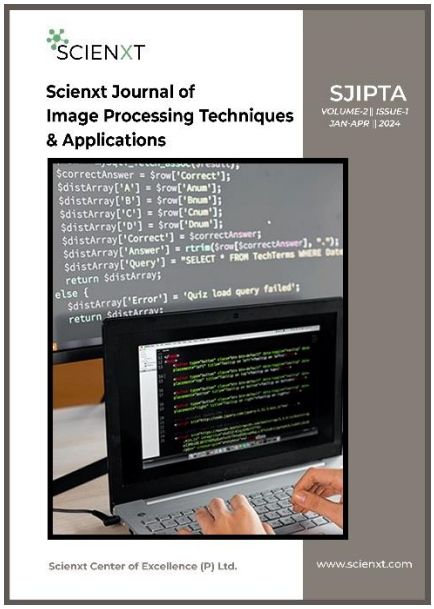

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Online information retrieval tool (OIRT) for pollen morphological studies of some local plant species of Amravati (M.S.) India

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Abstract:

Pollen morphological studies of fifteen different plant species representing different families from the local flora of Amravati were undertaken. Morphological characters were studied using Light Microsope (LM) and Scanning Electron Microscope (SEM). To store the morphological features online information retrieval tool (OIRT) was developed. The diversified characters of the sporomorphs provide an important basis for generic and specific delimitations. An attempt has been made to see how far Palynology helps in taxonomy and throws light on the evolutionary trends. Pollen morphology is widely used in taxonomic treatments particularly with differences in exine structure and aperture forms. The OIRT stores these taxanomical characters in the form of digital data as well as the morphological images of the pollen grains. The report generated using this online tool will helpful to researchers working in the field of interdisciplinary sciences, taxonomist and modern palynologist to share the information for future studies. The demo of OIRT is available in the form of web application which can be used as digital database to store and retrieve large number pollen morphological data.

Keywords:

Pollen grains, pollen morphology, OIRT

1. Introduction:

Pollen morphology has a wide application in various fields of applied Palynology. The study of pollen morphology is necessary for Palyno-taxonomy, Mellitopalynology, Aeropalynology, Palaeopalynology, Palyno-criminology etc. It helps to determine the phylogenetic relationships amongst different plant species and subsequently helps to solve many stratigraphical and taxonomical problems.

Light Microscopy (LM) and Scanning Electron Microscopy (SEM) studies provide information about pollen morphological characters including shape, size, symmetry, AMB, pollen wall stratification, sculpture pattern, ornamentation and aperture type. Various features of pollen were studied including morphological characters like shape, size, symmetry, pollen wall, exine stratification and ornamentation. The variation in morphological character helps academicians in classification of plant taxa and proper assessment of their phylogenetic relationship (Agashe, 2006). Previously attempts have been made for presenting the pollen morphological information on web using text, graphics, and audio and in some cases video. However, the digital databases for storing these characters are not available on the internet. Hence attempt is being made to accumulate such digital data using web based and Database technologies which are used in developing in the present online tool.

The investigations on the pollen morphology and palynotaxonomy found to be undertaken by number of researchers. Sharma (1970) has studied pollen morphology of some species belonging to Bombacaceae. Perveen (1999) studied species of Compositae by LM and SEM. El-Husseini (2006) studied species of Tiliaceae and Sterculiaceae from Egypt and compared with pollen morphology of Malvaceae. Zuraw (2007) has given pollen morphological measurements for some Allium species. Maciejewska-Rutkowska et al (2007) studied pollen morphology of Erysimum pieninicum (Brassicaceae) by SEM. Thangaraja and Ganesan (2008) studied pollen morphology of Terminalia paniculata. Dematteis and Pire (2008) have given pollen morphological characters of some species of Vernonia from Argentina and Paraguay. Recently Perveen and Quiser (2009) studied pollen morphology of two species of family Moringaceae from Pakistan.

From the review of literature, it was observed that, the databases on pollen and spore published on internet by University of Arizona consist of images only (Davis, 2009). Boucher et al (2008) developed a Semi-Automatic System for pollen recognition. Collin and Meijer (1999) developed a Kinase Inhibitor Database dedicated to gathering of information on protein kinase inhibitors. The database is accessible through World Wide Web system. The attempt has been

made to develop the web-based application for storage and retrieval of pollen morphological data.

2. Materials and methods:

2.1. Acetolysis of pollen sediment:

The acetolysis was carried to remove protoplast so that the exine characters would be made discernible in order to facilitate better identification of pollen. The pollen material was acetolysed as per the method suggested by Erdtman (1960) and modified by Nair (1960). Pollen sediment was mounted with glycerin jelly on slides for microscopical observations.

2.2. Light microscopy:

The pollen grains were observed for various morphological characters by Light Microscope (Trinocular Fluroscence Microscope, Axiostar Model No. HBO 50/AC, Carl Zuiss) at Central Instrumentation Cell, Sant Gadge Baba Amravati University, Amravati. The reference slides of pollen grains were prepared for future studies.

2.3. Scanning electron microscopy:

For Scanning Electron Microscopic (SEM) studies, acetolysed pollen sediments were dehydrated in an ethanol series and transferred with pasteur pipettes to the aluminum stubs. Once air-dried, they were covered with a gold- palladium film by sputter coater (Polaron SC7640). SEM micrographs were obtained by using secondary electron detector on a SEM microscope (LEO 430) at Birbal Sahni Institute of Palaeobotany, Lucknow.

Various morphological observations like shape, size, symmetry, AMB, pollen wall stratification, sculpture pattern, ornamentation, aperture type, NPC of aperture etc. were undertaken by Light Microscopy (LM) and Scanning Electron Microscopy (SEM) studies. The observations were presented in tabulated form. The plant species selected for the present study are Brassica campestris L. (Brassicaceae), Bombax ceiba L. (Bombacaceae), Terminalia arjuna (Roxb.) W. and A. Prodr. (Combretaceae), Azadirachta indica A. Juss. (Meliaceae), Moringa oleifera Lamk. (Moringaceae), Butea monosperma (Lamk.) Taub. (Fabaceae), Cajanus cajan (L.) Millsp. (Fabaceae), Cassia siamea Lamk. (Caesalpiniaceae), Prosopis juliflora (SW.) DC. Prodr. (Mimosaceae), Eucalyptus globulus Labill. (Myrtaceae), Syzygium cumini (L.) Skeels (Myrtaceae), Coriandrum sativum L. (Apiaceae), Helianthus annuus L. (Asteraceae), Parthenium hysterophorus L. (Asteraceae) and Tridax procumbens L. (Asteraceae).

The recorded observations were stored in the database using the data entry form provided on the home page of the OIRT. Data entry was made through the form titled 'New Record'. A search facility was also provided on the home page contains a text box where a keyword is entered to search the records. Report in sorted alphabetical order on Genus name was displayed for which the 'Report' button was provided on the home page. LM and SEM images of each pollen type were placed in image dataset and the hyperlink is given on the report page of OIRT.

3. Observations:

As shown in Table No. 1 which shows the Pollen Morphological Characterization

4. Results and discussion:

The shape of the pollen grains were prolate spheroidal in Brassica campestris and Parthenium hysterophorus, oblate to sub-oblate in Bombax ceiba, subprolate in Terminalia arjuna and Azadirachta indica, prolate-subprolate spheroidal in Moringa oleifera, oblate spheroidal in Butea monosperma, Cajanus cajan, Helianthus annuus and Tridax procumbens, subprolate to prolate in Cassia siamea and Prosopis juliflora, oblate in Eucalyptus globulus and Syzygium cumini and perprolate in Coriandrum sativum (Table No. 1). AMB was rounded triangular in Cajanus cajan, Cassia siamea, Prosopis juliflora and Coriandrum sativum, rounded triangular to spheroidal in Brassica campestris, rounded triangular to squarish in Tridax procumbens, triangular in Bombax ceiba, Eucalyptus globulus and Syzygium cumini, spheroidal in Terminalia arjuna, Moringa oleifera, Helianthus annuus and Parthenium hysterophorus, rounded in Butea monosperma and squarish in Azadirachta indica. All studied pollen types were radially symmetric. The size of the pollen grain of all studied plant species were medium-sized excluding Bombax ceiba having medium-large sized and Moringa oleifera, Prosopis juliflora and Coriandrum sativum were of small-sized. All of studied pollen types were tricolporate. Only in case of Brassica campestris and Azadirachta indica, pollen grains were tricolpate and tetracolporate respectively. The exine was generally thick and in some types, it was tectate, echinate, subtectate, reticulate, psilate or heterobrochate (Table No. 1).

This study provides the basis for the future use of OIRT techniques for routine pollen classification by simplifying the procedure and thus can be used by unskilled persons. There are two additional advantages: the system avoids the repetitiveness required in microscopic

observation and slide preparation and secondly, it store and retrieve data among different species of pollens with easy access and retrieval application with accuracy, which was not possible in any of the current applications. Thus, to store the images of pollen grains and their morphological characters the indigenously developed online information retrieval tool (OIRT) was used.

Sr. No.	***Pollen Type***	***Family***	***Shape, Size and Symmetry***	***Apertural Pattern (NPC Parameter)***	***Pollen Wall Structure and Sculpture***	***Plate (Fig.) No.***
1.	*Brassica campestris*	Brassicaceae	Prolate spheroidal, AMB - rounded triangular to spheroidal, medium-sized, 24-27 µm, P = 24-27 µm, E = 21-24 µm, P/E = 1.12-1.14, radially symmetrical	Tricolpate, type - colpi, number - 03 (tritreme), position - zonotreme, characters - colpi tapering, tips acute NPC: $N_3 P_4 C_3$	Exine thick, sub-tectate, reticulate, heterobrochate, meshes narrow at mesocolpium	I (1), II (16)
2.	*Bombax ceiba*	Bombacaceae	Oblate to sub-oblate, AMB - triangular, medium-large sized, 45-51 µm, P = 43-45 µm, E = 30-32 µm, P/E = 1.40-1.43 µm, radially symmetrical	Tricolporate, type - colpi and pore, number - 03 (tritreme), position - zonotreme, characters - colporate, colpi with blunt ends, ora faint, more or less rounded NPC: $N_3P_4C_5$	Exine thick, subtectate, surface reticulate, reticular meshes smaller near the colpi, psilate	I (2), II (17 & 18)
3.	*Terminalia arjuna*	Combretaceae	Subprolate, AMB - spheroidal, medium-sized, 13-17 µm, P = 10-12 µm, E = 15-17 µm, P/E = 0.66-0.70, radially symmetrical	Tricolporate, 3 colpi alternating with pseudocolpi, type - colpi and pore, number - 03 (tritreme), position - zonotreme, characters - colporate, colpi linear, acute tips, pseudocolpi and colpi the same size, ora circular	Exine thick, tectate, psilate to granular	II (19 & 20)

Sr. No.	*Pollen Type*	*Family*	*Shape, Size and Symmetry*	*Apertural Pattern (NPC Parameter)*	*Pollen Wall Structure and Sculpture*	*Plate (Fig.) No.*
				NPC: $N_3 P_4 C_5$		
4.	*Azadirachta indica*	Meliaceae	Subprolate, sides convex, poles smoothly rounded, AMB – squarish, medium-sized, 36-38 µm, P = 32-35 µm, E = 36-38 µm, P/E = 0.88-0.92, radially symmetrical	Tetracolporate, type - colpi and pore, number - 04 (tetratreme), position - zonotreme, characters- colporate, colpi long, tapering, acute tips, ora lalongate, NPC: $N_4P_4C_5$	Exine - thick, tectate, surface psilate to granular	I (3), II (21)
5.	*Moringa oleifera*	Moringaceae	Prolate-subprolate spheroidal, AMB – spheroidal, small-sized, 19-21 µm, P = 15-17 µm, E = 19-21 µm, P/E = 0.78-0.80, radially symmetrical	Tricolporate, type - colpi and pore, number - 03 (tritreme), position - zonotreme, characters - colporate NPC: $N_3 P_4 C_5$	Exine thick, tectate, surface sub-psilate	I (4& 5), II (22)
6.	*Butea monosperma*	Fabaceae	Oblate spheroidal, AMB – rounded, medium-sized, 35-41 µm, P = 35-37 µm, E = 38-41 µm, P/E = 0.90-0.92, radially symmetrical	Tricolporate, type - colpi and pore, number - 03 (tritreme), position - zonotreme, characters - colporate, NPC: $N_3 P_4 C_5$	Exine thick, tectate, surface psilate to granular	I (6)
7.	*Cajanus cajan*	Fabaceae	Oblate spheroidal, AMB – rounded triangular, medium-sized, 32-39 µm, P = 32-34 µm, E = 35-39 µm, P/E = 0.87-0.91, radially symmetrical	Tricolporate, type - colpi and pore, number - 03 (tritreme), position - zonotreme, characters - colporate, colpi long, tips tapering	Exine thick, subtectate, surface reticulate, psilate	I (7)

Sr. No.	***Pollen Type***	***Family***	***Shape, Size and Symmetry***	***Apertural Pattern (NPC Parameter)***	***Pollen Wall Structure and Sculpture***	***Plate (Fig.) No.***
				and acute, ora circular NPC: $N_3 P_4 C_5$		
8.	*Cassia siamea*	Caesalpiniaceae	Subprolate to prolate, AMB – rounded triangular, medium-sized, 32-35 µm, P = 32-34 µm, E = 34-35 µm, P/E = 0.94-0.97, radially symmetrical	Tricolporate, type - colpi and pore, number - 03 (tritreme), position - zonotreme, characters - colporate, colpi linear, long, ora circular NPC: $N_3 P_4 C_5$	Exine thick, tectate, surface psilate to granular	I (8), II (23)
9.	*Prosopis juliflora*	Mimosaceae	Prolate to subprolate, AMB - rounded triangular, small-sized, 21-23 µm, P = 13-15 µm, E = 21-23 µm, P/E = 0.61-0.65, radially symmetrical	Tricolporate, type - colpi and pore, number - 03 (tritreme), position - zonotreme, characters - colporate, colpi tapering towards poles, acute tip, ora lalongate NPC: $N_3 P_4 C_5$	Exine thick, subtectate, faintly reticulate	I (9), II (24 & 25)
10.	*Eucalyptus globules*	Myrtaceae	Oblate, AMB - triangular, sides concave to flat, medium sized, 23-27 µm, P = 26-27 µm, E = 23-24 µm, P/E = 1.12-1.13, radially symmetrical	Tricolporate, syncolpate, type - colpi and pore, number - 03 (tritreme), position - zonotreme, characters - colporate, NPC: $N_3 P_4 C_5$	Exine thick, more thick near pore, tectate, psilate	I (10), II (26)
11.	*Syzygium cumini*	Myrtaceae	Oblate, AMB – triangular, medium-sized, 13-45 µm, P = 11-13 µm, E = 43-45 µm, P/E = 0.25-0.28,	Tricolporate, syncolpate type - colpi and pore, number - 03 (tritreme),	Exine thick, tectate, granular to smooth	I (11), II (27)

Sr. No.	*Pollen Type*	*Family*	*Shape, Size and Symmetry*	*Apertural Pattern (NPC Parameter)*	*Pollen Wall Structure and Sculpture*	*Plate (Fig.) No.*
			radially symmetrical	position - zonotreme, characters - colporate, syncolpate, ora lalongate **NPC:** $N_3 P_4 C_5$		
12.	*Coriandrum sativum*	Apiaceae	Perprolate, AMB - rounded triangular, (Occasionally seen), small-sized, 10-16 µm, P = 09-10 µm, E = 15-16 µm, P/E = 0.60-0.62, radially symmetrical	Tricolporate, type - colpi and pore, number - 03 (tritreme), position - zonotreme, characters - colpi long, narrow, ora lalongate to circular NPC: $N_3 P_4 C_5$	Exine thick, subtectate, finely reticulate	I (12), II (28)
13.	*Helianthus annuus*	Asteraceae	Oblate spheroidal, AMB – spheroidal, medium-sized, 38-40 µm, P = 38-40 µm, E = 23-25 µm, P/E = 1.60-1.65, radially symmetrical	Tricolporate, type - colpi and pore, number - 03 (tritreme), position - anatreme, characters - colporate NPC: $N_3 P_3 C_5$	Exine thick, tectate, surface densly echinate, spines long, wide base, point acute	I (13), II (29)
14.	*Parthenium hysterophorus*	Asteraceae	Prolate spheroidal, AMB – spheroidal, small-sized, 18-21 µm, P = 18-20 µm, E = 20-21 µm, P/E = 0.90-0.95, radially symmetrical	Tricolporate, type - colpi and pore, number - 03 (tritreme), position - anatreme, characters - colporate, ora lalongate NPC: $N_3 P_3 C_5$	Exine thick, tectate, surface echinate, spines long, point acute	I (14)
15.	*Tridax procumbens*	Asteraceae	Oblate spheroidal, AMB – rounded triangular to squarish,	Tricolporate, type - colpi and pore, number - 03 (tritreme),	Exine thick, tectate, surface echinate, spines long, wide at base, point acute	I (15), II (30)

Sr. No.	***Pollen Type***	***Family***	***Shape, Size and Symmetry***	***Apertural Pattern (NPC Parameter)***	***Pollen Wall Structure and Sculpture***	***Plate (Fig.) No.***
			medium-sized, 30-38 µm, P = 30-35 µm, E = 32-38 µm, P/E = 0.92-0.93, radially symmetrical	position - anatreme, characters - colporate, colpi linear, ora circular NPC: $N_3 P_3 C_5$		

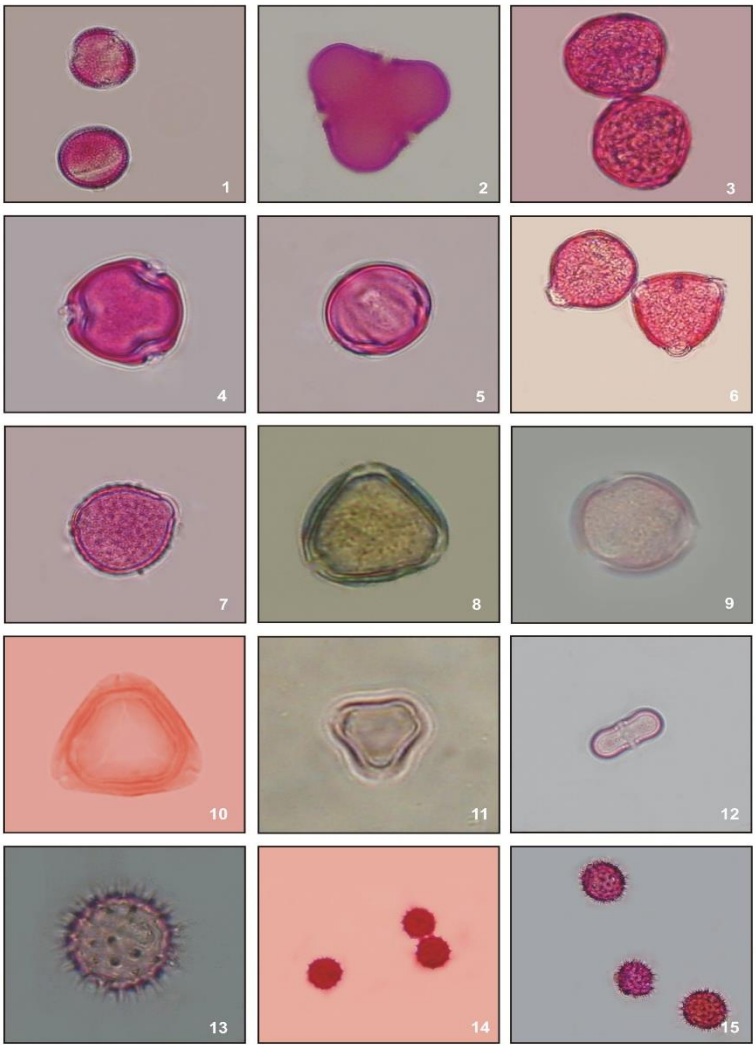

Fig. No. 1 to 15 Light microscopic (LM) images of different pollen types. Fig. No. 1 *Brassica campestris*, **Fig. No. 2** *Bombax ceiba*, **Fig. No. 3** *Azadirachta indica*, **Fig. No. 4** and **5** *Moringa oleifera*, **Fig. No. 6** *Butea monosperma*, **Fig. No. 7** *Cajanus cajan*, **Fig. No. 8** *Cassia siamea*, **Fig. No. 9** *Prosopis julifera*, **Fig. No. 10** *Eucalyptus globulus*, **Fig. No. 11** *Syzygium cumini*, **Fig. No. 12** *Coriandrum sativum*, **Fig. No. 13** *Helianthus annuus*, **Fig. No. 14** *Parthenium hysterophorus* and **Fig. No. 15** *Tridax procumbens*.

PLATE I

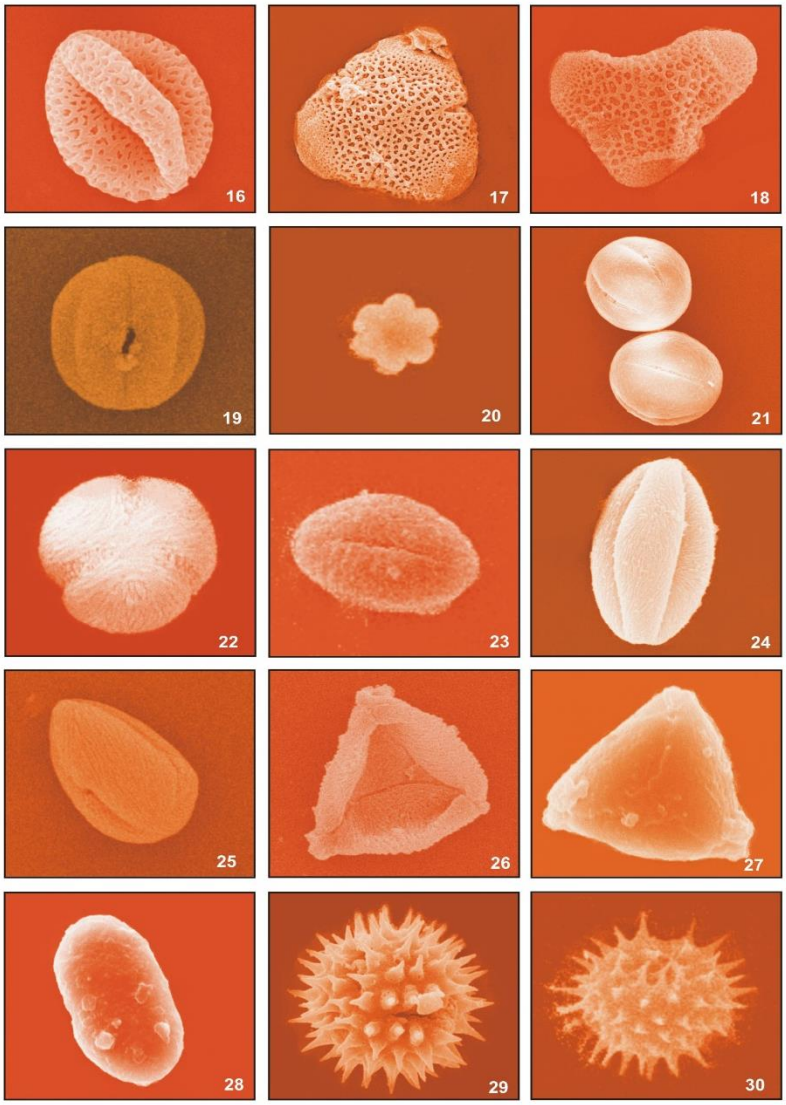

Fig. No. 16 to 30 Scanning electron microscopic (SEM) images of different pollen types. Fig. No. 16 *Brassica campestris*, **Fig. No. 17** and **18** *Bombax ceiba*, **Fig. No. 19** and **20** *Terminalia arjuna*, **Fig. No. 21** *Azadirachta indica*, **Fig. No. 22** *Moringa oleifera*, **Fig. No. 23** *Cassia siamea*, **Fig. No. 24** and **25** *Prosopis juliflora*, **Fig. No. 26** *Eucalyptus globulus*, **Fig. No. 27** *Syzygium cumini*, **Fig. No. 28** *Coriandrum sativum*, **Fig. No. 29** *Helianthus annuus* and **Fig. No. 30** *Tridax procumbens*.

PLATE II

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