

A Contribution to the Pollen Morphology of Family Gramineae

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Abstract: Pollen morphology of 20 species belonging to the 14 genera of the family Gramineae has been investigated using light microscope and scanning microscope. It is a stenopalynous in nature. Pollen grains mostly spheroidal, monoporate rarely diporate, ±circular, pores small operculate, non-operculate, annulate or non-annulate. Tectum areolate to scabrate. On the basis of exine ornamentations 5 distinct pollen types are recognized. Palynology do not correspond with tribal classification. However, palynology is significantly helpful at the specific and generic level within the tribes.

Key words: Gramineae • Pollen • tectum

INTRODUCTION

A large family with c. 620 and 1000 species [1, 2]. A number of authors studied the pollen morphology of family Gramineae like, Wodehouse [3], Fibris [4], Joens and Newell [5], Sampath and Ramnathan [6], Ethirajan [7], Rowley [8], Bourriel and Reyel [9], Bourriel *et al.* [10], De Lisle [11], Bonnifile [12] and Gornall [13] and Siddiqui and Qaiser [14].

Pollen of some European grasses was examined by Faegri and Iversen [15]. Andersen and Bertelsen [16] examined studied some members of Gramineae by scanning electron microscope. Page [17] divided areolate tectum type in two groups on the basis of granules proximity i.e. widely space type and closely space type. Kohler and Lange [18] distinguished cereal from grass pollen by LM and SEM. Pollen morphology of 49 species of family Gramineae from Venezuelan mountain have examined by Salgado-Labouriau and Rinaldi [19, 20]. Salgado-Labouriau *et al.* [21] also examined exine structure of the genus *Pariana* pollen. In the present study, 22 species of family Gramineae representing 12 genera belonging to 10 tribes were examined by light and scanning microscope.

MATERIALS AND METHODS

Pollen samples were obtained from Karachi University Herbarium (KUH) or collected from the field. The list of voucher specimens is deposited in KUH. The pollen grains were prepared for light (LM) and scanning microscopy (SEM) by the standard methods described by Erdtman [22] for light microscopy, the pollen grains were mounted in unstained glycerine jelly and observations were made with a Nikon Type-2 microscope,

under (E40, 0.65) and oil immersion (E100, 1.25), using 10×eye piece. For SEM studies, pollen grains suspended in a drop of water and directly transferred with a fine pipette to a metallic stub using double sided cellotape and coated with gold in a sputtering chamber (Ionspitter JFC-1100). Coating was restricted to 150A. The S.E.M. examination was carried out on a Jeol microscope JSM-1200. The measurements were based on 15-20 readings from each specimen. Pollen diameter, pore diameter and exine thickness were measured (Tables 1 and 2).

The terminology used is in accordance with Erdtman [22], Kremp [23], Faegri and Iversen [15], Moore and Webb [24] and Andersen and Bertelsen [16].

RESULTS AND DISCUSSIONS

General descriptions of Gramineae pollen grains: Pollen grains apolar, medium rarely large sized, 18.7-72 μm in diameter, spheroidal, mono-diporate, rarely triporate, operculate to non-aperculate, annulate to non-annulate or reduce annulus, generally sexine as thick as nexine often thicker or some time thinner than nexine. Tectum usually areolate-scabrate, rarely areolate cum scabrate. In areolate tectum, scabrae fine-large in size, grouped in 2-40 on regular or irregular areolae.

Key to the pollen types

1	+	Tectum scabrate	Type-V
	-	Tectum areolate-areolate cum scabrate	2
2	+	Tectum areolate cum scabrate	Type-IV
	-	Tectum areolate	3
3	+	Areolate with coarse scabrae	Type-III
	-	Areolate with fine-medium scabrae	4
4	+	Areolate with fine or diffuse scabrae	Type-I
	-	Areolate with medium scabrae	Type-II

Table 1: Single and double diporate pollen grains in the family Gramineae

Taxa	Single diporate size in μm	Double diporate size in μm
<i>Aristida adscensionis</i> L.	28.3x25.8	128.87x28.87
<i>A. cyanantha</i> Nees & Steud.	28.8x28.87	-
<i>A. hystriacula</i> Edgew.	31.9x31.91	-
<i>Coix lacryma-jobi</i> L.	75.39x75.39	-
<i>Cymbopogo. pospischilii</i> (K.Schum.) C.E. Hubbard	32.31x34.12	-
<i>Cynodon arcuatus</i> Prest	23.3x21.8	-
<i>Diplachne fusca</i> (L.) P. Beauv. Ex Roem. & Schult.	21.5x21.54	-
<i>Enneapogon persicus</i> Boiss.	25.1x25.1	32.3x28.72
<i>E. schimperanus</i> (Hochst. Ex A. Rich.) Renvoize		
<i>Echinochloa stagnina</i> (Retz.) P. Beauv.	42.7x42.7	
<i>Hemarthria compressa</i> (Forssk.)Hilu	28.0x28.7	
<i>Melanocenchris abyssinica</i> (R. Br.ex Fersen.) Hochst.	28.7x28.7	32.2x32.31
<i>Pennisetum divisum</i> (Gmel.) Hern.	30x32	
<i>P. orientatale</i> L. C. Rich.	35.9x35.9	
<i>Stipagrostis hirtigulma</i> (Steud. Ex Trin & Rupr.) De Winter	35.9x28.9	

Table 2: General characters of pollen grains of species studied in the family Gramineae

Name of Taxa	Annulus	Operculum	Pore diameter	Diameter	Exine Thickness	Tectum
			(μm)	Pollen (μm)		
<i>Aristida adscensionis</i> L.	Annulate	Non-Operculate	3.43(3.56±0.08)3.73	26.7(31.5±0.57)35.5	0.72(1.27±0.13)1.79	Scabrate
<i>A. cyanantha</i> Nees & Steud.	Annulate	Non-Operculate	3.59(3.82±0.49)3.94	25.13(27.6±0.44)29.0		Areolate-cum-scabrate
<i>A. funiculata</i> Trin. & Rupr.	Annulate	Operculate	2.87(3.37±0.14)3.95	31.33(33.6±0.51)35.9	1.43(1.61±0.12)2.51	Areolate-cum-scabrate
<i>A. hystriacula</i> Edgew.	Annulate	Operculate	2.87(3.05±0.18)3.32	28.7(29.1±0.25)30.5	0.34(0.12±0.17)1.07	Areolate-cum-scabrate
<i>Coix lacrymo - jobi</i> L.	Annulate	Operculate	3.59(4.55±0.31)6.82	62.8(68.6±0.78)72.15	1.43	Areolate-cum-scabrate
<i>Cymbopogon pospischilii</i> (K.Schum) C.E. Hubbard	Annulate	Operculate	3.23(3.7±0.05)3.59	32.3(34.9±0.54)63.76	0.72(1.38±0.13)1.79	Areolate
<i>Cynodon arcuatus</i> Presl	Annulate	Operculate	1.79(2.66±0.26)3.23	19.74(21.77±0.32)24.71	1.07(1.43±0.08)1.79	Areolate
<i>Danthonopsis stocksii</i> (Boiss.) C.H. Hubbard	Annulate	Operculate	3.23(3.36±0.10)3.95	21.54(22.74±0.48)25.14	0.35(1.79±0.52)2.89	Scabrate
<i>Stipagrostis hirtigulma</i> (Stend.) ex Trin and Pupr.) De Winter	Annulate	Operculate	3.23(3.55±0.111)3.94	32.3(37.93±1.15)50.29	0.36(2.16±0.32)2.99	Scabrate
<i>Diplachne fusca</i> (L.) P. Beauv. Ex Roem and Schult		Operculate	2.89(3.69±0.47)4.66	23.73(24.43±0.23)25.78	0.36	Areolate-cum-scabrate
<i>Echinochloa stagnina</i> (Retz.) P. Beauv.	Annulate	Operculate	2.81(3.11±0.11)3.87	39.119(42.77±0.46)50.26		Areolate
<i>Enneapogon brachystachys</i> (Jaub.) Spach) Stapf	Annulate	Operculate	3.23(3.47±0.49)8.59	26.9(30.15±0.64)32.3	1.08(1.51±0.08)1.79	Scabrate
<i>E. persicus</i> Boiss.	Annulate	Non-oper	2.87(3.31±0.13)3.94	23.33(25.07±0.12)28.36	0.36(0.94±0.13)1.79	Areolate
<i>E. schimperanus</i> (Hochst. ex A. Rich.) Renvoize	Annulate	Non-operculate	c.3.59	28.7(30.80±0.71)35.9	1.08(1.34±0.19)1.30	Areolate
<i>Hemarthria compressa</i> (L.D.) R. Br	Annulate	Non-operculate	1.43(2.94±0.21)3.95	28.72(31.3±0.46)34.1	0.35(2.17±0.44)2.69	Areolate
<i>Melanocenchris abyssinica</i> (R. Br. E & Fresen.) Hochst	Annulate	Non-operculate	1.79(2.39±0.32)2.87	28.72(31.27±0.34)32.31	2.51(3.07±0.08)3.23	Areolate
<i>M. jacquemontii</i> Jaub. & Spach.	Annulate	Non-operculate	2.66(3.26±0.28)4.32	23.31(26.5±0.45)4.32	0.33(1.2±0.35)2.45	Areolate
<i>Pennisetum divisum</i> (Gmel.) Hern.	Annulate	Operculate	2.87(3.30±0.20)3.54	0.72(1.11±0.18)1.43	30.5(31.20±0.32)32.6	Areolate-cum-scabrate
<i>P. orientatale</i> L. C. Rich.	Annulate	Operculate	0.39(3.76±0.08)9.4	35.9(36.6±0.36)39.4	0.71(1.10±0.07)1.35	Areolate
<i>Sehima ischaemoides</i> Frossk.	Annulate	Operculate	3.59(3.81±0.01)3.94	32.31(33.6±0.39)35.9	1.07(1.35±0.08)1.79	Scabrate

Descriptions of pollen types

Type I: Areolate with minute or fine scabrae-type (Fig. 1D).

Size: 18.5-46 μm in diameter.

Spheroidal, monoporate-diporate, operculate to non-operculate, annulate to non-annulate, often annulus reduced, annulus 1-5.1 μm thick, 4-10.11 μm in diameter. Pore 0.31-3.95 μm in diameter. Exine 0.71-3.61 μm thick,

sexine as thick as nexine or thicker or thinner than nexine. Tectum areolate, scabrae minute or fine some times diffused in groups of 2-25, closely-medianly distributed on small-large areolae.

Species included: *Enneapogon persicus*, *Enneapogon schimperanus*.

Type II: Areolate with medium scabrae-type (Fig. 1A and B).

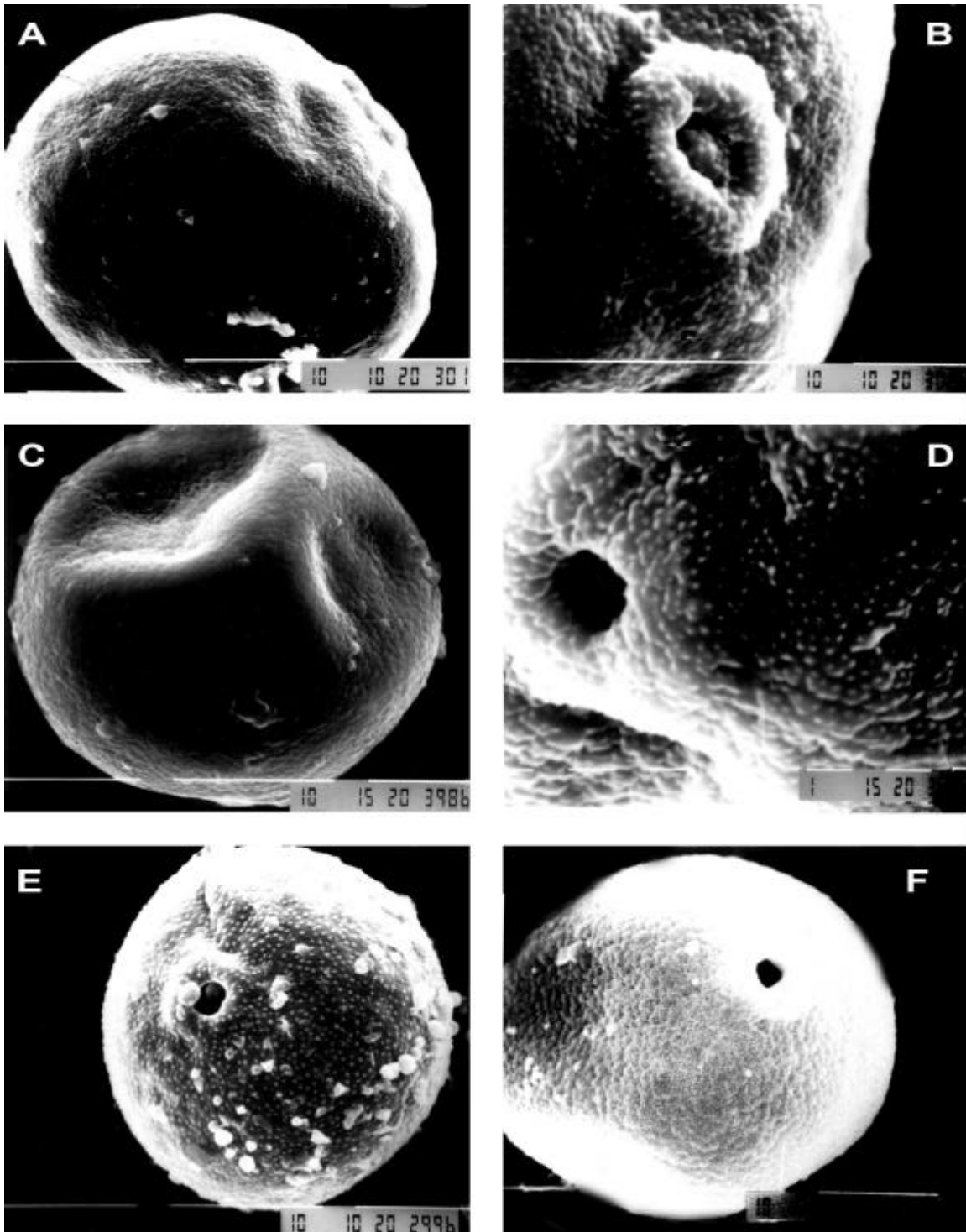


Fig. 1: Scanning Electron micrographs of pollen grains. A and B, *Hemarthria compressa*: A, Pollen grains, B, Exine pattern. *Pennisetum divisum*: C, Pollen grain, D, Exine pattern. *Aristida adscensionis*: E, Pollen grain. *Pennisetum orientale*: F, Pollen grain
Scale bar = A-C, E and F = 10 μ m; D = 1 μ m

Size: 18.3-50.99 μm diameter.

Spheroidal, monoporate-diporate, operculate-non-operculate, annulate to non-annulate, sometimes annulus reduced, annulus 3-7.81 μm in diameter, 0.85-4.11 μm thick, pore 1-4.32 μm in diameter. Exine 0.33-3.49 μm thick, sexine as thick as or slightly thicker or thinner than nexine. Tectum areolate, scabrae medium size in groups of 2-25, closely-widely distributed on small-large size regular or irregular areolae.

Species included: *Cymbopogon pospischilii*, *Cynodon arcuatus*, *Echinochloa stagnina*, *Hemarthria compressa*, *Melanocenthris abyssinica*, *M. jacquemontii*.

Type III: Areolate with coarse scabrae-type.

Size: 23.3-50.29 μm in diameter.

Spheroidal, monoporate-diporate rarely triporate, operculate to non-operculate, annulate sometimes annulus reduce annulus 1.05-3.91 μm thick, 4.2-7.81 μm diameter. Pore 2.11-3.96 in diameter. Exine 0.35-2.99 μm thick, sexine thicker than or as thick as nexine rarely thinner than nexine. Tectum areolate with coarse scabrae, in groups of 2-20 closely-widely distributed on small-large regular or irregular areolase.

Species included: *Enneapogon persicus*, *Enneapogon schimperanus*.

Type IV: Areolate cum scabrate-type (Fig. 1C and D).

Size: 20.2-35.5 μm in diameter.

Spheroidal, monoporate-diporate, rarely triporate, operculate to non-operculate or indistinct operculum, annulate, often with reduce annulus, annulus 0.71-4.14 μm thick, 4.76-8.61 μm in diameter. Pore 0.71-4.94 μm in diameter. Exine 0.35-1.43 μm thick, sexine as thick as nexine often slightly thicker than nexine. Tectum areolate-cum-scabrate, scabrae medium-coarse often minute in groups of 8-40 mostly widely distributed sometimes closely on large sized regular or irregular areolae.

Species included: *Aristida cyanantha*, *A. hystricula*, *Pennisetum divisum*, *Diplachne fusca* (L.) P.Beauv.ex Roem and Schult. .

Type V: Scabrate type (Fig. 1E).

Size: 21.11-72.15 μm in diameter.

Spheroidal, monoporate-diporate rarely triporate,

operculate non-operculate, annulate, annulus 1.12-4.58 μm thick, 3.41-11.79 μm in diameter, pore 1.43-8.59 μm diameter. Exine 0.35-2.9 μm thick, sexine as thick as nexine often slightly thicker or thinner than nexine. Tectum scabrate, scabrae fine-coarse size, closely-widely distributed on smooth surface.

Species included: *Aristida adscensionis*, *Coix lacryma-jobi*, *Danthoniopsis stocksii*, *Enneapogon brachystachyus*, *Sehima ishaemoides* and *Stipagrostis hirtigluma*.

DISCUSSION

Gramineae is a stenopalynous family. The pollen morphology of various taxa at the generic or even at the tribal level is remarkably uniform. Most of the pollen characters such as shape, size, aperture and exine pattern play a little role in the classification and delimitation of the various taxa of the family.

Tectum in the pollen grains of the family Gramineae is generally areolate, areolate cum scabrate, or simply scabrate. Similar type of tectum has also been observed in the other members of the family Gramineae by Faegri and Iversen [15] and Andersen and Bertelsen [16].

Pollen morphology and taxonomy:

Tribe: Aristideae.

This tribe includes 3 pollen types. Pollen types-I, IV and V from this tribe pollen morphology of two genera were investigated i.e. *Aristida* (representing three species) and *Stipagrostis*, *Aristida funiculate* and *Stipagrostis hirtigluma* have similar pollen type (pollen type-I) which are characterized by areolate with fine scabrate exine [10], whereas two species of *Aristida* i.e. *Aristida cyanantha* and *A. hystricula* are easily recognized by areolate cum scabrate exine i.e., pollen type-IV and a single species *Aristida adscensionis* falls in pollen type-V, in which exine is scabrate. Similar type of pollen in the genus *Aristida* have also been examined by Bourriell and Reyer [9]. Although, this tribe is very heterogeneous but pollen morphology is significantly helpful at specific level 4 species of *Aristida* are easily delimited on the basis of palynology (Table 1).

Tribe: Pappophoeae.

In this tribe also more than one pollen type are observed. Although within this tribe only a single genus representing three species were examined. *Enneapogon*

persicus and *E. schimperanus* are characterized by areolate with coarse scabrae i.e. pollen type-III, whereas remaining one species is included in pollen type-II which is characterized by areolate with medium scabrate exine.

Tribe: Eragrostideae.

Within this tribe a single species i.e. *Diplachne fusca* was examined. This species is characterized by areolate cum scabrate tectum i.e. pollen type-IV.

Tribe: Chlorideae.

Two genera i.e. *Cynodon* (*Cynodon arcuatus*) and *Melanocenchris* (*Melanocenchris abyssinica*, *M. jacquemontii*) were investigated. Both the genera fall in pollen type-II, which is recognized by areolate with medium scabrate exine. However, these genera are easily delimited on the basis of pollen grains diameter for instance, pollen of *Cynodon* are 19-24 µm in diameter, whereas in the genus *Melanocenchris* 24-32 µm diameter of pollen are found. The two species of *Melanocenchris* are further separated on the basis of other pollen characters (Table 1).

Tribe: Arundinelleae.

From this tribe a single genus i.e. *Danthoniopsis* (*Danthoniopsis stocksii*) was examined. It is characterized by scabrate exine i.e. belonging to pollen type-V.

Tribe: Paniceae.

From this tribe two genera were investigated i.e. *Pennisetum* (*Pennisetum orientale* and *P. divisum*) and *Echinochloa* (*E. stagnan*). *Pennisetum orientale* is characterized by areolate with fine scabrate exine (pollen type-I), whereas *Pennisetum divisum* is easily recognized by pollen type-IV, areolate cum scabrate exine and *Echinochloa stagnina* is easily delimited by areolate with medium scabrate exine.

Tribe: Andropogoneae.

This tribe includes 2 pollen types i.e. III and V. Four genera are examined from this tribe namely, *Coix*, *Cymbopogon*, *Hemarthria* and *Schima* each representing by a single species. *Coix lacryma-jobi* and *Sehima ishaemoides*, belonging to pollen type-V, which is recognized by scabrate tectum, whereas *Cymbopogon pospischilii* and *Hemarthria compressa* are easily characterized with medium scabrate exine. However, these genera are further delimited on the basis of other pollen characters (Table 1).

CONCLUSIONS

In most of the pollen types, species of different tribes are present e.g., areolate with medium scabrate exine (pollen type-II) included the species of tribes Chlorideae and Andropogoneae. On the other hand some species of the tribe Andropogoneae are found in pollen type-IV, in which exine is scabrate. Similarly, four species of the genus *Aristideae* are distributed in three different pollen types i.e. In the present study five pollen types recognized on the basis of exine do not correspond with the tribal classification of family Gramineae. However, palynology is significantly helpful at the generic and specific level within the tribe. Pollen morphology also confirms stenopalynous nature of the family Gramineae.

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