

THE DISTRIBUTION OF RAGWEED POLLEN AND ALTERNARIA SPORES IN THE UPPER ATMOSPHERE

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DAILY pollen counts made by the gravity method on slides exposed near the ground have become routine among allergists. Few have had the equipment or the opportunity to correlate these counts with the distribution and migration of these pollens and molds in the upper atmosphere. The most comprehensive previous studies were made by Durham,¹⁻³ who exposed slides while traveling in transport planes. His studies established the distribution of pollen at various altitudes and important geographic variations. The present study was made possible by the unrestricted use of our own Piper Supercruiser from which slides were exposed in order to discover the effect of altitude, diurnal and nocturnal variations, and the influence of clouds. All observations were limited to the vicinity of Mitchell Field, Milwaukee, so that the changes in the distribution of pollens involving the influence of time, altitude, and clouds could be effectively studied. The altimeter readings are expressed as the number of feet above sea level. The airport is 676 feet above sea level. The investigation was limited to the distribution of ragweed pollen and alternaria spores, since these particles not only greatly outnumbered all others, but presented morphologic characteristics which made identification simple. The "sky hook" was placed in the slipstream of the plane within three inches of the front window.

Preliminary sampling of the upper atmosphere revealed some surprising discrepancies which were later shown to be due to variations in the speed of the plane. The importance of this factor is shown in Table I. All counts were made by the same technique of the ordinary gravity method on unstained slides and represent the number of granules in one square centimeter. No conversion factors were used.

One would expect that the number of pollen grains on the slide would vary directly with the speed of the plane. However, the enormous increase in the number of particles on the slide with minor increases of speed indicates that other factors beside speed are responsible for the counts obtained.*

Table I shows the importance of maintaining a constant speed while collecting samples. Therefore, an airspeed of 90 m.p.h. was arbitrarily selected for all collection of particles, as this speed could safely be maintained even in the turbulent atmosphere encountered in and near cumulus clouds. All subsequent counts were based on five-minute exposures.

EFFECT OF ALTITUDE AND FAIR WEATHER CUMULUS CLOUDS

An analysis of the findings shown in Table II indicates that the greatest concentration of pollen and molds occurred at 3,500 feet with a decrease

*Further study is necessary to determine the effect of air compression in front of the slide, as well as the difference in behavior of the heavier spherical ragweed pollen grains and the lighter bowling pin-shaped alternaria spores.

TABLE I. FIVE-MINUTE EXPOSURES OF SLIDES AT 2,500 FEET

REVOLUTIONS OF PROPELLER PER MIN.	INDICATED AIR SPEED M.P.H.	RAGWEED (R)	ALTERNARIA (A)	RATIO R/A
2,250	110	6,000	4,700	1.3
1,930	90	1,200	1,800	.7
1,875	70	740	900	.8
1,950	50	740	1,000	.7
24-hour gravity slide		150	33	4.5

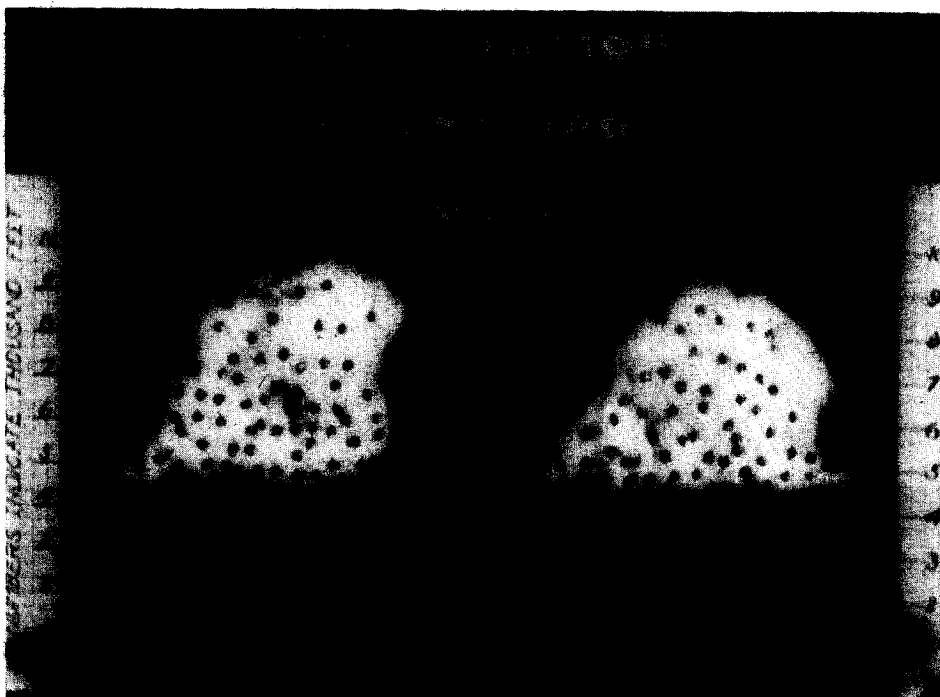


Fig. 1.—Note pollen and spore granules in and adjacent to clouds in contrast to the space above and below these concentrations.

TABLE II. COUNTS MADE IN CLEAR AIR AND IN CUMULUS CLOUDS (SEPT. 1, 1947; WIND, WNW; 25 M.P.H.; SCATTERED CUMULUS 5,500 FEET TO 10,000 FEET; 24-HOUR GRAVITY SLIDE RAGWEED, 100; ALTERNARIA, 5)

ALTITUDE	TIME (P.M.)	IN CLEAR AIR AWAY FROM CLOUDS RAGWEED—ALTERNARIA	TIME (P.M.)	ABOUT ½ TIME IN CLOUDS RAGWEED—ALTERNARIA
9,500			2:20	8-2
8,500	2:00	0-0		
7,500	1:40	18-2	2:40	800-100
6,500	1:25	85-8		
5,500	1:10	175-125	2:50	1,600-300
4,500	1:00	1,100-125		Below clouds
3,500	12:50	1,700-375	3:00	1,300-75
2,500	12:40	1,450-325		
1,500	12:30	1,000-225	3:10	1,650-150

in number of particles at higher and lower altitudes. However, the cumulus clouds and surrounding atmosphere contained many times the number of particles found in the clear air further from the clouds. The reported

counts in the clouds are actually much lower than they would have been if the entire five minutes could have been spent in the clouds. Continuous flying through the clouds is impracticable, so the figures represent the compromise of flying through clouds about one-half of the time. These fair weather cumulus clouds are caused by the rising of heated moist air to an altitude where the dew point and temperature meet and condensation occurs. The turbulence in the clouds is associated with the liberation of heat as condensation proceeds. The cloud itself then acts as a huge chimney drawing

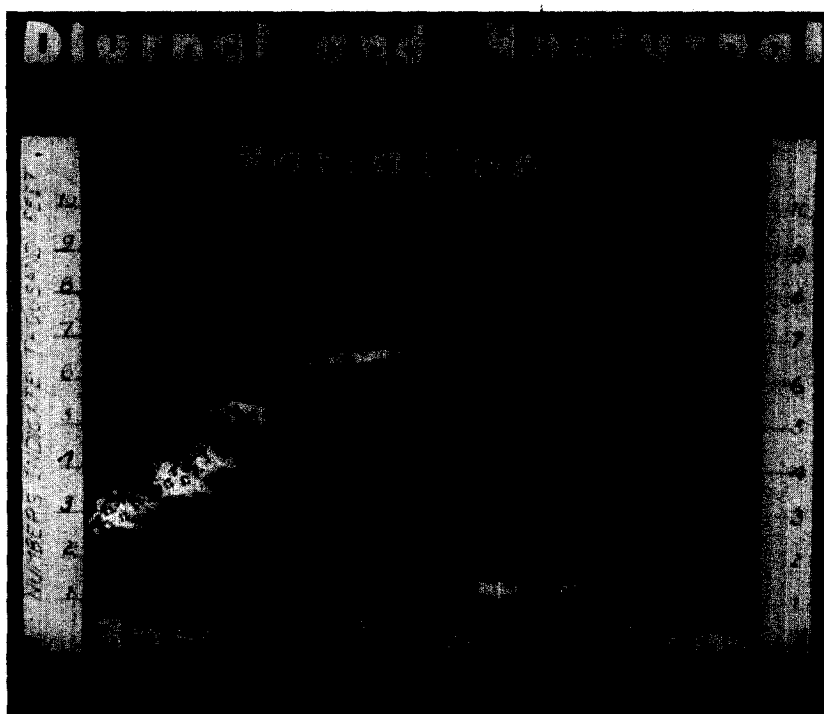


Fig. 2.

pollen from the lower atmosphere and lifting it far above its usual altitude. It is also probable that some of the condensation of moisture in the clouds takes place on the pollen or mold granule, the granules themselves serving as condensation nuclei without which cloud formation is impossible. Regarding this possibility it is an interesting finding that slides exposed in the clouds frequently revealed pollen grains that were attached to or surrounded by globules of water.

DIURNAL AND NOCTURNAL VARIATIONS

Table III shows the actual counts obtained at various altitudes at the indicated times of day or night. Since the time required for collection of pollens and molds prevented a simultaneous determination of the counts at various altitudes, there are necessarily many gaps in Fig. 2. The gaps are filled in according to the trends which have been established in Table III.

In addition, the maximum concentrations have been exaggerated in order to demonstrate more clearly the variations depending on the time of day or night. The data indicate that the level of maximum concentration rose from early afternoon until about 8 P.M. when the particles slowly fell until dawn, at which time there was ground fog. An analysis of these findings seems to indicate that the convection currents during the day and early evening are responsible for the lifting of the particles to high altitudes, and that the particles then sink as the ground cools off. Fig. 2 also indicates a tendency for the particles to be most numerous in haze and ground fog. The importance of these observations is that they help explain the well-known fact that pollenosis is usually at its worst in the early morning hours.

Some interesting comparisons of the number of particles obtained by the airplane method with the gravity method of counting are worthy of mention. The present study indicates that during the daytime at 2,500 feet and 90 m.p.h. as much ragweed is collected in about thirty-five seconds as can be collected in twenty-four hours by the gravity method. At night, at 2,500 feet, it takes as much as eight minutes to collect an amount of pollen equaling the twenty-four hour gravity count. Alternaria spores, on the other hand, may be collected during daylight hours at a rate indicating that ten seconds of flying under the conditions established for ragweed counts equals a twenty-four hour gravity count. At night, however, about one and one-half minutes of flying are necessary to equal the twenty-four hour gravity count.

Further study is expected to explain these findings. Plans for the future are concerned with a correlation of meteorologic data with upper air pollen counts, with the hope of obtaining information which may be of value in prophesying pollen counts on a twenty-four hour basis.

SUMMARY

1. Counts of ragweed pollen and alternaria spores in the upper atmosphere were made during flight.
2. The greatest concentration of pollen occurred at 3,500 feet.
3. Cumulus clouds and surrounding atmosphere contained many times the number of particles found in clear air away from the clouds.
4. The level of maximum concentration of particles rose from early afternoon until about 8 P.M. when it fell slowly until dawn.

REFERENCES

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