or oval in cross section; perforation plate simple; end walls of element transverse, tailed at one or both ends or truncate; inter-vessel pits alternate, dentate; vessel element extremely short to moderately short, 82.0 – 307.50 μm (mean 190.99 μm) long.

Fibers: Libriform; extremely short to medium-sized, 410.0 – 1691.25 μm (mean 1022.40 μm) long; 10.0 – 27.50 μm (mean 17.45 μm) in tangential diameter; fiber wall 2.5 – 7.5 μm (mean 5.04 μm) thick; non-septate; crystals present; interfiber pits minute; simple; slit-like.

Rays: Homogeneous; uniseriate to multiseriate; 8 – 14 per mm tangentially, normally space to close; uniseriate rays mean height 71.75 μm (range 30.75 – 123.0 μm); mean width 22.69 μm (range 20.50-30.75 μm); very fine to moderately fine; 2-7 cell high; multiseriate rays mean height 201.58 μm (range61.50 – 440.75 μm); mean width 39.80 μm (range 20.50-71.75 μm); very fine to medium-sized; 3-44 cell high; ray vessels pitting alternate, elliptical in shape; gum deposits present; crystals present.



A.Wood of stem as seen. **B.** T. S of stem wood showing solitary vessel and group of vessel and gum deposits in parenchyma.



C.T. L. S of stem wood showing multiseriate rays. **D.** R. L. S ofstem wood showing multiseriate rays and crystals chamber in parenchyma.

Figure 4.8 Internal structure of stem wood of *Acacia leucophloea.*

Axial parenchyma: Paratracheal parenchyma, vasicentric, banded; apotracheal parenchyma diffuse; gum deposits present; prismatic crystals present.

4.2.2.2 Bark of the stem

General characteristics and properties of the bark

Bark of *Acacia leucoplphloea* stem studied is gray, thick, with longitudinal fissures and vertical and horizontal cracks, fissures deep in older barks. Thick, hard, brittle.

Microscopic characteristics

Primary body of the stem

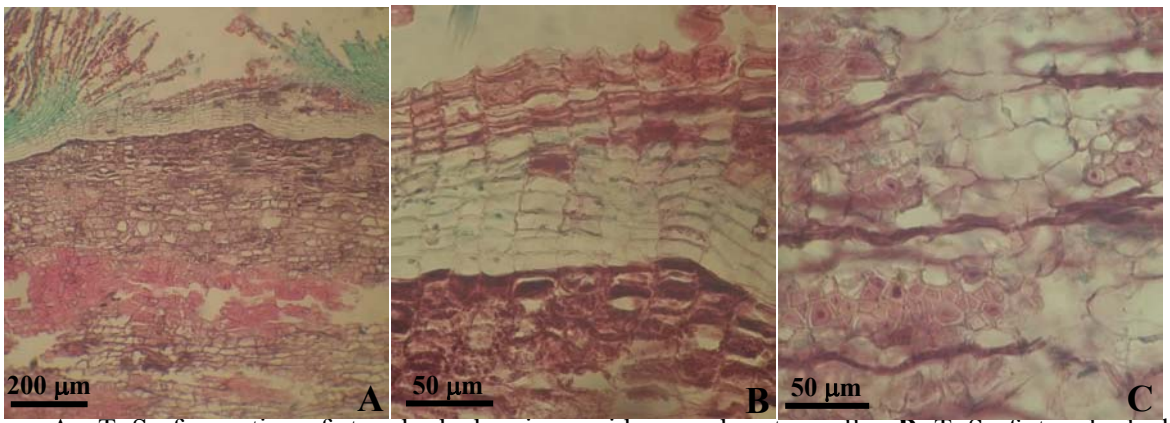
Dermal tissue system: Epidermal cells torn off and no trace of cells left.

Ground tissue system: Primary cortex outermost, covered by periderm; cortical cells parenchymatous and sclerenchymatous, parenchymatous cells tangentially elongated, some cell forming sclereids, sclereids thick-walled and with narrow luman; prismatic crystal abundant.

Vascular tissue system: Primary phloem located outward and tangenially overlapped cortex, forming groups of thick-walled sclereids of various shape, many groups of thick-walled phloem fibers alternating phloem parenchyma and old sieve tubes, phloem ray cells distinct and thin-walled.

Secondary body

Periderm: Lying in cortex, outermost in position, forming a continuous ring, many-layered; 130 – 520 µm thick, composed of phellogen or cork cambium, phellen or cork and phelloderm. Phellogen or cork cambium compactly arranged and tangentially flattened, 4 – 10 layered with its immediately derived cells, rectangular in shape, thin-walled, mostly colourless, sometimes stained brown due to the presence of tanniferous materials, initiation of cork cambium observed many times in tne formation of 27enegal27s; cork cells or phellem which was derived from phellogen outward, many layered, parenchymatous, stained green, rectangular in shape, tangentially elongated, thin-walled, not distinctly suberised, probably filled with air;



A. T. S of a portion of stem bark showing periderm and cortex cells. **B.** T. S of stem bark showing

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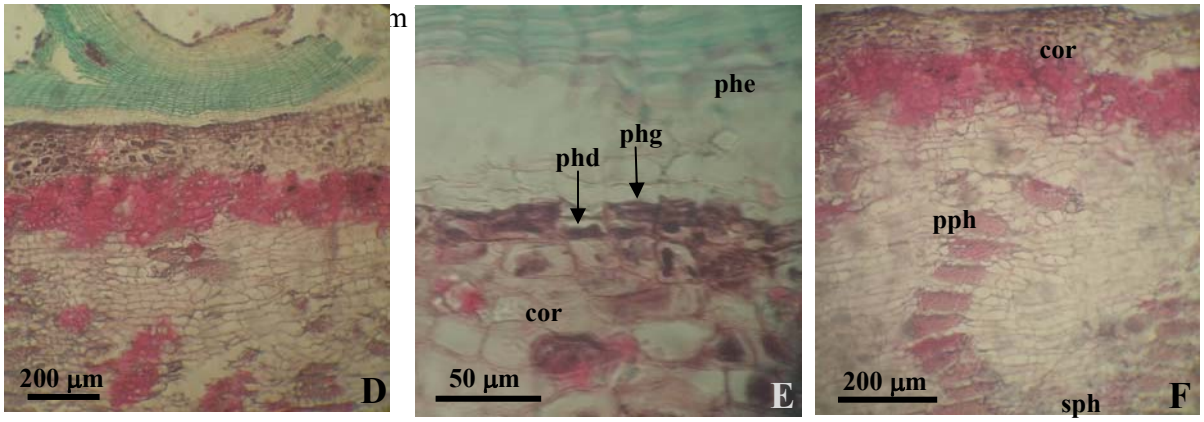
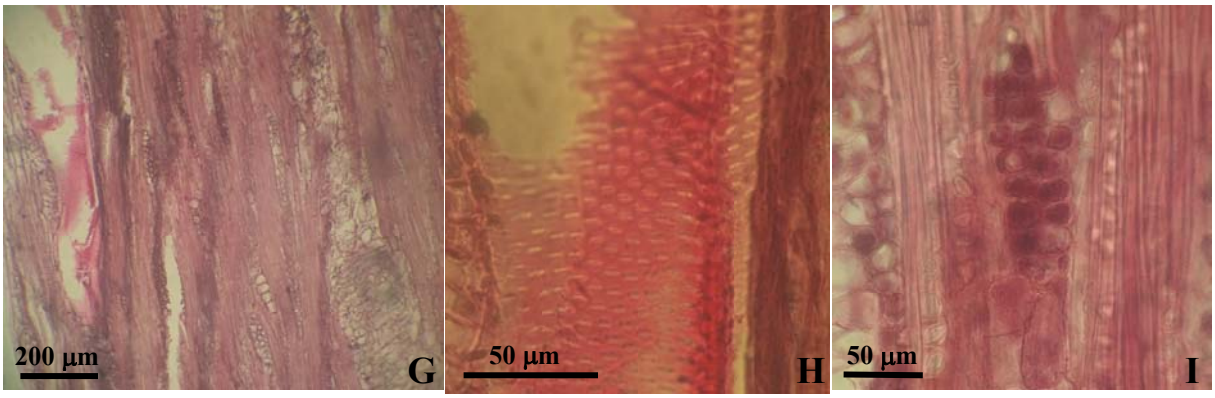


D. T. S of a portion of root bark showing periderm and cortex cells. **E.** T. S of root bark showing periderm (phg – phellogen, phd – phelloderm, phe – phellem, cor – cortex cells). **F.** T. S of a root bark showing cortex and secondary phloem (pph – primary phloem, sph – secondary phloem, cor – cortex cells).



G T. L. S of a portion of root showing wood and bark tissue. **H.** T. L. S of root wood showing vessel with bordered pits. **I.** T. L. S root bark showing phloem rays and prismatic crystals.

Figure 4.9 Internal structure of stem and root of *Acacia leucophloea*.

Phelloderm inward, parenchymatous, 1 – 7 layered, deeply stained brown due to presence of tannin.

Vascular cambium: One-layered**,** parenchymatous, tangentially flattened, slightly shrunk in some cells, 3 – 5 layered together with its immediate derivatives, compactly arranged, differentiated into ray initial and fusiform initials, thin-walled.

Secondary phloem: Many-layered, composed of sieve tubes, companion cells, phloem parenchyma, phloem fibers and sclereids; phloem fibers in groups forming discontinuous ring, interrupted by phloem ray cells, phloem fibers rings alternating with layers of a mass of sieve tubes, companion cells and phloem parenchyma: phloem fibers 2 – 6 layered per ring, thick-walled, wall thicker than that of xylem fiber, prismatic crystal present in some cells, 550 – 1500 µm (mean 1070.8 µm) long and 10 – 15 µm (mean 10.2 µm) wide: sieve tube thin-walled, oval in shape, companion cells distinct in active phloem; phloem parenchyma oval, polygonal, or irregular in shape; sclereids present in groups at the outer portion of the phloem, lumen very narrow, some with gums.

4.2.2.3 Roots

Macroscopic Characters

The roots of *Acacia leucophloea* studied are grey in colour.

Microscopic Characters

Primary body of the root

The lateral root studied was 20 – 24 mm in diameter, circular in outline in transverse section.

Dermal tissue system: Epidermal cells (epiblema) one layered, ruptured, no trace of cells left in old bark.

Ground tissue system: Cortex lying outermost in position and internal to the epiblema, cells parenchymatous, thin-walled, many-layered, mostly tangentially elongated, some cells polygonal, oval, or irregular in shape, compactly arranged. Some cortex cells radially

overlapped with primary phloem cells. Column or groups of sclereids formed in the cortex, prismatic crystals present in some sclereids. Some cortex cells stained coloured materials.
Vascular tissue system: Primary phloem lying outward and internal to cortex, primary phloem overlapped with some layers of cortex, old phloem contained groups of phloem fibers and phloem parenchyma cells; a few number of sclereids formed between phloem cells.
Secondary body of the root

Periderm lying outermost in position due to the damage of epiblema cells and surrounding the cortex, periderm consisted of phellogen or cork cambium, phellem or cork lying outward, and phelloderm inward. In transverse section, phellogen or cork cambium compactly arranged, tangentially flattened, 1 – 3 layered with its immediately derived cells, rectangular in shape, thin-walled, brownish yellow due to the presence of tanniferous or resinous materials; cork cells or phellem derived from phellogen and lying outward, many layered, parenchymatous, thin-walled, cork cells rectangular in shape, flattened and radially arranged, a few layers of cells near the phellogen stained colourless and distal cells stained green coloured; phelloderm 2 – 5 layered, parenchymatous, thin-walled, slightly elongated, polygonal or irregular in shape, some filled with coloured materials.

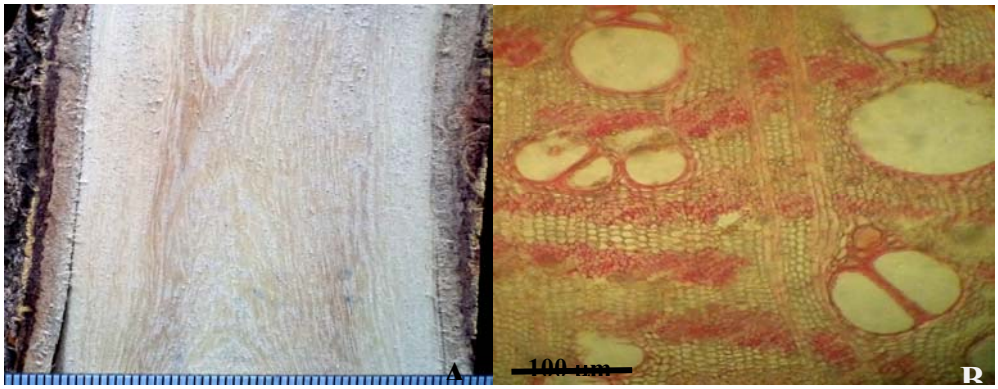
Secondary phloem lying outside the vascular cambium, many-layered, composed of sieve tubes, companion cells, phloem parenchyma, phloem fibers and phloem ray cells; phloem fibers forming discontinuous rings, alternating with sieve tubes and phloem parenchyma cells, interrupted by phloem ray cells, sieve tube thin-walled, ring-like structure of tannin materials alternate with phloem fibers.

Vascular cambium and its derivatives lying between secondary phloem and secondary xylem, cells together with immediate derivatives compactly arranged, parenchymatous, tangentially flattened, thin-walled.

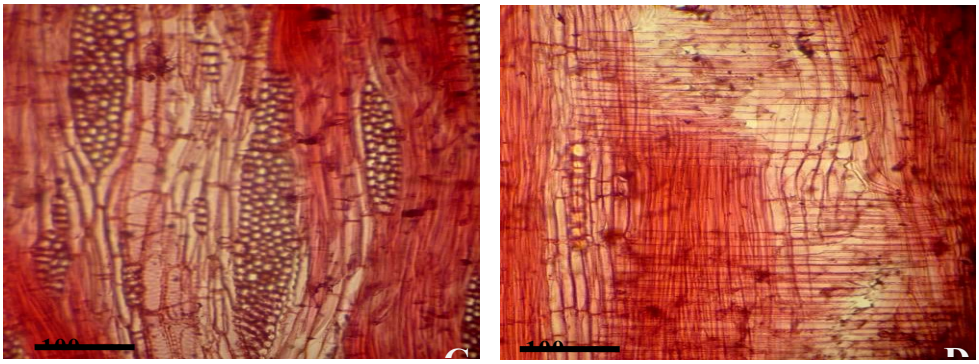
4.2.3 *Acacia planifrons*
4.2.3.1 Wood of stem
General characteristics and properties of the wood

Sapwood of stem of *Acacia planifrons* studied is yellowish white, heartwood yellowish white. It is hard, straight-grained or slightly interlock-grained and very fine-textured. The wood is diffuse-porous and its growth ring is not distinct.
Microscopic characteristics
Vessel elements: Diffuse-porous, pores very small to medium-sized, tangential diameter 30.75 – 143.50 μm (mean 80.15 μm), very fine textured; number per square mm moderately few to moderately numerous (range 6 – 15); pores almost exclusively solitary or as radial multiples of 1 – 3 (mostly 1 – 2), circular in cross section; thick-walled; gum deposits frequently present; perforation plates simple, end walls of elements transverse or oblique; tailed one end, truncate; intervessel pits alternate, elliptical in shape; vessel elements extremely short to moderately short, 51.25 – 297.25 μm (mean 160.72 μm) long, gum present.
Fibres: Libriform, extremely short to medium-sized, 410 – 1640 μm (mean 969.04 μm) long and 10 – 20 μm (mean 13.9 μm) wide; with tapering ends; fiber wall 3.75 – 7.50 μm (5.85 μm) thick, non-septate; interfiber pits minute; simple; slit-like, rows of prismatic crystals present between the fibre cells.
Rays: Homogeneous, uni- to multi-seriate; moderately numerous to very numerous, 6 – 12 per mm tangentially, normally spaced to fairly spaced; uniseriate rays extremely fine to very fine, 10.3 – 20.5 μm (mean 86.5 μm) in width, 71.8 – 666.3 μm (mean 287.4 μm) in height;

multiseriate rays moderately fine to medium-sized, 20.5 – 82.0 µm (mean 41.3 µm) in width, 5.0 – 7.5 µm (mean 6.3 µm) in height, 5 – 53 cells high; ray vessel pitting alternate, circular or oval in shape.



A. Wood of stem as seen. **B.** Transverse section of stem wood showing solitary and group of vessel, and banded axial parenchyma.



C.T. L. S of stem wood showing multiseriate rays and uniseriate rays. **D.** R. L. S of stem wood showing chambered crystals and homogenous ray cells.

Figure.4.10 Internal structure of stem wood of *Acacia planifrons.*

Axial parenchyma: Paratracheal parenchyma banded, vasicentric, aliform; crystals present.

4.2.3.2 Bark of stem

General characteristics and properties of the bark

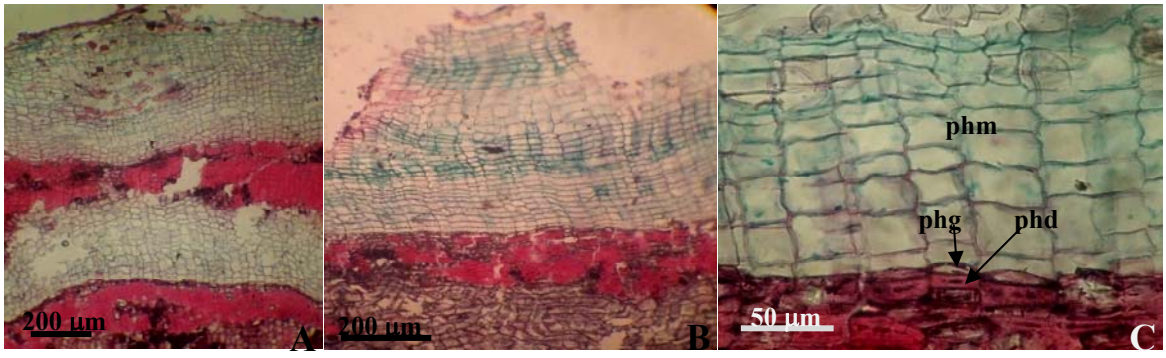
Bark of *Acacia planifrons* **stem** studied is blackish gray, 3 – 5 mm thick; brittle, with longitudinal fissures and vertical and horizontal cracks, fissures deep in older barks; inner bark 2 – 3 mm thick; pale yellow, fibrous, soft.

Microscopic characteristics

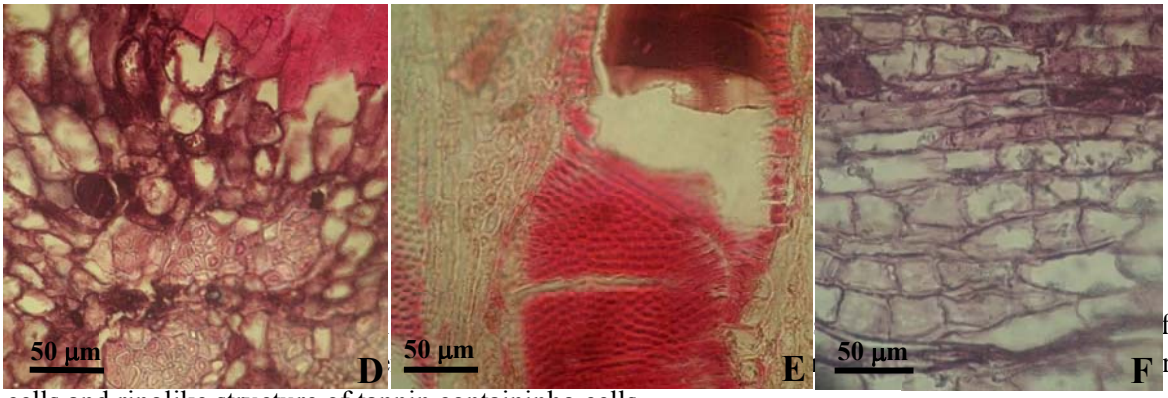
Primary body of the stem

Dermal tissue system: Epidermal cells torn off and no trace of cells left.

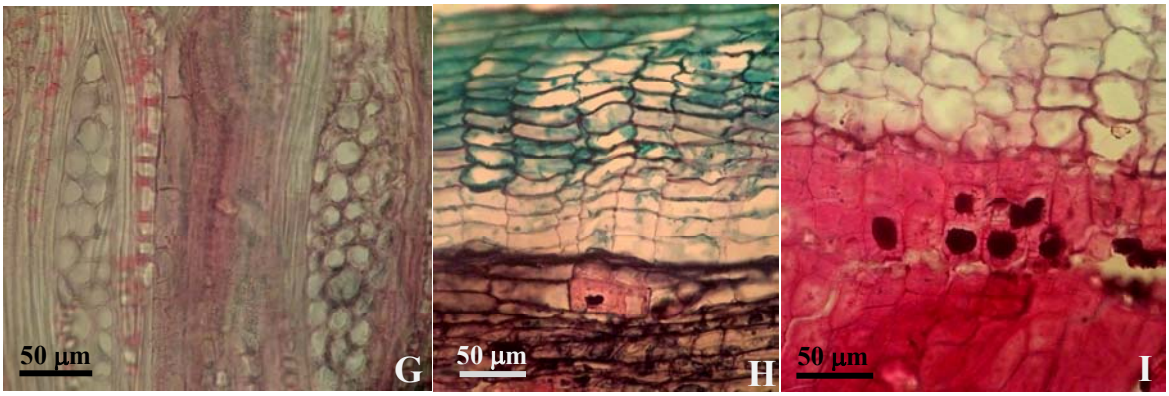
Ground tissue system: Primary cortex outermost in position, embedded cork cambium and tissue of its activity, cortical cells forming a column of different shape of sclereids, fibers, and parenchymatous cells of irregular shape, sclereids thick-walled and with narrow lumin, gum present in some sclereids, prismatic crystals observed in some sclereids.
Vascular tissue system: Primary phloem located outward and tangenially overlapped primary cortex, forming groups of thick-walled sclereids, many patches of thick-walled phloem fibers alternating phloem parenchyma and old sieve tubes; phloem ray cells distinct and thin-walled.
Secondary body of the stem
Periderm: Lying in the cortex, outermost in position due to the damage of epidermal cells, surrounding the cortex cells forming a continuous ring, many-layered; 150 – 1400 µm thick, composed of phellogen or cork cambium, phellen or cork and phelloderm. Phellogen or cork cambium compactly arranged and tangentially flattened, 1 – 3 layered with its immediately derived cells, rectangular in shape, thin-walled, pale-brownish colour stained due to the presence of tanniferous or resinous materials, initiation of cork cambium observed up to 4 times in the cortex; cork cells or phellem which was derived from phellogen outward, many layered; parenchymatous, a number of layers of cork cells next to phellogen colourless, the peripheral layers of cork cells usually stained green colour, rectangular in shape, thin-walled, not distinctly suberised, probably filled with air, one or a few numbers of sclereids formed in cork cells, prismatic crystal present in some cork cells; phelloderm inward, parenchymatous, 3 – 10 layered, a few to many layers of sclereids formed in phelloderm, prismatic crystals present in some of sclereids and parenchyma cells.
Vascular cambium: One-layered**,** parenchymatous, tangentially flattened, a few layered and compactly arranged together with its immediate derivatives, differentiated into ray initial and fusiform initials, thin-walled.
Secondary phloem: Many-layered, composed of sieve tubes, companion cells, phloem parenchyma, phloem fibers and sclereids; phloem fibers of continuous rings alternating with layers of a mass of sieve tubes, companion cells and phloem fibers; phloem fibers usually 2 to 5 layered in each ring, thick-walled, wall thicker than that of xylem fiber, 580 – 1680 µm (mean 1218.4 µm) long and 10 – 15 µm (mean 10.4 µm) wide, pit not distinct, loosely irregular thickenings usually observed in the phloem fibers; sieve tube thin-walled, compound sieve plates present on the lateral walls; phloem parenchyma oval or rounded in shape; ring-like structure of tannin cells alternated with phloem cells, ring-like structure slightly compact, sclereids in many groups, lumen very narrow, pits very small.
4.2.3.3 Roots
Macroscopic characters
The roots of *Acacia planiferons* studied are gray in colour.
Microscopic characters
Primary body of the root
The lateral root studied was 18 – 30 mm in diameter, circular in outline in transverse section.



A.T. S of a portion of stem bark showing repeated periderms. **B.** T. S of of a portion of stem bark showing a single periderm. **C.** T. S of of a portion of stem bark showing phellogen, phelloderm and phellem (phg – phellogen, phd – phelloderm, phm – phellem).



f stem
rtical cells and ringlike structure of tannin containinhg cells.



G. T. L. S of a portion of stem bark showing phloem fibers, rays, and row of prismatic crystals. **H.** T. S of a root bark showing periderm, sclereid plugged with gum, and sclereid with crystal formed in phelloderm. **I.** T. S of a root bark showing periderm with sclereids in phelloderm.

Figure 4.11 Internal structure of stem and root of *Acacia planifrons*.

Dermal tissue system: Epidermal cells (epiblema) one layered, ruptured, no trace of cells left in old bark.

Ground tissue system: Cortex lying outermost in position and internal to the periderm due to the demage of epiblema cells, cells parenchymatous, thin-walled, many-layered, mostly tangentially elongated, some cells polygonal, oval, or irregular in shape, compactly arranged. Some cortex cells radially overlapped with primary phloem cells. Column or groups of sclereids formed in the cortex, column of sclereids moderately thick and forming 2 or more discontinuous rings and prismatic crystals present in some sclereids. Some cortex cells containing deeply stained tannin materials.

Vascular tissue system: Primary phloem lying outward and internal to cortex, primary phloem overlapped with some layers of cortex, old phloem contained patches of phloem fibers and phloem parenchyma cells; a few number of sclereids formed between phloem cells.

Secondary body of the root

Periderm lying outermost in position due to the damage of epiblema cells and surrounding the cortex,; periderm consisted of phellogen or cork cambium, phellem or cork lying outward, and phelloderm inward. In transverse section, phellogen or cork cambium compactly arranged, tangentially flattened, 1 – 3 layered with its immediately derived cells, rectangular in shape, thin-walled, brownish due to the presence of tanniferous or resinous materials; cork cells or phellem derived from phellogen and lying outward, many layered, parenchymatous, thin-walled, cork cells rectangular in shape, flattened and radially arranged, a few layers of cells near the phellogen stained colourless and distal cells stained green coloured; phelloderm 2 – 8 layered, parenchymatous, thin-walled, slightly elongated, polygonal or irregular in shape, some filled with coloured materials, sclerenchymatous cells sometimes formed in phelloderms, prismatic crystals or gums present in some sclereids.

Secondary phloem lying outside the vascular cambium, many-layered, composed of sieve tubes, companion cells, phloem parenchyma, phloem fibers and phloem ray cells; phloem fibers forming discontinuous rings, alternating with sieve tubes and phloem parenchyma cells, interrupted by phloem ray cells, sieve tube thin-walled, ring-like structure of tannin materials alternate with phloem fibers.

Vascular cambium and its derivatives lying between secondary phloem and secondary xylem, cells together with immediate derivatives compactly arranged, parenchymatous, tangentially flattened, thin-walled.

4.2.4 *Acacia 33enegal*

4.2.4.1 Wood of stem

General characteristics and properties of the wood

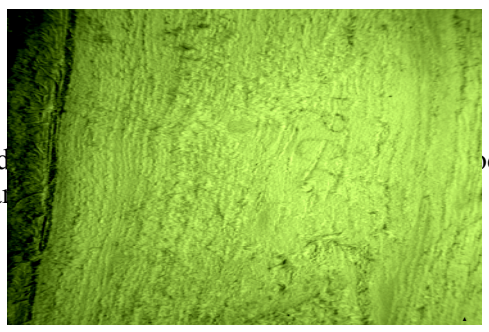
Sapwood and heartwood of stem of *Acacia 33enegal* studied is pale yellow, odour and taste not distinct. It is hard, interlock-grained and fine-textured. The wood is diffuse-porous and its growth ring is not distinct.

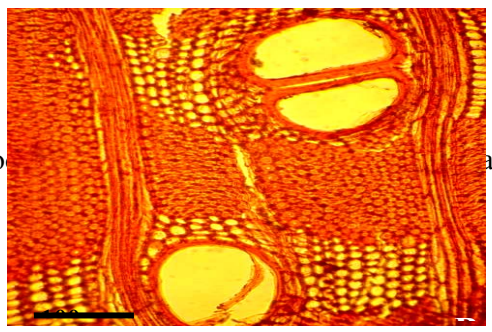
Microscopic characteristics

Vessel elements: Diffuse-porous, pores moderately large, tangential diameter 205.0 – 235.8 µm (mean 118.1 µm); number per square mm few to moderately numerous (range 3 – 11); solitary pores 33 – 100% (mean 86%), pores almost exclusively solitary, radial pore multiples of 2 – 4; circular or oval in cross section; thick-walled; perforation plates simple, end walls of elements transverse or oblique; truncate; intervessel pits opposite, small to medium-sized, one end tailed; vessel elements extremely short to very short, 82 – 328 µm (mean 224.1 µm) long, gum present.

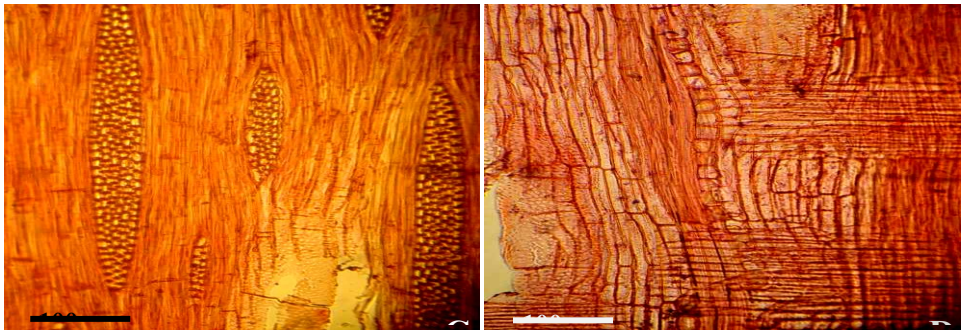
Fibre: Libriform, extremely short to medium-sized, 430.5 – 1383.8 µm (mean 920 µm) long and 10 – 20 µm (mean 14.6 µm) wide; with tapering ends; mean fiber wall 3.8 – 7.5 µm (mean 5.9µm) thick, non-septate; interfibre pits minute, simple, slit-like.

Rays: Homogeneous, 2- to 8-seriate, widely spaced to normally spaced; 4 – 8 per mm tangentially, few to numerous; uniseriate rays extremely fine, 10 – 15 µm (mean 12.5 µm) in width, 60 – 190 µm (mean 91.3 µm) in height; multiseriate rays very fine to medium-sized, 20.5 – 82.0 µm (mean 44.9 µm) in width, 41.0 – 973.8 µm (mean 414.8 µm) in height, ; 4 – 57 cell high; ray vessel pitting minute, pits bordered, alternate, oval in shape.





A.Wood and paratracheal axial par



C.Tangential longitudinal section showing multiseriate rays. **D.** R. L. S of a stem wood showing crystals chamber in parenchyma and multiseriate rays.

Figure 4.12 Internal structure of stem wood of *Acacia Senegal.*

Axial parenchyma: Paratracheal parenchyma vasicentric, aliform, aliform confluent; prismatic crystals present.

4.2.4.2 Bark

General characteristics and properties of the bark

Bark of *Acacia Senegal* studied is whitish gray, 7 – 9 mm thic, inner bark 3 – 4 mm thick; yellowish brown, fibrous, soft; odour and taste not distinct.

Microscopic characteristics

Primary body of the bark

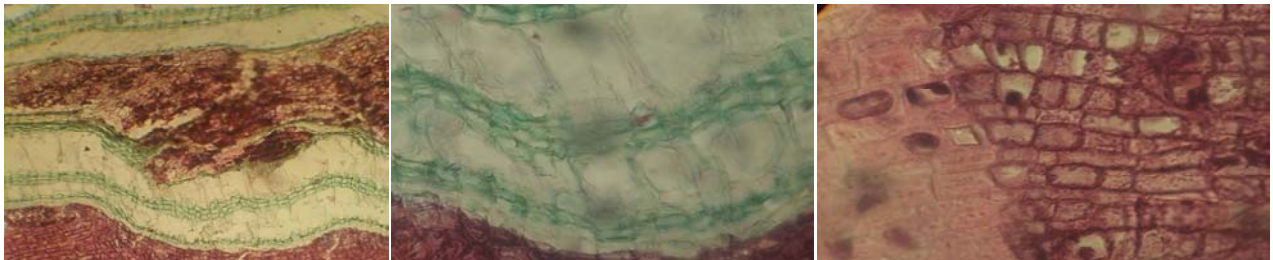
Dermal tissue system: Epidermal cells damaged due to the growth of inner tissue and no trace of cells left.

Ground tissue system: Primary cortex outermost in position internal to periderm, most of the cells damaged and detached; cortical cells observed between the repeated periderm, forming sclereids, fibers, and parenchymatous cells, sclereids thick-walled and with narrow lumin, most of parenchyma cells filled with deeply stained of tannin or gum materials.

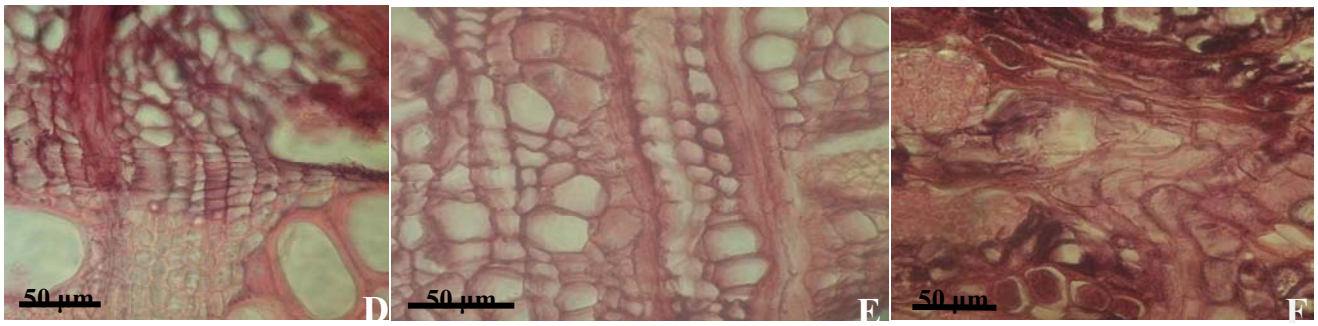
Vascular tissue system: Primary phloem located outward, and overlapped the cortex, forming groups of phloem fiber of continuous ring, alternating with groups of sieve tube, companion cell, and phloem parenchyma; phloem fibers thick-walled; phloem ray cells distinct and thin-walled.

Secondary body of the bark

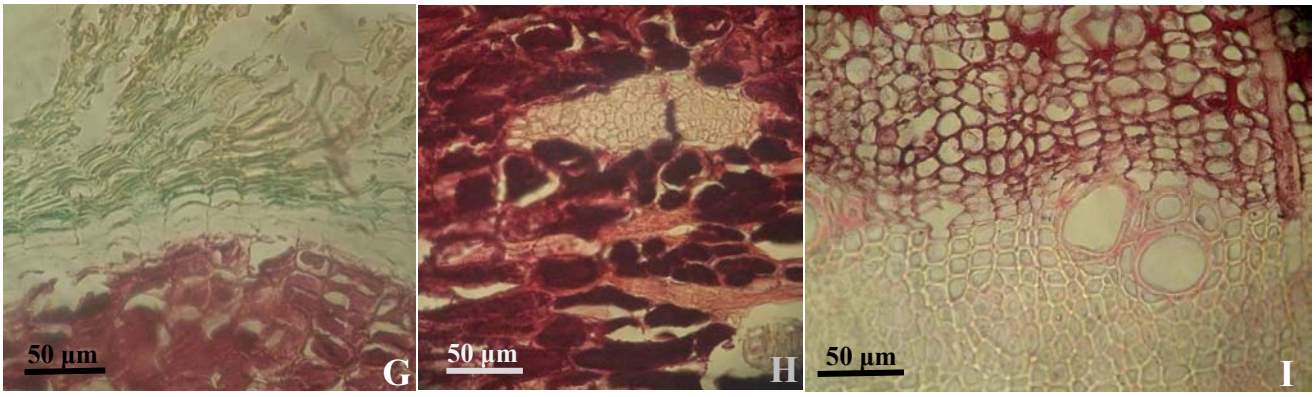
Periderm: Situated in cortex, primary phloem and secondary phloem, forming a continuous ring in outermost periderm, but discontinuous ring in the inner periderm, periderm repeatedly formed in the phloem tissues, outermost periderm 160 – 270 µm and inner periderm 40 – 350 µm thick, each periderm composed of phellogen or cork cambium, phellen or cork and phelloderm. Phellogen or cork cambium compactly arranged and tangentially flattened, 1 – 3 layered with its immediately derived cells, rectangular in shape, thin-walled, pale-yellowish, sometime deeply stained brown due to the presence of tanniferous or resinous materials, initiation of cork cambium 1 or 2 times



A.T. S of a portion of stem bark showing double periderm. **B.** T. S of a portion of stem bark showing inner periderm. **C.** T. S of a portion of stem bark showing cortex cells of upper region.



D. T. S of a portion of stem bark showing vascular cambium. **E.** T. S of of stem bark showing active phloem near vascular cambium. **G.** T. S of stem bark showing phloem cells of outer region.



G. T. S of a portion of root bark showing vascular cambium **H.** T. S of a portion of root bark showing phloem cells of outer region. **I.** T. S of root bark showing vascular c ambium.

Figure 4.13 Internal structure of stem and root of *Acacia Senegal.*

In the cortex and phloem; cork cells or phellem which was derived from phellogen outward, many layered parenchymatous, colourless or some cells stained green, rectangular in shape, thin-walled, not distinctly suberised, one or two rows of separate large and radially elongated cells formed in cork cells, air cavity present between the elongated cells; phelloderm inward, parenchymatous, cells tangentially elongated, some cells filled with deeply stained tannin or gum-likes materials.

Vascular cambium: One-layered**,** parenchymatous, tangentially flattened, a few layered and compactly arranged together with its immediate derivatives, differentiated into ray initial and fusiform initials, thin-walled.

Secondary phloem: Many-layered, composed of sieve tubes, companion cells, phloem parenchyma, phloem fibers and sclereids; phloem fibers of continuous rings alternating with layers of a mass of sieve tubes, companion cells and phloem fibers, phloem fibers 3 – 7 layered per ring, thick-walled, wall thicker than that of xylem fiber, 600 – 1600 μm (mean 1222 μm) long and 10 – 20 μm (mean 10.6 μm) wide; sieve tube thin-walled, polygonal in shape, companion cells distinct in active phloem but not distinct in old layers of phloem; phloem parenchyma oval, or polygonal in shape, some cells filled with deeply stained tannin or gum-like materials; ring-like structure of cells containing tannin or gum-like materials alternating phloem fibres; prismatic crystal present.

4.2.4.3 Root

Macroscopic Characters

The roots of *Acacia 36enegal* studied are grey in colour.

Microscopic Characters

Primary body of the root

The lateral root studied was 7 – 8 mm in diameter, circular in outline in transverse section.

Dermal tissue system: Epidermal cells (epiblema) one layered, ruptured, no trace of cells left in old bark.

Ground tissue system: Cortex lying outermost in position and internal to the periderm due to the demage of epiblema cells, cells parenchymatous, thin-walled, many-layered, mostly tangentially elongated, some cells polygonal, oval, or irregular in shape. Some cortex cells radially overlapped with primary phloem cells. Most of cortex cells stained coloured materials.

Vascular tissue system: Primary phloem lying outward and internal to cortex, primary phloem overlapped with some layers of cortex, old phloem contained patches of phloem fibers and phloem parenchyma cells; a few number of sclereids formed between phloem cells.

Secondary body of the root

Periderm lying outermost in position due to the damage of epiblema cells and surrounding the cortex, one or more inner periderms formed in the phloem; periderm consisted of phellogen or cork cambium, phellem or cork lying outward, and phelloderm inward. In transverse section, phellogen or cork cambium compactly arranged, tangentially flattened, 1 – 3 layered with its immediately derived cells, rectangular in shape, thin-walled, brownish due to the presence of tanniferous or resinous materials; cork cells or phellem derived from phellogen and lying outward, many layered, parenchymatous, thin-walled, cork cells rectangular in shape, flattened and radially arranged, a few layers of cells near the phellogen stained colourless and distal cells stained green coloured; phelloderm 2 – 6 layered, parenchymatous, thin-walled, slightly elongated, rectangular or polygonal in shape, some filled with coloured materials.

Secondary phloem lying outside the vascular cambium, many-layered, composed of sieve tubes, companion cells, phloem parenchyma, phloem fibers and phloem ray cells; phloem fibers forming discontinuous rings, alternating with sieve tubes and phloem parenchyma cells, interrupted by phloem ray cells, sieve tube thin-walled, ring-like structure of tannin materials alternate with phloem fibers and discontinuous. Vascular cambium and its derivatives lying between secondary phloem and secondary xylem, cells together with immediate derivatives compactly arranged, parenchymatous, tangentially flattened, thin-walled.

5. DISCUSSION AND CONCLUSION

In this research, four species of the genus *Acacia* viz. *A. chundra, A. leucophloea, A. planifrons, and A. senegal* from dry zone of Myanmar were selected and studied, described, and

compared. The former three species were indigenous in Myanmar but *A. senegal* was known to be cultivated which was native to Africa.

Kress *et al.* (2003) listed 36 species of the genus *Acacia* in Myanmar, based on the list of 26 species of *Acacia* given by Hundley and Chit Koko (1987).

Although *A. chundra* and *A. leucophloea* were included among the species of *Acacia* in the list mentioned above, *A. planifrons* and *A. senegal* were not described. *A. senegal* was well known for its gum arabic but *A. planifrons* was not popular in so far. This species was an important member of *Acacia* that might be useful in preventing forest degradation and desertification. It possessed xerophytic characters and its long and white thorns might be supportive to be well grown without being damaged by herbivorous animals in its environment.

In this research, among four species of the genus *Acacia*, *A. chundra* and *A. senegal* were of cylindrical spike inflorescence type and the rest two being of globose inflorescence type.

In *A. planifrons*, the inflorescences were white globose head and it bore white and long thorn on branches while young whereas *A. leucophloea* being pale yellow globose head and its brown and long thorn on branch while young.

In this research, characteristics of the stem bark of each species was remarkably distinct and the species were easily distinguishable among them by using this character. In *A. chundra* deep and long longitudinal furrow and ridges were completely formed so that no plain area was left. In *A. leucophloea* outer bark was thick, brownish black and longitudinal deep and long cracks formed and outer bark was usually detached so that some of the bark exposed their inner bark. In *A. planifrons*, the barks were filled with longitudinal and vertical cracks, but not deep as being in *A. chundra*.

In *A. Senegal*, the longitudinal crack was very long and deep but some area of the bark remained without any crack. These characteristics of the bark were useful to identify the species even while in the deciduous period of the plants.

In this research, an oval gland was found on primary rachis of *A. leucophloea* and an extra two small glands present on the terminal portion of primary rachis, one at each point of attachment of uppermost and next to uppermost pairs of secondary rachis respectively. However Khi Ni Lar San and Soe Myint (2002) described that 2 – 4 minute glands were usually found on the terminal portion of primary rachis of *A. leucophloea* var (1) of linear felcate fruit type, and 1 – 5 minute glands were borne on that of *A. leucophloea* var (2) of dorsiventrally spiral or curved fruit type. This variation might be ecological.

In this research, in *A. leucophloea*, number of flower was in the range of 77 – 97 per head, however 62 – 84 flowers were found in *A. leucophloea* var (1) and 97 – 106 in *A. leucophloea* var (2) in the statement of Khin Ni Lar San and Soe Myint (2002).

The four species of the genus studied in this research were found abundant along the roadside and nearby in study area and they might be multiplied by natural regeneration. This meant that they were important species of *Acacia* community that were maintaining soil erosion and preventing desertification in dry zone of Myanmar through systematic management.

In this research, sapwood of *A. leucophloea* was whitish yellow, heartwood pale yellowish-brown. However, Khin Ni Lar San and Soe Myint (2002) stated that the sapwood was pale yellowish white, heart-wood raddish brown, with darker streaks.

In this research the wood was hard, straight-grained or slightly interlock-grained and fine textured. But Khin Ni Lar San and Soe Myint (2002) described that the wood was moderately hard, irregularly interlocked-grained, and medium-textured.

In this research, the wood of *A. leucophloea* was diffuse-porous and its growth ring was not distinct and agreeing with those described by Khin Ni Lar San and Soe Myint (2002). But, Pearson and Brown (1932) stated that the wood of *A. leucophloea* was a moderately heavy, irregularly interlocked-grained and coarse-textured.

Qualitative and quantitative characteristics of the stem wood of four species of the genus *Acacia* were described and compared in Table 4.4 and 4.5 in this research. Wood of all of the four species of *Acacia* studied were diffuse porous and growth rings not distinct. Size of pores were very small to moderately large in *A. chunda* and *A. leucophloea*, whereas very small to medium-sized in *A. planifrons* and moderately large in *A. senegal*. Gum deposits were found in vessels and rays in *A. chunda*, *A. leucophloea*, and *A. planifrons*; but gum deposits were found only in vessels in *A. senegal.*

In the stem barks of all of the four species studied in this research, periderms were initiated in the phloem cells and in *A. chunda* and *A. planifron*, periderms were repeatedly formed, up to 4 times. In *A. senegal*, periderm was formed twice in the phloem, but in *A. leucophloea* studied, periderm was formed once. In the roots of four species, periderm was formed only once except in the case of *A. chunda* in which periderm initiation was observed 4 times.

In all of the barks of stem and root of four species of the genus *Acacia* studied, ring-like structures of cells were observed, and these cells might be containing tannin and gums because of they were stained deeply. Moreover, many parenchymatous cells in the cortex and phloem contained deeply stained materials and these materials might be tannin or gums.

The morphological and anatomical characteristics of the stem and roots of the four species studied in this research were found to be different from each other and morphological characteristics were useful in identification of the species of *Acacia* community. Anatomical characteristics of the four species might also support in identification. By identifying the *Acacia* species, the useful species of *Acacia* could be selected for continuous growing together with the other species of trees, shrubs and herbs in maintaining soil erosion and preventing desertification of dry zone or other area under systematic management. These species were important not only in forest conservation but also in local need such as fuel-wood consumption and other utilization to meet sustainable amount of trees for progressing rural and urban population.

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