

Palynological Studies on Certain Members of the Malvaceae Family in Rivers State, Nigeria

J.E. Udofia¹, B.O. Green², M.G. Ajuru^{3*}

^{1,2,3}Dept. of Plant Science and Biotechnology, Rivers State University, Nkpolu-Oroworuko, P.M.B. 5080, Port Harcourt, Rivers state, Nigeria

*Corresponding Author: ajurumercygospel@yahoo.com, Tel.: +2347036834588

Available online at: www.isroset.org

Received: 10/Aug/2020, Accepted: 13/Aug/2020, Online: 31/Aug/2020

Abstract—Palynological study was undertaken in five species *Hibiscus rosa-sinensis* L., *Abelmoschus esculentus* (L) Moench, *Abelmoschus caillei* (A.Chev.) Stevels, *Sida acuta* Burm. F. and *Sida rhombifolia* L. belonging to three genera of the family Malvaceae. The family Malvaceae, commonly known as the hibiscus, or mallow contain about 85 genera and 1500 species of herbaceous, shrubby, and tree plants. Representatives of this family can be found in all except the coldest parts of the world but are most abundant in the tropics. The aim was to establish some useful diagnostic pollen morphological features that may be employed in combination with other characters as inter-specific or generic tools for identification. Pollen samples were collected manually from mature closed anthers. Mature anthers were teased out in water in a petri dish for 5 minutes. Fixation of the pollen grain in 70% alcohol was undertaken, followed by decantation and rinsing to wash off the alcohol. The samples were placed on clean microscope slides. Another slide was used to tease out the content of the anther after which it was mounted in glicerol. The results revealed oblate to spheroidal pollen shape and pantoporate pollen class in all the studied species. Pollen diameter ranged from 139.01 μ m – 359.10 μ m. The largest pollen diameter was recorded in *A. esculentus* (359.10 μ m). All the species possessed spinous pollen and the longest spine was observed in *A. esculentus* (359.10 μ m) while spine index was highest in *A. caillei* (3.65 μ m) and lowest in *S. rhombifolia* (1.62 μ m). The information provided in this study may be useful in delimiting the family alongside other taxonomic markers and also in the preparation of the pollen flora of Nigeria.

Keywords— Malvaceae, pollen morphology, Nigeria, Spine index, Pollen diameter, Hibiscus, Abelmoschus, Sida

I. INTRODUCTION

The family Malvaceae, commonly known as the mallow family is estimated to contain about 85 genera with 1500 species [1]. The family is cosmopolitan in distribution with most of the species confined to the tropics and subtropics. 13 genera and 78 species have been recorded in West Africa [2]. *Hibiscus* is the largest genus in terms of number with about 300 species [3] and *Hibiscus rosa-sinensis* is the most popular while *Abelmoschus sp* is a common vegetable in Nigeria.

The Malvaceae are herbs, shrubs or lianas although there are some trees [4]. They can easily be recognized in the field by their funnel shaped flower with five separate petals and a distinct column of stamens surrounding the pistil. Their leaves are alternate with well developed stipules, petiolate with palmate venation [5]. A diagnostic feature of the family is the presence of a natural gum (mucilage, pectin and asparagines) which gives them a slimy texture when crushed. This feature is pronounced even in the dry desert species. The investigated species *Abelmoschus esculentus*, *Abelmoschus caillei*, *Hibiscus rosa-sinensis*, *Sida acuta* and *Sida rhombifolia* belong to

the division Magnoliophyta, class Magnoliopsida, subclass Dilleniidae, order Mavales and family Malvaceae.

The family has been investigated severally due to the great economic importance of some of its genera. Owing to the high fiber content, the Malvaceae family is of great economic importance throughout the world. Nearly all genera can produce some kind of fibres. The genus *Gossypium* is the source of the commercial cotton. After the removal of fiber, cotton seeds are used as fodder to feed cattle and the seed oil used for edible purposes while the oil cake is useful as good organic manure. *Abelmoschus esculentus*, *A. manihot*, *A. callei*, *Hibiscus sabderiffa* are eaten as vegetable in all the parts of the country. *Urena lobata*, *Hibiscus tiliaceus*, *Thespesia populnea* are good sources of wood and fiber. The roots of *Sida cordata* and *Hibiscus hispidissimus* are used in the treatment of urinary tract diseases [6, 7] due to their cooling, diuretic and anti-inflammatory properties. Many species are cultivated as ornamentals including the popular *Hibiscus rosa sinensis*, *H. mutabilis*, *H. radiates*, *Abutilon striatum*. Several species of the genera *Sida* and *Abutilon* are common weeds along road sides and equally serve as fodder for sheep and cattle.

Pollen morphology has in recent times played an important role in plant systematics and experimental taxonomy as documented by various researchers [8, 9, 10, 11]. Structural characters of pollen are of great taxonomic investigative importance [12] and are important in species identification in areas of evolution and often times in environmental restoration activities [13]. Pollen characters are more or less uniform [14]. [15] divided the family into six pollen types based on the number of apertures, pollen diameter and spinular morphology. However, the most comprehensive study conducted on pollen characters of the malvaceae family was carried out by [16]. Generic delimitation based on pollen morphology was termed difficult according to the findings. Prior to that, [17] had in his study concluded that pollen morphology can be used in the malvaceae family to distinguish species at the generic level owing to their distinctive characteristics. Emphasis were laid on the importance of the aperture and spine morphology as well as exine stratification to distinguish taxa.

In Nigeria, the pollen morphology of only a few genera of the family has been studied. This study is therefore aimed at bridging this gap by providing general knowledge of the palynology of these species as well as a comparison of the pollen morphology of different species of these three genera within the same family.

II. RELATED WORK

The authors [18, 19, 20] have worked on species of Malvaceae and also reported Spheroidal, oblate or globular shaped pollen grains as revealed in this study. Malvaceous pollen are characteristic for the extension of their exine into definite spines [19].

The author, [21], carried out a research on Palynological studies on some medicinal mallows from Punjab, India. He worked on the pollen grains of seven species of the family Malvaceae. From his results, it was recorded that the pollen grains are oblate spheroidal, porate with reticulate exine and are echinate. His study showed that palynological markers are useful in the identification and classification of the plant taxa in this family.

A study was also carried out by [22]. The research was based on Palyno-taxonomic study of nine members of Malvaceae in Purba Medinipur, West Bengal, India. The results showed that the pollen shape of the species were Oblate, Oblate-spheroidal, Subprolate and Per-oblate. He concluded that pollen morphology is one of the most significant tool for the taxonomic study as well as systematics of plant taxa in this family.

III. METHODOLOGY

Plant specimens were collected from different areas of Rivers state. Pollen samples were collected manually from mature closed anthers. Collected plant specimens were identified at the department of Plant Science and

Biotechnology herbarium of Rivers state University, Rivers state, Nigeria using field reference materials and relevant taxonomic literature. Voucher specimens were deposited in the herbarium of the Department.

The specimens were prepared following [23] simplified method. Mature anthers were teased out in water in a petri dish for 5minutes. Fixation of the pollen grain was followed by placing it in 70% alcohol for another 5minutes. This were decanted and rinsed several times in distilled water to wash off the alcohol. The pollen grains were stained with 1% safranin and mounted in glycerol on microscopic slide. A cover slip was placed on the pollen glycerol mixture and left to cool; the microscopic slide was labeled and edges of the cover slip sealed with nail polish. The prepared slides were studied under the light microscope. Pollen shape, pollen diameter, exine thickness, exine sculpturing, height of the spine, width of the spine at its base, spine index, inter-spinal distance and pore diameter were observed. Phytomicrographs of the pollen grain were taken. Pollen shape, class, spine description and aperture type were noted and pollen diameter, spine height and width were accurately measured.

IV. RESULTS AND DISCUSSION

Findings from the study of palynological characters in the five species are presented in Plate 1 and summarized in Table 1 below:

Hibiscus rosa sinensis

Pollen grains of *H. rosa sinensis* was globulose, pantoporate and colporate. The pollen diameter measured $173.54(211.43 \pm 10.66) 244.16\mu\text{m}$. The spines were short and straight with blunt apices. Spine height measured $19.86(28.11 \pm 3.68) 42.82 \mu\text{m}$ and the width measured $5.97(8.16 \pm 0.62) 9.63 \mu\text{m}$. The spine index recorded was 3.45.

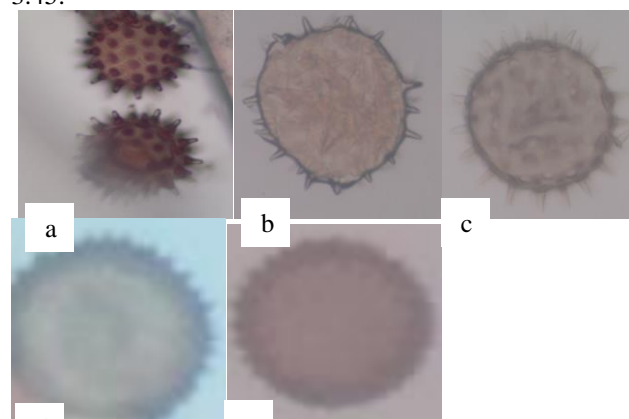


Figure 1. Pollen morphology of: a - *H. rosa sinensis*; b - *Abelmoschus caillei*; c - *A. esculentus*; d - *S. acuta*; and e - *Sida rhombifolia* L. X10

Abelmoschus caillei

Pollen grain of *A. caillei* was oblate-spheroidal, pantoporate and colporate. Pollen diameter measured $300.78(351.07 \pm 11.29) 370.82 \mu\text{m}$. Spines varied from straight to slightly bent with a height of

15.57(32.97±5.09)51.15 μm and a width of 5.97(9.04±0.89)11.94 μm . Spine index recorded 3.65.

Abelmoschus esculentus

Pollen of *A. esculentus* was spheroidal, pantoporate and colporate. The pollen diameter measured 307.04(359.10±22.66) 406.62 μm which was the largest pollen in all the studied species. The spines measured 26.71(44.13±3.11)56.66 μm in height and 11.01(11.16±1.52)21.33 μm in basal width. Spine index measured 2.74.

Sida acuta

Pollen grain of *S. acuta* was oblate-spheroidal, pantoporate and colporate. The Pollen diameter measured

126.22(152.22±8.02)175.53 μm . Spines were very short with height of 3.76(5.15±0.33)5.97 μm and width of 2.67(2.67±0)2.67 μm . Spine index recorded 1.92.

Sida rhombifolia

Pollen of *Sida rhombifolia* L. was spheroidal, pantoporate and porate. The pollen diameter measured 124.91(139.01±1.33) 142.93 μm making it the smallest pollen grain in all the studied taxa. Spines were almost inconspicuous and measured 2.00(2.35±0.11)2.67 μm in height and 1.00(1.45±0.14) 1.83 μm in width. Spine index was 1.62.

Table 1. Pollen Structures of the Studied Species.

Species	Pollen diameter (μm) Min(mean ±S.E)Ma	Spine length (μm) Min(mean ±S.E)Ma	Spine width(μm) Min(mean ±S.E)Ma	Spine index (μm)
<i>H. rosa sinensis</i>	173.54(211.43±10.66)244.16	19.86(28.11±3.68)42.82	5.97(8.16±0.62)9.63	3.45
<i>A. caillei</i>	300.78(351.07±11.29)370.82	15.57(32.97±5.09)51.15	5.97(9.04±0.89)11.94	3.65
<i>A. esculentus</i>	307.04(359.10±22.66)406.62	26.71(44.13±3.11)56.66	11.01(16.08±1.52)21.23	2.74
<i>S. acuta</i>	126.22(152.22±8.02)175.53	3.76(5.15±0.33)5.97	2.67(2.67±0)2.67	1.92
<i>S. rhombifolia</i>	134.91(139.01±1.33)142.93	2.00(2.35±0.11)2.67	1.00(1.45±0.14)1.83	1.62

Table 2.

Species	Pollen shape	Pollen Class	Spine description	Aperture shape
<i>H. rosa sinensis</i>	Oblate-spherical	Pantoporate	short Spines with blunt apice	Colporate
<i>A. caillei</i>	Oblate	Pantoporate	Long Spines with pointed apice	Colporate
<i>A. esculentus</i>	Spheroidal	Pantoporate	Long Spines with pointed apice	Colporate
<i>S. acuta</i>	Spheroidal	Pantoporate	short Spines	Porate
<i>S. rhombifolia</i>	Spheroidal	Pantoporate	short Spines	Porate

Min= Minimum, S.E= Standard error, Ma= Maximum

Discussion

Pollen morphology of the studied species showed considerable variations indicating that the parameter can be used in distinguishing the species. Generally, pollen shape was observed to be spheroidal or oblate and spinous, possessing spines of different heights and description. This agrees with the findings of [16, 18, 19], that pollen grains are more or less uniform in the Malvaceae family. However, the variations in the pollen diameter proves that it can serve as a useful tool in distinguishing species at the generic level [14].

Pollen diameter varied between 126.22 μm – 406.62 μm . The maximum diameter was observed in *A. esculentus*(359.10 μm) followed by *A. caillei*, *H. rosa sinensis*, *S. acuta* and the minimum size in *S. rhombifolia*. This result contradicts that reported by [14] that *Hibiscus* pollen are the largest in the family whereas *A. esculentus* is reported here to be larger. [20] did not agree with [14] findings also. However, his other results are in line with those confirmed in this study. The variations in pollen size is considered to be an index to variation in the number of chromosomes and proven to be of value in cytological studies [24].

Spheroidal and oblate shapes were observed in the study. This findings are in accordance with [18, 19, 20] that pollen of the family are generally round, spheroidal or globular. [25, 26] have opined that pollen shape is taxonomically less useful due to its variation even within species. They attributed this fact to the method of extraction or the media used. Malvaceous pollen are characteristic for the extension of their exine into definite spines [19]. Spine types were monomorphic for all the studied species indicating only one form. *A. esculentus* recorded the longest spine of 26.71(44.13 ± 3.11) 56.66 and a width of 11.01(16.08 ±), while the *S.rhombifolia* had the shortest spine of length 2.00(2.35 ± 0.11) 2.67 and width 1.00(1.45 ± 0.14) 1.83. The size of the spine appears to be directly proportional to the pollen size such that larger pollen had longer spines and vice versa. [6] reported that spine index was significant in clearly differentiating the genera *Alceae* and *Althaea* in Pakistan especially at the intrageneric level. Spine index was highest in *A.caillei* (3.62) and lowest in *S. rhombifolia* (1.62).

V. CONCLUSION AND FUTURE SCOPE

Pollen morphology is one of the most significant tool for taxonomic study as well as systematics of plant taxa in this family, as seen from this study.

The extension of the exines into spines in all the studied species justifies their placement in the same family. However variations in pollen diameter observed are of taxonomic importance and can be useful in distinguishing the species. Spine height and width are also diagnostic at the generic level. This study showed that palynological markers are useful in the identification and classification of the plant species in this family. The information provided in this study may be useful in delimiting the family alongside other taxonomic markers such as phytochemistry, anatomy, cytology and morphology and also in the preparation of the pollen flora of Nigeria.

REFERENCES

- [1] M.J. Christenhusz, J.W. Byng, "The number of known plants species in the world and its annual increase," *Phytotaxa. Magnolia Press*. Vol. **261**, Issue **3**, pp. **201-217**, **2016**
- [2] B.O. Green, "Principles of Angiosperm Taxonomy (2nd Ed.),". Osia Int'l Publishers Ltd. **Diobu, Port Harcourt, Nigeria**, pp. **40-67**, **2015**
- [3] W.S. Judd, C.S. Campbell, E.A. Kellogg, P.F. Stevens, M.J. Donoghue, "Plant Systematics : A Phylogenetic Approach. (Third Ed.)," pp. **43-60**, **2008**
- [4] V.H. Heywood, "Flowering plants of the World," Andromeda **Oxford Ltd**, pp. 34-50, 1979.
- [5] C. Bayer, M.F. Fay, A. Y. .Bruijin, V. Savolainen, C.M. Morton, K. Kuitzki, W.S. Alverson, M.W. Chase, "Support for an expanded family concept of Malvaceae within a recircumscribed order Malvales: A combined analysis of plastid atpB and rbcL DNA sequences," *Botanical Journal of the Linnean Society*. Vol. **129**, pp. **267-303**
- [6] N. Shaheen, M.A. Khan, G. Yasmin, M.Q. Hayat, "Pollen morphology of 14 species of Abutilon and Hibiscus of the family Malvaceae (sensu stricto)," *Journal of medicinal plants Resource*, Vol. **3**, Issue **11**, pp. **921-929**, **2009**.
- [7] D.L. Dilcher, "Approaches to the identification of Angiosperms," *Botanical Journal of Linnean Society*, Vol. **80**, **91-124**, **1974**.
- [8] L.W. Cranwell, "Newzealand Pollen Studies. The monocotyledons," *Bulletin of Auckland Institute Museum*, Vol. **3**, pp. **1-91**, **1952**
- [9] G. Erdtman, "Pollen Morphology and Plant Taxonomy," *Angiosperms, Almqvist and Wiksell, Stockholm*, pp. **539**, **1952**
- [10] A. Perveen, M. Qaiser, "Pollen Flora of Pakistan; Malvaceae Dombeyoideae -Lxii., Pakistan," *Journal of Botany*, Vol. **41**, pp. 491-494, 2009
- [11] C. Paramjeet, "Palynological studies on some medicinal mallows from Punjab, India," *Annals of Plant Sciences*, Vol. **7**, Issue **3**, pp. **2166 - 2169**, **2018**.
- [12] F.N. Mbagwu, E.G. Chime, C.I. Unamba, "Palynological studies on five species of Asteraceae," *Journal of Plant Science*, Vol. **3**, pp. **126 - 129**, **2008**.
- [13] O.E. Ige, "A late tertiary pollen record from Niger Delta, Nigeria," *International Journal of Botany*. Vol. **5**, pp. **203 - 215**, **2009**.
- [14] S.M. El-Naggar, N. Sawady, "Pollen morphology of malvaceae and its taxonomic significance in Yemen," *Journal of Botany*, **18**: 431-439, 2008
- [15] K.J. Culhane, G.C. Blackmore, "Malvaceae. In: the NorthWest," *European Pollen Flora*, Vol. **41**, pp. **45- 79**, **1988**.
- [16] P.B. Christensen, "Pollen morphological studies in the Malvaceae," *Grana*, Vol. **25**, pp. **95 - 117**, **1986**.
- [17] S.I. Saad, "The sporoderm stratification in Malvaceae," *Pollen Et Spore*, **2**: **13-41**, **1960**.
- [18] A. Perveen, M. Qaiser, "Pollen flora of Pakistan- Malvaceae Dombeyoideae - Lxii.," *Pakistan Journal of Botany*, Vol. **41**, pp. **491 - 494**, **2009**.
- [19] S.M. El Naggar, "Pollen morphology of Egyptian Malvaceae: an assessment of taxonomic value," *Turkish Journal of Botany*, Vol. **28**, pp. **227-280**, **2003**
- [20] N. Bibi, N. Akhtar, M. Hussain, K.M. Ajab, "Systematic implication of pollen morphology in the family Malvaceae from North West Frontier Province Pakistan. *Pakistan Journal of Botany*, Vol. **42**, Issue **4**, pp. **2205 - 2214**, **2010**.
- [21] P. Cheema, "Palynological studies on some medicinal mallows from Punjab, India," *Annals of Plant Sciences*, Vol. **7**, Issue **3**, pp. 2166-2169, 2018
- [22] S. K. Maity, A. Patra, B. Pal, A. Malakar, "Palyno- taxonomic study of some members of Malvaceae in Purba Medinipur, West Bengal, India," *Annals of Plant Sciences*, Vol. **7**, Issue **2**, pp. 2069-2072, 2018
- [23] J. Mangaly, J. Najor, "Palynology of South Indian, Zingiberaceae," *Botanical Journal of the Linnean Society*, Vol. **4**, Issue **103**, pp. **351 - 366**, **1990**.
- [24] K.G. Lakshmi, "Palynological studies on certain Malvales. *Ph.D. Thesis*, Mhatma Gandhi University, **India**, pp. **56**, **2003**
- [25] P.H. David, V.H. Heywood, "Principles of Angiosperms Taxonomy," Van Nostrand, Princeton, **New Jersey**, pp. **3-45**, **1963**
- [26] P.D. Moore, J.A. Webb, M.E. Collinson, "Pollen Analysis, Blackwell scientific publication, **London**, pp: **216**, **1991**.

AUTHORS PROFILE

Jane Effiong Udofia pursued her B.Sc. in Botany from University of Calabar, Cross River State, Nigeria in 2015; MSc in Plant Taxonomy and Biosystematics from the Rivers State University, Rivers State, Nigeria in 2019. She is a member of BOSON since 2015. She is in the process of becoming a lecturer in the Department of Plant Science and Biotechnology, Faculty of Science, Rivers State University, Port Harcourt, Rivers State, Nigeria. She has attended conferences. Her main research work focuses on Plant Taxonomy, Plant Palynology, Plant Anatomy and Gross Morphology

Blessing Oparite Green pursued her B.Sc. in Botany, MSc. and PhD. in Plant Taxonomy and Biosystematics from the University of Port Harcourt, Rivers State, Nigeria. She is currently a Professor of Plant Taxonomy in the Department of Plant Science and Biotechnology, Faculty of Science, Rivers State University, Port Harcourt, Rivers State, Nigeria. She is a member of BOSON, STAN, etc, since 2000. She has published more than 60 research papers in highly indexed international journals and attended conferences. Her main research work focuses on Plant Taxonomy, Biosystematics, Phytochemistry, Plant Anatomy, Plant Palynology and Gross Morphology. She has put in 20 years of teaching and research experience.

Mercy Gospel Ajuru pursued her B.Sc. in Botany from University of Uyo, Uyo, Akwa Ibom State, Nigeria in 1999; MSc. and PhD. Plant Taxonomy and Biosystematics from the University of Port Harcourt, Rivers State, Nigeria in 2009 and 2014. She is currently working as a Senior Lecturer in the Department of Plant Science and Biotechnology, Faculty of Science, Rivers State University, Port Harcourt, Rivers State, Nigeria since 2010. She is a member of BOSON, OWSD, Science Alert, STAN since 2010. She has published more than 35 research papers in international journals with high index factor and attended conferences. Her main research work focuses on Plant Taxonomy, Phytochemistry, Medicinal Plants, Ethnobotany, Plant Anatomy and Gross Morphology. She has put in 10 years of teaching and research experience.