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ORIGINAL ARTICLES

THE INCIDENCE OF AIRBORNE HORMODENDRUM AND ALTERNARIA SPORES AS DETERMINED BY A VOLUMETRIC SAMPLER

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CERTAIN airborne spores of fungi have gradually been accepted as an important cause of allergic reactions. The atmospheric incidence of airborne spores has been determined almost entirely by the use of two standard sampling methods—(1) the plate method, which is considered best for identification, and (2) the slide method, which is used for those spores that can be identified microscopically and to determine seasonal fluctuations.

A few volumetric samplers have been used in an attempt to measure more accurately the incidence of certain airborne spores. Durham¹ employed a volumetric device devised by Hawes² and obtained simultaneous gravity slide counts. In a comparison of the number of alternaria spores collected by these two sampling methods, he found that there was a marked difference in the day-to-day ratios in the number of spores collected and suggested that gravity slide counts must be regarded as being much more inaccurate than many workers have assumed.

Alvarez and Castro,³ recognizing the limitations of the culture plate method and attempting to determine quantitatively the spore count of air, designed a four-sided wooden box on the bottom of which was placed an exposed culture plate. Preliminary experiments indicated that the spores in this closed box would settle out of the air in one hour. After exposure, the plate was incubated and the colonies were counted. Knowing the dimensions of the box and the surface area of the exposed plate, Alvarez and Castro reported these counts as colonies per cubic meters of air. They found in Havana that the greatest concentration of fungi is at night.

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Hirst,⁴ in England, used a power-operated suction trap by which spores are impacted onto the sticky surface of a slowly moving slide, a sampling method similar to that employed in the Hawes impinger. During a fourteen-day period in June Hirst found a marked diurnal variation of pollen and cladosporium (hormodendrum). Maximal concentrations of both were usually reached in the afternoon, with the lowest concentration occurring shortly after midnight. Although the incidence of alternaria was much lower than that of hormodendrum, Hirst reports a similar diurnal variation for alternaria.

STATEMENT OF PROBLEM

This is a volumetric concentration measurement study of airborne alternaria and hormodendrum spores. It was hoped that further study of these two spores with a volumetric sampler would give a clearer picture as to their actual incidence and their diurnal and hourly variation, if any, and that a comparison with the standard gravity slide method would help in the interpretation of these daily counts.

PROCEDURE

The volumetric sampler used was constructed, with minor alterations, according to instructions received from Stenborg and Hall.⁵ The principle involved in sampling is impingement of particles in a given volume of air onto the adhesive side of moving cellulose tape and the covering of this collecting surface during sampling with a facing piece of adhesive tape. Movement of the tape during sampling spreads out the collected spores over a sufficient area to make counting and identification accurate although time-consuming.

Both the volumetric sampler and the standard gravity sampler were located on the topmost ledge of a tower above the roof of the Medical Laboratories Building in Iowa City, Iowa. The standard gravity sampler was located at the same height and just a few feet distant from the volumetric sampler, so that a comparison was possible in the incidence of spores collected by both samplers. The results reported here are based on readings taken during the month of August, 1952, and during a twelve-day period in August, 1956.

The sampler was necessarily stopped for a few minutes at 9 A.M. each day in order that the portion of the tape representing the previous twenty-four hours of sampling might be removed. This portion of the tape was divided into twenty-four equal parts, with each representing one hour of sampling time and approximately one cubic yard of air. All hormodendrum and alternaria spores were identified and counted under high-power magnification and in terms of the volumetric sampler expressed as spores per cubic yard of air. During the counting of all hormodendrum spores on both the slides and the tapes, a recording was made as to whether the spore occurred singly or in clumps (masses or aggregates) and, if in clumps, the number of spores per aggregate.

The efficiency of this volumetric sampler was found in a previous study,⁶ under certain experimental conditions, to be 76 per cent for commercially collected ragweed pollen (*Ambrosia trifida*). The efficiency is not known for

spores, but it must be less than for ragweed pollen because of their smaller size. Similarly, the sampling efficiency is less for hormodendrum than for alternaria because of their smaller size. Although the sampling efficiency of this instrument is low for these two allergens, the volumetric readings do give pertinent information as to the exposure of the patient to these two spores in that the sampling rate approximates the volume of air inspired by an adult during normal activity.

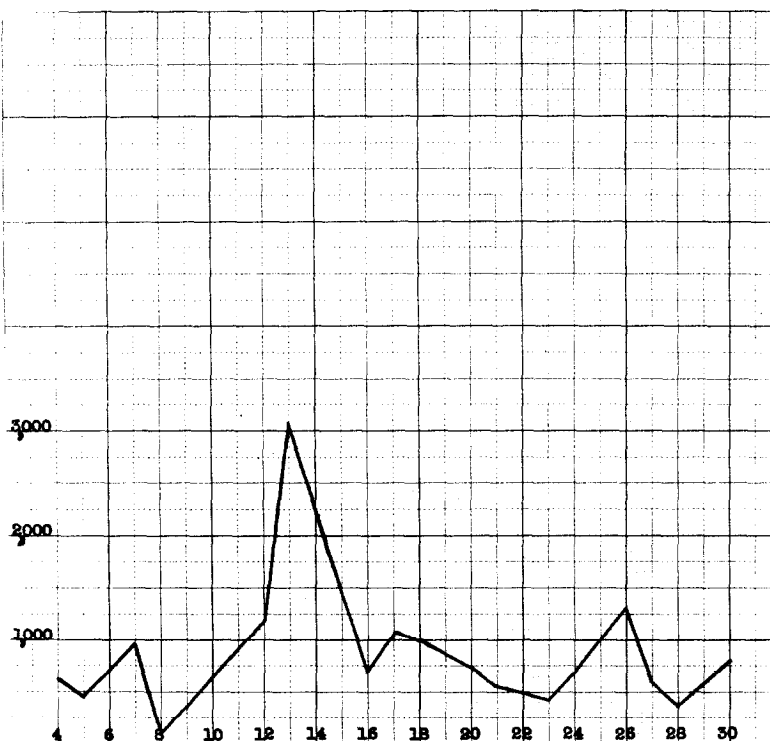


Fig. 1.—Daily alternaria spore count, August, 1952, Iowa City, Iowa.

DISCUSSION AND RESULTS

Daily Incidence of Airborne Alternaria and Hormodendrum Spores.—Figs. 1 and 2 indicate the marked daily variation in the aerial concentration of these two spores. Each daily reading represents approximately 24 cubic yards of sampled air. Although hormodendrum always had the greatest daily incidence, the difference in daily totals fluctuated markedly from day to day. Eighty-eight times as many hormodendrum spores as alternaria spores were collected on August 8, and the ratio was 50 to 1 on August 4, while on August 23 the hormodendrum count only slightly exceeded that of alternaria. These sudden daily changes and these changing ratios indicate how rapidly the spore content of the air can undergo alteration. Certain factors that might be expected to influence this count, such as atmospheric temperature, soil temperature, sunshine, turbulence, and humidity, do not have the same effect on both spores if

they are important in influencing atmospheric spore counts. The peak incidence of both spores was reached on August 13. There were no known unusual weather changes or meteorological factors that can be used to explain this high incidence of both spores on this particular day. Readings taken during the month of August, 1956, show the same daily changes and similar changing ratios in the number of spores collected.

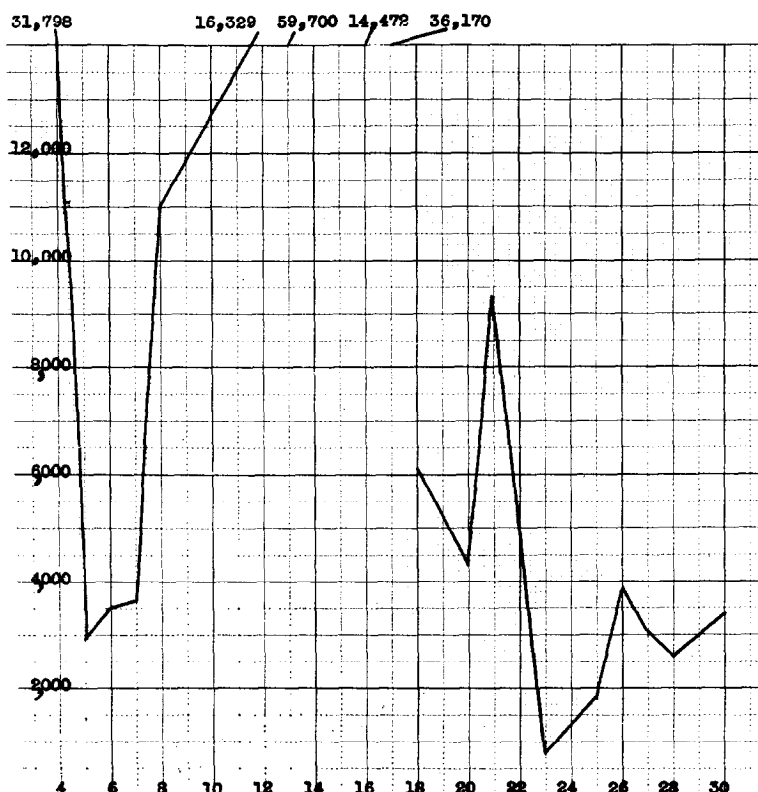


Fig. 2.—Daily hormodendrum spore count, August, 1952, Iowa City, Iowa.

The more marked daily changes in the occurrence of hormodendrum spores were not due to a change in the number of spores per clump. On some days the total hormodendrum count was high and the number of spores per clump was small, while on other days the total count was low and the number of spores per clump was twice that of days with a high incidence.

A comparison of day-and-night total counts shows that both spores had their highest incidence during the day (6 A.M. to 6 P.M.). For the month of August the alternaria and hormodendrum counts were approximately 23 per cent higher during the daylight hours. In three instances the number of alternaria spores collected during the night exceeded that of the daytime readings, and on one of these same days the hormodendrum count was higher at night.

On eight days during the month of August there was a fall in incidence of hormodendrum spores during the night and in one instance this amounted to a 90 per cent reduction. In each instance there was an associated fall in the

alternaria counts, although the decrease was less than that for hormodendrum. This decrease was not associated with rainfall, as even a small shower destroyed the adhesive qualities of the sampling tape and if a rain occurred during a twenty-four-hour period the sampling tape was discarded. The number of hormodendrum spores per clump was usually slightly greater during the day as compared to night readings, but a change in clumping does not account for this decrease in hormodendrum spores at night on these eight occasions.

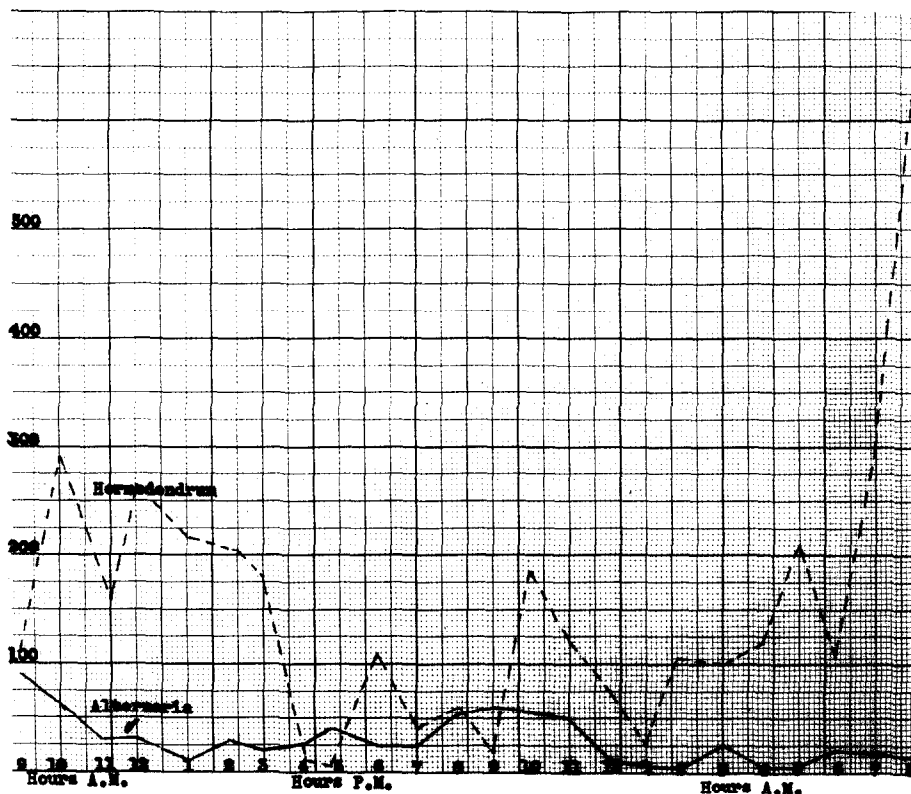


Fig. 3.—Hourly variation of airborne hormodendrum and alternaria spores. Gravity slide count per square centimeter slide area: hormodendrum, 5; alternaria, 14. Aug. 7, 1952, Iowa City, Iowa.

Hourly Incidence of Airborne Alternaria and Hormodendrum Spores.—

Figs. 3, 4, and 5 show the marked hourly variation in the number of these two airborne spores. These three days are representative of the two sampling periods in that every day was characterized by abrupt hourly changes in the number of spores sampled. A comparison on an hourly basis indicates little relationship in the peak incidence of these two spores. On four days during the month of August, however, the maximum count of each was reached at the same hour of the day, and in each instance this occurred during the morning hours.

The peak incidence of alternaria spores was reached on every day during the daylight hours and in all but three days during the morning hours. Hormodendrum spores showed a greater variation in that on two occasions during the month the greatest hourly concentration occurred at night, although on all other days the peak incidence was also during the morning hours.

The total number of spores collected during August was highest during the period from 6 A.M. to noon (hormodendrum 54 per cent, alternaria 35 per cent). The lowest incidence during the month was from 6 P.M. to midnight (hormodendrum 11 per cent, alternaria 18 per cent).

These sudden hourly changes indicate that there is no homogenous mixture of spores in a given volume of air. It appears more likely, as suggested by Gregory,⁷ that spore clouds are formed. These results show that in some instances these clouds are made up of large numbers of both hormodendrum and

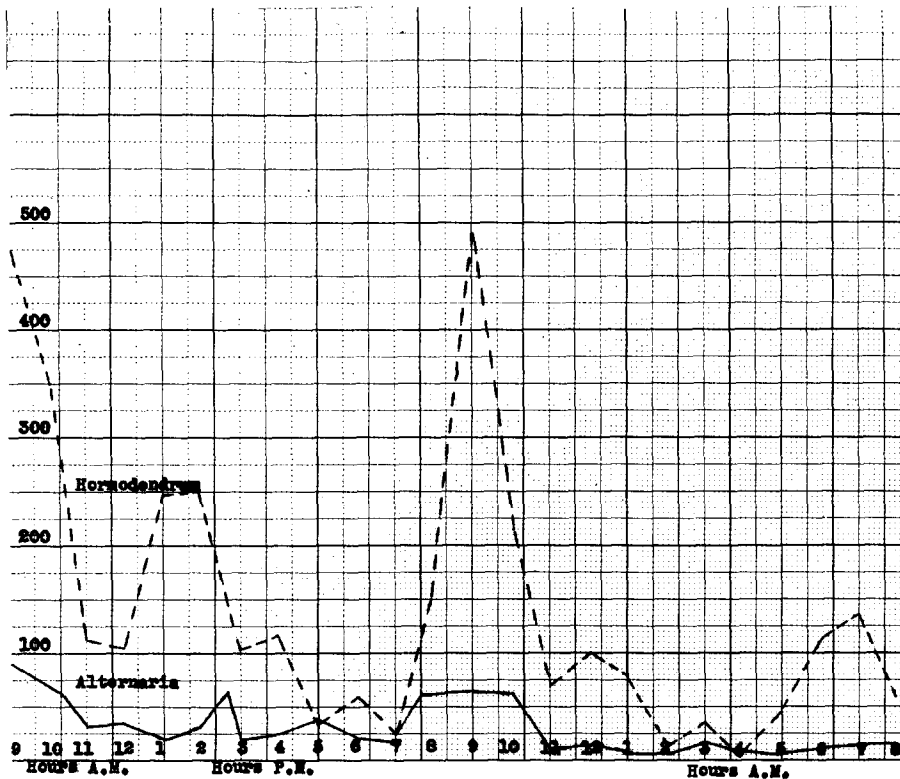


Fig. 4.—Hourly variation of airborne hormodendrum and alternaria spores. Gravity slide count per square centimeter slide area: hormodendrum, 6; alternaria, 22. Aug. 6, 1952, Iowa City, Iowa.

alternaria spores, as when the maximum hourly incidence is the same for both spores. Usually, however, these clouds are composed of alternaria or hormodendrum spores, as is indicated when the peak incidence of both spores is not the same and in the many instances in which there is little agreement in the hourly counts.

These spore clouds of both spores occurred more commonly during the morning hours, but they do take place at any time of the day or night, as is shown by the sudden increase of spore counts that may occur at any time. These abrupt hourly changes emphasize the suddenness of air spore changes and indicate how difficult it would be, because of a lack of uniformity in these counts, to try to explain these changes in terms of weather or meteorological conditions.

It has been previously pointed out⁸ that when volumetric readings were taken at twelve-minute intervals there was little agreement between these readings in terms of the number of hormodendrum and alternaria spores collected. These readings indicate that volumetric readings of one hour in length, even if taken at the same time each day, cannot be used to indicate the daily incidence of these two spores.

Volumetric Incidence of Alternaria and Hormodendrum Spores as Compared With Gravity Slide Counts.—Slide counts and plate counts are in rather poor agreement⁹ for both alternaria and hormodendrum spores. Because of the much longer exposure time of slides by the gravity method as compared to culture plates that are exposed for twelve minutes, one might suppose that slide counts would more nearly reflect the incidence of these two airborne spores.

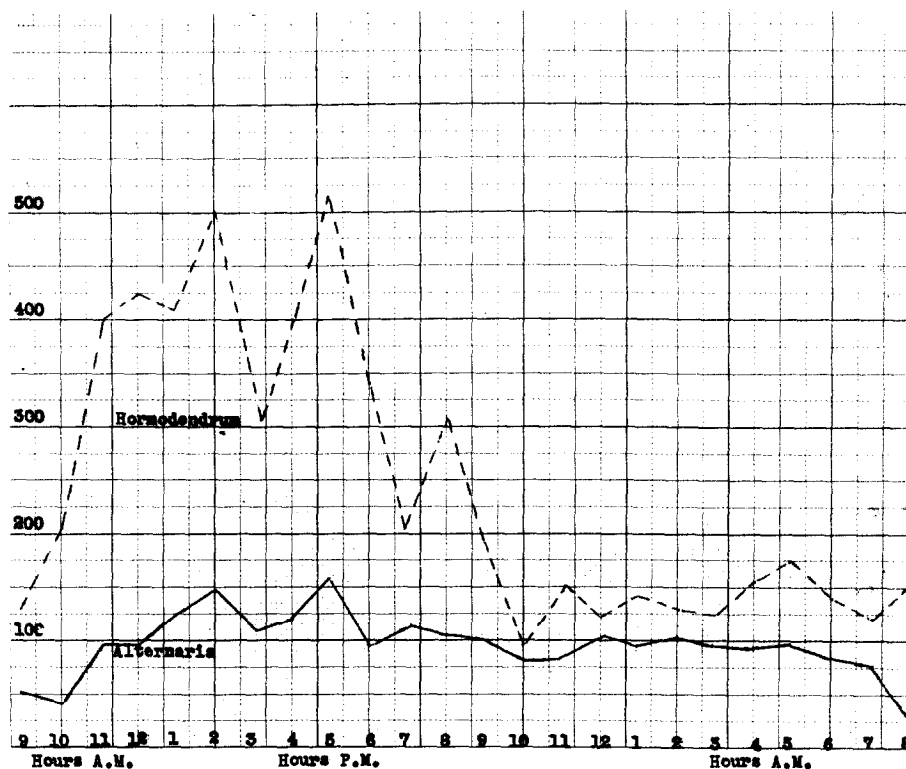


Fig. 5.—Hourly variation of airborne hormodendrum and alternaria spores. Gravity slide count per square centimeter slide area: hormodendrum, 26; alternaria, 8. Aug. 9, 1956, Iowa City, Iowa.

In this study a direct comparison of the incidence of these two spores in terms of a volumetric sampler and the gravity slide method was possible during the two sampling periods of 1952 and 1956. Figs. 3, 4, and 5 show the hourly slide counts on three representative days during these sampling periods. These slide counts do not suggest the high atmospheric concentration of these spores when a comparison is made with the hourly volumetric incidence, and they are still less suggestive as to the occurrence of these spores when a comparison

is made with the daily volumetric incidence. August 6 (Fig. 1) alternaria, with a gravity slide count of 22, represents 766 alternaria spores collected volumetrically on this day. Similarly, the gravity slide count of 22 represents 3,416 hormodendrum spores collected volumetrically (Fig. 2). On August 7, another day with a comparatively low volumetric incidence of these two spores—990 for alternaria and 3,681 for hormodendrum—the gravity slide counts were alternaria 8 and hormodendrum 26. If we take the peak incidence during the month of August, in terms of both spores, which was reached on August 13, the gravity slide counts were alternaria 19 and hormodendrum 10. Yet on this day, according to the volumetric sampler, the individual inspired during the course of twenty-four hours some 3,000 alternaria and 59,700 hormodendrum spores.

Durham¹ has pointed out the marked daily variation when ratios are computed for the gravity slide and the volumetric recovery of alternaria spores. A similar variation was found in this study, in that the daily ratios for alternaria varied from 1 to 30 to 1 to 386. A still greater fluctuation occurred in ratios for hormodendrum spores, 1 to 369 to 1 to 6,359. These changing daily ratios indicate that about the only interpretation that can be placed on gravity slide counts in terms of these two spores is that this count indicates that the two spores were airborne on a given day.

SUMMARY

Air samples for hormodendrum and alternaria spores were taken simultaneously by the use of a volumetric sampler and a standard gravity sampler. Both samplers were located on the topmost ledge of a tower above the roof of the Medical Laboratories Building in Iowa City, Iowa. The results here reported are based on readings taken during the month of August, 1952, and during a twelve-day period in August, 1956.

1. Volumetric readings indicated that there is a marked daily variation in the aerial concentration of these two spores and, although the hormodendrum count always exceeded the alternaria count, computed ratios indicated little relationship in their daily concentration.

2. The total number of both spores collected volumetrically during August was highest during the period from 6 A.M. to noon, with the lowest total incidence from 6 P.M. to midnight.

3. Although usually the peak hourly concentration of both spores was reached during the morning hours, a sudden hourly decrease or increase did occur at any time.

4. A comparison of volumetric counts with the gravity slide counts shows that the only interpretation that can be placed on slide counts is that the two spores were airborne on a given day.

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