

## Pollen Morphology of Some Species in Panglong University Campus

Nwe Ni Tin<sup>1</sup>, Khin Lay Phyu<sup>2</sup>

### Abstract

The present study deals with the six species of six genera from three families. They are collected from study area of Pang Long University Campus, Pang Long Township. Pollen Morphological studies on both vegetative and reproductive parts of the plants have been investigated. As a result of collections from each of 2 species from family Asteraceae, Fabaceae and Malvaceae were studied. One species each of have been identified, nomenclature and colored photograph presented. For pollen morphology shape, size, aperture type and exine sculpture were studied. In Family Asteraceae, tricolporate and tetracolporate; Family Fabaceae, tricolporate and Family Malvaceae, polyporate sculptures were founded. Very large size of Pollen found in *Urena lobata* L. and small size found in *Eclipta prostrata* L. and *Senna siamea* (Lam.), Irwin in study area. Finally, color photographs of both equatorial and polar view were presented.

Keywords: Pollen morphology, some species, Panglong University

### Introduction

The Asteraceae (Compositae) or Sunflower family (Aster meaning star) is one of the largest and best known families of the flowering plants and certainly the largest of the dicotyledonous families. They are a significant element in the floras of the semiarid regions of the tropics and subtropics, such as the Mediterranean regions, Mexico, southern Africa, and the woodland, wooded grassland, grassland, and bush ecosystems of Africa, South America and Australia. They are also abundant in arctic, arctic-alpine, temperate through the world (Heywood *et al.* 2007).

Family Leguminosae, ( Fabaceae ) generally are considered to be one of the 3 largest Family of angiosperm, represented by about 550 genera and perhaps 13,000 species. This Family as circumscribe above is divided into 3 subfamilies. These 3 subfamilies are treated as distinct families by many botanists (The Mimosaceae, the Caesalpinaceae, and Papilionaceae respectively) ( Lawrence, 1969 ).

The Malvaceae is the most well-known family of shrubs, trees and especially herbs. It is a staple product which is important to human not only as a source of wearing dresses and that of cooking vegetable plants but also as a garden ornamental plants and medicinal uses. It belongs to an order known as Malvales. The Malvaceae and other closely related families (eg. Bombacaceae, Tiliaceae and Sterculiaceae) are arbitrary, and genera frequently have been shifted among them (Heywood 1978).

Palynology is the study of pollen and spores of plants. Sporological research is either basic or applied. Pollen and spore morphology belong to the former, as do the borderline fields of palynology and cytology, genetics and taxonomy etc; to the latter belong geopalynology, aeropalynology, phamacopalynology, melitopalynology. Pollen biology has direct relevance in agriculture, horticulture, forestry, plant breeding and biotechnology. (Shivanna, 1997)

---

<sup>1</sup>Dr. Associate professor, Department of Botany, Panglong University.

<sup>2</sup>Dr, Professor, Department of Botany, Panglong University.

Apertures are distinct regions in the pollen wall through which the pollen tube emerges. Pollen grains are classified on the basis of shape, number, and position of the apertures. Exine is impregnated with a substance called sporopollenin. Sporopollenin is very tough and resistant to mechanical damage and decay. The sporopollenin impregnated exine is also resistant to acetolysis, which is a standard acid treatment used to dissolve all but the exine in order to better observe pollen wall structure with the light microscope. (Simpson 2006).

Pollen is rich in sugars, starches, amino acids, vitamins, and hormones. It is natural for man to utilize for food, medicine and cosmetics. Pollen has become very popular recently as a health food. Honeybees collect nectar from flowers and accumulate honey with pollen grains in the beehive (Yamada & Iwanmai 1988).

Pollen aperture plays an important role demarcating definite evolutionary levels. In Asteraceae family, pollen grains with apertures 3-colporate, provided with lalongateora. Shapes oblate, spheroidal, prolate, slightly more. Grains provided with ridges are known as lophae (Erdtman 1971). Pollen in Malvaceae is spheroidal or globular in outline and colporate or porate with an echinate sculpture. Spines are always evenly distributed over the surface of the grain and many vary in length, shape and density. (Nair, 1961)

The aims and objectives of this paper are to identify the taxonomic and evolutionary importances of pollen grain are significant at specific, generic or even higher levels. To know the plant distribution in Pang Long University Campus.

### **Materials and Methods**

The specimens of the six species from three families were collected from Panglong University, during December 2021 to March 2023. Tools and equipment's were used for collecting the specimen. During the time of flower bloomy, all the species collected are recorded by photographs. Identifying and classifying of the species are made by fresh specimens. The plants were collected and later identified. The plants are identified by using flora of Java and flora of British India by Hooker (1885). The valid species names had been based on A Revised Handbook to the flora of Ceylon by Dassanayake, 1983. Local names are received from local inhabitants and recorded by Hundley, 1987. All collected species are systematically arranged and stated their characters by constructing artificial keys.

#### **1. Collection of pollen samples**

All pollen samples were obtained from fields trips. Pollen collected during early, middle, and late periods of the flowering season and at different times of the day. Method of pollen collection is to excise mature anthers and allow them to dehisce under low humidity in desiccators. Debris is then removed with a forceps, or the pollen is sieved through a mesh of suitable pore size. Scientific name of the plant and its locality were labeled on the glass vials.

#### **2. Acetolysis of reference material**

Polliniferous material was crushed with a glass rod; 1cc of glacial acetic acid was added to it. Then the mixture was transferred to a test tube and a few drops of concentrated sulphuric acid were added. The test tube was put in a water-bath for 15 to 30 minutes (depending on the size and sculpture of the pollen grains). The fluid in the test tube was stirred frequently and boiled. On cooling, the mixture was diluted

with distilled water and to centrifuge for 15-30 minutes. This was repeated twice, decanting the water each time.

### 3. Preparation of glycerine jelly and slide

The glycerine jelly was prepared according to half ration of Kisser's formula (Erdtman, 1952). 25 g of gelatine, 75 ml of glycerine and 3.5 g of phenol crystals were mixed with 90 ml of distilled water in a beaker and stirred with a glass rod. This was heated in a water bath till homogenous, the process taking about 3 hours. 0.03g of saffranin was finally added before removal and storage. A drop of melted glycerine jelly was taken out with a pair of forceps and placed on the glass slide, and then covered with a cover slip. The pollen sample was examined by using electric Binocular light Microscope with 40 X imaged by taking Oppo Digital Camera. Erdtman (1952).

### 4. Classified and measuring the pollen

A micrometer was used to measure the size of the grains. Measurement were recorded based on 15 pollen grains per sample; Pollen Classified according to their size – less than 10  $\mu$  are very small spores, 10 - 25  $\mu$  are small, 25 - 50  $\mu$  are medium, 50 - 100  $\mu$  large, 100 - 200  $\mu$  are very large spores and above 200  $\mu$  are gigantic ones. (Erdtman ,1952) The ratio between the polar axis (P) and the equatorial diameter (E) can based to assign the pollen grains to shape classes as follows – P/E  $\rightarrow$  < 1 oblate, P/E  $\rightarrow$  1 spheroidal, P/E  $\rightarrow$  1- 1.14 prolate spheroidal, P/E $\rightarrow$ 1.14 -1. 33 subprolate, P/E  $\rightarrow$  1. 33- 2.00 prolate, P/E $\rightarrow$  > 2 perprolate. Pollen aperture was observed directly. The terminology used in the identification of pollen is according to Erdtman (1969), Hoen (1999).

## Results

The present research concerns the palynology of 6 species from belonging to 6 genera of the family Asteraceae, Fabaceae and Malvaceae. The resulting palynological data are provided in illustrated in Figure (1-6).

### Pollen Key to the species of Family Asteraceae, Fabaceae and Malvaceae

1. Pollen Polyporate -----2
1. Pollen Tricolporate and Tetracolporate, ----- 3
  2. Pollen Large size, exine 2.0 - 3.0 thick ----- *Sida accuta* Burm.
  2. Pollen very large size exine 5.0 - 7.0 thick-----*Urena lobata* L.
3. Pollen Tricolporate -----4
3. Pollen Tetracolporate, M-medium size-----*Tridax procumbens* L.
  4. Pollen size medium-----Cassia
  4. Pollen size small-----5
5. Pollen Sculpture echinate, shape spheroidal -----*Eclipta prostrata* L.
5. Pollen Sculpture obscurely reticulate, shape subprolate -----
 

-----*Senna siamea* (Lam.), Irwin

### Taxonomic descriptions and pollen morphology of six species of Family Asteraceae, Fabaceae and Malvaceae

#### 1. *Eclipta prostrata* L., 2 : 286. 1771.

- Myanmar name : Kyeik-hman  
Common name : False daisy

Family : Asteraceae  
 Flowering period : Almost throughout the year

Annual or biennial, erect or procumbent herbs; stems and branches terete, pubescent. Leaves simple, opposite and decussate, subsessile; blades oblong-lanceolate, cuneate at the base, serrate along the margin, acute at the apex, strigose on both surfaces. Capitula terminal, heterogamous, radiate; involucre campanulate, 2-seriate, phyllaries elliptic, pubescent; receptacles convex, paleaceous. Ray florets pistillate, ligulate, corolla with 2-toothed, white. Disc florets bisexual, tubular-campanulate, with 4 teeth, creamy white. Stamens 4, inserted; anthers bases obtuse, the appendages obtuse at the apex; ovary of outer florets oblong or ovate, those of inner florets complanated, styles exserted. Achenes obovate-oblongoid, trigonous, black, pappose.

### Pollen Morphology

Tricolporate, spheroidal, small, 20.0 - 24.0  $\mu$  in diameter; amb rounded triangular; operculum present, about 2.5  $\mu$  wide, pori longitudinal, 3.5 - 6.0  $\times$  2.5 - 5.0  $\mu$  in length and breadth; colpi longiculate 10.0 - 12.0  $\times$  2.0 - 3.0  $\mu$  in length and breadth; exine about 2.0 - 2.5  $\mu$  thick, sexine about 3.0  $\mu$ , sexine thicker than nexine; sculpturing echinate; spine 3.5 - 5.5  $\mu$  long, tip pointed and straight, basal cushion about 2.0  $\mu$  in width, about 1.5  $\mu$  in height, interspinal space about 3.0  $\mu$  wide.



Fig.1. A. Habit  
 B. Inflorescence  
 C. Capitulum  
 D. Polar view  
 E. Equatorial view *Eclipta prostrata* L.

### 2. *Tridax procumbens* L., Sp. Pl. 2: 900. 1753.

Myanmar name : Negya-gale, Tapin-shwehti,  
 English name : Coatbuttons, tridax daisy  
 Family : Asteraceae  
 Flowering period : Nearly throughout the year

Perennial, procumbent herbs; stems terete, hirsute. Leaves simple, opposite and decussate, petiolate; blades ovate, cuneate at the base, coarsely dentate or lobed along the margin, acute at the apex, hirsute on both surfaces. Capitula solitary, heterogamous, radiate; involucre campanulate, 3-seriate; phyllaries ovate, herbaceous; receptacles subconical, paleaceous. Ray florets pistillate, ligulate, corolla with 2-3 lobes, creamy white. Disc florets bisexual, corolla with 5-lobes, bright yellow. Stamens 5, exserted; anthers bases sagittate, acute at the apex, ovaries of outer and inner florets oblongoid, styles exserted. Achenes narrowly obconical, blackish, pappose.

### Pollen Morphology

Tetracolporate, spheroidal, medium, 35.0 - 40.0  $\mu$  in diameter; amb rounded; operculum present; colpi 19.0 - 23.0  $\times$  2.4 - 3.5  $\mu$  in length and breadth; porilongate, 2.5 - 3.5  $\times$  1.5 - 2.5  $\mu$  in length and breadth; exine 2.5 - 3.5  $\mu$  thick, sexine about 4.0  $\mu$  thick, sexine thicker than nexine; sculpturing echinate;

spine 3.5 - 4.5  $\mu$  long, basal cushion about 2.5  $\mu$  in width, about 1.5  $\mu$  in height, interspinal space about 2.5  $\mu$  wide.

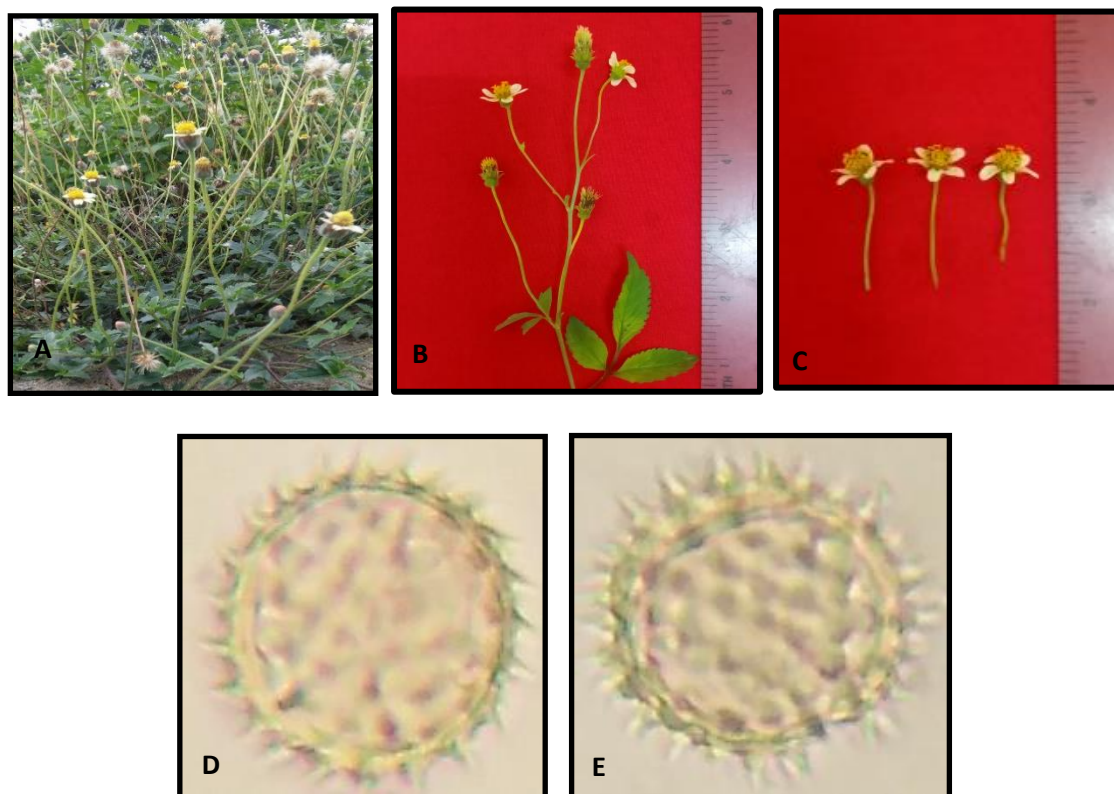


Fig. 2. A. Habit

B. Inflorescence

C. Capitulum

D. Polar view

E. Equatorial view of *Tridax procumbens* L

### 3. *Cassia javanica* (Wall. ex Benth.) K.Larsen. Nord.J. Bot. 13.404. 1933

Myanmar name	: Pwa- bet, Ngu-sat
English name	: Pink and white shower tree
Family	: Fabaceae
Flowering period	: March to June

Perennial deciduous trees, about 13 m high; stems and branches terete, reddish - brown in age. Leaves unipinnately compound, paripinnate, alternate; stipules reniform; petioles terete, green; rachae green, shallowly grooved above; leaflets 10-20 paired, oblong, obtuse at the base, entire and ciliate along the margin, rounded or emarginated at the apex. Inflorescence axillary dense racemes, many-flowered. Floweres pink, fragrant, about 3.0 cm in diameter at anthesis, zygomorphic, showy; bracts ovate; pedicels slender. Sepals 5, ovate, unequal in size, pinkish - brown. Petals, caesalpinaceous, ovate - oblong, pink. Stamens 10, free, 7 fertile and 3 sterile; filaments filiform, bright yellow; anthers ditheous, sagittate, basifixed. Ovary linear, pale green, unilocular with many - ovules in the locule on the marginal placentae; style terminal; stigma simple. Pods indehiscent, cylindrical, many- seed.

### Pollen Morphology

Tricolporate, prolate spheroidal, medium, 33.0 - 37.0 x 30.0 - 33.0  $\mu$  in length and breadth; pori circular, about 2.0 - 3.0  $\mu$  wide, interporal space about 10.0  $\mu$  wide ; colpi 12.0 - 15.0 x 2.5 - 3.5  $\mu$  in length and breadth, longicollate: exine 2.0 - 3.0  $\mu$  thick, sexine about 3.5  $\mu$  thick, sexine thicker than nexine; sparsely reticulate sculpture.

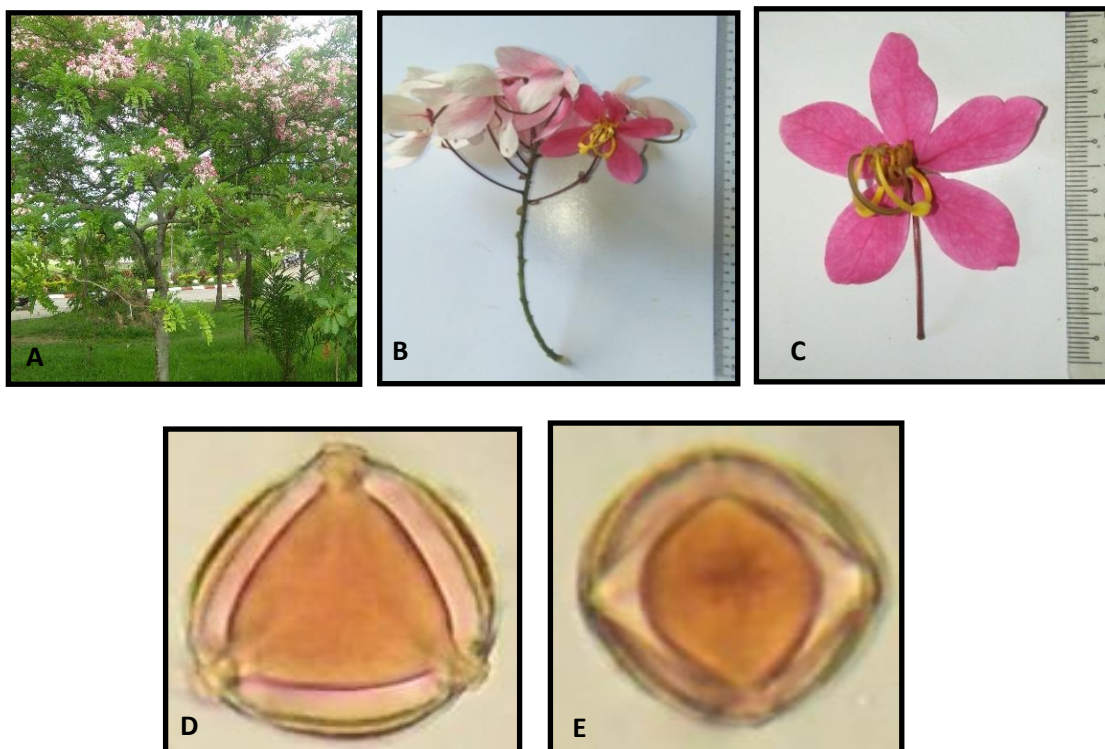


Fig. 3. A. Habit  
 B. Inflorescence  
 C. Flower  
 D. Polar view  
 E. Equatorial view of *Cassia javanica*

#### 4. *Senna siamea*(Lam.), Irwin & Barneby, Mem. New York Bot. Gard. 35:98.1982.

Myanmar name	: Mezali
English Name	: Thailand shower; Siamese Cassia
Family	: Fabaceae
Flowering period	: August to November

Trees, about 6 m high; stems cylindrical, glabrescent. Leaves alternate, unipinnately compound, paripinnate, the leaflets 6 - 12 pairs, opposite, the laminae oblong to elliptic, the tips apiculate, the margins entire, the bases oblique, unicostate; petiolules pubescent, petioles cylindrical, pulvinate; stipulate, the stipules linear. Inflorescences axillary and terminal, corymb, the peduncles cylindrical. Flowers yellow, about 2.0 cm long and 3.5 cm wide, bracteate, the bracts lanceolate; pedicels cylindrical, ebracteolate; calyx 1+2+2, aposepalous, ovate, imbricate; corolla 1+2+2, apopetalous, ovate, imbricate and ascending; stamens 3+4+3<sup>st</sup>, 7 fertiles, 3 staminodes, apostemonous, the fertile filaments linear, the staminodes 3.0 mm long, inserted, the anthers 2-celled, oblongoid, basifixed, introrse, porous dehiscence; ovary superior, 1-carpelled, oblongoid, unilocular, the placentation marginal, many ovules in the locule, the style cylindrical, the stigma simple, gynophore present. Fruits legume, linear-oblong, flattened, green; seeds ovoid, green, non-endospermic.

### Pollen Morphology

Tricolporate, subprolate, small, 20.0 – 23.0 x 17.0 – 20.0  $\mu$  in length and breadth; amb rounded triangular; pori lolongate, 3.5 - 5.0 x 3.0 – 4.0  $\mu$  in length and breadth, ; interporal space about 6.0  $\mu$  wide; colpi  $\frac{1}{2}$  way up to the pole 10.0 - 12.0 x 2.0 – 3.5  $\mu$  in length breadth; exine 1.5 – 2.5 $\mu$  thick, sexine thicker than nexine; sculpturing obscurely reticulate.

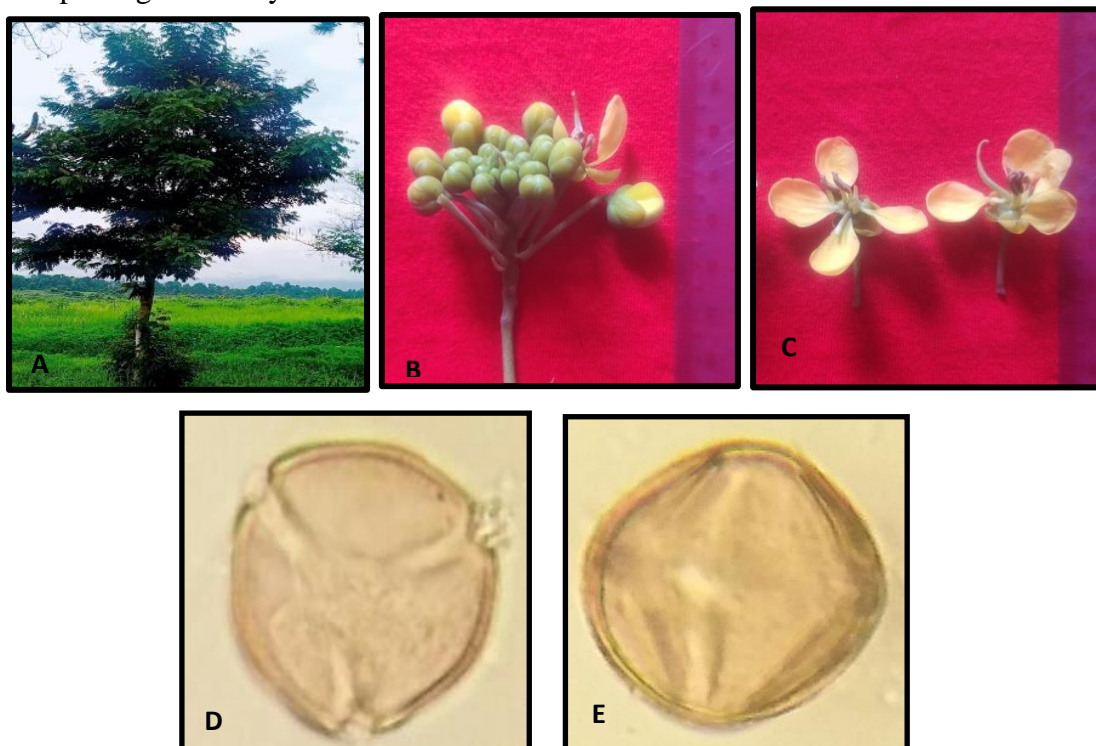


Fig. 4. A. Habit  
 B. Inflorescence  
 C. Flower  
 D. Polar view  
 E. Equatorial view of *Senna siamea*

### 5. *Sida acuta* Burm.f., Fl. Ind. 147.1768.

Myanmar name : The-byet-sie-pin  
 English name : Unknown  
 Family : Malvaceae  
 Flowering period : Throughout the year

Annual or perennial erect undershrubs, 0.5 - 1.2 m high; stem and branches terete. Leaves simple, alternate; stipules lanceolate; petioles slender; laminae oblong-lanceolate, green, minutely stellate-tomentose on both surface, palm-nerved with 6-10 pairs of lateral nerve. Inflorescence terminal or axillary uniflorous cymes. Flowers afternoon bloomers, bisexual, actinomorphic, hypogynous, light yellow, complete, about 1 cm across at anthesis, ebracteate, pedicellate, ebracteolate; pedicels filiform, joined above the middle, green. Calyx capanulate, 5-lobed, persistent; lobes connate at the upper one third. Petals 5, obovate, light yellow. Stamens numerous, monadelphous; staminal tube conical; free filaments linear, yellow; anthers dorsifixed, reniform. Ovary superior, pentalocular with 1 ovule in the locule on axile placentae, globose; style terminal cylindrical; stigmatic branches 5, each stigmatic branch bears a stigma; each stigma capitate. Fruits schizocarpic, globoid.

### Pollen Morphology

Polyporate (about 30), pantoporate, spheroidal, large, 70.0 – 80.0  $\mu$  in diameter, pori circular, 4.0 - 6.0  $\mu$  in diameter, interporal space 5.0 - 8.0  $\mu$  in wide ; exine 3.0 - 5.0  $\mu$  thick, sexine thicker than nexine; sculpturing echinate, spines 6.0 - 8.0  $\mu$  in length, slender, tips pointed, straight, basal cushion 2.0 -3.5  $\mu$  in height and 1.5 - 2.5  $\mu$  in width, interspinal space 4.0 - 6.0  $\mu$ .

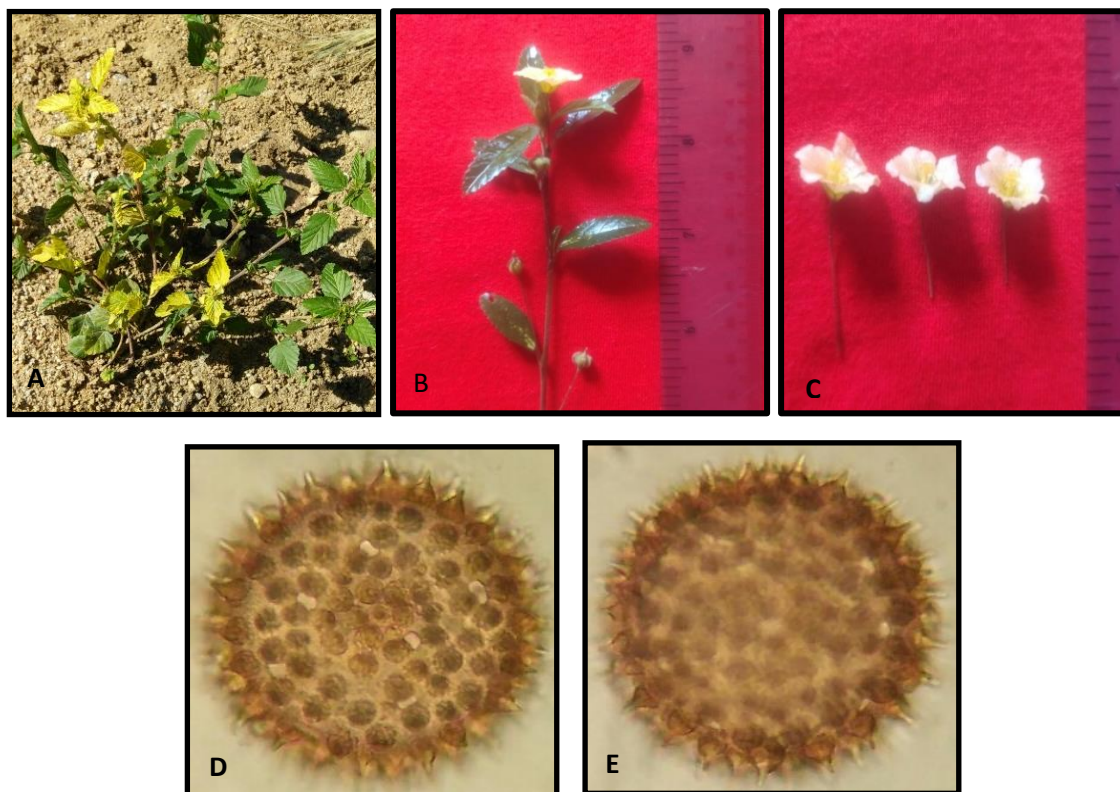


Fig. 5. A. Habit  
 B. Inflorescence  
 C. Flower  
 D. Polar view  
 E. Equatorial view of *Sida acuta*

### 6. *Urena lobota* L., Sp. Pl.692. 1753

Myanmar name : Kat-sine,  
 English name : Congo jute, Aramina  
 Family : Malvaceae



Flowering period : Throughout the year

Annual erect herbs, stem and branches stout; internodes terete. Leaves simple, alternate, stipules linear lanceolate; laminae ovate with 3 shallow lobes, palminerved with 5-7 veins and a glan on the midrib beneath, shallowly cordate at the base, serrate to crenate along the margin, acute at the apex. Inflorescence terminal or axillary solitary cymes. Flowers morning bloomers, bisexual, actinomorphic, hypogynous, pink or rose purple with dark purple centre, complete, ebracteate, pedicellate, stellate-pubescent; bracteoles of epicalyx 5, elliptic-lanceolate. Calyx campanulate, 5-lobed, sparsely stellate-tomentose within. Petals 5, obovate, pink or rose purple with dark purple at the base. Stamens numerous, monadelphous; staminal tubes conical; free filaments very short, pink; anther dorsifixed, reniform, pink. Ovary superior, pentalocular with 1 ovule in the locule on axile placentae, globoid; style terminal; stigmatic branches 10, each stigmatic branch bear a stigma; each stigma capitate. Fruits schizocarpic, depressed globose, stiff- hooked spines-hairy with 5 trigonous mericarps; each mericarp 1- seeded with short awns at the apex.

### Pollen Morphology

Polyporate (about 50), pantoporate, spheroidal, very large, 110.0 – 125.0  $\mu$  in diameter, pori circular, 5.0 - 7.0  $\mu$  in diameter, interporal space 7.0 - 10.0  $\mu$  in wide ; exine 5.0 -7.0  $\mu$  thick, sexine thicker than nexine; sculpturing echinate, spines 10.0 - 12.0  $\mu$  in length, slender, tips pointed, slightly blunt, basal cushion 4.0 -5.0  $\mu$  in height and 2.5 - 3.5  $\mu$  in width, interspinal space 6.0 - 8.0  $\mu$ .

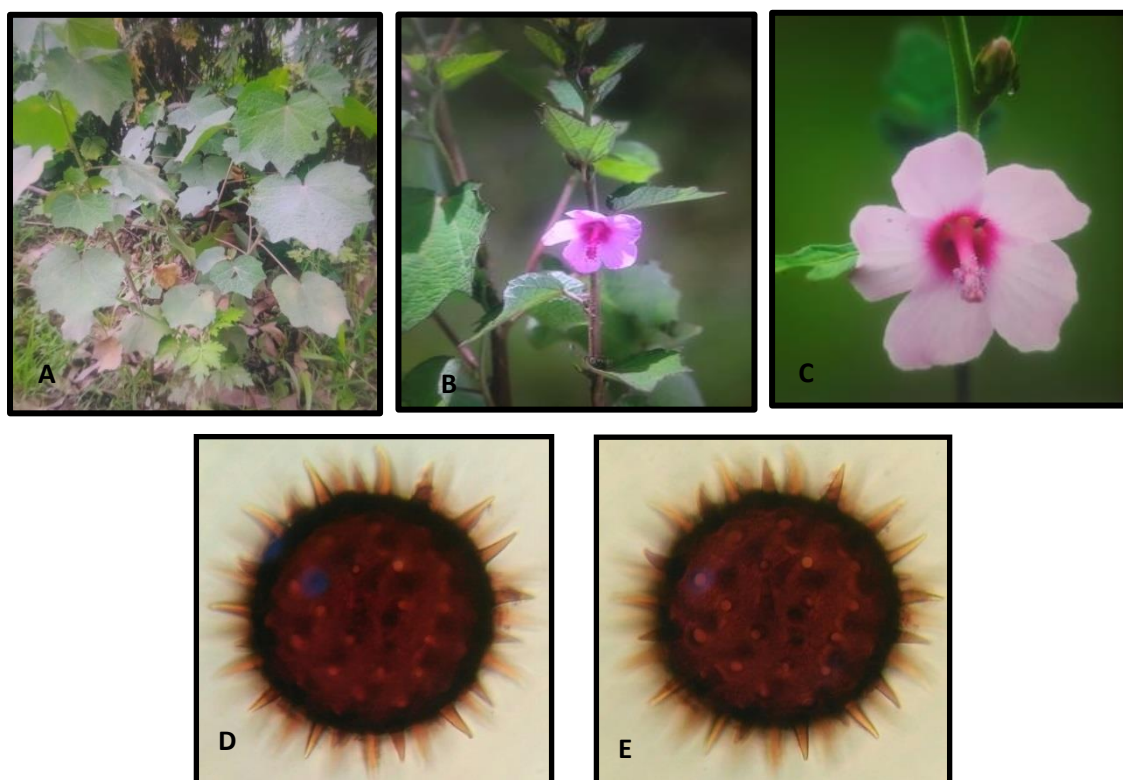


Fig. 6. A. Habit  
 B. Inflorescence  
 C. Flower  
 D. Polar view  
 E. Equatorial view of *Urena lobata* L.

### Discussion and Conclusion

The present study with the taxonomy and pollen morphology of 6 species of three families collected from Pang Long University Campus. In the present study, each of two species from family Asteraceae, Fabaceae and Malvaceae. Among them included trees, shrubs and herbs. Types of inflorescence and flowers were variable in shape and size. Family Asteraceae, leaves simple, opposite and decussate, subsessile. capitula terminal, heterogamous; stamens 4; anthers bases obtuse, the ovary of outer florets oblong or ovate, found in *Eclipta prostrata*. Perennial, procumbent herbs, leaves simple, opposite and decussate, petiolate, capitula solitary, heterogamous, ray florets pistillate, ligulate, disc florets bisexual, corolla with 5-lobes; stamens 5, exserted; anthers bases sagittate found in *Tridax procumbens* L

Family Fabaceae, perennial deciduous tree; leaves unipinnately compound, paripinnate; Inflorescence axillary dense racemes, many-flowered; flowers pink, fragrant; stamens 10, free, 7 fertile and 3 sterile; filaments filiform, bright yellow found in *Cassia javanica*. *Senna siamea* (Lam.), trees, stems cylindrical, leaves alternate, unipinnately compound, paripinnate; flowers yellow; calyx 1+2+2, aposepalous, ovate, corolla 1+2+2, apopetalous; stamens 3+4+3<sup>st</sup>, 7 fertiles, 3 staminodes, apostemonous; the anthers 2-celled, oblongoid, basifixed was studied.

Family Malvaceae, Annual or perennial erect undershrubs, leaves simple, alternate; inflorescence terminal or axillary uniflorous cymes. Flowers afternoon bloomers, bisexual, actinomorphic, hypogynous; stamens, numerous, monadelphous, anthers dorsifixed, found in *Sida acuta* Burm.f., Annual erect herbs, stem and branches stout; leaves simple, alternate, laminae ovate; inflorescence terminal or axillary solitary cymes. Flowers morning bloomers, bisexual, actinomorphic, hypogynous; stamens numerous; anther dorsifixed, reniform found in *Urena lobota* L.

The result has shown that pollen characteristics, principally shape, aperture characters, variation in the size, spine characteristics, as well as exine sculpture and structure are important for identification. In this study, the grains occur in varied from very large size, medium and small size. Very large size found in *Urena lobota* L and large size in *Sida acuta* Burm. of family Malvaceae; medium size found in *Tridax procumbens* L., of family Asteraceae and *Cassia javanica* (Wall. ex Benth.) K. Larsen. of family Fabaceae; small size found in *Eclipta prostrata* L., of family Asteraceae and *Senna siamea* (Lam.), Irwin & Barneby of family Fabaceae.

Pollen Tricolporate and tetracolporate; sculpturing echinate found in Family Asteraceae. Pollen Tricolporate and sculpturing obscuring reticulate found in Family Fabaceae. Pollen polyporate and sculpturing echinate found in Family Malvaceae. According to resulting data, the spines, sculpture, aperture, shape and size are useful taxonomical character in systematic study of Families. Characters may provide valuable information for taxonomic identification and classification.

Therefore, the palynological data are very important not only for taxonomy point of views but also the identification of related species. Thus, the present study will provide a few knowledge of taxonomy and palynological characters to solve taxonomic problems of identification and classification of species.

#### Acknowledgements

My especially are indebted to Dr Ni Lar Myint, Rector and Dr Min Lwin and Dr Khin Lay Yee, Pro-Rector, Panglong University, for their kindness and encouragement of this work for successful completion of this paper.

#### References

- Backer C.A & R.C Bakhuizen van & Den Brink, Jr 1965. **Flora of Java**.  
Noorhoff Groningen I.
- Bhattacharyya. B & B.M. Johri **Flowering Plants Taxonomy and Phylogeny**. Dept.of Botany, Gari  
College, Univ.of Delhi South Campus, New Delhi (India).
- Brummit R.K. 1992. **Vascular Plant Families and Genera**. The Board of Trustees of the Royal  
Botanical Garden, Kew London.
- Dassanayake, M.D & W.C.Clayton, 1997. **A Revised Handbook to the flora of Ceylon**, Vol XI.  
American publishing Co. Pvt. Ltd. New Delhi.
- Erdtman G. 1952. **Pollen Morphology and Plant Taxonomy (Angiosperms)**. The Chronica Botanica  
Co. Waltham, Mass.
- Erdtman G. 1954. **An Introduction to Pollen Analysis**. Chronica Botanica Co.Mass.
- Erdtman G., B. Bergland & J. Praglocoski. 1961.**An Introduction to a Scandinavian Pollen Floza**.  
Almqvist & Wiksell Stockholm.
- Erdtman G. 1969. **Handbook of Palynology, Morphology, Taxonomy, Ecology**. Hatnat Publishing  
Co., New York.
- Erdtman G. 1985. **Palynology. In Advances in Botanical Research. Academic Press**.
- Hoen, P. (1999). **Glossary of Pollen and Spore Terminology**. Second and revised edition.  
Utrecht. The Netherlands.
- Hooker J.D. 1879. **The Flora of British India**, Vol II. Clarendon Press. Oxford, London.
- Hundley H.G & Chit Ko Ko 1978. **List of Trees, Shrubs Herbs and Principle Climber of Burma**.  
Supdt, Govt. Print & Staty Yangon, Myanmar.
- Hutchinson, J. 1967. **Key to the Families of Flowering Plants of the World**. Clarendon Press.  
Oxford. London.
- Kress. J. *et al.* 2003. **A Checklist of the Trees, Shrubs, Herbs and Climbers of Myanmar**. Dept. of  
Systematic Biology-Botany National Museum of Natural History Washington DC. USA.
- Shivanna. K.R & V.K. Sawhney. (1997).**Pollen Biotechnology for Crop Production And  
Improvement**. Combridge University Press.
- Lawrence. G. H. M. 1969. **Taxonomy of Vascular Plants**. The Macmillan Company. New York.
- Simpson,M.G.(2006) **Plant Systemics**. Elsevier Academic Press.Burlington, MA 01803,USA

### Terminology

- Amb : ambit; outline of a spore as viewed with one of the poles exactly  
uppermost, i.e with the polar axis directed straight towards the observer.  
In isopolar, unstricted spores the maximum amb is the same as the  
equator.
- Angulaperturate : those apertures situated at the angles of the amb.
- Aperture : apertures are specially delimited, generally thin walled  
areas in the outer pollen wall or exine through which the pollen tube.
- Colpate : pollen grain with an elongate aperture or furrow.
- Colporate : with a composite aperture, consisting of both a colpous and a pore.
- Exine : the main outer usually resistant layer of a sporoderm.
- Heterobronchate : with brochi of  $\pm$  distinctly different sizes.
- Lumina : the spaces between the muri of a reticulation (sing. lumen)
- Muri : ridges separating the lumina of an ordinary reticulum.
- Nexine : the inner usually "non-sculptured" part of the exine which lies below  
the sexine.
- Oblate : distinctly flattened, the ratio between the polar axis and equatorial  
diameter is 6:8 - 4:8.
- Reticulate : with a reticulum.
- Reticulum : network formed by muri and luminae. (Pl. reticula)
- Retipilate : with a reticuloid pattern with pila instead of muri.
- Sexine : the outer sculpture part of the exine.
- Syncolpate : with colpi anastomosing at the poles.