

Leaflet No.

The Republic of the Union of Myanmar
Ministry of Natural Resources and Environmental Conservation



**Investigation on Wood Anatomical Characteristics of *Mansonia gagei*
J.R.Drumm. and *Pterospermum acerifolium* (L.) Willd. Growing in
Myanmar**



Aye Nyein Chan, Research Assistant – 2
Kyi Kyi Khaing, Assistant Research Officer
Forest Department

March, 2026

Contents

List of Figures	ii
List of Tables.....	ii
စာတမ်းအကျဉ်း.....	iv
Abstract	iii
1. Introduction	1
2. Literature Review	2
3. Materials and Methods	3
4. Results.....	3
4.1 Taxonomic description	3
4.2 Anatomical description	5
5. Discussion and conclusion.....	15
Acknowledgements.....	17
References.....	18

List of Figures

Figure		Page
1.	Location map of the collection site of Forest Research Institute, Yezin, Naypyidaw and Taninthayi Region in Myanmar	4
2.	Habit of <i>Mansonia gagei</i> J.R.Drumm.	6
3.	Habit of <i>Pterospermum acerifolium</i> (L.) Willd.	8
4.	Internal structure of the wood of <i>Mansonia gagei</i> J.R.Drumm.	9
5.	Macerated elements of <i>Mansonia gagei</i> J.R.Drumm.	10
6.	Internal structure of the wood of <i>Pterospermum acerifolium</i> (L.) Willd.	11
7.	Macerated elements of <i>Pterospermum acerifolium</i> (L.) Willd.	12

List of Tables

Table		Page
1.	Comparative morphological characters of <i>Mansonia gagei</i> J.R.Drumm. and <i>Pterospermum acerifolium</i> (L.) Willd.	13
2.	Qualitative characteristics of wood structure of <i>Mansonia gagei</i> J.R.Drumm. and <i>Pterospermum acerifolium</i> (L.) Willd.	14
3.	Frequency, size and type of vessel in the wood of <i>Mansonia gagei</i> J.R.Drumm. and <i>Pterospermum acerifolium</i> (L.) Willd.	14
4.	Size and type of xylem ray of <i>Mansonia gagei</i> J.R.Drumm. and <i>Pterospermum acerifolium</i> (L.) Willd.	15
5.	Size of wood fiber of <i>Mansonia gagei</i> J.R.Drumm. and <i>Pterospermum acerifolium</i> (L.) Willd.	15

Investigation on Wood Anatomical Characteristics of *Mansonia gagei* J.R. Drumm. and *Pterospermum acerifolium* (L.) Willd. Growing in Myanmar

Aye Nyein Chan, Research Assistant 2
Kyi Kyi Khaing, Assistant Research Officer
Forest Research Institute, Yezin

Abstract

Fresh specimens (vegetative parts, reproductive parts, and stem wood) of *Pterospermum acerifolium* (L.) Willd. were collected from the Forest Research Institute, Yezin and those of *Mansonia gagei* J.R.Drumm. were collected from the Taninthayi Region, in 2025. They were examined and identified at the Forest Research Institute, Yezin. The morphological characteristics of both vegetative and reproductive parts of *Pterospermum acerifolium* (L.) Willd. and the anatomical characteristics of their wood of stems were studied and described with relevant photograph and photomicrographs. Leaves of *Pterospermum acerifolium* (L.) Willd. were simple and alternate. The inflorescences of *Pterospermum acerifolium* (L.) Willd. were terminal and axillary, raceme, few-flowered cymes. The wood of both species studied were diffuse-porous. Xylem rays were homogeneous in *Mansonia gagei* J.R.Drumm. but heterogeneous in *Pterospermum acerifolium* (L.) Willd. Xylem fibers were non-septate in *Mansonia gagei* J.R.Drumm., whereas they were septate in *Pterospermum acerifolium* (L.) Willd. Gum deposits were present in the wood of both species. The tangential diameter of vessel elements was very small to moderately small in *Mansonia gagei* J.R.Drumm. whereas that was very small to medium-sized in *Pterospermum acerifolium* (L.) Willd. The rays seriate of *Mansonia gagei* J.R.Drumm. were 2 – 3 seriate (mostly 3) but 1 – 4 seriate (mostly 2-3) in *Pterospermum acerifolium* (L.) Willd. Non-libriform fibres were studied in both species. The findings in this research provide value information on the morphology and wood anatomy of the both species studied. Moreover, the wood anatomical characteristics will also support in the identification of the tree species of the family Malvaceae.

Keywords: tree identification, vegetative and reproductive parts, diffuse-porous wood, xylem ray structure, non-libriform fibres

မြန်မာနိုင်ငံတွင်ပေါက်ရောက်သော ကရမက်ပင်နှင့် တောကရမက်ပင်တို့၏ သစ်သား

အင်္ဂါဗေဒလက္ခဏာများကို လေ့လာခြင်း

အေးငြိမ်းချမ်း၊ သုတေသနလက်ထောက် (၂)

ကြည်ကြည်ခိုင်၊ လက်ထောက်သုတေသနအရာရှိ

သစ်တောသုတေသနဌာနခွဲ၊ ရေဆင်း

စာတမ်းအကျဉ်း

တောကရမက်ပင်၏ (အပင်ပိုင်း၊ မျိုးပွားပိုင်းနှင့် သစ်သားပိုင်း) နမူနာများကို သစ်တော သုတေသနဌာနဝန်း၊ ရေဆင်းနှင့် ကရမက်ပင်၏ သစ်သားနမူနာများကို တနင်္သာရီတိုင်းဒေသကြီးတို့မှ စုဆောင်း၍ မျိုးမည်ခွဲခြားခဲ့ပါသည်။ ဤစာတမ်းတွင် ၎င်းတို့၏ သစ်သားအင်္ဂါဗေဒလက္ခဏာ များကို ပုံများနှင့်တကွ ဆွေးနွေးတင်ပြထားပါသည်။ တောကရမက်ပင်၏ အရွက်သည် ရွက်ထီးဖြစ်ပြီး ရွက်လွှဲထွက်သည်။ ပန်းခိုင်သည် ထိပ်သို့မဟုတ် ကြားမှထွက်သော အဆုံးမရှိ ပန်းခိုင်အမျိုးအစားဖြစ်ပြီး တစ်ချို့သော ပန်းပွင့်အနည်းငယ်သည် အဆုံးရှိပန်းခိုင်အမျိုးအစား ဖြစ်ပါသည်။ မျိုးစိတ် (၂) မျိုးလုံး၏ သစ်သားများသည် diffuse-porous ဖြစ်၍ ကော်စေးများ ပါဝင်သည်။ ရေကြောရောင်ခြည်ဆဲလ်များသည် ကရမက်ပင်တွင် တူညီသောဆဲလ်ပုံသဏ္ဌာန် (homogeneous) ၊ 2 - 3 seriate (mostly 3) ဖြစ်သော်လည်း တောကရမက်ပင်တွင် မတူညီ သောဆဲလ်ပုံသဏ္ဌာန် (heterogenous) ၊ 1 - 4 seriate (mostly 2-3) ဖြစ်သည်။ ကရမက်ပင်၏ ရေကြောဖိုက်ဘာများသည် အကန့်နံရံမဲ့ဖြစ်၍ တောကရမက်ပင်တွင် အကန့်နံရံရှိသည်။ ရေကြောဆဲလ်များ၏ တန်းဖွင့်ချဉ်းအလိုက်အချင်းသည် ကရမက်ပင်တွင် very small to moderately small ဖြစ်၍ တောကရမက်ပင်တွင် very small to medium-sized ဖြစ်သည်။ Non-libriform fibres များကို မျိုးစိတ် (၂) ခုလုံးတွင် တွေ့ရှိရပါသည်။ ဤသုတေသနရလဒ် များသည် လူအများစု လွဲမှားတတ်သော ကရမက်ပင်နှင့် တောကရမက်ပင်တို့၏ ပြင်ပရုပ်သွင် လက္ခဏာများနှင့် သစ်သားအင်္ဂါဗေဒလက္ခဏာများကို သိရှိနိုင်သည့်အပြင် Malvaceae မျိုးရင်းဝင်သစ်ပင်မျိုးစိတ်များကို မျိုးမည်ဖော်ထုတ်ရာတွင် အထောက်အကူပြုပါသည်။

Investigation on Wood Anatomical Characteristics of *Mansonia gagei* J.R. Drumm. and *Pterospermum acerifolium* (L.) Willd. Growing in Myanmar

1. Introduction

Malvaceae is a family of flowering plants comprising about 120 genera and 1,500 species worldwide (Dassanayake, 1997). Malvaceae *sensu lato*, is estimated to contain 244 genera with 4,225 known species (Wikipedia, 2026). Two species, *Mansonia gagei* J.R. Drumm. and *Pterospermum acerifolium* (L.) Willd., belong to the family Malvaceae. Kress et al. (2003) listed 10 species of *Pterospermum* and only one species of *Mansonia* as widely distributed in Myanmar. *M. gagei* is distributed in India, Myanmar, and Thailand (Santisuk, 2001; World Flora Online, 2022). In Myanmar, *M. gagei* is distributed across natural forests in the Mandalay and Tanintharyi Regions (Kress et al., 2003). *M. gagei* commonly known as Kalamet, is a medium-to large-sized tree (Fern, 2014). It is highly valued for its fragrant heartwood. It is one of the most popular plants in Myanmar, recognized as one of the five kinds of scented woods and a traditionally significant medicinal tree. It is widely used in traditional medicine and plays a vital role in Myanmar's trade and medicinal applications.

The wood of *M. gagei* is used for handicrafts, while its essential oil is utilized in cosmetics and perfumes. The dry wood is aromatic (Santisuk, 2001) and is used in traditional medicine to treat heart disease, urinary disorders and skin ailments. It is also known to promotes hair growth (Nagathin & Ashin, 1946). This species is highly valued and expensive (Khin Maung Lwin, 1995), acting as a cardiac stimulant and a natural revitalizer (Htut Htut Htoo, 2022).

Furthermore, extracts from the heartwood of *M. gagei*, such as mansonone E, have potential to be developed as natural pesticides for managing agricultural pathogens (Mongkol, 2016). The roots and wood are prepared as a paste for oral consumption to clear phlegm and treat anemia, heart conditions, and urinary tract issues, or applied externally to soothe itching and provide a cooling effect on the skin (Robert A. DeFilipps, 2018).

Pterospermum acerifolium (L.) Willd. is native to Myanmar, Thailand and India (Fern, 2014). It is commonly known as Taw-Kalamet or Taung-phet-wun and is a large tree with fragrant flower. Its wood is used to produce various items, including wooden boxes, firewood sticks, flooring planks and furniture. The wood is soft and slightly durable, making it suitable for interior construction. In addition, it is also used as fuel (Iplantz, 2024).

Both species are well-known in Myanmar for their important medicinal value and timber utility. Wood is a renewable resource that plays a vital role in sustainable living. Consequently, fast and accurate wood identification technology is necessary for the majority of organizations and personnel engaged in wood production and processing, management, customs and wood inspection, scientific research and education in all aspects of the timber trade activities.

Therefore, this research studied the morphological and anatomical characteristics of two wood species, *Mansonia gagei* J.R.Drumm. and *Pterospermum acerifolium* (L.) Willd. which are often confused due to the perception of local people who regard them as the same species.

Morphological observations of *Pterospermum acerifolium* (L.) Willd. was made by a previous researcher (Aye Nyein Phyu, 2016). Anatomical studies of *P. acerifolium*, was also studied and described by (Thein Kywe, 2021). The pertinent literature for anatomical studies on this species, *Mansonia gagei* J.R.Drumm. is not described yet in Myanmar. The present research focuses on the morphological characters as well as the anatomical characters of the woody portion of *Mansonia gagei* J.R.Drumm. and *Pterospermum acerifolium* (L.) Willd.

In this paper, the aim and objectives of the present study are to describe the anatomical characteristics of the wood of *Mansonia gagei* J.R.Drumm. and *Pterospermum acerifolium* (L.) Willd., to support the identification of tree species and to provide anatomical characteristics of Myanmar's native tree species for the publication of a xylarium book.

2. Literature Review

Malvaceae sensu lato, has been more recently defined on the basis of genetics studies and can be expanded to include the families Bombacaceae, Tiliaceae, and Sterculiaceae so as to compose a monophyletic group. Adopting this circumscription, the Malvaceae incorporate a much larger number of genera (Wikipedia, 2026).

Santisuk (2001) described the morphological characteristics of *Mansonia gagei* J.R.Drumm as follows: it was a tree growing up to 20 m high; stipules lanceolate and caducous; leaves ovate to elliptic-oblong; petiole blackish when dry; flowers white and hairy outside; petals free, spatulate or oblanceolate; stamens alternating with staminodes; anthers one-celled with a short filament; carpels hairy; fertile locules with ovules; style slender and curved outwards; stigma pointed; fruit an ellipsoid and indehiscent.

According to Aye Nyein Phyu (2016), *Pterospermum acerifolium* (L.) Willd. was a perennial, evergreen large tree with simple, alternate leaves. The young parts of the plant were covered with stellate-tomentose hairs.

The heartwood of *Mansonia gagei* J.R.Drumm was a dark, olive-brown; the sapwood was light brown. The wood was very hard, the texture close and homogeneous (Fern, 2014).

Meier (2007) stated that the heartwood color of *M. gagei* was medium to dark brown, sometimes with darker streaks. Sapwood was tan-colored and fairly well demarcated from the darker heartwood. The wood had a straight grain with a fine and uniform texture. It was diffuse-porous, usually with vessels in radial multiples of two to four pores; the number of vessels ranged from few to numerous. The parenchyma was diffuse in aggregates and storied structures were found in this species. The wood possessed a distinct, pleasing odor and was sometimes used as incense. It was utilized for boxes, carvings, chests and other small special wood items as well as for making perfume.

According to Metcalfe & Chalk (1950), the vessel elements of *M. gagei* was very small, solitary or in small multiples and clusters. Solid deposits were present in small amount when observed in transverse section. The perforation plates were simple and intervacular pitting alternate, occasionally minute within the genus *Mansonia*. The ray cells in the genus *Mansonia*, were typically homogenous in contrast the heterogeneous rays observed in most species of family Sterculiaceae. The rays were prominently storied in *Mansonia*. Fibres were found to be small simple pits, very thin-walled, and moderately to distinctly storied within the genus.

Metcalfe & Chalk (1950) also mentioned the wood anatomical characteristics of *Pterospermum acerifolium* (L.) Willd. that the vessels were mostly medium-sized, although they may be slightly larger in some species of genus *Pterospermum*. Crystals were also observed in the wood of some species within the genus *Pterospermum*.

Thein Kywe (2021) also described that the heartwood colour of *P. acerifolium* was found to be pale red to pinkish red and it was sharply demarcated from the white sapwood. The wood anatomical characteristics of *P. acerifolium* were identified by focusing on the structure of vessel elements, the pattern of parenchyma, and the type of perforation. Additionally, the nature of fibre cells, as well as the structure and composition of ray cells (as observed in tangential longitudinal section) were studied to aid in the identification of tree characteristics.

According to Jena et al. (2023), the bark of *P. acerifolium* was smooth and grayish-brown. The wood was found to have uniseriate to biseriate medullary rays, more than 50 cells high and one to two cells wide.

Deshwal et al. (2019) stated that the bark of *P. acerifolium* was grey, thin, and smooth. The heartwood was red in colour, while the sapwood was lighter.

Saboo et al. (2010) described the bark as greyish-brown, the sapwood as pale white, and the heartwood as light pinkish-red.

Vijay et al. (2023) also mentioned that the wood was yellowish in colour, with a smooth texture and characteristic odour.

The sapwood colour of *P. acerifolium* was pale white; heartwood was light pinkish-red when freshly cut and gradually turned slightly darker upon exposure. The timber was moderately hard and not durable when exposed to the open, but fairly durable under cover. They studied the characteristics of vessel elements, the structure of parenchyma, fibres, and the types of ray cells. Yellowish or reddish-brown gummy deposits were found in the ray cells (Pearson & Brown, 1932).

3. Materials and Methods

Pterospermum acerifolium (L.) Willd. were collected from the compound of Forest Research Institute, Yezin and *Mansonia gagei* J.R.Drumm. was collected from the Taninthayi Region, in 2025. They were examined and identified at the Forest Research Institute, Yezin, based on available literature. For morphological studies, descriptions of the collected specimens were carried out by using dissecting microscope.

For anatomical studies, the small portions of wood were taken out at the height of 1.37 m of the plant. The wood blocks were boiled in water for 12 hours. The boiled specimens were then placed in solution of mixed glycerin and 50% ethyl alcohol for 2 – 3 days. Afterwards, the specimens were cut into 25 – 30 µm thick sections by using a sliding microtome. For staining and mounting, these sections were stored in alcohol-glycerin fluid. The sections were washed with water, then immersed in 3 % ferric ammonium sulphate for about 10 to 15 minutes and rinsed in water about three times. Next, the sections were stained in hematoxylin for about 10 to 15 minutes and then washed again and repeated changes of water. They were transferred to safranin solutions and stored overnight. The staining sections were new transferred to 50 %, 70%, 90 % and 95 % alcohol solution for the dehydration process. The sections were cleared with xylol at least 2 times and put into clove oil for further clearing. Finally, they were mounted on cover slips using Canada balsam in xylol and dried on a slide tray for a few days according to (Johansen, 1940). The sections were studied under the biological microscope (MT 4300 H).

Small pieces of stem wood were macerated separately by boiling with a mixture of two parts of hydrogen peroxide solution and one part of glacial acetic acid solution according to Frankly method (Berlyn and Mikshe, 1946). After then, the macerated tissues were washed with water and kept in ethyl alcohol solution with a few drops of safranin and glycerin for further study. Macerated elements were observed under a light microscope and recorded by a digital camera.

4. Results

4.1 Taxonomic description

4.1.1. *Mansonia gagei* J.R. Drumm.

Scientific name:	<i>Mansonia gagei</i> J. R. Drumm., J. Linn. Soc., Bot 37:260 (1905)
Synonyms:	<i>Burretiodendron umbellatum</i> Kosterm.
Common name:	Bastard sandalwood
Local name:	Kala-met, Ka-la-mak
Family:	Malvaceae
Flowering period:	August - October
Fruiting period:	October - January

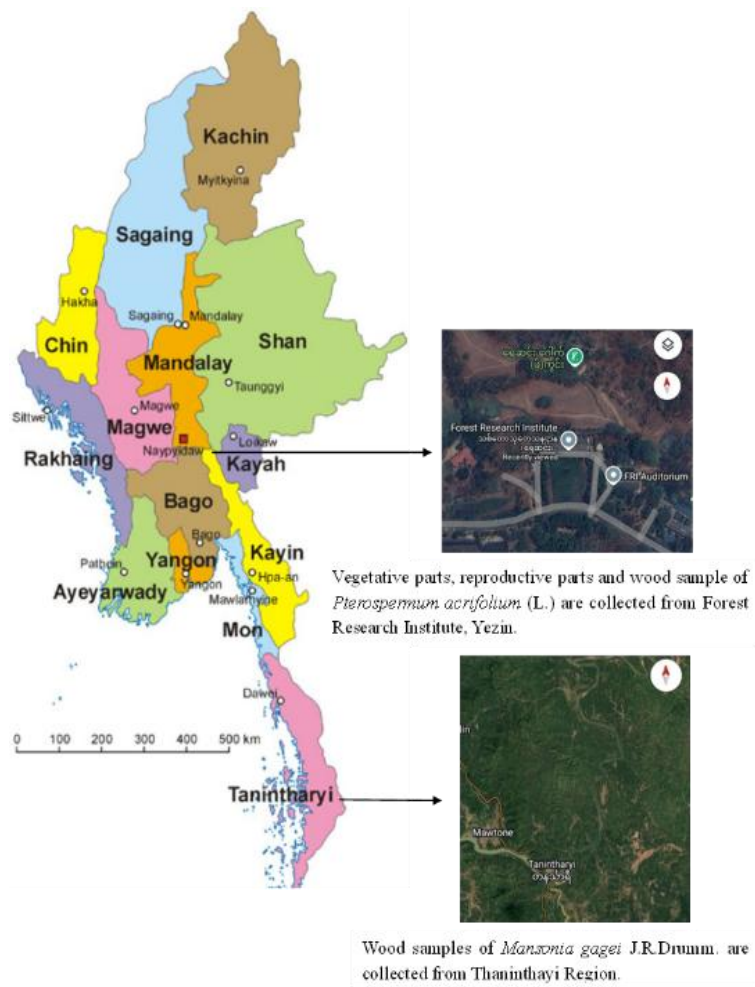


Figure 1. Location map of the collection site of Forest Research Institute, Yezin, Naypyidaw and Taninthayi Region in Myanmar (Location Map Photo from Google)

Morphological characteristics of *Mansonia gagei* J.R.Drumm.

Perennial, evergreen tree growing to about 20 m high; bark whitish brown; stems and branches terete, sparsely hairy to glabrous. Leaves simple, alternate; stipules lanceolate, caducous; petioles, terete, 0.5 – 1 cm green, glabrous, blackish when dry; leaf-blades ovate to elliptic oblong, 8 – 14 cm by 3 – 6 cm, glabrescent, subcordate at the base, slightly serrate along the margin, acute at the apex; nerves 3- 5 at base (Fig. 2 C). Inflorescence terminal and axillary, raceme, up to 15cm. Flower white, hairy outside (Fig. 2 D). Petals 5, oblanceolate, free. Stamens alternating with staminodes; anthers 1-celled with a short filament. Carpels hairy; ovary superior; locules with 5 – 9 ovules (Flora of Thailand, Vol-7, Part-3, 2001); style slender and curved outwards; stigma pointed. Fruit an ellipsoid samara, indehiscent, usually pairs, the apical wings curved (Fig. 2 E).

(Source: Flora of Thailand, Vol-7, Part-3, 2001)

4.1.2. *Pterospermum acerifolium* (L.) Willd.

Scientific name: *Pterospermum acerifolium* (L.) Willd., Sp. Pl. 3(1):729 (1800)

Synonyms: *Cavanilla acerifolia* (L.) J.F.Gmel.

Dombeya acerifoila (L.) Gaertn.

Pentapetes acerifolia L.

	<i>Pterospermadendron acerifolium</i> (L.) Kuntze
	<i>Pterospermum macrocarpum</i> Hochr.
Common name:	Dinner plate tree, Bayur tree, Maple-leafed bayur tree
Local name:	Taw-kalamet, Taung-phet-wun
Family:	Malvaceae
Flowering period:	January - April
Fruiting period:	May – July

Morphological characteristics of *Pterospermum acerifolium* (L.) Willd.

Perennial, deciduous large tree, about 35 m high, with irregular crowned; bark grayish-brown; stems and branches slender or terete, stellate-tomentose. Leaves simple, alternate; stipules lanceolate, 0.9 – 1.2 cm, deeply divided, stellate-tomentose, caducous; petioles terete, 2.7 – 11.0 cm long, brownish green, stellate-tomentose; leaf-blades oblong, obovate, orbicular or peltate, 11 – 24 cm by 9.5 – 22.5 cm, green and glabrous above, reddish-brown and stellate-tomentose beneath, cordate at the base, lobed or slightly divided or irregular edge along the margins, obtuse at the apex (Fig. 3 C). Inflorescences terminal and axillary, raceme, few-flowered cymes; peduncles terete, 0.5 – 1.5 cm long, brownish green, stellate-tomentose. Flowers pale yellow or white, about 8 cm across at the anthesis, fragrant, ebracteate, bisexual; pedicels terete, 1 – 2 cm long, brownish green, stellate-tomentose; bracteoles lanceolate or laciniate (lobes irregular), 5 – 12 mm long, brownish green, stellate-tomentose, caducous. Sepals 5, lanceolate, 6.0 – 9.5 cm long, basally connate, fleshy, greenish-brown, hairy on both surfaces (Fig. 3 E).

Petals 5, linear-oblong, 6.5 – 8.0 cm long, reflexed after anthesis, pale yellow or white, glabrous. Stamens 5, connate into the staminal tube, exserted; free portions of the filaments filiform, 6 – 10 cm long, white, glabrous; anthers dithecal, oblongoid, dorsifixed, yellow, longitudinal dehiscent. Gynophore slender. Ovary superior, oblongoid, 5 – 7 mm long, with 5 longitudinal angles, pentalocular, with many ovules in each locule on the axile placentae; styles slender, 4.3 – 5.0 cm long, white, glabrous; stigma clavate (Fig. 3 F). Fruits loculicidal capsules, ellipsoid, brown, stellate-tomentose, many-seeded. Seeds ovate, brown, glabrous.

Specimen examined: N 19° 52' 16.151" and E 96° 20' 04.061", Naypyidaw Union Territory, ZeyaThiri Township, Forest Research Institute, Yezin, 27th March, 2025; Aye Nyein Chan

4.2 Anatomical description

4.2.1. *Mansonia gagei* J.R.Drumm.

Scientific name: *Mansonia gagei* J.R.Drumm., J. Linn. Soc., Bot 37:260 (1905)

Synonyms: *Burretiodendron umbellatum* Kosterm.

Common name: Bastard sandalwood

Local name: Kala-met, Ka-la-mak

Family: Malvaceae

General characteristics and properties of the wood

Sapwood of the stem of *Mansonia gagei* J.R.Drumm. studied is light brown and heartwood yellowish-brown to dark brown, with black streak lines in the heartwood (Fig. 4 A); its odour distinct and taste not distinct. It is heavy wood, straight-grained and very fine textured. The wood is diffuse porous and its growth ring is not distinct. Gum deposit in the vessel. Crystal present.

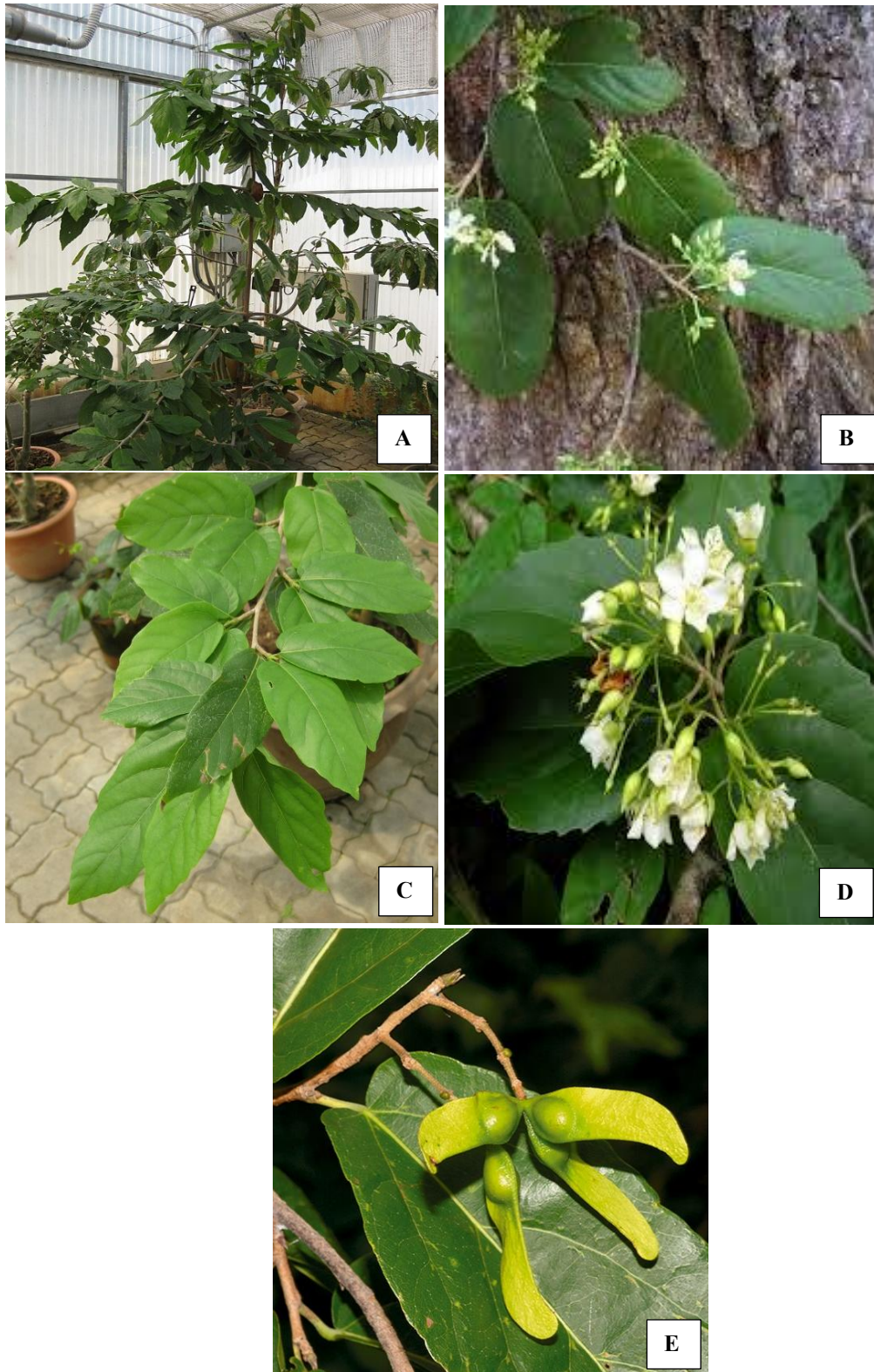


Figure 2. Habit of *Mansonia gagei* J.R.Drumm.

- A. Plant in natural habit (Source from <https://en.wikipedia.org/wiki/Mansonia>)
- B. A portion of stem showing bark (Source from internet)
- C. Leaves (Source from <https://tropical.theferns.info/image.php?id=Mansonia+gagei>)
- D. A branch with inflorescences (Source from BGO plant Database, The Botanical Garden Organization)
- E. Fruit (source from <https://botany.dnp.go.th/detaildict.html?wordsname>)

Microscopic characteristics

Vessel element: Diffuse porous, pores very small to moderately small, tangential diameter 25 – 70 μm (mean 49.23 μm), very fine textured; number per square mm very numerous (range 93 – 130); pores solitary, radial multiples 2 – 11, sometimes pore cluster; pore circular or oval in cross section, occasionally reddish resinous materials in vessel elements (Fig. 4 B); thin-walled; perforation plate simple; end wall oblique, tailed at one end or both ends (Fig. 5 A, B, C & D); intervessel pits alternate, crowded; vessel element extremely short to medium-sized; 240 – 370 μm (mean 312.7 μm) long.

Fibres: Non-libriform, very short to medium-sized, 510 – 1050 μm (mean 861.3 μm) long and 12.5 – 22.5 μm (mean 16.54 μm) wide, thick-walled, wall 5 – 15 μm (mean 9.45 μm) thick, thick-walled, size of pits small, simple, silt-like; lumen 3.75 – 12.5 μm (mean 7.08 μm) wide, non-septate, with tapering end (Fig. 5 E).

Rays: Homogeneous, 2 – 3 seriate (mostly 3), rarely uniseriate; 13.7 (range 11 – 16) per mm tangentially, very numerous; biseriate rays 120 – 260 μm (mean 213.1 μm) in height, 7 – 18 cells high, extremely fine to moderately fine, 13 – 30 μm (22.2 μm) in width; triseriate rays 150 – 260 μm (mean 222.5 μm) in height, 10 – 16 cells high, very fine to moderately fine, 25 – 40 μm (mean 33.0 μm) in width (Fig. 4 C). Ray cells consist of crystal and reddish resinous materials. Rays storied.

Axial parenchyma: Apotracheal parenchyma diffuse in aggregate with tangential bands, relatively abundant.

4.2.2. *Pterospermum acerifolium* (L.) Willd.

Scientific name: *Pterospermum acerifolium* (L.) Willd., Sp. Pl. 3(1):729 (1800)

Synonyms: *Cavanilla acerifolia* (L.) J.F.Gmel.
Dombeya acerifoila (L.) Gaertn.
Pentapetes acerifolia L.
Pterospermadendron acrifolium (L.) Kuntze
Pterospermum macrocarpum Hochr.

Common name: Dinner plate tree, Bayur tree, Maple-leafed bayur tree

Local name: Taw-kalamet, Taung-phet-wun

Family: Malvaceae

General characteristics and properties of the wood

Sapwood of the stem of *Pterospermum acerifolium* (L.) Willd. is studied creamy white to pale yellow, and heartwood was light pinkish-red to light red when young, turning darker pinkish-red when mature and then after the freshly cut, the color is light and it changes when dried (Fig. 6 A); its odour and taste not distinct. It is heavy wood, interlocked grained and very fine to medium textured, lustrous. The wood is diffuse porous and its growth ring distinct. Crystal present.

Microscopic characteristics

Vessel element: Diffuse porous, pores very small to medium-sized, tangential diameter 30 – 172 μm (mean 112 μm), very fine to medium textured; number per square mm few to moderately numerous (range 4 – 16); pores solitary, radial multiples of 2 – 5, occasionally pore cluster (Fig. 6 B); pore circular or oval in cross section, gum deposits present, tyloses absent; thin-walled; perforation plate simple; end walls oblique, tailed at end one end or both ends; intervessel pits alternate, crowded; vessel element extremely short to medium-sized; 150 – 490 μm (mean 302 μm) long.

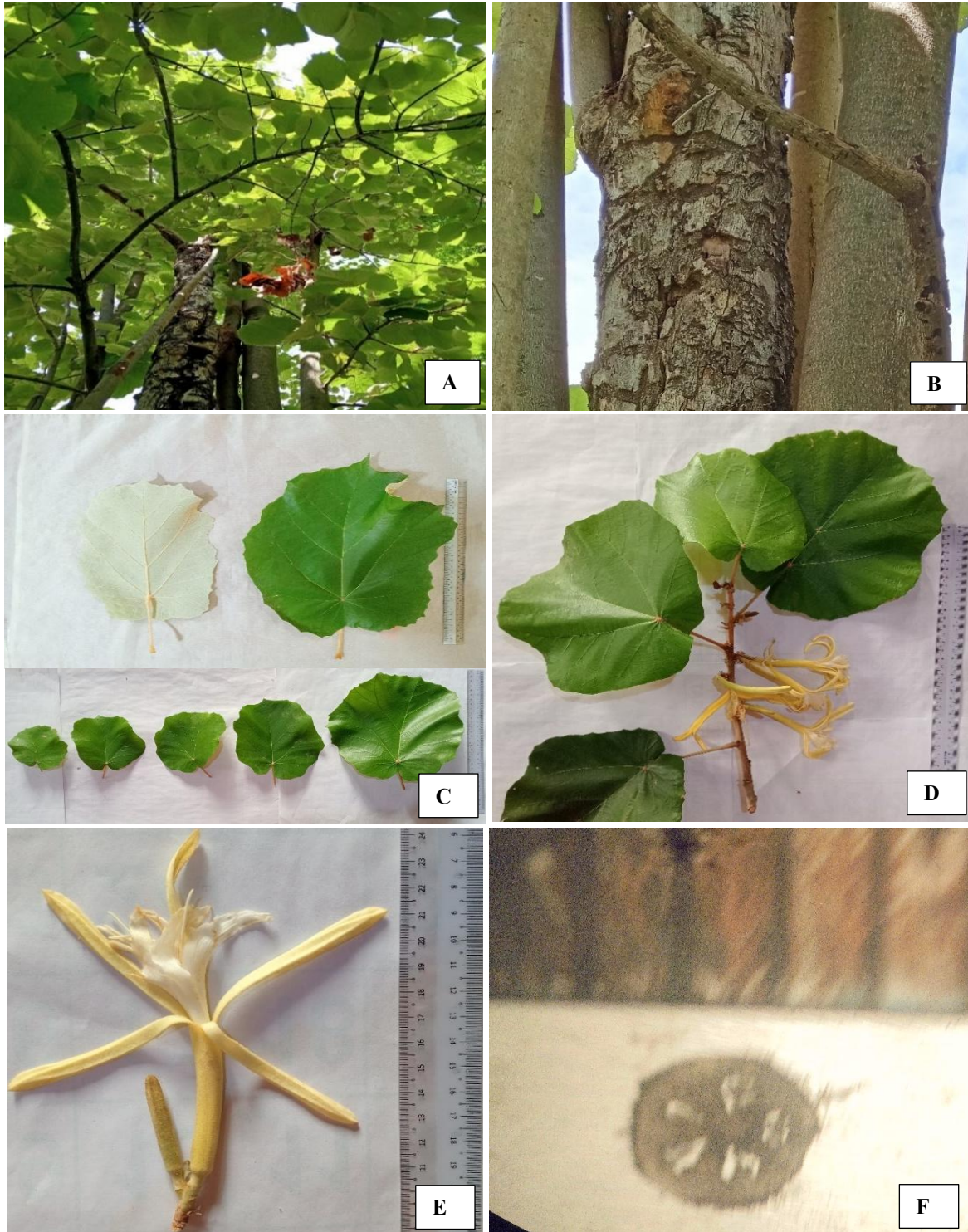


Figure 3. Habit of *Pterospermum acerifolium* (L.) Willd.

A. Plant in natural habit

C. Leaves

E. Flower as seen

B. A portion of stem showing bark

D. A branch with inflorescences

F. T S of an ovary

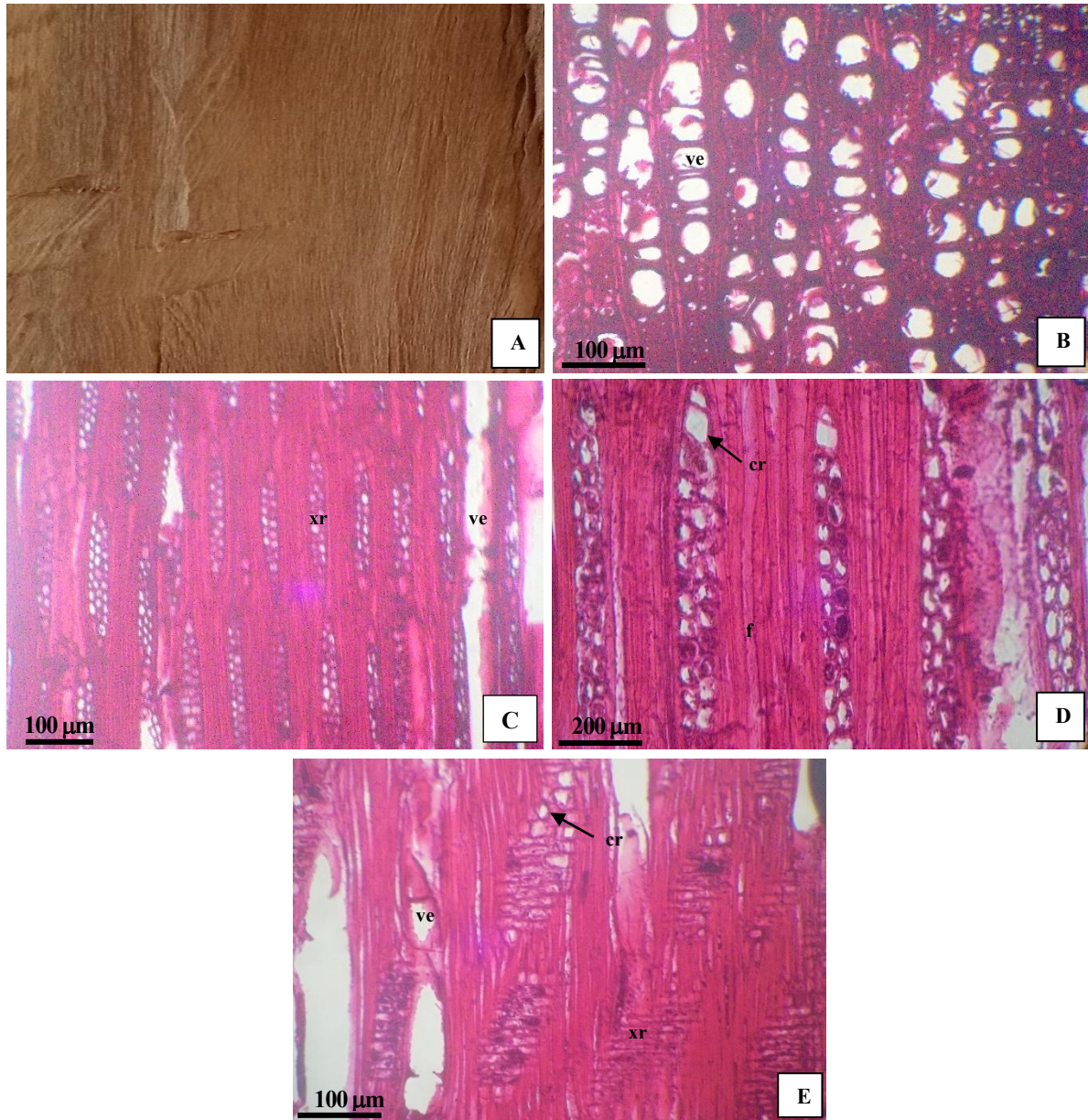


Figure 4. Internal structure of the wood of *Mansonia gagei* J.R.Drumm.

- A. A portion of wood of stem showing natural color and wood figure pattern
 - B. T. S of a portion of wood of stem showing solitary, radial multiple and pore cluster and xylem parenchyma cells
 - C. T.L.S of a portion of wood of stem showing biseriate and triseriate rays
 - D. T.L.S of a portion of wood of stem showing fibres and crystals in the ray cells with reddish resinous materials
 - E. R.L.S of a portion of wood of stem showing xylem rays, vessel and crystals
- (ve – vessel element, xr – xylem ray, f – fiber, cr – crystal)

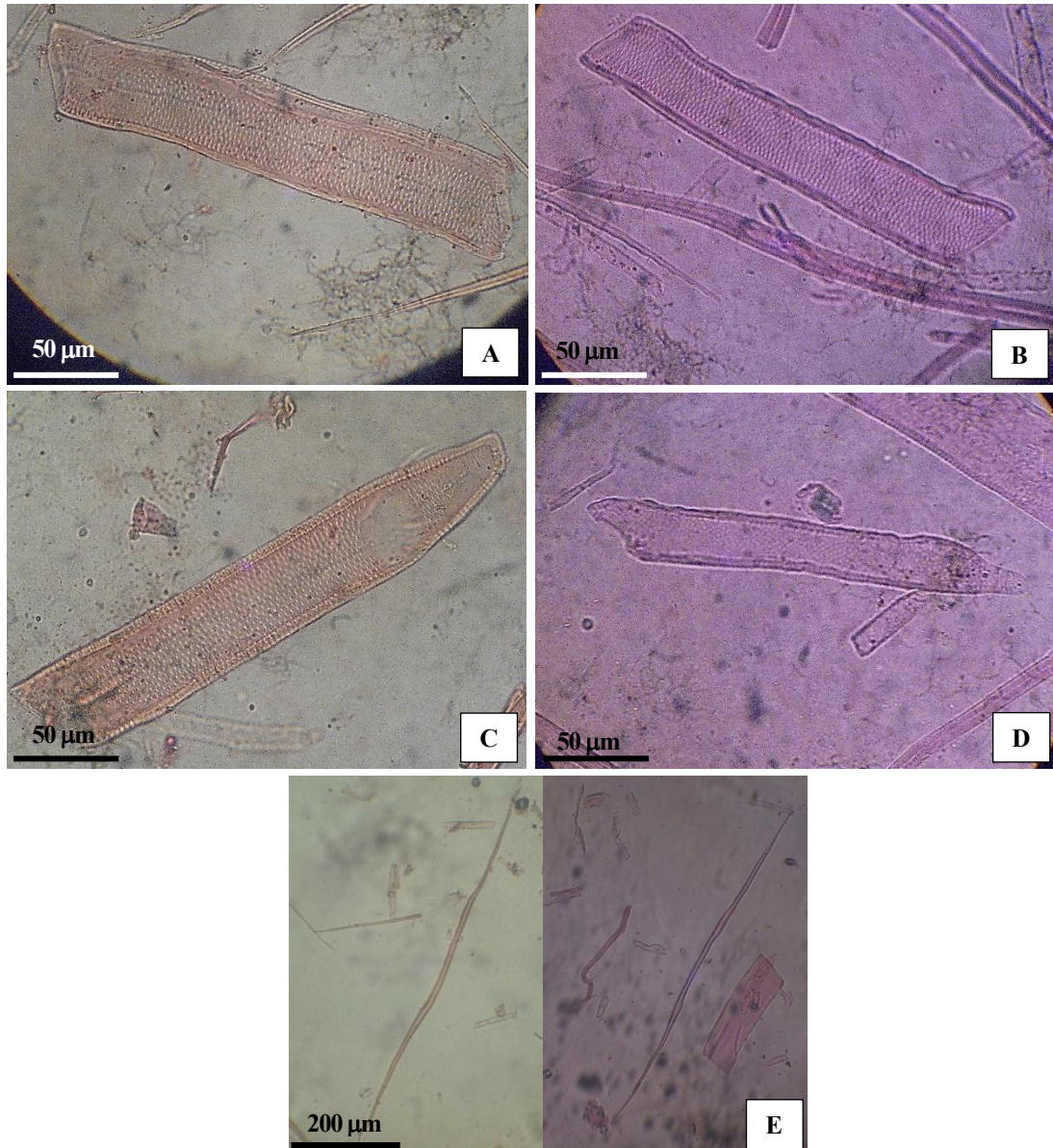


Figure 5. Macerated elements of *Mansonia gagei* J.R.Drumm.

- A. Macerated element showing vessel element with simple pits, simple perforation plates, and oblique end wall.
- B. Macerated element showing vessel element with simple pits, simple perforation plates, and oblique end wall.
- C. Macerated element of showing vessel element with simple perforation plate and tailed at both ends.
- D. Macerated element of showing vessel element with pitted tailed at both ends.
- E. Fibres.

Fibres: Non-libriform, moderately short to moderately long, 700 – 1930 µm (mean 1437.2 µm) long and 15.0 – 31.25 µm (mean 21 µm) wide, thick-walled, wall 5.0 – 22.5 µm (mean 13.75 µm) thick, thick-walled, sized of pits small, simple, silt-like; lumen 2.5 – 13.75 µm (mean 7.41 µm) thick, septate, with tapering end (Fig. 7 D).

Rays: Heterogeneous, 1 – 4 seriate (mostly 2 – 3), rarely uniseriate and mostly biseriate; 11.3 (range 6 – 18) per mm tangentially, moderately numerous to very numerous; uniseriate rays 120 – 1000 μm (mean 243.9 μm) in height, 6 – 19 cells high, extremely fine to moderately fine, 10 – 25 μm (mean 14.6 μm) in width; multiseriate rays 290 – 3050 μm (mean 775.1 μm) in height, 12 – 143 cells high, very fine to medium-sized, 20 – 90 μm (mean 43.2 μm) in width (Fig. 6 C). Gum deposits present in uniseriate rays and multiseriate rays.

Axial parenchyma: Apotracheal parenchyma diffuse in aggregate forming uniseriate bands, crystals present; gum deposits absent; storied.

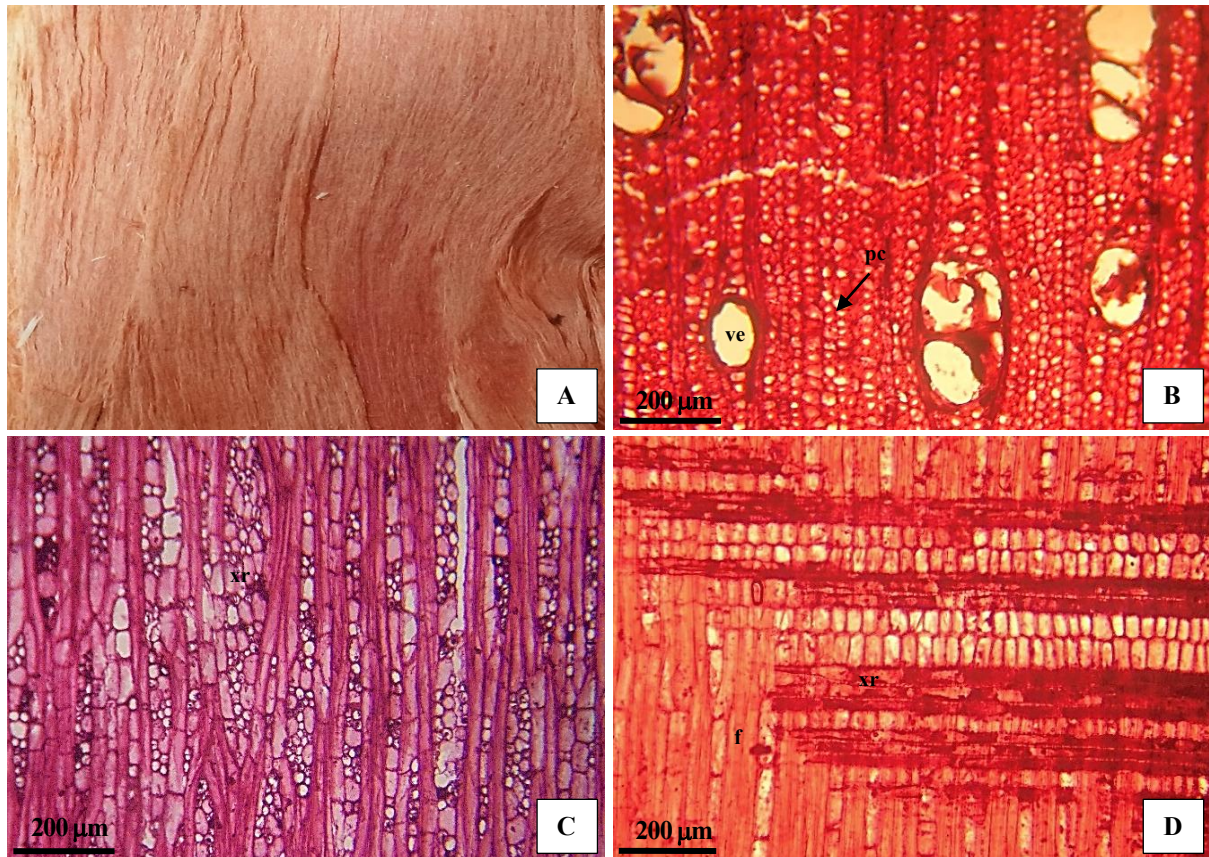


Figure 6. Internal structure of the wood of *Pterospermum acerifolium* (L.) Willd.

- A. A portion of wood of stem showing natural color and wood figure pattern
 - B. T. S of a portion of wood of stem showing solitary, radial multiple and pore cluster and xylem parenchyma cells
 - C. T.L.S of a portion wood of stem showing uniseriate and multiseriate rays
 - D. R.L.S of a portion of wood of stem showing xylem rays and fibres.
- (ve – vessel element, xr – xylem ray, f – fiber, pc – parenchyma cell)

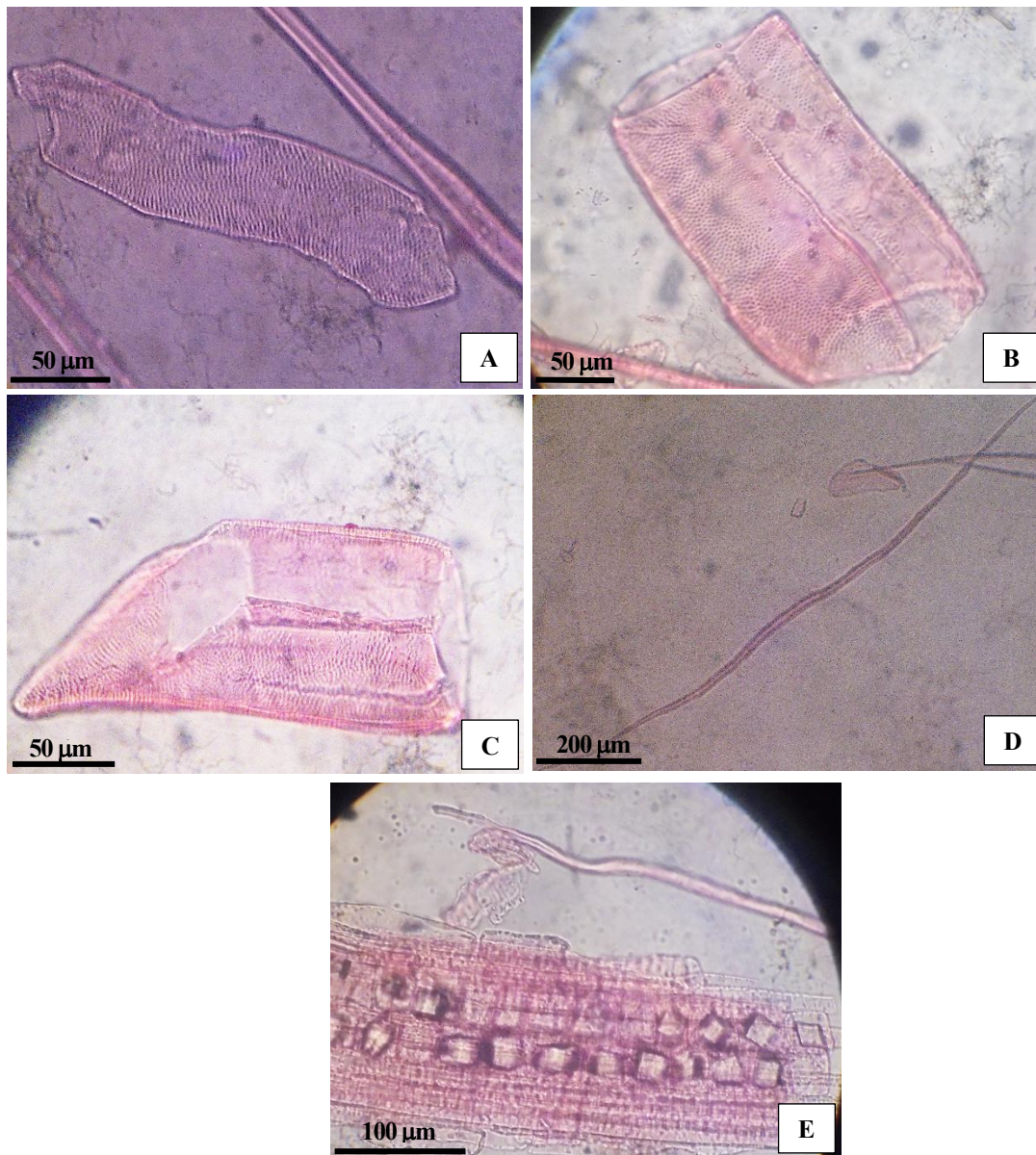


Figure 7. Macerated elements of *Pterospermum acerifolium* (L.) Willd.

- A. Macerated element showing vessel element with reticulate thickening.
- B. Macerated element showing vessel element with simple pits.
- C. Macerated element showing vessel element with simple perforation plates, and oblique end wall at one end.
- D. Fibre
- E. Macerated elements showing the parenchyma cells with crystals

Table 1. Comparative morphological characters of *Mansonia gagei* J.R.Drumm. and *Pterospermum acerifolium* (L.) Willd.

Sr No.	Characters		Species	
			<i>Mansonia gagei</i> J.R.Drumm	<i>Pterospermum acerifolium</i> (L.) Willd.
1.	Habit	-	Perennial/ evergreen tree	Perennial/ deciduous tree
2.	Barks	Colours of barks	whitish-brown	grayish-brown
3.	Stems	Texture of stems	sparsely hairy to glabrous	stellate-tomentose
4.	Leaves	Types of leaves	simple, alternate	simple, alternate
		Shapes of leaf-blades	ovate to elliptic-oblong	oblong, obovate or peltate
		Texture of leaf surfaces	glabrescent	glabrous above, rusty and stellate-tomentose beneath
5.	Stipules	Types of stipules	caducous	caducous
		Shapes of stipules	lanceolate	lanceolate (deeply divided)
6.	Petioles	Shapes of petioles	terete	terete
7.	Inflorescences	Position and types of inflorescences	terminal and axillary raceme	terminal and axillary raceme, few-flowered cymes
		Colour of flowers	white	pale yellow or white
8.	Calyx	Numbers of sepal	5	5
		Shapes of sepal	-	lanceolate (fresly/hairy on both surfaces)
9.	Corolla	Numbers of petal	5	5
		Shapes of petal	oblanceolate	linear-oblong
10.	Androecium	Numbers of anther	1-celled	ditheous
11.	Gynoecium	Types of the ovary	superior	superior
		Shapes of style	slender	slender
		Shapes of stigma	pointed	clavate
12.	Fruits	Types of fruit	Indehiscent (the apical wings curved)	loculicidal capsules

(Source: Morphological characteristics of *Mansonia gagei* J.R.Drumm referred from the Flora of Thailand, Vol-7, Part-3, 2001)

Table 2. Qualitative characteristics of wood structure of *Mansonia gagei* J.R.Drumm. and *Pterospermum acerifolium* (L.) Willd.

Sr No.	Qualitative characteristics	<i>Mansonia gagei</i> J.R.Drumm.	<i>Pterospermum acerifolium</i> (L.) Willd.
1.	Growthings	not distinct	distinct
2.	Texture	very fine textured	very fine to medium textured
3.	Grain	straight-grained	interlocked-grained
4.	Odour & taste	distinct & not distinct	not distinct
5.	Porosity	diffuse porous	diffuse porous
6.	Size of pores	extremely small to moderately small	very small to medium-sized
7.	Shape of pores	circular or oval	circular or oval
8.	Perforation plate	simple	simple
9.	Axial parenchyma	diffuse in aggregate	diffuse in aggregate
10.	Ray type	homogeneous	heterogeneous
11.	Fibre separation	non-septate	septate
12.	Fibre type	non-libriiform	non-libriiform
13.	Tyloses	absent	absent
14.	Gum deposits	gum deposit present in the vessel	gum deposits present in ray cells
15.	Crystals	crystals present	crystals present

Table 3. Frequency, size and type of vessel in the wood of *Mansonia gagei* J.R.Drumm. and *Pterospermum acerifolium* (L.) Willd.

Sr No.	Characters	<i>Mansonia gagei</i> J.R.Drumm.	<i>Pterospermum acerifolium</i> (L.) Willd.
1.	Pore frequency (per.sq mm)	range 93 – 130 Very numerous	range 4 – 16 Few to moderately numerous
2.	Pore radial multiples	2 – 11	2 – 5
3.	Vessel diameter	25 – 70 μm (mean 49.23 μm) Very small to moderately small	30 – 172 μm (mean 112 μm) Very small to medium-sized
4.	Vessel length	240 – 370 μm (mean 312.7 μm) Extremely short to medium-sized	150 – 490 μm (mean 302 μm) long extremely short to medium-sized

Table 4. Size and type of xylem ray of *Mansonia gagei* J.R.Drumm. and *Pterospermum acerifolium* (L.) Willd.

Sr No.	Characters	<i>Mansonia gagei</i> J.R.Drumm.	<i>Pterospermum acerifolium</i> (L.) Willd.
1.	Ray of seriate	2 – 3 seriate (mostly 3)	1 – 4 seriate (mostly 2-3)
2.	Ray per mm tan.	13.7 (range 11 – 16)	11.3 (range 6 – 18)
3.	Uniseriate ray height	-	120 – 1000 μm (mean 243.9 μm)
4.	Uniseriate ray width	-	10 – 25 μm (mean 14.6 μm) Extremely fine to moderately fine
5.	Uniseriate ray high	-	6 – 19 cells
6.	Biseriate ray height	120 – 260 μm (mean 213.1 μm)	-
7.	Biseriate ray width	13 – 30 μm (22.2 μm) Extremely fine to moderately fine	-

Table 4. Size and type of xylem ray of *Mansonia gagei* J.R.Drumm. and *Pterospermum acerifolium* (L.) Willd. (Cont.,)

Sr No.	Characters	<i>Mansonia gagei</i> J.R.Drumm.	<i>Pterospermum acerifolium</i> (L.) Willd.
8.	Biseriate ray high	7 – 18 cells	-
9.	Triseriate ray height	150 – 260 μm (mean 222.5 μm)	-
10.	Triseriate ray width	25 – 40 μm (mean 33.0 μm) Very fine to moderately fine	-
11.	Triseriate ray high	10 – 16 cells	-
12.	Multiseriate ray height	-	290 – 3050 μm (mean 775.1 μm)
13.	Multiseriate ray width	-	20 – 90 μm (mean 43.2 μm) Very fine to medium-sized
14.	Multiseriate ray high	-	12 – 143 cells

Table 5. Size of wood fibre of *Mansonia gagei* J.R.Drumm. and *Pterospermum acerifolium* (L.) Willd.

Sr No.	Characters	<i>Mansonia gagei</i> J.R.Drumm.	<i>Pterospermum acerifolium</i> (L.) Willd.
1.	Fibre length	510 – 1050 μm (mean 861.3 μm) Very short to medium-sized	700 – 1930 μm (mean 1437.2 μm) Moderately short to moderately long
2.	Fibre width	12.5 – 22.5 μm (mean 16.54 μm)	15.0 – 31.25 μm (mean 21 μm)
3.	Fibre wall thickness	5 – 15 μm (mean 9.45 μm)	5.0 – 22.5 μm (mean 13.75 μm)
4.	Lumen width	3.75 – 12.5 μm (mean 7.08 μm)	2.5 – 13.75 μm (mean 7.41 μm)

5. Discussion and conclusion

Mansonia gagei J.R. Drumm. (Kala-met) and *Pterospermum acerifolium* (L.) Willd. (Taw-kalamet), belonging to the family Malvaceae, were collected from the Yezin area, Nay Pyi Taw District and the Taninthayi Region. Their morphological and anatomical characteristics were described, discussed and compared. Photographs and photomicrographs were also presented. Macroscopic and microscopic studies of the genuine parts were referred to a few publications in Myanmar. The microscopic characters of the stem were found to be in agreement with those described by Metcalfe & Chalk (1950), Pearson & Brown (1932), Flora of Thailand, Vol.7, Part-3 (2001) but whereas some characters are not in agreement.

Mansonia gagei J.R.Drumm was perennial, evergreen tree, the bark colour whitish brown; stems and branches were terete, sparsely hairy to glabrous; leaves simple and alternate, leaf-blades ovate to elliptic oblong, glabrescent; white flowers; petals 5, oblanceolate; anthers 1-celled with a short filament; style slender and curved outwards; stigma pointed; ellipsoid and indehiscent samara-type fruits as has been described by Santisuk et al. (2001).

In this paper, *Pterospermum acerifolium* (L.) Willd. was perennial, deciduous large tree, the bark colour grayish-brown; stems and branches were found to be slender or terete, stellate-tomentose; leaves simple and alternate, leaf-blades oblong, obovate, orbicular or peltate, green and glabrous above, reddish-brown and stellate-tomentose beneath; flower was pale yellow or white; with five linear-oblong petals; anthers ditheous; styles slender; stigma clavate and fruits loculicidal ellipsoid capsules. The morphological characters of *P. acerifolium* were found to be in agreement with Hooker (1874), Dassanayake (1981), Jena (2023) and Aye Nyein Phyu (2016).

The sapwood of the stem of *Mansonia gagei* J.R.Drumm was found to be light brown and heartwood yellowish-brown to dark brown. Fern (2014) stated that the sapwood was light brown and the heartwood was dark olive-brown.

In this paper, the sapwood of the stem of *Pterospermum acerifolium* (L.) Willd. studied was found to be creamy white to pale yellow and the heartwood was light pinkish-red to light red when young, turning darker pinkish-red when mature. However, Saboo et al. (2010) described the bark as grayish-brown, the sapwood as pale white and the heartwood as light pinkish-red.

The growth rings of *Mansonia gagei* J.R.Drumm were not distinct in the transverse section. The wood of *M. gagei* was found to be very fine-textured.

The growth rings of the wood of *Pterospermum acerifolium* (L.) Willd. were distinct and the wood texture ranged from very fine to medium in transverse section. However, Thein Kywe (2021) stated that the wood of *P. acerifolium* was fine-textured.

In this study, *Mansonia gagei* J.R.Drumm was found to be the straight grained. The odour of wood of *M. gagei* was distinct but it was tasteless.

The grains of the wood of *Pterospermum acerifolium* (L.) Willd. were interlocked. The odour and taste of *P. acerifolium* were not distinct.

In both species, the wood was diffuse-porous, indicating a similar vessel distribution pattern throughout the growth ring. This finding was in agreement with those described by ITTO (2025).

Size of pores was in the range of very small to moderately small in *Mansonia gagei* J.R.Drumm; whereas it ranged from very small to medium-sized in *Pterospermum acerifolium* (L.) Willd. The wood vessel pores were generally circular or oval in shape. Perforation of vessel elements of both species studied were found to be simple. These characters were in accordance with those described by Metcalfe & Chalk (1950).

In this paper, the number per square mm of *Mansonia gagei* J.R.Drumm studied was very numerous, ranging from 93 to 130; whereas Metcalfe and Chalk (1950) reported a range of 50 to 75 number per square mm in this species. In *Pterospermum acerifolium* (L.) Willd, number per square mm was few to moderately numerous (range 4 – 16); however, the number per square mm was 4 – 18 according to Pearson & Brown (1932).

In this study, the pores of *Mansonia gagei* J.R.Drumm were found to be solitary or arranged in radial multiples of 2–11, and occasionally pore clusters. In *Pterospermum acerifolium* (L.) Willd, the pores were solitary or in radial multiples of 2–5, also occasionally forming pore clusters. The pore characteristics of *P. acerifolium* were similar to those described by Pearson & Brown (1932). However, Thein Kywe (2021) reported that the pores were solitary or in radial multiples of 2–8.

Tangential diameter of the vessel of both species was found to be extremely short to medium-sized; however, tangential diameter of the vessel of *P. acerifolium* was moderately short to medium-sized according to Thein Kywe (2021).

Fibres found in the wood of *M. gagei* studied were non-septate, but septate in *P. acerifolium*. However, this contrasts with the findings of Thein Kywe (2021), who reported that the fibres of *P. acerifolium* were non-septate.

In this paper, the length of fibre elements of *Mansonia gagei* J.R.Drumm studied was found to be in the range of very short to medium-sized, 510 – 1050 μm (mean 861.3 μm) long. In contrast, the fibre elements of *Pterospermum acerifolium* (L.) Willd were moderately short to moderately long, ranging from 700 – 1930 μm (mean 1437.2 μm). These values indicate that the fibre elements of *P. acerifolium* are generally longer than those of *Mansonia gagei* J.R.Drumm., as indicated by their higher mean and maximum lengths. According to Thein Kywe (2021), the fibre elements of *Pterospermum acerifolium* (L.) Willd were medium-sized to moderately long, with a mean length of 1471 μm and a range of 943 – 2050 μm .

The rays of *Mansonia gagei* J.R.Drumm. studied were found to be homogeneous, 2 – 3 seriate. These characters were similar to those mentioned by Metcalfe & Chalk (1950).

In this paper, the rays of *Pterospermum acerifolium* (L.) Willd were found to be heterogenous and 1 – 4 seriate. These characters were in accordance with those described by

Pearson & Brown (1932). However, Thein Kywe (2021) mentioned that rays to be uniseriate to multiseriate (2 – 6, mostly 2 cells wide) and heterocellular. Additionally, ITTO (2025) described that those were homogenous or sub-homogenous rays and more than 4 seriate.

The number of rays per mm (tangentially) range from 11 – 16 and was classified very numerous in *Mansonia gagei* J.R.Drumm. In *Pterospermum acerifolium* (L.) Willd, the number of rays per mm ranged from 6 – 18 per mm tangentially and moderately numerous to very numerous. However, according to Thein Kywe (2021), the number of rays per mm (tangentially) in *P. aecrifolium* ranged from 7 to 15 and moderately numerous to numerous.

In this present study, the biseriate ray width of *Mansonia gagei* J.R.Drumm studied was extremely fine to moderately fine, while the triseriate ray width of this species ranged from very fine to moderately fine.

In *Pterospermum acerifolium* (L.) Willd, the uniseriate ray width was observed to be extremely fine to moderately fine. The multiseriate ray width ranged from very fine to medium.

Crystals were present in the ray cells of *Mansonia gagei* J.R.Drumm. and in the axial parenchyma of *Pterospermum acerifolium* (L.) Willd.

Gum deposits were found in the wood of both species. In *Mansonia gagei* J.R.Drumm., gum deposits (reddish resinous materials) were observed in the vessel elements of both species and ray cells, whereas in *Pterospermum acerifolium* (L.) Willd, they were found only in the ray cells.

Apotracheal parenchyma was observed as diffuse in aggregate in both of *Mansonia gagei* J.R.Drumm and *Pterospermum acerifolium* (L.) Willd.

The findings in this research provide value information on the morphology and wood anatomy of the species studied. The morphological characteristics of the two species are particularly useful for the identification of flowering plants. Moreover, the wood anatomical characteristics will also support in the identification of the tree species of the family Malvaceae.

Acknowledgements

Ministry of Natural Resources and Environmental conservation is deeply acknowledged for providing research grant for this research work.

We are grateful to Dr. Thaung Naing Oo, Director General of Department of Forestry, Ministry of Natural Resources and Environmental conservation for his kind permission to carry out this research work.

We also thank U Nyunt Win, Director of Forest Research Institute, Yezin for his valuable support and encouragement during the course of this work.

We are deeply grateful to U Soe Tint, Director (Retired), Forest Research Institute, Yezin, for providing wood samples and his insightful suggestions during the course of this work.

We would like to mention our gratitude to U Soe Myint, Rector (Retired), Pakokku University, Pakukku, for his valuable advice, keen interest and supervision with constructive criticism throughout this research work.

My thanks are also due to all members of staff of Wood Anatomy Section and Library, Forest Research Institute, Yezin for their valuable help and support in many ways.

References

- Aye Nyein Phyu. 2016. Taxonomic Characterization of Some Species of Malvaceae Grown in Dee Dote Area, Pyin Oo Lwin Township. MSc Thesis. Department of Botany, Yadanabon University.
- Dassanayake, M.D. 1981. A reversed handbook to the flora of Ceylon. Vol.11. New Dehli: Amerind Publishing Co. Rt. Ltd. Dilcher, m L. J., 1974.
- Deshwal, N. & Sharma, S. 2019. *Pterospermum acerifolium* Linn.: A Comprehensive Review with Phytochemical and Pharmacological Investigation. International Journal of Pharmacognosy and Phytochemical Research 2019; 11 (3); 135-138. doi: 10.25258/Phyto. 11. 3.7. ISSN: 0975-4873.
- Fern, Ken. 2014. Useful Tropical Plants Database. tropical.theferns.info. 2024-10-13. ([http://www.tropical.theferns.info/view_tropical.php?id=Mansonia gagei](http://www.tropical.theferns.info/view_tropical.php?id=Mansonia_gagei))
- Fern, Ken. 2014. Useful Tropical Plants Database. tropical.theferns.info. 2024-10-13. (http://www.tropical.theferns.info/view_tropical.php?id=Pterospermum+acerifolium)
- Hooker. J.D. 1874. Vol. 1. Flora of British India. London, L. Reeve, 1875-97. Oxford-Clarendon Press.
- Htut Htut Htoo; Tuyet; N. N. Thi; Nakprasit, K.; Aonbangkhen, C.; Chaikeeratisak, V.; Chavasiri, W.; Nonejuie, P. 2022. Mansonone G and its Derivatives Exhibit Membrane Permeabilizing activities Against Bacteria. Institute of Molecular Biosciences, Mahidol University, Nakhon Pathom, Thailand. <https://doi.org/10.1371/journal.pone.0273614>. Editor: Marcos Pileggi, Universidade Estadual de Ponta Grossa, BRAZIL.
- International Tropical Timber Organization (ITTO).2025. Bayur (*Pterospermum acerifolium*). (<http://www.tropicaltimber.info/specie/bayur-pterospermum-acerifolium>)
- Iplantz.2024. *Pterospermum acerifolium*-common: name bayurtree. <https://www.iplantz.com>plant>pterospermumacerifolium-common:namebayurtree>.
- Jena, J.; Verma, S.; Rai, J. K; & Tripathi, R. 2023. *Pterospermum acerifolium* Linn: Ethnomedicinal uses, phytochemistry and pharmacology: A review. Journal of Pharmacognosy and Phytochemistry 2023; 12(1): 708-715.
- Khin Maung Lwin. 1995. Myanmar. In Beyond timber: social, economic and cultural dimensions of non-wood forest products in Asia and the Pacific. RAP Publication 1995/13. Bangkok, FAO Regional Office for Asia and the Pacific.
- Kress, W. John, Robert A. DeFilipps, Ellen Farr and Daw Yin Yin Kyi. 2003. A Checklist of the Trees, Shrubs, Herbs and Climbers of Myanmar. Department of Systematic Biology-Botany. National Museum of Natural History, Washington DC, USA.
- Meier, E. 2007. Musk Sandalwood (*Mansonia gagei*). The wood database. <https://www.wood-database.com/musk-sandalwood>.
- Metcalf, C. R. & Chalk, L. 1950. Anatomy to the Dicotyledons. Vol. 1 and II. The Clarendon Press, Oxford.
- Mongkol, R. & Chavasiri, W. 2016 Antimicrobial, herbicidal and antifeedant activities of mansonone E from the heartwoods of *Mansonia gagei* Drumm. Journal of Integrative Agriculture 2016, 15(12): 2795–2802.
- Nagathin, Ashin. 1946. Illustrated Medicinal Handbook (in Myanmar). Mingalar Press, Yangon.
- Pearson, R.S. & H.P. Brown. 1932. Commercial Timbers of India. Vol I and II. Calcutta, Government of India Central Publication Branch.

- Robert, A.; DeFilipps & Gary; A. Krupnick. 2018. The Medicinal plants of Myanmar. PhytoKeys 102: 1–341 (2018) doi: 10.3897/phytokeys.102.24380 <http://phytokeys.pensoft.net>.
- Saboo S. S., Tapadiya G. G., Metku M. V., Vaidya V. D., Khadabadi S. S. 2010. Pharmacognostic and Physicochemical investigation of *Pterospermum acerifolium* Willd leaves (Sterculiaceae). Volume 2. Issue 6. College of Pharmacy, Kathora Naka, Amravati.
- Santisuk, T. & Larsen, K. 2001. *Mansonia gagei*. Flora of Thailand. Vol.7. Part 3. Royal Forest Department.
- Thein Kywe. 2021. Wood Characteristics Properties, Identification and Uses (Fifty Hardwood Species in Myanmar). ISBN: 978-99971-0-920-0.
- Vijay, M.K., Singh, N., Chauhan, S., Joshi, M., Tiwari, S. & Kahar, L. 2023. Insights into *Pterospermum acerifolium* (L) Willd: A Rare Gem of Central Indian Flora. Volume 34, Issue 11-12, Page 92-103, 2023; Article no. EJMP.112388.
- Wikipedia. 2026. The free Encyclopedia. <https://en.wikipedia.org/wiki/Malvaceae>.
- World Flora Online. 2022. *Mansonia gagei* J.R.Drumm. <http://www.worldfloraonline.org/taxon/wfo-0000450926>.