

PALYNOLOGICAL STUDY ON SOME MANGROVE PLANTS FOUND IN SITTWAY COASTAL AREA*

Kyi Kyi Iwin¹, Oo Soe Than², Aye Myat San³

Abstract

Pollen morphology of 14 mangrove species belonging to 10 genera of 9 families were studied, classified and identified by available literatures. Pollen of 14 mangrove species (*Nypa fruticans*, *Ticantio crista*, *Kandelia obovate*, *Excoecaria agallocha*, *Sonneratia apetala*, *S. caseolaris*, *Sesuvium portulacastrum*, *Aegiceras corniculatum*, *A. floridum*, *Vincetoxicum flexuosum* var. *tenuis*, *Acanthus ilicifolius*, *Avicennia alba*, *A. marina*, *A. officinalis*) were observed with a binocular electric microscope. Pollen study area is in Yae- chan- pyin village, Kyauk- tan village, Aung- mingalar village, Nar- yae- kan village and along the Sittway costal, Rakhine State. The pollen key to the species has been constructed based on the acquired palynological assessment. Pollen of all the species have been recorded with aperture number, position, shape, size, and sculpture of the exine; investigated species were pollinia and monads; varying form porate, colpate, colporate to sulcate. The equatorial and polar views of each taxon were recorded by photomicrographs. The present study revealed that the pollen morphology of some mangrove species in study area. Mangrove pollen is crucial for the reproduction of mangrove trees, which are key components of coastal ecosystems. These trees provide habitats for numerous species, contributing to biodiversity. Therefore, the pollen morphology of mangrove plants needs to be protected and regularly assessed.

Keywords: Mangrove; micromorphology; pollen; Sittway costal area

Introduction

The mangrove of the world grows in the tropical and temperate zone of the 123 countries. There are about 73 kinds of trees and in 152,000 square meter area. About 94 species belonging to 67 genera of 41 families in Myanmar. Draft (2005) stated that, 29 species mangroves plants belong to 15 genera were presented in Myanmar. and Cherry Aung (2016) reported that 44 species of true mangroves and associated plants belonging to 22 genera of 14 families were presented. And then, 40 species, true mangroves and associated plants belonging to 28 genera of 21 families were found in Yae-Chan-Pyin and Aung-Mingalar village, Rakhine State (Saw Saw Khine, 2015).

In this study, 14 mangrove species belonging to 10 genera of 9 families of pollen morphology were investigated. Pollen morphology, such as grain size, the number of pores and exine sculpturing are the most distinctive features for species delimitation. Pollen morphology, including its shape and structure, can provide valuable information for identifying and classifying various taxa and solving taxonomic issues within a particular group of plants (Britannica, 2023). This study aimed to determine the pollen morphology of various mangrove species in study area. The study is expected to add value to the taxonomic study of mangrove species and to provide the valuable pollen characters that can be used in plant classification and identification.

* Special Award (2024)

¹ Department of Botany, University of Yangon

² Department of Botany, Sittway University

³ Department of Botany, Sittway University

Materials and Methods

The specimens were collected from some Sittway coastal area in January to September 2022. The collected plants were photographed to record their habits, inflorescences, and flowers. Identification of specimens was accomplished in accordance with the taxonomic procedures. By using floristic literature of Gilbert (1994), Dassanayake (1980-2000) and HU Qi-ming and WU Delin (SCGB) (2007-2009). Myanmar names were referred to Hundley and Chit Ko Ko (1987). Pollen samples of specimens were freshly collected from the anther in blooming flowers. According to Erdtman method (1952), the pollen grains were observed with acetolysis method. The terminology used in the identification of pollens was according to Erdtman, (1952), Punt et al. (2007), Hesse et al. (2009) and Halbritter et al. (2018).

Results

In pollen morphology of mangrove plants, 14 species belonging to 10 genera of 9 families have been studied. They were monocotyledonous and eudicotyledonous plants. The families were listed according to APG IV of Byng et al. (2016) systems as follows in Table 1 and the species according to alphabetical order.

Table 1. List of mangrove species studied in Sittway coastal area

Family	Scientific name	Myanmar name	Rakhine name
Areaceae	1. <i>Nypa fruticans</i> Wurmmb	Dah-ni	Ye-ohn
Fabaceae	2. <i>Ticanto crista</i> L.	Sukyanbo	Kaung-chit-sue
Rhizophoraceae	3. <i>Kandelia obovata</i> Sheue.	Byu	Byu
Euphorbiaceae	4. <i>Excoecaria agallocha</i> L.	Tayaw	Jakant-pin
Lythraceae	5. <i>Sonneratia apetala</i> Banks,	Kambala	Pyar-zee
	6. <i>Sonneratia caseolaris</i> (L.) Engl	Lamu	Lamu
Aizoaceae	7. <i>Sesuvium portulacastrum</i> (L.) L.	Pinle-teji	Pinle-teji
Primulaceae	8. <i>Aegiceras corniculatum</i> (L.) Blanco	Ye-khaya	Jetrome
	9. <i>Aegiceras floridum</i> Roem. & Schult.	Pya-pin	Sapaung
Apocynaceae	10. <i>Vincetoxicum flexuosum</i> var. <i>tenuis</i> (Blume) Schneidt,	Not known	Ma-line-twat
Acanthaceae	11. <i>Acanthus ilicifolius</i> L.	Kaya	Phad-yan sue
	12. <i>Avicennia alba</i> Blume	La-me	Pya-chun
	13. <i>Avicennia marina</i> (Forssk.) Vierh.	Tha-mai phyu	Pyar-phyu
	14. <i>Avicennia officinalis</i> L.	Thame	Pyar-wine

1. *Nypa fruticans* Wurmb

Family : Arecaceae

Myanmar Name : Dah-ni

Rakhine Name : Ye-ohn

Pollen morphology

Disulcate, zonaulcate, spheroidal, medium, 32.5-38.7 μm in diameter; amb ribbon shaped; sulcus long and narrow, about 0.7x25.0 μm in length and breadth; exine 5.0-6.2 μm thick, sexine slightly thinner than nexine; sculpturing echinate, spines 2.5-5.0 μm in length, straight, pointed, basal cushion 2.0-2.5 μm in width, the interspinal spaces 2.5-3.7 μm in width, the interspinal areas reticulate.

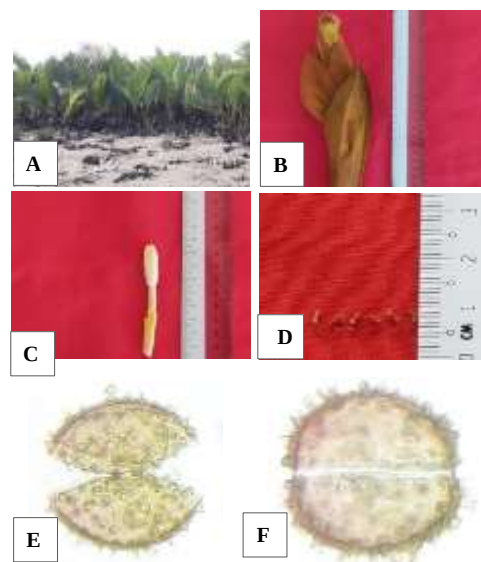


Figure.1 *Nypa fruticans* Wurmb
(A)Habit (B)Inflorescences (C)Flowers
(D)Androecium (E)Polar view (F)Equatorial view

Specimen examined: Sittway area, Kyauk-tan village & Sittway coastal; January 2022.

2. *Ticanto crista* L.

Family : Fabaceae

Myanmar name : Sukyanbo

Rakhine name :Kaung-chit- sue

Pollen morphology

Tricolporate, zonocolporate, subspheroidal, medium, 31.2-38.7 x 38.7-37.5 μm in length and breadth; amb rounded; colpi longicollate, 25.0-27.5 x 7.5 μm in length and breadth; pori lolongate, about 5.0x2.5 μm in length and breadth; exine 2.0-2.5 μm thick, sexine thicker than nexine; sculpturing distinctly reticulate, the lumina heterobrochate, 2.0- 3.7 μm in width, the muri simplibaculate, about 1.2 μm in width

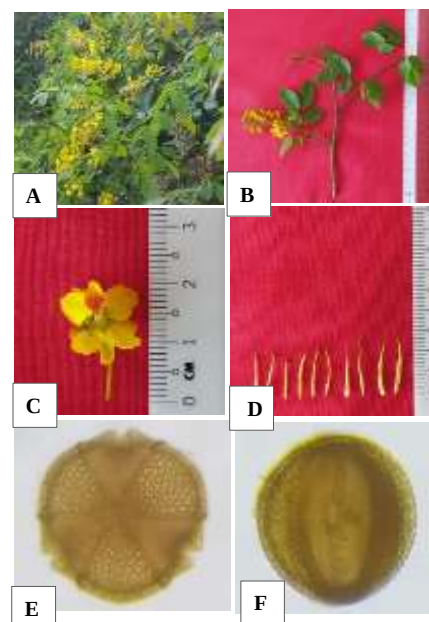


Figure.2 *Caesalpinia crista* L.
(A)Habit (B)Inflorescences (C)Flower
(D)Androecium (E)Polar view (F)Equatorial view
Specimen examined: Sittway area; Aung-mingalar village; June 2022.

3. *Kandelia obovata* Shue.

Family : Rhizophoraceae

Myanmar name : Byu

Rakhine Name : Byu

Pollen morphology

Tricolporate, zonocolporate, subprolate, small, 17.5-18.7 x 14.5-15.0 μm in length and breadth; amb rounded triangular; colpi longicollate, 12.5-15.0 x 2.0-2.5 μm in length and breadth; pori lalongate, 3.0-5.0 x 2.2-2.5 μm in length and breadth; exine 2.0-2.5 μm thick, sexine thinner than nexine; sculpturing striate.

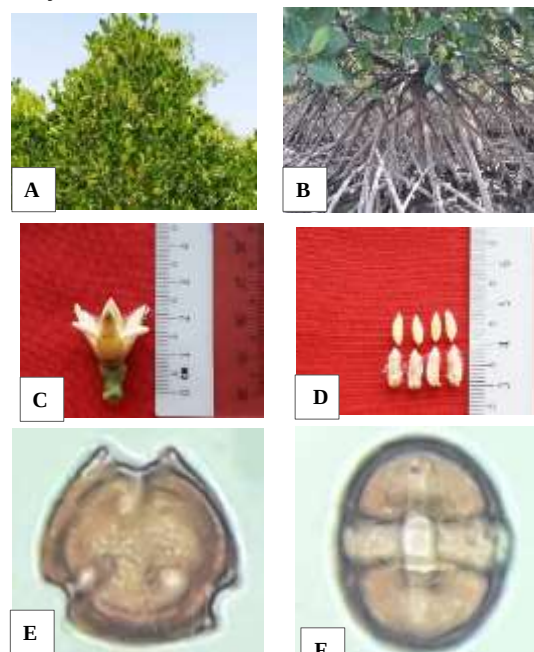


Figure.3. *Kandelia obovata* Shue. (A)Habit (B)Inflorescences (C)Flower (D)Androecium (E)Polar view (F)Equatorial view Specimen examined: Sittway area, Nar-ya-kan village, April 2022.

4. *Excoecaria agallocha* L.

Family : Euphorbiaceae

Myanmar name : Tayaw

Rakhine name : Jakant-pin

Pollen morphology

Tricolporate, zonocolporate, oblate spheroidal, small, 20.0-22.5 x 22.5-25.0 μm in length and breadth; amb rounded; colpi longicollate, 13.7-16.2 x 1.2 μm in length and breadth; pori lalongate, 2.5 x 3.7-5.0 μm in length and breadth; exine 2.0-2.5 μm thick, sexine as thick as nexine; sculpturing striate.

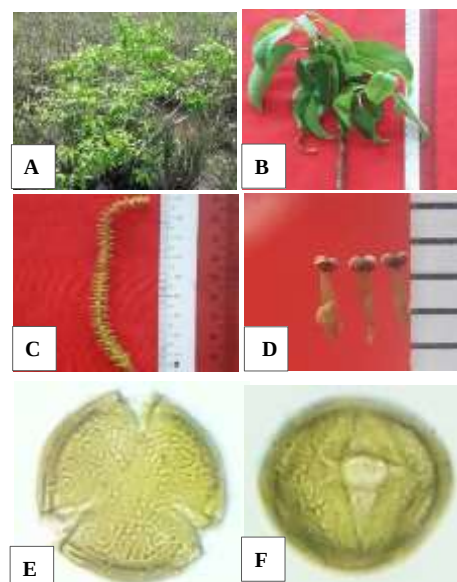


Figure.4. *Excoecaria agallocha* L. (A)Habit (B)Inflorescences (C) Flower (D)Androecium (E) Polar view (F) Equatorial view **Specimen examined:** Sittway area, Yae-chan-pyin, September 2022

5. *Sonneratia apetala* Banks,

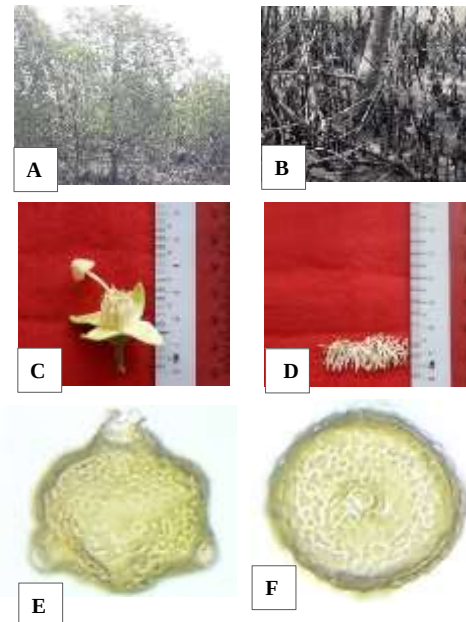
Family : Lythraceae

Myanmar name : Kambala

Rakhine name : Pyar-zee

Pollen morphology

Triporate, zonoporate, oblate spheroidal, small, 19.5-23.7 x 20.0-25.0 μm in length and breadth; amb rounded hexagonal; 3 pseudocolpi present; pori circular (crassi marginate), about 3.0 μm in diameter; exine 2.5-3.7 μm thick, sexine thicker than nexine; sculpturing gemmate.

**Figure.5 *Sonneratia apetala* Banks**

(A)Habit (B)Roots (C)Flower (D)Androecium

(E)Polar view (F)Equatorial view

Specimen examined: Sittway area, Nar-yae-kan, September 2022.

6. *Sonneratia caseolaris* (L.)**Engl.**

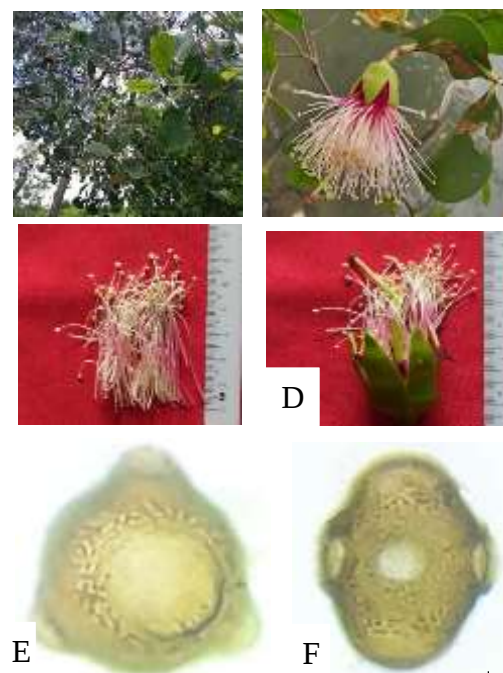
Family : Lythraceae

Myanmar name : Lamu

Rakhine Name : Lamu

Pollen morphology

Triporate, zonoporate, prolate, medium, 27.5-30.0 x 21.7-22.5 μm in length and breadth; amb rounded hexagonal; 3 pseudocolpoidorate; pori circular, surrounded by distinctly thin collar, 4.7-5.0 μm in diameter; exine 2.5-3.5 μm thick, sexine thicker than nexine; sculpturing gemmate.

**Figure.6 *Sonneratia caseolaris* (L.) Engl.**

(A)Habit (B)Inflorescences (C) Flower

(D)Androecium(E)Polar view (F) Equatorial view

Specimen examined: Sittway area; Nar-yae-kan; January 2022

7. *Sesuvium portulacastrum* (L.)

Family : Aizoaceae

Myanmar Name : Pinle-teji

Rakhine Name : Pinle-teji

Pollen morphology

Tricolpate, zonocolpate, oblate spheroidal, small, 13.7-15.0 x 15.0-17.0 μm in length and breadth; amb rounded; colpi longicollpate, 11.2-13.7 x 5.0-7.5 μm in length and breadth; exine 1.2-2.0 μm thick, sexine as thick as nexine; sculpturing striate.

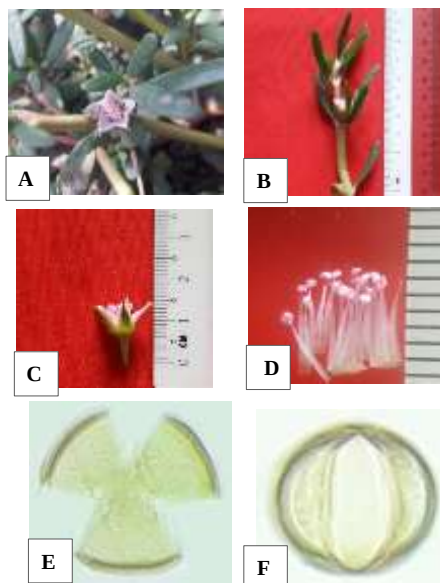


Figure.7 *Sesuvium portulacastrum* (L.)

(A)Habit (B)Inflorescences (C)Flower

(D) Androecium (E)Polar view (F) Equatorial view

Specimen examined: Sittway area; Yae-chan-pyin; May 2022

8. *Aegiceras corniculatum* (L.) Blanco

Family : Primulaceae

Myanmar Name : Ye-khaya

Rakhine Name : Jetrome

Pollen morphology

Tricolporate, zonocolporate, prolate spheroidal, small, 12.7-15.5 x 12.5-15.0 μm in length and breadth; amb rounded; colpi longicollpate, 10.0-11.2 x 0.7 μm in length and breadth; pori lalongate, 2.5 x 4.5-5.0 μm in length and breadth; exine 2.0-2.5 μm thick, sexine as thick as nexine; sculpturing reticulate, the lumina heterobrochate 1.2-2.5 μm in width, the muri simplibaculate about 0.5 μm in width.

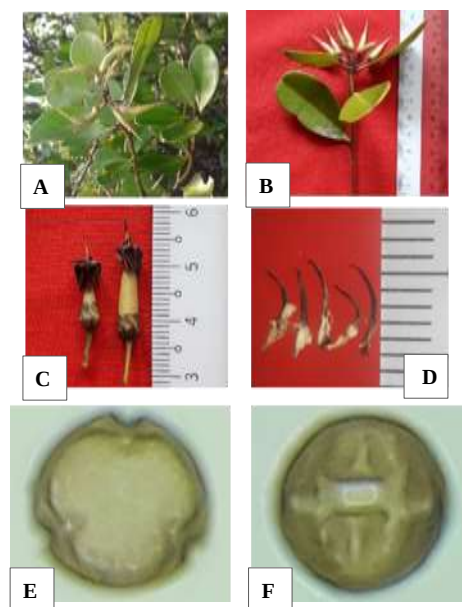


Figure 8. *Aegiceras corniculatum* (L.) Blanco

(A)Habit (B)Inflorescences (C) Flower

(D)Androecium (E)Polar view (F) Equatorial view

Specimen examined: Sittway area; Yae-chan-pyin; May 2022

9. *Aegiceras floridum* Roem. & Schult.

Family : Primulaceae

Myanmar Name : Pya-pin

Rakhine Name : Sapaung

Pollen morphology

Tricolpate, zonocolpate, oblate, large, 37.5-50.0 x 62.5-72.5 μm in length and breadth; amb rounded triangular; colpi longicolpate, 27.5-35.0 x 6.2-17.5 μm in length and breadth; exine 3.7-5.0 μm thick, sexine thicker than nexine; sculpturing retipilate.

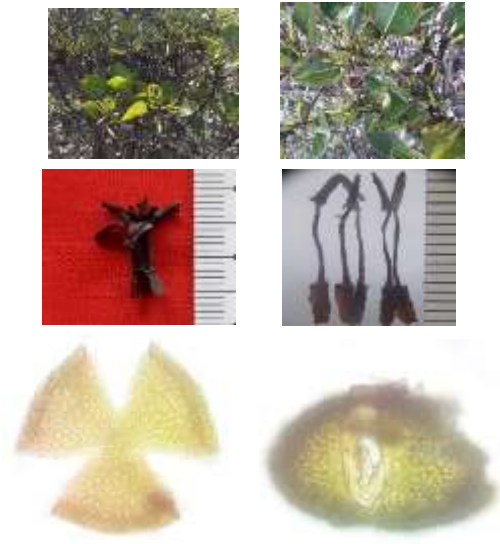


Figure 9. *Aegiceras floridum* L.
(A)Habit (B)Inflorescences (C) Flower
(D)Androecium (E)Polar view
(F) Equatorial view **Specimen examined:**
Sittway area; Yae-chan-pyin; May 2022

10. *Vincetoxicum flexuosum* var. *tenuis* (Blume) Schneidt,

Family : Apocynaceae

Myanmar Name : Notknown

Rakhine Name : Ma-line-twat

Pollen morphology

Pollinia (a coherent mass of pollen grains), pollinial sac 51.2-73.7 x 27.5-50.0 μm in length and breadth, obovate shaped with rounded at the apex, golden yellow, orientation of pollinum pendulus; corpusculum 67.5-71.2 x 16.2-18.7 μm in length and breadth, linear oblong shaped of head, dark brown; translator arms 57.5-75.0 x 15.0-16.2 μm in length and breadth, cylindrical in shape, creamy yellow, the translator attachment to the pollinial terminal.

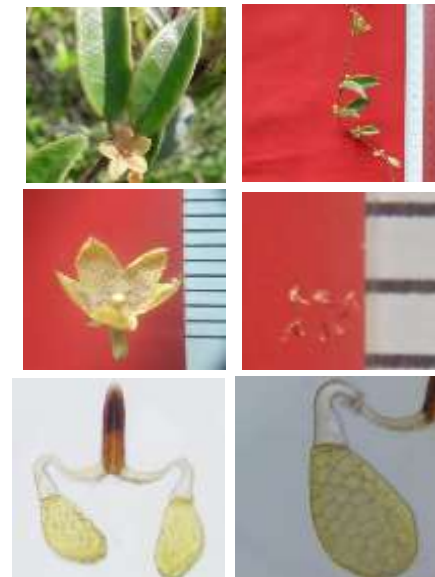


Figure 10. *Vincetoxicum flexuosum* var. *tenuis* (Blume) Schneidt,
(A)Habit (B)Inflorescences (C)Flower
(D)Androecium (E) Pollinia (F)Pollinium
Specimen examined: Sittway area; Nar-yae-kan; June 2022

11. *Acanthces ilicifolius* L.

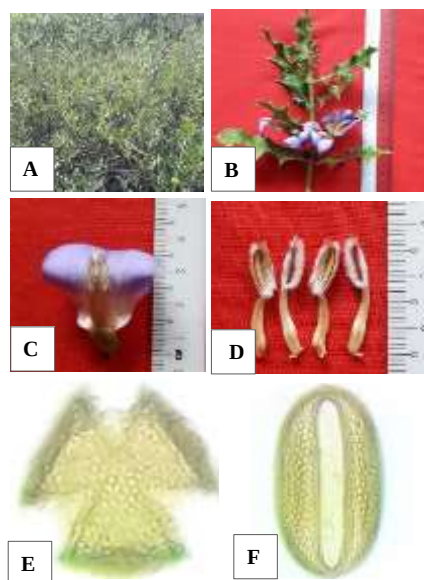
Family : Acanthaceae

Myanmar Name : Kaya

Rakhine Name : Phet-yan-sue

Pollen morphology

Tricolpate, zonocolpate, perprolate, small, 32.5-37.5 x 17.5-22.5 μm in length and breadth; amb triangular; colpi longicolpate, 37.5-38.7 x 4.5-5.0 μm in length and breadth; exine 2.0-2.5 μm thick, sexine thicker than nexine; sculpturing distinctly reticulate, the lumina heterobrochate, 1.2-2.0 μm in width, the muri simplibaculate, about 0.7 μm in width.

**Figure 11. *Acanthus ilicifolius* L.**

(A)Habit (B)Inflorescences

(C)Flower(D)Androecium (E)Polar view

(F) Equatorial view **Specimen examined:**

Sittway area; Yae-chan-pyin; May 2022

12. *Avicennia alba* Blume.

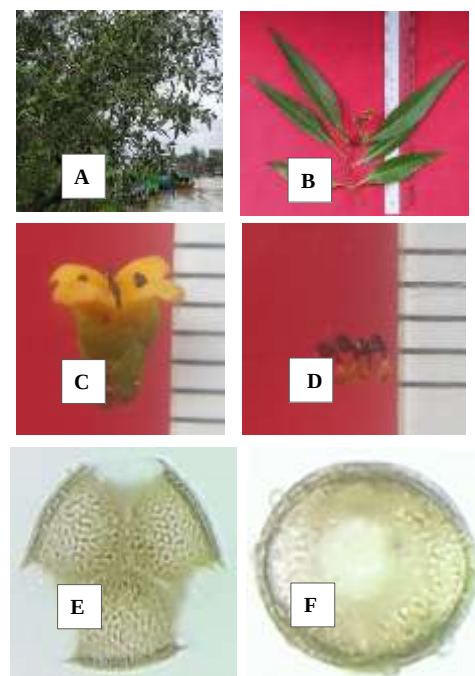
Family : Acanthaceae

Myanmar Name : La-me

Rakhine Name : Pyae shun

Pollen morphology

Tricolporate, zonocolporate, suboblate, small, 16.2-18.7 x 20.0-22.5 μm in length and breadth; amb rounded triangular; colpi syncolpate, 13.0-15.0 x 4.7-5.0 μm in length and breadth; pori lolongate, 7.5-8.7 x 6.2-7.5 μm in length and breadth; exine 2.0 μm thick, sexine thicker than nexine; sculpturing striato-reticulate, the lumina heterobrochate, 1.2-2.0 μm in width, the muri simplibaculate, about 0.7 μm in width.

**Figure 12. *Avicennia alba* Blume.**

(A)Habit (B)Inflorescences (C)

Flower(D)Androecium (E)Polar view

(F) Equatorial view **Specimen examined:**

Sittway area; Yae-chan-pyin; April 2022

13. *Avicennia marina* (Forssk) Vierth.

Family : Acanthaceae

Myanmar Name : Tha-mai-phyu

Rakhine Name : Pyar-phyu

Pollen morphology

Tricolporate, zonocolporate, oblate spheroidal, small, 19.7-20.2 x 20.0-22.5 μm in length and breadth; amb rounded triangular; colpi longicollate, 14.7-15.0 x 3.7-5.0 μm in length and breadth; pori lolongate, 7.5-8.7 x 5.0-6.5 μm in length and breadth; exine about 2.5 μm thick, sexine as thick as nexine; sculpturing striate.

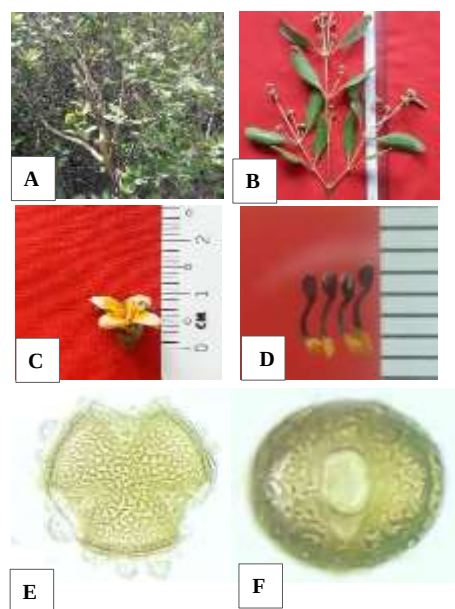


Figure 13. *Avicennia marina* (Forssk) Vierth (A) Habit (B) Inflorescences (C) Flower (D) Androecium (E) Polar view (F) Equatorial view **Specimen examined:** Sittway area; Yae-chan-pyin; May 2022

14. *Avicennia officinalis* L.

Family : Acanthaceae

Myanmar Name : Thame

Rakhine Name : Pyar wine

Pollen morphology

Tricolporate, zonocolporate, oblate spheroidal, small, 20.5-22.5 x 23.0-25.0 μm in length and breadth; amb rounded triangular; colpi longicollate, 15.0-17.2 x 6.2-7.5 μm in length and breadth; pori lolongate, 7.5 x 5.7-5.0 μm in length and breadth; exine 2.0-2.5 μm thick, sexine thinner than nexine; sculpturing striato-reticulate, the lumina heterobrochate, 0.7-1.2 μm in width, the muri simplibaculate, about 0.2 μm in width.

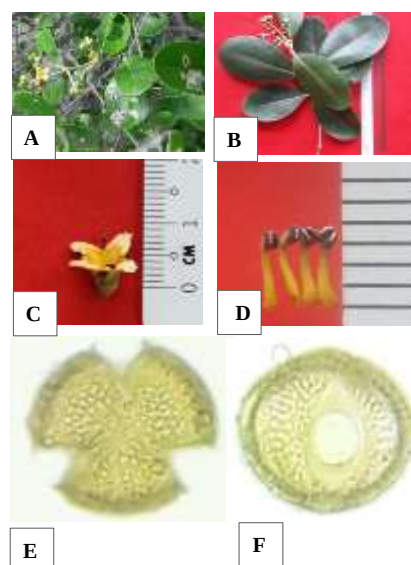


Figure 14. *Avicennia officinalis* L. (A) Habit (B) Inflorescences (C) Flower (D) Androecium (E) Polar view (F) Equatorial view **Specimen examined:** Sittway area; Yae-chan-pyin; May 2022

Artificial key to the species by using pollen morphology

1. Pollen grains pollinia ----- 10. *Vincetoxicum flexuosum*
1. Pollen grains free from each other -----2
 2. Aperture sulcate or colpate -----3
 2. Aperture porate or colporate -----6
3. Aperture disulcate ----- 1. *Nypa fruticans*
3. Aperture tricolpate ----- 4
 4. Grains large; exine more than 3.5 μm thick ----- 9. *Aegiceras floridum*
 4. Grains small; exine less than 2.5 μm thick-----5
5. Shape perprolate; sculpturing distinctly reticulate-----11. *Acathus ilicifolius*
5. Shape oblate spheroidal; sculpturing striate----- 7. *Sesuvium portulacastrum*
 6. Aperture porate-----7
 6. Aperture colporate-----8
7. Grains small; shape oblate spheroidal ----- 5. *Sonneratia apetala*
7. Grains medium; shape prolate ----- 6. *Sonneratia caseolaris*
 8. Pori lalongate -----9
 8. Pori lolongate -----10
9. Sculpturing striate ----- 4. *Excoecaria agallocha*
9. Sculpturing reticulate ----- 8. *Aegiceras corniculatum*
 10. Sexine thicker than nexine ----- 11
 10. Sexine as thick as or thinner than nexine -----12
11. Grains small; colpi syncolpate -----12. *Avicennia alba*
11. Grains medium; colpi longicarpate ----- 2. *Ticanto crista*
 12. Sexine as thick as nexine -----13. *Avicennia marina*
 12. Sexine thinner than nexine -----13
13. Shape subprolate; grains size 14.5-15.0 μm in breadth -----3. *Kandelia obovata*
13. Shape oblate spheroidal; grains size 23.0-25.0 μm in breadth -----14. *Avicennia officinalis*

Discussion and Conclusion

Pollen of 14 mangrove species in Sittway coastal area were observed with a binocular electric microscope. All the species are classified as true mangrove species. Most species belong to the Acanthaceae (4 species) followed by Primulaceae (2 species), Lythraceae (2 species), Arecaceae (1 species), Fabaceae (1 species), Rhizophoraceae (1 species), Euphorbiaceae (1 species), Aizoaceae (1 species) and Apocynaceae (1 species).

Pollen characters of mangrove species were studied, namely the ratio of polar/ equatorial (P/E), shape, size, outline, polar view, equatorial view, aperture and ornamentation.

The types of pollen grains found in the study were pollinia and monads; pollinia in only one species (*Vincetoxicum flexuosum* var. *tenuis*) and the rest species were monads.

With respect to the number of apertures, pollen may be classified as inaperturate and aperturate. In aperturate, the investigated pollens were sulcate, colpate, colpoate and porate. Disulcate aperture was found in *Nypa fruticans*; tricolpate was found in *Sesuvium portulacastrum*, *Aegiceras floridum* and *Acathus ilicifolius*; triporate was found in *Sonneratia apetala* and *Sonneratia caseolaris*; tricolporate was found in the rest species.

Based on the shape of equatorial view, angiosperms pollen can be grouped into 9 classes such as peroblate, oblate, subspheroidal, suboblate, oblate spheroidal, spheroidal, subprolate, prolate and perprolate (Erdtman, 1946 & Walker and Doyle, 1975). In this research, pollen shape was described by the polar axis and equatorial diameter ratio: spheroidal, subspheroidal, oblate spheroidal, oblate, suboblate, subprolate, prolate and perprolate were found.

Schoch-Bodmer (1940) has demonstrated that the size of pollen grains depends on the state of nutrition of the plant. Heese et al. (2009) and Halbritter et al. (2018) stated that pollen size varies less than 10 µm to more than 100 µm. In the present study, the large pollen size was found in *Aegiceras floridum*; medium was found in *Nypa fruticans*, *Ticanto crista*, *Sonneratia caseolaris* and *Vincetoxicum flexuosum* var. *tenuis* while the rest species were small grains.

In this study, variation in pollen grains outline was discovered, specifically obovate, rounded, rounded triangular, rounded hexagonal, ribbon shaped, triangular.

In palynology, ornamentation is applied to study the surface feature of pollen. Walker and Doyle (1975) stated that the sculpture patterns' appearance also varies significantly from one species to another. In this research, the sculpture patterns of the pollens were observed echinate, striate, gemmate, and various reticulate patterns.

In 2016, Cherry Aung conducted a research work on the mangrove of Myanmar and collected 44 species altogether; the study of mangrove Myanmar by draft, 2005 and he accomplished recordings 29 species. But this research is done on palynological study of some mangrove plants found in Sittway coastal areas. No one has yet worked on the pollen morphology of mangrove plants from Sittway coastal areas. The benefit of mangroves is improving the water quality flowing from rivers and streams into the estuaries and ocean environment. Therefore, mangrove scientists around the world are involved in studying pollen from different points of view and from different points of interest and practical uses.

The aim of the current study is to provide knowledge on pollen morphology of mangrove plants. The importance of pollen in environmental studies, ancient geography of the continents,

climate in certain places were also informed in this paper. It is sincerely hoped that the present study will support as a useful information for further studies and identification of families distributed in Myanmar.

Acknowledgements

We are greatly indebted to Dr Thet Thet Mar Win, Professor and Head, Department of Botany, University of Yangon for her kind permission to apply this paper.

References

- Britannica, (2023) *Pollen*. <https://www.britannica.com/science/pollen>. Accessed on 3 April 2023.
- Byng J.W., M.W. Chase, M.J.M. Christenhusz & M.F.Fay, (2016) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean society* 181: 1-20.
- Cherry Aung, (2016) The Status of mangroves in Ayeyarwady Region. Paper presented at symposium proceeding of third Japan –Myanmar joint Symposium, Patheingyi University.
- Dassanayake, M.D. (1980-2000) *A Revised Handbook to the Flora of Ceylon*, Vol 1-14. Washington, D. C., U. S. A.
- Draft, August' (2005) *Global Forest Resources Assessment 2005 Thematic Study on Mangroves*.
- Erdtman, G. (1946) Pollen morphology and plant taxonomy. VI. On pollen and spore formulae. *Svensk bot. Tidskr.* 40.
- Erdtman, G. (1952) *Pollen Morphology and Plant Taxonomy*, Angiosperms. Chron Bot. Co, Waltham, Massachusetts.
- Gilbert, G.M. (1994). *Flora of China*. 17: 1-49.
- Halbritter, H., S. Ulrich, F. Grímsson, M. Weber, R. Zetter, M. Hesse, R. Buchner, M. Svojtka, & A. Frosch-Radivo, (2018) *Illustrated Pollen Terminology*. 2nd ed. Switzerland: Springer.
- Hesse, M., H. Halbritter, R. Zetter, M. Weber, R. Buchner, A. Frosch-Radivo and S. Ulrich. (2009) *Pollen Terminology*. University of Vienna, Austria.
- Hundley, H. G. and Chit Ko Ko (1987) *List of Trees, Shrubs, Herbs and Principle Climbers of Myanmar*. Government Printing Press, Yangon.
- HU Qi-ming and WU Delin (SCBG), Hong Kong Herbarium (2007-2009) *Flora of Hong Kong*. (Vol 1-3), Agriculture, Fisheries and Conservation Department, Hong Kong.
- Punt, W., P. P. P. Hoen, S. Blackmore, S. Nilsson and A. Thomas (2007) Glossary of pollen and spore terminology. *Review of paleobotany and palynology*, 143(1-2): 1-81
- Saw Saw Khine (2015) *Taxonomic Study on Some Mangrove and Associate Mangrove Plants Grown in Yae Chan Pyin and Aung Min Galar Villages*.
- Schoch-Bodmer (1940) The influence of nutrition upon pollen grains in *lythrum* so *J.Genetics* 40.
- Walker, J.W. and J.A. Doyle, (1975) The base of angiosperm phylogeny: Palynology. *America Journal of Botany* 61; 891- 902 *Missouri Bot. Gard.* 62: 664-723.