

COMPARATIVE POLLEN MORPHOLOGY OF TEN *GREWIA* SPECIES

Ohmar Htwe¹, Soe Myint Aye², Tin Tin Khaing³

Abstract

Pollen morphology of 10 species belonging to the genus *Grewia* of subfamily Tilioideae were studied. All the specimens were collected from Mandalay and Magway Regions during 2018. Plant identification was carried out and pollen grains were studied. Pollen grains of all investigated species were monad. The aperture types of pollen grains of all species were found as colpiate, except *Grewia villosa* Willd which is colpiate. The shapes of pollen grains were found as subprolate in *Grewia columaris* Smith, *Grewia parviflora* (Burge) Handen-Mazzetti, and *Grewia villosa* Willd and the remaining seven species were prolate. The sizes of pollen grains were medium and large. Among the studied species, the smallest pollen grains was found in *Grewia columaris* Smith and the largest pollen grains was in *Grewia laevigata* Vahl.ex Juss. The taxonomic descriptions of each species were described with their inflorescences. The polar view and equatorial view of the pollen for each species were presented. Moreover, the comparative pollen morphological characters were presented in table.

Keywords: pollen morphology, genus *Grewia*, acetolysis technique, key to identification

Introduction

Palynology is the study of the pollen grains and spores of plants. Spores and pollen grains have a number of morphological and ultrastructural features. These palynological features have been important in inferring phylogenetic relationships of plants. In addition, the features of spores and pollen grains can often be used to identify a particular plant taxon. For this reason, palynological studies are used extensively to examine the fossil record, a field called paleopalynology. It is also applicable in genetic study, forensic science in tracing history of vegetation, which consists of individual species, community and climate change study. It is also used in the field agriculture, forestry, archaeology and plant geography (Aftab & Perveen 2006).

Malvaceae are found throughout the world, growing in many different environments and climates. Malvaceae had been divided into four subfamilies: Sterculioideae, Tilioideae, Malvoideae and Bombacoideae. Genus *Grewia* consists of 90 species distributed in tropical and subtropical regions. In Myanmar, 24 species of genus *Grewia* of Tilioideae were presented in Checklist of Myanmar (2003).

The genus *Grewia* consists of about 280-300 species of trees, shrubs or climbers, distributed from Madagascar, tropical Africa northwards and southeastwards to the Himalayas, China and Taiwan, India, Sri Lanka, Myanmar, Thailand, Indo-China, Malesia, Western Pacific and the northern parts of Australia (Chung *et al.* 2003).

People always depend on plants for their various needs. The fruits of *Grewia* species are edible, tasty and loved by birds. This species make a good screen for the forest, being very attractive with its green leaves and bright yellow flowers. The pollen morphology of *Grewia* species will still lacking to be studied in Myanmar. So, some species of genus *Grewia* will focus to be studied.

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The aim and objectives of the genus *Grewia* is to identify and classify the *Grewia* species, to attain the morphological variation in the pollen of genus *Grewia*, to accomplish the taxonomic value and to contribute to a better understanding of palynological characters of these members.

Materials and Methods

(A) Data Collection and Plant Identification

The specimens were collected from Mandalay and Magway Regions during 2018. The photographic records were taken during flowering time and field notes were taken specifically. Identification of collected specimens was carried out by comparing to key and description referring to floristic literature: Hooker (1878), Dassanayake (1991), Flora of China Vol.12 (2008). All the fresh pollen were collected from the anthers of mature flowers. The collected pollens of each species was stored in glass vial containing 1cc of glacial acetic acid and then labeled.

(B) Acetolysis of Materials

The pollen samples were acetolysed by Erdtman method (1960). The pollen samples in a glass vials were put into a test tube, then crushed with a glass rod. Acetolysis solution was mixed by 9 part of glacial acetic acid and 1 part of concentrated sulphuric acid. 1cc of acetolysis mixture was poured into the test tube containing the pollen sample and stirred with a glass rod. The test tube was heated in a water bath 70°C-80°C for 25-30 minutes. The test tube was allowed to cool, and the sample diluted with distilled water and centrifuged for 20-30 minutes at 3000 rpm. This was repeated twice decanting the water each time. Dilute glycerine solution was added to the residue, then transferred and stored in air tight glass vial and labeled.

Results

1. *Grewia acuminata* Jussieu, Ann. Mus. Natl. Hist. Nat. 4:91.1804. (Figure 1 A)

Myanmar name	: Thayaw
English name	: Unknown
Flowering period	: July to September

Perennial shrubs; stems and branches terete, coarsely stellate. Leaves simple, alternate; stipules linear, densely pubescent; blades linear-oblong, cordate at the base, serrate along the margin, acuminate at the apex, 3 basal nerved, dark green above with stellate tomentose, pale green beneath with densely stellate tomentose. Inflorescences axillary cymes, 2- to 3-flowered per leaf axil; stellate tomentose. Flowers bisexual, actinomorphic, pentamerous, hypogynous, creamy white; bracts linear, caducous. Sepals 5, free, ovate oblong, stellate tomentose without, glabrous within, persistent. Petals 5, ovate, creamy white, glabrous. Stamens numerous, free; filaments filiform; anthers dithecal, basifixed, yellow, dehiscent by longitudinal slit. Carpels 2, ovary superior, oblongoid, bilocular, two ovules in each locule on the axile placentae; styles slender, stigma 2-lobed, glabrous. Fruits drupaceous, subglobose, tetragonous, stellate tomentose.

Pollen morphology (Figure 1 B, C)

Tricolporate, prolate, medium, 38 – 39 × 28 – 29 µm in length and breadth; amb rounded triangular; colpi ¾ way up to the pole, 31.2 – 33.7 × 2.5 – 3.5 µm in length and breadth; pori

lolate, $7 - 8 \times 5 - 6 \mu\text{m}$ in length and breadth; exine $1.8 - 2.5 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate; lumina heterobroccate, $5.3 - 6.2 \mu\text{m}$ width; muri simplibaculate, $0.3-0.5 \mu\text{m}$ wide.

2. *Grewia columaris* Smith in Reces, Cyclop. 17. 1811. (Figure 1 D)

Myanmar name : Unknown
 English name : Unknown
 Flowering period : July to August

Perennial shrubs; stems and branches terete, stellate tomentose. Leaves simple, alternate; stipules subulate, densely pubescent; blades elliptic ovate, cordate at the base, serrate along the margin, acuminate at the apex, 3 basal nerved, dark green above with stellate tomentose, pale green beneath with densely stellate tomentose. Inflorescences axillary cymes, 1- to 2-flowered per leaf axil; stellate tomentose. Flowers bisexual, actinomorphic, pentamerous, hypogynous, creamy white; bracts ovate to narrowly linear, caducous, densely stellate tomentose. Sepals 5, free, ovate oblong, recurved, stellate tomentose without, glabrous within, persistent. Petals 5, ovate, glabrous. Stamens numerous, free; filaments free, unequal, pale yellow, glabrous; anthers dithecal, basifixed, yellow, dehiscing by longitudinal slit. Carpels 2, ovary superior, ovoid, bilocular, two ovules in each locule on the axile placentae; styles slender; stigma dilated, glabrous. Fruits drupaceous, subglobose, tetragonous, stellate tomentose.

Pollen morphology (Figure 1 E, F)

Tricolporate, subprolate, medium, $37.5 - 38.7 \times 31.2 - 32.5 \mu\text{m}$ in length and breadth; amb rounded triangular; colpi $\frac{3}{4}$ way up to the pole, $29.0 - 30.2 \times 5.0 - 6.2 \mu\text{m}$ in length and breadth; pori lolate, $7.5 - 8.2 \times 5.0 - 6.0 \mu\text{m}$ in length and breadth; exine $3.7 - 5.0 \mu\text{m}$ thick, sexine as thick as nexine; sculpturing reticulate; lumina heterobroccate, $2.8 - 3.5 \mu\text{m}$ width; muri simplibaculate, $1.0 - 1.5 \mu\text{m}$ wide.

3. *Grewia damine* Gaertn., Fruct. 12:113.t.106.f. 7. 1790. (Figure 1 G)

Myanmar name : Unknown
 English name : Unknown
 Flowering period : April to May

Perennial small tree; stems and branches terete, stellate pubescent when young. Leaves simple, alternate; stipules linear lanceolate; densely pubescent; blades elliptic ovate, cordate at the base, serrate along the margin, acute at the apex, 3 basal nerved, glabrous above, finely tomentose below, base slightly oblique. Inflorescences axillary cymes, many-flowered per leaf axil; stellate tomentose. Flowers bisexual, actinomorphic, pentamerous, hypogynous, creamy white; bracts ovate to narrowly linear, caducous, densely stellate tomentose. Sepals 5, free, ovate oblong, recurved, stellate tomentose without, glabrous within, persistent. Petals 5, ovate, glabrous. Stamens numerous, free; filaments free, unequal, pale yellow, glabrous; anthers dithecal, basifixed, yellow, dehiscing by longitudinal slit. Carpels 2, ovary superior, ovoid, densely appressed villous, bilocular, two ovules in each locule on the axile placentae; styles slender, densely hairs; stigma discoid, glabrous. Fruits depressed globose, 2-lobed when dry, black with brown dots when dry, almost glabrous when mature, stellate tomentose.

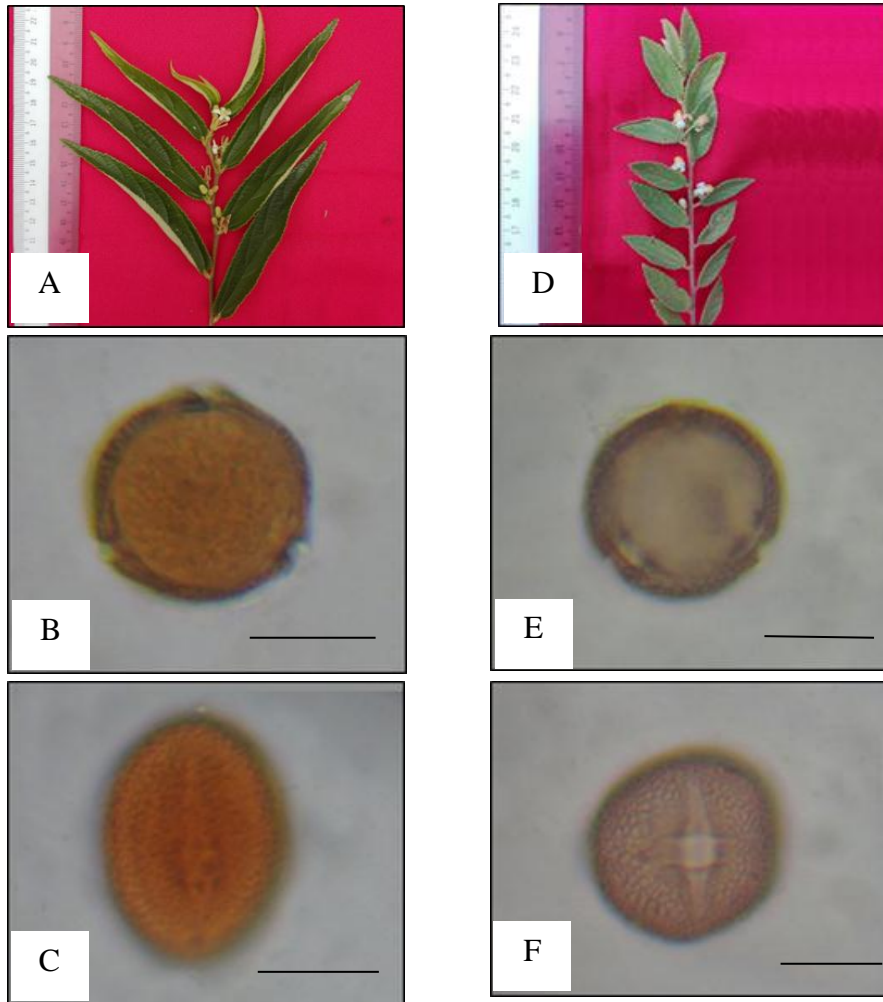


Figure 1 A. Inflorescences of *Grewia acuminata* Juss.
 B. Polar view pollen of *G. acuminata* Juss.
 C. Equatorial view pollen of *G. acuminata* Juss.
 D. Inflorescences of *Grewia columaris* Smith.
 E. Polar view pollen of *G. columaris* Smith.
 F. Equatorial view pollen of *G. columaris* Smith.

Pollen morphology (Figure 1 H, I)

Tricolporate, prolate, medium, $45.2 - 46.2 \times 28.7 - 31.2 \mu\text{m}$ in length and breadth; amb rounded triangular; colpi $\frac{3}{4}$ way up to the pole, $40.2 - 41.2 \times 1.2 - 1.8 \mu\text{m}$ in length and breadth; pori lologate, $8.7 - 10.0 \times 6.5 - 7.5 \mu\text{m}$ in length and breadth; exine $1.8 - 2.5 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate; lumina heterobroccate, $3.5 - 4.0 \mu\text{m}$ width; muri simplibaculate, $0.3 - 0.4 \mu\text{m}$ wide.

4. *Grewia flava* DC., Cat. Pl. Horti Monsp. 113. 1813. (Figure 1 J)

Myanmar name	: Unknown
English name	: Unknown
Flowering period	: May to June

Perennial multi-stemmed shrubs; stems and branches terete, stellate. Leaves simple, alternate, often upright; stipules caducous; densely pubescent; blades oblanceolate to obovate, cuneate at the base, serrate along the margin, obtuse at the apex, 3 basal nerved, base symmetric, densely tomentose. Inflorescences axillary cymes, solitary or in few flowered per leaf axil; stellate tomentose. Flowers bisexual, actinomorphic, pentamerous, hypogynous, creamy white; bracts ovate to narrowly linear, caducous, densely stellate tomentose. Sepals 5, free, linear lanceolate, recurved, stellate tomentose without, glabrous within, persistent. Petals 5, ovate, glabrous. Stamens numerous, free; filaments free, unequal, pale yellow, glabrous; anthers unequal, dithecous, basifixed, yellow, dehiscing by longitudinal slit. Carpels 2, ovary superior, ovoid, bilocular, two ovules in each locule on the axile placentae; styles slender, densely hairs; stigma lobed, glabrous. Fruits depressed globose, 2-lobed when dry, reddish brown when ripe, glabrescent.

Pollen morphology (Figure 1 K, L)

Tricolporate, prolate, medium, $48 - 48 \times 35 - 36 \mu\text{m}$ in length and breadth; amb rounded triangular; colpi $\frac{3}{4}$ way up to the pole, $38.7 - 39.8 \times 4.0 - 5.0 \mu\text{m}$ in length and breadth; pori lalongate, $2.0 - 2.5 \times 3.0 - 3.7 \mu\text{m}$ in length and breadth; exine $2.5 - 3.7 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate; lumina heterobrocate, $1.5 - 1.8 \mu\text{m}$ width; muri simplibaculate, $0.3 - 0.4 \mu\text{m}$ wide.

5. *Grewia laevigata* Vahl., Symb. Bot. 1:34. 1790. (Figure 1 M)

Myanmar name : Kyet tayaw, Tayaw nyo, Yaw

English name : Unknown

Flowering period : July to September

Perennial trees; stems and branches terete, glabrous. Leaves simple, alternate; stipules linear subulate, caducous; pubescent; blades oblong, cuneate at the base, serrate along the margin, sharply acuminate at the apex, 3 basal nerved, glabrous, base symmetric, dark green above, pale green beneath, densely tomentose. Inflorescences axillary cymes, solitary or 2- to 3-flowered per leaf axil; stellate tomentose. Flowers bisexual, actinomorphic, pentamerous, hypogynous, creamy white; bracts linear subulate, caducous, stellate tomentose. Sepals 5, free, linear lanceolate, stellate tomentose without, glabrous within, persistent. Petals 5, oblong, glabrous. Stamens numerous, free; filaments free, unequal, pale yellow, glabrous; anthers dithecous, basifixed, yellow, dehiscing by longitudinal slit. Carpels 2, ovary superior, ovoid, tetralocular, two ovules in each locule on the axile placentae; styles slender, densely hairs; stigma lobes, glabrous. Fruits drupaceous, globose, 1- to 4-lobed when dry, black when ripe.



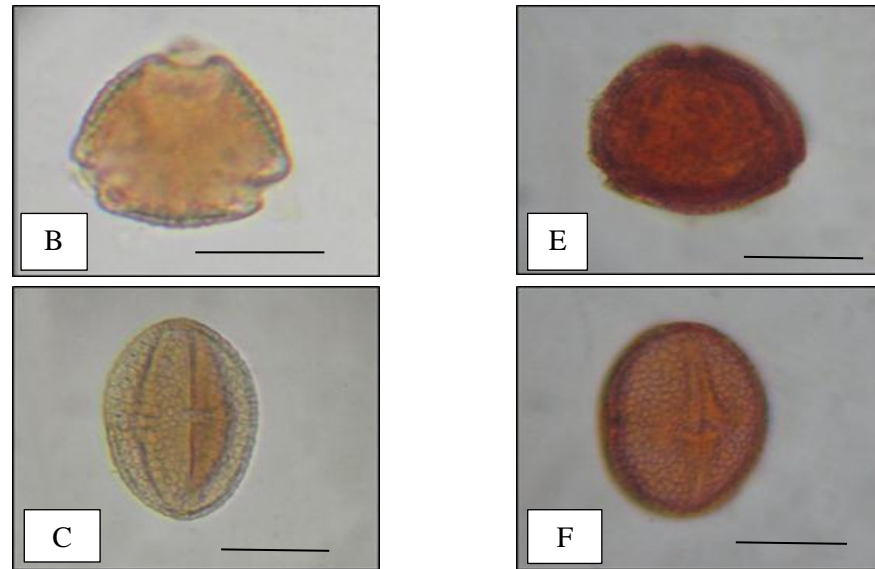


Figure 2 A. Inflorescences of *Grewia diamine* Gaertn.
 B. Polar view pollen of *G. diamine* Gaertn.
 C. Equatorial view pollen of *G. diamine* Gaertn.
 D. Inflorescences of *Grewia flava* DC.
 E. Polar view pollen of *G. flava* DC.
 F. Equatorial view pollen of *G. flava* DC.

Pollen morphology (Figure 1 N, O)

Tricolporate, prolate, large, $66.2 - 67.5 \mu\text{m} \times 49.2 - 50.2 \mu\text{m}$ in length and breadth; amb circular; colpi $\frac{3}{4}$ way up to the pole, $52.0 - 56.5 \times 2.0 - 2.5 \mu\text{m}$ in length and breadth; pori lolongate, $11 - 12 \times 9 - 10 \mu\text{m}$ in length and breadth; exine $3.7 - 4.2 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing obscurely reticulate; lumina heterobrocate, $2.0 - 2.7 \mu\text{m}$ width; muri simplibaculate, $0.8 - 1.0 \mu\text{m}$ wide.

6. *Grewia parviflora* (Burge) Handen-Mazzetti, Symb. Sin 7: 612. 1933. (Figure 2 A)

Myanmar name	: Unknown
English name	: Unknown
Flowering period	: May to July

Perennial small trees; stems and branches terete, glabrous. Leaves simple, alternate; stipules linear subulate; blades ovate orbicular, cuneate at the base, serrate along the margin, acute at the apex, 3 basal nerved, glabrous above, base symmetric, dark green above, pale below, tomentose. Inflorescences axillary cymes, 2- to 3-flowered per leaf axil; stellate tomentose. Flowers bisexual, actinomorphic, pentamerous, hypogynous, white; bracts linear subulate, caducous, stellate tomentose. Sepals 5, free, linear lanceolate, recurved, stellate tomentose without, glabrous within, persistent. Petals 5, ovate, glabrous. Stamens numerous, free; filaments free, unequal, pale yellow, glabrous; anthers ditheous, basifixed, yellow, dehiscing by longitudinal slit. Carpels 2, ovary superior, ovoid, tetralocular, two ovules in each locule on the axile placentae; styles slender, densely hairy; stigma lobed, glabrous. Fruits drupaceous, globose, 2- to 4-lobed when dry.

Pollen morphology (Figure 2 B, C)

Tricolporate, subprolate, medium, $42.5 - 43.7 \times 36.2 - 37.5 \mu\text{m}$ in length and breadth; amb circular; colpi longicolate, $39.5 - 40.0 \times 1.2 - 1.8 \mu\text{m}$ in length and breadth; pori longate, $9 - 10 \times 7 - 8 \mu\text{m}$ in length and breadth; exine $2.5 - 3.0 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate; lumina heterobrodate, $1.8 - 2.3 \mu\text{m}$ width; muri simplibaculate, $0.8 - 0.9 \mu\text{m}$ wide.

7. *Grewia retusifolia* Pierre, Fl. Forest. Cochinch. t. 168. 1888. (Figure 2 D)

Myanmar name : Unknown

English name : Unknown

Flowering period : June to August

Perennial shrubs; stems and branches terete, stellate hairy. Leaves simple, alternate; stipules caducous; pubescent; blades linear ovate, oblique at the base, serrate along the margin, obtuse at the apex, 3 basal nerved, densely pubescent on both surfaces, pale below. Inflorescences axillary cymes, solitary or 2- to 3-flowered per leaf axil; peduncles very short, pale green, pubescent. Flowers bisexual, actinomorphic, pentamerous, hypogynous, white; pedicel short; bracts small, caducous, pubescent. Sepals 5, free, linear lanceolate, white, pubescent, persistent. Petals 5, ovate, glabrous. Stamens numerous, free; filaments free, unequal, pale green, glabrous; anthers dithecal, basifixed, green, dehiscent by longitudinal slit. Carpels 2, ovary superior, ovoid, tetralocular, two ovules in each locule on the axile placentae; styles slender, densely hairy; stigma 4-lobes, glabrous. Fruits drupaceous, globose, 4 lobed when dry.

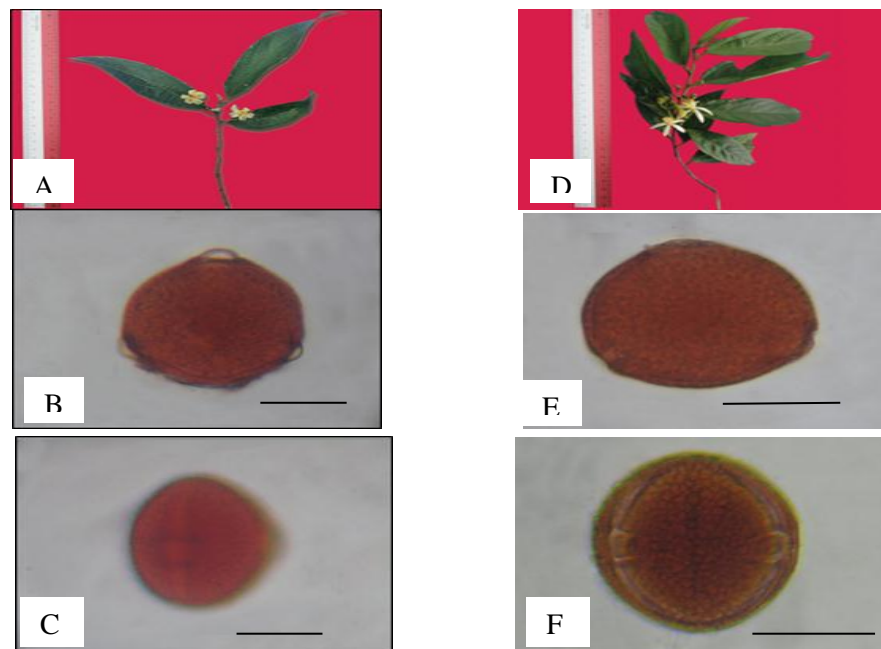


Figure 3 A. Inflorescences of *Grewia laevigata* Vahl.
 B. Polar view pollen of *G. laevigata* Vahl.
 C. Equatorial view pollen of *G. laevigata* Vahl.
 D. Inflorescences of *Grewia parviflora* (Burge) Handen-Mazzetti.
 E. Polar view pollen of *G. parviflora* (Burge) Handen-Mazzetti.
 F. Equatorial view pollen of *G. parviflora* (Burge) Handen-Mazzetti.

Pollen morphology (Figure 2 E, F)

Tricolporate, prolate, medium, $41.2 - 42.3 \times 30.0 - 31.2 \mu\text{m}$ in length and breadth; amb rounded triangular; colpi $\frac{3}{4}$ way up to the pole, $31.2 - 32.5 \times 2.5 - 3.7 \mu\text{m}$ in length and breadth; pori lolongate, $6.2 - 7.5 \times 5.0 - 6.2 \mu\text{m}$ in length and breadth; exine $3.0 - 3.7 \mu\text{m}$ thick, sexine as thick as nexine; sculpturing reticulate; lumina heterobroccate, $0.7 - 0.8 \mu\text{m}$ width; muri simplibaculate, $0.2 - 0.4 \mu\text{m}$ wide.

8. *Grewia sapida* Roxb. ex DC., Prodr.1: 512. 1824. (Figure 2 G)

Myanmar name : Unknown

English name : Unknown

Flowering period : April to May

Perennial shrubs; stems and branches terete, stellate pubescent. Leaves simple, alternate; stipules linear lanceolate, small; pubescent; blades ovate to suborbicular, cuneate at the base, serrate along the margin, obtuse to acute at the apex, stellate pubescent, pale below. Inflorescences axillary cymes, solitary or 2- to 3-flowered per leaf axil; pubescent. Flowers bisexual, actinomorphic, pentamerous, hypogynous, white; pedicel short; bracts small, pubescent. Sepals 5, free, linear lanceolate, pubescent, persistent. Petals 5, ovate, glabrous. Stamens numerous, free; filaments free, equal; anthers dithecous, basifixed, green, dehiscing by longitudinal slit. Carpels 2, ovary superior, ovoid, tetralocular, two ovules in each locule on the axile placentae; styles slender, densely hairs; stigma 4-lobes, glabrous. Fruits drupaceous, globose, 4 lobed, brown.

Pollen morphology (Figure 2 H, I)

Tricolporate, prolate, medium, $42.5 - 43.7 \times 30.0 - 31.2 \mu\text{m}$ in length and breadth; amb circular; colpi $\frac{3}{4}$ way up to the pole, $37.5 - 38.7 \times 5.0 - 6.2 \mu\text{m}$ in length and breadth; pori lalongate, $6.5 - 7.0 \times 7.5 - 8.0 \mu\text{m}$ in length and breadth; exine $2.5 - 3.0 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate; lumina heterobroccate, $1.8 - 2.5 \mu\text{m}$ width; muri simplibaculate, $0.7 - 0.8 \mu\text{m}$ wide.

9. *Grewia titifolia* Vahl., Symb. Bot. 1: 35. 1790. (Figure 2 J)

Myanmar name : Pin tayaw, Tayaw

English name : Unknown

Flowering period : July to August

Perennial trees; stems and branches terete, stellate tomentose. Leaves simple, alternate; stipules linear lanceolate; pubescent; blades ovate to suborbicular, cordate at the base, serrate along the margin, shortly acute at the apex, stellate pubescent, pale green. Inflorescences axillary cymes, many-flowered per leaf axil; pubescent. Flowers bisexual, actinomorphic, pentamerous, hypogynous, greenish yellow; bracts small, pubescent. Sepals 5, free, linear lanceolate pubescent, persistent. Petals 5, ovate, glabrous. Stamens numerous, free; filaments free, unequal, pale green, glabrous; anthers dithecous, basifixed, green, dehiscing by longitudinal slit. Carpels 2, ovary superior, ovoid, bilocular, two ovules in each locule on the axile placentae; styles slender, densely hairs; stigma 4-lobes, glabrous. Fruits drupaceous, globose, 1 or 2 lobed, brown.

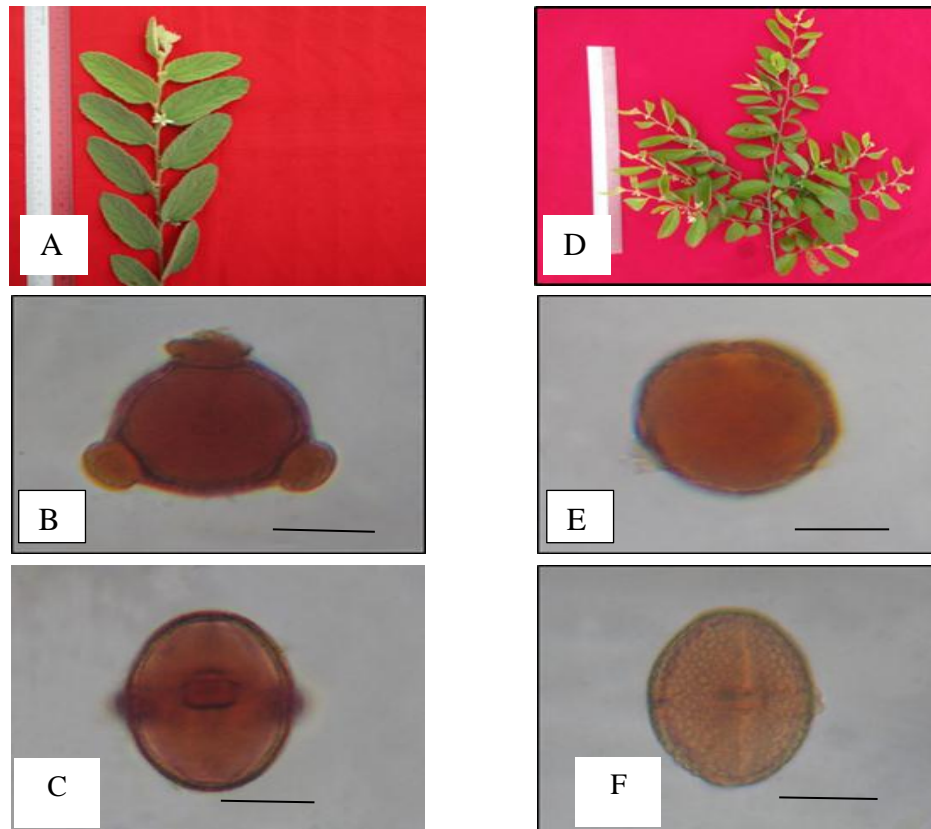


Figure 4 A. Inflorescences of *Grewia retusifolia* Pierre.
 B. Polar view pollen of *G. retusifolia* Pierre.
 C. Equatorial view pollen of *G. retusifolia* Pierre.
 D. Inflorescences of *Grewia sapida* Roxb. ex DC.
 E. Polar view pollen of *G. sapida* Roxb. ex DC.
 F. Equatorial view pollen of *G. sapida* Roxb. ex DC.

Pollen morphology (Figure 2 K, L)

Tricolporate, prolate, medium, $45.5 - 46.0.5 \times 33 - 34 \mu\text{m}$ in length and breadth; amb rounded triangular; colpi $\frac{3}{4}$ way up to the pole, $36 - 38 \times 4 - 5 \mu\text{m}$ in length and breadth; pori lalongate, $6.3 - 6.8 \times 7.2 - 7.8 \mu\text{m}$ in length and breadth; exine $2.8 - 3.5 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate; lumina heterobrocate, $2.1 - 2.5 \mu\text{m}$ width; muri simplibaculate, $0.7 - 0.9 \mu\text{m}$ wide.

10. *Grewia villosa* Willd., In Nov. Act. Nat. Cur. Berol. 205. 1803. (Figure 2 M)

Myanmar name : Unknown
 English name : Unknown
 Flowering period : June to August

Perennial shrubs; stems and branches terete, stellate tomentose when young. Leaves simple, alternate; stipules caducous; densely pubescent; blades ovate, cordate at the base, serrate along the margin, shortly acute at the apex, stellate pubescent, pale green. Inflorescences axillary cymes, 2- to 3-flowered per leaf axil; pubescent. Flowers bisexual, actinomorphic, pentamerous,

hypogynous, reddish yellow; bracts small, pubescent. Sepal 5, free, lanceolate, reddish yellow, pubescent, persistent. Petals 5, linear lanceolate, glabrous. Stamens numerous, free; filaments free, unequal, glabrous; anthers ditheous, basifixed, green, dehiscing by longitudinal slit. Carpels 2, ovary superior, globose, bilocular, two ovules in each locule on the axile placentae; styles slender, densely hairs; stigma 4-lobes, glabrous. Fruits drupaceous, globose, 1 or 2 lobed, yellow brown or red.

Pollen morphology (Figure 2 N, O)

Tricolpate, subprolate, medium, $38.7 - 40.0 \times 33.7 - 35.0 \mu\text{m}$ in length and breadth; amb rounded triangular; colpi longicolpate, $36 - 38 \times 7 - 8 \mu\text{m}$ in length and breadth; exine $1.2 - 2.0 \mu\text{m}$ thick, sexine thicker than nexine; sculpturing reticulate; lumina heterobroccate, $1.0 - 1.5 \mu\text{m}$ width; muri simplibaculate, $0.3 - 0.4 \mu\text{m}$ wide.

Table Pollen Morphological Characters of Ten *Grewia* species

No.	Scientific Name	Aperture Type	Shape of EV	Size of PG	Pori Shape
1	<i>Grewia acuminata</i> Juss.	CP	Pro	M	Lo
2	<i>Grewia columaris</i> Smith.	CP	Subpro	M	Lo
3	<i>Grewia diamine</i> Gaertn.	CP	Pro	M	Lo
4	<i>Grewia flava</i> DC.	CP	Pro	M	La
5	<i>Grewia laevigata</i> Vahl.	CP	Pro	L	Lo
6	<i>Grewia parviflora</i> (Burge) Handen-Mazzetti.	CP	Subpro	M	Lo
7	<i>Grewia retusifolia</i> Pierre.	CP	Pro	M	Lo
8	<i>Grewia sapida</i> Roxb. ex DC.	CP	Pro	M	La
9	<i>Grewia titiifolia</i> Vahl.	CP	Pro	M	La
10	<i>Grewia villosa</i> Willd.	C	Subpro	M	-

EV = Equatorial View

PG = Pollen Grains

CP = Colporate

Pro = Prolate

Subpro = Subprolate

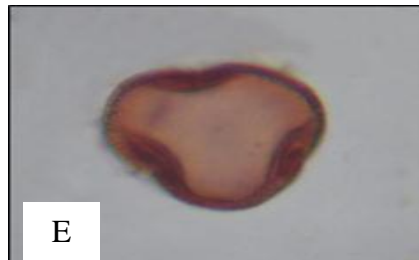
L = Large

M = Medium

La = Lalongate

Lo = Lolongate

C = Colpate



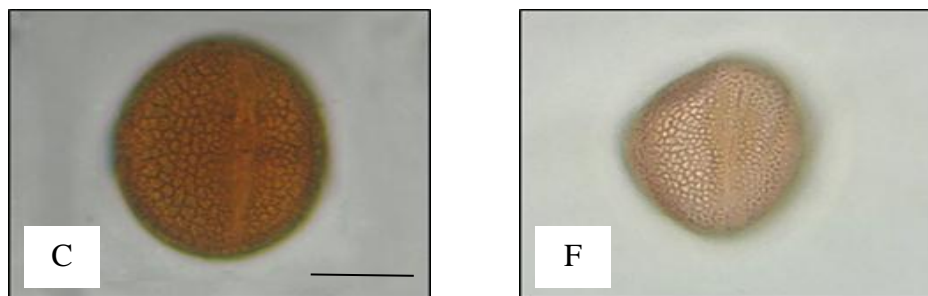


Figure 5 A. Inflorescences of *Grewia titiifolia* Vahl.
 B. Polar view pollen of *G. titiifolia* Vahl.
 C. Equatorial view pollen of *G. titiifolia* Vahl.
 D. Inflorescences of *Grewia villosa* Willd.
 E. Polar view pollen of *G. villosa* Willd.
 F. Equatorial view pollen of *G. villosa* Willd.

Discussion and Conclusion

The present research work deals with the study on taxonomy and pollen morphology of genus *Grewia* of Tilioideae. The collected species were *Grewia acuminata* Juss., *G. columaris* Smith., *G. diamine* Gaertn., *G. flava* DC., *G. laevigata* Vahl., *G. parviflora* (Burge) Handen-Mazzetti., *G. retusifolia* Pierre., *G. sapida* Roxb. ex DC., *G. titiifolia* Vahl., and *G. villosa* Willd. In the present study, different morphological characters were observed. *Grewia diamine* Gaertn, *Grewia laevigata* Vahl, *Grewia parviflora* (Burge) Handen-Mazzetti, *Grewia titiifolia* Vahl were trees and the other species were shrubs. In the shape of leaf, the linear-oblong was occurred in *Grewia laevigata* Vahl and *Grewia acuminata* Juss, and the remaining species were occurred as ovate to linear ovate and orbicular. In the inflorescences of *Grewia diamine* Gaertn and *Grewia titiifolia* Vahl, the flowers were numerous but those of the others are solitary to 3-flowered. All of the studied species were simple leaves, stipulate and leaf arrangement of these were alternate. The flowers were bisexual, actinomorphic, pentamerous and hypogynous in all studied species. All the studied species have superior ovary and the placentation was all axile.

Pollen morphology was studied based on aperture type, shape, size and sculpturing pattern. In this research, the types of pollen grain were found as monad. The species of colpate pollen grains was found in *Grewia villosa* Willd and the remaining species were colpate pollen grains. Sharma (1968) proposed that colpate character is considered as an advanced character over colpate and porate condition as still advanced.

In equatorial view, pollen shape is described by the P/E ratio (P- polar axis, E- equatorial diameter). In this study, the shape of pollen grains were found as prolate and subprolate. In polar view, amb was circular and rounded triangular. The size of pollen grains were medium and large. The sculpturing patterns of pollen grains of all studied species were reticulate.

In the present study, the pollen grains of *Grewia* sp., are prolate, subprolate; tricolpate; colpi $\frac{3}{4}$ way up to the pole; sexine thicker than nexine; sculpturing reticulate. Preveen (2004) proposed that the pollen grains of *Grewia* sp., are prolate to subprolate; tricolpate; colpi $\frac{3}{4}$ way up to the pole; sexine thicker than nexine; sculpturing reticulate. Chung *et al.* (2003) proposed that the pollen grains of *Grewia* species are single, isopolar, radially symmetric, tricolpate,

and rounded-triangular in equatorial outline (amb). The pollen grains are medium to large. Therefore, these characters are the same as present result.

In conclusion, these pollen characters will support in identification and classification. All of these interesting pollen characters are undoubtedly important and beneficial for the future researchers. Therefore, this research is provided the knowledge of pollen morphology of genus *Grewia*.

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