

POLLEN MORPHOLOGY OF SOME HERBACEOUS FLORA OF SALT LAKE CITY,
WEST BENGAL

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A B S T R A C T

Pollen morphology of 30 plant species collected from Salt Lake City area has been examined for the present study. Most of these species are new entrants in terms of plant succession after reclamation of saline swampy low land area of the present day greater Calcutta by dredged silt from Hooghly river. Pollen morphology shows a heterogeneous assemblage of morphoforms. Pollen dimorphism is also observed in some species. This study will be very much helpful in correlation of sedimentary samples of the area towards better understanding of past and present vegetation.

INTRODUCTION

Salt Lake City, the eastern garden suburb of Calcutta was a swampy and low land area once used to be the bed of the river Bidyadhari. The City lies between 88°10' and 88°40' E., longitude and between 22°20' and 22°45' N., latitude at the north eastern part of Calcutta within the limits of the district 24-Parganas. In fact, Salt Lakes were low-lying saucer-shaped 'beel' areas, which were lower than the adjoining drainage channels and formed of a considerable number of depressions filled with saline water surrounded by or alternating with extensive stretches of marshy lands. These were gradually filled up to a higher level by dredged soil and silt from the river Hooghly being dredged and pumped to the Salt Lakes through pipeline via a number of pumping stations. Reclamation of these swampy areas was taken up in 1962 at the initiative of Dr. B.C. Roy, the then Chief Minister of West Bengal to enable Calcutta Metropolis to expand

eastwards for accommodation of the additional population that began to congest the city. The total area reclaimed so far is 12.35 sq. km. which is equivalent to one-seventh of the existing Calcutta proper (Anonymous, 1981, Map-I). The area is still under development by the Salt Lake City Authority. In the meantime, after reclamation a good number of plants, mostly herbaceous, have appeared in this area. Subsequently, some selected trees and shrubs have been planted to beautify the city. The soil of this city is sandy and the flora is somewhat distinct and different from the flora of Calcutta and neighbouring district due to slightly different ecological, meteorological and lithological factors. In the Salt Lake City the occurrence of a large number of xerophytic plants indicate its physiological dry condition for salinity. But it is obvious that in course of gradual urbanisation, the uncared herbaceous flora will be wiped out from the city in future. During the course of this work, the authors collected several important herbaceous

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plants of different families growing in the waste places of the area. This study will be of much help for correlation of past and present flora of the Salt Lake City as well as greater Calcutta.

Pollen analysis of sedimentary samples helps us to reconstruct pollen diagram which provide a picture of the past vegetation of the area (Nayar, 1990). Since, pollen grains are indicators of species components in a vegetation, dominance or absence of pollen grains in pollen diagram can be correlated to deduce a general picture of dominant habitats prevailed during a particular period like the distributional pattern of forest trees, scrub elements or components in a grass land vegetation and so on. Changes in palynostratigraphy normally correspond to changes in vegetational succession. In certain cases pollen analysis has so faithfully reflected the climatic conditions that it has been found useful in explaining the cause of desertification and providing resolutions for various desert problems.

In view of the above understanding, the pollen morphology of some herbaceous dicotyledonous plants commonly growing at Salt Lake City during May to June has been studied so that their existence in that city may be recovered from the soil deposits when they will be exterminated in near future. In addition, an attempt has also been made to correlate them taxonomically in the context of pollen characters.

REVIEW OF LITERATURE

In 1973, Das Gupta reported 97 species of angiosperms belonging to 41 different families from a part of Salt Lake area as a systematic enumeration.

In an attempt, Pal and Paria (1986) carried out an investigation to provide clues to the systematic position of three economically important members of the pedaliaceae (*s.l.*) with special reference to their pollen affinity. An emphasis was placed by the authors on the occurrence of these taxa in Salt Lake City which in turn indicated a similar habitat

condition of these plants, *i.e.* the occurrence in dry and coastal areas. Banik *et al.* (1986) worked on the pollen flora of Dum Dum and the adjacent areas of West Bengal with reference to the identification of dispersed palynomorphs.

Literature reveals that various attempts were made in the past by many workers to study the pollen morphology of different areas or from different approaches. But none of them represented a comprehensive account or even fragmentary account of the pollen morphological diversity prevailing in the Salt Lake area. In view of that, it was decided to consider this area in part for a pollen morphological investigation. For the present study authors consider monsoon herbaceous flora of the area.

MATERIALS AND METHOD

Specimens collected for the present study have been housed in the Herbarium of the Deptt. of Botany, Calcutta University. List of voucher specimens has been appended in the Table-I. For palynological study polliniferous materials were collected from the field collections (fresh) in respective reference of voucher. For palynological preparation both fresh & herb., materials were used. Pollen slides have been prepared by acetolysis method (Erdtman, 1960). The slides have been deposited in the Calcutta Univ. Herbarium and in the sporotheca, Palynology Laboratory of the Central National Herbarium (CAL). Observations were made with Leitz microscope with apochromatic objective $100 \times$ n.h.m. ap. 1.25, eyepiece periplan GF 10×18 were used. Measurements were taken using oil-immersion objectives $\times 100$, Mean of 25 readings was considered for measurements. Photomicrographs were taken using Leitz binocular research microscope and Wild MPZ 12 Camera attachment and Leitz Diaplan microscope filled with wide photoautomat MPS 45. Pollen morphological terminology was used as per Faegri & Iversen (1950) and Erdtman (1968). Magnification for SEM is given along with the Plates/Figures.

Table 1 : List of the plants treated in the investigation

Sl. No.	Name of the plant	Family	Date of collection	Locality
1.	<i>Justicia simplex</i> Don	Acanthaceae	2.6.95	SL - LB
2.	<i>Ruellia tuberosa</i> Linn.	Acanthaceae	20.5.95	SL - KC
3.	<i>Tridax procumbens</i> Linn.	Asteraceae (Compositae)	28.5.95	SL - CP
4.	<i>Cleome gynandra</i> Linn. [Syn. <i>Gyandropsis pentaphylla</i> (Linn.) DC.]	Capparidaceae	10.6.95	SL - ST
5.	<i>Cleome rutidosperma</i> DC.	Capparidaceae	20.5.95	SL - KC
6.	<i>Cleome viscosa</i> Linn.	Capparidaceae	20.5.95	SL - GV
7.	<i>Ipomoea pes-caprae</i> (Linn.) R.Br.	Convolvulaceae	20.5.95	SL - KC
8.	<i>Ipomoea pes-tigridis</i> Linn.	Convolvulaceae	17.6.95	SL - BB
9.	<i>Ipomoea purpurea</i> Lamk.	Convolvulaceae	10.6.95	SL - (IA)
10.	<i>Mukia maderaspatana</i> (Linn.) Roem. [Syn. <i>Mukia scabrella</i> (L.f.) A.]	Cucurbitaceae	20.5.95	SL - KC
11.	<i>Hyptis suaveolens</i> Poit	Lamiaceae (Labiatae)	10.6.95	SL - (IA)
12.	<i>Leucas aspera</i> Spreng.	Lamiaceae (Labiatae)	10.6.95	SL - (IA)
13.	<i>Hibiscus vitifolius</i> Linn.	Malvaceae	28.5.95	SL - CP
14.	<i>Sida rhombifolia</i> Linn.	Malvaceae	12.6.95	SL - GV
15.	<i>Crotalaria pallida</i> Klotz.	Papilionaceae	8.6.95	SL - (CA)
16.	<i>Crotalaria verrucosa</i> Linn.	Papilionaceae	1.6.95	SL KM
17.	<i>Tephrosia purpurea</i> (Linn.) Pers. (Syn. <i>Tephrosia hamiltonii</i> Drumm. ex Gamble)	Papilionaceae	28.5.95	SL - CP
18.	<i>Passiflora foetida</i> Linn.	Passifloraceae	12.6.95	SL - BARC
19.	<i>Martynia annua</i> Linn. (Syn. <i>Martynia diandra</i> Glox.)	Pedaliaceae	10.6.95	SL (IA)
20.	<i>Pedaliium murex</i> Linn.	Pedaliaceae	10.6.95	SL - (IA)

Sl. No.	Name of the plant	Family	Date of collection	Locality
21.	<i>Sesamum orientale</i> Linn. (Syn. <i>Sesamum indicum</i> Linn.)	Pedaliaceae	2.6.95	SL - LB
22.	<i>Portulaca oleracea</i> Lnn.	Portulacaceae	1.6.95	SL KM
23.	<i>Lindenbergia muraria</i> (Roxb. ex D. Don) Bruehl (Syn. <i>Lindenbergia urtic- aefolia</i> Lehm.)	Scrophulariaceae	25.6.95	SL - (CA)
24.	<i>Nicotiana plumbaginifolia</i> Viv.	Solanaceae	8.6.95	SL - (CA)
25.	<i>Physalis minima</i> Linn.	Solanaceae	17.6.95	SL - BB
26.	<i>Solanum nigrum</i> Linn.	Solanaceae	28.5.95	SL - CP
27.	<i>Solanum sisymbriifolium</i> Lamk.	Solanaceae	25.6.95	SL (AA)
28.	<i>Triumfetta rhomboidea</i> Jacq.	Tiliaceae	10.6.95	SL - (IA)
29.	<i>Kallstroemea pubescens</i> (G. Don) Dandy	Zygophyllaceae	17.6.95	SL - BB
30.	<i>Tribulus lanuginosus</i> Linn. (Syn. <i>Tribulus terrestris</i> auct. non Linn.)			

Abbreviations used :

BARC = Adjacent to Bhava Atomic Research Centre;	KM = Karunamoyee;
BB = Banabitan;	LB = Laboni ;
CP = Central Park;	SL. (..) = Salt Lake (Block No.);
	ST = Adjacent to stadium.

POLLEN MORPHOLOGY OF THE TAXA STUDIED
ACANTHACEAE

Justicia simplex Don

Pollen grains prolate, isopolar, bilaterally symmetrical, $P \times E = 22-25 \mu\text{m} \times 15-18 \mu\text{m}$. Trizonicolporate. Colpi long, L/B of colpus $15-16/1-2 \mu\text{m}$; Ora lalongate, L/B of os $1/2-2.5 \mu\text{m}$. Mesocolpium $3-5 \mu\text{m}$, apocolpium diam. $2-3 \mu\text{m}$.

Exine $3 \mu\text{m}$ thick, thickness of sexine $1-2 \mu\text{m}$ and nexine $1 \mu\text{m}$, sexine thicker in mesocolpium region. Surface ornamentation micro-reticulate.

Ruellia tuberosa Linn.

Pollen grains spheroidal, radially symmetrical. (Diameter ranges from $62-71 \mu\text{m}$). Tricolporate, colpi not exceeding up to poles.

Exine $6 \mu\text{m}$ thick, sexine pilate in optical section, thickness of sexine and nexine $4 \mu\text{m}$ and $2 \mu\text{m}$ respectively. Supra-ectal processes present, muri composed of compact bacular heads. Pila heads form reticulate surface ornamentation.

ASTERACEAE

Tridax procumbens Linn.

Pollen grains oblate-spheroidal, isopolar, radially symmetrical, $P \times E = 35-36 \mu\text{m} \times 40-42 \mu\text{m}$. Tetrazonicolporate, colpi elliptic, $10.5 \mu\text{m}$ long, $4-5 \mu\text{m}$ wide at equator, tapering at the poles, tips acute, Ora lalongate L/B of os $10.5-11 \mu\text{m}/1-3 \mu\text{m}$. Mesocolpium $16-17 \mu\text{m}$, apocolpium diam. $5.5-8 \mu\text{m}$.

Exine $3-4 \mu\text{m}$ thick; thickness of sexine and nexine $1-1.5 \mu\text{m}$ and $2-2.5 \mu\text{m}$ respectively. Surface ornamentation echinate; spines narrowly triangular in outline, $6-7 \mu\text{m}$ long, $3-4 \mu\text{m}$ broad at base, interspinal distance $3-4 \mu\text{m}$.

CAPPARIDACEAE

Cleome gynandra Linn.

Pollen grains prolate, isopolar, radially symmetrical, peritreme in equatorial view. Subcircular in polar view $P \times E = 20-21 \mu\text{m} \times 13-14 \mu\text{m}$. Trizonicolporate; colpi long, L/B of colpus $14-15/2-2.5 \mu\text{m}$, tapered at both ends, tenuimarginate; Ora

lalongate (L/B of os $1-1.2/4-4.5 \mu\text{m}$). Mesocolpium $3-4 \mu\text{m}$ and apocolpium diam. $2.5-3 \mu\text{m}$.

Exine $1.5-2 \mu\text{m}$ thick, sexine and nexine of equal thickness. Surface ornamentation micro-reticulate.

Cleome rutidosperma DC.

Pollen grains prolate, isopolar, radially symmetrical, peritreme, in equatorial view. Subcircular in polar view $P \times E = 21-22 \mu\text{m} \times 13-14 \mu\text{m}$. Trizonicolporate; colpi long, L/B of colpus $17/2 \mu\text{m}$, tip tapered at both ends, Margo colpate, Ora lalongate (L/B of os $1.5/4-4.5 \mu\text{m}$). Mesocolpium $5 \mu\text{m}$ and apocolpium diam. $2.5-3 \mu\text{m}$.

Exine $1.5-2 \mu\text{m}$ thick; sexine and nexine of equal thickness. Surface ornamentation micro-reticulate.

Cleome viscosa Linn.

Pollen grains prolate isopolar, radially symmetrical in equatorial view. Subcircular in polar view $P \times E = 26-30 \mu\text{m} \times 14-15 \mu\text{m}$. Trizonicolporate; colpi long L/B of colpus $23-24/2-2.5 \mu\text{m}$, tip tapered at both ends; Ora lalongate (L/B of os $3-4/6 \mu\text{m}$). Mesocolpium $5 \mu\text{m}$ and apocolpium diam. $5-6 \mu\text{m}$.

Exine $1.5 \mu\text{m}$ thick; sexine thicker than nexine, sexine $1 \mu\text{m}$ and nexine $0.5 \mu\text{m}$ thick. Surface ornamentation finely reticulate.

CONVOLVULACEAE

Ipomoea pes-caprae (Linn.) R.Br.

Pollen grains spheroidal isopolar, radially symmetrical, diameter ranges from $100-105 \mu\text{m}$. Pantoporate, diameter of pore $9-10 \mu\text{m}$. Interporal distance $8-11 \mu\text{m}$.

Exine $4-6 \mu\text{m}$ thick, crassinexinous, spiniferous (echinate). Spines broad at base, gradually tapering towards the apex with more or less rounded tips. Length of spine $18-20 \mu\text{m}$ and breadth at base $13 \mu\text{m}$. Surface ornamentation microreticulate.

Ipomoea pes-tigridis Linn.

Pollen grains spheroidal, isopolar, radially symmetrical, diameter ranges from $80-88 \mu\text{m}$. Pantoporate, diameter of pore $4-5 \mu\text{m}$. Interporal distance $8-10 \mu\text{m}$.

Exine 4-6 μm thick, spiniferous. Spines short, length about 9 μm , broad at base, with a rounded tip. Surface ornamentation micro reticulate.

***Ipomoea purpurea* Lamk.**

Pollen grains spheroidal isopolar, radially symmetrical, diameter ranges from 75-84 μm . Pantoporate. Diameter of pore 4.5-5 μm . Interporal distance 12-14 μm .

Exine 4-6 μm thick, crassinexinous and spiniferous. Spines bulbous and broad at base, gradually tapering towards the apex with a blunt tip. Length of spines 10-12 μm and breadth at base 4-5 μm . Surface ornamentation finely reticulate.

CUCURBITACEAE

***Mukia maderaspatana* (Linn.) Roem.**

Pollen grains oblate-spheroidal isopolar, radially symmetrical, $P \times E = 40-42 \mu\text{m} \times 47-50 \mu\text{m}$. Subtriangular in polar view $53 \times 57 \mu\text{m}$ across. Trizonicolporate. Brevicolpate, L/B colpus 6-8/2 μm . Mesocolpium 42-45 μm and apocolpium diam. 40-45 μm .

Exine 2 μm thick, sexine and nexine of equal thickness. Surface ornamentation finely reticulate.

LAMIACEAE

***Hyptis suaveolens* Poit.**

Pollen grains prolate-spheroidal, isopolar, radially symmetrical, $P \times E = 45-50 \mu\text{m} \times 38-45 \mu\text{m}$. Trizonicolporate; colpi narrowly elliptic, L/B of colpus 26/2 μm . Mesocolpium 10 μm and apocolpium diam. 2-3 μm .

Exine 2-3 μm thick; sexine and nexine of equal thickness. Surface ornamentation faintly reticulate.

***Leucas aspera* Spreng.**

Pollen grains prolate, isopolar, bilaterally symmetrical. Subcircular in polar view $P \times E = 25-27 \mu\text{m} \times 15-17 \mu\text{m}$. Trizonicolporate; colpi long, L/B of colpus 22/1 μm , narrowly elliptic, tips acute. Mesocolpium 9 μm and apocolpium diam. 2-3 μm .

Exine 1.5-2 μm thick; sexine and nexine of equal thickness. Surface ornamentation psilate obscure.

MALVACEAE

***Hibiscus vitifolius* Linn.**

Pollen grains spheroidal, isopolar, radially symmetrical, diameter ranges from 100-107 μm . Pantoporate; pores distantly placed, diameter of pores 6-7 μm , interporal distance 12-17 μm .

Exine tectate, 5-7 μm thick. Sexine 2-3 μm and nexine 3-4 μm thick. Surface ornamentation micro-reticulate. Ectine surface echinate, spines beset into sexine layer. Spine tip blunt, length of spine 20-21 μm and breadth 4-5 μm . Interspinal distance 16-17 μm .

***Sida rhombifolia* Linn.**

Pollen grains spheroidal, isopolar, radially symmetrical, diameter ranges from 80-87 μm . Pantoporate, pores radially arranged, diameter of pores 5-6 μm , interporal distance 17-20 μm .

Exine tectate, thickness 11.5 μm , sexine 8.5 μm and nexine 3 μm , micro-reticulate. Ectine surface echinate, basal cushion of excrescence system high and sharply defined, columella fused. Spines sharp, length of spines 8-9 μm and breadth at base 6-6.5 μm .

PAPILLIONACEAE

***Crotalaria pallida* Klotz.**

Pollen grains prolate, isopolar, bilaterally symmetrical. More or less triangular in polar view $P \times E = 23-27 \mu\text{m} \times 15-17 \mu\text{m}$. Trizonicolporate; colpi long L/B of colpus 21/1.5 μm , colpi margin parallel reaching the poles. margo colpate, Margo 1-1.25 μm thick. Ora circular, diameter of os 2.5 μm . Mesocolpium 9-10 μm and apocolpium diam. 6-6.5 μm .

Exine 1 μm thick; sexine and nexine indistinguishable. Surface ornamentation obscure faintly reticulate.

***Crotalaria verrucosa* Linn.**

Pollen grains prolate isopolar, bilaterally symmetrical, circular in polar view $P \times E = 36-40 \mu\text{m} \times 20-24 \mu\text{m}$. Trizonicolporate, colpi long, L/B of colpus 30/3 μm , margin parallel reaching the poles, margo colpate. Ora circular, diameter of os 3 μm . Mesocolpium 11-14 μm and apocolpium diam. 8-9 μm .

Exine 2 μm thick. Sexine and nexine indistinguishable. Surface ornamentation psilate.

***Tephrosia purpurea* (Linn.) Pers.**

Pollen grains prolate-spheroidal, isopolar, radially symmetrical, peritreme. Subcircular in polar view. $P \times E = 24-25 \mu\text{m} \times 22-23.5 \mu\text{m}$. Trizonicolporate, colpi long, L/B of colpus 20/1 μm , tenuimarginate, margo 0.5 μm thick. Ora circular, os 3.5 μm in diameter. Mesocolpium 6-7 μm and apocolpium diam. 10-11 μm .

Exine 2 μm thick, sexine and nexine of equal thickness. Surface ornamentation psilate.

PASSIFLORACEAE

***Passiflora foetida* Linn.**

Pollen grains spheroidal, radially symmetrical, diameter 38-40 μm . Some heteromorphic pollen grains are also observed. Aperture not discernible. Supratectal process present, Curvimurate; muri simplibaculate and lumina beset with great number of baculoid roads.

Exine semi-tectate, 4-5 μm thick. Sexine psilate; thickness of sexine and nexine 3 μm and 1-2 μm respectively. Surface ornamentation reticulate.

PEDALIACEAE

***Martynia annua* Linn.**

Pollen grains spheroidal, radially symmetrical diameter 60-65 μm inaperturate. Intectate, surface divided into hexagonal or pentagonal, convex, reticulate areas separated by smooth rugoid streaks.

Exine 3-4 μm thick; sexine 2-3 μm and nexine 1 μm in thickness.

***Pedaliium murex* Linn.**

Pollen grains oblate-spheroidal, isopolar, bilaterally symmetrical, peritreme, $P \times E = 67-69 \mu\text{m} \times 71-73 \mu\text{m}$. Circular in polar outline $\pm 85 \mu\text{m}$ across. 7-colpate (?); colpi long, L/B of colpus 28/2 μm , tips acute, tenuimarginate. Mesocolpium 11-12 μm and apocolpium diam. 25-28 μm .

Exine 5.5-6 μm thick, punctitectate, thickness of sexine and nexine 4-5 μm and 1-1.5 μm respectively. Surface ornamentation micro-reticulate.

***Sesamum orientale* Linn.**

Pollen grains subprolate, isopolar, bilaterally symmetrical, peritreme, $P \times E = 70-72 \mu\text{m} \times 67-68 \mu\text{m}$. Circular in polar outline, 75 $\times$ 75 μm across. 11-13 colpate, ends pointed, tenui-marginate. Colpi long, L/B of colpus 32-34/2-4 μm . Mesocolpium 8 μm and spocolpium diam. 32-35 μm .

Exine tectate, tectum $\pm 3.5 \mu\text{m}$ thick, tenui-sexinous provided by a thin sexine (1 μm) and thick nexine (3 μm); verrucate, shown in optical section.

PORTULACACEAE

***Portulaca oleracea* Linn.**

Pollen grains subprolate, isopolar, bilaterally symmetrical, $P \times E = 68-72 \mu\text{m} \times 52-56 \mu\text{m}$. Polar outline circular, 58 $\times$ 58 μm across. 6-colpate; colpi faint, arranged in penta to hexagonal pattern, 11-14 μm long, 2 μm width at middle, ends tapering to acute tips.

Exine 3-4 μm thick, sexine 2 μm and nexine 1 μm thick. Sculpturing spinules; spinulose 1 μm long. Surface ornamentation micro-reticulate.

SCROPHULARIACEAE

***Lindenbergia muraria* (Roxb. ex D.Don) Bruehl**

Pollen grains prolate isopolar, radially symmetrical, peritreme, $P \times E = 21-23 \mu\text{m} \times 11-12 \mu\text{m}$. Trizonicolporoidate; colpi long, L/B of colpus 15-16/1.5-2 μm , colpi tip tapered at both ends. Ora indistinct. Mesocolpium 2 μm and apocolpium diam. 3-3.5 μm .

Exine 1.5 μm thick; sexine 1 μm and nexine 0.5 μm thick. Surface ornamentation micro-reticulate.

SOLANACEAE

***Nicotiana plumbaginifolia* Viv.**

Pollen grains oblate-spheroidal, isopolar, radially symmetrical, dimorphic, peritreme. Semiangular in polar view, $P \times E = 24-25.5 \mu\text{m} \times 26-27 \mu\text{m}$. Tri- and tetrazonicolporate, colpi long, L/B of colpus 16.5/3 μm , ends of colpi acute. Os circular, diameter 3-3.5 μm . Mesocolpium 8-9 μm and apocolpium 4-4.5 μm .

Exine semi-tectate, thickness 2-2.5 μm ; sexine and nexine not clearly demarcated. Surface ornamentation striatoreticulate.

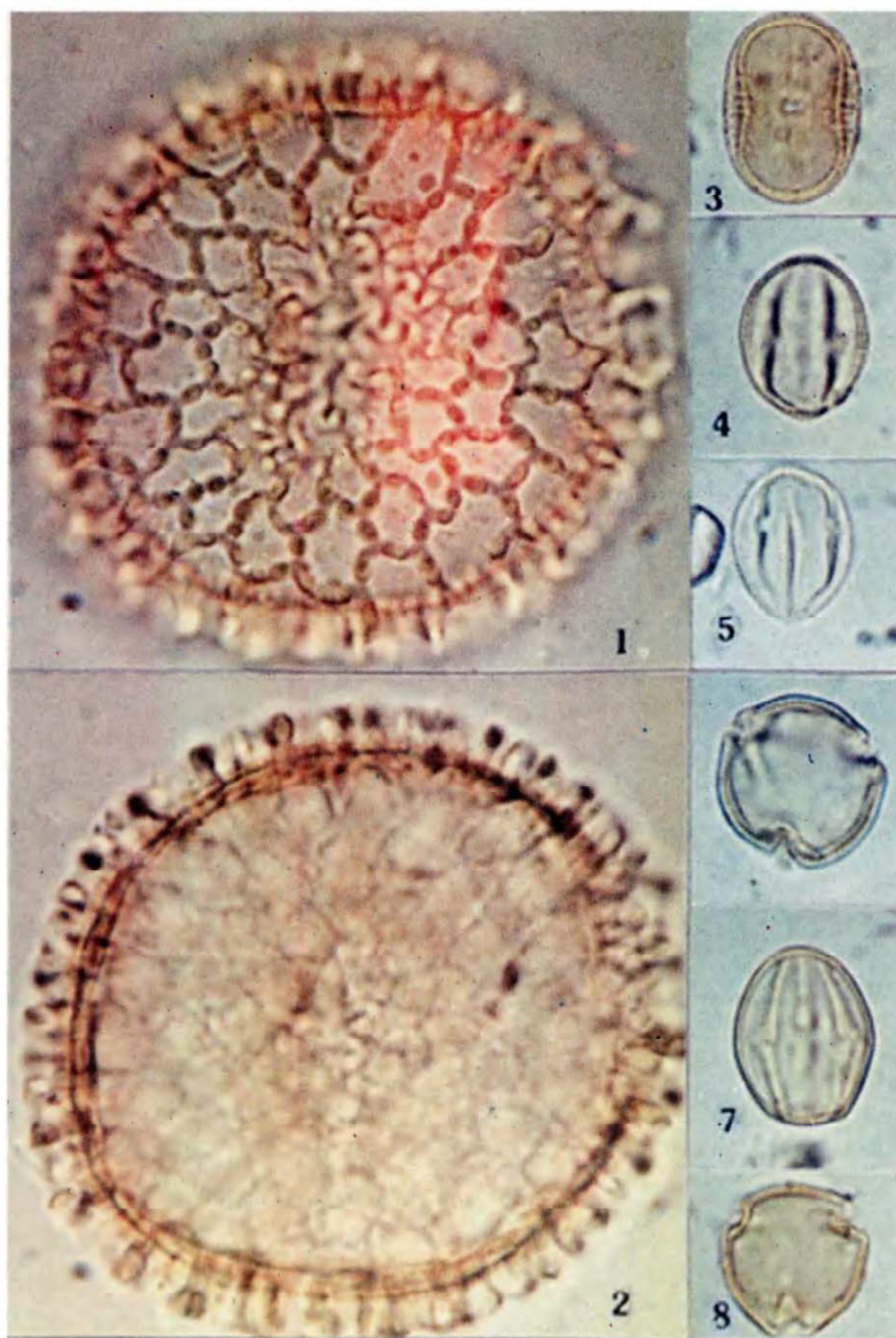


Plate-I: Figs.1 & 2 $\times 1500$; Figs. 3-8 $\times 1000$

Fig.1-2. *Ruellia tuberosa* : Distinct bacula heads in reticulate ornamentation : Fig. 2. Optical section. : Fig.3. *Justicia simplex* : optical section meridional.; Fig. 4. *Cleome rutidosperma* : optical section meridional; Fig. 5. *C. gynandra* : optical section meridional; Fig. 6. : *C. viscosa* : optical section equatorial; Fig.7. *Crotalaria pallida* : optical section meridional; Fig. 8. *C. pallida* : optical section equatorial.

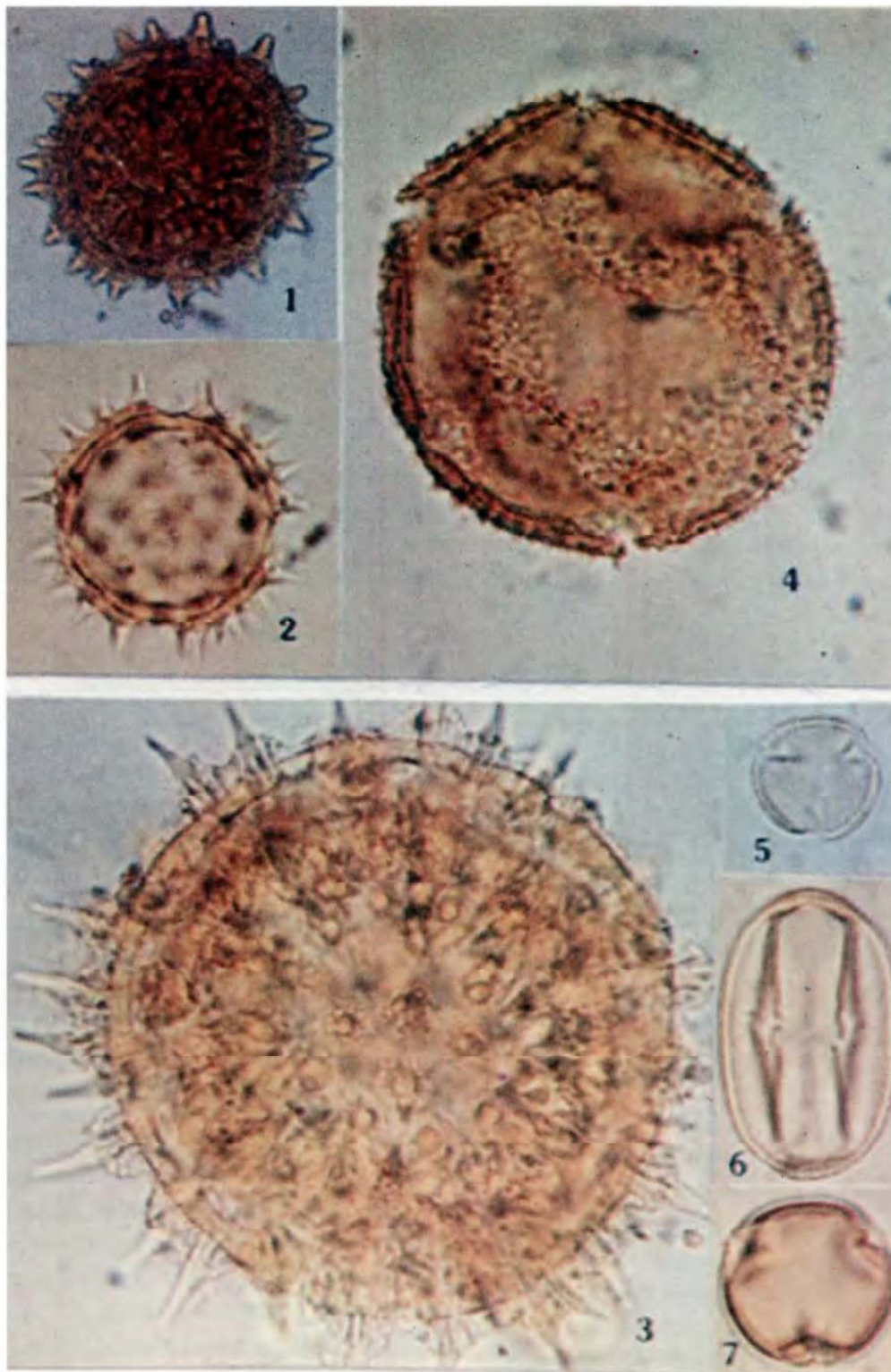


Plate-II. (Fig.1 $\times 500$; Fig.3 $\times 1200$; Fig.2, 4-7 $\times 1000$)

Fig.1: *Ipomoea pes-tigridis* : showing spinulata exine;
 Fig.3: *I. purpurea* : optical section; Fig.2: *Tridax procumbens* : optical section; Fig. 4: *Portulaca oleracea* : optical section; Fig. 5: *Lindenbergia muraria* : optical section equatorial; Fig. 6: *Crotalaria verrucosa* : optical section meridional; Fig.7: *Tephrosia purpurea* : optical section equatorial.

Physalis minima Linn.

Pollen grains subprolate, isopolar, radially symmetrical, peritreme, subcircular in polar view $P \times E = 27-28 \mu\text{m} \times 21-22 \mu\text{m}$. Tetrazonicolporate, L/B of colpus $14/2.5 \mu\text{m}$. Ora lalongate, L/B of Os $3.5/10.5 \mu\text{m}$. Mesocolpium $11-12 \mu\text{m}$ and apocolpium $4-5 \mu\text{m}$.

Exine tectate, thickness $2 \mu\text{m}$; sexine and nexine of equal thickness. Surface ornamentation psilate.

Solanum nigrum Linn.

Pollen grains prolate-spheroidal, isopolar, radially symmetrical, peritreme. Subcircular in polar view $P \times E = 17.5-20 \mu\text{m} \times 14.5-19 \mu\text{m}$. Trizonicolporate; colpi long, L/B of colpus $16/2 \mu\text{m}$, colpi tip acuminate, constricted at equator. Ora lalongate, L/B of Os $7-8/1-2 \mu\text{m}$. Mesocolpium $12-13 \mu\text{m}$ and apocolpium $5-6 \mu\text{m}$.

Exine $1.5 \mu\text{m}$ thick; exine and nexine $1 \mu\text{m}$ and $0.5 \mu\text{m}$ respectively. Surface ornamentation psilate.

Solanum sisymbirifolium Lamk.

Pollen grains prolate spheroidal isopolar, radially symmetrical. Subcircular in polar view $P \times E = 26-28 \mu\text{m} \times 24-25 \mu\text{m}$. Trizonicolporate; colpi long, L/B of colpus $22/2 \mu\text{m}$, tip acute. Ora lalongate, L/B of Os $5-6/-3 \mu\text{m}$. Mesocolpium $9 \mu\text{m}$ and apocolpium $4-5 \mu\text{m}$.

Exine tectate, thickness $1 \mu\text{m}$; sexine and nexine and equal thickness. Surface ornamentation - psilate.

TILIACEAE

Triumfetta rhomboidea Jacq.

Pollen grains prolate, isopolar, radially symmetrical, peritreme, circular in polar view $P \times E = 38-47 \mu\text{m} \times 21-28 \mu\text{m}$, $18-20 \mu\text{m}$ across. Trizonicolporate; colpi linear, L/B of colpus $32-35/4 \mu\text{m}$, slightly constricted at equator. Ora lalongate, L/B of Os $4-5/10 \mu\text{m}$. Mesocolpium $10.5-20 \mu\text{m}$ and apocolpium $3-4 \mu\text{m}$.

Exine $3-4 \mu\text{m}$ thick; sexine $2-3 \mu\text{m}$ and nexine $1 \mu\text{m}$ in thickness. Sexine thicker in polar region. Surface ornamentation micro-reticulate.

ZYGOPHYLLACEAE

Kallstroemea pubescens (G.Don) Dandy

Pollen grains spheroidal, isopolar, radially symmetrical, diameter ranges from $56-62 \mu\text{m}$. Pantoporate, pores distantly placed, diameter of pores $2-2.5 \mu\text{m}$, interpore distance $7-10 \mu\text{m}$.

Exine tectate, $7-9 \mu\text{m}$ thick; thickness of sexine and nexine $4-5 \mu\text{m}$ and $2-4 \mu\text{m}$ respectively. Supratectal processes present. Muri composed of compact bacular heads and almost each lumina flanked by one pore.

Tribulus lanuginosus Linn.

Pollen grains spheroidal, isopolar, radially symmetrical, diameter ranges from $46-50 \mu\text{m}$. Pantoporate, pores distantly placed, diameter of pores $1.5-2 \mu\text{m}$, interpore distance $6-9 \mu\text{m}$.

Exine $6-8 \mu\text{m}$ thick, sexine $4-5 \mu\text{m}$ and nexine $2-3 \mu\text{m}$ thick. Tectate, supratectal processes present. Muri composed of loose bacular heads and almost each lumina flanked by one pore.

DISCUSSION

A general survey of the pollen morphology of the investigated taxa of a part of the ground vegetation of Salt Lake, Calcutta reveals a heterogeneous assemblage of palynomorph. The apertural types vary from colpate to colporate, colpoidate, etc. Inaperturate types are also found. Salient pollen morphological characters like shape, surface ornamentations, exine stratifications, etc. have been depicted in the Table-2.

The trizonicolporate, prolate pollen grains are found in all the investigated members of *Cleome* (*C. gynandra*, *C. rutidosperma* and *C. viscosa*) of the family Capparidaceae. The basic difference among the three species is the size of the whole grain. The degree of reticulation is also slightly different (finely reticulate in *Cleome viscosa* and the remaining grains are micro-reticulate). Trizonicolporate grains are also found in the investigated members of Papilionaceae. In *Tephrosia purpurea*, the grains are prolate-spheroidal and psilate whereas in *Crotalaria*, the grains are prolate. In *Crotalaria pallida*, the grains are faintly reticulate

and in *C. verrucosa*, the grains are psilate. Trizonicolporate grains are common in *Triumfetta rhomboidea*, a tiliaceous member where the grains are prolate and micro-reticulate and similar grains are also found in all the investigated members (except *Physalis minima*) of Solanaceae. In some members of solanaceae (*Solanum nigrum*, *S. sisymbriifolium*) the grains are tricolporate, prolate-spheroidal and psilate. In *Physalis minima*, the grains are tetrazonicolporate and psilate and the shape of the grain is subprolate. An assemblage of tri- and tetrazonicolporate types are found in another member of Solanaceae (*Nicotiana plumbaginifolia*) in which the surface ornamentation is striato-reticulate and the grains are oblate-spheroidal and semi-ectate in comparison with the other members of the family where the grains are prolate-spheroidal to subprolate and ectate. Trizonicolporate type is also found in *Justicia simplex* (Acanthaceae) and *Mukia scabrella* (Cucurbitaceae). In both the cases the grains are reticulate but in the latter type the grains are brevicolpate in nature. Pollen dimorphism is very much common in the genus *Passiflora*. In *Passiflora foetida* (Passifloraceae) the grains are also inaperturate. Sperlet (1979) explained this availability of pollen dimorphism as the resultant of cost of natural selection and genetic assortment.

Trizonicolporate grains with indistinct Os (colporoidate) are tetrazonicolporate and found in *Lindenbergia muraria*. In *Tridax procumbens* (Asteraceae), the grains are tetrazonicolporate and exine provided with spines.

The investigated lamiaceous members are characterised by trizonicolpate type of pollen grains. In *Hyptis suaveolens*, the grains are spheroidal to subspheroidal and with faintly reticulate surface pattern whereas in *Leucas aspera*, the grains are 6-colpate and the exine provided with spinules 1 μ m). In the members of Pedaliaceae like *Pedaliium murex*, the grains are 7-colpate and punctitectate whereas in *Sesamum orientale*, the grains are 11-13-colpate and verrucate. *Martynia annua* of Pedaliaceae exhibits inaperturate, reticulate pollen grains. In this taxon the surface ornamentation is peculiar in having the areoles being separated by smooth rugoid streaks. It is interesting to note that such

characteristics are not to be found either in *Pedaliium murex* or *Sesamum orientale*. Thus, from the apertural point of view and surface ornamentation, these three genera were segregated into two different families, the Martyniaceae and the Pedaliaceae by some past workers Pal & Paria (1986) which is in conformity with the present finding also.

Pantoporate type of apertures is found in the investigated taxa of Malvaceae, Convolvulaceae and Zygophyllaceae. In the pantoporate type, two main categories may be seen. In one category, the grains are provided with spines (echinate) and in the other, grains are without spines but with supratectal process. The members of the Malvaceae and the Convolvulaceae belong to the first group and the Zygophyllaceae come under the second category. In *Sida rhombifolia* and *Hibiscus vitifolius* of Malvaceae, the grains are spheroidal and with micro-reticulate surface ornamentation. The differences of these two types are in respect of size and in the structure of spines. In *S. rhombifolia*, the spine tips are sharp and short (8-9 μ m) and in *H. vitifolius*, the spine tips are blunt and comparatively long (20-21 μ m). In *Ipomoea pes-caprae*, *I. pes-tigridis* and in *I. purpurea* (Convolvulaceae), spine characters are variable. In *I. pes-caprae*, spines are long (18 μ m) and with finger-like tips; in *I. pes-tigridis*, spines are short (9 μ m) and with rounded tips. In *I. purpurea*, spines are bulbous, broad at base, gradually tapering towards the apex with a blunt tip. On the other hand, in *Kallstroemea pubescens*, a member of Zygophyllaceae, the grains are baculate (in optical section) and lumina are flanked by one pore in each. *Tribulus lanuginosus* shows similarities with *K. pubescens* except some minor characters. In the former case, the muri are composed of loose bacular heads whereas in latter, bacular heads are compact. The grains of *T. lanuginosus* are slightly smaller than *K. pubescens*. The brochi of *Tribulus* are relatively smaller than in *Kallstroemea* as suggested by Erdtman (1952).

The variation and heterogeneity in pollen characters refers to the statement of West (1964) who pointed out that the pollen assemblage does not normally represent an even mixture of pollen

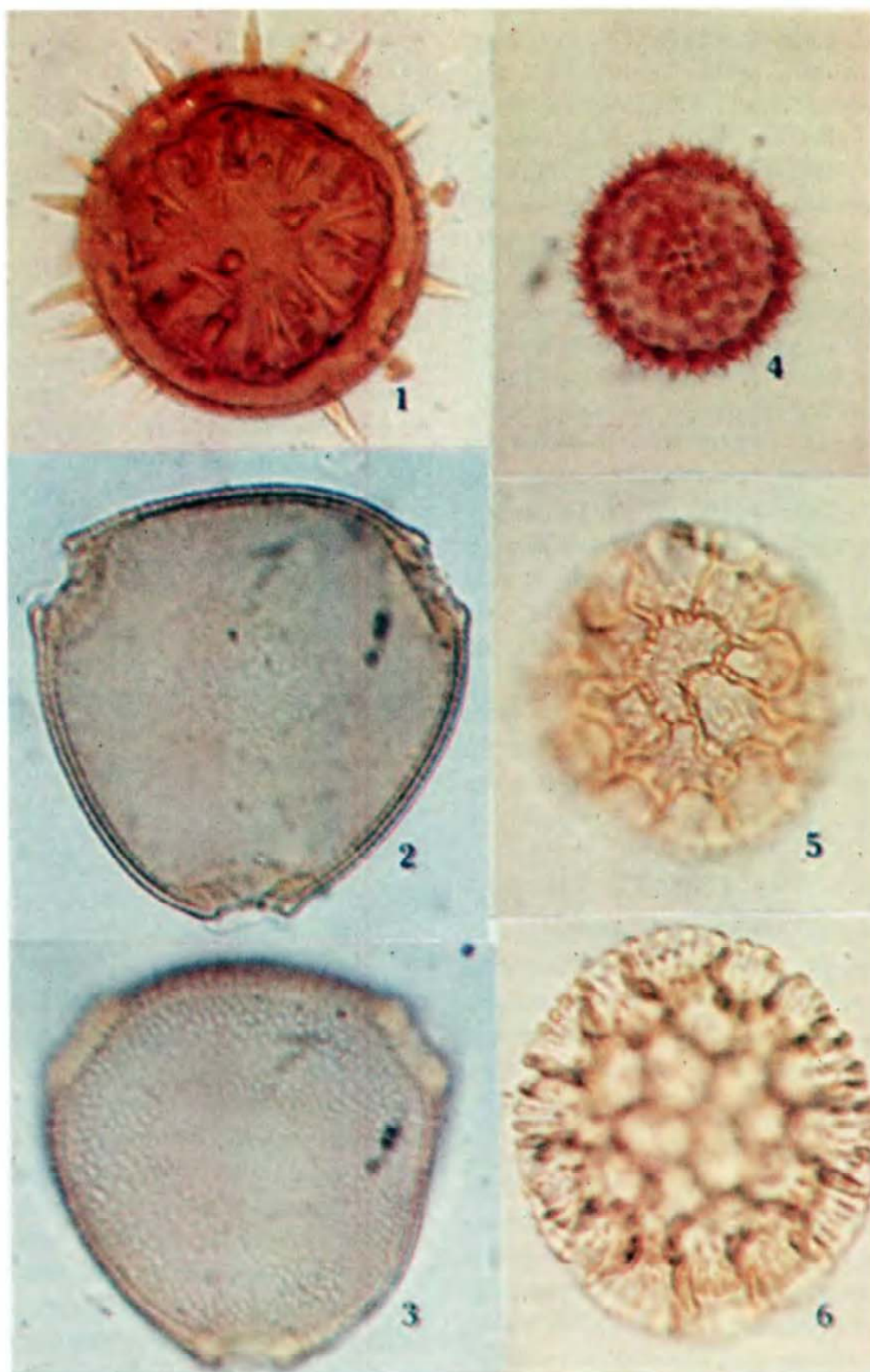


Plate-III. (Figs.1 & 4 $\times$ 500; Figs.2-3 & 5-6 $\times$ 1200)

Fig.1 : *Hibiscus vitifolius* : showing very thick echinate exine; Fig. 2-3 : *Mukia maderaspatana* : 2. optical section equatorial; 3. showing fine exine ornamentation; Fig. 4 : *Sida rhombifolia* : showing exine ornamentation; Fig.5-6 : *Passiflora foetida* : 5. showing muri and bacula heads and reticulate exine ornamentation, 6. optical section.

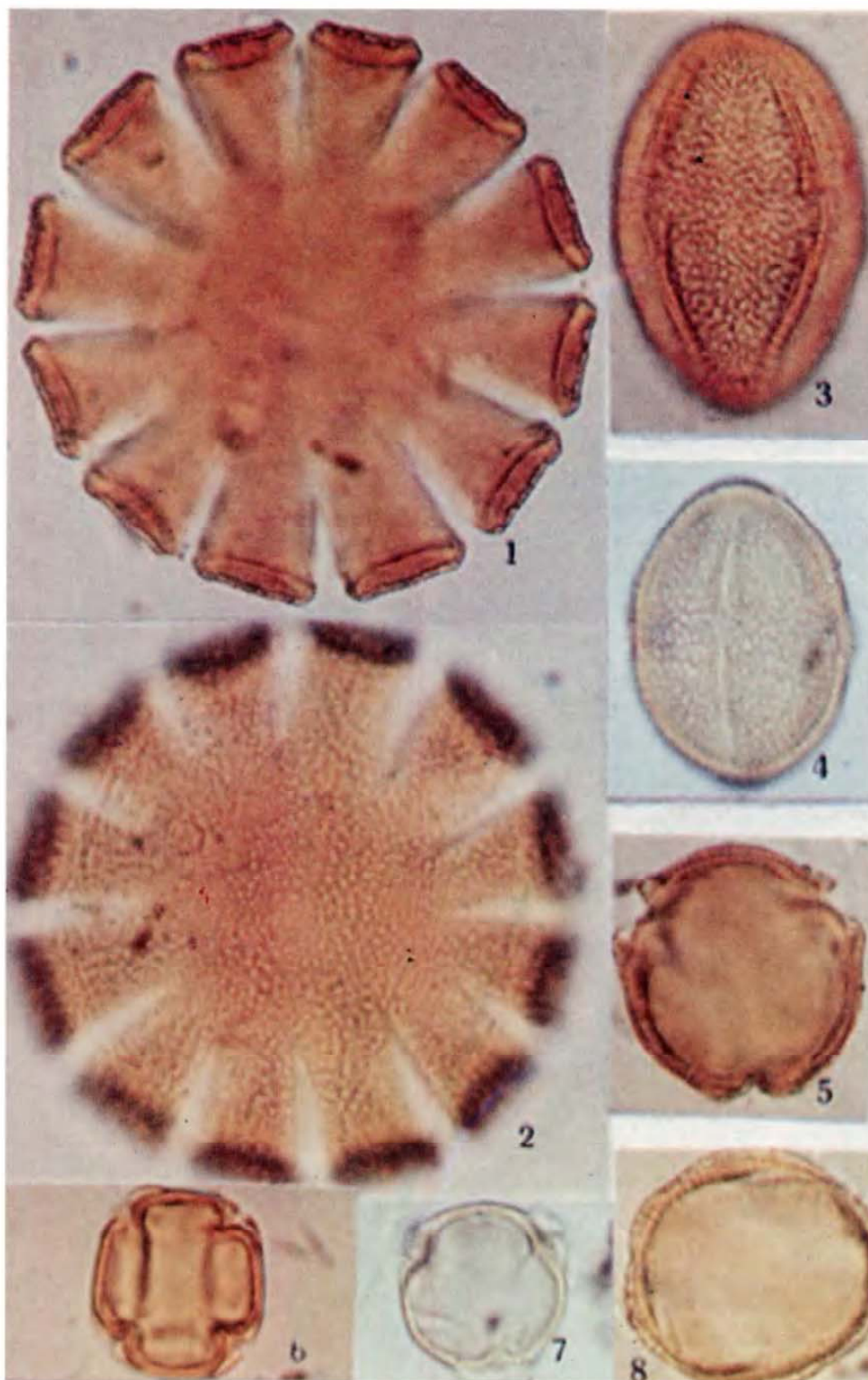


Plate-IV : (Fig. 1-7 $\times 1000$; Fig.8 $\times 800$)

Fig. 1-2 : *Sesamum orientale* : optical section equatorial;
 2. showing exine ornamentation; Fig. 3-5 : *Triumphetta rhomboidea* : 3. optical section meridional,
 4. showing slit like constriction and exine ornamentation, 5. optical section equatorial; Fig. 6 : *Physalis minima* :
 optical section equatorial; Fig. 7 : *Solanum nigrum* : optical section equatorial;
 Fig.8 : *Hyptis suaveolens* : optical section equatorial.

Table-2. Pollen morphological characters of the investigated taxa

Name of the plant	Family	Pollen Characters at a glance		
		Shape	Aperture	Exine ornamentation
1	2	3	4	5
1. <i>Justicia simplex</i>	Acanthaceae	Prolate	Trizonicolporate	Tectate, micro-reticulate
2. <i>Ruellia tuberosa</i>	Acanthaceae	Spheroidal	Seemingly inaperturate	Semi-tectate, grossly reticulate
3. <i>Tridax procumbens</i>	Asteraceae	Spheroidal	Tetrazonicolporate	Echinate
4. <i>Cleome gynandra</i>	Capparidaceae	Prolate	Trizonicolporate	Micro-reticulate
5. <i>Cleome rutidosperma</i>	Capparidaceae	Prolate	Trizonicolporate	Micro-reticulate
6. <i>Cleome viscosa</i>	Capparidaceae	Prolate	Trizonicolporate	Finely reticulate
7. <i>Ipomoea pes-caprae</i>	Convolvulaceae	Spheroidal	Pantoporate	Echinate, Micro-reticulate
8. <i>Ipomoea pes-tigridis</i>	Convolvulaceae	Spheroidal	Pantoporate	Echinate, Micro-reticulate
9. <i>Ipomoea purpurea</i>	Convolvulaceae	Spheroidal	Pantoporate	Echinate, micro-reticulate
10. <i>Mukia maderaspatana</i>	Cucurbitaceae	Subspheroidal	Trizonicolporate (brevicolpate)	Finely reticulate
11. <i>Hyptis suaveolens</i>	Lamiaceae	Subspheroidal	Trizonicolpate	Faintly reticulate
12. <i>Leucas aspera</i>	Lamiaceae	Prolate	Trizonicolpate	Psilate to faintly reticulate
13. <i>Hibiscus vitifolius</i>	Malvaceae	Spheroidal	Pantoporate	Tectate, echinate, micro-reticulate
14. <i>Sida rhombifolia</i>	Malvaceae	Spheroidal	Pantoporate	Tectate, Echinate, micro-reticulate
15. <i>Crotalaria pallida</i>	Papilionaceae	Prolate	Trizonicolporate	Faintly reticulate

Name of the plant	Family	Pollen Characters at a glance		
		Shape	Aperture	Exine ornamentation
1	2	3	4	5
16. <i>Crotalaria verrucosa</i>	Papilionaceae	Prolate	Trizonicolporate	Psilate
17. <i>Tephrosia purpurea</i>	Papilionaceae	Prolatespheroidal	Trizonicolporate	Psilate
18. <i>Passiflora foetida</i>	Passifloraceae	Spheroidal	Not discernible	Semi-ectate, grossly reticulate
19. <i>Martynia annua</i>	Pedaliaceae	Spheroidal	Inaperturate	Intectate, reticulate
20. <i>Pedaliium murex</i>	Pedaliaceae	Oblate-spheroidal	7-colpate	Punctitectate, reticulate
21. <i>Sesamum orientale</i>	Pedaliaceae	Subprolate	11-13 colpate	Tectate, verrucate
22. <i>Portulaca oleracea</i>	Portulacaceae	Subprolate	6-colpate	Micro-reticulate
23. <i>Lindenbergia muraria</i>	Scrophulariaceae	Prolate	Trizonicolporoidate	Micro-reticulate
24. <i>Nicotiana plumbaginifolia</i>	Solanaceae	Oblate-spheroidal	Tri-& Tetrizonicolporate	Semi-ectate, striato-reticulate
25. <i>Physalis minima</i>	Solanaceae	Subprolate	Tetrizonicolporate	Tectate, psilate
26. <i>Solanum nigrum</i>	Solanaceae	Prolate-spheroidal	Trizonicolporate	Psilate
27. <i>Solanum sisymbirifolium</i>	Solanaceae	Prolate-spheroidal	Trizonicolporate	Tectate, Psilate
28. <i>Triumfetta rhomboidea</i>	Tiliaceae	Prolate	Trizonicolporate	Micro-reticulate
29. <i>Kallstroemea pubescens</i>	Zygophyllaceae	Spheroidal	Pantoporate	Tectate, baculate
30. <i>Tribulus lanuginosus</i>	Zygophyllaceae	Spheroidal	Pantoporate	Tectate, baculate

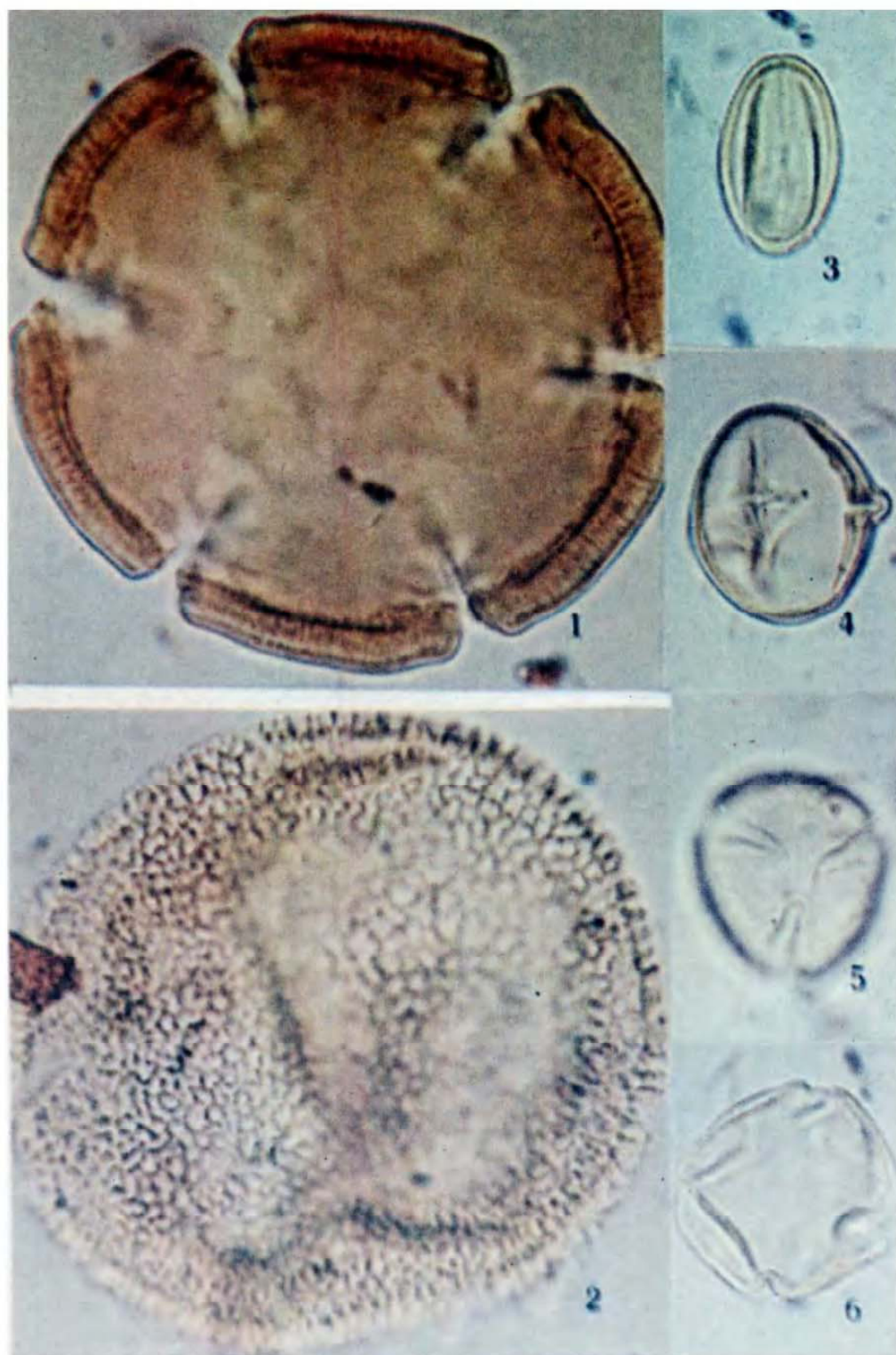


Plate-V (Figs.1-2 $\times 1200$; Figs.3-6 $\times 1000$)

Fig. 1 : *Pedalium murex* : optical section equatorial; Fig. 2 : *Martyuia annua* : showing exine ornamentation; Fig. 3 : *Leucas aspera* : optical section meridional; Fig. 4 : *Solanum sisymbriifolium* : optical section, showing median colpus; Fig. 5-6 : *Nicotiana plumbaginifolia* : 5. apocolpium with colpus ends, 6. an abnormal dimorphic spores.

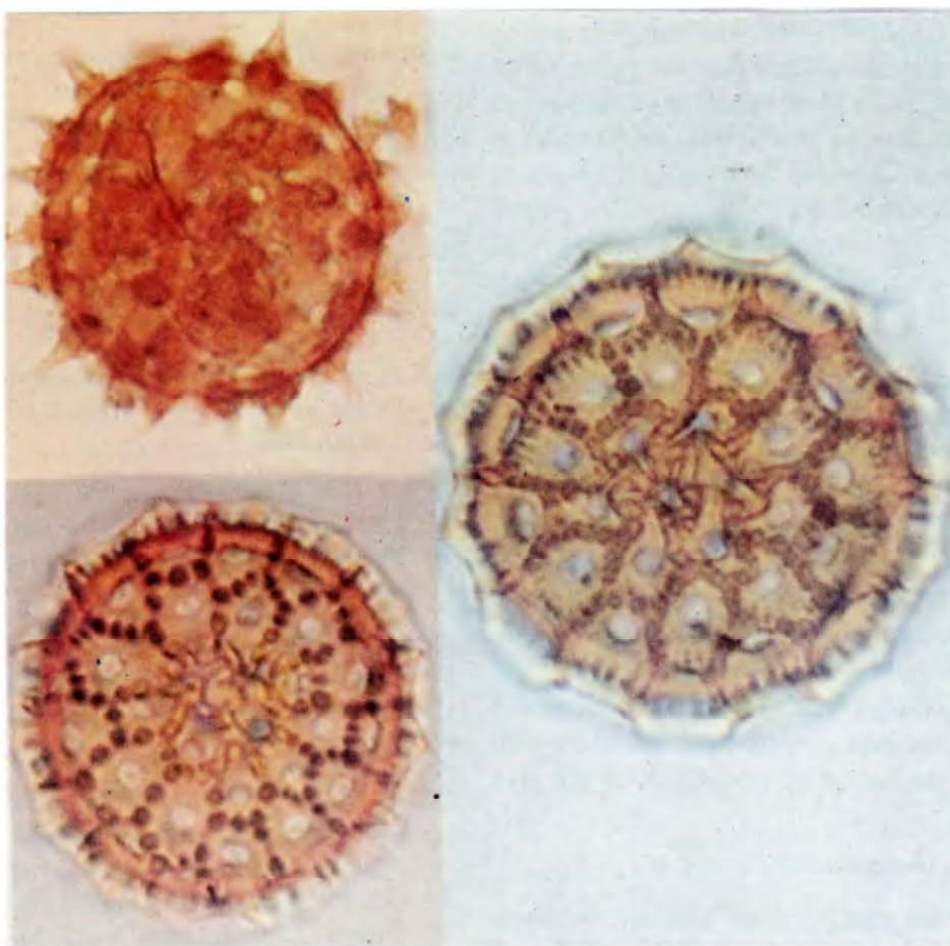


Plate-VI : (Fig.1 $\times$ 500; Figs. 2-3 $\times$ 1000)

- Fig. 1 : *Ipomoea pes-caprae* : optical section with details of spinules base;
Fig. 2 : *Tribulus lanuginosus* : optical section showing distribution of apertures and bacula heads;
Fig.3 : *Kallstroemea pubescens* : showing bacula heads and distribution of apertures.

types, derived from a homogeneous vegetation, rather does it comprise a collection of pollen from a complex mosaic of plant communities. The different species of such communities have a distinctive pollen morphology which allows a specific determination of the vegetation. The value of such studies could be augmented appreciably where it is possible to supplement the other data with pollen records for the more distant past and experimental treatment of postulated vegetational processes (Harris, 1965; Saucer, 1967). However, the present investigation is expected to invoke an integrated view on the plant community in part of the ground vegetation of Salt Lake from the fossil recovery of pollen grains, when the existing vegetation may get exterminated due to biotic pressure and other factors in future. Correlation of the present data with the tertiary and quarternary pollen deposits of the greater Calcutta peats would speak about the past and present flora of the area. This is probably quite natural because there is hardly any doubt from the previous and present vegetational records that qualitatively and quantitatively the plant community is being depleted gradually. As a matter of fact, the heterogeneous pollen assemblage, that we usually find in fossil record, will reflect the nature of plant population composing the vegetation, which in turn will signify the past climatic condition along with an idea of the nature of topography of the area concerned.

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