

AIR-BORNE FUNGI IN THE AIR OF BARCELONA (SPAIN). IV. VARIOUS ISOLATED GENERA

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Abstract

During a two-year survey on the air-borne fungi in the atmosphere of Barcelona (Spain), the following genera were isolated in decreasing order: *Aureobasidium*, *Rhizopus*, *Mucor*, *Arthrinium*, *Phoma*, *Fusarium*, *Trichoderma*, and *Botrytis*.

Introduction

In a previous paper (10), the authors carried out studies on the air-borne fungi in the air of Barcelona metropolitan area, reporting as the most frequently isolated genera the genus *Alternaria*, *Cladosporium*, *Penicillium* and *Aspergillus*. The present study deals with those genera which showed a frequency of incidence not below 0.1 % of the total colony counts, and whose implications with human health are well established. The isolated genera were found in decreasing order of frequency as follows: *Aureobasidium*, *Rhizopus*, *Mucor*, *Arthrinium*, *Phoma*, *Fusarium*, *Trichoderma*, and *Botrytis*.

Material and methods

The sampling method employed in the study was the volumetric technique in which the spores entering a narrow orifice by means of an air stream produced by a small electric ventilator were impacted on a Petri dish coated with a proper medium. The medium utilized was 2 % malt extract agar (10).

Results and discussion

The genus Aureobasidium Viala et Boyer.

Aureobasidium spores are frequently isolated from the atmosphere. Morrow (41) concluded from his own investigations that isolates of the genus could be encountered in all towns and habitats, but in low percentage of incidence. Among the volumetric studies on the spore content in the air of this genus, the most important ones are those of Barkai-Golan *et al.* (5, 6, and 7), Kramer *et al.* (34, 35, and 36), and Ongulana (44). The frequency recorded by these authors oscillated between 5 and 7.2 % of the total colony counts. These figures are in good agreement with our data in the air of Barcelona: 6.6 % of the total colony counts. On the other hand, similar studies carried out in France by Boutin (9), using gravimetric methods of sampling, showed that the incidence of *Aureobasidium* spores in the air of Marseille was 2.9 % of the total colony counts.

Isolates of this genus are very commonly encountered in the Northern European countries, accounting for a 10 % in the air of Stockholm (Sweden) (27), a 18 % in the air of Copenhagen (Denmark) (19, and 20), and 10.4 % in the air of Cardiff (U.K.) (29, 30, and 31). The maximum concentration of *Aureobasidium* spores was found in Stockholm to be during the spring and autumn (49) and in Copenhagen during the months of September and October (19, and 20).

Flensburg *et al.* (20) in Denmark, Hyde *et al.* (30 and 31), Richards (48), Adams (1), and Harvey (26) in Great Britain, while studying the relationship between

the life cycle of *Aureobasidium* species and the climatic factors, found that the highest incidence of spores occurred during the summer and autumn months, while the lowest incidence could be observed during the winter months.

In Italy, Caretta et al. considered this genus as being frequently isolated in the air of Pavia (13), reporting a 0.35 % of the total colony counts.

In the various surveys carried out in Spain by several authors, this genus was only cited in the air of León (3), accounting for a 0.5 % of the total colony counts.

In Perú, Requejo (46) isolated spores of this genus more frequently during the winter months in the air of Trujillo, reporting a 0.45 % of the total colony counts.

In the United States, the genus *Aureobasidium* has been reported in the air of Phoenix, Arizona (24) and Albuquerque, New Mexico (16), accounting for a 15.2 % and 8.4 % of the total colony counts respectively.

Our own findings in the air of Barcelona, along a 18-months study showed that the incidence of *Aureobasidium* spores was found to be at a steady rate, accounting for a 6.6 % of the total colony counts. The species identified was *Aureobasidium pullulans* (de Bary) Arnaud.

The genus Mucor Micheli.

The species of the genus *Mucor* occupied the ninth rank among the most frequently found isolates during our two-year survey, representing in the air of Barcelona the 0.74 % of the total colony counts. Colonies of species of this genus were found in the 13.46 % of the exposed plates.

Studies on the presence of the genus *Mucor* in the air carried out by various authors in different countries showed variable results. Feinberg (1) found that isolates of this genus occupied the eighth rank in frequency among other genera of fungi isolated in the air of Chicago, Illinois. Hyde et al. (29, 30, and 31), studying the spore content in the air of Cardiff (U.K.), reported figures of incidence of isolates of this genus quite similar to our findings in the air of Barcelona. In the air of Pavia, Italy (13), the isolates of this genus accounted for a 0.51 % of the total colony counts, while in Copenhagen, Denmark (19, and 20) and in Paris, France (56), isolates of *Mucor* species were rarely reported. Similar studies carried out by various authors in Spain (3, 10, 12, 14, 15, 22, 23, and 40) showed that spores of this genus were present in the air of most Spanish towns under study, but Madrid and Barcelona attained the higher records of incidence with 0.71 % of the total colony counts. Papavassiliou

et al. (45) reported an incidence of *Mucor* spores in the air of Athens, Greece accounting for 1.26 % of the total colony counts. Similar studies carried out in the metropolitan areas of Albuquerque, New Mexico, (16) and Phoenix, Arizona (24) did not detect any presence of species of *Mucor*. However, a 0.45 % of incidence of *Mucor* spores was found in the air of Trujillo, Perú, (46). The air of Kuwait, Arabia (42), was reported to present an incidence of 0.1 %.

Most of the studies on aeromycology already cited were performed by the gravimetric techniques, not being then quite comparable with our own. Ongulana (44), using the volumetric methods did not find any incidence of *Mucor* spores in the atmosphere of Ibadan, Nigeria. However, the incidence of spores of this genus in the air of Israel (5, 6, and 7) was found to be 1–1.5 % of the total colony counts.

The species of *Mucor* identified in our study were *Mucor circinelloides* van Tieghem and *M. hiemalis* Wehmer.

The genus Rhizopus Ehrenberg.

The genus *Rhizopus* has rarely been reported in aeromycological surveys in the various study areas of the world. It is not abundant in the air of towns. Hyde (29, 30, and 31) reported its presence in the air of Cardiff (U.K.), where it occupied the 13th rank in order of incidence among other isolated genera. A very low incidence of isolates of this genus was reported in the air of Paris, France (52), and no reports of incidence of isolates of *Rhizopus* can be found in other studied French towns as Marseille (37), Lyon and Briançon (9). Kramer et al. (34, 35, and 36) reported an incidence of isolates of this genus accounting for a 0.1 % of the total colony counts using the volumetric methods. Barkai-Golan et al. (5, 6, and 7) with the same sampling techniques, reported the presence of *Rhizopus* isolates in the air of Israel.

The frequency of isolates of *Rhizopus* in the air of Barcelona was found to be 0.19 % of the total colony counts, ranking the 6th among the most frequently encountered genera. The only species isolated in this study was *Rhizopus stolonifer* (Ehrenberg ex Fresenius) Lind.

The genus Arthrimum Kunze ex Fresenius.

This genus is easily distinguished by the dark, one-celled, distinctively shaped conidia with a pronounced hyaline rim or germ slit. Highly refractive septa are also

characteristic of the genus.

The genus *Arthrimum* occupied the 10th rank in order of frequency in the air of Barcelona, accounting for a 0.4 % of the total colony counts. It was isolated in the 6.16 % of the exposed plates. The only species identified was *Arthrimum phaeospermum* (Corda) Ellis.

This genus was reported in low incidence in the air of Manhattan, Kansas (34, 35, and 36), and in the air of Israel (5, 6, and 7).

The genus Phoma Desm.

The genus *Phoma* occupies a distinguished place in aeromycological studies. However, Feinberg et al. (18) reported a low incidence of 0.4 % in the air of Chicago, Illinois. On the other hand, Sorenson et al. (51), studying the aeromycology of five sites in the continental United States and Puerto Rico reported incidences which were oscillating between 1.6 and 8.8 %. In Denmark, Flensburg et al. (19 and 20) found an incidence of isolates of the genus accounting for the 1.5 % of the total colony counts with the highest peaks in March and October and high values in August in the air of the metropolitan area of Copenhagen. Isolates of *Phoma* occupied the 4th rank in incidence among other isolates in the air of Cardiff (U.K.) (29, 30, and 31), with the highest peaks in April. The genus represented in the air of Paris (France) (52) the 5.5 % of the total colony counts. In Italy (59) the months of November and December showed the maximum of incidence. Kramer et al. (35 and 36) found that isolates of *Phoma* in the air of Manhattan, Kansas occupied the second rank in order of incidence among other genera of sphaeropsidales isolated with the genus *Coniothyrium* in the first place. The studies carried out in Israel (5, 6 and 7) showed incidences quite similar with those found in the air of Barcelona, which were of the order of 1.6 % of the total colony counts. The genus *Phoma* occupied the ninth place in order of incidence among the other genera isolated in the air of Barcelona, and the most frequently found species was identified as *Phoma herbarum* Westd.

The genus Fusarium Link.

The genus *Fusarium* has generally been reported by various authors with a low incidence. Morrow (41) found that isolates of the genus appeared seasonally, with maximum incidences during the summer months. March, April and May, on the other hand, were found to be the months of maximum incidences in the air of Pau (France)

(9). Isolates of the genus *Fusarium* were found in low percentages in the air of Paris (France), Lyon (France), Briançon (France) (9), and Marseille (France) (37), were the incidence of isolates, accounting for a 0.15 % of the total colony counts, presented similar values with those found in the air of Barcelona. A low incidence of this genus were also reported in the air of Manhattan, Kansas (34, 35, and 36) and in the air of Israel (5, 6, and 7), using the volumetric sampling techniques. On the other hand, high incidences of *Fusarium* isolates have been reported in the air of Madrid (Spain) (12). Requejo (46), studying the spore content in the air of Trujillo (Perú), found a 7.03 % of incidence of isolates of this genus, occupying the third place in order of incidence, behind *Cladosporium* and *Penicillium*. In the air of Haifa (Israel) (38) the incidence of isolates of the genus *Fusarium* oscillated between 3 and 12 %, depending on the study area. Isolates of this genus were commonly found in the air of Phoenix, Arizona (24) and in the air of Albuquerque, New Mexico (16).

We found that isolates of this genus in the air of Barcelona represented the 0.1 % of the total colony counts, occupying the ninth place in order of incidence among the other isolated genera. They were found in 2.64 % of the exposed plates. The species identified was *Fusarium moniliforme* Sheldon.

The genus Trichoderma (Persoon) Harz.

Most aeromycological studies do not indicate the presence of isolates of the genus *Trichoderma* in the air. However, they were found regularly in the air of Trujillo (Perú) (46) and in the air of Britain (48).

In the air of Barcelona we found an incidence of isolates of this genus accounting for 0.1 % of the total colony counts, showing similar percentage as these found in the air of Manhattan, Kansas (34, 35, and 36) and in the air of Israel (5, 6, and 7). The species identified were *Trichoderma viride* Persoon ex Gray and *Trichoderma harzianum* Rifai. Isolates of this genus were encountered in 6 % of the exposed plates.

Genus Botrytis Micheli.

The genus *Botrytis* has rarely been reported in most aeromycological studies. Kramer et al. (34, 35, and 36) reported 39 isolates of this genus in the air of Manhattan, Kansas, and Aller et al. (3) were the only Spanish

authors that mentioned the presence of isolates of *Botrytis* in Spain.

Botrytis cinerea Persoon was the species isolated in the air of Barcelona, accounting for a 0.2 % of the total colony counts.

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