AIR-BORNE POLLEN GRAINS AND FUNGAL SPORES AT LUCKNOW DURING 1969-1970

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ABSTRACT

The atmosphere of Lucknow has been found highly charged with pollen grains and fungal spores during February, March, April and then September, October, November in the year 1969-70.

There are considerable qualitative and quantitative differences in the pollen calendar prepared earlier by Lakhanpal and Nair (1958) and the pollen calendar of 1969-70. Pollen grains of *Casuarina equisetifolia* (2·4%), *Ricinus communis* (2·2%), *Emblica officinalis* (1·9%), *Putranjiva roxburghii* (1·4%), etc., were not recorded earlier. The shift in the flowering periods of *Morus*, *Ailanthus* and *Azadirachta* has been noted by a month. Long distance transport of *Alnus* pollen has been noticed in the months of September and October.

INTRODUCTION

THE paper presents the results of the aeropalynological studies conducted at Lucknow during the year 1969-1970. The survey of atmospheric pollen grains at Lucknow was earlier carried out by Lakhanpal and Nair (1958). The work remained discontinued till 1969. The present studies also include for the first time a survey of aeromycoflora at Lucknow.

The slides were exposed on the terrace of Birbal Sahni Institute of Palaeobotany at a height of about 25-30 ft above ground level almost at the same height where surveys were conducted earlier by Lakhanpal and Nair in 1954-1955 (*op. cit.*). Further we have used the same apparatus and the method for preparation of slides for microscopic examination as explained by Lakhanpal and Nair (*op. cit.*) so as to have comparative idea of incidence and frequency of pollen in the air in the year 1955 and during 1969-1970. The only exception is that we used rectangular cover slips (22×50 mm) as contrasted to the square cover slips (22×22 mm) used by the earlier workers. The increase in the area of exposure would indeed give qualitative abundance of pollen grains and spores per sq cm and these have been calculated both for qualitative and quantitative comparisons.

As an aid to the atmospheric pollen and spore survey, the Lucknow area was thoroughly botanised. The anemophilous and common entomophilous species have been listed and observations gathered on their flowering periods and their distribution at Lucknow. The identification of the atmospheric pollen and spores is based upon reference slides made in safranin-stained glycerine-jelly.

OBSERVATIONS

The data of pollen and spore catch together with the presence of other organic particles such as scales and other parts of insects, stellate hairs, septate hyphae, etc., are shown in Tables 1 & 2. The unidentified pollen grains and fungal spores are grouped together and entered separately in these tables under the unidentified ones. The table for the year 1969-1970 is accompanied by graphic representation of important pollen grains (Text-fig. 1) and fungal spores (Text-fig. 2) for ready assessment of the fluctuations in their frequencies. The slides were exposed on the terrace of Birbal Sahni Institute of Palaeobotany.

From the annual distribution of atmospheric pollen grains during 1969-1970, it has been possible to distinguish the following three periods in relation to the seasons obtained here:

1. Spring and early summer (February to May) when pollen grains of arboreals abound in the atmosphere.
2. Late summer and rainy season (June to September) when pollen grains of grasses and weeds abound.
3. Late rainy season and winter (October to January) when pollen grains of grasses (including those of the cultivated ones) abound.

However, there are some pollen grains which occur throughout the year in small or sporadic numbers and these are not included in the seasons recognized above.

Unlike the seasonal distribution of pollen grains observed in the pollen calendar, the fungal spore calendar does not exhibit such a seasonal distribution. Broadly speaking, two periods in the year can be distinguished when fungal spores were highly present in the atmosphere at Lucknow: period one, from February to June; and period two, from July to December. In keeping with the seasons recognized, the distribution of fungal spores reveals that during spring and early summer (February to May) there are large numbers of fungal spores; during late summer and rainy season (June to September) the number is considerably reduced and during late rainy season and winter (October to January) there is again high number of fungal spores in the atmosphere though comparatively less than those during the spring and early summer. Most of the fungal spores are present throughout the year showing high fluctuations in some parts of the year. In the absence of clear-cut seasonal distribution of fungal spores, only the salient features of the spore catch are described.

POLLEN CALENDAR FOR THE YEAR 1969-1970

Fortyeight kinds of pollen grains were identified among the total pollen catch of 13,005 (Table 1; Text-fig. 1). Maximum pollen grains were recorded in the month of March (3,959/30·4% T.A.P.C.*) and they were largely derived from tree species. This may be attributed to the spring season during which most of our trees flower. A few pollen grains of crop and ornamental plants, which flowered during this period, were also caught on the slides.

After March, the second highest pollen catch largely constituted by pollen grains of Gramineae (76·7% T.M.P.C.**) was noted in the month of October (2,727/20·9% T.A.P.C.). Pollen grains of a few of the rainy season weeds were also there.

There was a good pollen catch during the month of April (2,103/16·1% T.A.P.C.). Most spring trees continued flowering during this month.

The month of September too recorded high number of pollen grains obtaining fourth position in the annual pollen calendar (1,205/9·26% T.A.P.C.). The pollen catch was dominated by grass pollen as most of them came up during the month of September soon after rains (late part of rainy season).

The next high pollen catch was obtained in August and February (610/4·69% T.A.P.C., 605/4·65% T.A.P.C. respectively). In August the large number of pollen was derived from Gramineae (351/57·5% T.M.P.C.) and in February from *Ailanthus excelsa* (162/26·7% T.M.P.C.).

Though less but still comparatively high numbers of pollen grains were caught in May (496/3·3% T.A.P.C.), November (429/3·29% T.A.P.C.), July (311/2·3% T.A.P.C.), January (292/2·24% T.A.P.C.) and December (215/1·65% T.A.P.C.).

The least number of pollen grains was recorded in the month of June (53/0·4% T.A.P.C.). The month was characterized by high winds and high temperatures. The former perhaps prevented settling of pollen grains and the latter provided adverse environment for the growth and flowering of herbaceous plants in particular.

The Spring and Early Summer Pollen Catch: During this period the pollen grains of tree species such as of *Morus alba, Eucalyptus citriodora* and *Ailanthus excelsa* first appeared on February 5, 17, 18 respectively with their peaks on February 23, March 22, and 7. Their pollen grains continued up to April 15, March 31 and April 17 respectively.

The pollen grains of *Coriandrum sativum* and *Salmalia malabarica* first appeared on February 10 and 18 and continued to March 26 and March 21 respectively without attaining a peak.

The pollen of *Dodonaea viscosa* which had appeared in the month of January attained peak on February 28, the last day of its appearance on the slides.

A single pollen grain each of *Jatropha pendurifolia* and *Pyrostegia venusta* was observed in the month of February alone. The pollen grains of trees of *Holoptelea integrifolia, Syzygium cumini, Pinus roxburghii* (a few pollen grains caught in the months of January and February too), *Pithecolobium dulce, Emblica officinalis, Azadirachta indica, Putranjiva roxburghii* and *grevillea robusta* first appeared on March 5, 7, 12, 15, 18, 19, 26 and 28 and

*T.A.P.C.= Total Annual Pollen Catch.
**T.M.P.C.= Total Monthly Pollen Catch.

TABLE 1 — POLLEN CALENDAR FOR THE YEAR 1969-70

POLLEN GRAINS	MARCH '69	APRIL '69	MAY '69	JUNE '69	JULY '69	AUGUST '69	SEPT. '69	OCT. '69	NOV. '69	DEC. '69	JAN. 70	FEB. '70	TOTAL	%
1. Gramineae	154(3·8)*	239(19·7)	103(20·8)	22(41·5)	145(46·6)	351(57·5)	914(75·8)	2094(76·7)	264(61·7)	72(33·4)	62(21·2)	90(16·5)	4510	34·6
2. *Holoptelea integrifolia*	1675(42·3)	25 (1·17)	1(0·12)	—	—	—	—	—	—	—	—	—	1701	13·0
3. *Syzygium cumini*	1369(34·3)	263(12·5)	8(1·6)	—	—	—	—	—	—	—	—	—	1648	12·7
4. Amaranth-chenopod type	197(4·9)	149(6·6)	27(5·4)	11(20·7)	56(17·5)	120(19·6)	133(11·0)	248(9·1)	64(14·9)	28(13·0)	20(6·8)	72(11·9)	1125	8·6
5. *Azadirachta indica*	13(0·3)	447(27·7)	8(1·6)	—	—	—	—	—	—	—	—	—	468	3·6
6. *Ailanthus excelsa*	146(3·7)	14(0·65)	—	—	—	—	—	—	—	—	—	162(26·7)	322	2·4
7. *Casuarina equisetifolia*	7(0·20)	214(10·1)	90(18·3)	8(14·8)	—	—	—	—	—	—	—	—	319	2·14
8. *Ricinus communis*	3(0·07)	—	—	—	—	2(0·32)	23(1·9)	75(2·7)	70(18·6)	49(22·7)	44(15·0)	31(5·1)	297	2·2
9. Leguminosae (Caesalpinoideae, Papilionatae)	1(0·025)	54(2·5)	85(17·1)	—	1(0·32)	18(2·9)	—	—	—	20(13·9)	27(9·2)	45(7·6)	251	1·93
10. *Emblica officinalis*	122(3·0)	125(5·9)	1(0·12)	—	—	—	—	—	—	—	—	—	248	1·9
11. Cyperaceae	5(0·15)	36(1·7)	33(6·4)	—	52(16·3)	54(8·8)	47(3·9)	10(0·3)	1(0·23)	—	—	5(0·82)	243	1·8
12. *Xanthium strumarium*	—	—	—	—	—	5(0·8)	14(1·1)	179(6·5)	10(2·3)	—	—	—	208	1·6
13. Cruciferae	11(0·27)	18(0·84)	—	—	—	—	—	—	1(0·23)	4(1·8)	108(36·9)	61(10·0)	203	1·5
14. *Putranjiva roxburghii*	40(1·0)	137(6·5)	2(0·24)	—	—	—	—	—	—	—	—	—	179	1·4
15. *Artemisia vulgaris*	—	—	—	—	—	5(0·8)	36(3·0)	79(2·8)	3(0·69)	—	—	—	123	0·94
16. *Morus alba*	27(0·68)	21(1·0)	—	—	—	—	—	—	—	—	—	74(10·5)	122	0·93
17. *Cannabis sativa*	3(0·07)	52(2·4)	36(7·2)	2(3·7)	25(8·3)	—	—	—	—	—	—	—	118	0·9
18. *Polyalthia longifolia*	—	95(4·5)	—	—	—	—	—	—	—	—	—	—	95	0·73
19. *Pinus roxburghii*	7(0·20)	35(1·63)	18(3·6)	8(14·8)	1(0·32)	—	—	—	—	—	2(0·74)	2(0·22)	73	0·56
20. Compositae	5(0·15)	15(0·71)	—	—	—	—	1(0·08)	—	2(0·46)	23(10·5)	8(2·9)	10(1·6)	64	0·49
21. Urticaceae	—	—	—	—	—	19(3·1)	9(0·7)	3(0·1)	2(0·46)	1(0·46)	5(1·7)	—	39	0·3
22. *Eucalyptus citriodora*	23(0·58)	—	—	—	—	—	—	—	—	—	—	12(1·9)	35	0·26
23. *Dodonaea viscosa*	—	—	—	—	—	—	—	—	—	—	3(1·2)	25(9·1)	28	0·22
24. *Cedrela toona*	—	15(0·71)	10(2·0)	—	—	—	—	—	—	—	—	—	25	0·19
25. *Argemone mexicana*	17(0·4)	5(0·23)	—	—	—	—	—	—	—	—	—	—	22	0·16
26. *Justicia* sp.	3(0·07)	3(0·14)	5(0·9)	—	—	—	2(0·16)	5(0·16)	3(0·69)	1(0·46)	—	—	22	0·16
27. *Prosopis juliflora*	—	20(0·9)	—	—	—	—	—	—	—	—	—	—	20	0·14
28. *Heliotropium* sp.	—	4(0·19)	15(3·0)	—	—	—	—	—	—	—	—	—	19	0·13
29. *Rumex dentatus*	2(0·05)	14(0·65)	—	—	—	—	—	—	—	—	—	—	16	0·12
30. *Pithecolobium dulce*	9(0·25)	7(0·33)	—	—	—	—	—	—	—	—	—	—	16	0·12
31. *Terminalia arjuna*	—	10(0·47)	6(1·2)	—	—	—	—	—	—	—	—	—	16	0·12
32. *Coriandrum sativum*	7(0·20)	—	—	—	—	—	—	—	—	—	—	6(0·99)	13	0·09
33. *Grevillea robusta*	2(0·05)	10(0·47)	—	—	—	—	—	—	—	—	—	—	12	0·09
34. *Anagallis arvensis*	—	—	8(1·6)	—	—	—	—	2(0·07)	—	—	1(0·37)	—	11	0·077
35. *Acacia arabica*	—	—	—	—	—	6(0·96)	1(0·08)	3(0·1)	—	1(0·046)	—	—	11	0·077
36. *Alnus* sp.	—	—	—	—	—	—	—	8(0·33)	3(0·69)	—	—	—	11	0·077
37. *Salmalia malabarica*	7(0·20)	—	—	—	—	—	—	—	—	—	—	3(0·49)	10	0·07
38. *Anethum graveolens*	—	5(0·23)	—	—	—	—	—	—	1(0·23)	4(1·8)	—	—	10	0·07
39. *Citrus* sp.	—	—	1(0·12)	—	—	5(0·08)	—	—	—	—	—	—	6	0·04
40. *Carica papaya*	—	—	—	—	—	—	—	—	3(0·69)	—	—	—	3	0·02
41 Malvaceae	2(0·05)	—	—	—	—	—	—	—	—	—	—	—	2	0·014
42. *Ephedra* sp.	—	1(0·047)	1(0·12)	—	—	—	—	—	—	—	—	—	2	0·014
43. *Tamarindus indica*	—	—	—	—	2(6·4)	—	—	—	—	—	—	—	2	0·014
44. *Tribulus terrestris*	—	—	—	—	—	—	—	1(0·03)	—	—	—	—	1	0·007
45. *Cleome viscosa*	—	—	—	—	—	—	—	1(0·03)	—	—	—	—	1	0·007
46. *Jatropha pendurifolia*	—	—	—	—	—	—	—	—	—	—	—	1(0·16)	1	0·007
47. *Pyrostegia venusta*	—	—	—	—	—	—	—	—	—	—	—	1(0·16)	1	0·007
48. *Santalum album*	1(0·02)	—	—	—	—	—	—	—	—	—	—	—	1	0·007
49. Unidentified and damaged	101(2·6)	70(3·3)	38(7·8)	2(3·7)	29(9·3)	25(4·0)	25(2·07)	19(0·69)	2(0·46)	12(5·5)	5(1·7)	4(0·66)	332	2·55
TOTAL	3959	2103	496	53	311	610	1205	2727	429	215	292	605	13005	
%	30·4	16·1	3·3	0·40	2·3	4·69	9·26	20·9	3·29	1·65	2·24	4·65		
Pollon/sq cm	17·9	7·08	1·59	2·2	1·0	3·08	5·2	11·8	1·3	0·8	1·02	2·5		

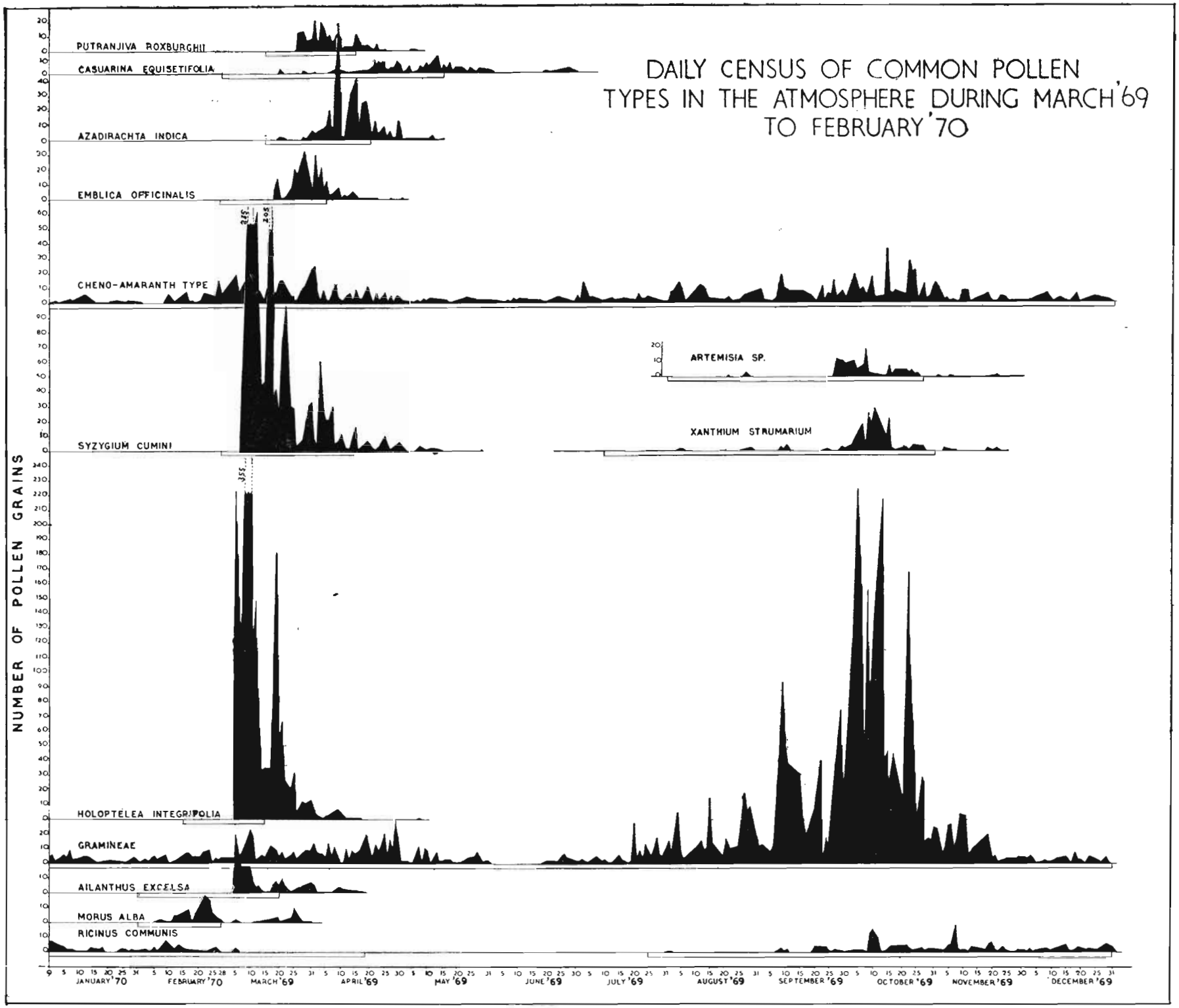
*All percentages are calculated in terms of total monthly pollen catch (T.M.P.C.).

TABLE 2 — SPORE CALENDAR FOR THE YEAR 1969-1970

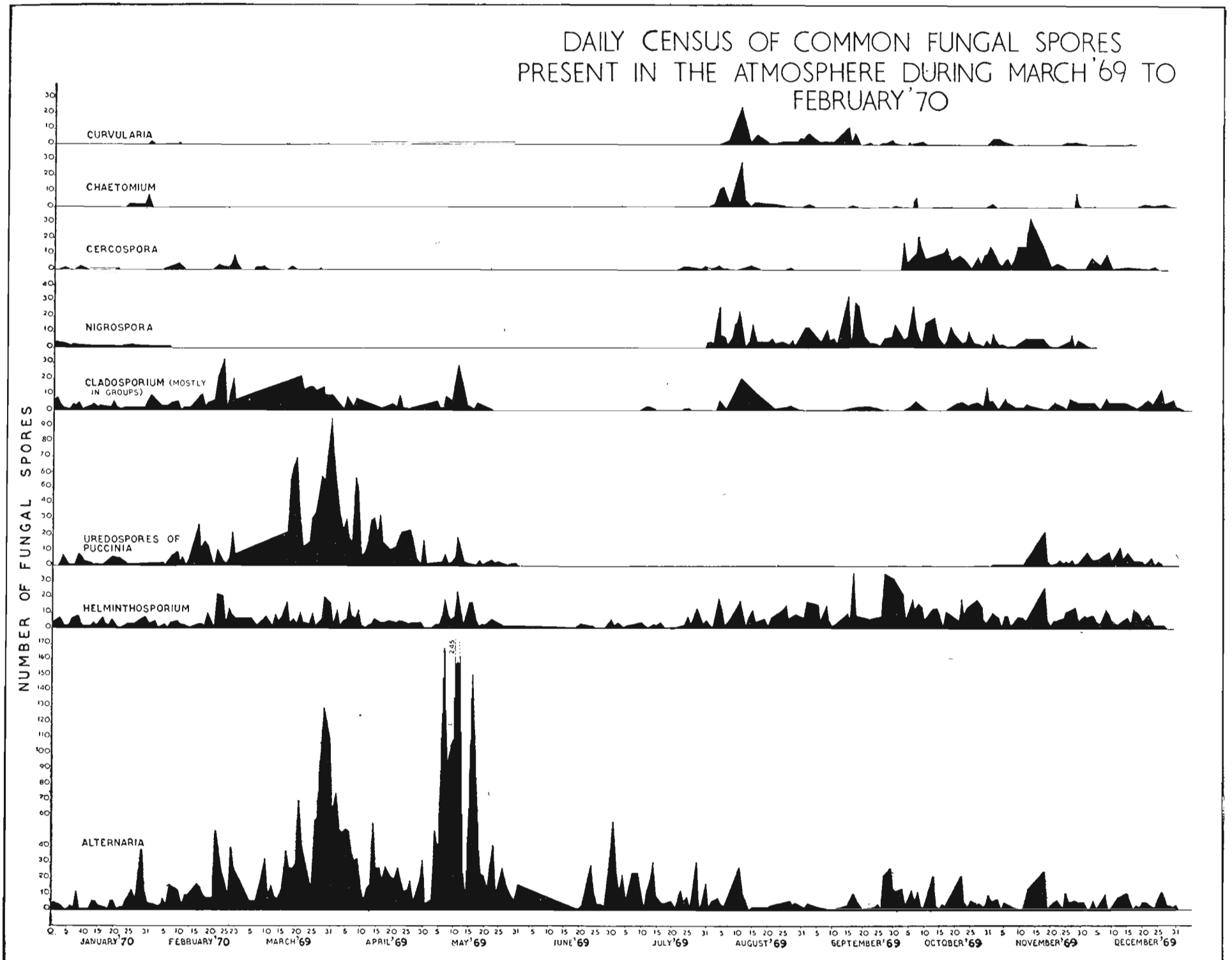
Fungal spores	March '69	April '69	May '69	June '69	July '69	August '69	Sept. '69	Oct. '69	Nov. '69	Dec. '69	Jan. '70	Feb. '70	Total	%
1. *Alternaria* sp.	789(49·4)	827(46·7)	1461(70·5)	101(66·0)	388(63·9)	96(12·7)	99(10·1)	144(9·2)	132(14·3)	83(11·8)	148(27·2)	315(29·6)	4583	35·8
2. *Helminthosporium*	152(9·5)	119(6·7)	152(7·3)	18(11·8)	62(10·2)	145(19·2)	251(25·8)	240(15·4)	144(15·6)	141(20·1)	95(17·4)	125(10·9)	1644	12·8
3. Uredospores of *Puccinia*	552(34·6)	612(34·6)	68(3·2)	—	—	—	—	—	45(4·9)	77(11·0)	40(7·3)	158(13·8)	1552	12·1
4. 2-4 celled coloured spores	—	—	243(11·7)	26(17·2)	80(13·1)	48(6·9)	195(19·9)	535(34·3)	166(18·0	38(5·5)	7(1·2)	20(1·7)	1358	10·6
5. *Aspergillus, penicillium* or *Mucor* spores	—	30(1·7)	26(1·25)	3(1·9)	9(1·5)	74(9·8)	101(10·3)	124(7·9)	106(11·4))	142(20·4)	118(21·6)	132(11·4)	865	6·7
6. *Cladosporium*	87(5·4)	52(2·9)	63(3·0)	1(0·66)	6(0·99)	32(4·2)	6(0·52)	44(2·8)	52(5·6)	77(11·0)	67(12·3)	156(13·6)	643	5·0
7. *Nigrospora*	—	—	—	—	3(0·49)	130(17·2)	192(19·6)	181(11·6)	53(5·7)	62(8·8)	12(2·2)	5(0·43)	638	4·9
8. *Cercospora*	—	—	—	—	8(1·3)	10(1·3)	—	211(13·5)	142(15·4)	28(4·2)	5(1·2)	30(2·6)	434	3·4
9. Smut spores	14(0·89)	89(5·0)	—	—	—	—	4(0·41)	—	—	—	—	69(6·0)	176	1·4
10. *Chaetomium*	—	—	—	—	16(2·6)	77(10·2)	3(0·26)	12(0·76)	11(1·1)	5(0·71)	2(0·36)	7(0·61)	133	1·04
11. *Curvularia*	—	—	—	—	—	50(6·6)	47(4·8)	3(0·19)	16(1·7)	2(0·28)	2(0·36)	1(0·08)	121	0·9
12. *Epicoccum*	—	—	—	—	—	—	—	—	—	—	11(2·03)	103(9·04)	114	0·89
13. *Fusarium*	—	—	1(0·04)	—	13(2·14)	24(3·1)	7(0·72)	23(1·4)	34(3·7)	—	—	—	102	0·8
14. *Diplodia*	—	—	—	—	—	34(4·5)	24(2·4)	—	—	—	—	—	58	0·45
15. *Acrothecium*	—	—	—	—	—	3(0·39)	14(1·4)	9(0·57)	3(0·3)	11(1·5)	6(1·1)	5(0·43)	51	0·4
16. *Tetraploa*	—	—	—	—	3(0·39)	3(0·39)	3(0·26)	6(0·38)	1(0·1)	5(0·71)	1(0·18)	3(0·26)	25	0·2
17. *Tilletia*	—	—	1(0·048)	—	—	—	1(0·1)	1(0·1)	—	3(0·43)	2(0·36)	3(0·26)	11	0·08
18. Teleutospores of *Puccinia*	—	3(0·17)	—	—	—	—	—	—	—	—	—	4(0·35)	7	0·05
19. Unidentified fungal spore	—	32(1·8)	57(2·7)	2(1·3)	19(3·1)	27(3·5)	25(2·5)	25(1·6)	13(1·4)	25(3·5)	28(5·1)	3(0·26)	256	2·0
Total	1594	1764	2072	151	607	753	972	1558	918	699	544	1139	12771	
%	12·4	13·8	16·2	1·18	4·7	5·8	7·6	12·1	7·18	5·47	4·25	8·9		
Spores/sq cm	7·2	5·9	6·7	0·6	2·06	3·6	4·2	5·8	4·3	2·7	1·33	4·7		

REMAINS OTHER THAN POLLEN AND SPORES

Varia	March '69	April '69	May '69	June '69	July '69	August '69	Sept. '69	Oct. '69	Nov. '69	Dec. '69	Jan. '70	Feb. '70	Total
1. Small parenchymatous pieces	10	13	13	2	18	11	14	15	10	10	18	12	146
2. Insect's scales, wings and other body parts	1	1	3	3	9	12	12	17	14	20	13	13	118
3. Aseptate hyphae	—	4	14	6	24	10	6	4	11	8	16	9	112
4. Brown hyphae	9	2	7	2	3	2	2	9	7	7	9	7	66
5. Very small fragments of trachieds	2	5	5	3	6	7	5	3	6	7	4	5	58
6. Stellate hairs	2	8	9	6	10	5	4	3	—	1	—	1	49
7. Epidermal peeling with stomata	—	3	—	—	—	—	1	—	3	4	4	—	15
8. Needle like structures	—	—	—	—	1	—	4	—	1	—	—	3	9
9. Septate hyphae	—	—	3	—	2	1	—	—	1	—	2	—	9
Total	24	36	54	22	73	48	48	51	53	57	66	50	582


DAILY CENSUS OF COMMON POLLEN TYPES IN THE ATMOSPHERE DURING MARCH'69 TO FEBRUARY'70
NUMBER OF POLLEN GRAINS
PUTRANJIVA ROXBURGHII
CASUARINA EQUISETIFOLIA
AZADIRACHTA INDICA
EMBLICA OFFICINALIS
CHENO-AMARANTH TYPE
ARTEMISIA SP.
XANTHIUM STRUMARIUM
SYZYGIUM CUMINI
HOLOPTELEA INTEGRIFOLIA
GRAMINEAE
AILANTHUS EXCELSA
MORUS ALBA
RICINUS COMMUNIS
JANUARY'70
FEBRUARY'70
MARCH'69
APRIL'69
MAY'69
JUNE'69
JULY'69
AUGUST'69
SEPTEMBER'69
OCTOBER'69
NOVEMBER'69
DECEMBER'69

TEXT-FIG. 1


DAILY CENSUS OF COMMON FUNGAL SPORES
PRESENT IN THE ATMOSPHERE DURING MARCH '69 TO
FEBRUARY '70
NUMBER OF FUNGAL SPORES
CURVULARIA
CHAETOMIUM
CERCOSPORA
NIGROSPORA
CLADOSPORIUM (MOSTLY IN GROUPS)
UREDOSPORES OF PUCCINIA
HELMINTHOSPORIUM
ALTERNARIA
245
JANUARY '70
FEBRUARY '70
MARCH '69
APRIL '69
MAY '69
JUNE '69
JULY '69
AUGUST '69
SEPTEMBER '69
OCTOBER '69
NOVEMBER '69
DECEMBER '69

TEXT-FIG. 2

continued up to May 7, 28; July 3; April 19; May 1, 5, 11; and April 9 respectively. The peaks of *Holoptelea integrifolia* and *Syzygium cumini* pollen curves were attained on the same day, i.e. on March 5, and, of *Emblica officinalis* and *Putranjiva roxburghii* on April 1.

The pollen grains of *Casuarina equisetifolia* and *Azadirachta indica* attained peaks on April 23 and 10. Owing to uniform distribution of pollen grains throughout the pollen catch *Pithecolobium dulce* and *Grevillea robusta* did not attain a peak. A single pollen grain of *Santalum album* was observed in the month of March (1/0·02% T.M.P.C.).

Amongst the pollen of non-arboreals, *Argemone mexicana, Rumex dentatus* and *Cannabis sativa* first appeared on March 7, 17 and 18 respectively with peaks on March 29, April 5 and 21. Their pollen grains continued to be caught up to April 10, 12 and July 28 respectively. Pollen grains of *Polyalthia longifolia, Cedrela toona, Prosopis juliflora* and *Terminalia arjuna* among arboreals and *Heliotropium* sp., *Ephedra* sp. and *Anethum graveolens* among non-arboreals made their first appearance in the month of April.

The pollen grains of *Cedrela toona, Polyalthia longifolia, Terminalia arjuna* and *Prosopis juliflora* first appeared on April 1, 8, 8 and 12 respectively and continued up to May 27; April 23; May 13 and 13 with peaks on May 27; April 17, 25 and 13 respectively. The pollen of *Heliotropium* sp. appeared from April 21 to May 13 with the peak on May 11. The pollen of *Anethum graveolens* was sporadic from April to November and December. Only a single pollen of *Ephedra* sp. was noticed in the months of April and May throughout the year.

Those making first appearance during May include *Citrus* sp. (1/0·12% T.M.P.C.) and *Anagallis arvensis* (8/1·6% T.M.P.C.) although in very small numbers.

The Late Summer and Rainy Season Pollen Catch: The pollen grains of *Casuarina equisetifolia* (8/14·8% T.M.P.C.), *Cannabis sativa* (2/3·7% T.M.P.C.) and *Pinus roxburghii* (8/14·8% T.M.P.C.) continued to be caught up to the end of June. Pollen grains of Gramineae (41·5% T.M.P.C.) and Cheno-amaranth type (20·7% T.M.P.C.) had higher numbers than the others.

In the month of July only two pollen grains of *Tamarindus indica* (0·64% T.M.P.C.) were caught, the first one appearing on July 2. The pollen grains of *Xanthium strumarium* and *Artemisia vulgaris* appeared first on August 4 and 21 respectively and continued up to November 21 and 22 with their peaks on October 7 and 10 respectively. The pollen of *Acacia arabica* appeared first on August 21 and was caught uniformly up to December 8. The pollen grains of Gramineae (145/46·6% T.M.P.C.), Cheno-amaranth type (56/17·5% T.M.P.C.), Cyperaceae (52/16·3% T.M.P.C.) and *Cannabis sativa* (25/8·3% T.M.P.C.) were caught in good numbers.

The pollen of *Ricinus communis* was first caught on August 2 and only two pollen grains were recorded in August.

The pollen grains of *Artemisia vulgaris* (36/3·0% T.M.P.C.) and *Xanthium strumarium* (14/1·1% T.M.P.C.) were recovered in good numbers.

Late Rainy Season and Winter Pollen Catch: The highest number throughout the year of pollen of Gramineae was recovered in October (2,094/76·7% T.M.P.C.). An increasing tendency was observed in the pollen grains of *Xanthium strumarium* (179/60·5% T.M.P.C.) and *Artemisia vulgaris* (79/2·8% T.M.P.C.).

A single pollen grain each of *Tribulus terrestris* and *Cleome viscosa* (0·03% T.M.P.C.) was caught in this month. The pollen of *Alnus* has been encountered from October 8 to November 7 with uniform distribution in the calendar.

The number of pollen grains of Gramineae (264/61·7% T.M.P.C.) and of Cheno-amaranth type (70/18·6% T.M.P.C.) were considerably reduced in November. Pollen grains of Cruciferae (1/0·23% T.M.P.C.) and of *Carica papaya* (3/0·69% T.M.P.C.) appeared for the first time during this month. The pollen grains of *Alnus* sp. (3/0·69% T.M.P.C.), *Xanthium strumarium* (10/2·30 T.M.P.C.) and *Artemisia vulgaris* (3/0·6% T.M.P.C.) were not recorded after November.

In December the pollen grains of Compositae (23/10·5% T.M.P.C.), *Anethum graveolens* (4/1·8% T.M.P.C.) and Cruciferae (108/36·9% T.M.P.C.) were found in good number.

FUNGAL-SPORE CALENDAR FOR 1969-1970

Eighteen types of fungal spores were identified among the total spore catch of

12,771. The spores of *Alternaria, Helminthosporium* and *Cladosporium* sp. were distributed all the year round. Spores of *Aspergillus, Penicillium* or *Mucor* together with 2-4 celled coloured spores were recorded in all the months excepting March and April respectively.

The maximum number of spores of *Alternaria, Helminthosporium* and *Cladosporium* were caught in the months of May (1,461/70·5% T.M.S.C*.), September (251/25·8% T.M.S.C.) and February (156/13·6% T.M.S.C.) with their maxima on May 11, September 17 and February 24 respectively. The spores of *Aspergillus, Penicillium* or *Mucor* attained maxima in the month of October (124/7·9% T.M.S.C.).

The spores of *Chaetomium, Curvularia, Acrothecium, Tetraploa, Tilletia* and of other smuts, *Cercospora* and *Nigrospora* were mainly confined to the rainy and winter season. The spores of *Chaetomium* and *Curvularia* were found from July to February and August to February respectively with the highest number of spores of each in August (77/10·2% T.M.S.C. and 50/6·6% T.M.S.C.) with the peaks attained on August 11 in both the cases. The spores of *Acrothecium* and *Tetraploa* were found from August to February and July to February respectively with the maximum number of spores of the former in September (14/1·4% T.M.S.C.) and of the latter in October (6/0·38% T.M.S.C.). *Tilletia* and the other smut spores were prevalent during this period with the spores concentrated mainly in April (89/5·0% T.M.S.C.). The spores of *Cercospora* and *Nigrospora* were found from July to February and large number of spores of *Cercospora* were noted in October (211/13·5% T.M.S.C.) and of *Nigrospora* in September (192/19·6% T.M.S.C.) with their maximum on October 19 and September 15 respectively.

The uredospores of *Puccinia* were found in the late rainy and winter season and in spring and early summer whereas the teleutospores of *Puccinia* were restricted to spring and early summer only.

The spores of *Diplodia* were recorded in August and September. The maximum number of spores of *Fusarium* were noted in August (24/3·1% T.M.S.C.).

The spores of *Epicoccum* were recorded only in January (11/2·03% T.M.S.C.) and February (103/9·04% T.M.S.C.).

The highest number of the unidentified spores constituting 2% of the total annual spore catch was recorded in May (57/2·7% T.M.S.C.).

*T.M.S.C. — Total Monthly Spore Catch.

COMPARISONS OF POLLEN CATCHES FOR 1955 AND 1969-70

The pollen calendar for the year 1954-1955 prepared earlier by Lakhanpal and Nair (1958) is comparable with the pollen calendar for March 1969-February 1970 in respect of the technique, i.e. apparatus, stain used, the time of exposure and the site. The difference lies in quantitative and qualitative registration of pollen grains in the calendars of 1969-70 and of 1955. The total number of pollen grains caught in 1969-70 was less than that in 1955 though the qualitative abundance was greater in 1969-70. Fortyeight types of pollen grains were recorded in which there were a few which were not recorded earlier. The latter include *Ricinus communis* (2·2%), *Putranjiva roxburghii* (1·4%), *Emblica officinalis* (1·9%), *Argemone mexicana* (0·16%), *Casuarina equisetifolia* (2·4%), *Prosopis juliflora* (0·14%), *Terminalia arjuna* (0·12×), *Tribulus terrestris* (0·07%), *Dodonaea viscosa* (0·22%), etc. Their non-recovery in 1955 might be due to some unfavourable meteorological conditions or to their non-recognition due to their low frequencies. The pollen grains of Cupressineae and of *Loranthus* recorded in the pollen calendar of 1954-1955 (Lakhanpal & Nair, 1958) were not caught during 1969-1970. The pollen of *Alnus* during September and October in both the calendars was obviously a transport from N.W. Himalayas.

The comparison further reveals interesting cases of shifts in the flowering periods of some taxa. The pollen of *Morus alba* which appeared in the 3rd week of January during 1955 was shifted a month ahead, i.e. to the last week of February in 1969-1970. Similar cases were observed in *Ailanthus excelsa, Azadirachta indica,* etc.

CONCLUSION

It is evident that pollen and spore spectra based on the catches obtained at the same location may be different in successive years

depending upon meteorological factors and change in vegetation. It would be advantageous to conduct aeropalynological surveys for several successive years than to depend upon a single year's survey.

REFERENCES

LAKHANPAL, R.N. & NAIR, P.K.K. (1958). Survey of atmospheric pollen Lucknow. *J. scient. ind. Res.* **17C** (5): 80-87.