

DIURNAL PERIODICITY AND THE EFFECT OF METEOROLOGICAL
FACTORS ON AIR-BORNE FUNGUS-FLORA*

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Abstract

Air-borne fungus-flora during May to September, 1957 showed hour to hour variations and their pattern of diurnal periodicity also varied from day to day. On the basis of hourly averages of several days data *Alternaria* spores had a major peak at 3 p.m. *Cercospora* spores were maximum in the forenoon whereas hyphal fragments did not show marked variations during 24-hour period. *Helminthosporium* spores showed somewhat consistent diurnal pattern, being maximum in the afternoon but this pattern was altered, because of a morning peak due to a spore shower on July 20. Long hyaline and brown ascospores appeared in the atmosphere after dew or rain but *Alternaria* spores and hyphal fragments disappeared from the atmosphere shortly after rain.

Introduction

Diurnal periodicity of a number of air-borne fungus-flora is well established. However, marked variations in the diurnal pattern of certain fungi have also been reported. For instance, in England *Alternaria* spores were recorded maximum in the afternoon (Hirst, 1953). At Maryland these were maximum at 9 a.m. on the days of high spore load but on the days of low spore count these were maximum at 4 p.m. (Panzer, Tullis & van Arsdell, 1957). During initial studies at Manhattan these spores exhibited one major peak in the afternoon and a minor at night (Pady, 1959), but later studies did not show any marked variations in their number during 24 hours of the day (Pady, Kramer & Willey, 1962). Similarly spores of *Cercospora* showed different diurnal patterns during the summers of two consecutive years (Pathak & Pady, 1965). In view of such variations in the diurnal pattern of air-borne fungus-flora which may be due to geographical or climatic differences, studies were conducted at Manhattan, Kansas, U.S.A. to find out the diurnal periodicity of air-borne fungus-flora during the summer months of 1957.

Materials and Methods

Adhesive coated microscopic slides were exposed in a continuous-type spore sampler mounted on the roof of Willard Hall (Kansas State College) about 150 feet above ground (Bhatti, 1958; Pady, 1959). The slides were placed in the spore-trap between 8 and 9 a.m. The mycoflora was studied under low power of the microscope. Spores of *Alternaria*, *Helminthosporium* and *Cercospora* were grouped according to their generic characters. Spores of *Stemphylium* were also observed in traces and as these were difficult to differentiate from *Alternaria* spores under low power of the microscope, the chances of their inclusion in the total counts of *Alternaria* cannot be excluded. Another group composed of filiform hyaline and brown

*A portion of a thesis submitted in partial fulfilment of the requirements for the degree of Master of Science at Kansas State College, Manhattan, Kansas, U.S.A.

spores which were probably ascospores and resembled those of *Claviceps purpurea* in shape. In the text these spores are designated as long hyaline and brown ascospores. Fragments of hyphae and conidiophores were also recorded which were mostly thick-walled, one to many-celled and brown to dark brown in colour.

Results

Alternaria spores showed marked variations in their numbers through out the period of study (Fig. 1). During the first week (July 15-20) their numbers did not exceed 5 spores/cu.ft. on any day. About 0.87 inch rain was recorded on July 20, between 5 and 6 p.m. when a sudden drop from 2 to 0.04 spores/cu. ft. was recorded at 6. p.m. Subsequently the count remained low until 5 a.m. but in the following hour their number again rose to 2.5 spores/cu. ft. In the second week (July 22-27) the count exceeded 12 spores/cu.ft. on several occasions with great fluctuations hour to hour. In the following two weeks (July 29-August 3 and August 5-10) their number remained low and did not exceed 8 spores/cu.ft. except on August 2, when 18 spores/cu.ft. were recorded on two occasions in one day.

Alternaria spores also showed marked variations in the pattern of diurnal periodicity (Fig. 1). These spores had one major peak during day time on five days and at night on two days. Two or more peaks in one day were recorded on nine

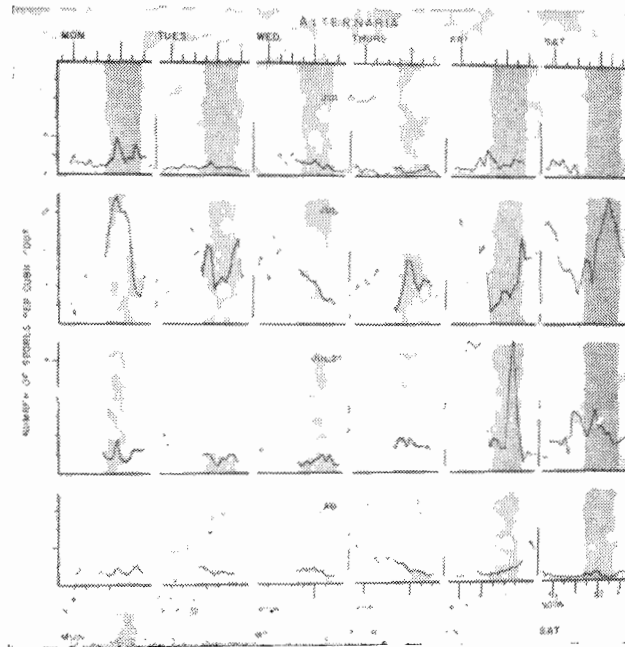


Fig. 1. Hourly variations in the number of *Alternaria* spores from July 15 to August 10, 1957. Shaded areas indicate night-time.

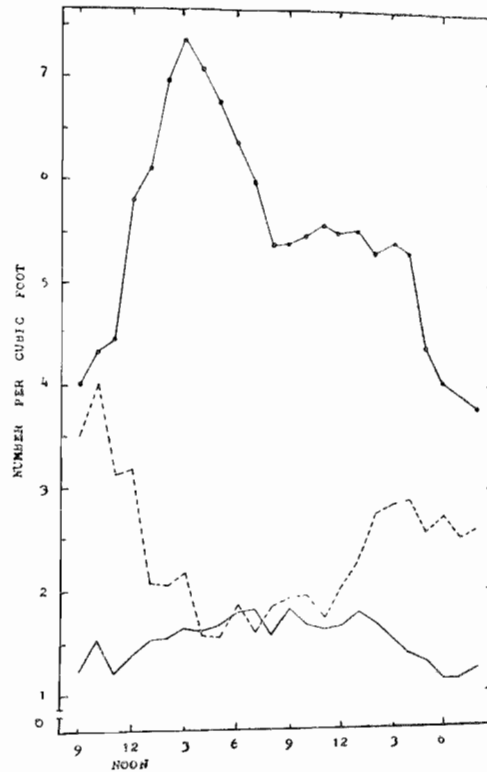


Fig. 2. Diurnal periodicity of *Alternaria* (—•—•—•—) and *Cercospora* spores (.....) and the hyphal fragments (————) in the atmosphere.

days and no definite diurnal pattern was recorded on eight days. Whereas hourly data for several individual days showed variations in the diurnal periodicity, hourly averages of data for 45 days obtained during the months from May through September indicated a distinct peak at 3 p.m. (Fig. 2).

Helminthosporium spores were abundant during the months of June but few in July (Fig. 3). During the period, June 18 to 20, one major peak on each day was recorded between 3 to 5 p.m., while minor peaks were apparent at night. During the second period, maximum spores were recorded in the afternoon on July 11 and 12 but on July 13, a sudden rise in their number from 0.2 to 6.9 spores/cu.ft. was recorded at 9 a.m. followed by a quick drop in their number in the next hour. The wind direction between 8 and 9 a.m. remained from east to west but at 10 a.m. its direction changed to north.

Marked fluctuations in the number of *Cercospora* spores were recorded only for certain days (Fig. 4). One major peak during the day-time or at night was recorded each on two days, two or more peaks during 24 hours of the day were re-

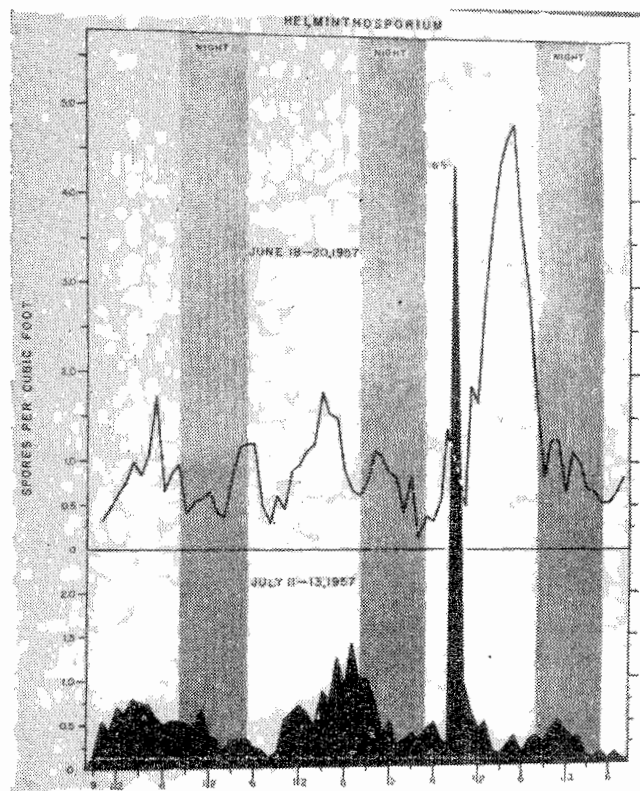


Fig. 3. Hourly variations in the number of *Helminthosporium* spores.

corded on four days, while no marked variations were observed on other four days. Hourly data on daily basis did not show any fixed diurnal pattern but hourly averages of data for 12 days showed their maximum number in the forenoon (Fig. 2.)

Long hyaline and brown ascospores appeared immediately after dew or rain (Fig. 5). On May 12 (not shown in the Fig.) 13, 24 and 29 rain was recorded in the evening or at night. Coincident with the rain these spores abruptly appeared in the atmosphere. During June 11 to 13 only dew was recorded and these spores also appeared in the atmosphere suddenly. The spores on all occasions after attaining their peak showed a quick decline in their number and with the sunrise these totally disappeared from the atmosphere.

Hyphal fragments also showed hourly variations in their number and their pattern of diurnal periodicity also varied from day to day (Fig. 4). The number of hyphal fragments exceeded 4/cu.ft. on only 4 days, but on other days their count

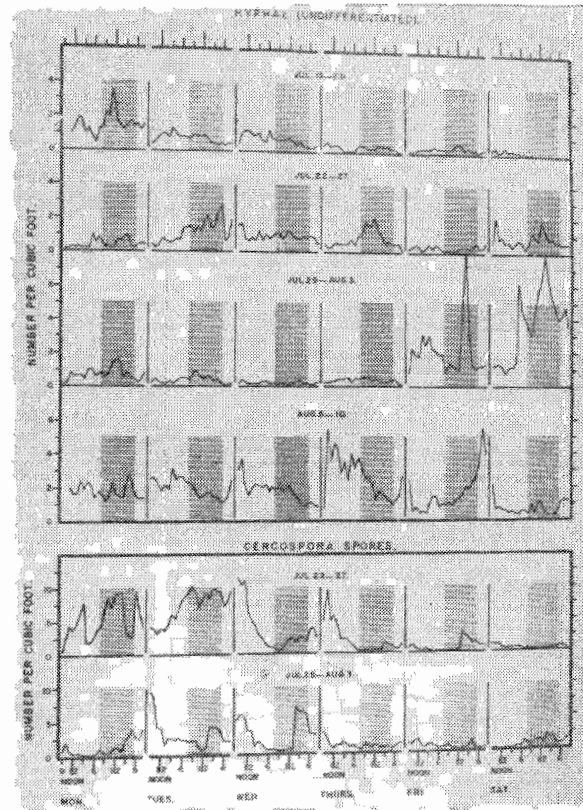


Fig. 4. Above: Hourly variations in the number of hyphal fragments from July 15 to August 10, 1957.

Below: Hourly variations in the number of *Cercospora* spores from July 22 to August 3, 1957

remained low. On July 20, the hyphal fragments however, completely disappeared from the atmosphere shortly after 0.87 inch of rain between 5 and 6 p.m. and their number remained low throughout the following night and early hours of the day.

Hyphal fragments showed one distinct peak during day-time or at night each on four days. Two or more peaks at any time during 24-hour period were recorded on seven occasions and marked fluctuations in their number were not recorded on nine days. Averages of hourly data for 49 days obtained from May through September did not show marked variations during 24-hours of the day (Fig. 2).

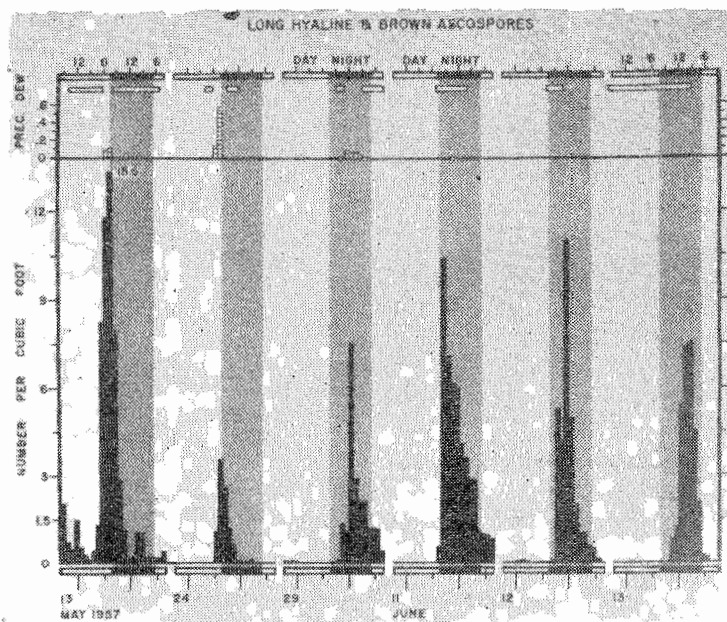


Fig. 5. Effect of dew or rain on the number of long hyaline and brown ascospores in the atmosphere.

Discussion

Hour to hour variations were recorded in the number of air-borne fungus-flora and their pattern of diurnal periodicity also varied from day to day. On certain days these variations in their number were possibly due to certain meteorological factors since *Alternaria* spores and the hyphal fragments disappeared from the atmosphere with the onset of rain on July 20, at 6 p.m. (Fig. 1 and 4). Effect of rain to remove certain types of spores from the atmosphere has also been reported by Hirst (1953) and Pady (1959).

A sudden rise in the number of *Helminthosporium* spores from 0.2 to 6.9 spores/cu.ft. at 9 a.m. on July 13, indicates a spore shower as also noted by for *Alternaria* (Durham, 1938) and rust spores (Pady & Johnston, 1959). Quick drop in the number of *Helminthosporium* spores in the following hour indicates either the small volume of the spore shower, which passed over Manhattan between 8 and 9 a.m. or change in its direction with the change in the direction of the wind from West to North at 10 a.m.

Spores of certain ascomycetous fungi are released as their mature asci come in contact with moist air, thus long hyaline and brown ascospores appeared in large numbers in the atmosphere immediately after dew or rain, but showed a quick decline after attaining peak and completely disappeared from the atmosphere with the sunrise.

Since the dew formation takes place mostly at night, this composite group can be considered as night-flora as also noted by Hirst (1953) for filiform spores. However, these spores may also appear during the day-time after rain as recorded on May 13, 1957.

Whereas diurnal periodicity of air-borne fungi may change with changes in meteorological factors and daily data may not show their definite diurnal pattern, hourly averages of data of *Alternaria* spores for 45 summer days showed a distinct peak in the afternoon, and this pattern is by and large similar to that reported by Hirst (1953) in England and Pady (1959) at Manhattan and that reported by Panzer, Tullis & van Arsdle (1957) at Maryland for days of high spore count. However, this is in complete contrast to other studies at Manhattan (Pady, Kramer & Willey, 1962) who did not find much variations in the number of *Alternaria* spores; one reason may be that the present studies include the data for only summer days, whereas later studies include the data for the whole year, thus showing their maximum number at different times of the day. Hourly averages of data for *Cercospora* spores indicate their maximum number in the morning, but Pady, Kramer & Willey (1962) did not find much variations in their number during 24-hours of the day.

Acknowledgements

Thanks are due to Professor S.M. Paddy, Head, Department of Botany and Plant Pathology, Kansas State College, Manhattan, Kansas, U.S.A. for the facilities and help given by him. I am also thankful to Dr. J.H. Mirza, Department of Plant Pathology, University of Agriculture, Lyallpur for suggestions in the preparation of this manuscript.

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