

Atmospheric Spore Content at Mount Cimone, Italy, in Relation to the Winds

by

N. Bagni*, P. Mandrioli** and G.L. Puppi*

ABSTRACT.— A preliminary research on air spora (bacteria and fungi), captured by an air impinger at M. Cimone (2,160 m), Northern Apennines, Italy, shows that the frequencies of the air spora collected during the period February-July 1971, was generally related to the directions of the prevailing winds (from SW, NW and NE). It was also found that while fungi (without yeasts) and bacteria were related to these wind directions, the yeasts were only associated with the SW and NW wind. During the whole period of sampling a progressive decrease of fungi and an increase of bacteria was noted. During the period of maximum snow cover of the area surrounding M. Cimone, the bacteria represented 7% only of the examined air spora.

INTRODUCTION

The composition of air spora (pollen grains, spores of fungi and bacteria) and its variation with time and space has been extensively studied for many years especially in relation to the problem of infections of plants and human allergy. Only recently, however, has there arisen considerable interest in the dispersal of airborne spores in relation to meteorological problems, such as tracers of air masses (Hirst, Stedman and Hogg, 1967), condensation nuclei (Rosinski, 1966) and rain-out mechanisms (May, 1958). These researches are abundant in North Europe and in the United States, and very scanty in the Mediterranean area, mostly limited to the fields of plant disease epidemiology and of those allergies in which pollen grains and fungal spores are of relevant importance (Mammarella, Tarsitani and Zaio, 1968; Padalino, Antonicelli and Grasso, 1970).

With our present investigations we have begun a preliminary research on the capture of airborne spores. The Experimental Scientific Observatory of the Italian Air Force, located at Mount Cimone (2,160 m) in the Northern Apennines, was chosen as sampling station because of its significant location in relation to the movements of large air masses.

The study here reported is limited to the examination of germinating air spora, cultivable on agar media, although the non viable spores represent a component of remarkable interest for some aspect of aerobiological research.

MATERIALS AND METHODS

The sampler was a sequential air impinger with 6 consecutive bottles containing a known volume of liquid sterile medium (All-Glass Impinger, Millipore Corp.).

*) Istituto di Botanica, Università di Bologna, Via Irnerio 42-40126 Bologna, Italy.

**) Istituto di Fisica dell'Atmosfera, C.N.R., Via Castagnoli, 1-40126 Bologna, Italy.

Received 25 March 1976

The air flow was produced by a suction pump sampling 5 l/min for two hours daily. The air spora collected was maintained at 0°C till the samples could be inoculated in sterile conditions in Petri dishes containing two different agar media: a Sabouraud dextrose agar (Difco) and a medium consisting of 5% glucose, 0.5% yeast autolysate, 2% peptone and 1.3% agar and 50 ml/l of mineral solutions (Bertossi, 1959). Two ml of every sample, corresponding 40 l of air, were plated out on 8 dishes. Each dish was inoculated with 0.25 ml liquid medium; 4 dishes Sabouraud medium and 4 dishes fungus medium were used for each investigation. The bacteria and fungi were grown in the dark at two different temperatures: 24°C and 37°C, and the growth was controlled daily for an average of 20 days.

After a convenient period of growth, varying with the different organisms appearing in the Petri dishes, the bacteria and fungi were analyzed by light microscope and the number of colonies defined as colony-forming units (CFU/m³ air). When necessary subcultures were made and observed till the formation of asexual or sexual reproduction.

On the bacteria the Gram's method was applied.

RESULTS AND DISCUSSION

Data on airborne spores captured at Mount Cimone during period from February to July 1971 is given in Figs 1-4.

During an early period of sampling, air spora was also grown at 4°C, because in some preliminary experiments (carried out in July 1970 at Mount Cimone), the capture of a yellow-orange bacterium with an optimal growth temperature of 4°C took place. This bacterium was later identified as *Mycobacterium phlei*, a parasite of *Phleum alpinum*, a graminaceous plant characteristic of the mountain vegetation of the sampling area. Figure 1 shows the frequency of different taxa of fungi and bacteria through the whole sampling period.

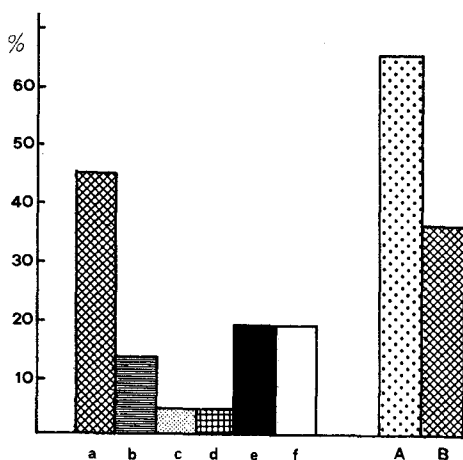


Fig. 1. Frequencies of *Penicillium* (a), *Aspergillus* (b), *Chaetomium* (c), *Alternaria* (d), yeasts (e), other fungi (f), gram-pos. (A) and gram-neg. (B) bacteria of the total sample.

Fungal air spora shows little variety: the genus *Penicillium* represents about 44% of all fungi, then *Aspergillus* about 12%, *Alternaria* and *Chaetomium* 3%; in addition to those we have detected several colonies of *Cladosporium*, *Scopulariopsis*, *Acremonium* and sterile mycelia.

Yeasts (19% of fungal colonies) were represented mainly by *Saccharomycetaceae* (80%), the remaining yeasts (20%) are asporigenous and probably also include some *Sporobolomyces*. Finally 65% of bacteria were found gram-positive and 35% gram-negative.

The composition of viable air spora captured on M. Cimone is quite different from that observed at lower altitudes (Davies, 1969; Hyde, 1969). Moreover the concentration of fungal spores and bacteria seems to be very low (Gregory, 1973) during all the sampling period: we counted on an average 100 CFU/m³ of air.

A very slow increase of concentration has been also observed from Winter towards Summer, probably connected with seasonal periodicity of air spora production and viability conditions (in March 60 CFU/m³, while in June 150 CFU/m³).

Figure 2 shows the frequency of fungi, yeasts and bacteria during three different periods: yeasts were calculated separately following a criterion adopted by many authors.

Although the sampling days have not been consecutive, the per cent increase of bacteria from February to July is evident, as well as the decreasing percentage of fungi and especially of yeasts, which disappeared found in the latest period.

A probable cause of the varying ratios of fungi, yeasts and bacteria during the three periods, may be due to different snow cover condition in the surrounding areas. In fact, during the period in which the zone around M. Cimone was completely snow capped, bacteria were practically absent in the examined air.

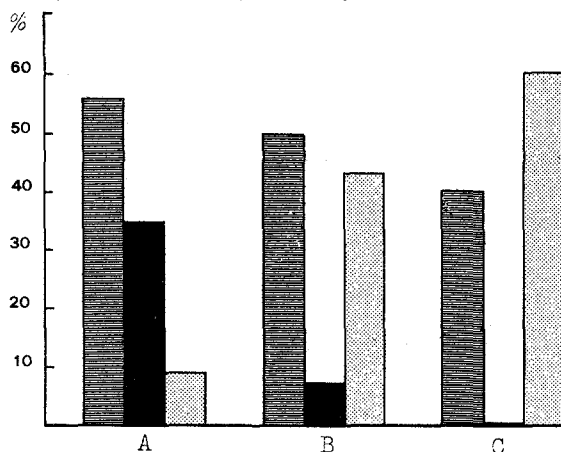


Fig. 2. Frequencies of fungi (lines), yeasts (solid) and bacteria (dotted), subdivided into 3 periods of sampling: 24 February-23 March (a), 31 March-2 June (b) and 3 June-8 July (c).

During the subsequent period, when the territory snow capped was reduced to 200 km², bacteria increased rapidly, and attained their maximum in the third period during which the snow was limited to the mountain massif (70 km²) and lasted till the beginning of June.

However the presence of fungi and yeasts, seems to be connected with other meteorological factors and to seasonal periodic variations. Besides the distribution of airborne micro-organisms should be examined over a greater period of time.

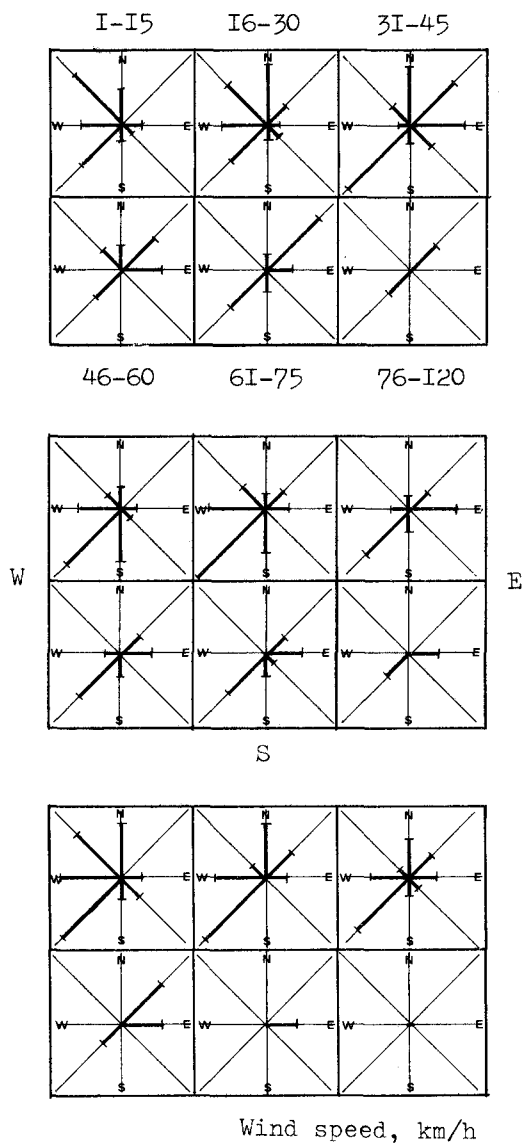


Fig. 3. Wind frequencies at M. Cimone during three periods of sampling (from on top to the bottom), with speed (km/h).

The winds prevailing in the three periods are from SW, NW and NE. The SW winds come from Sardinia, the Tyrrhenian and the West Mediterranean sea, while the NW and NE winds come from the Po plain and from the Northern Adriatic Sea. A wind of low force comes from the SE (Fig. 3) in correspondence to the Tuscan-Emilian divide of the Apennines.

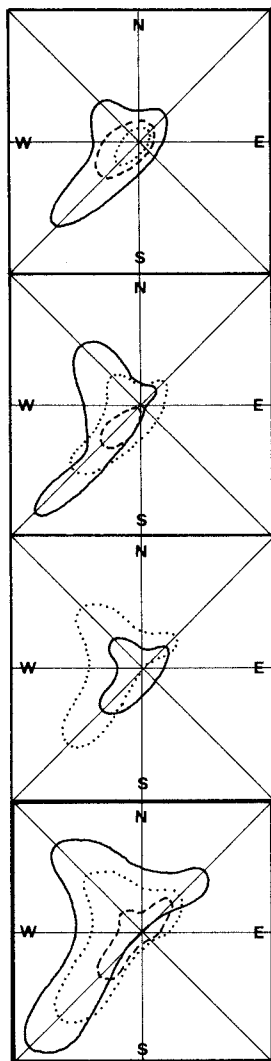


Fig. 4. Frequencies of fungi (—), yeasts (---) and bacteria (···) related to the wind rose. Sampling results for three periods with the sum total of sampling (bottom field).

It is possible to observe (Fig. 4) that while the presence of fungi (without yeasts) and bacteria in the air depends on the wind directions cited above, the yeasts are associated only with the SW and NE winds, that is with transport directions without relevant obstacles.

REFERENCES

- BERTOSSI, F. (1959) : L'acido 3-indolglycolico come regolatore naturale della crescita. N.G. Bot. Ital. n.s., 66: 497-505.
- DAVIES, R.R. (1969) : Climate and topography in relation to aero-allergens at Davos and London. Acta Allerg., 24: 396-409.
- GREGORY, P.H. (1973) : Microbiology of the Atmosphere, Leonard Hill.
- HIRST, J.M., STEDMAN, O.J. and HOGG, W.H. (1967): Long-distance transport spore: methods of measurements vertical spore profiles and the detection of immigrant spores. J. gen. Microbiol., 48: 329-355.
- HYDE, H.A. (1969) : Aeropalinology in Britain - an outline. New Phytol., 68: 579-590.
- MAMMARELLA, L., TARSITANI, F. and ZAIO, A. (1968): Studio delle infezioni aerodiffuse: metodi, apparecchiature e principi per il prelievo dell'aria da esaminare. Antol. Med. e Ig., 6: 3-24.
- MAY, F.G. (1958) : The washout of *Lycopodium* spores by rain. Quart. J. roy. Meteor. Soc., 84: 451-458.
- PADALINO, O., ANTONICELLI, M. and GRASSO, V. (1970): Biologia della *Erysiphe graminis* DC. f. sp. *tritici* Marchal nelle condizioni ambientali dell'Italia Meridionale. Phytopath. Mediterranea, 9: 122-135.
- ROSINSKI, J. (1966) : Solid water-insoluble particles in Hailstones and their geophysical significance. J. appl. Meteor., 4: 481-492.