

Pollen morphology of some cultivated cucurbits of Ganga Plain

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ABSTRACT

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Pollen morphology of 8 species belonging to 7 genera of the family Cucurbitaceae has been studied under light and scanning electron microscope. Taxa under study show marked variations in their palynomorphs. Pollen grains of *Cucurbita pepo* are pantoporate, having pores spread all over the surface of pollen whereas pollen of *Cucumis melo* and *Cucumis sativus* are trizonoporate. Pollen grains of other studied genera are found to be trizonocolporate. Pollen size falls in the category of large sized spores (Sporae Magnae, MA) except *Coccinia cordifolia* where pollen grains are medium sized (Sporae Mediae, ME). Pollen shape also varies from euoblate, to euprolate with all intermediate shapes. Amb (polar outline) is circular to slightly triangular, equatorial outline elliptical. Exine with two distinct layers sexine and nexine is clearly demarcable and found to be tegillate and integillate both.

Key-words: Cucurbitaceae, palynology, eurypalynous, pantoporate, trizonoporate, trizonocolporate.

INTRODUCTION

Cucurbitaceae is a tropical family of about 120 genera and 825 species (Mabberley 1987). In India it is represented by 37 genera and about 97 species. There has been considerable difference of opinion as to the relationship of this family, Bentham & Hooker (1862-1883), following the older botanists, such as, Robert Brown, De Candolle and Naudin, placed the family in the passiflorales among the perigynous polypetalous families (Saad 1964). Eichler (1867), on the other hand, placed it near Campanulaceae as an appendage to his series Campanulinae on the basis of typical epigynous pentamerous flowers, frequently gamopetalous corolla, the tendency to union of the stamens and the form of calyx. This view is followed by Engler who placed the family in an order by itself,

the cucurbitales, next to campanuales (Saad 1964).

Hutchinson (1959, 1969) placed the family in the cucurbitales along with Bignoniaceae, Dasticaceae and Caricaceae. Cronquist (1968, 1981) included it in the violales and placed close to Bignoniaceae and Dasticaceae. Cucurbitaceae is the only family of Takhtajan's (1980) cucurbitales. He considers it very closely related to the Passifloraceae.

The Cucurbitaceae family is characterized by prostrate or scandent herbs, annual or perennial, usually climbing by means of tendrils. Tendrils have a different origin in different genera. The stem is pentangular, leaves are alternate, exstipulate, long petiolate, frequently cordate and simple but often palmately or pinnately compound. The flowers are usually solitary or arranged in cymose inflorescence, yellow or white, unisexual,

actinomorphic, pentamerous and epigynous rarely perigynous. Sepals form a tube, petals united in tube. Anthers show much variation. Gynoecium is usually of three syncarpous carpels with a completely inferior or rarely half- inferior ovary. The type of fruit is pepo, which are eaten raw or cooked. They have delicious flavor and much food value.

Cucurbita has 25 species, of which 3 species are economically important. *Lagenaria* is monotypic genus. Around five species of *Luffa* are found in India as wild. *Luffa cylindrica* is grown as kitchen garden plant for vegetable. About thirty-five species of *Coccinia* are distributed in tropical Africa and Asia. *C. cordifolia* is commonly found in India. Only two species of *Citrullus* are known in India and *Citrullus lanatus* is grown for its edible fruits. There are about 60 species of *Cucumis* distributed in tropics and subtropics of the world out of which four species are found in India, *C. melo* and *C. sativus* are widely cultivated for their edible fruits. Six-seven species of *Momordica* are found in India. *M. charantia* is widely cultivated as vegetable crop (Sastri 1950, 1962).

From palynological point of view, Cucurbitaceae is a eurypalynous family having marked variations in its palynological characters. Previously, the palynology of the family was studied by Erdtman (1952), Marticorena (1963), Jeffrey (1964, 1967), Saad (1964), Moore & Webb (1978), Stafford & Sutton (1994), Khunwasi (1998), Pruesapan & Van der Ham (2005), Jeffery & Wilde (2006) and Perveen & Qaiser (2008). However, no study on pollen morphology of cucurbits of Indian region has been carried out so far. Therefore, the present study is based on detailed pollen morphological investigations of some common garden cucurbits growing in the Ganga Plain viz., *Citrullus lanatus* (Thunb.) Matsumura & Nakai, *Coccinia cordifolia* Cong., *Cucumis melo* L., *Cucumis sativus* L., *Cucurbita pepo* L., *Lagenaria siceraria* (Mol.) Standl., *Luffa cylindrica* L., *Momordica charantia* Descourt.

MATERIAL AND METHODS

To make present investigation more authentic and to avoid contamination, the polliniferous material were

collected from mature unopened buds of the well identified plants during their flowering period growing in Kanpur District of Uttar Pradesh. The pollen samples were prepared for light microscopy by standard acetolysis method described by Erdtman (1952, 1969). The pollen grains were mounted in unstained glycerine jelly and sealed with paraffin. Observations were made with Olympus BX 50 microscope under 10x and 40x objectives. The microphotographs of the pollen were taken with attached digital camera DP-25 using DP2-BSW software.

For the scanning electron microscopic studies (Model: Philips 505) samples were dehydrated in a series of ethanol and small amount of sample was mounted on 'Aluminium Stub' and was coated with 'Gold-Palladium'. The stub was inserted in SEM chamber and vacuum was created. The pollen morphological observations were seen on the attached computer screen. Finally microphotographs of the pollen grains were taken in different views focusing the prominent features in perfect magnification.

Pollen shape, size, polar axis, equatorial diameter. P/E ratio, aperture size, mesocolpium, apocolpium. exine thickness and stratification were observed and measured. Each measurement is based on at least 12-15 readings for each specimen. The pollen key is prepared for the identification of different taxa of the family. Finally the detailed characters of pollen grains for each taxon are presented in Table 1 and 2 for better understanding.

RESULTS

General pollen description of the family Cucurbitaceae:

Pollen grains in monads, medium to large sized (34.0-130.0 μm x 32.0-122.0 μm), radially symmetrical, euoblate, suboblate, oblate spheroidal, spheroidal, prolate spheroidal, subprolate to euprolate, mostly triaperturate sometimes pantoaperturate also. Amb circular to subtriangular, equatorial outline circular to elliptical. Exine two-layered, sexine and nexine clearly demarcable. Sculpturing retipilate, reticulate or echinate.

Table 1. Summary of main characteristics of porate pollen grains in Cucurbitaceae.

Name of Taxa	Size of Pollen (Px E)	Shape of Pollen	Nature of Aperture	Pores			Exine		
				Diameter (µm)	Interporal distance (µm)		Thickness (µm)	Stratification	Ornamentation
<i>Cucurbita pepo</i>	116.0 (125.2) 130.0 µm x 106.0 (114.8) 122.0 µm	Prolate Spheroidal	Pantoporate	20.0 (21.6) 24.0	32.0 (33.0) 34.0		3.0	Two-layered Sexine twice thicker than nexine	Echinate (tegillate)
<i>Cucumis melo</i>	34.0 (35.0) 36.0 µm x 48.0 (50.0) 52.0 µm	Euoblate	Trizonoporate	8.0 (8.5) 9.0	Mesoporia (µm)	Apororia (µm)	3.0	Two-layered Sexine as thick as nexine	Retipilate (integillate)
					13.0 (14.0) 15.0	13.0 (13.5) 14.0			
<i>Cucumis sativus</i>	34.0 (40.4) 48.0 µm x 48.0 (51.6) 60.0 µm	Euoblate, suboblate to oblate spheroidal	Trizonoporate	10.0 (10.5) 11.0	28.0 (30.0) 32.0	12.0 (15.2) 19.0	3.0	Two-layered Nexine much thicker than sexine	Faintly reticulate (tegillate)

Table 2. Summary of main characteristics of colporate pollen grains in Cucurbitaceae.

Name of Taxa	Size of Pollen (Px E)	Shape of Pollen	Nature of Aperture	Colpi			Ora	Exine		
				LxB (µm)	Meso-olpium (µm)	Apo-olpium (µm)		Thickness (µm)	Stratification	Ornamentation
<i>Citrullus lanatus</i>	48.0 (52.0) 62.0 µm x 40.0 (43.6) 48.0 µm	Prolate spheroidal, subprolate to euprolate	Trizono-colporate	30.0 (34.8) 44.0 x 4.0 (4.2) 4.5	15.0 (17.0) 19.0	8.0 (8.6) 9.0	Circular to lolongate	3.5	Two-layered Nexine thicker than sexine	Retipilate (integillate)
<i>Coccinia cordifolia</i>	36.0 (38.4) 40.0 µm x 32.0 (35.6) 38.0 µm	Spheroidal to prolate spheroidal	Trizono-colporate	30.0 (30.8) 32.0 x 3.5 (3.8) 4.0	12.0 (14.0) 16.0	3.0 (3.8) 4.0	Faint, somewhat lolongate	2.0	Two-layered Sexine as thick as nexine	Retipilate (integillate)
<i>Momordica charantia</i>	46.0 (50.0) 52.0 µm x 46.0 (48.0) 50.0 µm	Oblate spheroidal, spheroidal to prolate spheroidal	Trizono-colporate	36.0 (37.3) 40.0 x 2.0 (2.1) 2.5	26.0 (29.0) 32.0	5.0 (5.7) 6.0	Faint, circular to lolongate	3.0	Two-layered Sexine twice thicker than nexine	Retipilate (integillate)
<i>Lagenaria siceraria</i>	56.0 (56.6) 58.0 µm x 42.0 (46.6) 50.0 µm	Prolate spheroidal to subprolate	Trizono-colporate	44.0 (44.7) 46.0 x 1.5 (1.7) 2.0	30.0 (31.0) 32.0	6.0 (6.3) 7.0	Lalongate	2.0	Two-layered Sexine as thick as nexine	Reticulate, heterobrochate (tegillate)
<i>Luffa cylindrica</i>	52.0 (70.4) 80.0 µm x 50.0 (60.8) 66.0 µm	Prolate spheroidal to subprolate	Trizono-colporate	40.0 (59.2) 70.0 x 2.0 (2.5) 3.0	26(28)30	5.0 (5.6) 7.0	Lolongate	4.0	Two-layered Sexine much thicker than nexine	Reticulate, heterobrochate (tegillate)

Pollen key to different genera and species of Cucurbitaceae:

1. Pollen grains pantoporate
Cucurbita pepo
2. Pollen grains trizonoporate
2a. Exine integillate (retipilate)
Cucumis melo
2b. Exine tegillate (faintly reticulate).....
Cucumis sativus
3. Pollen grains trizonocolporate
3a. Exine integillate (retipilate)

- 3a¹. Nexine thicker than sexine
Citrullus lanatus
- 3a². Sexine as thick as nexine
Coccinia cordifolia
- 3a³. Sexine thicker than nexine
Momordica charantia
- 3b. Exine tegillate (reticulate)
3b¹. Sexine as thick as nexine
Lagenaria siceraria
3b². Sexine much thicker than nexine
Luffa cylindrica

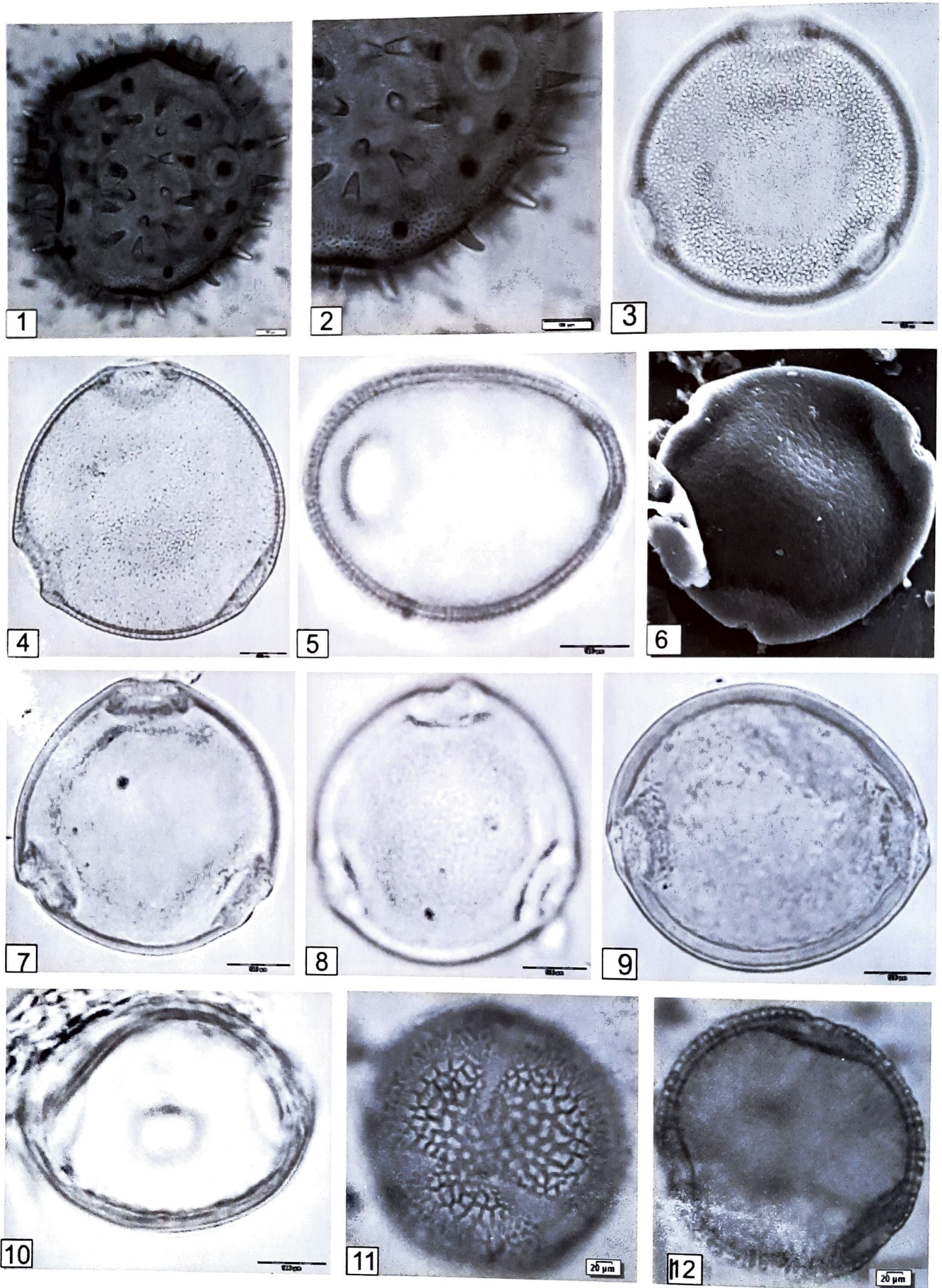


Plate 1

Cucurbita pepo: 1. showing pores and spines. 2. enlarged view of spines showing broad base and blunt tips; *Cucumis melo*. 3. polar view showing retipilate exine sculpturing. 4. polar view showing exine stratification in optical section. 5. equatorial view with lateral pores; *Cucumis sativus*. 6. faintly reticulate exine sculpturing. 9. equatorial view with lateral pores. 10. equatorial view with middle pore; *Citrullus lanatus*. 11. polar view showing colpi and retipilate exine sculpturing. 12. polar view showing exine stratification in optical section.

Description of pollen morphology of cucurbits:

Cucurbita pepo L. (Plate 1: 1-2)

Common Name: Squash, field pumpkin

Local Name: Kaddu, sitaphal

Pollen grains prolate spheroidal, P/E 1.03 (1.08) 1.12, PA, 116.0 (125.2) 130.0 μm x 106.0 (114.8) 122.0 μm . Outline almost circular; pantoporate.

Pores circular with distinct annulus, 20.0 (21.6) 24.0 μm in diameter. Interporal distance 32.0 (33.0) 34.0 μm .

Exine 3.0 μm thick, sexine (2.0 μm) twice thicker than nexine (1.0 μm) [crassisexinous], sculpturing echinate, echinae 8.0-10.0 μm long, 2.5-3.0 μm broad at base, tips blunt, sparsely distributed, 8.0-16.0 μm apart; tegillate.

Cucumis melo L. (Plate 1: 3-5)

Common Name: Muskmelon, Sweet melon

Local Name: Kharbuja

Pollen grains euoblate, P/E 0.70 (0.71) 0.72, MA, 34.0 (35.0) 36.0 μm x 48.0 (50.0) 52.0 μm , polar outline sub-triangular, equatorial outline elliptical; trizonoporate.

Pores circular with distinct annulus, 8.0 (8.5) 9.0 μm in diameter. Mesoporia 13.0 (14.0) 15.0 μm , apoporia 13.0 (13.5) 14.0 μm across.

Exine 3.0 μm thick, sexine (1.5 μm) as thick as nexine (1.5 μm) or slightly thicker, sculpturing retipilate; integillate.

Cucumis sativus L. (Plate 1: 6-10)

Common Name: Cucumber

Local Name: Khira

Pollen grains euoblate, suboblate to oblate spheroidal, P/E 0.68 (0.78) 0.88, MA, 34.0 (40.4) 48.0 μm x 48.0 (51.6) 60.0 μm , polar outline sub-triangular, equatorial outline elliptical; trizonoporate.

Pores circular with distinct annulus, 10.0 (10.5) 11.0 μm in diameter. Mesoporia 28.0 (30.0) 32.0 μm , apoporia 12.0 (15.2) 19.0 μm across.

Exine 3.0 μm thick, nexine (2.5 μm) much thicker than sexine (1.0 μm) [crassinexinous], sculpturing faintly

reticulate; tegillate.

Citrullus lanatus (Thunb.) Matsumura & Nakai (Plate 1: 11-12 & Plate 2: 1-4)

Common Name: Water melon

Local Name: Tarbuz, tarmuj, tarbuch

Pollen grains prolate spheroidal, subprolate to euprolate, P/E 1.04 (1.19) 1.41, MA, 48.0 (52.0) 62.0 μm x 40.0 (43.6) 48.0 μm , polar outline almost circular to slightly triangular, equatorial outline elliptical; trizonocolporate.

Colpi linear, 30.0 (34.8) 44.0 μm long, 4.0 (4.25) 4.5 μm wide at equator, tips blunt, margins smooth. Ora circular to lolongate, 5.0 (5.5) 6.0 μm long, 4.0 (4.5) 5.0 μm wide at equator. Mesocolpia 15.0 (17.0) 19.0 μm , apocolpia 8.0 (8.6) 9.0 μm across.

Exine 3.5 μm thick, nexine (2.0 μm) slightly thicker than sexine (1.5 μm), sculpturing retipilate; integillate.

Coccinia cordifolia Cogn. syn. *C. indica* Wight & Arn. (Plate 2: 5-8)

Common Name: Ivy gourd

Local Name: Kunduru, Kunduri

Pollen grains spheroidal to prolate spheroidal, P/E 1.0 (1.08) 1.12, ME, 36.0 (38.4) 40.0 μm x 32.0 (35.6) 38.0 μm , polar outline almost circular, equatorial outline circular to slightly elliptical; trizonocolporate.

Colpi linear, 30.0 (30.8) 32.0 μm long, constricted in the middle, 3.5 (3.8) 4.0 μm wide at equator, tips acute, margins smooth. Ora faint, not clearly distinct, somewhat lolongate, 5.0 μm long, 4.0 μm wide at equator. Mesocolpia 12.0 (14.0) 16.0 μm , apocolpia 3.0 (3.8) 4.0 μm across.

Exine 2.0 μm thick, sexine (1.0 μm) as thick as nexine (1.0 μm), sculpturing retipilate; integillate

Momordica charantia Descourt. (Plate 2: 9-12)

Common name: Bitter melon, bitter gourd

Local name: Karela

Pollen grains oblate spheroidal, spheroidal to prolate spheroidal, P/E 0.96 (1.01) 1.04, MA, 46.0 (50.0) 52.0 μm x 46.0 (48.0) 50.0 μm , polar outline sub-triangular, equatorial outline circular to slightly elliptical; trizonocolporate.

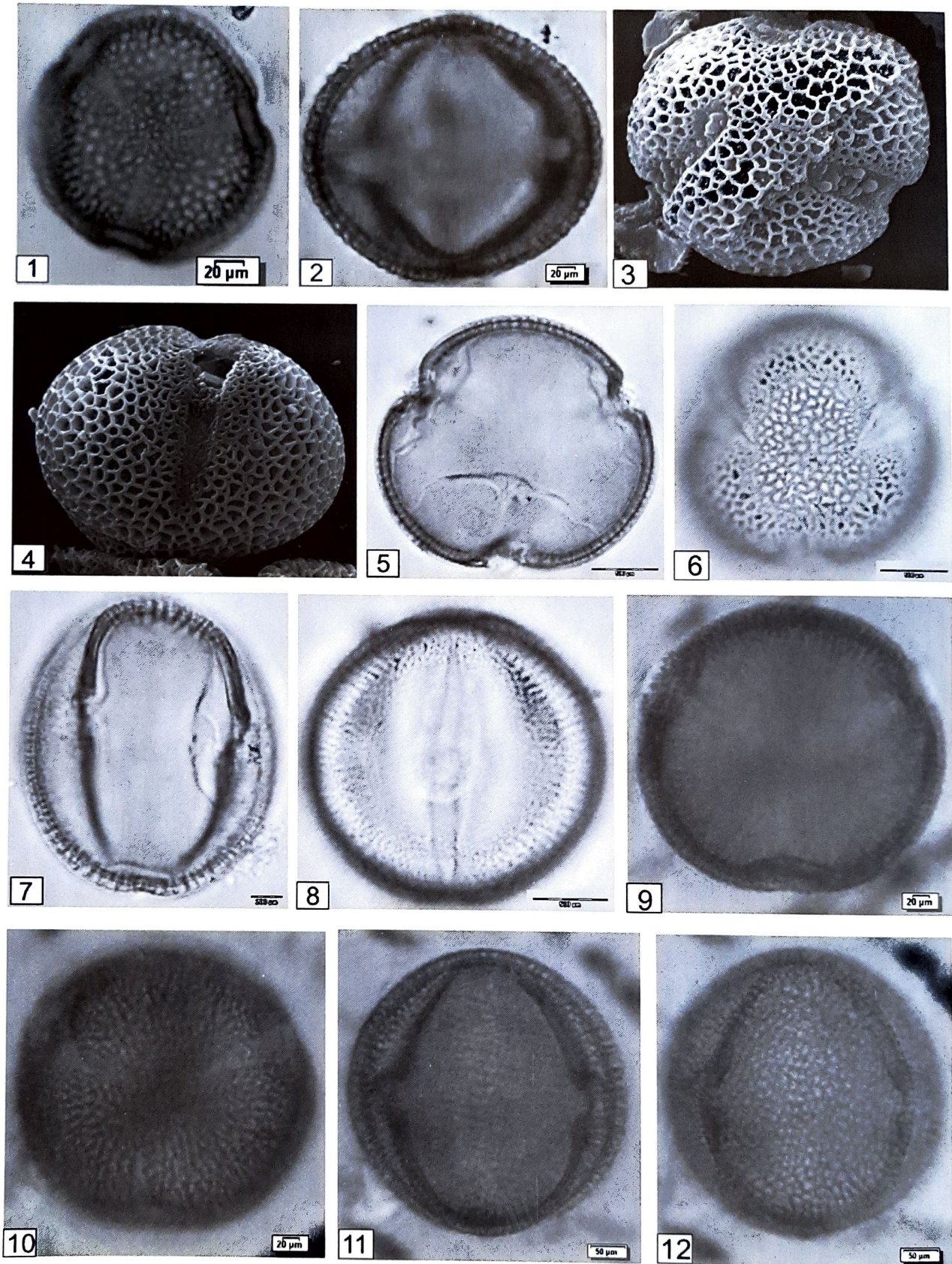


Plate 2

Citrullus lanatus: 1. polar view showing ora and exine sculpturing. 2. equatorial view with lateral colpi and ora. 3. SEM (x 1490) polar view showing colpi and exine sculpturing. 4. SEM (x130) equatorial view showing exine sculpturing with a colpus and os; *Coccinia cordifolia*. 5. polar view showing exine stratification in optical section. 6. polar view showing retipilate exine sculpturing. 7. equatorial view with lateral colpi. 8. equatorial view with middle colpus and os; *Momordica charantia*. 9. polar view showing exine stratification in optical section. 10. polar view showing retipilate exine sculpturing. 11. equatorial view showing lateral colpi and ora. 12. equatorial view showing retipilate exine sculpturing.

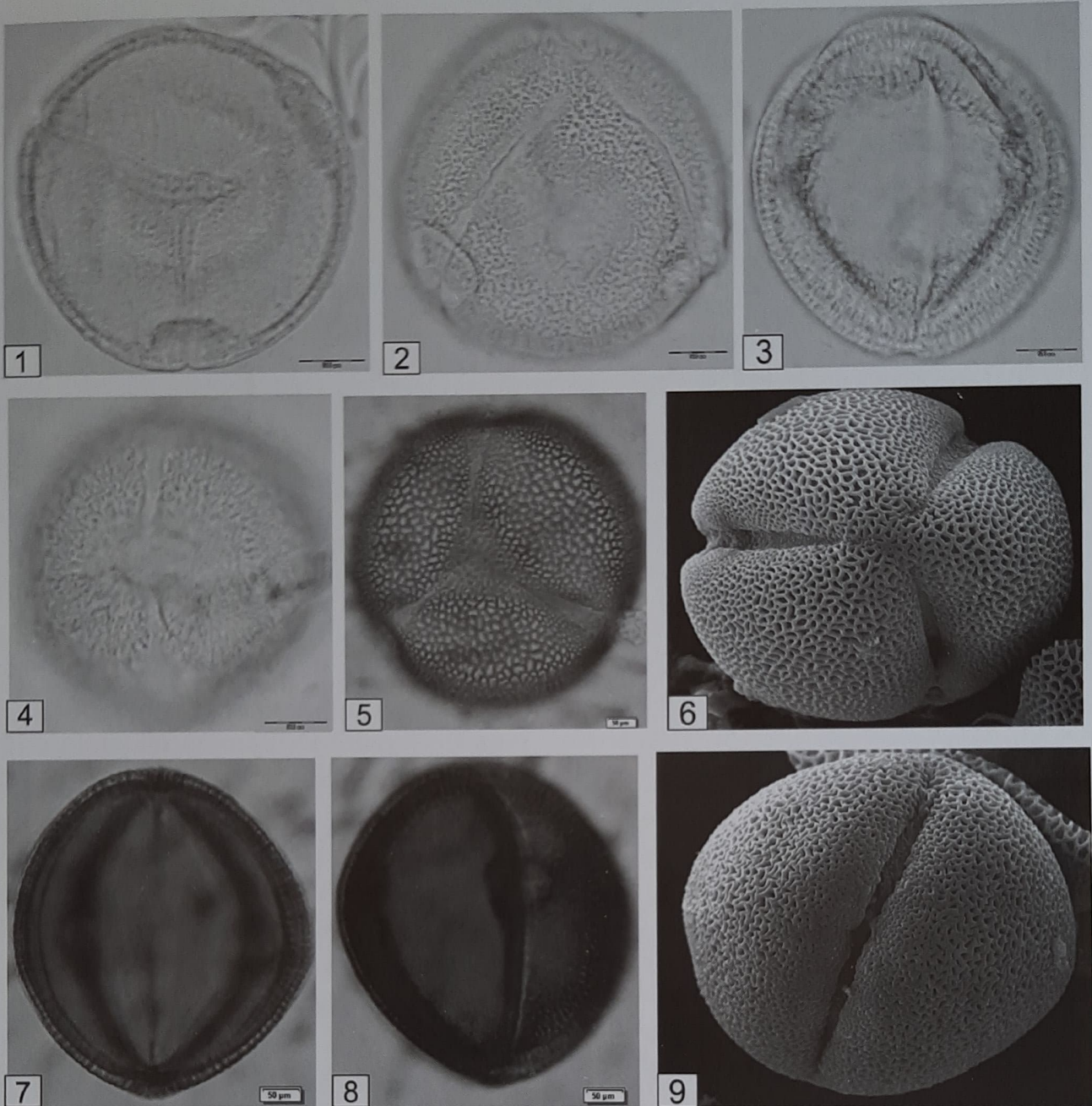


Plate 3

Lagenaria siceraria: 1. polar view showing exine stratification in optical section. 2. polar view showing reticulate exine sculpturing. 3. equatorial view with lateral colpi. 4. equatorial view with middle colpus and os; *Luffa cylindrical*. 5. polar view showing reticulate exine sculpturing and colpi. 6. SEM (x1250) polar view showing exine sculpturing. 7. equatorial view with lateral colpi exine stratification in optical section. 8. equatorial view with middle colpus and os. 9. SEM (x1550) equatorial view showing exine sculpturing and middle colpus.

Colpi very long, narrow, linear, 36.0 (37.33) 40.0 μm long, 2.0 (2.17) 2.5 μm wide at equator, tips acute, margins smooth. Ora faint, circular to lolongate, 12.0 (12.67) 14.0 μm long, 10.0 (11.0) 12.0 μm wide at equator. Mesocolpia 26.0 (29.0) 32.0 μm , apocolpia 5.0 (5.67) 6.0 μm across.

Exine 3.0 μm thick, sexine (2.0 μm) twice thicker than nexine (1.0 μm) [crassisexinous], sculpturing retipilate; integillate.

Lagenaria siceraria (Mol.) Standl. (Plate 3: 1-4)

Common Name: Bottle gourd

Local Name: Ghiya, Lauki

Pollen grains prolate spheroidal to subprolate, P/E 1.12 (1.22) 1.33, MA, 56.0 (56.67) 58.0 μm x 42.0 (46.67) 50.0 μm , polar outline circular, equatorial outline elliptical; trizonocolporate.

Colpi very long, narrow, linear 44.0 (44.67) 46.0 μm long, 1.5 (1.67) 2.0 μm wide at equator, tips acute,

margins smooth. Ora lalongate, 6.0 (7.33) 8.0 μm long, 10.0 (10.67) 11.0 μm wide at equator. Mesocolpia 30.0 (31.0) 32.0 μm , apocolpia 6.0 (6.33) 7.0 μm across.

Exine 2.0 μm thick, sexine (1.0 μm) as thick as nexine (1.0 μm), sculpturing reticulate, heterobrochate, brochi of variable size and shapes; tegillate.

Luffa cylindrica (L.) M.J. Roem syn. *L. aegyptica* Mill. (Plate 3: 5-8)

Common Name: Sponge gourd, Vegetable sponge

Local Name: Turai, ghiya tori

Pollen grains prolate spheroidal to subprolate, P/E 1.04 (1.16) 1.29, MA, 52.0 (70.4) 80.0 μm x 50.0 (60.8) 66.0 μm , polar outline sub-triangular, equatorial outline elliptical; trizonocolporate.

Colpi very long, linear, 40.0 (59.2) 70.0 μm long, 2.0 (2.5) 3.0 μm wide at equator, tips acute, margins smooth. Ora lalongate 10.0 (11.2) 12.0 μm long, 6.0 (7.0) 8.0 μm wide at equator. Mesocolpia 26.0 (28.0) 30.0 μm , apocolpia 5.0 (5.6) 7.0 μm across.

Exine 4.0 μm thick, sexine (3.0 μm) much thicker than nexine (1.0 μm) [crassisexinous], sculpturing distinctly reticulate, heterobrochate, brochi of variable size and shapes; tegillate.

DISCUSSION AND CONCLUSION

Conspicuous variations in pollen morphological features among different genera show that Cucurbitaceae is eurypalynous family. Pollen grains are isopolar and radially symmetrical.

Pollen size falls in the category of large sized spores (Sporae Magnae, MA) except *Coccinia cordifolia* where pollen grains are medium sized (Sporae Mediae, ME). Their size ranges from 36 (38.4) 40 μm x 32 (35.6) 38 μm in *Coccinia cordifolia* to 116 (125.2) 130 μm x 106 (114.8) 122 μm in *Cucurbita pepo*.

Pollen shape varies from euoblate, suboblate, oblate spheroidal to spheroidal, prolate spheroidal, subprolate to euprolate. Other than spheroidal pollen the Amb (polar outline) is circular to slightly triangular, equatorial outline elliptical.

On the basis of nature of the aperture, family is heterogenous having simple (porate) and compound (colporate) aperturate pollen. Number of aperture is

usually 3, sometimes many (as in *Cucurbita*). Pollen grains of *Cucumis melo* and *Cucumis sativus* are trizonoporate with circular, annulate pores, 8 (9.5) 11 μm in diameter. Mesopodium ranges from 13 (14) 15 μm in *C. melo* while it ranges from 28 (30) 32 μm in *C. sativus* whereas, apopodium in both the species is from 12 (15.2) 19 μm . *Cucurbita pepo* is pantoporate with circular annulate pores, 20 (21.6) 24 μm in diameter with interporal distance ranging from 32 (33) 34 μm . All other taxa under study viz. *Citrullus lanatus*, *Coccinia cordifolia*, *Lagenaria siceraria*, *Luffa cylindrica* and *Momordica charantia* are found to be trizonocolporate, having distinct ecto (colpi) and endo (ora) apertures. Colpi narrow, linear, length ranges between 30-70 μm , where as width ranges between 1.5-4.5 μm at equator, tips acute. Ora mostly lalongate, sometimes circular or lalongate. Mesocolpium ranges between 12-32 μm and apocolpium between 3-9 μm .

The exine is tegillate and integillate both. It is two-layered with sexine and nexine clearly demarcable. In *Coccinia cordifolia*, *Cucumis melo* and *Lagenaria siceraria* sexine is as thick as nexine; in *Cucurbita pepo*, *Luffa cylindrica* and *Momordica charantia* sexine is much thicker than nexine while in *Citrullus lanatus* and *Cucumis sativus* nexine is found to be thicker than sexine.

Integillate exine with retipilate ornamentation is found in *Citrullus lanatus*, *Coccinia cordifolia*, *Cucumis melo* and *Momordica charantia*. Rest of the taxa have tegillate exine with reticulate ornamentation in *Cucumis sativus*, *Lagenaria siceraria*, *Luffa cylindrica* and echinate in *Cucurbita pepo* which bears more or less conical spines with acute ends.

The pollen of *Cucumis melo* have integillate exine with retipilate ornamentation while that of *Cucumis sativus* have tegillate exine with very faint reticulation, though both of them are triporate. Thus, these two species of *Cucumis* can be delimited on the basis of exine ornamentation. The present communication will provide illustrated guide for identification of pollen grains of cucurbits present in quaternary lake profile and archaeological sites up to genus and species level, in order to understand the antiquity of exotic as well as indigenous cucurbits.

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