Spore morphology of pteridophytes from Valley of Mexico, Mexico

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The Valley of Mexico is situated in the center of Mexico (19°02' and 20°12' latitude N; 98°32' and 99°32' longitude W). In this valley we found 18 families, with 40 genera and 113 species of pteridophytes. There are four heterosporous families (Selaginellaceae, Isoëtaceae, Marsileaceae and Salviniaceae) and 14 isosporous families (Aspleniaceae, Blechnaceae, Dennstaedtiaceae, Dryopteridaceae, Equisetaceae, Grammitidaceae, Lomaropsidaceae, Ophioglossaceae, Plagiogyraceae, Polypodiaceae, Psilotaceae, Pteridaceae, Thelypteridaceae and Woodsiaceae). We describe the spore morphology of all the species.

In this work we include descriptions and lightmicrographs of spores taking in consideration the presence of isosporous or heterosporous spores, aperture type, spore shapes in proximal and distal view, exospore and perispore ornamentation, perispore thickness, presence or absence of crests and folds on the perispore, and presence or absence of a laesural margo. Also a key for determination of the taxa is included, and the taxonomic position of some taxa is discussed based in spore morphology.

It appeared to be possible to distinguish through the spores 60% of the taxa here studied. The genera with very similar spores were the cheilanthoid group (*Astrolepis, Bommeria, Cheilanthes, Mildella*), as well as the genera *Campyloneurum, Polypodium, Pleopeltis* and *Pecluma*. Using spore morphology we were able to determine the genera *Selaginella, Thelypteris, Pteris* and *Pellaea*.

New data in relation to the fertile frond and the spore maturation process in *Weichselia reticulata* (Stokes et Webb) in Ward emend alvin Fern

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Weichselia reticulata is widely distributed, both in space and time. This tree fern is known from the Bathonian to the Cenomanian and has been reported from Europe, North of Africa, Middle East, Siberia, India, North America and South America. Despite its widespread distribution, fertile fronds with *in situ* spores are very scarce.

In the village of Escucha (Teruel) an exceptional record of fertile structures of *Weichselia reticulata* has been found; this fertile material was found in deltaic deposits belonging to the Middle Member of the Escucha Formation and Albian in age (AGUILAR et al, 1971). It consists of several rachises containing soral clusters, spherical in shape, alternately arranged and composed of 12 to 24 sori; each sorus is covered by a peltate indusium of polygonal shape.

The palynological analysis of the *in situ* spores shows a morphologycal variation in relation to the stage of maturity inside the sporangium.

These results are similar to those described by ALVIN (1968) for the spores already mature. Nevertheless in our case we also observe isolated spores from immature sori of *Weichselia reticulata* (still not detached). In this way, different morphologies are distinguished for each Ontogenetic Development Stage (ODS) in relation to the structure, size and shape of the spores.

There are some controversial aspects due to the classification of spores of *Weichselia reticulata*. ALVIN (1971) suggested that spores of this tree fern have been described dispersed as *Biretisporites potoniaei* by DELCOURT & SPRUMONT (1955) and DELCOURT, DETTMAN & HUGHES (1963), but it appears with differences from those described by us. Although most authors would identify these dispersed spores as *Matonisporites*

COUPER (1958), DÖRING (1965) considers it to be a *Triloboporites*. The characteristics of the spores described from the Escucha Formation resemble *Toroisporis* (*Crassiangulisporis*) *planatorosus* described by DÖRING (1964) due to the greater thickness of the exine at the angles than at the sides.

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COUPER, R. A. 1958. British Mesozoic microspores and pollen grains. *Palaeontographica*, B, 103, 75-179.

Poster session b2

SPERMATHOPHYTE POLLEN: EVOLUTION, PHYLOGENY AND SYSTEMATICS

Palynological affinities between cultivated crops and their wild allies- a substantial approach in crop taxonomy

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In palynological studies, the characteristic morphological features of pollen exine which is specific in relation to plant taxa forms the basis for its applicability in plant taxonomy. Poaceae among the monocotyledons and the legumes among the dicotyledons constitute some major crops and studies in pollen morpho-features including ultrastructure in some genera of the two families have provided some important information of taxonomical relevance which can be used in delimitation of taxa in subgeneric level as well as in tracing affinities of cultivated species with their wild allies and progenitors. Interrelationship among the taxa were based on studies conducted in the genus *Oryza*, *Saccharum*, and *Sorghum* of Poaceae and *Cajanus*, *Atylosia*, and *Cicer* of Leguminosae. Exine ultrastructural studies in 19 species of *Oryza* (VAUGHAN 1989) showed three basic types of surface ornamentation e.g. granulose, spinulose and insular which were further categorized according to aggregation of surface excrescences. The study revealed that section *Sativa* comprising cultivated and wild species possess largergrains than other sections of the genus. Size wise, the grains of Asian cultivated species *O. sativa* race Indica is closer to its wild relative *O. nivara* and the African cultivated species *O. glaberrima* and its wild relatives *O. barthii* and *O. longistaminata* have uniform size denoting palynological affinities among the taxa. In *Sorghum*, pollen ultrastructural studies presumes that cultivated *Sorghum* (series *Sativa*) might have evolved from the species of the series *Spontanea* which contains wild grass. Both of the above series are included in the subsection *Arundinacea* under section *Eu-sorghum* (MOENCH 1794) and contain pollen having both granular and insular exine surface pattern. Pollen ultrastructural studies in cultivated and wild species of *Saccharum* have also shown distinguishing exine surface patterns of taxonomic importance. Examination in size parameter in the genus indicates a distinct palynological affinity between the cultivated species *S. officinarum* and its wild ally *S. robustum* as both have larger grains with wider size range than other species of the genus. This may be considered as a palynological evidence in support of GRASSL's (1946) view that *S. robustum* is a wild cognate ancestor of *S. officinarum*. Despite of the strictly stenopalynous nature of the above three Poaceous genera which is limiting factor of palynological differentiation, ultrastructural characterization in subgeneric level and congruence in size factor provided conclusive evidences of affinities between the cultivated species and their wild progenitors. In legumes, pollen morphological similarities with regard to aperture and exine ornamentation identified between

cultivated species *Cicer arietinum* and wild species *C. reticulatum* indicating the latter is a possible progenitor of the former. Studies in another important cultivated legume crop, *Cajanus cajan* shows striking similarities in pollen features of taxonomic importance between cultivars of *C. cajan* and five species of *Atylosia* e.g. *A. albicans, A. lineata, A. platycarpa, A. scarabaeoides* and *A. volubilis*, which indicates strong interrelationship among them and support the views of VAN DER MAESEN (1985) for merger of these five *Atylosia* species to *Cajanus*. The information of interrelationship between cultivated crops and their wild allies is of potential practical utility as many wild and weedy relatives of cultivated crops comprised an inherent repository of desirable genes which may be incorporated to the cultivated crops to improve yield and value based qualities to the product.

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The key to Compositae pollen from the Middle Russia

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The pollen grains of Compositae have some specific morphological features of sporoderm structure, in particular, thick exine. They are usually divided into two large groups: echinate and echino-lophate pollen. The species of subfamily Cichorioidea with echino-lophate pollen grains are well studied (BLACKMORE, 1981,1982). The pollen grains with echinate surface are less investigated. We have studied more than 200 species of Compositae with light, scanning and transmission electron microscopes and distinguished 19 pollen-types:

1. Surface sculpture is echino-lophate — tribe Cichorioideae
- Surface structure is echinate — 2.
2. Spines are small, not more than 0,5-1,0 mkm — 3.
- Spines are big, 2,0-5,0 mkm — 9.
3. Pollen grains are more than 50 mkm — 4.
- Pollen grains are small, polar axis is 18-45 mkm — 5.
4. Exine with cavities in mesocolpia, nexine around apertures is not thicken — Centaurea scabiosa, C.orientalis
- Exine without cavities in mesocolpia, nexine around apertures is thicken — Echinops
5. Colpi are very shot, deep, ora are often merged forming equatorial belt — Xanthium
- Colpi are long, more than 2/3 of polar axis — 6.
6. Pollen grains are elliptic, ora are oval, often form equatorial belt — 7.
- Pollen grains are spheroidal, ora are circle — Artemisia
7. Exine without cavities in mesocolpia — 8.
- Exine with cavities in mesocolpia — Centaurea diffusa, C.jacea, C.pseudomaculosa, C.phrygia
8. Nexine around apertures is thicken — Centaurea cyanus
-. Nexine around apertures is almost not thicken — Centaurea sibirica, C.marschalliana
9. Spines are numerous, about 2,0 mkm. Ectexine is with two collumella layers — 10.
- Spines are not so numerous, they are higher with sharp peaks — 13.
10. Polar axis is less than 30 mkm. Bases of spines are connect — 11.
-Polar axis is more than 35 mkm. Spines are numerous, irregularly distributed on pollen surface — 12.
11. Polar axis is 21-25 mkm. Spines are 1,5-2 mkm, regularly distributed on pollen surface — Ambrosia.
- Polar axis is 24-30 mkm. Spines are 2,5-3 mkm, irregularly distributed on pollen surface — Saussurea.
12.Pollen grains are large, polar axis 52-64 mkm — Onopordum, Jurinea, Serratula
-Pollen grains are not very big, polar axis is 38-53 mkm — Carlina, Arctium
13. The distance between spine bases is about 5-8 mkm. Exine surface between spine bases are plicate with big perforations — Antennaria, Tussilago, Solidago, Ligularia
- Spines bases are connect, the distance between spine peaks is about 4-5 mkm — 14.

14. Spines are narrow conic, spine height is more than diameter of their bases — 15.
- Spines are broad conic, diameter of their bases is more than the spine height — 16.
15. Spines have sharpen elongated peaks on hemispheric Bidens, Calendula, Galinzoga Erigeron, Gnaphalium
-Spines are conic — Aster, Helianthus, Galatella, Tripolium, Petasites, Filago, Eupatorium
16. Spines are connected with low bridges — Cirsium, Centaurea rutenica
-Spines are not connected with each other — 17.
17.Exine with cavities in mesocolpia — 18.
- Exine without cavities in mesocolpia — 19.
18.Poleen grains are big, polar axis is more than 35-40 mkm — Carduus
-Polar axis is 17-35 mkm — Senecio, Inula
19.Polar axis more than 30 mkm — Dendranthema, Xeranthemum
-Polar axis not more than 30 mkm Anthemis, Achillea, Chamomilla, Helichrysum, Leucanthemum, Tanacetum.

Pollen morphology in Lamiaceae: *Lamium* L., *Phlomis* L., and *Ballota* L.

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The *Lamiaceae* is a large family widely distributed throughout the world, specially in the Mediterranean region where such genera are characteristic components of the maquis and the garrigue.
In view of nectaripherous interest on the family and in order to facilitate the identification of different species in the melissopalynology analyse, the pollen morphology of nine taxa of *Lamiaceae* belonging to the genera *Lamium* L., *Phlomis* L. and *Ballota* L. has been study by light and scanning electron microscopy: *L. flexuosum* Ten., *L. purpureum* L., *L. amplexicaules* L., *P. herba-venti* L., *P. purpurea* L., *P. lychnitis* L., *P. composita* Pau, *B. hirsute* Benth. subsp. *hirsute* and *B. nigra* L. subsp. *foetida* Hayek.

From a palynology point of view the genera *Lamium* L., *Phlomis* L. and *Ballota* L. show a considerable morphological uniformity. The pollen grains are trizonocolpate, with medium size and ornamentation microreticulate. Nevertheless, several differences among the genera examined can be established based on the ornamentation, shape and size of pollen grains. The results are discussed and compared with other vegetative characte such as the flowers and nutlets morphology.

Pollen morphology and taxonomy of the family Vochysiaceae

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Pollen of 19 species from 5 genera of the family Vochysiaceae was examined by LM and SEM. This family comprises 6 genera and about 200 species in Central and South America, particulary in Brazil, and 1 monotypic genus in Africa. Its members are mainly tall trees, rarely shrubs or canopy lianas, and occur in tropical rain forests and savannas. The Vochysiaceae are included in the order Polygalales and are divided into two tribes. Palynological aspect have not been still investigated and have not used in the systematics and taxonomy. There are some data about pollen morphology of certain species (ERDTMAN 1952; KAWASAKI 1998; ROUBIK & MORENO 1991; SIMPSON & SKWARLA 1981).

We have studied pollen of the next genera: *Callisthene*, *Qualea*, *Ruizterania*, and *Vochysia* from bigger tribe Vochysieae and *Erisma* from smaller tribe Erismeae. Only two monotypic genera are excluded from our study. Pollen grains of all investigated species are oblate-speroidal, speroidal,or prolate-speroidal, strictly 3-colporate, polar view is mainly 3-angularis and equatorial view is circularis or ellepticus. *Vochysia's*, *Qualea's*, *Ruizterania*'s pollen is medium (20-36 x 23-38 mkm), *Callisthene*'s, *Erisma*'s pollen is small (13–23 x 15-22

mkm). The furrows are long, the endoaperture are equator elongated, oval or rhomboidal. Costae ectocolpi ("a thickening of the endexine following the outline of an ectoaperture) and costae endoaperture are well expressed in pollen of every genera, but the *Vochysia*'s pollen has another lines of thicknings in parallel with costae ectocolpi. ERDTMAN (1952) described Vochysiaceae's pollen surface as more or less "obscure". By SIMPSON & SKWARLA (1981) the *Vochysia's* pollen surface, observed with SEM, appears "psilate to subgranulate", and *Callisthene's* one is "light striate". The pollen surface of *Erisma* was described as striate (KAWASAKI 1998). We also use the pollen samples, which previously were asetolyzed for study with SEM. And we found out all untreated *Vochysia*'s pollen and some of others are subgranulate. But acetolyzed pollen samples show the tectum in detail. *Vochysia*'s pollen have microperforate tectum with multi perforations 0,2-0,5 mkm in diameter. So, there are outer layer of unknown origin, covered the tectum. The other genera's pollen surface are striate. The striae mainly are long, thin, extended from pole to pole, but some species have short, thick and disorintated striae (*E.bicolor, Q.calophylla, Q.parviflora*). Exine of all species is tectate, columellate, but the thickness of exine layers may change. So, we determine 1 pollen morphological type with 2 pollen morphological groups in the Vochysiaceae: 1) 3-colporate with microperforate tectum (*Vochysia*) and 2) 3-colporate with striate tectum (*Callisthene, Erisma, Qualea, Ruizterania*).

The systematics consider *Vochysia* to be very natural genus and palynological data confirm this. Its pollen is diverse from pollen of other genera by costae, parallel with costae ectocolpi and microperforate tectum. *Qualea*'s pollen is similar to one another and to of *Ruizterania*. Some systematics this last genus considered to be one section of *Qualea*, but latter it was made into a separate genus. *Callisthene*'s and *Erisma*'s pollen is slightly diverse by smaller sizes.

Closely related Trigoniaceae have 4-porate pollen (SIMPSON & SKWARLA 1981), which is rather distinct from Vochysiaceae's pollen. So, from the systematical and palynomorphological point of view the Vochysiaceae is quite homogeneous family with clear boundarys either of all family or of some genera. But we have not found any confirmation of modern dividing in the tribes.

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Palynological study of the genus *Rinorea* in respect to its systematics and position in the family Violaceae

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The family Violaceae includes 29 genera and 2900 species and is widespread just every where, particulary in the tropics and subtropics. The Violaceae is divided into two subfamilies Violeoideae with two tribes and small monotypic Leontioideae. The genus *Rinorea* (tribe Rinoreae) is one of the three more numerous of this family and the most primitive at the same time. It is pantropical genus. There are four centers of its distribution (each center has its own sets of species): 1) Tropical Africa (100 species), 2) Tropical America (50 species), 3) India and SE Asia (12 species), 4) Australia and Pacific area (2 species). Usually *Rinorea*'s species are trees and treelets and occur mainly in tropical forests. Comparative palynologycal studies have been carried out neither in the genus *Rinorea* nor in the Violaceae. Pollen of 4 *Rinorea*'s species was investigated with light (PRESTING et al., 1983; POZHIDAEV 2000; ROUBIK & MORENO, 1991) or scanning electron microscopes.

We have studied pollen grains of 20 species of the genus *Rinorea* (10 of them grow in tropical America, 7 of them are from Africa and 3 from Asia) with light and scanning electron microscopes. *Rinorea*'s pollen grains are small (13-28 x 14-23 mkm), spheroidal, rarely ellipsoidal, mainly 3-colporate (13 species), rarely 3-colpate (6 species), only 1 species has 3-(4-(5)-porate pollen (*R.racemosa*). Pollen of African and Asian species are only 3-colporate, a half of American species has 3-colpate grains. The pollen surface is mainly microperforate or microechinate-microperforate; 1 species (*R.paniculata*) has reticulate-microperforate and 1 species (*R.bornensis*) has rugulate pollen surphace. Perforations on the tectum are less than 0,1 mkm , and can be named

"ultramicroperforations". Exine is thin, tectate, columellate. Microechinate-microperforate exine surface is diagnostic features of *Rinorea*, it occurs in a half of species from African and American tropics. Asian species have not microechinate-microperforate pollen. So, it is appears that there are 3 morphological pollen types with 6 subtypes in the genus *Rinorea*: 1) 3-(4)-(5)-porate, microperforate; 2) 3-colpate, (a) microperforate; (b) microechinate-microperforate; 3) 3-colporate, (a) microperforate; (b) microechinate-microperforate; (c) reticulate-microperforate; (d) rugulate. Pollen of Palaeotropical species belongs to third type and pollen of Neotropical species demonstrates the most diversities. But there is not correlation between systematic groups and subgroups into *Rinorea* (HEKKING 1988) and their palynomorphological features. Some *Rinorea* 3-aperturate species have also patterns of polyaperturate (4-colpate, 4-colporate, 4-5-porate) grains. This variations occur in 5 from 20 investigated species.

Moreover we have palynomorphological data about 21 species from 9 genera of Violaceae. The most part of which was examined for the first time. *Rinorea* is the largest genus of the circumtropical tribe Rinoreeae, two other numerous genera of the Violaceae (*Viola* and *Hybanthus)* belong to the tribe Violeae. Other Rinoreeae's genera are small and consist from 1 to 15 species. *Rinorea* is closely related to 4 genera of subtribe Rinoreinae. But there are not palynomorphological data of the species from this subtribe. Last 5 Rinoreeae genera put together 3 subtribes. Neotropical *Paypayrola* and *Amphirrox* form subtribe Paypayrolinae. Our data show that 2 of 3 investigated species of this subtribe have diporate microperforate pollen grains – rare pollen type in advanced dycotyledonous taxons. Pollen of *Hybanthus* and other woody tropical genera of both subfamilies Violoideae and Leontioideae is small or medium, 3-colporate, perforate and is resemble to third pollen morphological type, which was established in *Rinorea*. Viola is the most numerous, mainly herbaceous world-wide genus. Its pollen is rather different by sizes, shapes, exine structure and number and position of compound apertures. HEKKING (1988) considers the *Rinorea* to be primitive genus, but with some advanced, differing it from hypothetical actinomorphic ancestor features. By our pollen data *Rinorea* shows the basic dycotyledonous pollen type – 3-colpate, microperforate and some specializations in tectum and aperture structure. This features may change in other Viocaceae's taxons.

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Specific sporopollenin ornamentation of locular walls as exemplified by Acanthaceae

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Orbicules as sporopollenin by-products in anthers are common for Angiosperms with a secretory tapetum. In their respective ornamentation they often resemble the pollen ornamentation (HUYSMANS et al. 1998, for extensive review). Usually they are found dispersed or in crowded groups upon the locular walls and the pollen grains, as for example in *Eupomatia* (HESSE 1986), in Euphorbiaceae (HESSE 1986, EL-GHAZALY 1989), or concentrated, but still as isolated sporopolleninous elements in *Dioscorea* (SCHOLS et al. 2001) Poaceae or Cyperaceae. There is only a single record that in Poaceae the orbicules may be fused (in *Sorghum*, CHRISTENSEN et al. 1972; however, the authors did not investigate acetolysed material). Such layers are termed orbicular walls.

A survey on pollen and orbicular morphology in Acanthaceae was undertaken. We have found that a peculiar, often species-specific orbicular wall is typical for many genera. These orbicules may fuse to a coherent layer, then covering completely the locular walls, and remain coherent even after acetolysis. The ornamentation pattern of the respective orbicular wall usually recalls the pollen ornamentation pattern. In species with, for example, fine or gross reticulate pollen the ornamentation of the orbicular wall is similarly fine or gross reticulate,

parallels exist even up to details. However, beside the frequent reticulate pattern also other types exist, for example pilate, or minutely spinulate (with protuberances), or otherwise patterned.

The often stunning similarity in ornamentation details between the pollen grains and the orbicular wall strictly points to a genetically fixed, often species-specific identical pattern mode, rooted in the homology of the tapetum and the sporogeneous tissue.

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Pollen morphology of the Galapagos endemic genus *Scalesia* (Ecuador)

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There are 20 autochthonous genera of Asteraceae in Galapagos, four of them, *Darwiniothamnus*, *Lecocarpus*, *Macraea* and *Scalesia*, endemic to these islands. *Scalesia*, included by most authors within Heliantheae, is the largest and most diverse of the four and is present on most of the larger islands, where the different species show allopatric distributions. In general, older islands have more species. The genus comprises 15 species and 19 taxa, including subspecies and varieties, which have been grouped into 4 series.

Scalesia has been related to various genera of the tribe Heliantheae by different authors, on the basis of geographical distribution, habitat, morphological features, fruit dispersion, chromosome number or DNA but few pollen studies have been made on the genus.

In this work, the pollen morphology of several species of the genus *Scalesia* was examined. Pollen material from the herbarium of the Charles Darwin Research Station (CDS) was acetolysed, according to the method of Erdtman (1960), mounted in glycerine jelly and observed with a light microscope. For scanning electron microscopy, the pollen grains were coated with evaporated gold.

Scalesia present trizonocolporate pollen grains, which are isopolar and radiosimetric. They are medium sized, circular in polar view, and from circular to slightly elliptic in equatorial view, from spheroidal to prolate-spheroidal. The exine is thick (about 5-7 µm), with long, acute and conical echinae to 10µm as supratectal elements.

Distinguishing the Urticales in the fossil pollen record: The Maya Lowlands

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The Urticales is a large order with four families (Cecropiaceae, Moraceae, Ulmaceae, and Urticaceae), with as many as 139 genera and 3700 species. The Urticaceae are primarily herbaceous, while the other families are predominantly arboreal. Many, if not most, of the species are wind pollinated, and a vast majority of the species have small diporate pollen grains that can be difficult to distinguish. In the Maya Lowlands, the Moraceae often dominate the extant associations, and diporate Urticales pollen is abundant in fossil pollen spectra. It is therefore important to be as precise as possible when publishing pollen data from the region, but as yet there is no standard convention for dealing with the Urticales.

For the Maya Lowlands, I propose that the use of "Urticales" in pollen diagrams is unwarranted. In this area, there are only nine genera with diporate pollen. *Pilea, Trema, Ficus, and Cecropia*, can be readily distinguished at the genus level, while *Pourouma* is not an important taxon in Guatemala and Belize. Thus the use of "Moraceae" may be appropriate for *Brosimum, Maclura (Chlorophora)*, and *Trophis*. However, I propose that *Brosimum alicastrum* may be further separated from the other two.

Pollen morphology in the genus *Fritillaria* (Liliaceae)

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According to V. N. Kosenko's investigation (1991), pollen of 32 species from genus *Fritillaria* were examined under the light microscope (LM) and scanning electron microscope (SEM) was discovered correlation between taxonomy and pollen morphology in subgenus *Fritillaria* was discovered. Also LI Ping and colleagues (1991) found out that the exine ornamentation of pollen grains of 26 species in genus *Fritillaria* from China are divided into two groups: quasi-rugutat and reticulate.

We have studied pollen grains of 8 species from all subgenera of *Fritillaria* under LM, SEM, TEM (transmission electron microscope)

Pollen grains of studied species are monosulcate, heteropolar, single(in *Fritillaria eduardii* Regel are dyads), large (from 26.3-35.0 × 42.5 - 51.3 µm in *Fritillaria zagrica* stapf, to 35.0-42.5 × 62.5_87.7 µm in *Fritillaria imperialis* L). Sulcus is rather long reaching the end of the grain or extending to the proximal side (almost equal to equatorial diameter). The shape of pollen is oblate-spheroidal, and their outlines are flatten in equatorial position

Exine surface of pollen grains of *Fritillaria camschatcensis* (L). Ker. Gawl. (Subgenus Liliorhiza (Kellog) Baker) and *F. eduardii* Regel (Subgenus Petilium (L). Baker) is macroreticulate, in *Fritillaria zagrica* Stapf (Subgenus *Fritillaria L.*) and *Fritillaria stenanthera Regel* (Subgenus Rhinopetalum (Fisch.) Baker) and *Fritillaria persica L.* (Subgenus Theresia (C. Koch) Baker) is reticulate, in *Fritillaria sewerzowii* Regel (Subgenus Korolkowia (Regel) Baker) is microreticulate, but in *Fritillaria gibbosa* Bioss (Subgenus Rhinopetalum (Fisch.) Baker) and *Fritillaria imperialis* L (Subgenus Petilium (L.) Baker) is foveate-twisting. In addition these species differ from each other by the surface of membrane sulcus and sulcus margin, by structure and width of muri, size of lumina For example: the Minimal diameter of lumina of pollen grains in *F. gibbosa is* 0.05-0.2 µm and maximal in *F. camschatcensis* is 0.3-4.4 µm, so lumina has very variable sizes.

With the help of TEM it was revealed, that these species differ from each other by thickness of ectexine (thickness of tectum and foot-layer and, height and width of columns), by different layers of entine, by the of presence endexine, by shape and diameter of head of columns, by microrelief of sculptural elements. The maximal thickness of tectum in *F. Imperialis* (1.0-2.7 µm), and minimal in *F. stenanthera* (0.4-0.5 µm). Shape of the heads of columns of in *F. gibbosa* is elliptical, and in *F. zagrica is* spheroidal, and in *F. Imperialis* is irregular-rectangularis. Microrelief in *F. persica* is rough and tuberculata, in other species is smooth or nearly to smooth. Endexine exists in all of subgenera; it is thin, faltering, and in *F. imperialis* is absent. Endexine in *F. stenanthera* is formed by separate electron dense bar, and in *F. sewerzowii* by lamellar layer.

Thus, the material investigated by us has shown the big variety of a pollen grains structure in the representatives of all subgenera of *Fritillaria.*

Key word: Pollen grains, Ectexine, Endexine, Exine ornamentation, Entine, *Fritillaria*, Sulcus , Ultrastructure, Ultrasculpture.

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A morphological variety of pollen wall structure of Amaranthaceae Juss

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Pollen grains (p.g.) of the representatives of the family Amaranthaceae were investigated under LM (100 samples, 160 species from 14 genera), under SEM (140/120/32), and under TEM (2/2/2). Pollen material was obtained from herbaria KW, LE, MHW. The detailed, unified description of p.g. of 60 genera (85% of total quantity) and 213 species (27%) of Amaranthaceae is given as a result of our investigations and analysis of the data from literature. P.g. of the family are pantoporate, spherical or polyhedral. R.P. Wodehouse (1935) was the first drawn attention to principal distinctions in a structure of pollen wall of Amaranthaceae p.g. G. Erdtman (1952), Vishnu-Mittre (1963), W. Handro (1965), M.L. Salgado-Labouriau (1973), P. Zandonella, M. Lecocq (1977), T. Borsch (1998) have proposed to divide the p.g. into some morphological types. We suggest to recognize the existence of only two Erdtman's types of the p.g. (Amaranthus-type and Gomphrena-type), as soon as there are transitional forms between the other types which were described later (the latter types can be considered as subtypes or groups). For the distinct delimitation of the Erdtman's pollen types of the family we propose to take into account the following distinctive features: p.g. of the Gomphrena-type have interaperturate areas which could be distinctly divided into areas beside the pores and arias situated at a distance from the pores; interaperturate areas look like a wall between pores, which are dipped into sporoderm surface (it could be called lacunae); there are never spines or spinules on the lateral surface (the nearest to a pore margin) of the wall.

Pollen wall structure varies within the family in the following details: 1) diameter of p.g. – 8-62 μ (more often 15-35 μ); 2) quantity of pores – 4-250 (more often 12, then 18-40); 3) diameter of pores – 0.5-13.0 μ; 4) distance between pores – 0.5-7.0 μ; 5) location of the pore border (and border of mesoporial perforations as well) comparatively with the mesoporial surface is raised a little, or it is at the same level as the surface, or more often – sunken; 6) mesoporial surface turns into pore surface suddenly or gradually (pore border may be clear or not clear); 7) pore membrane (and mesoporial surface) – convex, flat or dipped. Other varieties: dimensions and density of mesoporial perforations; form, dimensions, density and regularity of location of pore and mesoporial spinules (as well as form and dimensions of spinulose base); form and dimensions of lacunate wall; structure of a lateral surface of lacunate wall; dimensions of exine and some elements of its interior structure etc. Bases of several pore spinules are sometimes consolidated and form "spinulose islands" (fragmentary operculum). Surface of p.g. may have very small granules and be smooth or undulating. There is a supposition that the normal p.g. may be not only spherical, but also with concave wall from one side as well (for better contact with pistil). We propose to use the relative area of pore surface (it is calculated by dividing total area of pore surface into area of pollen surface) as a sign of structure of pantoporate spherical p.g., if pores are not situated in lacunae. It may reflect the conditions of growing of the plants at the period of florescence: lesser relative area of pores correlates with lesser humidity of the air.

Pollen morphology of *Ruellia* species from Argentina and Paraguay

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One of the largest genera of the family *Acanthaceae*, is *Ruellia* L., represented in Argentina and Paraguay by 20 species. The aim of the present study is to provide detailed pollen descriptions and to investigate about the value of pollen characters as indicators of species relationships. Quantitative and qualitative characters have been analyzed by LM and SEM on acetolysed pollen. Although studied taxa show a great diversification in flowers and inflorescence morphology, the pollen grains present quite uniforms general characteristics. The pollen is 3-porate, occasionally 3-colporate, subspheroidal and coarsely reticulate. However, a more detailed analysis reveals exine character variations : columellae shape ("chandelier", "cane" and "amphora" forms), muri shape (pointed or rounded, smooth or crinkled), simplicolumellate or duplicolumellate muri, pattern of lumina granules (dense, sparse or absent) and three categories of exine thickness (< 4.5 μm, 4.6-7.5μm or > 7.5μm). The grain size can be small (< 50 μm), medium (51-70 μm) or large (> 70μm). Species present different combinations of pollen characters.

A cluster analysis based on a Q-type study using the similarity coefficient of Jaccard have been applied. One small group, comprising *R. epallocaulos* Leonard ex C.Ezcurra & Wassh., *R. angustiflora* (Nees) Lindau ex Rambo and *R. longipedunculata* Lindau is distinguished from all the other species by the shape of the columellae ("chandelier" form) and the two last species by a colporate aperture. The remaining species are grouped in a second longer group. Within this group several subgroups of species can be recognized that have a number of characters in common. This study confirms that the pollen characteristics of *Ruellia* represented in Argentina and Paraguay is a good diagnostic characters to differ species.

Cavate and saccate pollen grains

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Formation of large cava in ectexine is known for different plant species. In Gymnospermae such cava are named sacci and determined as " local separation within the exine of a pollen grain and at least partly filled with an alveolate infrastructure"(Glossary). Saccate pollen grains are typical for *Pinus, Picea, Abies, Podocarpus* and others, both recent and fossil species. Ectexine of *Welwitcia* and *Ephedra* also posses cava, but they are not so big as in Coniferales. Pollen grains with cava in ectexine are also typical for some Angiospermae. They are distinguished as " a cavity between two layers of the exine extending to the colpus margin where the layers meet"(Glossary). In *Compositae* cavate pollen grains have got three large cava in mesocolpium and two cava at apocolpium. All of them are connected with each other, thus tectum and foot layer merge only at aperture margins. A large cavea in ectexine is also typical for pollen grains of *Neuradaceae, Trapaceae* and some *Proteaceae*. Tectum and foot layer of *Neuradaceae* pollen grains are merged only at aperture margins, forming a big united cavea outside aperture regions. Pollen grains of *Trapaceae* and *Proteaceae* have got folding tectum, that forms narrow cavea of different size. Tectum and foot layer are also combined only near apertures.

Thus, sporoderm structure of anemophilous gymnosperms and entomophilous angiosperms have some common features. The sacci of gymnosperms may carry out several functions: 1) the improvement of aerodynamic characters of pollen grains; 2) functionally correct orientation of pollen grain on the receptor drop and nucellus; 3) harmomegate function. Inner sporoderm of saccus bottom is very thin and elastic, so it can sag inside the saccus (Meyer-Melikian N.R., 2000). 4) The most exotic possible function of gymnosperms sacci was proposed by A.P.Rasnicyn. He supposed that the origin of saccus can lead to the decrease in pollen attraction as a feeding resource because of comparative decrease in the volume of eatable hametophyte and increase in the volume of non-eatable sporoderm. Species of *Neuradaceae, Trapaceae* and *Proteaceae* are entomophilous, so aerodynamic ability of pollen grains is not so important. Large cavities in the sporoderm structure mainly function as harmomegate. This function is especially important for plants of arid regions of Southern Africa. Pollen grains of *Compositae* species can be cavate and non-cavate. The plants of this family are mainly entomophilous. The exeptions are anemophilous *Artemisia* with non-cavate pollen grains and *Ambrosia* with cavate pollen. In spite of the same structure of sporopollenin skeleton, cavities can be filled with water or air. Under harmomegate movements pollen grains with water in cavities loose it first of all. At the same time the size of cavities goes down, and the volume of protoplasm does not change (Blackmore S. et al., 1984). When the cavities are filled with air, pollen grains loose water from protoplast, and the size of cavities increase at the expense of protoplast.

All cavate and saccate pollen grains have got large or middle size and thick sporoderm. These are the only common characters of all studied examples. It is supposed that such convergation can be explain by a very easy loss of connections between ectexine layers in ontogeny. Cavities formed as a result of such loss, are used for different purpose: for flights in gymnosperms or for storage of biologically active substances in angiosperms.

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Pollen morphology and phylogeny of *Acalypha* (Euphorbiaceae)

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The genus *Acalypha* is composed of about 450 species and is the fourth largest genus in the family Euphorbiaceae. A palynological investigation was conducted in order to broaden the morphological database for phylogenetic analysis of the genus towards a revision of its infrageneric classification. The pollen of 87 collections consisting of 71 species representing 3/3 subgenera, 11/11 sections and 37/39 series were examined with LM and SEM. *Acalypha* pollen is small (not larger than 22 µm), subisopolar to isopolar and has an oblate-spheroidal to suboblate meridional outline. The aperture system is 2-8 colporate, ectocolpus short (1-5 µm) and almost equal to endopore diameter. Exine ornamentation is rugulate with vague to distinct scabrae localized on the margins of the muri or scattered over the pollen surface. Three types of exine ornamentation were recognized, but their distribution within the genus is not consistent with a molecular phylogeny based on ITS and ndhF. Aperture number variation is complex, making recognition of distinct types difficult. The present findings do not agree with previous studies describing *Acalypha* pollen to be homogenous within the genus.

Palynology of the Anacardiaceae: Tribe Mangifereae

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The pollen morphology of the Anacardiaceae is studied to contribute to the systematic position of this family. At present 16 species belonging to 6 genera of the tribe Mangifereae are investigated by light and scanning electron microscopy. The tribe Mangifereae is eurypalynous, characterised monad, tricolporate and isopolar, rarely heteropolar grains. Their size averages between 17.4 to 60.4 µm, the P/E ratio between 0.88 to 1.74. Most of grains are prolate spheroidal to prolate, some grains are oblate spheroidal. In polar view they show mostly a circular, rarely a subtriangular outline. The number of ectoapertures and endoapertures consists uniformly of three colpi and pori respectively. The apertures are zono-aperturate and situated at the equator. The pori are mostly large, lalongate and irregular rectangular, rarely lolongate. The exine thickness varies between 1.2 to 3.8 µm. The sexine is generally thicker than the nexine, and averages between 0.8 to 2.7 µm. The tectum is reticulate, reticulate-suprastriate, striato-reticulate and striate. Its thickness ranges from 0.4 to 1.6 µm. The columellae are mostly short and do not exceed 1 µm. The nexine is generally thin, varying between 0.5 to 1.2 µm.

Seven pollen types are recognised mainly on apertures morphology, sexine sculpture, pollen symmetry and size. Three groups of preliminary phylogenetic morphological trends emerge from this study. The first group comprises five pollen types: *Anacardium exelsum* type, *Anacardium occidentale* type, *Bouea burmanica* type, *Gluta usitata* type and *Mangifera foetida* type, with reticulate and striato-reticulate sculpture. Group two consists of the *Gluta bengas* type, with reticulate-suprastriate and heteropolar sculpture. Group three has also only one type, the *Buchanania arborescens* type, with finely striate sculpture. The present results support the existing taxonomic investigations by macro morphology and molecular studies. A key for the identification of these pollen types is presented.

Key words: palynology, pollen morphology, phylogeny, Mangifereae, Anacardiaceae.

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Palynologic study of *Spiraea* L. (Rosaceae)

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When carrying out the palinologic investigations of Miocene-Quaternary deposits the considerable difficulties arise due to availability in the spectra the abundant pollen of the diverse grassy and shrub plants, the morphology of which has been studied not well enough. Especially it is actual for Priamurye, where spores and pollen is the only paleontologic material, by which one can determine the age of enclosing rocks and restore the character of vegetation and climate as well as make the correlation of the sections.

The solution of this problem is possible, first of all, on the basis of detailed study of the recent plants' pollen morphology with use of light and scanning electron microscopes and creation the palyno-catalogue.

This work has being done by the author since 1998. Since then the detailed palinomorphological investigations of Scrophulariaceae (8 species from 4 genera), Ranunculaceae (11 species from 5 genera) (Torgaeva G.N., 2000) and *Spiraea.L.* Rosaceae (10 species) have been carried out. The conducted investigations allowed to establish the distinctive morphological features of the generic and specific level, to distinguish the types of pollen grains of these families.

The analysis of publications shows that the morphology of *Spiraea L.* pollen grains has been studied not well enough. In the presented paper the taxonomic status of similar species of *Spiraea L.* genus was made more precise. The morphostructure and peculiarities of pollen grains' sporoderm structure has been revealed. 10 species of *Spiraea L.* genus, growing on the territory of Priamurye, Siberia and other areas of the Far East, have been studied with the scanning electron microscope. The *Spiraea L.* pollen grains are radiosymmetric, equatorially tricolpatepore. They differ from each other by some details of the pore structure and by size. The exine of pollen grains is plain or weak-striated.

Exine ultrastructure of *Duplicisporites from* the Triassic of Italy

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During a palynological revision of the Upper Triassic units of Italy, Austria and Hungary, a large amount of pollen and spores became available and has helped to solve some taxonomic problems. At this paleolatitude (20-25° N), during the late Ladinian, Circumpolles appear, a pollen group with supposed cheirolepidiaceous affinity. The conifers producing this pollen would seem to be the most likely trees to have exuded the abundant fossil resin and cuticle fragments found in the Carnian of Italy. As plants macrorests are rare, the analysis of the ultrastructure of Upper Triassic Circumpolles could give new information about their affinity.

Samples have been collected from the mixed carbonate-clastic Dürrenstein Formation in the Dolomites, and from the subtidal marly shales with calcareous intercalation, "Rio del Lago" Formation, in the Julian Alps. These formations, well dated with ammonoids and conodonts, are late Julian – upper Tuvalian in age. Azonotriletes and cavatomonoletes spores and monosaccoid, bisaccoid and Circumpolles pollen are well

represented in both localities. Among the members of the latter group, the genera *Precirculina*, *Partitisporites*, *Paracirculina*, *Duplicisporites* and *Camerosporites* have been determined.

A morphological study of dispersed Circumpolles pollen grains from the Upper Triassic of the Southern Alps was started with the formal genus *Duplicisporites*. Individual pollen grains (LM image, Fig. 1) were treated by means of scanning electron microscopy (SEM) and transmission electron microscopy (TEM). With SEM, the pollen surface is finely verrucate (Fig. 2) with low verrucae of variable size. A sub-equatorial continuous circular furrow is clearly distinguished. The proximal trilete scar (seen with SEM) is small, close, and indistinct. TEM revealed a typical exine organization with the wall composed by a double layer (Fig. 3). The ectexine is formed by numerous, small, closely packed granulae subdivided by irregularly-spaced cavities. At the base of this layer the granulae are clearly visible, while superficially they are fused into an indistinct tectum with an undulating margin, which corresponds to the verrucate sculpture visible with SEM. In the region of the subequatorial canal, the ectexine becomes considerably thinner, about 1/3 of the usual thickness. At places, the ectexine is slightly separated from the underlying endexine. The endexine is prominent and significantly darker than the ectexine. It is homogeneous and of constant thickness. On the base of the older age with respect to the genus *Classopollis*, the present ultrastructural dataset, provides additional information on the possible origin of the cheirolepidiaceous-type morphology.

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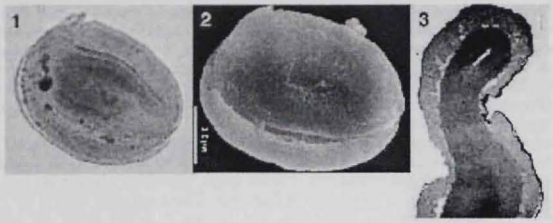

Pollen morphology of family Euphorbiaceae from Pakistan

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Pollen morphology of 40 species representing 5 genera viz *Andrachne*, *Chrozophora*, *Dalechampia*, *Euphorbia*, *Mallotus* and *Phyllantus* of the family Euphorbiaceae from Pakistan has been examined by light and scanning electron microscope. Euphorbiaceae is a eurypalynous family.

Pollen grains usually radially symmetrical, isopolar, prolate or oblate-spheroidal to prolate-spheroidal, often sub-oblate to sub-prolate tricolporate often 6-7 colporate. Colpi generally with colpal membrane psilate to sparsely or densely granulated, ora lalongate, sexine as thick as nexine, or slightly thicker or thinner than nexine. Tectum varies from reticulate to rugulate-reticulate or rugulate – foveolate. Rarely scabrate or striate. On the basis of exine pattern and apertures number 5 distinct pollen types are recognized. viz., *Andrachne* - type, *Euphorbia*-type. *Phyllanthus*- type, M*allotus*- type and *Chrozophora*-type. Pollen morphology of the family is significantly helpful at the generic and specific level.

Palynological analysis of section Crociseris Reichenb. in *Senecio* L. (Asteraceae) from the Iberian Peninsula

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The pollen morphology of Section Crociseris Reichenb. in genus *Senecio* L. (Asteraceae) from the Iberian Peninsula is investigated in the present study, namely *Senecio pyrenaicus* L. (4 subspecies), *S. doronicum* L. (2 subspecies), *S. lagascanus* DC., *S. paludosus* L., *S. auricula* Bourg. ex Coss. (2 subspecies), *S. eriopus* Wk., *S. lopezii* Boiss. We also studied one specie of different sections in *Senecio* L. and two species of the genus *Doronicum* L. as outgroup samples: *Senecio boissieri* DC., *S. linifolius* L., *S. doria* L. subsp. *legionensis* (Lange) Chater, *S. helenitis* (L.) Schinz & Thell. subsp. *helenitis*, *S. carpetanus* Boiss. & Reuter, *S. jacobaea* L., *S. minutus* (Cav.) DC., *S. vulgaris* L., *Doronicum grandiflorum* Lam. and *D. plantagineum* L.

To carry out this study we used 110 specimens of the taxa appointed before, selected among 1000 sheets from different herbaria. The samples were acetolyzed following the methods outlined in ERDTMAN (1969). We scored 29 characters using light and scanning electron microscopies. Quantitative data were analized using Simpson & Roe's test (BIDAULT 1968). The variation among similar structures were described by dividing the 29 characters into character states according to the standardized system 10-90 (HIDEUX, 1977; HIDEUX et MAHÉ, 1977). Two data matrices were used according to taxa and populations covered. Finally taxa were classified according to overall simirality using phenetic methods (SNEATH & SOKAL, 1973; HIDEUX, 1977; HIDEUX et MAHÉ, 1977). Principal components analyses and cluster analyses were performed using the NTSYSpc package (version 2.0). Principal components analysis was performed on the correlation matrix, obtained from the standardized data. Cluster analysis involved computing a distance matrix based on standardized data and performing a complete method analysis to construct a dendrogram. The cophenetic correlation coefficient was calculated and used as a measure of goodness of fit of the cluster analysis to the data.

Pollen grains of all taxa examined are trizonocolporate. Their shape varies from prolate- spheroidal to spheroidal, presenting a medium size. The tectum is always perforate-echinate. It was concluded that palinological characters are an useful complementary source of information in *Senecio*, being the most important:

- Shape of the pollen, all the characters studied relating to the spines: length, width, density, interspinal area, shape and perforations density on spine, and finally perforations density on tectum.
- Polar axis, Equatorial diameter, mesocolpium width and endoaperture (length and width).
- Mesoaperture, ornamentation, number of apocolpium and intercolpium spines.

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A study on pollen morphology of tundra plans from Barrow, Arctic

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Barrow is located in the northeast of Alaskan coastal plain (71021' N, 156040' W),which is encircled by the Chukchi Sea in the west and the Beaufort Sea in the north. Thus, it is considered to be a key region for studying the land-ocean interaction related to climatic and environmental changes. Climatically, Barrow is a quite cold area with the mean annual temperature of –12.4°C and the mean winter and summer temperatures ranges between –29°C and 2°C. Mean annual precipitation is less than 250mm/a.

Pollen morphology of 15 species of tundra plants from Barrow, Arctic are investigated in the present study. They are *Dryas integriflora* M.Vahl (Rosaceae), *Rubus chamaemorus* L. (Rosaceae),*Salix routundifolia* Trautv (Saliaceae),*Saxifraga cernua* L.(Saxifragaceae), *Silene acacelis* (L.) Jacq., *Honcknya peploides* (L.) Ehrh., *Stallaria laeta* Richards, (Caryophyllaceae), Rumex arcticus Trautv. (Polygonaceae) *Papaver macounii* Greane (Papaveraceae),*Ranunculus* nivalis L. (Ranunculaceae), *Saussurea viseidia* Hult (Compositae), *Mertensia martima* (L.) S.F.Gray (Boraginaceae), *Pyrola grandiflora* Radius (Pyrolaceae), *Pedicularis langsdorffi* Fisch (Scrophulariaceae), *Cardamine pratensis* L. (Cruciferae). The result shows that the pollen grains are mainly spherodal, subspheroidal and oblate, cocoon-formed or tetrads. The types of aperture are mostly tricolporate or trcolpate, rarely pantoporate. They are radially or bilaterally symmetric. All these plants from which the pollen materials were collected for this study are found to occur commonly in Arctic area. Most of them, except for 3 species which are bushes, are perennial or annual herbs. Investigation on pollen grains of tundra plants can provide significant data for comparative study of fossil pollen and for reconstruction of paleovegetation and paleoclimate in Barrow area.

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Description and differentiation of *Pseudolarix amabilis* (Nelson) Rehder pollen and implications on its fossil record

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We investigated fresh pollen of *Pseudolarix amabilis* (Pinaceae) through a morphometric analysis of its bisaccate pollen grains at light microscope and at SEM (see images below). The observed characters have than been compared with pollen grains from twelve living species of *Pinus*. Differentiation criteria from *Pinus* and other bisacccate have been established and then verified on a fossil sample from the Pliocene of Piedmont (Italy) in which abundance of *Pseudolarix* cone scale and needles was found by Martinetto (2001a, 2001b) Positive recognition of *Pseudolarix* pollen also concerns lacustrine sediment from Massif Central (France) about 4 millions years old. Distinction of *Pseudolarix* from *Pinus* pollen will enable to investigate the fossil history of this genus, so far remained obscure because of its low representation in macrofossil records.

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