

Palynology of Family Asteraceae from Flora of Rawalpindi-Pakistan

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ABSTRACT

Present study was confined to pollen morphology and pollen fertility estimation used an aid in taxonomic description of 7 species of family Asteraceae from flora of Rawalpindi. The species are *Ageratum conyzoides* L., *Calendula arvensis* L., *Cousinia minuta* Boiss., Diagn., *Eclipta alba* (L.) Hasskl, *Parthenium hysterophorus* L., *Saussuria heteromala* (D. Don) Hand-Mazz and *Taraxacum officinale* Weber. Polleniferous material and complete plant specimens were properly collected, identified and utilized for studies. Pollen morphology varies among these species very considerably. Palynomorph inventory was developed, which consist of family name, botanical name, local name, English name, distribution, flower color and season and pollen description. It was found that pollen characters i.e. shape, P/E ratio, surface of exine and pollen morphology was considered to be important characters used as an aid in taxonomy of these species. Pollen fertility estimation ranged from 90 - 98.11%, which shows that pollen flora of selected species is well established. It was concluded from this research that palynological data is very important not only for taxonomists but also for other scientists working in related disciplines of pure and applied sciences.

Key Words: Palynology; Asteraceae; Flora of Rawalpindi-Pakistan

INTRODUCTION

Rawalpindi is situated in North West corner of Punjab. It lies between 33' and 34' North latitude and 72' and 74' East longitude. Rawalpindi shares boundaries with Hazara District in North, with Poonch in East, with Jhelum District in South and with Attock District in West. Its total area is 2051 sq. miles and only 936 sq. miles are cultivated. The elevation rising from 1,500' at Gujar Khan and 1750' at Rawalpindi to 7,500' in the Hill Station of Muree. The district comprises six tehsils namely Rawalpindi, Murree, Kotli Sattian, Kahuta, Gujar Khan and Taxila (Anon, 1998).

The flora of Rawalpindi is Mediterranean type of flora. Because of long dry seasons the flora of the plains is distinctly arid. Grasses are also very numerous, no less than 185 are collected so far (Stewart, 1957). In view of its varied geographical feature, the Rawalpindi is rich in the diversity of its flora, differing in character at different elevations. *Acacia modesta* (phulahi), is the commonest tree and *Olea cuspidata* (Kao), is commonly associated with it. In addition to the trees there are *Zizyphus* spp., several *Grewia* spp., a *Rhammus* sp. and *Elhretia aspera*. As undergrowth, underneath or between the small trees there are a number of common shrubs, *Dodonaea viscosa* (sanatha), *Gymnosporia royleana* (Pataki), *Adhatoda vasica* (bhekar), *Otostegia limbata* (awani booti) and *Carissa opaca* (granda) being among the most common. *Capparis decidua* (C. aphylla) and *Periploca aphylla* (bata) are occasional in very dry places. One or more large *Ficus benghalensis* (bor) trees shade almost every village pond

and can be seen from a long distance. *Salix acmophylla* is the common wild willow found beside water. *Dalbergia sissoo* (shisham or tali) is the most valuable tree for furniture and is common both in wild and cultivated form. *Peganum harmala* (harmal) and *Calotropis* (akk) are also common species. Some of the wild products of the plants include floral buds of *Bauhinia variegata* (Kachnar), *Punica granatum* (Pomegranate), fruit of *Capparis aphylla* (Karien) and *Zizyphus nummularia* (Jangli Ber). There is also a rich and unique bio-diversity of herbaceous flora in various seasons of the year.

The family Asteraceae is an extremely natural taxon, with its unique floral theme and micro-morphological features including those of pollen grains. It is an eurypalynous family (Erdtman, 1952) and most of its genera posses zonocolporate pollen (Sachdeva & Malik, 1986).

There are many disciplines associated with taxonomy, which are used by taxonomists as an aid, or to improve the identification, classification and systematic position of plant taxa. Among these disciplines, palynology is one of the most significant tool used by modern taxonomist to identify and differentiate closely related taxa. The study of Pollen biology has direct relevance in agriculture, horticulture, forestry, plant breeding and bio-technology. Pollen grain have potential use in gene transfer, monitoring cytotoxic effect of bio-active chemical such as herbicides, pesticides and pollutants understanding the organization and function cyto-skeleton and association proteins, studies on expression and cloning of gene and researches on intracellular differentiation and polarity.

In present study an account was made to distinguish micro-morphological characters in order to strengthen the recognition of 7 species of Asteraceae. The purpose of the study is therefore to differentiate these species of Asteraceae on the basis of palynological studies.

MATERIALS AND METHODS

Study was conducted during 2005 - 06 in the Experimental Taxonomy Lab. and Herbarium of Quaid-i-Azam University, Islamabad. The study was confined to pollen description of 7 species of the family Asteraceae. Keeping in mind the objectives and need of the study, field trips were arranged to collect polleniferous material and plant specimen for study.

Glycerin jelly was used in pollen staining and prepared according to modified method of (Meo & Khan, 2005). Mature floral buds were utilized from the fresh plant material for palynomorph study. Fresh polleniferous material was used according to a special technique known as Wodehouse technique (Ronald, 2000). Different parameters were studied under light microscope for pollen morphology as Qualitative characters included Type of pollen, Shape in polar and equatorial view, Presence of colpi and spines, Shape of pore (ora) and Sculpturing. Quantitative characters included Polar and Equatorial diameter, P/E ratio, No. of spines/pollen, No. of spines b/e colpi, No. of colpi, Length/width of colpi, No. of pores, Spine length, No. of spine and Exine thickness. Microphotography was carried out in Electron Microscope (EM) Laboratory of Quaid-i-Azam University with the help of Camera fitted Nikon light Microscope (LM). Fully stained pollens were considered fertile, while the lightly stained, deformed pollens, un-stained pollens were considered sterile. Percentage of pollen fertility was calculated.

RESULTS

Palynomorph description. In this study total of 7 species belonging to 7 genera were investigated for Palynomorph features (Table I). Palynomorph inventory represents the finding in alphabetic order of families followed by botanical name, local name, English name, Phytography, Phytogeography, flower color and season and Palynomorph features.

(vi). Asteraceae

1. *Ageratum conyzoides* L.

A. houstonianum Mill. Gard.

Local Name : Neeli Booti
English Name : Goat weed
Phytogeography : Pantropicl, Central and South Amer Widespread weed. In Pakistan; Islamabad and Rawalpindi.
Flower Color and Season : Pruplish pink and

February-April.

Palynomorph : Pollen is monad, tricolporate. Shape of pollen in polar and equatorial view is circular. Polar diameter is 19.7 μm (15 - 20.5 μm). Equatorial diameter is 19 μm (16.5 - 20 μm). P/E ratio is 1.03 μm . The length of spine is 2.3 μm (2 - 2.5 μm). Exine thickness is 1.2 μm (1 - 1.5 μm).

2. *Calendula arvensis* L.

Local Name : Zergul
English Name : Pot Marigold
Phytogeography : South Europe, Caucasus, Iran and Afghanistan. In Pakistan; Swat, Lower Hazara, Poonch, Kashmir, Balti, Ladak and Rawalpindi.
Flower Color and Season : Orange yellow and March-April

Palynomorph : The pollen is monad, tetracolporate and echinate. The shape of pollen in polar view is rectangular and in equatorial view is circular to perprolate. The polar diameter with spines is 39 μm (36 - 40 μm) and equatorial diameter is 41.16 μm (39.5 - 44.5 μm). P/E ratio is 0.94 μm . Length of spine is 4.8 μm (4.5 - 5 μm), number of spines between colpi are 5 - 7. Length of colpi 7.5 μm (7 - 8 μm) and width of colpi is 7.75 μm (6.5 - 9 μm). Exine thickness is 1.66 μm (1.5 - 2 μm).

3. *Cousinia minuta* Boiss., Diagn.

Syn: *C. calcitrapella* Bormm. in Notizbl.

Local Name : Nika Kanda
English Name : Cousinia
Phytogeography : In Pakistan; Waziristan, Wana, Kurram, Kerkalla, Hariab, Peshawar, Slat Range, Sakesar, Lahore, Jhelum, Swat, Hazara and Rawalpindi.
Flower Color and Season : Yellow and February-May
Palynomorph : The pollen is monad and tricolporate. The shape of pollen equatorial view is prolate and subprolate. Equatorial diameter is 38 μm (35.5 - 40 μm). Exine thickness is 5.33 μm (4 - 6.5 μm).

4. *Eclipta alba* (L.) Hasskl.

Eclipta prostrata (L.) L. Mant.

Verbesina alba L.

Local Name : Bhangra
English Name : False daisy
Phytogeography : In Pakistan; Mingora, Saidu, Salt Range, Hazara, Mansera, Jaba, Hilkote, Poonch, Kashmir Islamabad and Rawalpindi.

Flower Color and Season : White with pale yellow and September-November

Palynomorph : The pollen is monad, tricolporate and echinate. The shape of pollen in polar and equatorial view is circular. Polar diameter is 22.45 μm (20 - 25 μm) and equatorial diameter is 22.5 μm (20 - 25 μm). P/E ratio is 0.99 μm . The length of spine is 2.5 μm (1.5 - 4 μm). Exine thickness is 7.4 μm (1 - 2 μm).

5. *Parthenium hysterophorus* L.

Syn: *Parthenium lobatum* Buckl.

Table I. Comparative pollen characters of 7 species of Asteraceae

Species Name	Pollen type	Polar and Equatorial view	Polar Diameter	Equatorial Diameter	P/E ratio	Exine thickness
<i>Ageratum conyzoides</i> L.	Monad, tricolporate and echinate	Circular	19.7 µm (15-20.5 µm)	19 µm (16.5-20 µm)	1.03 µm	1.2 µm (1-1.5 µm)
<i>Calendula arvensis</i> L.	Monad, tetracolporate and echinate	Rectangular and circular to perprolate	39 µm (36-40 µm)	41.16 µm (39.5-44.5 µm)	0.94 µm	1.66 µm (1.5-2 µm)
<i>Cousinia minuta</i> Boiss., Diagn.	Monad and tricolporate	Prolate to subprolate	--	38 µm (35.5-40 µm)	--	5.33 µm (4-6.5 µm).
<i>Eclipta alba</i> (L.) Hasskl.	Monad, tricolporate and echinate.	Circular	22.45 µm (20-25 µm)	22.5 µm (20-25 µm)	0.99 µm	7.4 µm (1-2 µm)
<i>Parthenium hysterophorus</i> L.	Monad, tricolporate and echinate	Circular to semi-angular	15.58 µm (14-17.5 µm)	16.37 µm (14-17.5 µm)	0.95 µm	1.75 µm (0.75-1 µm)
<i>Saussuria heteromala</i> (D. Don) Hand.-Mazz.	Monad and tricolporate	Prolate	36.66 µm (35-39 µm)	37 µm (35.5-39 µm)	0.98 µm	5.16 µm (5-5.5 µm)
<i>Taraxacum officinale</i> Weber	monad, hexacolporate and echinate	circular to semi-angular	25.9 µm (25-26 µm)	25 µm (24.5-25.5 µm)	1.03 µm	1.12 µm (1-1.5 µm)

Local Name : Gandi Booti
 English Name : Congress weed
 Phytogeography : Native to Mexico, Central and South America, introduced into several countries including Australia, India, Taiwan and Ethiopia. In Pakistan; Islamabad, Chakwal, Talagang and Rawalpindi.
 Flower Color and Season : Ceramic white and through out the year.

Palynomorph : Pollen is monad, tricolporate and echinate. Shape of pollen in polar and equatorial view is circular to semi-angular. Polar diameter is 15.58 µm (14 - 17.5 µm) and equatorial diameter is 16.37 µm (14 - 17.5 µm). P/E ratio is 0.95 µm. Number of spines between colpi are 6 - 7. Exine thickness is 1.75 µm (0.75 - 1 µm).

6. *Saussuria heteromala* (D. Don) Hand.-Mazz.

Syn: *S. candicans* (DC.) Sch.-Bip.

Local Name : Kali Ziri
 English Name : Costus
 Phytogeography : Afghanistan and Kashmir to Bhutan. In Pakistan; Kurram, Chitral, Gilgit, Swat, Hazara, Salt Range, Lahore, Murree, Kashmir, Jammu, Islamabad and Rawalpindi.

Flower Color and Season : Light purple and March-September

Palynomorph : The pollen is monad and dicolporate. The shape of pollen in polar view in both polar and equatorial view are prolate. The polar diameter is 36.66 µm (35 - 39 µm) and equatorial diameter is 37 µm (35.5 - 39 µm). P/E ratio is 0.98 µm. Exine thickness is 5.16 µm (5 - 5.5 µm).

7. *Taraxacum officinale* Weber

Local Name : Peeli Dodal
 English Name : Dandelion
 Phytogeography : Cosmopolitan. In Pakistan; Islamabad and Rawalpindi.

Flower Color and Season : Yellow and February-April

Palynomorph : The pollen is monad, hexacolporate and echinate. The shape of pollen in polar

view is circular to semi-angular and shape in equatorial view is circular to semi-angular. Polar diameter with spine is 25.9 µm (25 - 26 µm) and equatorial diameter is 25 µm (24.5 - 25.5 µm). P/E ratio is 1.03 µm. Length of spines is 0.66 µm (.5 - 1 µm) and spines between colpi are 3 - 5. Length of colpi is 4.75 (4.5 - 5) and width of colpi is 20 µm (15 - 25 µm), Exine thickness 1.12 µm (1 - 1.5 µm).

Pollen fertility estimation. Pollen fertility estimation confined to viability test of 7 species of Asteraceae from Rawalpindi flora. Data on botanical name, family name, sterile, fertile pollen count and percentage fertility estimation is presented in Table II.

DISCUSSION

Palynomorph description. Palynology is a science of pollen grain and spores. It is particularly related with the study of taxonomy, paleobotany, ethnobotany, genetic and evolutions studies, pollination and climatic changes and environment. The ease by which pollen grains can be prepared for study and its morphological diversity makes pollen morphology a taxonomic tool. Systematists and taxonomists are concerned to evolution, classification and identification of floras of various regions and groups. Like other disciplines pollen grains have an important part in the modern issues of plant taxonomy (Bashir & Khan, 2003).

In present study, an account was made, which was confined to the detailed palynological studies of both pollen morphology and fertility estimation of family Asteraceae.

Such types of studies are useful for taxonomists of any

Table II. Percentage Pollen Fertility Estimation of Flora of Rawalpindi

S#	Species Name	Family	Fertile Pollen	Sterile Pollen	% Fertility
01	<i>Ageratum conyzoides</i> L.	Asteraceae	244	08	96.82
02	<i>Calendula arvensis</i> L.	Asteraceae	300	08	97.40
03	<i>Cousinia minuta</i>	Asteraceae	68	04	94.44
04	<i>Eclipta alba</i> (L.) Hasskl.	Asteraceae	208	08	96.29
05	<i>Parthenium hysterophorus</i> L.	Asteraceae	222	12	94.87
06	<i>Saussuria heteromala</i> (D. Don) Hand.-Mazz.	Asteraceae	104	02	98.11
07	<i>Taraxacum officinale</i> Weber	Asteraceae	488	20	90

Plate 1. A-B: *Ageratum conyzoides*: Polar view, A. Equatorial view, B. (1000 x)

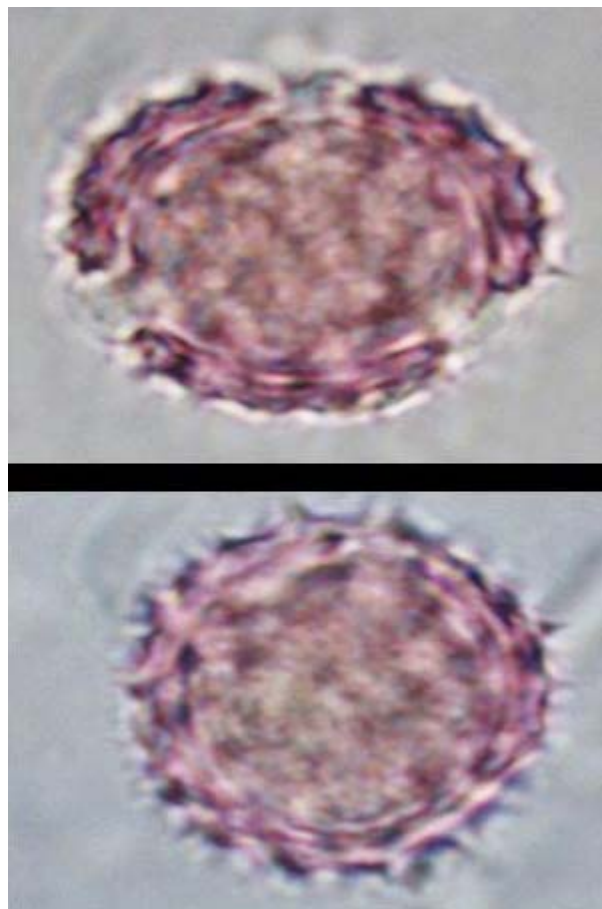
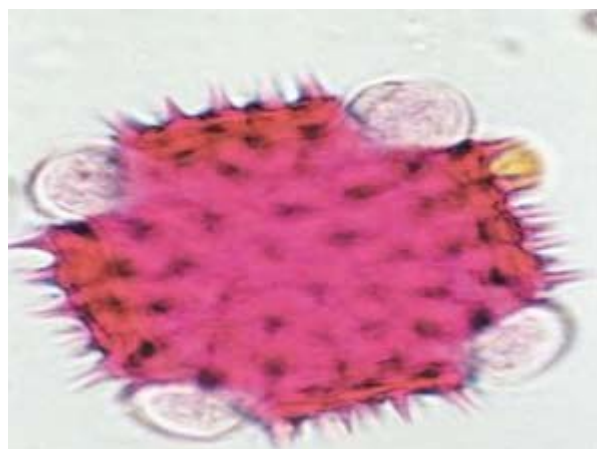


Plate 2. A: *Calendula arvensis*: Polar view, A. (400 x)



region, who study the floras of particular area of their interests. For example, in survey of spore diversity in the pteridophytes (Tryton, 1986) examined 250 genera. She was able to divide them into five main spore types, based on shape, aperture, surface and wall structure and these correspond well with current classification of there genera on whole plant morphological characters. Spores here

confirm the taxonomic work already conducted.

Asteraceae is a eurypalynous family (Erdtman, 1952) and most of its genera possess zonocolporate pollen (Sachdeva & Malik, 1986). The present study showed that there is a great diversity in pollen morphology of Asteraceae, variation mostly found in size, shape, spine length, number and colpi morphology. Maximum pollen size i.e. 39 μm was found in *Calendula arvensis* in polar view and minimum pollen size i.e. 15.58 μm in polar view was observed in *Parthenium hysterophorus*. Where as maximum pollen size in equatorial view is 38 μm in *Cousinia minuta* and minimum was 16.37 μm in *Parthenium hysterophorus*.

Pollen shape in *Calendula arvensis* was rectangular. In *Saussurea heteromala* and *Cousinia minuta* the shapes were prolate and sub-prolate, respectively where as in rest of the species of the family Compositae, the shape almost circular to semi-angular. The character of pollen spine is significance in evolution and at specific and generic level in classification of this family. Spineless pollen were observed in *Cousinia minuta* and *Saussurea heteromala*, where as rest

Plate 3. A: *Cousania minuta*: Equatorial view, A. (400 x)

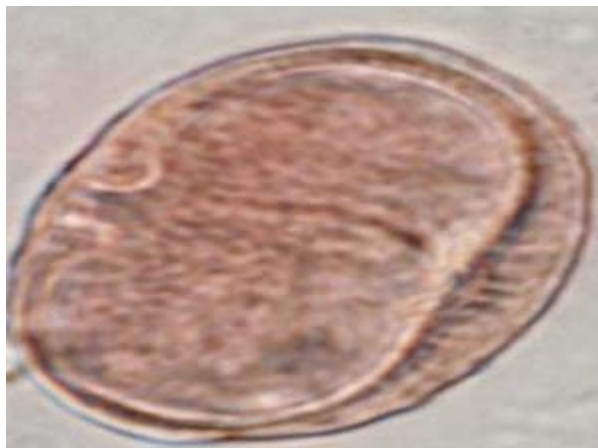


Plate 4. A: *Eclipta abla*: Polar view, A. (1000 x)



Plate 5. A: *Parthenium hysterophorus*: Polar view, A. (1000 x)

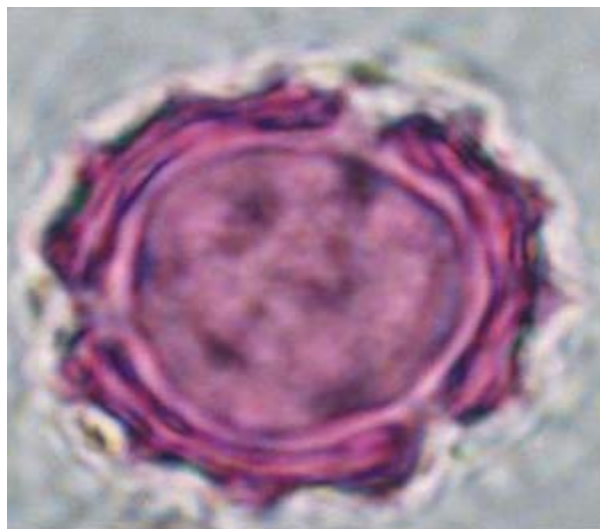


Plate 7. A: *Taraxacum officinale*: A. Polar view. (1000 x)



Plate 6. A: *Saussuria heteromala*: Equatorial view, A. (400 x)



of the species have spines in their pollen. These findings are in agreement with of Keeley and Jones (1977), who reports pinate and spineless pollen in some *Veronica* species and observed that both pollen and vegetative character indicate a divergence due to independent line of evolution of spine isolation. Wodehouse (1935) outlined the principles of morphological evolution of spine form in Compositae and suggested the reduction series from long to minute spines. The spinate pollen character is considered as a primitive feature as compared to spineless pollen.

Largest spine length was observed in *Calendula arvensis*, which was 4.8 μm and lowest in *Taraxacum officinale*, which was 0.66 μm , in a similar fashion the highest colpi length i.e. 7.5 μm in *Calendula arvensis*, where as smallest in colpi length was observed in *Taraxacum officinale* that was 4.75 μm , where as in *Parthenium*

hysterophours the colpi length was not clearly observed. It would be interesting to examine the relation of long spines with high colpi length. If this correlation exists it would be of much taxonomic significance. The rest of the species showed intermediate values of spine and colpi length. Our results of spine arrangement are in accordance with the finding of Meo and Khan (2004) and Dawar *et al.* (2002), who used spine length and number of spine rows between colpi as distinguishing taxonomic character in palynology of family Asteraceae. Spines in the genus *Calendula* are highly characteristic, i.e. a pair of closely placed spines are present in this genus (Meo, 2005). Such spines are highly diagnostic to distinguished this taxa form other taxa in any particular group.

Diversity in pollen morphology has made such studies a valuable taxonomic tool. Palynological research, while studying plant taxonomy, has proved useful in dealing critical and disputed taxonomic problems.

REFERENCES

- Anon, 1998. *District Census Report of Rawalpindi*, Pp: 1–19. Population Census Organization Statistical Division GOP, Islamabad
- Bashir, S. and M.A. Khan, 2003. Pollen morphology as an aid to the identification of Medicinal plants: *Trianthema portulacastrum* L., *Boerhaavia procumbens* Banks ex Roxb. and *Alternanthera pungens* Kunth. *J. Hamdard Medicus*, XLVI: 7–10
- Dawar, R., M. Qaiser and A. Perveen, 2002. Pollen morphology of *Inula* L. (S. STR.) and its allied genera (Inulea-Compositae) from Pakistan and Kashmir. *Pakistan J. Bot.*, 34: 9–22
- Erdtman, G., 1952. *Pollen and Spore Morphology/Plant Taxonomy*, (An introduction to palynology, II. Gymnospermae, Pteridophyta, Bryophyta) Almqvist and Wicksell, Stockholm
- Keeley, S.C. and S.B. Jr. Jones, 1977. Taxonomic implications of external pollen morphology to *Vernonia* (Compositae) in the West Indies. *American J. Bot.*, 64: 576–84
- Meo, A.A., 2005. Palynological studies of selected genera of the tribes of Asteraceae from Pakistan. *Ph.D Thesis*. Department of Biological Sciences Quaid Azam University Islamabad-Pakistan

- Meo, A.A. and M.A. Khan, 2004. Pollen morphology as an aid to the identification of *Scorzonera* (Cichorieae-Compositae) from Pakistan. *Pakistan J. Bot.*, 36: 701
- Meo, A.A. and M.A. Khan, 2005. Pollen morphology of invasive species *Pathenium hysterophorus* L. (Heliantheae-Asteraceae) from Islamabad and Rawalpindi, Pakistan. *Sarhad J. Agric.*, 21: 227–30
- Ronald, O.K., 2000. *Pollen and Spores*, 2nd Ed, Pp: 13–21. American Association of Stratigraphic Palynologists
- Sachdeva, S.K. and C.P. Malik, 1986. *Experimental Plant Taxonomy*. Kalyani Publications, New Delhi
- Stewart, R.R., 1957. *The Flora of Rawalpindi District, West Pakistan*. E.E. Press, Rawalpindi
- Tryton, A.F., 1986. In: Pollen and Spores (eds.), *Stasis, Diversity and Function in Spores Based on an Electron Microscope Survey of Pteridophyta*, Pp: 233–49. S. Blackmore and I.K. Ferguson, Academic press, London
- Wodehouse, R.P., 1935. *Pollen Grains*. New York

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