

Measurement of allergens in the air, problems of currently used methods

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Measurements of airborne allergen like microorganisms and pollens can be divided into two phases:

- sampling of particles from the air
- analysis of the collected sample

In the following, the methods of sampling will be focused while discussions on the methods of analysis will be limited to the traditionally used »viable count» and »total count».

The principles for sampling airborne particles are few according to aerosolphysics (Table 1). Impaction is the most used. Here an airstream of high velocity is directed

against the surface. Due to the inertia particles in the air stream are struck against the surface while the air stream is bent off. The surface could be solid (glass, metal, agar etc) or liquid.

In the Anderson sampler particles are impacted on solid surfaces. The particles are separated on six stages according to their size. In the slitsamplers particles are collected on a rotating agar surface which will result in variation of particle concentration in air with time. In spore traps, pollen and spores are often collected on a slowly rotating tape.

Table 1
Sampling principles for airborne particles and microorganisms.

Sampling principle	Type of apparatus	Equipment
<i>Impaction</i>		
- solid surface	aeroscope rotorod slitsamplers cascade impactors centrifuges spore traps precipitation	BIAP, Bourdillon, Casella Andersen, May impactor Wells aircentrifuge, Reutercentrifugal-sampler Hirst spore trap, Burkard spore trap Thermal, Lovelace, Electrostatic TSI 3200
- liquid	cyclones impingers	Porton, FOA-cyclone Allglass, Midget, Greenburg Smith, Marx, Multistage, Bubblers
<i>Filtration</i>	fiberfilters membranefilters	glassfiber Millipore, Sartorius
<i>Deposition</i>	gravity surfaces traps elutriators	petri dish, gravity slide Tauber, Durham Vertical elutriator

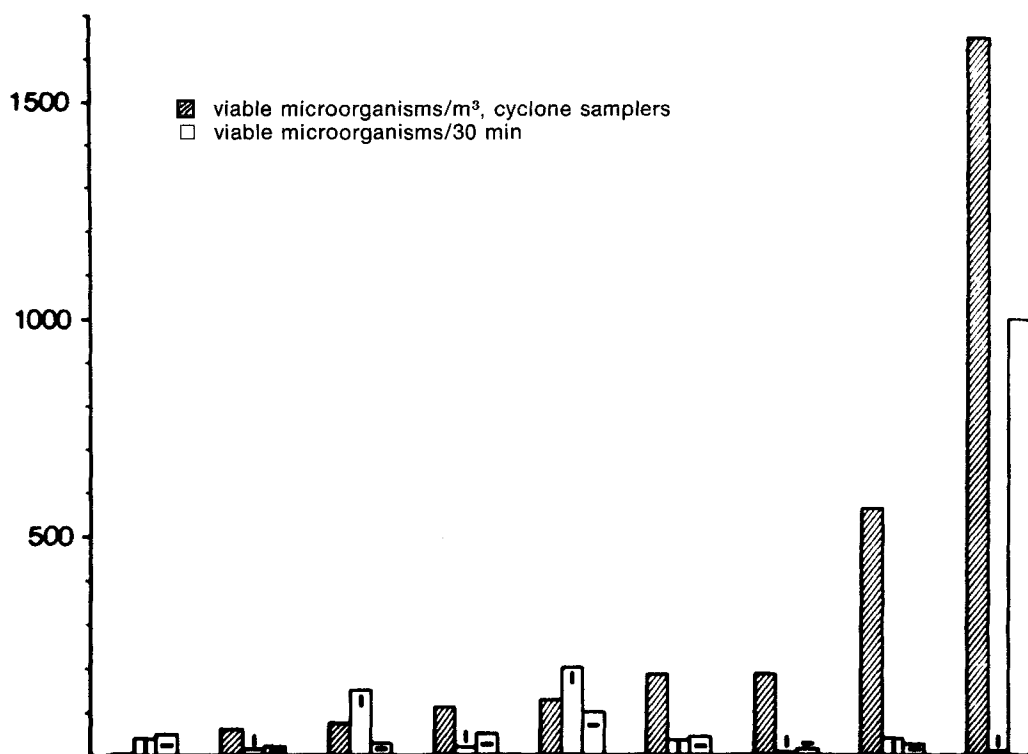


Fig. 1. Comparison of the sampling efficiency between cyclone sampler and «settling plates». The settling plates has been exposed in both horizontal (—) and vertical (l) position.

Sampling in liquid can be done in two principally different ways. In a cyclone sampler the particles are collected on a continuously replaced water film on the cyclone wall. This means that particles in a large air volume will be concentrated into a small liquid volume, and that the liquid can be divided into portions according to time. In the impingers the particles are impacted in a fixed, comparatively large volume of liquid. If the amount of particles in the air is low this means that a concentration step may be necessary before the analysis take place.

Filtration is another sampling principle. In this case, the air is sucked through a filter with such pore size that the relevant particles do not pass the filter. Different materials are used, such as cellulose, gelatine and different types of plastics. Gelatine filters are soluble in water, which means

that analysis could be done in a liquid sample. Some filters can be made transparent so that microscopic analysis could be made directly on the filter.

A third sampling principle is the so called «sedimentation» on different types of surfaces. In this case the particles cannot be related to any defined volume of air. «Sedimentation» is not a correct expression. Particles that are of interest in allergologic connections are in most cases so small that they will sediment only with a negligible speed. The particles that are collected on a settling plate are instead attached to the surface mainly by electrostatic forces and/or by impaction due to turbulent airstreams. This means that the amount of particles collected on a plate should be independent of the direction of the settling surface; and that seems to be the case (Figure 1). In the figure it is also shown that a comparison between

a volumetric sampling and »settling plates» in some cases gives similar results, but in other cases not. Thus, the reliability for this method is low.

There have been many reports on the content of allergenic particles in the air and especially concerning pollens and micro-organisms. However, today it is impossible to compare results from different investigators other than in a very general manner. This is partly due to genuine problems, but also to unawareness of the importance of a very thorough description of the material and the methods used. Both the sampling and the analysis procedure as well as the collecting strategy are often very briefly described.

Three important reasons for the varying results are: the variation in airborne particle concentration over time and location in the room, different efficiency and behaviour of different sampling apparatus and finally the different analysis procedure of the collected sample.

Due to air currents, ventilation and activities in an environment the particle concentration on one special place may vary very much and very fast; the result from one sampling taken not long after another may give quite different results. Two samplers running at the same time rather close to each other often give different particle values, which indicates a complex concentration pattern in many environments. A smoke generation may reveal the situation in a certain case.

Efficiency studies based on a comparison

of different samplers, is not a simple investigation. It can be shown that the relative efficiency between two types of apparatus is not a constant factor, but varies with meteorological conditions, e.g. wind speed and particle size profile in the sampling place (Table 2). Beside that, different commercial sampling apparatus may use different basic principles for particle collection and they are often adjusted to one type of analysis. Sampling on solid surfaces will in principle give an answer that tells how many single particles and particle aggregates there are in a sample. Sampling on solid surfaces is often simple and convenient but one sample can be used only for one type of analysis. On the other hand, if the airborne particles are collected in a liquid the particle aggregates often break up and the sample will in principle represent the total amount of single particles. A liquid sample can be used for many different types of analyses but the handling is more complex.

There are many methods for analysing a sample. For larger allergens like pollens, total count in a microscope has been the most used method while for smaller cells like fungi and bacteria, viable count on agar plates tends to dominate. In theory a higher count should be expected using total count. In practice this is not always the case due to problems in evaluating the total count in a microscope. Viable count estimations are of course restricted to viable organisms but further more different nutrient media as well as the conditions for growth will have

Table 2
Efficiency testing by comparing different airsampling apparatus.

Test sampler x %	Reference sampler 100 %	Environ- ment	Number of measurements				$\bar{x} \pm$ —	n
			~ 50	50-100	100-200	200-		
Andersen	Andersen	laboratory		17	17		100±3	34
Andersen	Andersen	cowshed	1	12	19		105±6	32
Cyclone	Andersen	animalquater	1	2	12	5	188±34	17
Cyclone	Andersen	country	5	12	15	17	255±54	47
Cyclone	Andersen	cowshed	2		1	54	1995±143	56

a great impact on the results. The problem how to measure small allergenic fragments has not been satisfactorily solved, although specific immunological methods are now under development.

It is thus difficult to compare results, even if similar techniques are used and it is almost impossible when both the sampling and the analysis technique differ (Figure 2).

To get better possibilities in the future to measure allergens in the air and to compare different published results there should be an effort to develop standardized procedures for different measuring situations. Considerations should be taken to e.g. type of environment, expected number of particles and type of allergen to be measured.

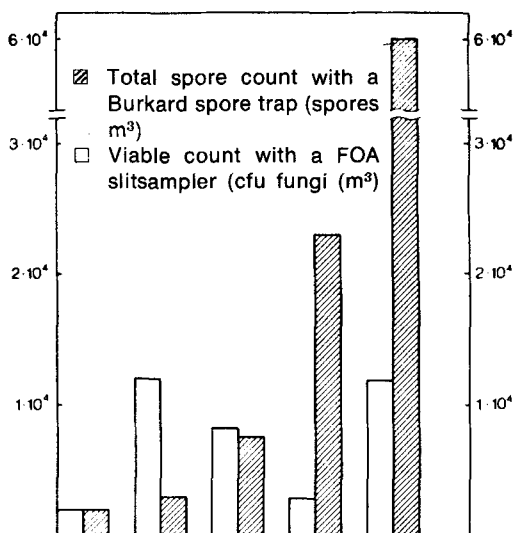


Fig. 2. Comparative results using two different methods of sampling fungi.

REFERENCES

- Batchelor, H. W. »Aerosol Samplers», Adv. in Appl. Micro., 2 (1960) 31–64.
- Blomquist, G., Bovallius, Å., Bucht, B., Häggerström, B., Möller, Å.L. »Provtagning av mikroorganismer i luft». Arbete och Hälsa. Vetenskaplig skriftserie 1983: 4, Arbetarskyddsverket. (In Swedish)
- Bovallius, Å., Bucht, B., Roffey, R., Ånäs, P. »Three year investigation of the natural airborne bacterial flora of four localities in Sweden». Appl. Environ. Microbiol. May (1978) 847–852.
- Davies, R. R. »Air Sampling for fungi, pollens and bacteria», in Methods in Microbiology (ed Both C) 4 (1971) 367–403.
- Dimmick, R. L., Akers, A. B. »An Introduction to Experimental Aerobiology». Eds: R. J. Heckley, H. Wolochow. Wiley-Intersciences.
- Edmonds, R. L. »Aerobiology. The Ecological systems Approach». (1979) Dowden, Hutchinson and Ross, Inc., Stroudsburg Pennsylvania.
- Gregory, P. H. »Microbiology of the atmosphere». 2nd edition, (1972) Leonard Hill.
- Henningsson, E. »Sammanställning av apparatur och metodik för provtagning och analys av luftburna mikroorganismer». FOA report C 40131-B1 (1981) FOA, Umeå, Sweden. (In Swedish)
- Henningsson, E., Bovallius, Å., Roffey, R. »A comparative study of sampling apparatus for microorganisms in air». The 4th Nordic symposium on Aerobiology held at Bergen, May 1980. Grana 20 (1980), 155–159.
- May, K. R. »Air Sampling». From the book »Airborne Microbes». 17th Sympos. of Soc. for General Microbiology, London 1967. University Press. Cambridge (1967).
- Micro-Organisms as an occupational hazard. A report on needs for research in the medical field. Arbetarskyddsfonden, Stockholm, Sweden.
- Suldrup-Larsen, L. »A Three-Year-Survey of Microfungi in the Air of Copenhagen 1977–79». Allergy 36 (1981) 15–22.