

The spectrum of allergenic pollens in Italy

A computerized method of aerobiological monitoring

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The monitoring of airborne pollens that provoke allergy is of interest to clinicians to enable them to correlate chronologically the relationship between pollen concentrations in the atmosphere and the symptoms of patients with pollen-related allergies. In Italy there are now 60 centres for monitoring airborne allergenic pollens, the data from which are compiled and filed using software developed by the Italian Association of Aerobiology (AIA) and run on personal computers. These data are then fed into a central data bank to which all centres have access. This information system makes it possible to achieve the following objectives: 1) to standardise monitoring methods, 2) to recognise varieties of pollen that cause allergies, 3) to improve the exchange and comparison of information among operators by compiling the results in graphs, and 4) to notify clinicians about atmospheric concentrations of allergenic pollens so that improved therapy can be provided.

Key words: allergy; data bank; hay fever; pollen counts; pollen season.

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CLINICAL ASPECTS

Pollen-related allergies are extremely common in Italy, and the number of pollen-allergic patients varies between the various regions. *Gramineae* are the most common pollens in northern and central Italy (more than 60% of patients have pollen-related allergies). *Parietaria* pollen is more common in the south, especially as cause of respiratory allergies (rhinitis and asthma). Clinicians have access to all the data gathered by the centres for monitoring airborne allergenic pollens. The data are then compiled and elaborated and fed into a national data bank.

The sampling and counting of airborne pollens have enabled medical staff to establish the chronological correlation between pollen concentrations in the air and the development of symptoms in patients sensitive to these pollens (5, 13, 22, 26-29).

The Italian aerobiological monitoring network, co-ordinated by the Italian Association of Aerobiology (AIA founded March 1985), started with eight centres in 1980 and now has a total of 60. The data collected by these centres are compiled and elaborated by the Department of Biological Data Processing at Lofarma Allergeni, Milano. The findings are published in Italian medical journals such as

Corriere Medico, *Medicus* and *Il Giornale del Medico* which have a large readership among the medical profession.

AIA has imposed fixed standards for the sampling equipment and the sampling procedures. Standards have also been introduced for pollen counting, for identifying allergy-provoking pollen particles, and for calculating their concentration in the air.

At the same time, AIA has put forward suggestions for the use of personal computers combined with a software package designed for gathering, elaborating and filing local data on pollen concentrations (3, 10, 16, 18). An integrated aspect of the software package is



Fig. 1. Map showing the location of Italian cities and towns with pollen monitoring stations.

the systematic collection and filing of meteorological data concerning the microclimate of each monitoring centre. This information is collected at the same time as the aerobiological monitoring.

On the basis of this data, it is possible to study the correlations between meteorological conditions and the variations in pollen concentrations so as to determine and foresee the high-risk periods for patients sensitive to pollen-related allergies (1, 4, 7, 8, 9, 14, 15, 19, 23, 24, 25, 28).

MATERIAL AND METHODS

Pollen counts

The geographical locations of the cities and towns with monitoring centres are shown in Fig. 1. The data is recorded by using sampling equipment which is either of the Burkard's volumetric type or the VPPS 2000 (Lanzoni-Bologna Italy) which gives a 7-day

recording period. These two models of Hirst-like pollen traps have the same level of efficiency and the same design characteristics.

The pollen traps are placed on roof-tops at about 15–20 m above ground level, at which height they give a true recording of the average local pollen distribution. The traps simulate normal breathing patterns. Air is sucked in by a pump at the rate of 10 l/min (14.4 m³ every 24 h). The aperture (2 × 14 mm) permanently faces the direction of the wind by means of a specially made rotating air vane. The sucked in airborne particles are deposited on an adhesive ribbon that moves at the rate of 2 mm/h and is mounted on a drum that revolves at 2 mm/h inside the trap. The ribbon, which is changed each week, is divided into seven segments of 48 mm each of which corresponds to a single day's sampling. The segments are fixed on slides covered with a thin layer of glycerol jelly, coloured with fuchsine, and another slide placed on top.

The daily pollen count is carried out by using an optical microscope for measuring

tangential fields. The surface area under inspection is calculated by multiplying the area of the single microscopic field by the number of circles for each strip. An algorithm is used to calculate a conversion factor which considers the area of the microscopic field, the enlargement adopted, and the number of strips under examination. This value, which is multiplied by the number of particles counted, gives the average concentration per cubic meter air. The average daily concentration for each cubic meter air equals

$$P \times \frac{672 \text{ mm}^2}{((0.29 \times 0.29 \times 3.14) \times 4 \times 82.75)} \times \frac{1}{14.4} =$$

$$= P \times \frac{672}{87.33} \times \frac{1}{14.4} = P \times 0.53 = \text{"conversion factor"}$$

where 672 mm² is the total surface area of the sample (14 × 48 mm), (0.29 × 0.29 × 3.14) the area of a single microscopic field, 4 the number of strips examined, and 82.75 the number of tangential fields for each strip that is obtained by dividing 48 mm by 0.58 mm (diameter of the microscopic field used by the operator). The examined area is 87.33 mm², i.e. more than 1/8 (13%) of the sampling area.

Aerobiological software

Elaboration of data at the local level. Each monitoring center has a series of specialised programs on floppy disks commissioned by the Italian Association of Aerobiology. Each program, which is in Basic, can be summoned by using one or more menus (see Table 1) that clearly and concisely indicate the possible options, together with the way to select them. In this way, operators who have not been trained in the use of computers are able to use these user-friendly applications (2, 11, 12, 17). The menu for compiling local data has the following items:

A) *A program which allows the operator to personalise the software package* so that he is able to

feed into the personal computer the data concerning his own monitoring centre, followed by particular information about the equipment and method of reading the data, together with the parameters used, so that the computer is able to work on the unprocessed data in order to arrive at elaborated output. Both the kind of data to be fed in, and the method and sequence are proposed by the computer on entering the data. The software also controls, as far as possible, the correct manner of feeding in the data in order to diagnose possible errors during entry procedures.

B) *Program for guided and controlled entry* of unprocessed pollen count data from the slide readings, which are divided into the relevant values for each day of the week (Table 2).

C) *Program for processing data*, at a local level, which are collected and filed. From these data, keeping in mind the parameters described in point A, the computer calculates the pollen concentrations/m³/day and then gives the average weekly values (Table 3). These data are filed in the computer's memory and transmitted to the Central Data Bank for filing, and if necessary, for publication in the media.

D) *A search/retrieval program* used with the computer's historical files to enable a statistical comparison with subsequent readings in order to graphically represent the relevant data and trends. By doing this, it is possible to compare present data with that of previous observation periods and with data for the same period in previous years.

E) *Statistical programs* for processing and comparing also graphically, the data from each monitoring centre with that of the other centres. These data are supplied both by the regional and central data banks.

Remote processing

The principal aim of the Aerobiological Information System is to gather data from the

Table 1

Some menus. A: main menu; B: inquiry menu (1st level); C: inquiry menu (2nd level); D: tables menu

ITALIAN ASSOCIATION OF AEROBIOLOGY

PROCESSING OF POLLEN COUNTS

- 1 Sampling station parameters
- 2 Weekly data input
- 3 Database query
- 4 Tables displaying
- 5 End

A

DATA BASE QUERY

- 1 Data selection by Equipe (all monitored pollens)
- 2 Data selection by single pollen and Equipe code
- 3 End

B

DATA BASE QUERY

- 1 Total graph of week's average values
- 2 Single graphs of daily values
- 3 Table of highest, lowest and average values in each month of the year
- 4 End

C

TABLES DISPLAYING

- 1 Equipes
- 2 Periods
- 3 Pollens
- 4 Sampling points
- 5 End

D

Table 2
Input of raw data

AEROBIOLOGICAL MONITORING Number of pollens counted on slides							
Equipe: M13 Cinzia BUTTI MILANO SUD Year: 86 Month: 07 Period: 4 from 28/ 7/86 to 3/ 8/86							
	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
1 Betulaceae	0	0	0	0	0	0	0
2 Compositae	7	16	18	13	7	28	40
3 Corilaceae	0	0	0	0	0	0	0
4 Fagaceae	9	6	5	7	3	4	2
5 Gramineae	45	24	29	23	16	14	25
6 Oleaceae	0	0	0	0	0	0	0

samples performed by Pollen trap
the values are referred to NUMBER OF POLLENS PER DAY

Table 3
Display of computed concentrations/m³

AEROBIOLOGICAL MONITORING								
Atmospheric pollen concentration per m3								
Equipe: M13 Cinzia BUTTI MILANO SUD								
Year: 86 Month: 07 Period: 4 from 28/ 7/86 to 3/ 8/86								
	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	average
1 Betulaceae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
2 Compositae	4.8	11.1	12.5	9.0	4.8	19.4	27.7	12.75
3 Corilaceae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
4 Fagaceae	6.2	4.1	3.4	4.8	2.0	2.7	1.3	3.5
5 Gramineae	31.2	16.6	20.1	15.9	11.1	9.7	17.3	17.41
6 Oleaceae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00

samples performed by Pollen trap
the values are referred to POLLENS PER CUBIC METRE of air

single centres and feed them into the National Data Bank. The results of data processing are then returned to the users of the system. The fact that the data is renewed weekly and because of the media requirements an off-line link between monitoring centres and the National Data Bank seems unsuitable, particularly when considering the collection of data. Although elaborated data is transmitted by periodically forwarding both graphs and tables, there are reasons to believe that also in this case an on-line link would be preferable.

The presently available professional personal computers function effectively as remote terminals for central mainframe computers via the

normal telephone lines that utilize either a modem or sound-coupling machine (12, 21).

The limited volume of data relayed during each transmission allows for satisfactory functioning and the time needed is acceptable even with low-speed 300 baud transmission lines relaying over normal telephone lines.

For remote link-ups each user has at his disposal the following:

- A) *Programs for defining* or varying the transmission parameters;
- B) *Programs for automatic relaying* of data, either singly or in batches, to regional data banks and the National Data Bank;

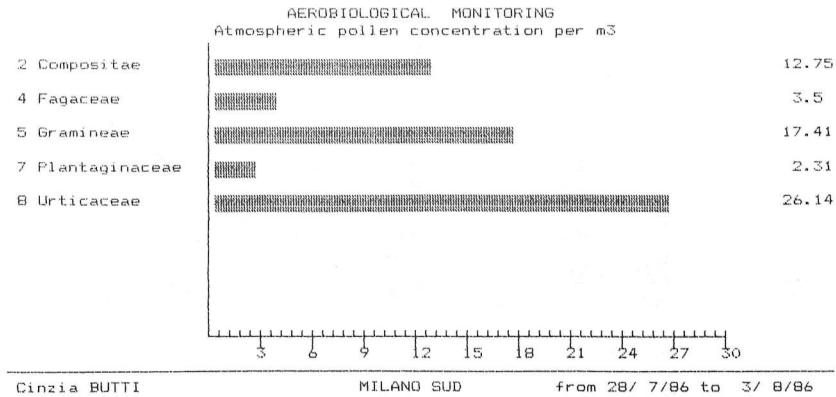


Fig. 2. Graph of pollen concentrations in a single week. Pollens not found are not displayed (Station of Milano Sud).

C) *Programs for the reception of data from regional and national data banks.*

The single regional centres are linked to the National Data Bank to which they relay the collected data or obtain the results both of the elaboration of data and the specific enquiries made to the centralised files.

The linking to the National Data Bank is carried out according to a precise time-schedule and a precise procedure.

The regional and national centres which function as data banks also have at their disposal a custom-made software package for statistical elaboration of the collected data, and can thus compile and distribute the data concerning the tendency within their catchment area.

Hardware requirements

The following hardware requirements are suggested:

- An IBM or IBM compatible Personal Computer
- An operating system MS DOS (2.00 or the latest up-dating of this system)
- At least 256 KB RAM of memory
- Two floppy disk drives of 360 KB or hard disk
- A monitor, preferably colour
- Printer with graphic facility is recommended.

RESULTS

The electronic elaboration of data relating to pollen counts has enabled the system operators to calculate the concentrations of particles/m³ much faster and more accurately than the manual procedure of multiplying single values by the conversion factor, which was usually approximated, to make calculation easier. Also with the computer system, data can be stored on magnetic disks in such a way that they are permanently available, in real time (20, 21).

The data are fed into the network from all the monitoring stations and from some of the regional data banks which are strategically located in various catchment zones, to centre on the National Data Bank.

The National Data Bank is able to supply specific data: graphs showing the correlation and comparison of data from many monitoring centres and/or different periods. These graphs indicate tendencies and are of interest not only to the operators in this field, but above all to clinics, where great importance is given to the levels of pollen concentrations in the diagnosis and treatment of pollen-related disease.

The establishment of the National Data Bank is undoubtedly the most significant result of the project for computerising pollen count procedures. Italy now has a more diverse network of monitoring centres and is collecting data on a larger scale than anywhere else in Europe.

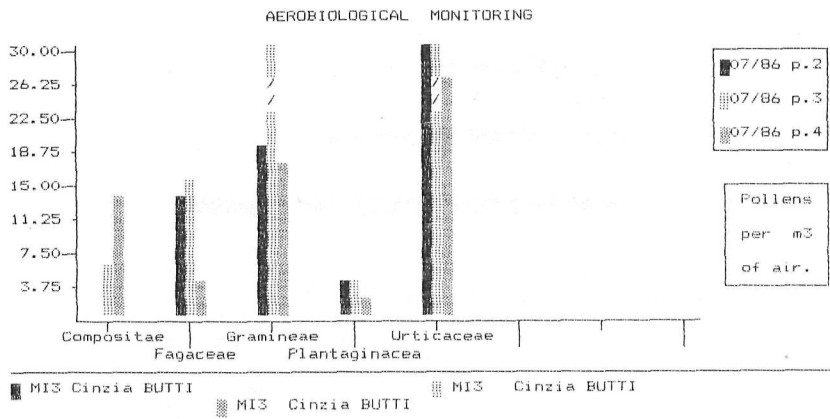


Fig. 3. Comparison between data from three consecutive periods of sampling (Station of Milano Sud).

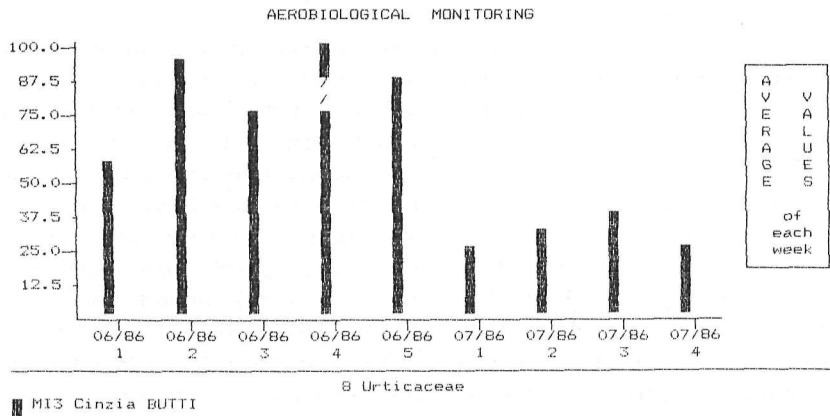


Fig. 4. Trend of concentrations of a single pollen in a 2-month period (9 consecutive weeks). This graph can be obtained by selecting item 2 in menu B and item 1 in Menu C (see Table 1) (Station of Milano Sud).

Beside containing all the data for 1987 (update on a weekly basis from the various monitoring centres, often via modem in real time) the Data Bank also has the data for 1985 and 1986. Equally important are the results individual computer users derive from access to the network using the specific software package MAP - Monitoring Airborne Pollen, which is a new type of application in this field (10, 16, 18).

The users of the system have welcomed the possibility of visualising data in graphs as these give immediate indication of the increase or decrease of particular types of pollen in the

weekly data (Fig. 2). Another important feature is the possibility of having graphs comparing different series of data. Fig. 3 shows a comparison of all major types of pollen in three consecutive periods at the same monitoring centre: a similar bar graph using three different colours can be produced to compare the findings of a single week in three different centres.

With the graph in Fig. 4 it is possible to plot the concentration levels of a single type of pollen during a 2-month period by visually comparing the vertical bars corresponding to the average values for the 9 weeks under consideration.

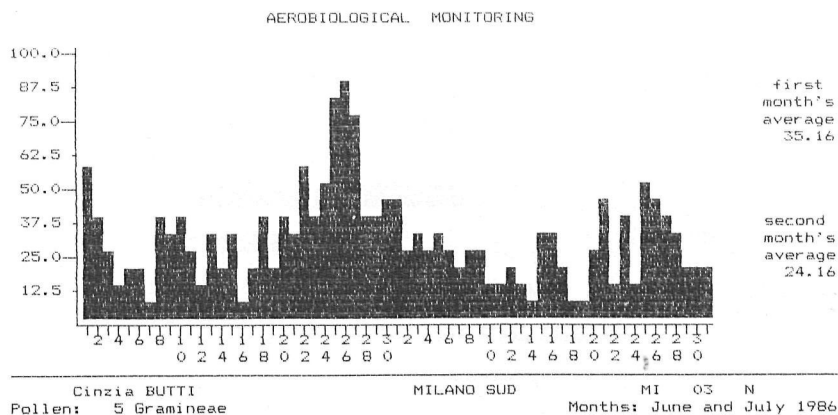


Fig. 5. Single graph of daily concentrations of a single pollen during a period of 2 months (Menu B - item 2; Menu C - item 2) (Station of Milano Sud).

The graph in Fig. 5 shows the daily pollen concentrations over a period of 60 days: the peaks are clearly seen even on a curve which is irregular and jagged. A more regular curve is seen by presenting mean values rather than daily values.

DISCUSSION

Systematic and comprehensive collation of data over a number years for the whole country by computer allows precise presentation of phenomena and prompt interpretation of graphs. This enables objective verification of what has been perceived intuitively and demonstrated empirically.

Pollen calendars have thus been perfected which give specific geographical data about the distribution of the particular strains of pollen that are highly allergenic in a given area. Finally, it is possible to compare pollen data with meteorological data, and on the basis of past phenomena to make accurate forecasts, thus allowing clinicians to introduce the best possible preventive treatment for allergic patients.

The aerobiological monitoring of allergenic pollens has revealed differences and discrepancies between flowering periods in different geographical areas (Fig. 6: pollen calendar for northern and southern Italy). Allergic sensitivity to *Gramineae* is prevalent in northern and central Italy with the exception of Liguria

where the incidence is lower due to the Mediterranean climate. The maximum flowering period for *Gramineae* is almost the same in both areas. The flowering period starts in May in northern and central Italy and in the middle of April in the south. Flowering continues until the end of June, then decreases in July and August and reaches a new but generally lower peak between the end of August and September, especially in northern Italy. The average values of *Gramineae* pollen concentrations in the atmosphere are much lower in the south as the average temperature is higher and the grasses dry more rapidly.

Parietaria pollens are more prevalent in the Mediterranean climate of southern Italy (3, 4) where the plants grow on walls and under trees and bushes. *Parietaria* has two long flowering cycles. The pollen first appears at the end of the winter and persists throughout the spring and summer months, often reaching peak levels at the end of May and beginning of June. A second generally lower peak is often recorded during the autumn months after which it diminishes until it disappears during the colder months of December and January.

Notably lower concentrations are found for other pollens in Italy. Among the *Compositae* only mugwort reaches concentrations higher than 50 pollen particles/m³ and then only in the last week of August and the first few days in September.

In the south the most important allergenic

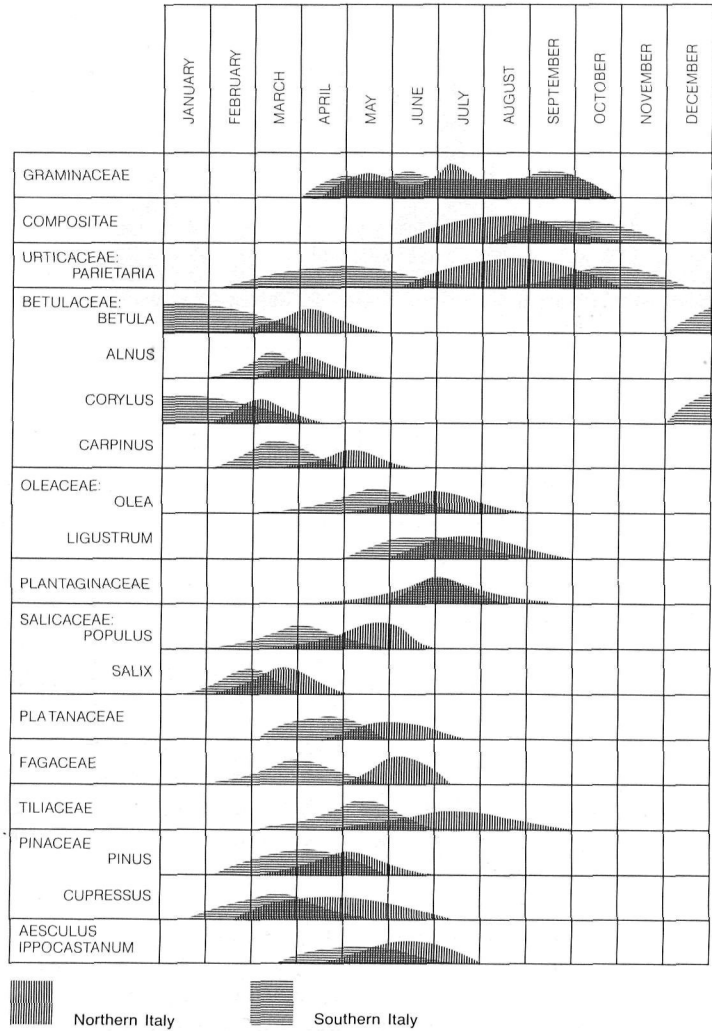


Fig. 6. Pollen calendars in Italy for geographic areas (north/south). A calendar unifying the data from cities with different latitudes and different climates will inevitably be indicative.

tree pollen is *Olea europaea*, while in the north are high concentrations of *Betulaceae* pollens.

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