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Pollen Grains of Asteraceae and Analogous Echinate Grains

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Abstract: Seven plant species belonging to 3 families were subjected to standard palynological sample preparation in other to provide additional tool in pollen identification. Taxa in this study include the families Asteraceae, Convolvulaceae and Malvaceae. Pollen grains belonging to the family Asteraceae are unique in being characteristically echinate. They can be differentiated from similar pollen in other families by the relatively small size of both the pollen and the spines and the irregular arrangement of the spines. Pollen of *Ipomoea aquatica* belonging to the family Convolvulaceae has spines like found in Asteraceae but can be distinguished in that those of Convolvulaceae are remarkedly bigger in size. *Hibiscus rosasinensis* a species in the family Malvaceae share the same echinate characteristics but peculiar in possessing isolated spines, which stand out conspicuously. The pollen grain is differentiated from Convolvulaceae pollen in being larger. Light micrographs, detailed descriptions of the species and where possible Scanning Electron Micrographs are provided. This study is expected to be useful in palaeoecology research, petroleum exploration, honey industry and in forensic investigations.

Key words: Pollen grains, exine sculpture, morphology, micrographs

INTRODUCTION

Pollen grains have several morphological characters on the exine, which are of diagnostic importance (Edeoga *et al*., 1998; Edeoga and Ikem, 2002; Mbagwu and Edeoga, 2006; Mbagwu *et al*., 2008). They are more often than not, species specific. Pollens therefore are used to identify source plant during the analysis of palynological samples in fields such as biostratigraphy, climatology, medicine-alleviation of pollinosis (hay fever-allergenic disease), forensic studies, mellisopalynology, plant evolution, taxonomy and environmental restoration activities (Bryant *et al*., 1990; Agwu and Uwakwe, 1992; Bayer and Kubitzki, 2003; Perveen *et al*., 2004; Palazzesi *et al*., 2007; Adeonipekun and Ige, 2007; Ige, 2009). However, due to high species diversity especially in wet tropics, there occurs the inability of the palynologist to identify or differentiate some pollen forms, which could result in the omission of some important indicator species.

At present, only few descriptions of pollen grains from some Nigeria plants exist, which are scattered over several journals. Existing atlases are in-house work of oil companies and are considered strictly confidential and therefore are not available for public use except the work of Sowunmi (1973, 1995) on the compilation of pollen grains of Nigerian woody plants; the works of Legoux (1978), Takahashi and Ulrich (1979), Jan du Chene *et al*. (1978), Salard-Cheboldaeff and Dejax (1991) and Biffi and Grignani (1983) which are published.

Realising that a complete coverage of all echinate grains will take several years of teamwork, the decision was made to publish the major differences in the commonly recovered echinate grains belonging to the families Asteraceae, Convolvulaceae and Malvaceae.

MATERIALS AND METHODS

The polliniferous material (some flowers, buds, or even single stamens) collected from University of Lagos and environs was treated with hot water in order to make it soft. Anthers were picked out under a dissecting microscope and placed in a centrifuge tube. Sample preparation was carried out at the Palynological Unit, Botany and Microbiology Department, University of Lagos and repeated at the Jodrel Laboratory, Micromorphology Section, Royal Botanic Garden, Kew, UK following standard sample preparation method which involves acetolysis, repeated wash in distilled water and sieving as outlined by Erdtman (1969). Five plant species belonging to the family Asteraceae and one species each of the families Convolvulaceae and Malvaceae were prepared. Seven species were prepared in all and slides were made.

Photomicrography was carried out under Olympus light microscope with Motic MC2000 (2.0 Megapixel) camera. Specimens are illustrated at either 1000x or 400x. Scanning Electron Micrographs were taken using Hitachi S-4700 Scanning Electron Microscope (SEM) from prepared stubs coated with gold in the Emitech Sputter

Coater K550. Pollen grains were described based on their morphological characteristics. Amb or overall grain shape is first defined, followed by shape classes as defined by Erdtman (1969). The shape classes are based on measurements of the polar axis (P) and equatorial diameter (E) and the resulting P/E ratio. Mean dimensions are provided, followed by minima and maxima in parentheses. The figures recorded for the various pollen grains dimensions were generally the average of measurements of 10 non-folded grains (polar and equatorial axis) measured in equatorial view at X400 magnification. Aperture and exine thickness were also measured. The measured values were directly rounded to the nearest micrometer unit (Moore and Webb, 1983; Moore *et al*., 1991).

RESULTS

Pollen morphological characters of the species studied is presented below by family. The descriptive photomicrographs are compiled in Fig. 1-4. The list of species included in the study, where they were collected from and collection date are showed in Table 1. Morphological characteristics of described palynomorphs are shown in Table 2.

Characteristic of pollen grains:

Asteraceae: *Aspilia africana* (Pers.) C.D. Adams haemorrhage plant (Fig. 1):

- **Shape:** Rounded triangular amb Prolate grain P/E (1.13)
- **Size:** Polar axis 14.3 (12.2-15.7 µm); Equatorial axis 12.7 (8.7-14.0 µm)
- **Aperture:** Tricolporate, aperture not very distinct
- **Exine:** Tectate, spines wide at the base, with pointed tip, supported by stout bacules

Chromolaena odorata Linn. (Fig. 1)

- **Shape:** Angular amb, Prolate grain P/E (1.38)
- **Size:** Polar axis 15.5 (12.2-19.2 µm); Equatorial axis 11.2 (8.7-14.0 µm)
- **Aperture:** Tricolporate to tetracolporate
- **Exine:** Tectate. Tectum supported with bacules. Possess supratectal spines

Helianthus sp. (Fig. 2)

- **Shape:** Rounded triangular amb, Prolate grain P/E(1.25)
- **Size:** Polar axis 15.5 (14.0-17.5 µm); Equatorial axis 12.4 (9.6-14.0 µm)
- **Aperture:** Tricolporate, aperture not very distinct
- **Exine:** Tectate, baculate, provided with supratectal spines

Tridax procumbens Linn. (Fig. 2)

- **Shape:** Rounded square amb, subspheroidal grain, isopolar, radially symmetrical. Prolate grain P/E(1.09)
- **Size:** Polar axis 18.7 (15.7-21.0 µm); Equatorial axis 17.2 (15.7-19.2µm)
- **Aperture:** Tri-tetracolporate; colpus long, pore lalongate
- **Exine:** Tectate, wavy margin, homogenous, spinose; spines wide at the base, with blunt tip, supported by stout bacules

Table 1: Collection information and common names of taxa included in pollen atlas

Family	Scientific name and authority	Common name	Collection site	Collection date
Asteraceae	*Aspilia africana* (Pers)	Haemorrhage plant	University of Lagos	08/31/05
Asteraceae	*Chromolaena odorata* (Linn.)	Triffid weed	Majidun	08/09/05
Asteraceae	*Helianthus* sp. (Mart)	Sunflower	Majidun	08/09/05
Asteraceae	*Tridax procumbens* (Linn)	Tridax Coat buttons	University of Lagos	08/31/05
Asteraceae	*Vernonia cinerea*	Little ironweed	University of Lagos	08/31/05
Convolvulaceae	*Ipomoea aquatica* (Forsk)	Water spinach	Majidun	08/09/05
Malvaceae	*Hibiscus rosasinensis* (Linn.)	Hibiscus	University of Lagos	08/31/05

Table 2: Morphological characteristics of described palynomorphs

Family	Scientific name	Aperture	Ornamentation	Micrograph
Asteraceae	*Aspilia africana*	Tricolporate	Echinate	Fig. 1
Asteraceae	*Chromolaena odorata*	Tricolporate	Echinate	Fig. 1
Asteraceae	*Helianthus* sp.	Periporate	Echinate	Fig. 2
Asteraceae	*Tridax procumbens*	Tri-tetracolporate	Echinate	Fig. 2
Asteraceae	*Vernonia cinerea*	Tricolpate	Echinate	Fig. 3
Convolvulaceae	*Ipomoea aquatica*	Periporate	Echinate	Fig. 3
Malvaceae	*Hibiscus rosasinensis*	Periporate	Echinate	Fig. 4

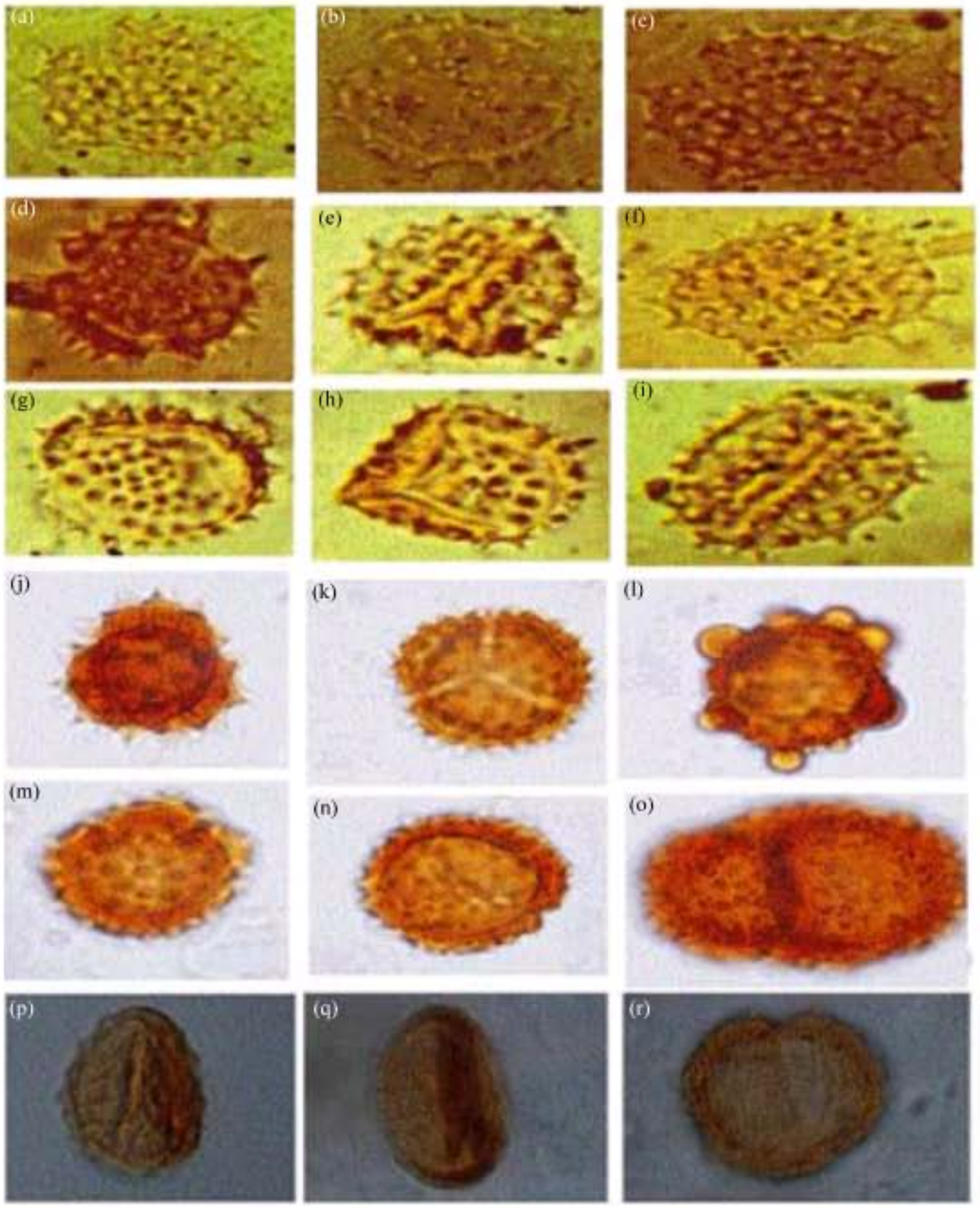

Fig. 1: Asteraceae. (a-i) *Aspilia africana* (Pers), LM x600 and (j-r) *Chromolaena odorata* (Linn.) LM x 1000. Note echinate structure of the family Asteraceae

Vernonia cinerea Linn. (Fig. 3)

- **Shape:** Spherical to rounded triangular amb, radially symmetrical
- **Size:** Maximum dimension 29.5 (27.3-32.5 µm)
- **Aperture:** Lophate tricolpate; colpus long
- **Exine:** Wavy margin, exine thickness: 3.5 (2.6-4.1); spinose; spines wide at the base, with sharp tips; spine height: 2.1 (1.6-2.5) µm

Convolvulaceae: *Ipomoea aquatica* Forsk (Fig. 3):

- **Shape:** Spherical amb. Grains apolar, radially symmetrical
- **Size:** 42.4 (39.0-46.0 µm); Equatorial axis 31.2 (27.0-33.0 µm)
- **Aperture:** Pantotreme, periporate, elliptic and circular, 1.89 µm wide
- **Exine:** Crassimarginate, differentiated into ectosexine and endosexine, 1.62 µm thick, spinose; spines 4.05 µm long, 2.43 µm wide at the base, blunt at the tip

Malvaceae: *Hibiscus rosasinensis* (Linn.) (Fig. 4):

- **Shape:** Spherical amb. Grains apopolar, radially symmetrical
- **Size:** Maximum dimension 79.3(72.0-83.5) µm

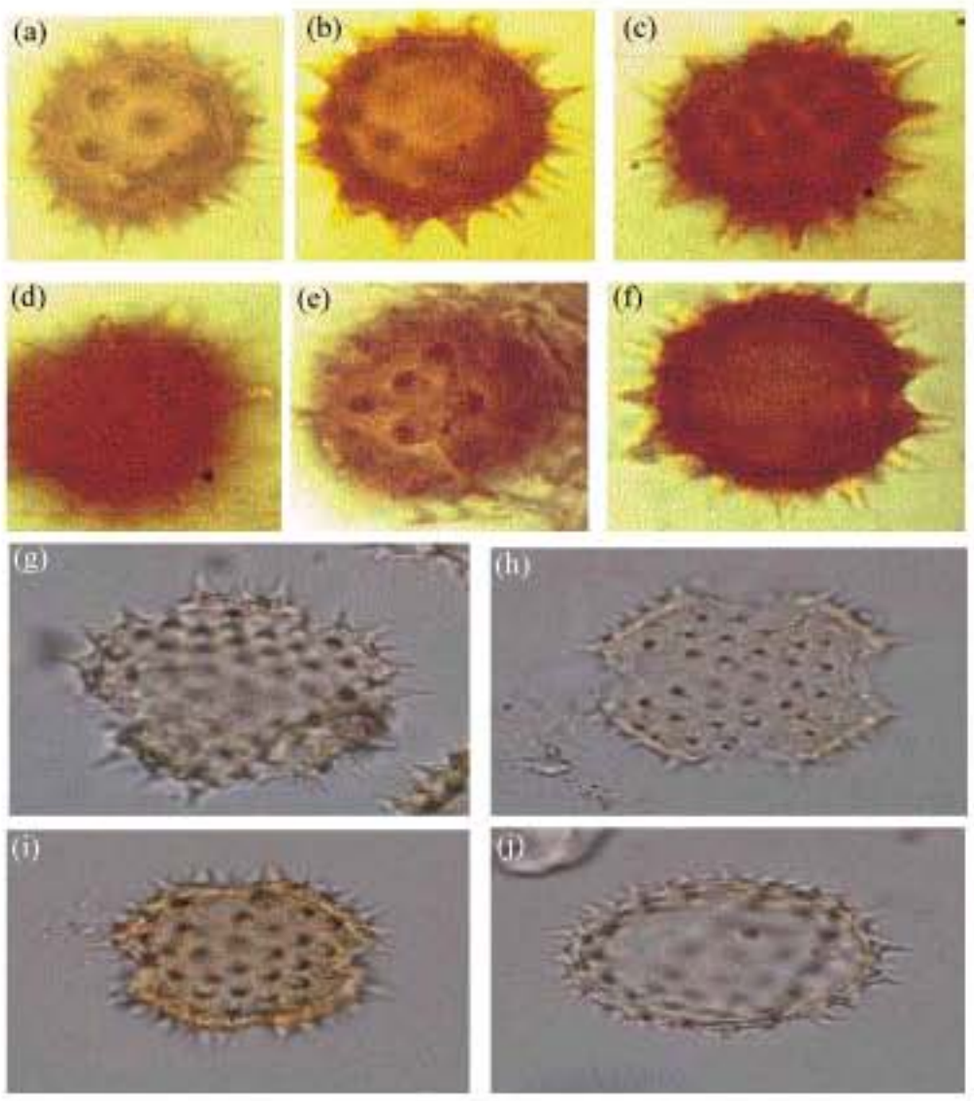

Fig. 2: Asteraceae (a-f) showing conspicuous spines and compound aperture in *Helianthus* sp. (Mart), LM x1000 and (g-j) *Tridax procumbens* (Linn), LM x1000

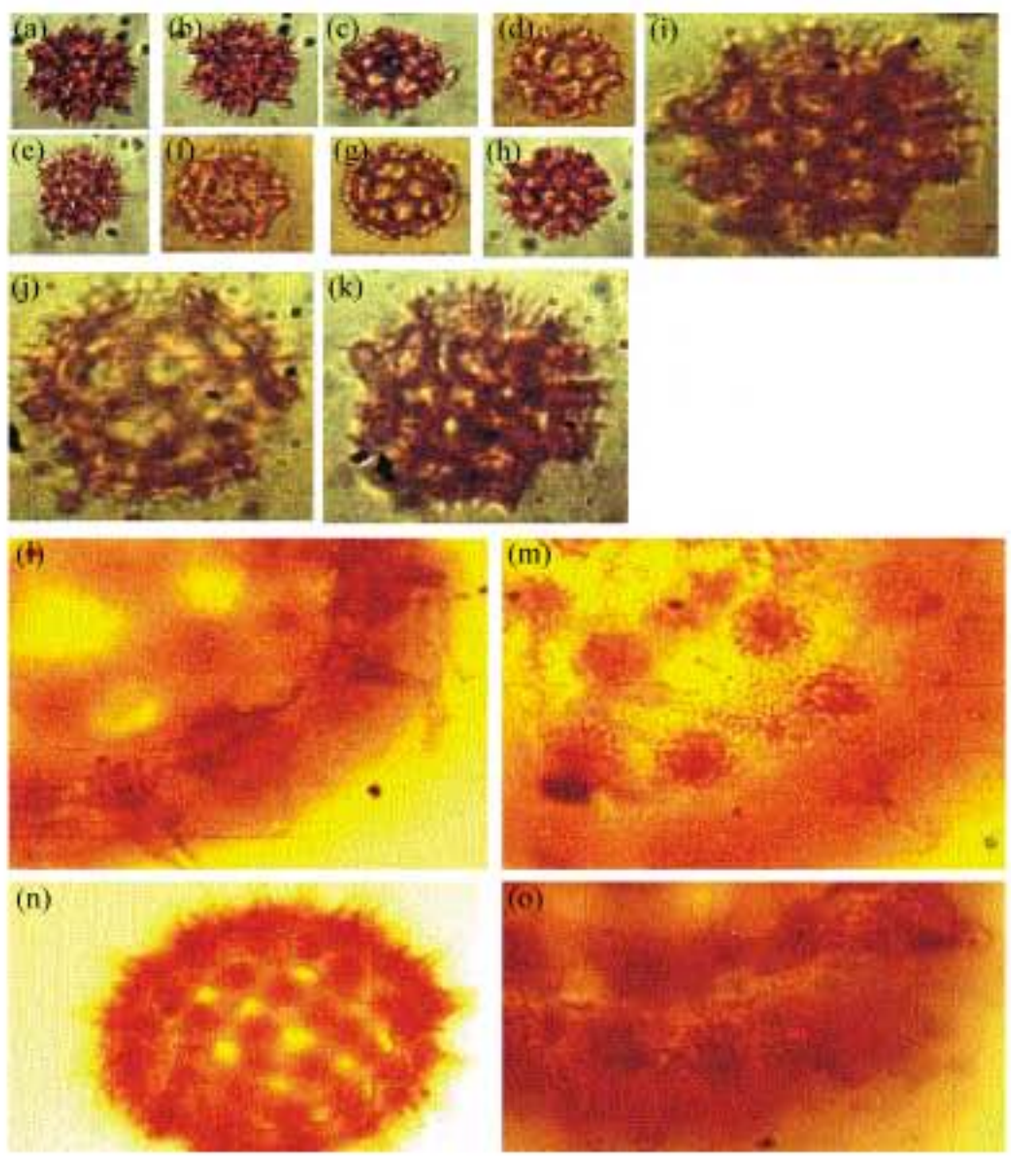

Fig. 3: Asteraceae (a-k) showing lacunae, ridges and micro spines in *Vernonia cinerea*, LM, A-H x400. I-K x1000. Convolvulaceae. *Ipomoea aquatica* (Forsk). (l-o) Showing echinate exine structure in *Ipomoea aquatica*, LM. L, M, O x1000, N x40

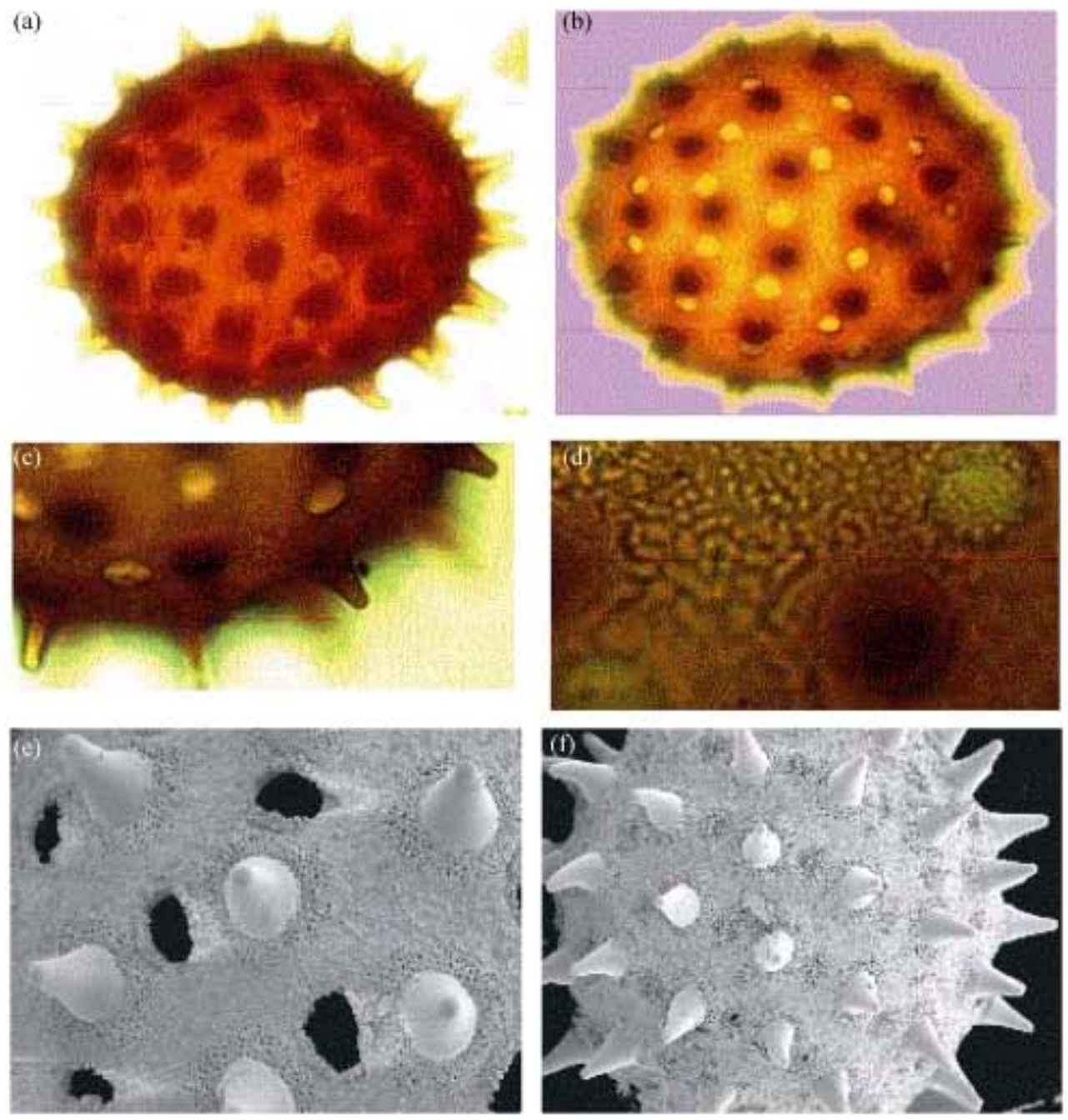

Fig. 4: Malvaceae (a-f) showing prominent spines and evenly distributed pori in *Hibiscus rosasinensis* (Linn.) (a-d) LM, A-B x400, C-D x1000, E, f: SEM E x1000, F x600

- **Aperture:** Periporate, poly pantoporate (pores more than 20), uniform in distribution
- **Exine:** Exine 2.7 µm thick, crassimarginate, spinose, spines 6.75 µm, 2.43 µm wide at the base, blunt apex, sometimes bent; baculate

DISCUSSION

This study has thrown light on the morphological and differentiating characteristics of the pollens studied. Pollen grains in Asteraceae family are relatively stenopalynous with less variation exhibited in the pollen morphology. Asteraceae pollens are mostly rounded triangular to square amb, sometimes circular in polar view and prolate in equatorial view. Apertures are usually tricolporate to tricolpate sometimes tetracolpate or tetracolporate as found in *T. procumbens*. Pollen grains in this family are characteristically echinate in ornamentation. This agrees with morphological description of species of Asteraceae treated by Sowunmi (1973). They can be differentiated from similar echinate pollen in other families by the relatively small size of both the pollen and the spines, as well as the irregular arrangement of the spines. Although, Erdtman (1969) reported that in genus *Artemisia* and a few other anemophilous genera of the Asteraceae, the pollen grains are without obvious spines, Rowley *et al*. (1981) confirmed the presence of spines which are short and hard to see with light microscopy.

The three families studied have one thing in common and that is the echinate nature of the exine ornamentation. *Ipomoea aquatica* has spines like found in Asteraceae but remarkedly bigger in size. Aperture in this species is pantotreme or periporate in arrangement.

Hibiscus rosasinensis a species in the family Malvaceae share the same echinate characteristics but peculiar in possessing isolated spines, which stand out conspicuously. The echinate nature of species of Malvaceae was also reported by Perveen and Qaiser (2009). *Hibiscus* pollen is differentiated from *Ipomoea aquatica* in being larger in size. This size disparity was noted by Sowunmi (1973), who reported *H. tiliaceus* of 116.1 µm in size. Slight size disparity is however noted in some pollen grain species reported by various

researchers. This may not be unconnected with the fact that pollen grain sizes are affected by acetolysis (Faegri and Iverson, 1989) and a few other chemicals used for grain isolation.

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