Palaeobotanist 51(2002) : 153-159
0031-0174/2002/153-159 $2.00

Long term monitoring of air-borne pollen and fungal spores and their allergenic significance

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(Received 15 November 2000; revised version accepted 23 April 2002)

ABSTRACT

Khandelwal A 2002. Long term monitoring of air-borne pollen and fungal spores and their allergenic significance. Palaeobotanist 51 : 153-159.

The qualitative and quantitative analyses of aerospora at Birbal Sahni Institute of Palaeobotany are assessed for the biogenic pollutants of Lucknow atmosphere. The Impaction method was employed for preparing annual pollen and spore calendars over six years (1969-1970, 1970-1971, 1971-1972, 1983-84, 1984-1985, 1985-1986). As many as 61 types of pollen grains and 27 types of fungal spores have been encountered. The maximum number of pollen grains were recorded in the year 1985-86 (24383) and minimum in the year 1969-70 (13005), whilst the maximum number of fungal spores encountered were in 1971-72 (22604) and minimum in the year 1969-70 (12771).

It has been visualized that long term pollen/spore monitoring at a particular site provides a strong base for the prediction of aeroallergens as a warning towards the allergenic disorders. The well recognised allergenic pollen and spore of Lucknow area include *Argemone mexicana, Amaranthus spinosus, Cannabis sativa, Chenopodium album, Prosopis juliflora, Cyperus rotundus, Ricinus communis, Xanthium strumarium* and many species of *Aspergillus*.

Key-words—Allergy, Pollen and fungal spore monitoring, India.

वायुजात परागकणों तथा कवकीय बीजाणुओं का दीर्घावधिक पर्यवेक्षण तथा इनका प्रत्यूर्जता की दृष्टि से महत्व

आशा खण्डेलवाल

सारांश

लखनऊ के वातावरण में जैवजनित प्रदूषकों के मूल्यांकन हेतु बीरबल साहनी पुरावनस्पतिविज्ञान संस्थान के वायु बीजाणुओं का गुणात्मक एवं मात्रात्मक विश्लेषण किया गया। लगभग 6 वर्षों (1969-70, 1970-71, 1971-72, 1983-84, 1984-85, 1985-86) के वार्षिक परागकण एवं बीजाणु कैलेण्डर निर्मित करने हेतु इम्पैक्शन प्रविधि का प्रयोग किया गया। 61 प्रकार के परागकण तथा 27 प्रकार के कवकीय बीजाणु समागमित किए गए हैं। वर्ष 1985-86 में सर्वाधिक परागकण (24383) प्राप्त हुए, जबकि वर्ष 1969-70 में न्यूनतम परागकण (13005) प्राप्त हुए। इसी प्रकार वर्ष 1971-72 में अधिकतम बीजाणु (22601) प्राप्त हुए, जबकि वर्ष 1969-70 में न्यूनतम बीजाणुओं की संख्या 12771 थी।

यह प्रेक्षित किया गया है कि एक विशिष्ट संस्थिति के परागकणों/बीजाणुओं का दीर्घावधि तक प्रेक्षण करने से प्रत्यूर्जता सम्बन्धी गड़बड़ियों के संकेतक के रूप में वायु प्रत्यूर्जकों का अनुमान अधिक सहजता से लगाया जा सकता है। लखनऊ क्षेत्र के सुनिर्धारित वायु प्रत्यूर्जक परागकणों तथा बीजाणुओं में *आर्जीमोन मेक्सिकाना, एमेरैन्थस स्पाइनोसस, कैनेबिस*

सैटाइवा, चीनोपोडियम एल्बम, प्रॉसोपिस जूलीफ्लोरा, साइपर्सस रोडण्डस, राइसिनस कम्यूनिस, ज़ैन्थियम स्ट्रूमैरियम तथा *एस्पर्जिलस* की अनेक प्रजातियाँ विद्यमान हैं।

संकेत शब्द—लखनऊ, परागकण तथा कवकीय बीजाणु पर्यवेक्षण, प्रत्यूर्जता.

INTRODUCTION

THE paper presents the long term monitoring of air-borne pollen grains and fungal spores on the premises of Birbal Sahni Institute of Palaeobotany, Lucknow. The pollen and fungal spore calendars of three consecutive years were prepared during 1969 and again in 1983. The aim of continuing similar type of investigation for longer duration was to have comparative accounts of aerospora on a yearly basis and to know the changing pattern of pollination periods of different plant taxa at different seasons of the year. The survey of atmospheric pollen grains at B.S.I.P, Lucknow, was earlier carried out by Lakhanpal and Nair (1958). In the year 1969, the analysis of aeromycoflora was incorporated along with pollen studies in order to complete the picture of the aerobiota (Vishnu Mittre & Khandelwal, 1973). During the year 1976-77, the survey of air-borne fungal flora of Lucknow University area was conducted in relation to plant and surface mycoflora (Wadhwani, 1979). A two-year (1980-81) survey of air-borne pollen alone was carried out in the National Botanical Research Institute, Lucknow (Chaturvedi *et al.*, 1987-88). The standard record of aerospora of Lucknow assembled in the present paper could be utilised as a 'Ready reckoner' for periodic biopollutant predictions required for the treatment of various allergic disorders caused by air-borne pollen grains and fungal spores. However, aerobiological data generated over a period of four years (Anonymous, 1994-1998) in All India Coordinated Project entitled "Aeroallergens and Human Health: Aerobiological studies" employing three internationally recognised samplers viz., Burkard, Rotorod and Andersen could not be compared with earlier records due to changed methodology and sampling sites. The aerobiological monitoring over an 11-years period in Italy have been utilised for building forecasting models of various species (Bricchi *et al.*, 1995).

MATERIAL AND METHODS

The district of Lucknow (26°30'-27°10' N and 80°30'-81°13' E) is an irregular quadrilateral area covering length and breadth of 72·5 km and 40·3 km respectively. The area is level plain, 117·8 m a.s.l. with old gangetic alluvial soil. The climate like that of entire north India consists of three well-marked seasons viz., the rainy, the cold and the hot.

The Lucknow flora comprises 927 plant species of which Gramineae (grasses) form the dominant group and next, in order, are Leguminosae, Compositae, Cyperaceae, Euphorbiaceae, Acanthaceae, Convolvulaceae, Scrophulariaceae, Amaranthaceae, Labiatae, Malvaceae and Polygonaceae (Kapoor, 1962). As an aid to the atmospheric pollen and spore survey, the Lucknow area was thoroughly botanised. The anemophilous and entomophilous species have been listed and observation was gathered on their flowering periods and distribution in Lucknow.

The apparatus used throughout the investigation, was first used by Lakhanpal and Nair (1958) which is placed in the group classified by Gregory (1961) under Impaction using wind movement by vertical and inclined microscopic slide. The slides were exposed on the terrace of B.S.I.P at a height of about 7·5 m above ground level. The Safranin stained glycerine jelly was smeared on the slide and exposed for 24 hrs. Rectangular cover slips (22 x 50 mm) were used and data were calculated in terms of pollen or fungal spores/sq cm of slide surface.

The petridish method was also adopted for one year during the period of April 1970-March 1971 simultaneously with a visual identification method for specific identification of Fungi (Khandelwal, 1992). The experiment was conducted for one year (March 1971-February 1972) by exposing slides on the ground and terrace level in order to ascertain the differences in qualitative and quantitative abundance of pollen grains and fungal spores, the time of first appearance, monthly maxima and period of settlement of aerobiota at two dissimilar heights (Khandelwal, 1988).

RESULT AND DISCUSSIONS

The pollen and spore monitoring over six years have shown marked variation in number and frequency of aerobiota each year (Figs 1 & 2). The qualitative and quantitative abundance of pollen grains and fungal spores over different years were as follows:

Years	Pollen grains	Fungal spores	
1954-55	23274 (29 types)	-	(Lakhanpal & Nair 1958)
1969-70	13005 (48 types)	12771 (18 types)	
1970-71	16726 (41 types)	19979 (22 types)	
1971-72	19521 (47 types)	22604 (21 types)	
1983-84	20485 (55 types)	18988 (23 types)	
1984-85	21326 (61 types)	15901 (27 types)	
1985-86	24383 (61 types)	17191 (25 types)	

On the basis of annual distribution of atmospheric pollen grains, three periods in relation to the seasons have been recognised viz., Spring and early summer (February to May),

POLLEN GRAINS		1969-70	1970-71	1971-72	1983-84	1984-85	1985-86
1	Gramineae (Poaceae)	4510(34·6)	3197(19·1)	2962(15·1)	3425 (16·7)	6619 (31·0)	8642 (35·4)
2	*Holoptelea integrifolia*	1701(13·0)	6009(35·9)	7746(39·7)	5501(26·85)	3765(17·66)	3463(14·20)
3	*Syzygium cumini*	1648(12·7)	246(1·4)	259(1·3)	635(3·09)	20(0·09)	462(1·89)
4	Amaranth-Chenopod type	1125(8·6)	1130(6·75)	2138(10·9)	2573(12·56)	2292(10·74)	2634(10·8)
5	*Azadirachta indica*	468(3·6)	482(2·8)	654(3·3)	378(1·84)	167(0·78)	246(1·00)
6	*Ailanthus excelsa*	322(2·4)	1902(11·3)	745(3·8)	1125(5·49)	939(4·40)	1034(4·24)
7	*Casuarina equisetifolia*	319(2·45)	168(1·0)	649(3·3)	941(4·59)	1100(5·15)	1420(5·82)
8	*Ricinus communis*	297(2·2)	405(2·4)	617(3·1)	1463(7·14)	2018(9·46)	2108(8·64)
9	Leguminosae (Caesalpinoidae, Papilionoidae)	251(1·9)	11(0·065)	3(0·01)	4 (0·019)	2(0·009)	23 (0·094)
10	*Emblica officinalis*	248(1·9)	114(0·68)	173(0·88)	328(1·60)	114(0.53)	112(0·45)
11	Cyperaceae	243(1·9)	98(0·58)	353(1·8)	314(1·53)	316(1·48)	312(1·27)
12	*Xanthium strumarium*	208(1·6)	143(0·8)	1108(5·6)	259(1·26)	609(2·85)	483(1·98)
13	Cruciferae (Brassicaceae)	203(1·5)	144(0·85)	142(0·72)	300 (1·4)	336 (1·5)	342 (1·4)
14	*Putranjiva roxburghii*	179(1·4)	353(2·1)	197(1·0)	765(3·73)	156(0·73)	236(0·96)
15	*Artemisia vulgaris*	123(0·94)	78(0·46)	33(0·16)	105(0·51)	91(0·42)	124(0·508)
16	*Morus alba*	122(0·93)	153(0·91)	117(0·59)	343(1·67)	599(2·8)	621(2·54)
17	*Cannabis sativa*	118(0·9)	59(0·35)	38(0·19)	103(0·50)	179(0·83)	310(1·27)
18	*Polyalthia longifolia*	95(0·73)	82(0·49)	124(0·63)	70(0·34)	41(0·19)	14(0·05)
19	*Pinus roxburghii*	73(0·56)	80(0·48)	166(0·85)	89(0·43)	317(1·48)	302(1·23)
20	Compositae (Asteraceae)	64(0·49)	42(0·25)	45(0·23)	103 (0·5)	148 (0·6)	94 (0·38)
21	Urticaceae	39(0·3)	13(0·07)	3(0·01)	2(0·009)	16(0·07)	32(0·13)
22	*Eucalyptus citriodora*	35(0·26)	541(3·2)	326(1·6)	223(1·08)	158(0·74)	211(0·86)
23	*Dodonaea viscosa*	28(0·22)	265(1·5)	97(0·49)	-	-	21 (0·08)
24	*Cedrela toona*	25(0·19)	6(0·03)	22(0·11)	-	-	3(0·012)
25	*Argemone mexicana*	22(0·16)	45(0·26)	30(0·15)	120(0·58)	57(0·26)	34(0·13)
26	*Justicia sp.*	22(0·16)	-	13(0·06)	50(0·24)	12(0·05)	14(0·05)
27	*Prosopis juliflora*	20(0·15)	79(0·47)	37(0·18)	17(0·08)	21(0·09)	26(0·10)
28	*Heliotropium* sp.	19(0·14)	24(0·14)	43(0·21)	25(0·12)	58(0·27)	18(0·07)
29	*Rumex dentatus*	16(0·12)	3(0·01)	-	-	-	-
30	*Pithecolobium dulce*	16(0·12)	161(0·96)	12(0·06)	67(0·32)	16(0·07)	14(0·05)
31	*Terminalia arjuna*	16(0·12)	166(0·99)	16(0·08)	9(0·04)	15(0·07)	4(0·016)
32	*Coriandrum sativum*	13(0·09)	37(0·22)	86(0·44)	121(0·59)	47(0·22)	36(0·14)
33	*Grevillea robusta*	12(0·09)	1(0·005)	32(0·16)	-	-	-
34	*Anagallis arvensis*	11(0·08)	-	9(0·04)	44(0·21)	37(0·17)	16(0·06
35	*Acacia arabica*	11(0·08)	9(0·05)	14(0·07)	10(0·04)	24(0·11)	10(0·04)
36	*Alnus* sp.	11(0·08)	22(0·13)	68(0·34)	69(0·33)	39(0·18)	12(0·04)
37	*Salmalia malabarica*	10(0·07)	6(0·03)	13(0·06)	195(0·95)	236(1·10)	243(0·99)
38	*Anethum graveolens*	10(0·07)	6(0·03)	-	63(0·30)	19(0·08)	14(0·05)
39	*Citrus* sp.	6(0·04)	-	-	-	9(0·04)	3(0·012)
40	*Carica papaya*	3(0·02)	-	-	3(0·01)	23(0·10)	4(0·016)
41	Malvaceae	2(0·015)	-	13(0·06)	47(0·22)	97(0·45)	34(0·13)

42	*Ephedra* sp.	2(0·014)	10(0·05)	6(0·03)	20(0·09)	16(0·07)	3(0·012)
43	*Tamarindus inidca*	2(0·014)	-	1(0·005)	4(0·01)	6(0·02)	-
44	*Tribulus terrestris*	1(0·007)	-	72(0·36)	18(0·08)	56(0·26)	5(0·02)
45	*Cleome viscosa*	1(0·007)	-	-	-	2 (0·009)	4 (0·016)
46	*Jatropha pendurifolia*	1(0·007)	-	-	29(0·14)	46(0·21)	32(0·13)
47	*Pyrostegia venusta*	1(0·007)	-	-	17(0·08)	19(0·08)	10(0·04)
48	*Santalum album*	1(0·007)	-	5(0·02)	-	-	-
49	*Aegle marmelos*	-	411(2·45)	44(0·22)	121(0·59)	28(0·13)	46(0·18)
50	*Melia azedarch*	-	-	41(0·21)	-	-	-
51	*Jasminum* sp.	-	5(0·03)	19(0·09)	-	-	-
52	*Albizia lebbek*	-	5(0·03)	-	7(0·03)	3(0·01)	4(0·016)
53	*Chrozophora rottleri*	-	1(0·005)	-	2 (0·009)	-	2 (0·008)
54	*Cycas circinalis*	-	-	130 (0·6)	14(0·06)	7(0·03)	4(0·016)
55	*Bauhinia* sp.	-	-	10(0·05)	-	7(0·03)	3(0·012)
56	*Typha* sp.	-	-	4(0·02)	10(0·04)	72(0·33)	6(0·024)
57	*Parthenium hysterophorus*	-	-	-	82(0·40)	131(0·61)	342(1·40)
58	*Polygonum* sp.	-	-	-	25(0·12)	4(0·01)	4(0·016)
59	*Alternanthera* sp.	-	-	-	11(0·05)	4(0·01)	12(0·04)
60	*Croton bonplandianum*	-	-	-	11(0·05)	3(0·01)	4(0·016)
61	Lamiaceae (Labiatae)	-	-	-	11(0·05)	1(0·004)	6(0·024)
62	Acanthaceae	-	-	-	-	3(0·01)	1(0·004)
63	Apiaceae (Umbelliferae)	-	-	-	-	4(0·01)	2(0·008)
64	*Galphimia gracilis*	-	-	-	-	5(0·023)	7(0·02)
65	*Impatiens balsamina*	-	-	-	-	2(0·009)	4(0·016)
66	Myrtaceae	-	-	-	-	9(0·04)	32(0·13)
67	*Betula* sp.	-	-	-	5 (0·02)	17 (0·07)	-
69	*Ligustrum* sp.	-	-	-	81 (0·39)	27 (0·12)	-
70	*Dendrophthoe falcata*	-	-	-	8 (0·03)	-	3 (0·12)
71	*Madhuca indica*	-	-	-	4 (0·01)	-	-
72	*Rauwolfia serpentina*	-	-	-	-	2 (0·009)	-
73	Trilete spores	-	-	-	17(0·08)	3(0·01)	1(0·004)
74	Unidentified and damaged	332(2·55)	14(0·08)	86(0·44)	99(0·48)	137(0·6)	115(0·47)
Total		**13005**	**16726**	**19521**	**20485**	**21326**	**24383**

Fig. 1—Number and percentage of pollen grains caught during different years of investigation (percentages are calculated in terms of total annual pollen catch)

FUNGAL SPORES	1969-70	1970-71	1971-72	1983-84	1984-85	1985-86
1 *Alternaria*	4583 (35·8)	6563 (32·8)	9170 (40·5)	7149 (37·65)	4463 (28·06)	4462 (25·95)
2 *Helminthosporium*	1644 (12·8)	2806 (14·0)	3332 (14·7)	2460 (12·95)	2944 (18·51)	3126 (18·18)
3 Uredospore of Puccinia	1552 (12·1)	3726 (18·64)	2532 (11·22)	2902 (15·28)	1261 (7·93)	2432 (14·14)
4 2-4 celled spores	1358 (10·6)	461 (2·3)	460 (2·03)	216 (1·13)	266 (1·67)	343 (1·99)
5 *Aspergillus, Penicillium, Mucor* type spores	865 (6·7)	1547 (7·74)	1404 (6·21)	1214 (6·39)	675 (4·24)	484 (2·81)
6 *Cladosporium*	643 (5·0)	866 (4·33)	701 (3·10)	864 (4·55)	865 (5·43)	782 (4.54)
7 *Nigrospora*	638 (4·9)	644 (3·22)	651 (2·87)	340 (1·79)	506 (3·18)	643 (3·74)
8 *Cercospora*	434 (3·4)	566 (2·83)	904 (3·99)	239 (1·25)	776 (4·88)	748 (4·35)
9 Smut spores	176 (1·4)	402 (2·01)	382 (1·68)	142 (0·74)	107 (0·67)	312 (1·81)
10 *Chaetomium*	133 (1·04)	193 (0·96)	312 (1·38)	28 (0·14)	69 (0·43)	40 (0·23)
11 *Curvularia*	121 (0·9)	459 (2·29)	539 (2·38)	583 (3·07)	1105 (6·94)	1423 (8·27)
12 *Epicoccum*	114 (0·89)	1288 (6·44)	1406 (6·22)	1242 (6·54)	1049 (6·59)	1124 (6·530
13 *Fusarium*	102 (0·8)	109 (0·54)	253 (1·11)	182 (0·95)	259 (1·62)	131 (0·76)
14 *Diplodia*	58 (0·45)	24 (0·12)	56 (0·24)	175 (0·92)	193 (1·2)	41 (0·23)
15 *Acrothecium*	51 (0·4)	73 (0·36)	104 (0·46)	482 (2·53)	283 (1·77)	312 (1·81)
16 *Tetraploa*	25 (0·2)	57 (0·28)	299 (1·32)	322 (1·69)	361 (2·27)	156 (0·90)
17 *Tilletia*	11 (0·08)	13 (0·06)	20 (0·08)	327 (1·72)	376 (2·36)	321 (1·86)
18 Teleutospores of *Puccinia*	7 (0·05)	87 (0·43)	15 (0·06)	14 (0·07)	53 (0·33)	14 (0·08)
19 *Torula*	-	17 (0·08)	13 (0·05)	22 (0·11)	31 (0·19)	44 (0·25)
20 *Zygodesmus*	-	5 (0·02)	-	-	-	8 (0·04)
21 *Beltrania*	-	4 (0·02)	-	-	4 (0·02)	-
22 *Botryodiplodia*	-	3 (0·01)	10 (0·04)	-	2(0·012)	-
23 *Spegazzinia*	-	-	2 (0·008)	4 (0·02)	9 (0·056)	4 (0·02)
24 *Cornespora*	-	-	-	2 (0·01)	9 (0·056)	11 (0·06)
25 *Pleospora*	-	-	-	9 (0·04)	30 (0·18)	44 (0·25)
26 *Sporedesmium*	-	-	-	18 (0·09)	133 (0·83)	142 (0·82)
27 *Trichoconis*	-	-	-	-	9 (0·056)	4 (0·02)
28 *Endophragmia*	-	-	-	-	2 (0·012)	-
29 Unidentified fungal spores	256 (2·0)	66 (0·33)	39 (0·17)	52 (0·27)	61 (0·38)	40 (0·23)
Total	**12771**	**19979**	**22604**	**18988**	**15901**	**17191**

Fig. 2—Number and percentage of fungal spores caught during different years of investigations (percentages are calculated in terms of total annual spore catch)

Late summer and rainy season (June to September) and Late rainy season and winter (October to January). In spring and early summer arboreal pollen grains dominated; in late summer and the rainy season, pollen grains of grasses and weeds were recorded, while in the late rainy season and winter, pollen of grasses and cultivated plants were found. However, there was some pollen, which occurred throughout the year in small or sporadic numbers. The graphic representation of important pollen grains and fungal spores of year 1969-70, 1970-71 and 1983-86 have been published elsewhere for ready assessment of daily fluctuations in their frequencies (Vishnu Mittre & Khandelwal, 1973; Khandelwal, 1988, 1991, 1992). The continuous air monitoring of pollen grains and fungal spores for the year 1997 was done in Vikas Nagar on Kursi Road by employing Rotorod sampler (Khandelwal, 2001)

Unlike the seasonal distribution of pollen grains observed in the pollen calendars, the fungal spore calendars do not exhibit such seasonal distribution; however, two periods, one from February to June and another from July to December have been recognised. Most of the fungal spores are present throughout the year showing high fluctuation in some part of the year.

Allergenic significance of pollen grains and fungal spores

Clinical investigation carried out at King George Medical College, Lucknow have proved the allergenicity of many fungal spores and pollen grains present in the air of Lucknow (Agnihotri & Singh, 1971; Khandelwal, 1974; Khandelwal *et al.*, 1996; Jamil *et al.*, 1981, 1986; Wadhwani *et al.*, 1986). The significant aeroallergens are *Alstonia scholaris, Amaranthus spinosus, Azadirachta indica, Chenopodium album, Cynodon dactylon, Cyperus rotundus, Holoptelea integrifolia, Prosopis juliflora, Putranjiva roxburghii, Ricinus communis, Alternaria alternata, Aspergillus flavus, A. fumigatus, A. nidulans, A. niger, A. terreus, Cladosporium cladosporioides, Curvularia lunata, Fusarium oxysporum, Helminthosporium spiciferum, Monilia* sp., *Penicillium citrinum, Phoma* sp., *Rhizopus* sp., *Trichoderma virde,* etc. Besides the cutaneous reactivity of these allergens, the preponderance of *Alternaria, Aspergillus, Candida, Curvularia, Helminthosporium, Mucor, Paecilomyces, Penicillium* and *Trichoderma lignorum* have also been reported in the respiratory tract of many allergic patients (Singh *et al.*, 1981).

CONCLUSIONS

The pollen spore calendars are useful in identifying allergies against particular airborne pollen and fungal spore types. Comparison of the time of sensitivity with the pollen/spore calendar can lead to diagnosis and preventive measures against the pollen and spore allergies. However, the limitation of pollen calendar is the occurrence of year-to-year variation in both number and time of appearance of each type of pollen grains and fungal spores. This kind of variation most probably be sought in both climatological/meteorological and plant physiological factors affecting various plant species.

Acknowledgements—*I am thankful to Professor Anshu Kumar Sinha, Director, BSIP, Lucknow for encouragement and keen interest in this work.*

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