http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 7 (9): 1594-1602, 2004
ISSN 1028-8880

Pollen Morphology of Plantaginaceae in Jordan

S.A. Al-Quran
Department of Biology, Mu'tah University, P.O. Box 26, Karak, Jordan

Abstract: A total number of 11 Plantaginacean species were investigated palynologically by LM and SEM, 5 different pollen types have been recognized and the keys for these observations were prepared. All specimens investigated have polypantoporate type with many pores in ecto-and endo-aperture, but with more or less or even no annuli and costae. Presence of sxine 1 (columella), sexine 2 (tectum) and sexine 3 (scabrae) as parts of pollen exine were observed. Thin and short columella, scabrae tectum were observed also. 18-40, 1-2, 3-6 μm were be pollen diameter, exine thickness and pore diameter, respectively. Verrucae of the specimens examined were be the channel with few or without punctae.

Key words: Plantaginaceae, pantoporate, exine, annulus, operculum

INTRODUCTION

Plantaginaceae in Jordan has one genus, Plantago, which has 19 species distributed through the different phytogeographical regions[1-3].

The basic structure of pollen grains is well-known[4,5]. Many publications gave descriptions and keys for those studied as guidelines for the others[6-30]. The palynological terms and expressions used by different researchers and investigators sometimes are making confusion and misleading[4,5,31]. All previous studies treated annulus and operculum as two parts from ectoaperture[7,10,12,19-25,29]. As two structures were developed to a greater or lesser extent, they were either present or absent with no intermediate state[4,5].

The development of annulus and operculum in pollen grains have been discussed by many investigators[8,9,14,18,19,25].

Annulus formed by a thickening and accumulation of verrucae aggregations round the pores to form nearly partial annulus appearance, or a complete thickened ring round the pores. While in case of operculum, it is developed and appeared as lid fixed in appropriate way with the rest of sexine structures, but in other cases, granules of sexine are giving the operculum a partial structure. Pollen grains were classified mainly depending on the presence or absence of the two structures into either annulate or operculate, nonannulate or nonoperculate[4,5,31].

The spine-like projection in seine 3 seen by LM has been classified as microechinae, while classified by other investigators using SEM as scabrae. The inner surface of the nexine is divided into discrete areas called endocracks, while at this time, this description is completely eliminated and substituted by channels as new term in pollen morphology[4,5,7,9,10,14,15,17,19,23-25,31-34].

Many investigators were trying to study the pollen grains as a major component in biological aerosol particles of the atmosphere and their application, others were trying to use pollen grains as new bioindicator for pollution. But the major type of investigators were using pollen grains as palynological evidence in paleobotany[8,9,11,14,17-19,25,35,36].

The purpose of this palynological study was trying to use the pollen morphology in taxonomy of plantaginaceae for delimitation the different taxonomic ranks from each other depending on concrete palynological evidences for indications since this family was not yet understood playnologically, which was helpful to give an illustrated guide to pollen grains of plantaginaceae.

MATERIALS AND METHODS

Fresh polliniferous material was collected from fresh speciemens belonging to 11 plantago species by using collecting brushes and field vials introduced to the laboratory to be studied.

For LM studies, the material was prepared according to acetolysis method of Erdtman, 4 duplicates for each species were prepared and 6 slides from each were made[31].

LM micrographs and measurements were taken by using Nikon HFX-11 microscope using ocular micrometer scale by glycerin Jelly method[21].

For SEM studies, the pollen grains prepared by acetolysis method were coated by carbon layer first, then by gold to increase the conduction and electron yield, micrographs were taken by SEM[31].

Corresponding Author: S.A. Al-Quran, Plant Taxonomist, Department of Biology, Mu'tah University, P.O.Box 26, Karak, Jordan Fax: 00962 32372528 E-mail: Salquran2@yahoo.com

Table 1: Pollen structures and measurements of *Plantago* species investigated

Species	Pollen class (µm)	Annulus	Operculum	Margins	Costae
Plantago lanceolata L.	(6)9- 10(15) pantoporate	++	++	++	++
Plantago coronopus L.	(3)6-8(10) pantoporate	++	0	++	+
Plantago major L.	(4)5-10 pantoporate	0	0	0	0
Plantago maris-mortui Eig.	(4)5-10 pantoporate	0	0	0	0
Plantago arabica Boiss	(1)5-8(12) pantoporate	0	0	++	0
Plantago ciliata Desf.	3-9 pantoporate	0	0	0	0
Plantago psyllium L.	(1)5-8(12) pantoporate	0(+)	0	++	0
Plantago ovata L.	(3)6-8(10) pantoporate	++	0	++	++
Plantago arenaria Waldest and Kit.	(1)5-8(12) pantoporate	0	0	++	0
Plantago amplexicaulis Cav.	3-9 pantoporate	0	0	0	0
Plantago crassifolia. Forsk.	(1)5-8(12) pantoporate	0(+)	0	++	0

Table 2: Pollen structures and measurements of *Plantago* species (plantaginaceae)

Species	Pollen dia. (µm)	Exine (µm)	Pore (µm)	Annulus (µm)	Shape and Ornamentation
Plantago lanceolata L.	(20)24- 30(34)	1-2	3-4	2	circular, verrucate with small punctae, sexine scabrae and nexine surface are not well-defined
Plantago coronopus L.	22-28(30)	2	2-4	2.5	circular, verrucate with few punctae, sexine scabrae and nexine surface are not well-defined
Plantago major L.	18-27	1-1.5	3-5	-	circular, verrucate without punctae, (Verrucae ++), sexine and nexine surfaces are not well-defined
Plantago maris-mortui Eig.	20-26	1-1.5	3-4	-	circular, verrucate without punctae, (Verrucae ++), sexine scabrae, nexine and sexine are not well-defined
Plantago arabica Boiss	22-32	1-2	3-5	-	circular, verrucate with few or no punctae, (Verrucae +), sexine scabrae and nexine surface are almost not well-defined
Plantago ciliata Desf.	(30)32-40	1.5-2	4-6	-	circular, verrucate with small punctae, (verrucae ++), sexine scabrae and nexine surface are almost not well-defined
Plantago psyllium L.	22-32	1-2	3-5	-	circular, verrucate with or without punctae, (Verrucae +), sexine scabrae, nexine and surface are almost not well-defined
Plantago ovata L.	22-30	1.5-2	3-5	2.5	circular, verrucate with few or no punctae, (Verrucae +), sexine scabrae, nexine surface are almost not well-defined
Plantago arenaria Waldest and Kit.	22-32	1.50-2	3-5	-	circular, verrucate with few or no punctae, (Verrucae +), sexine scabrae, nexine and surface are almost not well-defined
Plantago amplexicaulis Cav.	30(32)-40	1.5-2	4-6	-	circular, verrucate with few or no punctae, (Verrucae +), sexine scabrae, nexine and surface are almost not well-defined
Plantago crassifolia. Forsk.	22-32	1.5-2	3-5	-	circular, verrucate with few or no punctae, (Verrucae +), sexine scabrae, nexine and surface is almost not well-defined

++ : the structure is well-defined + : the structure is not well-defined 0 : the structure is not present

RESULTS AND DISCUSSION

It is obvious from the results obtained (Table 1 and 2) that the only possible way to delimit the species palynologically is by using the number of pores in each pollen grain because all of the examined species have the same pollen class (Pantoporate).

Five Pollen types were distinguished among the species examined (Table 1 and 2 and Fig. 1-5);

- ***Plantago lanceolata* type:** It has well-developed opercula truly formed, similar to lid fixed in appropriate way. The annuli, margins of ectoaperture, costae of endoaperture are also highly developed and they considered as distinguishing features in pollen grains. This pollen type was represented by one species, *Plantago lanceolata* L.
- ***Plantago coronopus* type:** The annuli and ectoaperture margins in this pollen type are highly developed while the opercula and endoaperture costae were poorly developed. This pollen type was represented by 2 species; *Plantago coronopus* L. and *Plantago ovata* L.
- ***Plantago crassifolia* type:** It is with highly developed ectoaperture margins, while the costae were not present. Both the annuli and operculae may or may not present. This pollen type was represented by 4 species from those examined; *Plantago arenaria* waldst kit, *Plantago psyllium* L., *Plantago crassifolia* Frossk. and *Plantago arabica* Boiss.
- ***Plantago major* type:** It has no annuli and costae. The opercula and ectoaperture surface were poorly developed. This pollen type was represented by 2 species; *Plantago maris-mortui* Eig and *Plantago major* L.

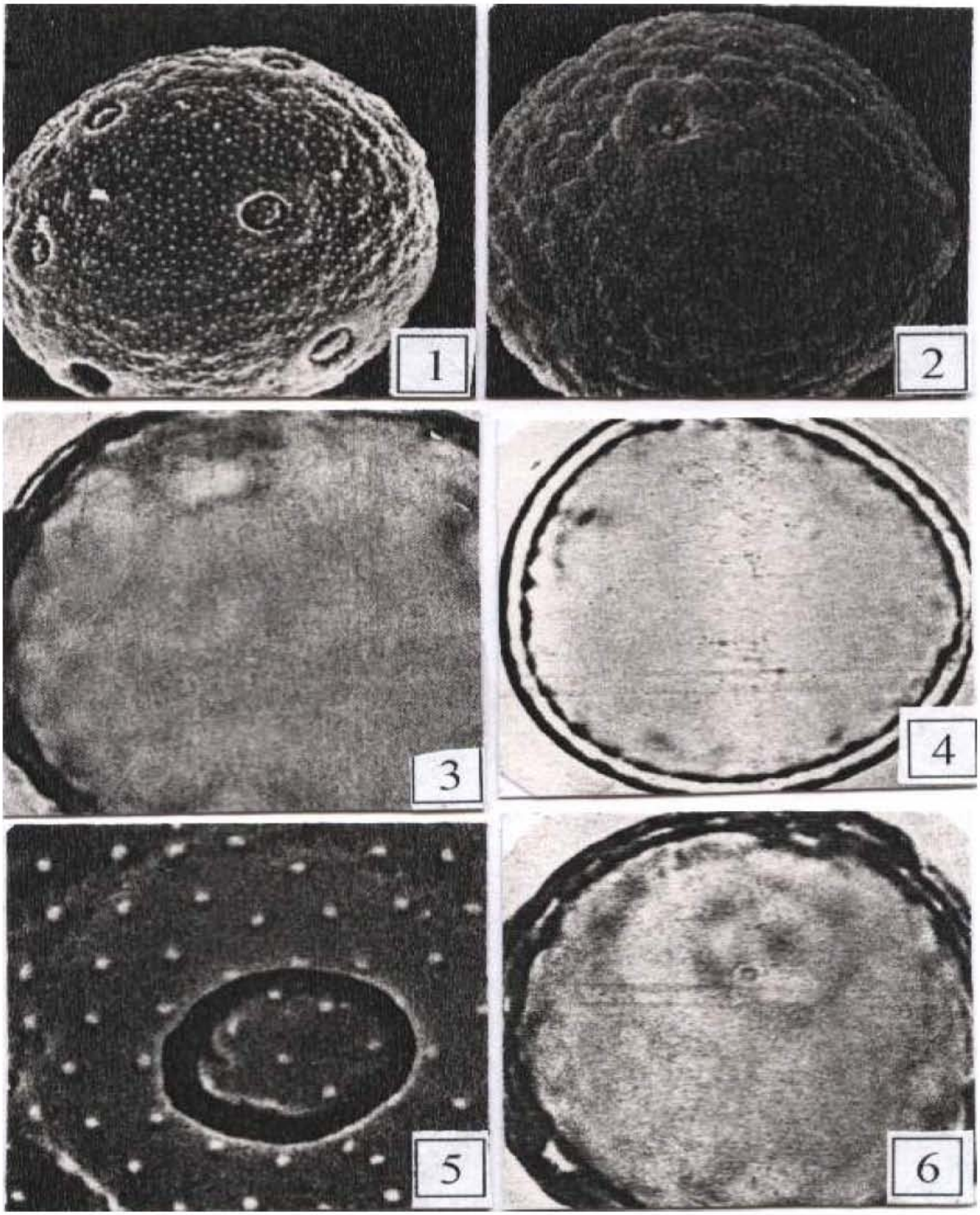

Fig. 1(1-6): 1: SEM showing overall view of pollen grain of *Plantago lanceolate* L. (1770x)
2: SEM showing overall view of pollen grain of *Plantago coronpus* L. (1750x)
3: LM showing the optical cross section in pollen grain of *Plantago coronpus* L. (2000x)
4: LM showing the optical cross section in pollen grain of *Plantago major* L. (2000x)
5: SEM showing the pore in pollen grain with operculum and annulus in *Plantago lanceolate* L. (1520x)
6: LM showing the optical cross section in pollen grain of *Plantago maris-mortui* L. (2000x)

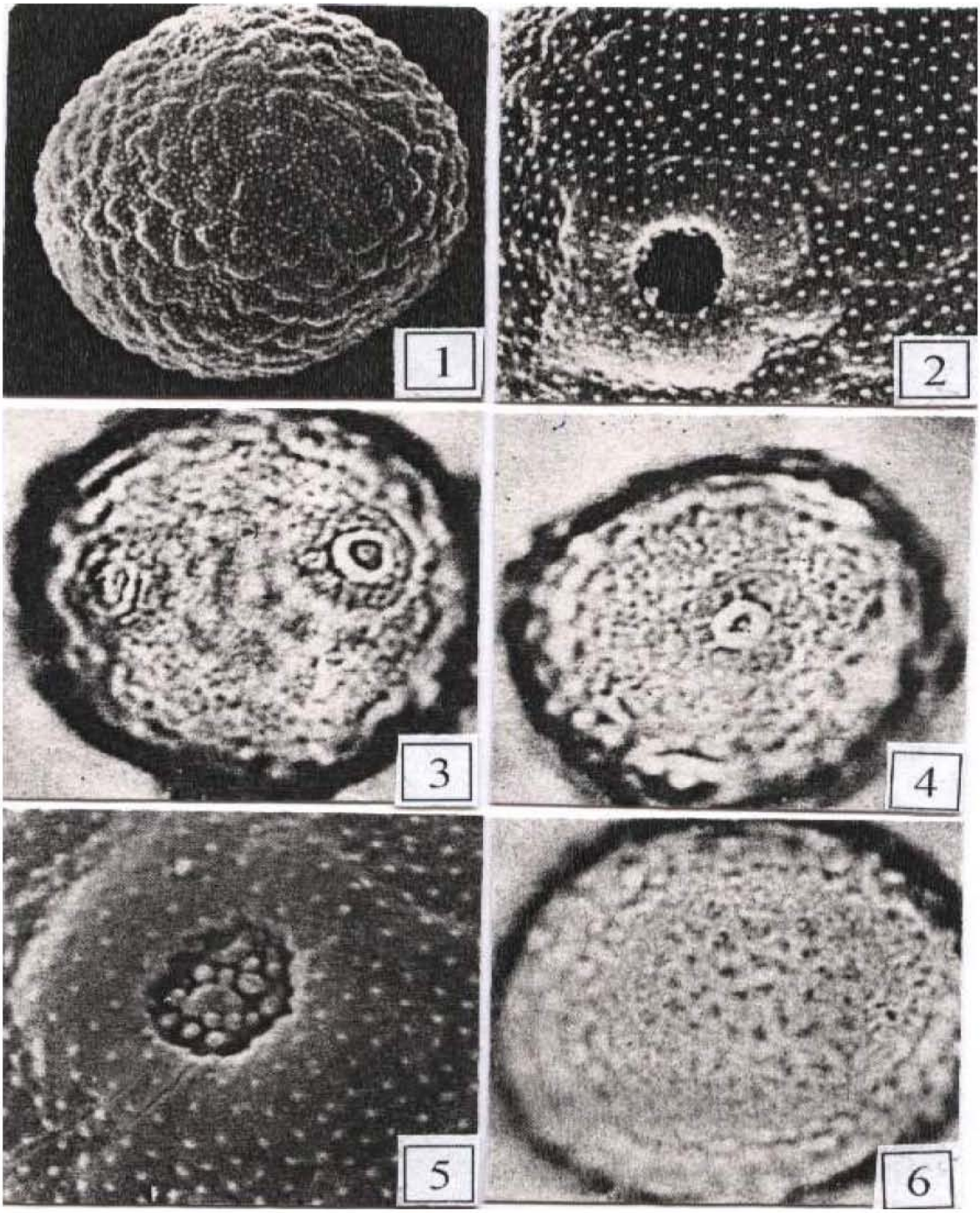

Fig. 2(1-6): 1: SEM showing the overall view of pollen grain with pore and disintegrated operculum in *Plantago major* L. (1960x)
2: LM showing the pollen grain of *Plantago coronopus* L., it is showing clearly the pore with complete annulus (2000x)
3: LM showing the optical cross section in pollen grain of *Plantago lanceolata* L., pore with operculi are obvious (2000x)
4: LMshowing the pore with granular operculum in pollen grain of *Plantago arabica*. Boiss. (2000x)
5: SEM showing the pore and ornamentation in pollen grain of *Plantago major* L. (5480x)
6: LM showing the pore with costae in pollen grain of *Plantago ciliata* Desf. (2000x)

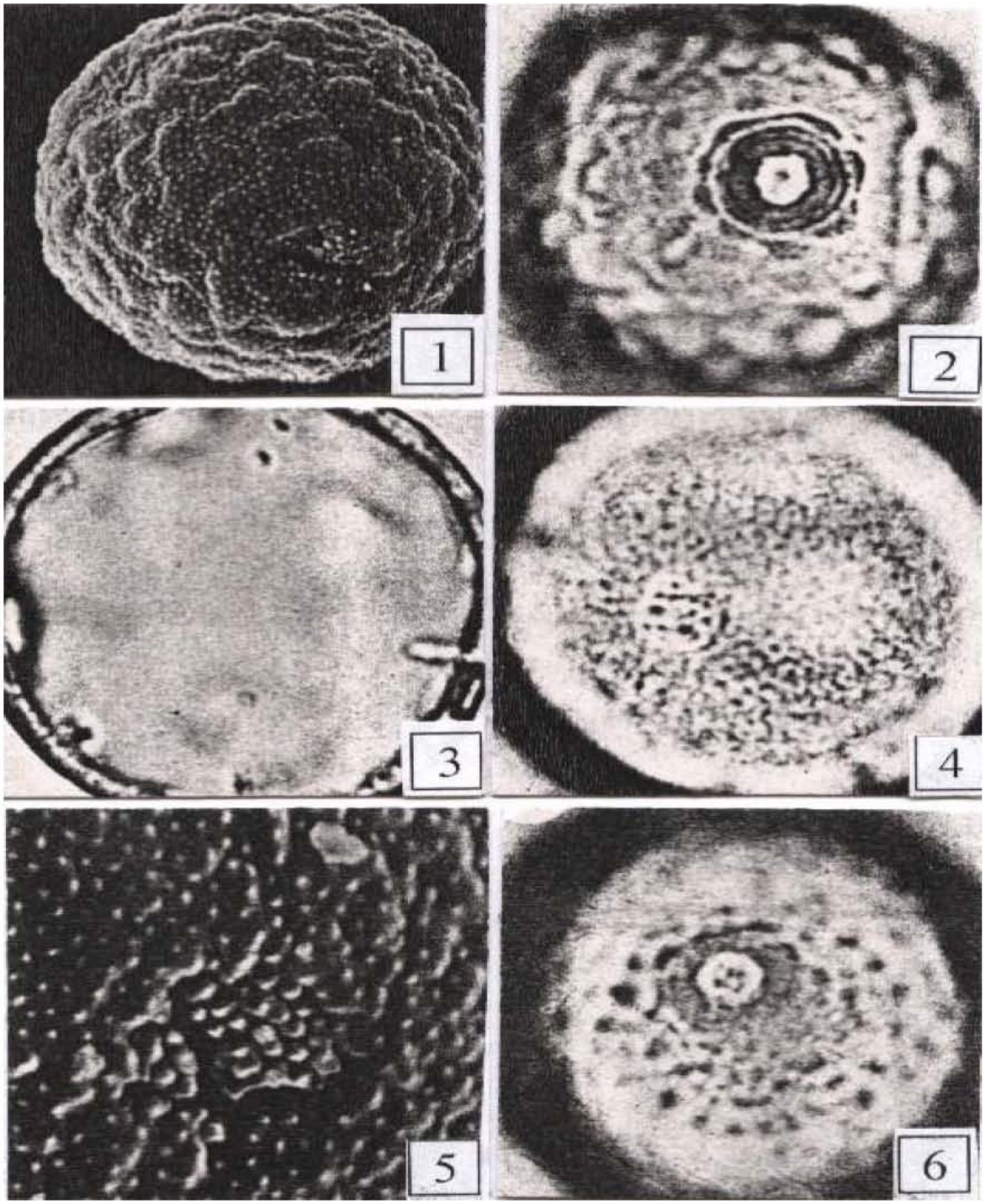

Fig. 3(1-6): 1: SEM showing the overall view of pollen grain of *Plantago psyllium* L., the pores and opercula are not highly focused (1990x)
2: SEM showing pore and verrucae in pollen grain of *Plantago psyllium* L. (1730x)
3: LM showing the overall view of pollen grain of *Plantago arabica* Boiss., Verrucae annuli and operculi are seen (2000x)
4: LM showing verrucae and ornamentation in pollen grain of *Plantago psyllium* L. (2000x)
5: SEM showing the pore with annulus and operculum in pollen grain of *Plantago ovata*. Forsk. (1490x)
6: LM showing the annulus and radiating nexine channels in pollen grain of *Plantago ovata*. Forsk. (2000x)

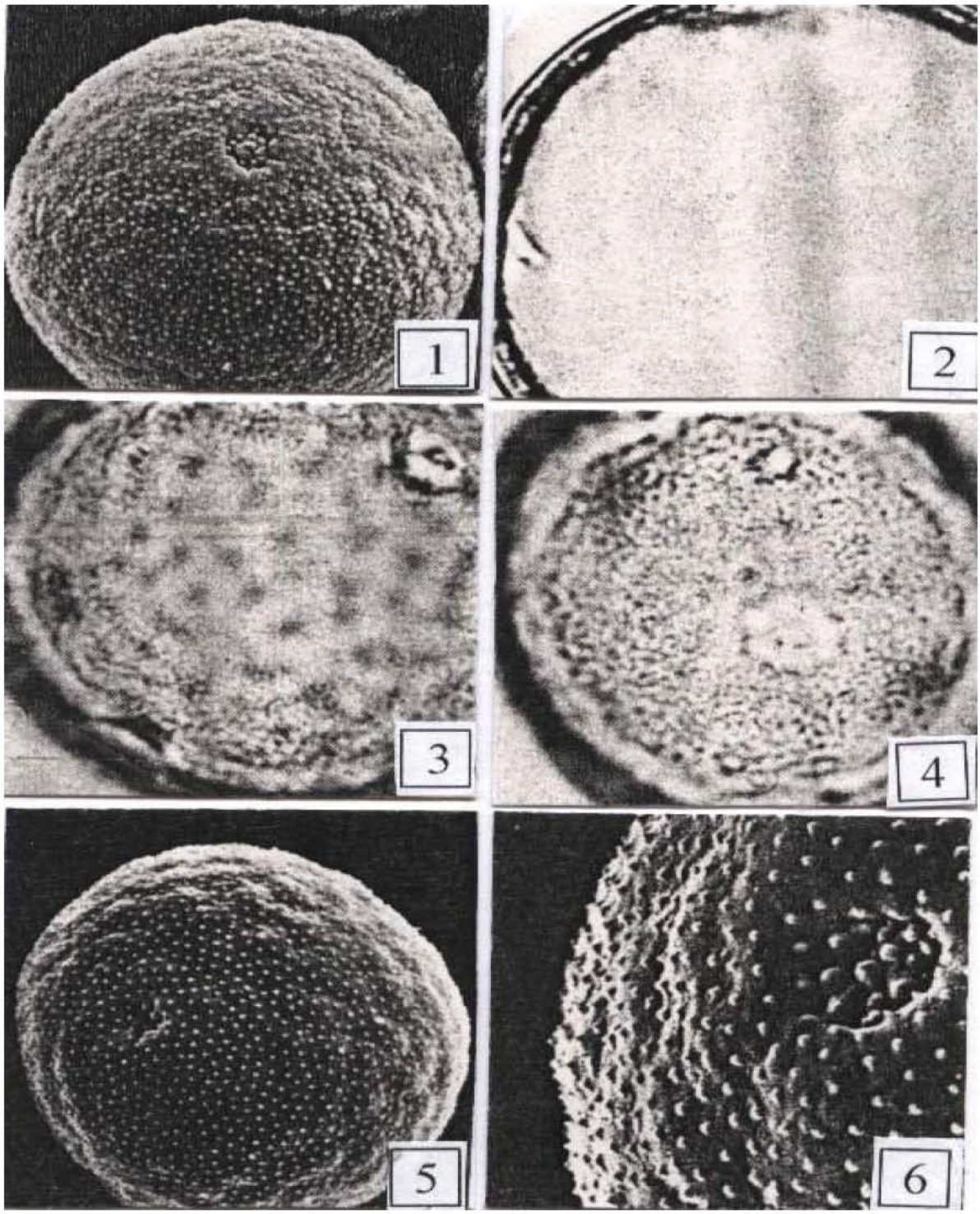

Fig. 4 (1-6): 1: SEM showing the overall view pores in pollen grain of *Plantago arenaria*. Waldst. and Kit. (1995x)
2: LM showing the optical cross section in pollen grain of *Plantago arenaria*. Waldst. and Kit. (2000x)
3: LM showing verrucae and ornamentation in pollen grain of *Plantago arenaria*. Waldst. and Kit. (2000x)
4: LM showing pore and ornamentation in pollen grain of *Plantago amplexicaulis* Cav. (2000x)
5: SEM showing the overall view with pores in pollen grain of *Plantago amplexicaulis* Cav. (1540x)
6: SEM showing the ornamentation with pores and opercula in pollen grain of *Plantago amplexicaulis* Cav. (4435x)

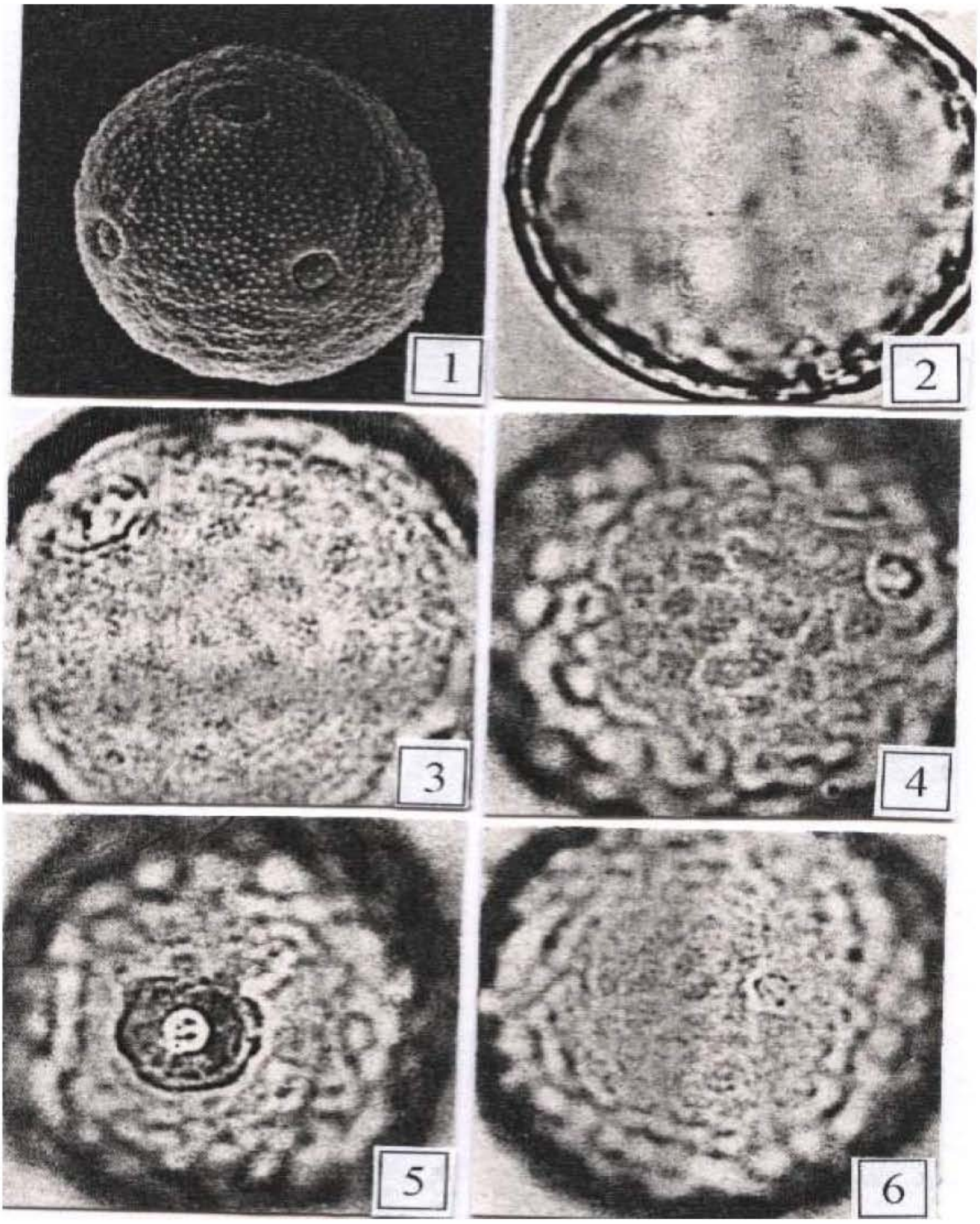

Fig. 5(1-6): 1: SEM showing the overall view pores in pollen grain of *Plantago crassifolia* Forsk. (2010x)
2: LM showing the optical cross section in pollen grain of *Plantago arenaria*. Waldst. and Kit. (2000x)
3: LM showing verrucae and ornamentation in pollen grain of *Plantago ovata* . Forsk (2000x)
4: LM showing pore and ornamentation in pollen grain of *Plantago arenaria*. Waldst. and Kit. (2000x)
5: LM showing pore and verrucae in pollen grain of *Plantago arenaria*. Waldst. and Kit. (2000x)
6: LM showing pore and costae in pollen grain of *Plantago crassifolia*. Forsk. (2000x)

- ***Plantago ciliata* type:** It has no annuli and costae, with poorly developed opercula and ectoaperture margins. This pollen type was represented by 2 species from those examined; *Plantago amplexicaulis* Cav. and *Plantago ciliata* Desf.

With respect to exine structures, all the species examined were similar, they have short and thin columella (sexine 1), variable thickness of tectum (sexine 2), with scabrae (sexine 3).

Pollen measurements were variable related to pollen diameter (size), exine thickness, pore diameter and annulus broad (Table 1, 2 and Fig. 1-5).

The using of this palynological study in taxonomy of plantaginaceae to delimit the different species of *Plantago* from each other is useful, because it was obvious from the results, that there were some playnological parameters can be depend upon to distinguish 5 types of pollen grains. They were; the presence or absence and the highly or poorly development of opercula, annulus, surface and margins of ectoaperture and costae of endoaperture.

Depending on the results obtained, the following taxonomic key can be concluded:

- Highly annulate:
  a) Highly operculate……..*Plantago lanceolata* type
  b) Not highly operculate.....*Plantago coronopus* type
- Poorly annulate:
  a) Pore size up to 40 μm……*Plantago ciliata* type
  b) Pore size up to 32 μm……*Plantago crassifolia* type
  c) Pore size up to 27 μm…… *Plantago major* type

It is clear from this study compared to the previous studies that each study using palynological characters as taxonomic evidence in delimitation to certain taxonomic categories has special case be controlled by, accordingly, the palynological characters used in this study may not valid as evidences in taxonomy of other taxonomic ranks, because the palynological characters used by the previous studies are steadily not valid for this study.

ACKNOWLEDGMENT

The researcher would like to thank the kind help given by technicians in particular to Christine Gruber from SEM unit in institute of Botany-free University of Berlin, Germany.

REFERENCES

1. El-Eisawi, D., 1982. List of Jordan Vascular Plants, Jordan University, Amman.
2. Karim, F. and S.Al-Qura'n, 1988. Wild Flowers of Jordan, Yarmouk University Press, Irbid, Jordan.
3. Zohary, M., 1973. Geobotanical Foundations of the Middle East, Gustav Fisher Verlag, Sttugart.
4. Panajiotidis, S. *et al.*, 2000. Pollen morphology in relation to the taxonomy and phylogeny of Aegilops species. Grana, 39: 126-132.
5. Moore, P.D. and J.A. Web, 1978. An illustrated Guide to Pollen Analysis, Hodder and Stoughton, London.
6. Banks, H. and P. Gasson, 2000. Pollen morphology and wood anatomy of the Crudia group (Leguminosae, Caesalpinioideae, Detarieae). Botanical J. Linnean Soc., 134: 19-59.
7. Banks, H. and L. Rico, 1999. Pollen morphology and phylogenetic analysis of *Eperua aublet* (Detarieae: Caesalpinioideae: Leguminosae). Grana, 38: 261-276.
8. Bernardello, L. and M.C. Lujan, 1997. Pollen morphology of tribe Lycieae: Crabowskia, Lycium, Phrodus (Solanaceae). Review of Palaeobotany and Palynol., 96: 255-280.
9. Carine, M.A. and R.W. Scotland, 1998. Pollen morphology of *Strobilanthes blume* (Acanthaceae) from Southern India. Review of Palaeobotany and Palynology, 103: 143-165.
10. Delaporte, K. *et al.*, 2001. Morphological analysis to identify the pollen parent of an ornamental interspecific Eucalyptus. Scientia Horticulturae, 89: 57-74.
11. Dessein, S. *et al.*, 2000. Pollen morphological survey of Pentas (Rubiaceae-Rubioideae). Review of Paleobotany and Palynology, 112: 189-205.
12. Banks, H. and P. Gasson, 2000. Pollen morphology and wood anatomy of the Crudia group (Leguminosae, Caesalpinioideae, Detarieae). Botanical J. Linnean Soc., 134: 19-59.
13. Harley, M.M. and W.J. Baker, 2001. Pollen aperture morphology in Arecaceae: application within phylogenetic analysis. Summary of record of palm-like pollen fossil. Grana, 40: 45-77.
14. Huysmans, S. *et al.*, 1998. A collapsed tribe revisited: pollen morphology of the isertieae. Review of Palaeobotany and Palynology, 104: 85-113.
15. Kosenko, V.N., 1999. Contributions to the pollen morphology and taxonomy of the Liliaceae. Grana, 38: 20-30.

16. Kosenko, V. and D.Y. Sventorzhetskaya, 1999. Pollen Morphology in the Family Asphodelaceae (Asphodeleae, Kniphofieae). Grana, 38: 218-227.
17. Krassilov, V.A. and L.B. Golovneva, 2001. Inflorescence with tricolpate pollen grains from the cenomanian of Tschulymo Basin, West Siberia. Review of Palaeobotany and Palynology, 115: 99-106.
18. Nowicke, J.W. *et al*., 1998. Pollen morphology, exine structure and systematic of Acalyphoideae (Euphorbiaceae) part 1. Tribes clutieae (clutia), pogonophoreae (pogonophora), chaetocarpeae (chaetocarpus, Trigonopleura), Pereae (pera), cheiloseae (cheilosa, Neoscorteon). Review of Palaeobotany and Palynology, 102: 115-152.
19. Nowicke, J.W. *et al*., 1999. Pollen morphology, exine structure and systematic of Acalyphoideae (Euphorbiaceae) part 2. Tribes Agrostistachydeae (Agrostistachys, Pseudagrostistachys, Cyttarastachys, Chondrostylis), chrozophoreae (Speranskia, Caperonia, Philyra, Ditaxis). Review of Palaeobotany and Palynology, 105: 1-62.
20. Osborn, J.M. *et al*., 2000. Pollen morphology and ultrastructure of *Marathrum schiedeanum* (podostemaceae). Grana, 39: 221-225.
21. Faegari, K. and J. Iversen, 1975. Text Book of Pollen Analysis, 3rd Ed. Munksgard, Copenhagen.
22. Pardo, C. *et al*., 2000. Pollen morphology in Cytisus (papilionoideae, Leguminosae) from morocco and its peninsula. Grana, 39: 159-168.
23. Premathilake, R. *et al*., 1999. Pollen morphology of some selected plant species from Horton Plains, Sri lanka. Grana, 38: 289-295.
24. Stenzel, H., 2000. Pollen morphology of the subtribe pleurothallidinae Lindl. (orchidaceae). Grana, 39: 108-125.
25. Urtubey, E. and M. Cristina Tellera, 1998. Pollen morphology of the subfamily Barnadesioideae (Asteraceae) and its phylogenetic and taxonomic significance. Review of Palaeobotany and Palynology, 104: 19-37.
26. Van Der Ham, R., *et al*., 2001. Pollen morphology and phylogeny of the Alyxieae (Apocynaceae). Grana, 40: 169-191.
27. Villodre, J.M. and N. Giarcia-Jacas, 2000. Pollen studies in subtribe centaureinae (Asteraceae): the Jacea group analyzed by electron microscopy. Botanical J. Linnean Soc., 133: 473-484.
28. Victor, J.E. and A.E. Van Wyk, 1999. Pollen morphology of Adenandra (Diosminae:Rutaceae) and its taxonomic implications. Grana, 38: 1-11.
29. Victor, J.E. and A.E. Van Wyk, 2000. Pollen morphology of phyllosma and sheilanthera (Diosminae:Rutaceae) and its taxonomic implications, Grana, 39: 103-107.
30. Victor, J.E. and A.E. Van Wyk, 2001. Pollen morphology of Euchaetis and Macrostylis (Diosminae-Rutaceae) and its taxonomic implications. Grana, 40: 105-110.
31. Erdtman, G., 1960. The acytolysis method, a revised description, sven. Bot. Tidsker, 54: 561-564.
32. Van Wichelen, J. *et al*., 1999. Comparison of different treatements for LM and SEM studies and systematic Value of grains in cyperaceae. Grana, 38: 50-58.
33. Suarez-Cervera, M. *et al*., 2001. Taxonomic significance of sporoderm structure in pollen of Euphorbiaceae: Tribe plukenetieae and Euphorbieae. Grana, 40:78-104.
34. Roque, N. and M.S.F. Silvestre-Capelato, 2001. Generic delimitation of Gochnatia and lanthopappus based on pollen morphology. Grana, 40: 197-204.
35. Golovko, V.V. *et al*., 1997. A pollen component of bioaerosol in the air of Novosibirsk. J. Erosol. Sci., 28: 591-592.
36. Mathias-Maser, S. *et al*., 1997. A conrtribution of primary biological aerosol particles as insoluble component to atmospheric aerosol over the south atlantic ocean. J. Aerosol. Sci., 28: 3-4.