

POLLEN MORPHOLOGY ON TEN SPECIES OF SAPINDALES FOUND IN MANDALAY REGION AND SOUTHERN SHAN STATE

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Abstract

The pollen morphology of 10 species belonging to 10 genera of Sapindales was studied. The specimens were collected from Mandalay Region and Southern Shan State from 2017 to 2018. The collected plants include 2 species of Anacardiaceae, 1 species of Sapindaceae, 5 species of Rutaceae and 2 species of Meliaceae. The examined pollen grains were found in monad type. The morphological characters of each grain were studied. The aperture types of all the pollen grains were porate and colpiate; triporate in one species, tricolporate in 5 species and tetracolporate in 4 species. The pollen shapes were found in prolate, oblate spheroidal, subprolate to prolate spheroidal. The sizes of pollen grains were small and medium. The small sizes of pollen grains were found in 6 species and medium size of pollen grains was found in 4 species. The sculpture patterns of 10 species are varied from psilate, reticulate to obscurely reticulate.

Keywords : Sapindales, Palynology, Southern Shan State.

Introduction

Palynology is the study of pollen and spores. Pollen characters which are only of limited taxonomic importance at the generic level or lower are largely ignored. Pollen characters have been grouped into seven categories, which will be treated in the following order: aperture type, pollen wall architecture, pollen-unit, polarity, symmetry, shape and grain size (Walker & Doyle 1975).

The basic palynology has contacts with cytology and genetics, morphology, physics, chemistry and other branches of science, even mathematics; to basic palynology can also be referred investigations of pollen and spore dispersal, preferably by wind and water and of the pollen and spore content of peat and sediments etc. Several types of pollen grains may even be produced by a single species (Erdtman 1952).

Pollen grains are microscopic; their detail cannot be resolved by the naked human eye unless they are at the larger end of the size range. They are measured in microns. Most pollen grains are between 20 and 80 microns. However, the smallest pollen grains are about 5 to 8 microns. In most plant pollen grains are released from the anthers of mature flowers as individuals. However, in some plant families (circa fifty) there are at least some species where the mature pollen grains are dispersed as 'tetrads' (Kessler 2009).

According to the classification system of Byng *et al.* (2016), Sapindales is an order of flowering plants. Well-known members of Sapindales include citrus; maples, horse-chestnuts, lychees and mangos and cashews; mahogany and neem. Sapindales includes Biebersteiniaceae, Nitrariaceae, Kirkiaceae, Burseraceae, Anacardiaceae, Sapindaceae (including Xanthoceraceae), Rutaceae, Simaroubaceae and Meliaceae. However, only six out of nine families are found in Myanmar. The remaining three families, namely, Biebersteiniaceae, Nitrariaceae, Kirkiaceae are not found in Chit Ko Ko (1961) and Kress *et al.* (2003). Sapindales is about 278 species (Hundley and Chit Ko Ko 1961) and is about 285 species (Kress *et al.* 2003).

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Pollen morphology of the family Anacardiaceae has radially symmetrical, isopolar, sub-prolate rarely prolate spheroidal or oblate-spheroidal, sexine thicker or thinner than nexine, colpal membrane granulate to spinulose (Perveen & Qaiser 2010).

Citrus species are a common and extremely important for their fruit. It is one of the genera in the family Rutaceae. *Citrus* comprises around 60 species, most of which are cultivated throughout the tropics and subtropics (Anbari *et al.* 2015).

In Meliaceae pollen descriptions of the three *Carapa* species were very similar presenting pollen grains stephanocolporate (4-6 aperture), oblate spheroidal, isopolar and circular shape (Zidko *et al.* 2016).

Sapindaceae are mostly tropical or subtropical, with a few genera extending to sub-temperate zones. Sapindaceae pollen grains are usually iso-polar or subisopolar monads, pollen grain size is usually between 20 and 30 mm, and the grains are oblate to prolate in shape (Rodriguez *et al.* 2010).

Many researchers had given an account on the classification and identification of order Sapindales in various localities in Myanmar. However, pollen morphology of the order Sapindales has not been mentioned in Myanmar. Therefore, a research on pollen morphology of order Sapindales still needed to be studied and recorded.

The aims and objectives of this research were to identify and classify the morphological variation in pollens of Sapindales, to study and record the collected species systematically from the palynological point of views and to provide the different pollen characters.

Materials and Methods

Collection of Plants

The specimens of the order Sapindales were collected from Mandalay Region and Southern Shan State from 2017 to 2018. The collected species were photographed to record their inflorescences and flowers. All the collected plants are pressed and preserved in the herbarium sheets. Locations of the collected specimens were described by using Global Position System (GPS). Identification of genera and species were carried out by referring to Backer (1965), Dassanayake (1980), Hooker (1881). Myanmar names were referred to Hundley and Chit Ko Ko (1961) and Kress and Daw Yin Yin Kyi (2003) in Myanmar.

Collection of Pollen Samples

All the fresh pollens were collected from the anthers of blooming flowers. The collected flowers of each species were stored in the glass vials with glacial acetic acid and the specimens were labeled.

Acetolysis of Pollen Grain

The pollen samples were acetolysed by the standard method of Erdtman (1960). The samples in glass vial were put into a test tube, then crushed with a glass rod. The acetolysis solution was mixed using a measuring cylinder; 9 parts of glacial acetic acid were added, and then 1 part of concentrated sulphuric acid was added. The acid was dropped gently down the side of the tube. 1 cc of acetolysis mixture was poured into the test tube containing the pollen

samples and stirred with a glass rod. The test tube containing the pollen sample was transferred to a water bath at 75°C for 30 minutes. The test tube was diluted with distilled water and the test tubes were put in an electric centrifuge tube for 30 minutes at 3000 rpm. This was repeated twice, decanting the water each time. After centrifuging and decanting, a few drops of dilute glycerin solution was added to the residue, then transferred and stored in air tight glass vial.

Slide Preparation

A drop of sample was taken from sample bottle with a glass rod and placed on a slide, then covered with a cover-slip. The glass slice was examined under light microscope and photomicrograph. Pollen grains were measured and recorded on their polar length (P); equatorial diameter (E); length and wide of colpi; diameter and length of pores and exine thickness. These measurements were based on 10-15 grains per sample. The pollen terminology used in identification is according to Erdtman (1952), Moore & Webb (1978), Hoen (1999) and Hesse (2009).

Results

In this research, pollen morphology of 10 species belonging to 10 genera in four family of Sapindales were studied. The list of collected species were arranged according to classification system of Byng *et al.* (2016) and listed in alphabetically as shown in Table 1.

Table 1 List of the collected specimens

Order	Family	No.	Scientific Name	Myanmar Name
Sapindales	Anacardiaceae	1	<i>Buchanania latifolia</i> Roxb.	Thit si bo, Lunbo
		2	<i>Melanorrhoea usitata</i> Wall.	Thit si
	Sapindaceae	3	<i>Cardiospermum canescens</i> Wall.	Kala myetsi
		4	<i>Aegle marmelos</i> (L.) Correa, Trans, L.	Okshit
	Rutaceae	5	<i>Atalantia monophylla</i> (Roxb.) DC.	Shauk yaing, Taw shauk
		6	<i>Clausena excavata</i> Burm. f.	Pyin daw thein
		7	<i>Glycosmis pentaphylla</i> (Retz.) DC.	Taw shauk ,Obok
		8	<i>Micromelum pubescens</i> Blume	Tanyin bo, Taw pyindaw thein
	Meliaceae	9	<i>Azadirachta indica</i> A. Juss.	Tama, Tama kha
		10	<i>Melia azedarach</i> L.	Thinbaw pan tama

1. *Buchanania latifolia* Roxb., Fl. Ind. 2.1832. (Figure 1 A)

Buchanania lanzan Sprengel.

Myanmar name	: Thit si bo, Lunbo
English name	: Almond
Flowering period	: December to March

Outstanding characters

Perennial trees, stems and branches terete, brown, pubescent. Leaves simple, alternate, exstipulate. Inflorescences axillary and terminal panicle raceme. Flowers bisexual, actinomorphic, pentamerous. Petals 5, free, oblong. Fruits drupaceous. Seeds one-seeded, brown, endospermic.

Specimens examined: Mandalay Region, Kyaukse Township, Yeywa village; 21° 40' 26" N and 96° 26' 30" E; 8 December, 2018; Hnin Yu Maw, collection no. 18.

Pollen morphology (Figure 1 B, C)

Tricolporate, prolate spheroidal, small, $19.2 - 22.8 \times 18.0 - 20.4 \mu\text{m}$ in length and breadth; amb rounded triangular; colpi longicolpate, $16.8 - 19.2 \times 4.8 - 6.0 \mu\text{m}$ in length and breadth; pori lalongate, $6.0 - 7.2 \times 7.2 - 8.4 \mu\text{m}$ in length and breadth; exine $0.6 - 1.2 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing obscurely reticulate.

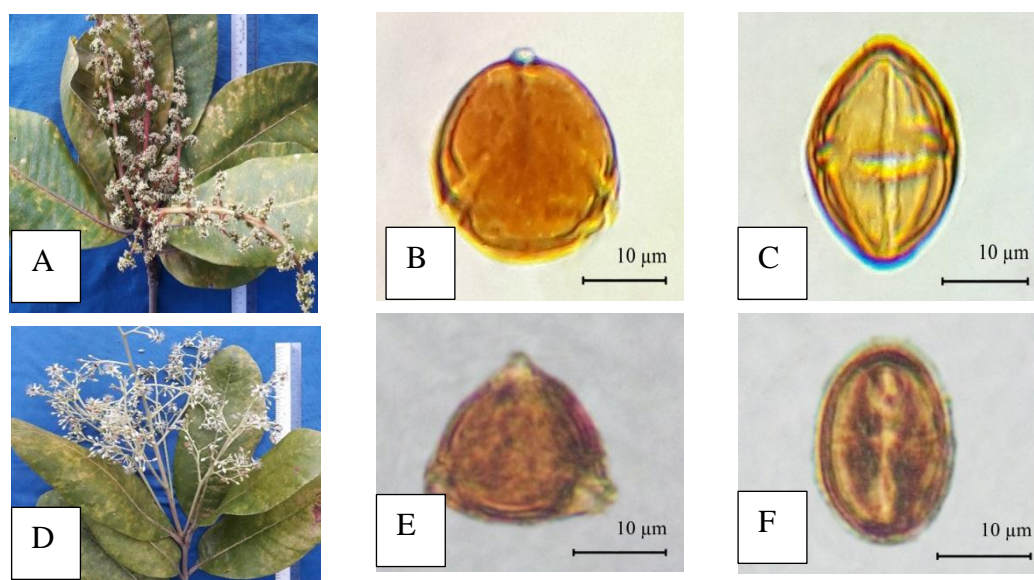


Figure 1 A. Inflorescences of *Buchanania latifolia* Roxb.
 B. Polar view of *B. latifolia* Roxb.
 C. Equatorial view of *B. latifolia* Roxb.
 D. Inflorescences of *Melanorrhoea usitata* Wall.
 E. Polar view of *M. usitata* Wall.
 F. Equatorial view of *M. usitata* Wall.

3. Family – Sapindaceae

Cardiospermum canescens Wall., P1. As. Rar.1:14.t.14.1829 (Figure 2A)

C. corundum L.f. *canescens* (Wall.) Radlk.in Pflanz. Ht. 98. 448.1937.

Myanmar name : Kala myetsi
English name : Ballon vine
Flowering period : May to December

Outstanding characters

Annual, tendrillar climber; stems and branches terete. Leaves bipinnately compound, imparipinnate, alternate; stipules subulate. Inflorescences axillary, umbelliform racemes, many-flowered. Flowers bisexual, zygomorphic, hypogynous, white. Sepals 4, two series, ovate in inner, suborbicular in outer two. Petals 4, 2 series, oblong in inner, suborbicular in outer, white. Fruit capsular, ovoid globose, 3-angled, not winged, valves membranous. Seeds orbicular, black.

Specimens examined: Mandalay Region, Madaya Township, 22° 12' 46" N and 96° 65' 42" E; 2 July, 2017; Hnin Yu Maw, collection no 1.

Pollen morphology (Figure 2 B, C)

Triplicate, prolate, medium, $37.2 - 42.0 \times 24.0 - 28.8 \mu\text{m}$ in length and breadth; amb triangular; pori lalongate, $3.6 - 8.4 \times 6.0 - 7.2 \mu\text{m}$ in length and breadth; exine about $2.4 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate, the lumina heterobrochate, $1.2 - 2.4 \mu\text{m}$ width; the muri simplibaculate, about $0.6 \mu\text{m}$ wide.

4. Family- Rutaceae

Aegle marmelos (L.) Correa, Trans. L. Soc. Landon 5: 223. 1800. (Figure 2 D)

Crataeva marmelos L., Sp. Pl. 444. 1753.

Bilacus marmelos (L.) Kuntze, Rev. Gen. 1:98. 1898.

Belou marmelos (L.) Lyons, Plant Names 69. 1907.

Myanmar name : Okshit
English name : Back fruit, Golden apple
Flowering period : March to July

Outstanding characters

Perennial deciduous spinous trees. Leaves palmately 3 to 5-foliolate compound, alternate; leaflets ovate to elliptic. Inflorescences axillary, few-flowered, fascicled raceme. Flowers bisexual, actinomorphic, pentamerous, hypogynous, greenish-white. Calyx campanulate, 5-toothed, puberulent. Petals 4-5, oblong-obovate greenish white, glabrous. Fruits subgloboid, 6-10 seeded with a hard woody shell. Seeds oblongoid, wooly-pubescent, endospermic.

Specimens examined: Mandalay Region, Patheingyi Township, Yae Tagon Taung; 21° 57' 53" N and 96° 12' 53" E; 31 March, 2018; Hnin Yu Maw, collection no. 10.

Pollen morphology (Figure 2 E, F)

Tetracolporate, prolate spheroidal, small, $20.4 - 24.0 \times 19.2 - 21.6 \mu\text{m}$ in length and breadth; amb quadrangular; colpi $\frac{3}{4}$ way up to the pole, $14.4 - 18.0 \times 2.4 - 4.8 \mu\text{m}$ in length and breadth; pori alongate, $2.4 - 4.8 \times 3.6 - 6.0 \mu\text{m}$ in length and breadth; exine about $2.4 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate, the lumina heterobrochate, $1.2 - 2.4 \mu\text{m}$ width; the muri simplibaculate, about $0.6 \mu\text{m}$ wide.

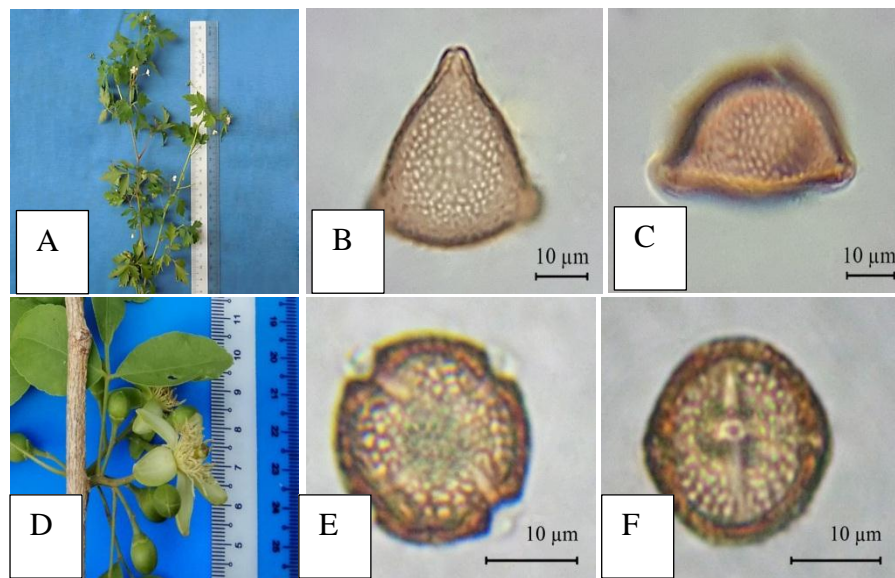


Figure 2 A. Inflorescences of *Cardiospermum canescens* Wall.
 B. Polar view of *C. canescens* Wall.
 C. Equatorial view of *C. canescens* Wall.
 D. Inflorescences of *Aegle marmelos* (L.) Correa, Trans, L.
 E. Polar view of *A. marmelos* (L.) Correa, Trans, L.
 F. Equatorial view of *A. marmelos* (L.) Correa, Trans, L.

5. *Atalantia monophylla* (Roxb.) DC., Prod. 1: 535. 1824. (Figure 3 A)

Limonia monophylla Roxb. (non L.), Pl. Corom. 1: 59. 1795.

Trichilia spinosa Willd., Sp. Pl. 2: 554. 1799.

Myanmar name : Shauk yaing, Taw shauk

English name : Juncle lemon, Wild lime

Flowering period : September to January

Outstanding Characters

Perennial armed shrub to small tree. Leaves simple, alternate. Inflorescences axillary fasciculate raceme, many-flowered. Flowers bisexual, actinomorphic, pentamerous, hypogynous, white, fragrant. Calyx campanulate, 2-lobed or irregularly 3-lobed, pale green, pubescent. Petals 5, free, obovate-oblong. Fruits hesperidium, globoid, yellowish-green, densely glandular dotted. Seeds oblongoid, endospermic.

Specimens examined: Mandalay Region, Patheingyi Township, Yae Tagon Taung; $21^{\circ} 57' 53''$ N and $96^{\circ} 12' 53''$ E; 27 October, 2018; Hnin Yu Maw, collection no. 16.

Pollen morphology (Figure 3 B, C)

Tetracolporate, oblate spheroidal, small, $16.8 - 20.4 \times 19.2 - 21.6 \mu\text{m}$ in length and breadth; amb quadrangular; colpi $\frac{3}{4}$ way up to the pole, $14.4 - 18.0 \times 3.6 - 6.0 \mu\text{m}$ in length and breadth; pori lalongate, $2.4 - 6.0 \times 4.8 - 7.2 \mu\text{m}$ in length and breadth; exine $1.2 - 2.4 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate, the lumina heterobrochate, $2.4 - 3.6 \mu\text{m}$ width; the muri simplibaculate, about $2.4 \mu\text{m}$ wide.

6. *Clausena excavata* Burm.f., Fl. Ind. 89,t. 29. 1768. (Figure 3D)

Myanmar name	: Pyin daw thein
English name	: Curry leaf tree
Flowering period	: August to February

Outstanding characters

Perennial, small tree; stems and branches terete, glabrous. Leaves unipinnately compound, imparipinnate, alternate; leaflets 7-13, blades oblong or lanceolate. Inflorescences terminal or axillary, panicate cymes. Flowers bisexual, actinomorphic, pentamerous, hypogynous, white. Calyx cup-shaped, 5-lobed. Petals 5, oblong, pubescent. Fruits baccate, globoid, whitish-green. Seeds oblongoid.

Specimens examined: Mandalay Hill, $22^{\circ} 00' 50''$ N and $96^{\circ} 06' 38''$ E; 27 Aug, 2017; Hnin Yu Maw, collection no 5.

Pollen morphology (Figure 3 E, F)

Tricolporate, subprolate, medium, $32.4 - 39.6 \times 28.8 - 33.6 \mu\text{m}$ in length and breadth; amb rounded triangular; colpi longicollate, $31.2 - 36.0 \times 6.0 - 10.8 \mu\text{m}$ in length and breadth; pori lalongate, $3.6 - 7.2 \times 7.2 - 9.6 \mu\text{m}$ in length and breadth; exine about $1.2 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate, the lumina $0.6 - 1.2 \mu\text{m}$ width; the muri simplibaculate, about $0.6 \mu\text{m}$ wide.

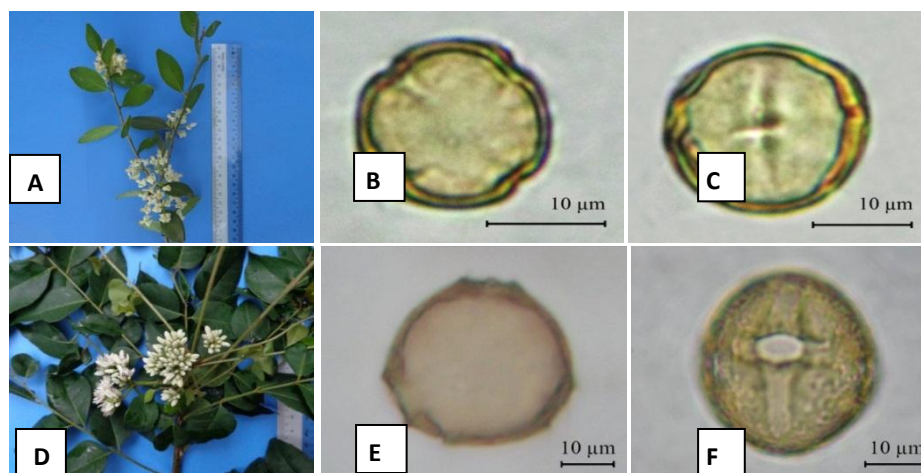


Figure 3 A. Inflorescences of *Atalantia monophylla* (Roxb.) DC.
 B. Polar view of *A. monophylla* (Roxb.) DC.
 C. Equatorial view of *A. monophylla* (Roxb.) DC.
 D. Inflorescences of *Clausena excavata* Burm.f.
 E. Polar view pollen of *C. excavata* Burm.f.
 F. Equatorial view pollen of *C. excavata* Burm.f.

7. *Glycosmis pentaphylla* (Retz.) DC. Prodr. 1:538.1824. (Figure 4A)

Glycosmis arborea (Roxb.) DC. Prodr. 1:538.1824.

Myanmar name	: Taw Shauk, Obok
English name	: Unknown
Flowering period	: September to November

Outstanding characters

Perennial, unarmed shrubs. Leaves unipinnately compound, imparipinnate, alternate; leaflets 3 – 5, oblong. Inflorescences terminal or axillary, fascicled paniculate cymes, many-flowered. Flowers bisexual, actinomorphic, pentamerous, hypogynous, white. Calyx campanulate, green, glabrous. Petals 5, obovate-elliptic. Fruits baccate, globoid, white to pink, with fleshy juice. Seeds round, suboblong, green.

Specimens examined: Mandalay Region, Patheingyi Township, Ye Ta Khun Taung, 21° 57' 59"N and 96° 12' 51" E; 24 Sep, 2017; Hnin Yu Maw, collection no 8.

Pollen morphology (Figure 4 B, C)

Tricolporate, prolate spheroidal, small grains, $19.2 - 24.0 \times 16.8 - 21.6 \mu\text{m}$ in length and breadth; amb rounded triangular; colpi $\frac{1}{2}$ way up to the pole, $8.4 - 15.0 \times 4.8 - 10.8 \mu\text{m}$ in length and breadth; pori circular, $2.4 - 3.6 \mu\text{m}$ in diameter; exine $1.2 - 2.4 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing obscurely reticulate.

8. *Micromelum pubescens* Blume, Bijdr. 138. 1825. (Figure 4D)

Myanmar name	: Tanyin bo, Taw pyindaw thein
English name	: Unknown
Flowering period	: August to December

Outstanding characters

Perennial, unarmed shrubs. Leaves unipinnate compound, imparipinnate, alternate; leaflets 10-15, ovate. Inflorescences terminal paniculate corymbs, many-flowered. Flowers bisexual, actinomorphic, pentamerous, hypogynous, yellowish-green. Calyx copular, 5-lobed; tube. Petals 5, ovate-oblong. Fruit baccate, ovoid, glabrous. Seeds ellipsoid.

Specimens examined: Southern Shan State, Kalaw Township, 20° 37' 19" N and 96° 33' 23" E; 7 Aug, 2017; Hnin Yu Maw, collection no 3.

Pollen morphology (Figure 4 E, F)

Tricolporate, subprolate, small, $22.5 - 25.0 \times 17.5 - 20.0 \mu\text{m}$ in length and breadth; amb rounded triangular; colpi $\frac{3}{4}$ way up to the pole, $15.0 - 19.0 \times 4.0 - 7.5 \mu\text{m}$ in length and breadth; pori lalongate, $2.5 - 5.0 \times 3.5 - 7.5 \mu\text{m}$ in length and breadth; exine $2.0 - 2.5 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate, the lumina heterobrochate, $0.25 - 0.5 \mu\text{m}$ width; the muri simplibaculate, about $0.5 \mu\text{m}$ wide.

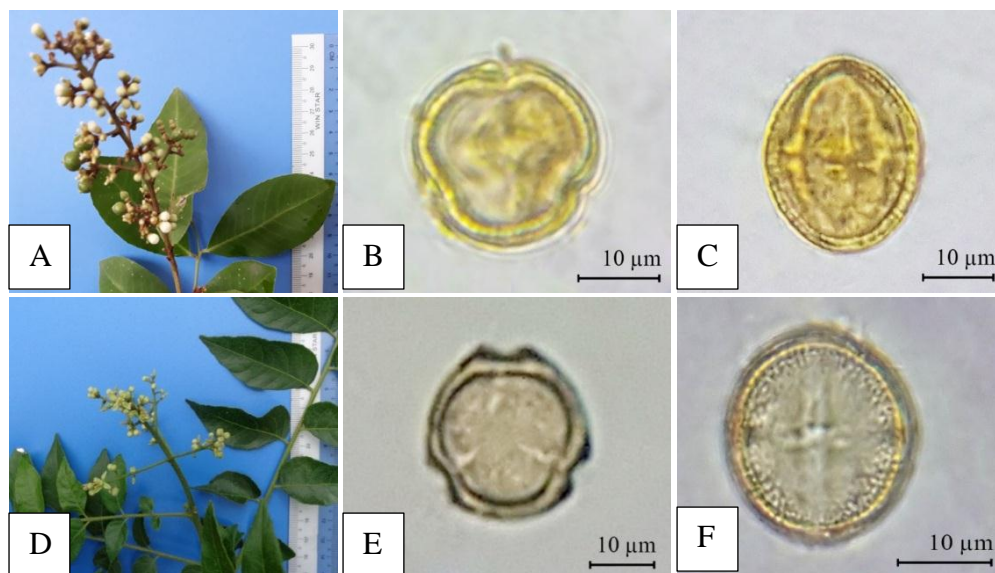


Figure 4 A. Inflorescences of *Glycosmis pentaphylla* (Retz.) DC.
 B. Polar view pollen of *G. pentaphylla* (Retz.) DC.
 C. Equatorial view pollen of *G. pentaphylla* (Retz.) DC.
 D. Inflorescences of *Micromelum pubescens* Blume.
 E. Polar view pollen of *M. pubescens* Blume.
 F. Equatorial view pollen of *M. pubescens* Blume.

9. Family – Meliaceae

Azadirachta indica A. Juss., Mem.Mus.Hist.Nat. 19:221.1830. (Figure 5 A)

Myanmar name : Tama, Tama Kha
 English name : Neem tree, Margosa tree
 Flowering period : April to September

Outstanding characters

Perennial, trees; stems and branches terete, glabrous.. Leaves unipinnately compound, imparipinnate, alternate; leaflets 10-15, alternate or opposite. Inflorescences axillary, paniculate cymes, many-flowered. Flowers bisexual, actinomorphic, pentamerous, hypogynous, white. Calyx campanulate, 5-lobed, pubescent. Petals 5, free, spathulate. Fruit drupaceous, oblongoid, 1-2 cm long. Seeds oblongoid, acute.

Specimens examined: Mandalay Region, Patheingyi Township, Yan King Taung, 21° 59' 06" N and 96° 10' 08" E; 2 Sep, 2017, Hnin Yu Maw, collection no 9.

Pollen morphology (Figure 5 B, C)

Tetracolporate, prolate spheroidal, medium, $33.6 - 39.6 \times 30.0 - 38.4 \mu\text{m}$ in length and breadth; amb quadrangular; colpi $\frac{3}{4}$ way up to the pole, $24.0 - 33.6 \times 4.8 - 6.0 \mu\text{m}$ in length and breadth; pori circular, $6.0 - 9.6 \mu\text{m}$ in diameter; exine $2.4 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing psilate.

10. *Melia azedarach* L., Sp. Pl. 1:384.1753. (Figure 5 D)

Myanmar name : Thinbaw pan tama

English name : Bead tree

Flowering period : April to July

Outstanding characters

Perennial, trees; stems and branches terete. Leaves bipinnately compound, imparipinnate; leaflets 7-12, opposite, elliptic or ovate. Inflorescences axillary, many-flowered. Flowers bisexual, actinomorphic, pentamerous hypogynous, purplish blue. Calyx tubular, 5-lobed, pubescent. Fruits drupe, 1.5-4.0 cm long, glabrous. Seeds oblong, brown.

Specimens examined: Mandalay Region, Meiktila Township, Kandawlay Village, 20° 52' 22" N and 95° 51' 47" E; 16 July, 2017, Hnin Yu Maw, collection no 2.

Pollen morphology (Figure 5 E, F)

Tetracolporate, prolate spheroidal, medium, $30.0 - 33.6 \times 28.8 - 21.66 \mu\text{m}$ in length and breadth; amb quadrangular; colpi $\frac{1}{2}$ way up to the pole, $16.3 - 18.0 \times 4.8 - 7.2 \mu\text{m}$ in length and breadth; pori circular, $6.0 - 9.6 \mu\text{m}$ in diameter; exine $0.6 - 2.4 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing psilate.

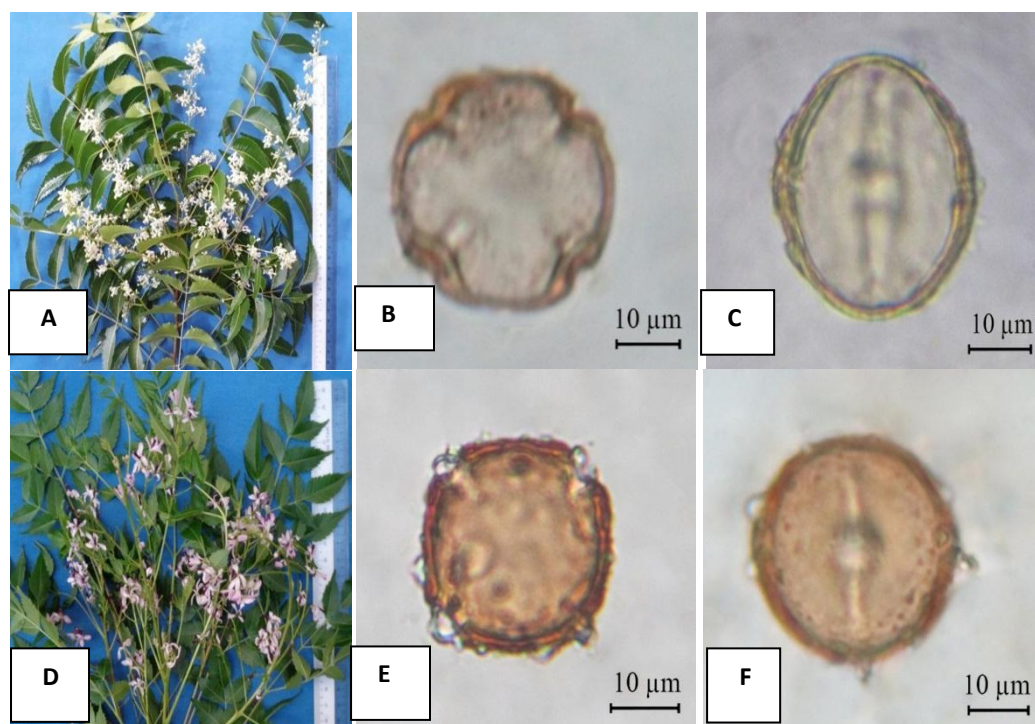


Figure 5 A. Inflorescences of *Azadirachta indica* A. Juss.
 B. Polar view pollen of *A. indica* A. Juss.
 C. Equatorial view pollen of *A. indica* A. Juss.
 D. Inflorescences of *Melia azedarach* L.
 E. Polar view pollen of *M. azedarach* L.
 F. Equatorial view pollen of *M. azedarach* L.

Table 2 Pollen Morphology of 10 Species of Sapindales

No.	Scientific Name	Types of Aperture	Shape of E.V	Size of E.V(μm)	Size of pollen grains	Colpi length	Pori shape	Exine Thickness (μm)	Sculptures	Amb	Lumina (μm)	Muri (μm)
1	<i>Buchanania latifolia</i> Roxb.	CP	PS	19.2-22.8 × 18.0-20.4	Small	Lon	Lalo	0.6-1.2	S>N	Or	Rounded triangular	-
2	<i>Melanorrhoea usitata</i> Wall.	CP	SP	16.0-25.2 × 12.0-21.6	Small	¾	Lalo	0.6-2.4	S>N	Or	Triangular	-
3	<i>Cardiospermum canescens</i> Wall.	P	Pro	37.2 – 42.0 × 24.0 – 28.8	Medium	-	Lalo	2.4	S>N	Re	Triangular	1.2-2.4
4	<i>Aegle marmelos</i> (L.) Correa, Trans, L.	CP	PS	20.4-24.0 × 19.2-21.6	Small	¾	Lalo	2.4	S>N	Re	Quadrangular	1.2-2.4
5	<i>Atalantia monophylla</i> (Roxb.) DC.	CP	OS	16.8-20.4 × 19.2-21.6	Small	¾	Lalo	1.2-2.4	S>N	Re	Quadrangular	2.4-3.6
6	<i>Clausena excavata</i> Burm. f.	CP	SP	32.4 – 39.6 × 28.8 – 33.6	Medium	Lon	Lalo	1.2	S>N	Re	Rounded triangular	0.6-1.2
7	<i>Glycosmis pentaphylla</i> (Retz.) DC.	CP	PS	19.2 – 24.0 × 16.8 – 21.6	Small	½	Cir	1.2-2.4	S>N	Or	Rounded triangular	-
8	<i>Micromelum pubescens</i> Blume	CP	SP	22.5 – 25.0 × 17.5 – 20.0	Small	¾	Lalo	2.0-2.5	S>N	Re	Rounded triangular	0.25-0.5
9	<i>Azadirachta indica</i> A. Juss.	CP	PS	33.6 – 39.6 × 30.0 – 38.4	Medium	¾	Cir	2.4	S>N	Psi	Quadrangular	-
10	<i>Melia azedarach</i> L.	CP	PS	30.0 – 33.6 × 28.8 – 21.66	Medium	½	Cir	0.6-2.4	S>N	Psi	Quadrangular	-

CP = Colporate Lon = Longicolpate P = Porate Lolo= Lolongate Psi= Psilate
 Lalo= Lalongate PS = Prolate spheroidal Cir = Circular Or = Obscurely reticulate
 SP = Subprolate S>N = Sexine>Nexine Pro = Prolate Re = Reticulate

Discussion and Conclusion

The pollen morphology of 10 species and 10 genera belonging to the order Sapindales found in Mandalay Region and Southern Shan State was examined. The order Sapindales consists of nine families, namely Anacardiaceae, Biebersteiniaceae, Burseraceae, Kirkiaceae, Meliaceae, Nitrariaceae, Rutaceae, Sapindaceae and Simaroubaceae. Among them, six families such as Anacardiaceae, Sapindaceae, Rutaceae, Simaroubaceae, Burseraceae and Meliaceae are found in Myanmar. In this paper, four families, Anacardiaceae, Sapindaceae, Rutaceae and Meliaceae were presented.

In the present study, 5 species are trees, 2 species are small tree, 2 species are unarmed shrubs and 1 species is armed tendrillar climber. The family Anacardiaceae including 2 genera and 2 species *Buchanania latifolia* Roxb. and *Melanorrhoea usitata* Wall. were recorded. One species of Sapindaceae was found in *Cardiospermum canescens* Wall.; 5 genera and 5 species of *Aegle marmelos* (L.) Correa, Trans, L. *Atalantia monophylla* (Roxb.) DC. *Glycosmis pentaphylla* (Retz.) DC. *Clausena excavata* Burm. f. and *Micromelum pubescens* Blume belong to family Rutaceae. In the study area, 2 genera and 2 species of family Meliaceae in *Azadirachta indica* A. Juss. and *Melia azedarach* L. were found.

According to the aperture types, three types were found in all studied species. These types of pollen aperture are tricolporate, tetracolporate and triporate. Tricolporate pollen grains present in *Buchanania latifolia* Roxb., *Melanorrhoea usitata* Wall., *Clausena excavata* Burm. f. *Glycosmis pentaphylla* (Retz.) DC and *Micromelum pubescens* Blume; tetracolporate pollen grains were found in 4 species *Aegle marmelos* (L.) Correa, Trans, L., *Atalantia monophylla* (Roxb.) DC., *Azadirachta indica* A. Juss and *Melia azedarach* L.; triporate pollen grains were found in *Cardiospermum canescens* Wall.

The shape of pollen grains are prolate spheroidal, oblate spheroidal, subprolate, prolate, suboblate and oblate. Prolate spheroidal were found in *Buchanania latifolia* Roxb., *Aegle marmelos* (L.) Correa, Trans, L., *Glycosmis pentaphylla* (Retz.) DC., *Azadirachta indica* A. Juss. and *Melia azedarach* L. Oblate spheroidal were found in *Atalantia monophylla* (Roxb.) DC., prolate pollen grain were occurred in *Cardiospermum canescens* Wall. and remaining three species are subprolate were described.

In the study area, 6 species of pollen grains are small and 4 species are medium grains. The size of small pollen grains was found in *Buchanania latifolia* Roxb., *Melanorrhoea usitata* Wall., *Aegle marmelos* (L.) Correa, Trans, L., *Atalantia monophylla* (Roxb.) DC., *Glycosmis pentaphylla* (Retz.) DC. and *Micromelum pubescens* Blume. The smallest pollen is *Melanorrhoea usitata* Wall. $16.0\text{--}25.2 \times 12.0\text{--}21.6 \mu\text{m}$ in length and breadth and the largest pollen is *Cardiospermum canescens* Wall. $37.2 - 42.0 \times 24.0 - 28.8 \mu\text{m}$ in length and breadth. The size of pollen grains are varied from small, medium to large or very large (Erdtman 1952). These pollen characters are agreed with the present finding.

The sculptures of pollen grains are psilate, reticulate and obscurely reticulate. species are obscurely reticulate, 5 species are reticulate and remaining 2 species are psilate.

According to the results, different types of pollen characters were investigated and recorded. This investigation will contribute not only to the pollen features but also varieties of the pollen morphological data in the study of the order Sapindales. The important pollen

morphological characteristics that are useful for classification and identification of flowering plants are pollen shape and type of exine sculpturing. These morphological features of pollens will support the identification and classification of order Sapindales. Therefore, these pollen characters are very important and beneficial for the future researchers.

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