Pollen Morphological Analysis of the Flora of North Rajasthan (Indian Desert)

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Abstract

North Rajasthan includes Ganganagar, Hanumangarh, Bikaner and Churu districts. It constitute a part of the Great Indian desert and is under intensive irrigation by a network of canals. The flora of north Rajasthan comprises 680 species belonging to 433 genera distributed among 105 families of flowering plan., out of which 85 belongs to dicots and 20 to monocots. Most dominating, families among dicots are Papilionaceae with 65 species and Asteraceac with 54 species, among monocots it is Poaceae with 86 species. The ratio of monocots to dicots is 1: 4.25 of families, 1: 4.22 of genera and 1: 4.04 of species. Due to protracted irrigation 87 extralimital species arc introduced and 153 species which belongs to Indian Desert have disappeared from irrigated regions but are still present in non-irrigated regions of North Rajasthan. Pollen morphologically most dominating aperture is 3-zonocolporate representing as much as 35.02% of total flora. In Dicotyledons most dominating aperture type is 3-zonocolporate (43.84%) while in monocotyledons it is 1-porate (62.97%). As regard the exine ornamentation most dominating type is reticulate with 32.20%. In dicotyledons the most dominant exine ornamentation is reticulate (35.30%) while in monocotyledons it is granulate (72.90%). The most dominating shape of the grain in both dicotyledons and monocotyledons is spheroidal with 35.60% and 70.37% respectively.

INTRODUCTION

North Rajasthan constitute a part of the Great Indian desert and is under intensive irrigation by a network of canals drawing water from Punjab rivers.. The region is being irrigated by Gang canal, Bhakra canal, and Indira Gandhi canal which has greatly affected the natural flora of area in many ways.The Gang Canal, that draws water from Sutlej in Punjab was launched in 1927 and irrigates Ganganagar and Hanumangarh districts. The Rajasthan canal, now named Indira Gandhi canal introduced in 1957, has a distinction of being longest canal system of the World which starts at Hari-ka-Pattan in Punjab. At present this canal system irrigates Ganganagar, Hanumangarh and Bikaner districts. How-ever, the work of reaching this canal right upto Jaisalmer district is almost complete. In Churu district agriculture is dependent on rain water as at present it have a very less facility on canal irrigation. In Churn district canal water is pumped to water works at Sahwa town for drinking purpose. The irrigation water which draws water from rivers of Punjab have been bringing seeds and other propagules of a number of extra-limital species year after year and many of these have successfully established in the area as crop weeds or along the bank of canals. The most wonderful example of this naturalization of Himalayan plants in the Great Indian Desert are species of Riccia, Marchantia and Ophioglossum

vulgatum L. (Singh and Brar, 1980) which are found frequently in the canal irrigated areas showing how the plants from Himalyas have become naturalised in this irrigated region of the Desert.

The pollen grains which arc one of the reproductive unit in Angiosperms are characterised by the astounding morphological features which can be used as an index for taxonomic and evolutionary consideration, along with other vegetative and floral characters of flowering plants (Wodehouse, 1935; Erdtman, 1952; Rowley1960, 81; Nair. 1965,70, 79). But the information concerning the pollen grains particularly of Indian Desert region which covers 11 percent of the total area of India is scanty except a few reports by Jain and Nanda (1966-67), Parveen and Bhandari (1982), Singh et al. (1991), Singh and Kaushik (1998).

STATISTICAL ANALYSIS OF THE FLORA

The present observations are based on extensive floristic exploration of the irrigated and non-irrigated parts of North Rajasthan (Dawre, 1979; Singh,1982, 1989,1995; Singh and Brar. 1980, 1984; Singh and Dhillon, 1989; Singh and Sidhu, 1990; Singh and Singh 1990; Singh and Arora 1994). A comparison of vegetation of the irrigated and non-irrigated region of the North Rajasthan, shows that irrigation has brought about remarkable changes in the composition of original flora, both by way of introduction of extra-limital species as well as elimination ofmany of the original species. The irrigation by a network ofcanal system over the last 76 years in Ganganagar and Hanumangarh districts has apparantly changed about 21% of the species of the natural flora (Dhillon and Bajwa, 1969; Singh and Dhillon, 1989), whereas in Bikaner the change is mere 12% (Singh and Sidhu, 1990).

The natural flora has been modified in another manner also. Many of the common species of the Indian desert which originally belong to this area have disappeared, obviously, due to protracted irrigation and extensive cultivation. Most probably this has happened as a result of loosing competition with the new extrants. With the availability of irrigation large tracts are now under cultivation and waste lands have become scarce. The reduction in the realm of wild plants has obviously contributed substantially to the reduction in the number of wild species.

When compared with the original flora of Indian Desert (Blatt &Hallb, 1918-21; Puri et al., I964, Shetty & Singh 1987, Bhandari, 1990), 153 species have been observed to be disappeared from irrigated region of the North Rajasthan These species still survive in the non-irrigated areas of Bikaner and Churu, districts.

In present work flora of North Rajasthan has been studied, a statistical synopsis of the flora and its comparison with those of other regions of India is given.

TABLE - I Ten largest families with no. of Species and Genera

S.No.	Name of Family	No. of Species	Name of Family	No. of Genera
1	Poaceae	86	Poaceae	51
2	Papilionaceae	65	Asteraceae	41
3	Asteraceae	54	Papilionaceae	30
4	Malvaceae	24	Brassicaceae	11
5	Euphorbiaceae	22	Verbenaceae	11
6	Convolvulaceae	20	Caryophyllaceae	10
7	Amaranthaceae	19	Malvaceae	09
8	Cyperaceae	19	Apiaceae	09
9	Brassicaceae	16	Cucurbitaceae	09
10	Cucurbitaceae	16	Solanaceae	09
			Scrophulariaceae	09
			Bignonianceae	09
			Amaranthaceae	09

A persual of above table (Table-1) shows Poaceae, Papilionaceae and Asteraceae are number 1, 2, and 3, respectively; all other families appear at different positions in the table. Poaceae and Papilionaceae are the largest families among the monocotyledons and dicotyledons respectively. Except Poaceae and Cyperaceae, the monocotyledons, are poorly represented. Of the 135 of monocotyledons 86 belongs to Poaceae and 19 to Cyperaceae and remaining 30 species belongs to 18 families, none of which has more than 4 species, except Liliaceae with 7 species.

The ratio ofmonocotyledons to dicotyledons is 1 : 425 of families, 1 : 4.22 of genera and I 4.04 of species. The ratio of the total number of genera to species is 1:1.57 which is rather low in comparison to a corresponding ratio for the whole ofindia which is 1:7 but it is more or less similar to the ratio of Indian Desert (1 : 1.9) as reported by Bhandari (1988), the upper gangetic plain (1:2.2) and equal to Delhi (1:1.6), as reported by Maheshawari (1963). The proportion of monocotyledons to dicotyledons when compared to a corresponding ratio ofthe Indian Desert (Bhandari, 1988), is low of families (1 : 7) and almost equal in respect ofgenera and species (1 : 3). The relative proportion of dicot and moncot taxa, families, genera and species is shown in Table -2.

Table – 2

S.No.	Taxa	Dicots		Monocots		Total	Ratio		
		No.	%	No.	%		Monocot	:	Dicot
1	Families	85	81	20	19	105	1	:	4.25
2	Genera	350	80.83	83	19.17	433	1	:	4.22
3	Species	545	80.15	135	19.85	680	1	:	4.04

Thitty nine families are represented by single species in this region out of which 27 families bdongs to dicotyledons and 12 families belongs to monocotyledons (Table-3) Thirty three families have the number of species between 2-4 out of which 28 families belongs to dicotyledons and remaining 5 to monocotyledons. There are 14 families with 5-9 species these are Capparacese (8), Tiliaceae (9), Zygophyllaceae (6), Rutaceae (6), Lythraceae 5), Molluginac.e. (6), Aizoaceae (5), Apiaceae (9), Asclepiadaceae (5), Bignoniaceae (9), Lemiaceae (7), Polygonaceae (8), Moraceae (6), and Liliaceae (7).

There are 14 families with 10-20 species. These are Brassicaceae (16), Caryophyllaceae (10), Mimosaceae (12), Caesalpiniaceae (15), Cucurbitaceae (16), Boraginaceae (11), Convolvulaceae (20), Solanaceae (14), Scrophulariaceae (13), Acanthaceae (I1), Verbenaceae (15), Amaranthaceae (19), Chenopodiaceae (10) and Cyperaceae (19). Thirty nine families are represented by a single species only, while 14 families are monogeneric, but comprise more than one species. Twenty five families are having 2-4 genera, twenty one families with 5-9 genera and six families have got 10 or more genera. (Table-4) Thus the reason for large no. of families (105) represented in area with such a small no. of species (680) is canal irrigation.

Table - 3

S.No.	Families with 2-4 Species	Families with 5-9 Species	Families with 10-20 Species	Families with more than 20 species
1	Ranunculaceae	Capparaceae	Brassicaceae	Malvaceae
2	Menispermaceae	Tiliaceae	Caryophyllaceae	Papilionaceae
3	Nympheaceae	Zygophyllaceae	Mimosaceae	Asteraceae
4	Papaveraceae	Rutaceae	Ceasalpiniaceae	Euphorbiaceae
5	Polygalaceae	Lythraceae	Cucurbitaceae	Poaceae
6	Portulaceaceae	Molluginaceae	Boraginaceae	
7	Tamaricaceae	Aizoaceae	Convolvulaceae	
8	Elatinaceae	Apiaceae	Solanaceae	
9	Oxalidaceae	Asclepiadaceae	Scrophulariaceae	
10	Simaroubiaceae	Bignoniaceae	Acanthaceae	
11	Meliaceae	Lemiaceae	Verbenaceae	
12	Rhamnaceae	Polygonaceae	Amaranthaceae	
13	Sapindaceae	Moraceae	Chenopodiaceae	
14	Rosaceae	Liliaceae	Cyperaceae	
15	Combretaceae			
16	Myrtaceae			
17	Cactaceae			
18	Rubiaceae			
19	Salvadoraceae			
20	Apocynaceae			
21	Ehretiaceae			
22	Cuscutaceae			
23	Orobanchaceae			
24	Pedaliaceae			
25	Rostellulariaceae			
26	Plantaginaaceae			
27	Nyctaginaceae			
28	Aristolochiaceae			
29	Amaryllidaceae			
30	Commelinaceae			
31	Arecaceae			
32	Lemnaceae			

Table - 4

S.No.	Families with 1 Genus and 1 Species	Families with 1 Genus and mote than one Species	Families with 2-4Genera	Families with 5-9 Genera	Families with 10 or more than 10 Genera
1	Fumariaceae	Polygalaceae	Ranunculaceae	Capparaceae	Brassicaceae
2	Hypecoaceae	Portulacaceae	Menispermaceae	Zygophyllaceae	Papilionaceae
3	Resedaceae	Tamaricaceae	Nympheaceae	Malvaceae	Caryophyllaceae
4	violaceae	Elatinaceae	Papaveraceae	Mimosaceae	Asteraceae
5	Bombacaceae	Oxalidaceae	Tiliaceae	Caesalpiniaceae	Verbenaceae
6	Linaceae	Rhamnaceae	Rutaceae	Molluginaceae	Poaceae
7	Malpighiaceae	Cactaceae	Simaroubiaceae	Apiaceae	
8	Geraniaceae	Salvadoraceae	Meliaceae	Cacurbitaceae	
9	Tropaeolaceae	Cuscutaceae	Sapindaceae	Asclepiadaceae	
10	Burseraceae	Rostellulariaceae	Rosaceae	Boraginancae	
11	Celastraceae	Plantaginaceae	Combretaceae	Convolvulaceae	
12	Anacardiaceae	Aristolochiaceae	Myrataceae	Solanaceae	
13	Moringaceae	Arecaceae	Lythraceae	Scrophulariaceae	
14	Crassulaceae	Potamogetonaceae	Aizoaceae	Bignoniaceae	
15	Vahliaceae		Rubiaceae	Acanthaceae	
16	Onagraceae		Apocynaceae	Euphorbiaceae	
17	Trapaceae		Ehretiaceae	Amaranthaceae	
18	Sphenocleaceae		Orobanchaceae	Chenopodiaceae	
19	Primulaceae		Pedaliaceae	Polygonaceae	
20	Sapotaceae		Lamiaceae	Liliaceae	
21	Periplocaceae		Nyctaginaceae	Cyperaceae	
22	Gentianaceae		Moraceae		
23	Lentibulariaceae		Amaryllidaceae		
24	Martyniaceae		Commelinaceae		
25	Proteaceae		Lemnaceae		
26	Urticaceae				
27	Cannabinaceae				
28	Cannaceae				
29	Ceratophyllaceae				
30	Musaceae				
31	Hydrocharitaceae				
32	Orchidaceae				
33	Potenderiaceae				
34	Juncaceae				
35	Pandanaceae				
36	Typhaceae				
37	Alismataceae				
38	Araceae				
39	Najadaceae				

ANALYSIS OF POLLEN MORPHOLOGICAL DATA

The pollen flora of North Rajasthan show a great variation in their morphoforms and in this head the trends of distribution of these morphological characters in various species studied have been analysed Out of 680 species, belonging to 433 genera and 105 families almost all type of aperture forms have been reported (Table-5). The most dominating aperture is 3-zonocolporate representing as much as 35.02% of total flora. 3-zonocolpate (15.49%), 1-porate (12.96%), pantoporate (11.17 %), 1-colpate (5.21%), 3-zonoporate (3.29 %), 3-zonocolproidate (2.98%), stephanocolporate (1.94%), stephanocolpate (1.5%), Inaperturate (1.5%), 3-zonocolpoidorate (1.34%), 1-aperturate (1.34%), Polyad (1.34%), 2-zonoporate (0 9%), Pantocolpate (0.89%), 3-4-5-zonocolporate (0.89%), Tetrad (0.74%), 3-zonoparasyncolporate (0.3%), 3(4)-zonoporate (0.3%), zonoporate (0.15%), Spiraperturate (0.15%), 1-sulcate (0.15%), 3-zonoparasyncolpate (0.15%), 3(4)-zonocolporate (0.15%), and Polycolporoidate (0.15%) are other representing apertural types and the percentage of their occurancc is mentioned in the brackets (Table-5)

As in the whole flora dominant apertural type in Dicotyledons are 3-zonocolporate (43.84%), 3-colpate (19.22%) and Pantoporatc (13 80%) These apertural form along, with other apertural forms like 3-zonoporate, heterocolpate, stephanocolpate, stephanocolporate, 3-zonoparasyncolporate, pantocolpatc, 3-zonoporate and spiraperturate are absent from Monocotyledons. Among the Monocotyledons the dominant types are 1-poratc (62.97%) and 1-colpate (25.93%) and these arc absent from the Dicotyledons except in Aristolochia sp. with 1-porate type The inaperturate condition is seen in both Monocotyledons and Dicotyledons.

As regards the exine ornamentation, percentage of various types mentioned in brackets are reticulate (32.20%), granulate (30 04%), spinate (9.73%), psilate (8.73%), spinulate (4.37%), baculate (2. 8254), foveolate (2.52%), areolate (2.31%), pilate (1.17%), retipilate (1.17%), punctitegillate (1.3%), striatoneiculate (0.83%), punctate (0 83%), echinolophate (0.68%), punctate-reticulate (0.34%), pilate-punctate (0.16%), undulating (0.16%), obscure (0.16%), tegillate (0.16%), verrucate (0.16%), and regulate (0.16%). Exine ornamentation like gammate, clavate, scorbiculate, fussulate etc are absent in the present study. In Dicotyledons the most dominant exine ornamentation is reticulate (35.3%), while in Monocotyledons it is granulate (72.9%). It is interesting to note that dominant aperture type i.e., 3-zonocolporate also have the dominant exine ornamentation, i.e., reticulate. Considering the exine thickness in present study it ranges from 1 μ in *Alhagi martrorum* and *Cleome gracilis* to 26 μ in *Barleria prionites*. (Table-5)

As regards the shape, in Dicotyledons the percentage of various shape types are spheroidal (35.6%), subprolate (17.26%), prolate-spheroidal (10.6°A), prolate (10.12%), oblate-spheroidal (8.36%), aiboblate (7.90%), convexo-convex (2. 90v), oblate (2.53%), ellipsoidal (1.64%), perprolate (1.04%), tetrahedral (0.6P/0), plano-convex (0.6%), ellipticle (0.3%), peroblate (0.2%), ellipsoidal-spheroidal (0.2%), subspheroidal (0.15%). In Dicotyledons majority of grains are from spheroidal (26.82%) to oblate-spheroidal (10.43%). In Monocotyledons majority of grains are spheroidal (70.37%) and other shapes (in lateral view) are convexo-convex (14.82%) and ellipsoidal (8.15%).(Table-5).

Table – 5

S.No.	Aperture Type	% in Flora	Exine Type	% in Flora	Shape Type	% in Flora
1	3-zonocolporate	35.02	Reticulate	32.20	Spheroidal	35.60
2	3-zonocolpate	15.49	Granulate	30.04	Subprolate	17.26
3	1-porate	12.96	Spinate	09.73	Prolate-spheroidal	10.60
4	Pantoporate	11.17	Psilate	08.73	Prolate	10.12
5	1-colpate	05.21	Spinulate	04.37	Oblate-spheroidal	08.36
6	3-zonoporate	03.29	Baculate	02.82	Suboblate	07.90
7	3-zonocolporoidate	02.98	Foveolate	02.52	Convexo-convex	02.90
8	Stephanocolporate	01.94	Areolate	02.31	Oblate	02.53
9	Stephanocolpate	01.50	Pilate	01.17	Ellipsoidal	01.64
10	Inaperturate	01.50	Retipilate	01.17	Perprolate	01.04
11	3-zonocolpoidorate	01.34	Punctitegillate	01.30	Tetrahadral	00.60
12	1-aperturate	01.34	Striatoreticulate	00.83	Plano-convex	00.60
13	Polyad	01.34	Punctate	00.83	Ellipticle	00.30
14	2-zonoporate	00.90	Echinolophate	00.68	Peroblate	00.20
15	Pantocolpate	00.89	Punctate-reticulate	00.34	Ellipsoidal-spheroidal	00.20
16	3-4-5-zonocolporate	00.89	Pilate-punctate	00.16	Subspheroidal	00.15
17	Tetrad	00.74	Undulating	00.16		
18	3-zonoparasyncolporate	00.30	Obscure	00.16		
19	3(4)-zonoporate	00.30	Tegillate	00.16		
20	6-zonoporate	00.15	Verrucate	00.16		
21	Spiraperturate	00.15	Rugulate	00.16		
22	1-sulcate	00.15				
23	3-zonoparasyncolpate	00.15				
24	3(4)-zonocolporate	00.15				
25	Polycolporoidate	00.15				

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