



Ministry of Forestry
Forest Department
Forest Research Institute



Identification and Salient Characteristics of Tung Oil Trees in Myanmar



Aung Zaw Moe, Assistant Research Officer
Mu Mu Aung, Assistant Research Officer
Yin Yin Kyi, Deputy Director (Retired)
Forest Research Institute

မြန်မာပြည်တွင် ပေါက်ရောက်သော တန်းဆီပင်မျိုးများကို အမျိုးအမည် ခွဲခြားစစ်ဆေးခြင်းနှင့် ယင်းတို့၏ ထင်ရှားသော ဝိသေသလက္ခဏာများ

အောင်ဇော်မိုး၊ လက်ထောက်သုတေသနအရာရှိ
မူမူအောင်၊ လက်ထောက်သုတေသနအရာရှိ
ရင်ရင်ကြည်၊ ဒုတိယညွှန်ကြားရေးမှူး (အငြိမ်းစား)
သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်း

တန်းဆီကို စက်မှုကုန်ကြမ်းသုံးဖြစ်သော အရောင်တင်ဆီအနေဖြင့် ကျယ်ကျယ်ပြန့်ပြန့် အသုံးပြုကြသည်။ တန်းဆီကို *Aleurites* မျိုးစိတ်များ၏ အစေ့မှ ထုတ်ယူရရှိသည်။ မျိုးစု *Aleurites* သည် *Euphorbiaceae* မျိုးရင်းဝင် အပင်ဖြစ်ပြီး စီးပွားရေးအရ အလွန်အရေးပါသော မျိုးစိတ်များပါဝင် သည်။ တန်းဆီပင် စိုက်ပျိုးခြင်းဖြင့် ဝင်ငွေရရှိနိုင်ရုံသာမက အခြားစွန့်ပစ်မြေနှင့် မြေတိုက်စားခြင်း ပြဿနာများ ကူညီဖြေရှင်းခြင်းစသည့် အကျိုးကျေးဇူးများကို ရရှိပါသည်။ သမိုင်းမှတ်တမ်းများအရ တန်းဆီပင်ကို ကချင်ပြည်နယ်၊ ရှမ်းပြည်နယ်တို့တွင် ဒေသခံပြည်သူများ၏ ဝင်ငွေတိုးတက်ဖွံ့ဖြိုးရေး အတွက် သီးနှံသစ်တောရောနှော စိုက်ပျိုးရေးအစီအစဉ်ဖြင့် ကျယ်ကျယ်ပြန့်ပြန့် စိုက်ပျိုးခဲ့ကြသည်။ သို့သော်လည်း စိုက်ပျိုးခဲ့သော တန်းဆီပင်များ၏ သိပ္ပံနည်းကျ အမျိုးအမည်မှန် ခွဲခြား စစ်ဆေးခြင်း များကို ဆောင်ရွက်ခြင်းမရှိခဲ့ပါ။ ထို့ကြောင့် တန်းဆီပင်များ၏ တိကျမှန်ကန်သော သိပ္ပံအမည်အား သိရှိရန် လိုအပ်ပါသည်။ ဤသုတေသန စာတမ်းတွင် တန်းဆီပင်သုံးမျိုးအား အမျိုးအမည်မှန် ခွဲခြားစစ်ဆေးနိုင်ပြီး မျိုးစိတ်တစ်ခုခြင်းစီ၏ ထင်ရှားသော ဝိသေသလက္ခဏာများကို ဖော်ပြထားပါ သည်။ ယင်းမျိုးစိတ် တစ်ခုခြင်းစီတွင် အရွက်၊ အသီး၊ ပန်းခိုင်များ၏ ကွဲပြား ခြားနားသော လက္ခဏာများကို နှိုင်းယှဉ် ညွှန်ပြထားပြီး ကွင်းဆင်းဆောင်ရွက်ရာ၌ အလွယ်တကူသိရှိ၍ အမျိုးအမည် ခွဲခြားနိုင်မည် ဖြစ်ပါသည်။ *Aleurites monotana* နှင့် *Aleurites fordii* ကို ရှမ်းပြည်နယ် မြောက်ပိုင်းတွင် တွေ့ရှိရပြီး *Aleurites moluccana* ကို ရှမ်းပြည်နယ် တောင်ပိုင်းတွင် တွေ့ရှိရပါသည်။

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Abstract

Tung oil is widely used in the varnish industry. It is obtained from the seeds of the species of *Aleurites*. A genus *Aleurites* belong to the family EUPHORBIACEAE and include species of considerable economic importance. The genus *Aleurites* is the sources of candlenut oil. Not only it is a profitable source of income, but also it has helped to solve the problem of eroded and other waste land. Historically, tung oil trees were widely planted in Kachin State, Shan State for income development of rural community by the agro-forestry programme. But the planted tung oil trees species were not scientifically identified. So that the planted tung oil tree species need to be known their scientific name. In this research paper, three species of tung oil trees were identified and described distinguish botanical characteristics of each species. Comparisons of their different features of leaf, fruit and inflorescence were pointed out easy to know and classify in the field. *Aleurites montana* and *Aleurites fordii* were occurred in the Northern Shan State and *Aleurites moluccana* was occurred in Southern Shan State.

Keywords: Taxonomy, Taxon, Botanical characteristics, *Aleurites*, Species identification

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1. Introduction

What Chinese call as “tung” trees are plants with broad heart-shaped leaves. Tung oil, sometime called China-wood oil, is widely used in the varnish industry. It is obtained from the seeds of three species of *Aleurites*. The trees are handsome and are often planted for ornament. Industry is dependent on plants for many of its raw materials. Cork; tanning materials and dyestuffs; the oils, resins, and gums used in making paints, varnishes, soap, and perfume and rubber.

Most tung trees in the world are introduced from China. Britain is the first country trying to plant tung trees in 1880 and 1917. It tries to plant tung trees in its colonies such as India, Sri Lanka, Myanmar, and Malaysia (Huang Chin-cheng, 1988).

A genus *Aleurites* belong to the family EUPHORBIACEAE and include species of considerable economic importance. The genus *Aleurites* is the sources of candlenut oil, used in the manufacture of soap, paints and varnishes; it comprises three species, from each of which is obtained an oil of commercial value known as tung oil, used making in varnishes and paints. Not only is it a profitable sources of income, but also it has helped to solve the problem of eroded and other waste land.

Three species of genus *Aleurites* naturally grow and planted in Myanmar. They are *Aleurites fordii*, *Aleurites moluccana* and *Aleurites montana* especially in Kachin State, Northern Shan State, and Southern Shan State. *Aleurites montana* and *Aleurites fordii* were mainly occurred in Northern Shan State meanwhile, *Aleurites moluccana* in Southern Shan State. But there are need to be confirmed their exact species name. In this paper, distinguishing taxonomical characteristics of each species were described.

2. Objectives

- to described the diagnostic features of genus *Aleurites* and its species which are grow in Myanmar.
- to support the information on the other fields of tung oil research
- to assist the identification of Tung-oil trees in the field using with the distinguish characteristics of each species of tung oil tree.

3. Materials and Methods

The plant specimens of the three species were collected from the tung oil plantations which are situated in both northern and southern part of Shan State. The collected herbarium specimens were brought and examined identification of the species and described their diagnostics features of each species at Herbarium, Forest Research Institute.

4. Literature Reviews

4.1. Family EUPHORBIACEAE (The spurge family)

The Euphorbiaceae is a large family of flowering plant kingdoms, including some 300 genera and over 5,000 species of dicotyledonous herbs, shrubs, and trees. Important products of the family include cassava, rubber, and tung oil. The family is predominantly tropical in its distribution, although there are strong local concentrations, particularly of the genus *Euphorbia*, in such extra-tropical regions as the southern United State of America, the Mediterranean basin, the Middle East and South Africa; the greatest number of the genera, however, are entirely tropical.

4.2. Diagnostic Features of Family Euphorbiaceae Juss.

The leaves are alternate or rarely opposite, and have stipule. They are usually simple, and when they are compound they are always palmate and never pinnate. The flowers are regular, unisexual, and may occur either on the same plant (monoecious), as in *Euphorbia*, or on different plants (dioecious) as in *Mercurialis*. The flowers usually have five perianth segments, but in some genera (eg. *Jatropha*, *Aleurites* and *Caperonia*) petals are also present and in others the perianth is lacking altogether. There is one to very numerous stamens, and anthers with two (sometimes three or four) locules usually opening lengthwise, rarely by pores. A pistillode (non-functional ovary) is often present in male flowers. The ovary is superior and usually consists of three fused carpels having three locules with one or two ovules on axile placentas in each locule; the styles are free or variously united. The fruit is usually a schizocarp, sometimes a drupe. In a number of genera, the seeds are carunculate, eg *Euphorbia*, *Jatropha* and *Ricinus*; they usually have copious endosperm.

4.3. Taxa of Tung

Tung belongs to Euphorbiaceae. There are seven taxa (Stuppy et al., 1999): *V. montana* (Wils.) Lour., *V. fordii* (Hemsl.) Airy Shaw, *Aleurites* Forst, *V. cordata* (Thunb.) Airy Shaw, *R. trisperma* (Blanco) Airy Shaw, *A. remyi* Sherff, and *A. rockinghamensis* (Baill.) P. I. Forst. They are mainly distributed in East South Asia, Pacific islands, tropical and subtropical Oceania (Tsai Chin-piao et al., 1997).

Plant taxonomists have different perspectives toward above taxa. Linnaeus included *Aleurites* Forst into *Jatropha* and claimed it as *J. moluccana* L. However, Forster & Foster (1776) set up a new genus (*Aleurites* Forst) and proclaimed six species. Loureiro (1790) separated *V. montana* (Wils.) Lour. from *Aleurites* and set up *Vernicia* Lour.; Mueller (1886) collated above genus and united *Aleurites*, *Dryandra*, and *Vernicia* into a genus. That is, there were six species in *Aleurites* Forst.

Airy Shaw (1966) investigated Euphorbiaceae in Asia, presenting three genus, six species, and a mutation. Three genres are *Aleurites* Forst, *Vernicia* Lour., and the new genus *Reutealis* Airy Shaw. Under *Aleurites* Forst are two species and one mutation: *Aleurites* Forst, *A. remyi* Sherff, and *A. moluccana* (L.) Willd. var. *floccsa* Airy Shaw. Under *Vernicia* Lour. are three species: 1. *V. fordii* (Hemsl.) Airy Shaw; 2. *V. montana* (Wils.) Lour.; 3. *V. cordata* (Thunb.) Airy Shaw. *Reutealis* Airy Shaw has only one species: *R. trisperma* (Blanco) Airy Shaw. Recently Stuppy et al. (1999) correct the taxa again. They think *A. moluccana* (L.) Willd. var. *floccsa* Airy Shaw differs from other *Aleurites* Forst in pedicle, stamen, length of stigma, and number of ovary, so they turn its taxa from mutation to species and give it the scientific name *A. rockinghamensis* (Baill.) P. I. Forst. (Stuppy et al., 1999) according to the naming rules.

Because there are always diversions for the taxa, some scholars adopt the material for figuring out the question of plant taxa. Wu Hang (1985) gets his result by leaf anatomy and pollen observation of *V. montana* (Wils.) Lour., *V. fordii* (Hemsl.) Airy Shaw, and *Aleurites* Forst for three years. He supports Airy Shaw to separate *Vernicia* Lour. from *Aleurites* Forst. Lin Chien-chun et al. (1995) compare the wooden structure and composition of above three species. They also prove the difference between *Vernicia* Lour. and *Aleurites* Forst in

anatomic features and amounts. Jensen et.al. (1994) study on the immunoreactions for legumin like protein of above two genus. They prove the relationship of two genus, but they can't tell the precise differences between them. According to the experimental result in past years, the initial result is got by exploring the question of taxa. Documents and books recently published separate *Aleurites* Forst. from *Vernicia* Lour.

4.4. Economic Uses of Family Euphorbiaceae

Commercial products include rubber (*Hevea*), tung oil (*Aleurites*), castor oil (*Ricinus*), and cassava and tapioca (*Manihot*). Many ornamentals, especially from *Euphorbia* (poinsettia, etc.), *Codiaeum* (croton), *Phyllanthus* (Otaheite gooseberry). The number of genus includes species of considerable economic importance. The genus *Aleurites* is the source of candle nut oil.

5. Genus *Aleurites*

Aleurites is a small arborescent genus of flowering plants in the tropical and subtropical regions of Asia, the Pacific and South America, belonging to the spurge family Euphorbiaceae. The name *Aleurites* is derived from a Greek word meaning "wheaten flour", because of the appearance of the lower surface of the leaf.

5.1. Diagnostic features of Genus ALEURITES

These monoecious, evergreen trees are perennials or semi-perennials. These are large trees, 15–40 metres (49–130 ft) tall, with spreading drooping and rising branches. The leaves are alternate, lobate, ovate to ovate - lanceolate with minute stipules. They are pubescent on both sides when young, but in a later stage they become glabrous. The inflorescence consists of terminal plumes of small, creamy white bell-shaped fragrant flowers, branching from the base. The flowers are usually bisexual, with a solitary pistillate flower at the end of each major axis. The lateral cymes are staminate. There are five or six imbricate petals. The staminate flowers are mostly longer and thinner than the pistillate flowers, with 17-32 glabrous stamens in four whorls. The pistillate flowers have a superior ovary. The fruits are rather large drupes with a fleshy exocarp and a thin, woody endocarp. They vary in shape, according to the numbers of developed locules. They contain oleiferous, poisonous seeds.

5.2. Economic Uses of Genus *Aleurites*

The seed oil has been used as a paraffin, lubricant and as a constituent of varnish, paint and soap.

6. Dichotomous Key to the Species of *Aleurites*

- 1a Leaves ovate-triangular or ovate oblong, entire, 3-5lobed with cordate base, 7 nerved. Twigs, leaves and inflorescence white stellate hairy. - - - - - *A. moluccana* (L.) Willd.
- 1b Leaves cordate or ovate (-orbicular), entire or 3-5 lobed, 5-7 nerved. Twigs, leaves and inflorescence brownish stellate hairy. - - - - - 2
- 2a Glands on petioles stalked, clavate, with a hollow apex, erecto-patent or downwardly directed. Inflorescences at the ends of young shoots, with well developed leaf. Fruits ovoid, with rounded truncate base, narrowly attenuate towards apex, longitudinally grooved, with 3-5 longitudinal and a few transverse ribs, finely brown-hairy. - - - - -
- - - - - *A. Montana* (Lour.) E. H. Wils
- 2b Glands on petiole sessile, tuberculiform or cushion-shaped, with vaulted apex. Inflorescence on apices of stems, appearing before the young leaves. Fruits subglobose, shortly mucronate, not transversely ribbed, glabrous. - - - - - *A. fordii* Hemsl.

7. Descriptions of Tung oil Species

There are three species of Genus *Aleurites* were recorded and identified in Myanmar. The followings species will be expressed:

1. *Aleurites fordii*
2. *Aleurites moluccana*
3. *Aleurites montana*

7.1. *Aleurites fordii* Hemsl.

Trees up to 12 m tall and wide, bark grey and smooth skin, wood soft; leaves dark green, up to 15 cm wide, heart-shaped, sometimes lobed, appearing usually just after, but sometimes just before flowering, 5-7 nerved; glands on petiole sessile, tuberculiform or cushion-shaped, with vaulted apex, petiole as long as leaf; Inflorescence on apices of stems, appearing before the young leaves; flowers in clusters, whitish, rosethroated (white petals with red bottom), produced in early summer from terminal buds of shoots of the previous season; monoecious, male and female flowers in same inflorescence, usually with the pistillate flowers surrounded by several staminate flowers; fruits spherical, pear-shaped or top shaped, green to purple at maturity, with 4–5 carpets each with one seed; seeds usually 4–5, but may vary from 1 to 15, 2–3.2 cm long, 1.3– 2.5 cm wide, consisting of a hard outer shell and a kernel from which the oil is obtained. Flowering time is from February to April and fruiting time is late September to early November.



Fig.1 Leafbase with glands of the petiole of *A. fordii*



Fig 2.Fruits of *A. fordii*

7.2. *Aleurites moluccana* (Linnaeus) Willdenow,

Medium-sized tree, up to 20 m tall, ornamental, evergreen, bark dark grey skin. The skin with shallow rifts is almost smooth, fairly smooth with fine vertical lines young branches densely gray-brown stellate-puberulent, subglabrous at maturity, with wide spreading or pendulous branches; leaves simple, variable in shape, leaf blade papery, young leaves large, up to 30 cm long, palmate, with 3–7 acuminate lobes, shining, while leaves on mature trees are ovate, entire, and acuminate, long-petioled, whitish above when young, becoming green with age, with rusty stellate pubescence beneath when young, and perisiting on veins and petiole; flowers in rusty-pubescent paniced cymes 10–15 cm long, stamens form three circles, totally 15-20 ; petals 5, dingy white or creamy, oblong, up to 1.3 cm long; ovary 2-celled; fruit an indehiscent drupe, roundish, 5 cm or more in diameter, with thick rough hard shell making up 64–68% of fruit, difficult to separate from kernels; containing 1 or 2 seeds. Flowering time is April to October and fruiting time is October to December.

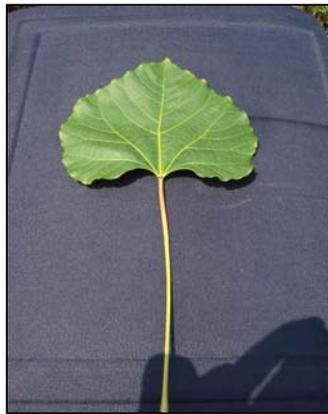


Fig 3. Leafbase with minute glands on the long petioles of *A. moluccana*



Fig 4. Fruit of *A. moluccana*

7.3. *Aleurites montana* (Lour.) Wils.

A small tree about 5 m tall, much-branched, partially deciduous, dioecious; leaves simple, ovate or more or less cordate, apex cuspidate, about 12 cm long, 10 cm broad, sometimes larger and 3-lobed; leaf-blade with 2 large, conspicuous glands at base, petiole up to 24 cm long; Glands on petioles stalked, clavate, with a hollow apex, erect or downwardly directed; flowers monoecious, petals large, white, up to 3 cm long; fruits egg-shaped, 3-lobed, wrinkled, about 5 cm in diameter, pointed at summit, flattened at base, generally with 3 or 4 one-seeded segments, the outer surface with wavy transverse ridges, the pericarp thick, hard and weedy. Flowering and fruiting are in March.



Fig 5. Leafbase with cup shape glands on the petiole of *A. montana*



Fig 6. Fruits of *A. montana*

8. Comparison of distinguish taxonomical characteristics of among species

Characters	<i>A. fordii</i>	<i>A. moluccana</i>	<i>A. montana</i>
Habit	Trees up to 12 m tall with spreading crown.	Medium sized tree, up to 20 m tall, ornamental, with widespreading or pendulous branches.	Small tree about 5-7 m tall, much branched, partially deciduous
Bark	smooth with brownish gray furrows that develop to a reddish brown.	dark gray, fairly smooth with fine vertical lenticles young branches densely gray-brown stellate-puberulent, subglabrous at maturity.	gray in colour with whitish round blotches
Leaves	dark green up to 15 cm wide, cordate in shaped, sometimes lobed, appearing usually just after, but sometimes just before flowering, 5-7 palmately nerved	variable in shape, leaf blade papery, young leaves large, up to 30 cm long, palmate, with 3-7 acuminate lobes, shining, while leaves on mature trees are ovate, entire, and acuminate, long-petioled	simple, ovate or more or less cordate, apex cuspidate, about 12 cm long, 10 cm broad, sometimes larger and 3-lobed; leaf-blade with 2 large, conspicuous glands at base, petiole up to 24 cm long.
Glands on petiole	petiole sessile, tuberculiform or cushion-shaped, with vaulted apex.	Inconspicuous	petioles stalked, cup shaped, with a hollow apex, erect or downwardly directed.

Inflorescence	on apices of stems, appearing before the young leaves.	terminal, branched, conical	terminal panicle at the ends of young shoots, with well developed leaf with small white flowers.
Flower	Attractive flowers with 5 white petals with streaks of red or purple in the throat. 5 stamen of outer series united into column.	valvate 5 lobes petals , white or cream; stamens 15-20 in series, outer ones free, inner ones united into column.	5 petals large, white, up to 3 cm long with 5 -15 stamens in 2 series, 5 stamens in outer series freely and inner series united into column.
Fruit	spherical, pear-shaped , green to purple at maturity, with 4–5 carpets each with one seed; seeds usually 4–5	an indehiscent drupe, subglobose (roundish); exocarp thinly fleshy; endocarp woody, 1- or 2-seeded. Seeds compressed globose,	ovoid, with rounded truncate base, narrowly attenuate towards apex, about 5 cm in diameter, pointed at summit, flattened at base, ,longitudinally grooved, with 3-5 longitudinal and a few transverse ribs, finely brown-hairy

9. Discussion

The afforestation programme in mountain reservations, tung oil tree is one of the important plants.

According to the identification, most of tung oil trees species which were planted in NSS were *A. montana* and only one species were planted in SSS was *A. moluccana* respectively.

But *A. fordii* species was not very common in both NSS and SSS. The species was occurred sometimes together with *A. montana* plantation in NSS.

The different three species of tung oil trees can be easily identified in the field using dichotomous key and their distinguish characteristics of each species.

10. Conclusion

According to some recorded data, four species of *Aleurites* can be found in Myanmar. But in this study, three species of *Aleurites* were found in Northern and Southern Shan State.

There were:

- *Aleurites fordii* Hemsl.
- *Aleurites moluccana* (L.) Willd.
- *Aleurites montana* (Lour.) Wils.

Aleurites fordii is grown abundantly in Northern Shan State in Muse District, Mon Pal Area and northern Shan and Kachin border area, Bahmo District, Mon wun gyi area at the elevation above 4000 feet.

Aleurites montana is naturally grown in Lashio District, Kyaukme and Muse in Northern Shan State, and also found some plantations in these areas.

Aleurite moluccana is only found in Southern Shan State, Taunggyi-Heho along the road side.

In this study, we can not get the specimen of *Aleurite cordata*, which is only found in Wa area in Northern Shan State. *Aleurites montana* is the only species, which is planting more plantations for the purpose of raw industrial material for tung oil in NSS.

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