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The daily variations of airborne fungal spores in Mexico City

IRMA ROSAS, BEATRIX ESCAMILLA, CARMEN CALDERON, PEDRO MOSIÑO

SUMMARY. The daily and seasonal distribution of airborne fungal particles was recorded in a high altitude tropical zone. Sampling was carried out in the southern part of Mexico City. An Andersen air sampler was used over a period of six months. Ten minutes sampling for each set of plates was done at fixed schedule: 07:30, 14:00 and 19:00 hours. The sampler was placed 10 m above the ground. Daily variation was found to be associated with the season, weather and atmospheric stability. The highest value of mold counts (3195 CFU m^{-3}) was recorded in the evening on October, a transitional month between the rainy and the dry seasons, the lowest (45 CFU m^{-3}) at noon during the rainy season. Mold counts were significantly correlated with temperature, having negative signs both in the morning and at noon, and being positive in the evening. The abundance of only three genera was recorded. Cladosporium, *was isolated more frequently, and its abundance at 14:00 h was of 38%;* Alternaria *represented 4.0%, at 14:00 h, and* Aspergillus *3.0% at 7:30 h. Fifteen species belonging to the latter genera were identified and most of them are considered as opportunistic molds of clinical significance.*

Key words: fungi, spores, Mexico.

Irma Rosas, Beatrix Escamilla, Carmen Calderón, Pedro Mosiño, Centro de Ciencias de la Atmósfera. Circuito Exterior, Ciudad Universitaria, Mexico D.F. 04510, Mexico.

INTRODUCTION

Information about ambient outdoor air spores in tropical regions is increasing (Hurtado and Riegler-Goihman, 1986; Rosas *et al.*, 1986; Joy-Royes, 1987; Youssef and Karam Eldin, 1988; Gupta and Chanda, 1989). Mexico City is one of the largest cities in the world, with an altitude of 2240 m, and with a subtropical climate (Fig. 1). The city presents a high annual record of respiratory diseases (SEDUE and CNE, 1988) that could be related to both, air pollution and inhalative allergens.

The composition of airborne fungal spores in outdoor environments is influenced by local weather which affects the biology of the fungi and the dispersion of their reproductive propagules (Gregory, 1973). The typical middle latitude seasons of the year may not be clearly reflected in seasonal temperature variations in the intertropical zone.

The present study was undertaken to reach the

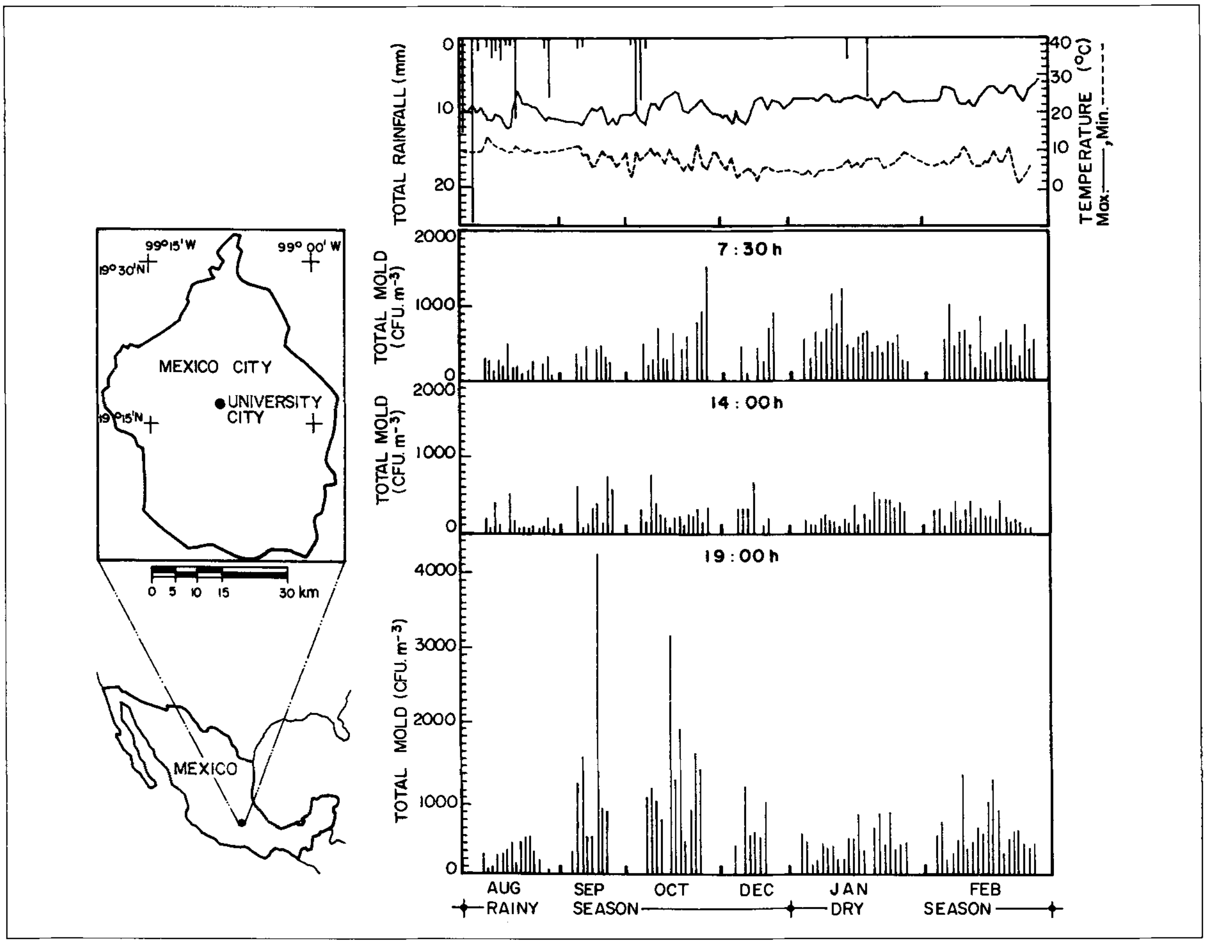

Figure 1. Location of the sampling area and variation record of temperature, rain and mold counts, recorded at different times of the day.

following objectives:

– To evaluate both the seasonal and diurnal variations of airborne mold counts.

– To determine the influence of meteorological parameters upon the diurnal variations of the mold counts, and to identify the most frequently isolated airborne molds.

MATERIALS AND METHODS

A two-stage Andersen Sampler placed at 10 m above ground level was used to isolate molds from the atmosphere in Mexico City. Sampling was carried out every day from Monday to Friday over a period of six months, from August 1988 through February 1989 at the University Campus, which is considered one of the largest green areas in Mexico City. Ten minutes samples for each set of plates were taken, thrice daily, at 7:30, 14:00 and 19:00 h. Isolation media were malt-extract agar and Sabouraud's dextrose agar. The pH of all media was adjusted to 6.8-7.0. Plates were usually incubated for three days at 27 °C. The developing colonies were examined, identified and counted. All counts were expressed as CFU per cubic meter, and the percentage composition on Cladosporium, Alternaria and Aspergil*lus* was recorded.

RESULTS

Daily airborne mold counts varied seasonally (Fig. 1). The maximum recorded during the rainy season was 3195 CFU m^{-3}, at 19:00 h and the maximum recorded during the dry season was 1539 CFU m-3, at 7:30 h. No significant differences were recorded between mold counts and season in the 14:00 h samples. Total mold counts varied according to the time of day; in general, the lowest values were recorded at noon (47 to 787 CFU m-3). Mold counts at the three sampled hours were correlated with meteorological parameters (Fig. 2). Air temperature varied with daytime. During the rainy season the average temperature, was 14.5 °C at 7:30 h, and mold mode concentration was 228 CFU m-3. In contrast, during the dry season, mean temperature was 10.2 °C, with a mold mode concentration of 475 CFU m-3. The average temperature during both seasons was almost the same, at 14:00 h. At 19:00 h the difference between seasons was only 1.5 °C, and between mold counts the difference was only of 137 CFU m-3. Vapor pressure presented the same pattern as temperature during the sampling period. Tab. I

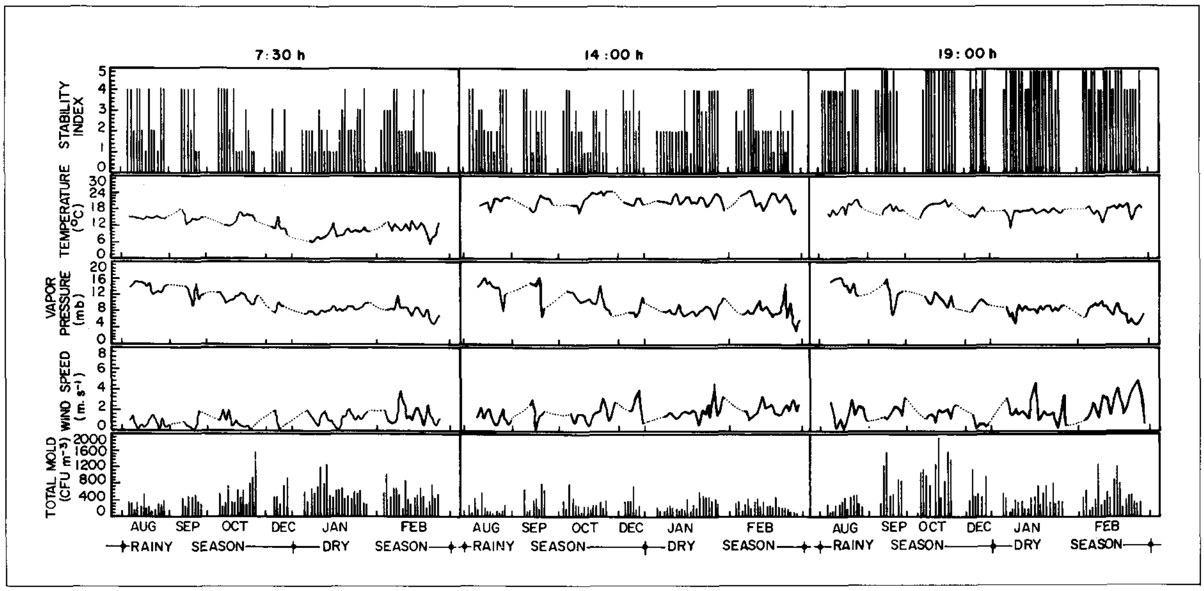

Figure 2. Diurnal variation of total molds counts and meteorological parameters through the rainy and dry seasons.

Table I. Correlation coefficient [a] values for meteorological parameters and total mold counts.

Dependent variable: Total mould counts						
Independent variable:	*7:30 h season rainy*	*dry*	*14:00 h season rainy*	*dry*	*19:00 h season rainy*	*dry*
Vapour pressure (mbar)	- 0.37[b]	0.04	- 0.04	- 0.44[b]	0.31[b]	0.10
Wind speed (m s-1)	- 0.12	- 0.07	0.14	0.09	0.09	0.007
Temperature (°C)	- 0.03	- 0.10	- 0.49[b]	- 0.14	0.18	0.21[b]
Stability index (Turner)	- 0.31[b]	- 0.08	0.09	0.03	- 0.09	0.11

[a] Pearson's r
[b] P = 0.05

shows the correlation coefficients found among the above mentioned weather parameters and mold counts. Vapor pressure and air temperature were negatively correlated with the airborne particules, both at 7:30 h and 14:00 h. In contrast, these meteorological parameters were positively correlated at 19:00 h.

Eleven mold genera were identified, but only the abundance of Cl*adosporium*, *Aspergillus* and *Alternaria* was recorded. *Cladosporium* was the most abundant genus found (30%). *Alternaria* and *Aspergillus* represented only 2% each (Fig. 3). The relative abundance of *Cladosporium* did not show important fluctuations during the sampling period.

The genera *Aspergillus* and *Alternaria* were frequently isolated, but their respective abundance was low. The isolation percentage for *Aspergillus* was high in the morning, while for *Alternaria* it was high both at noon and evening.

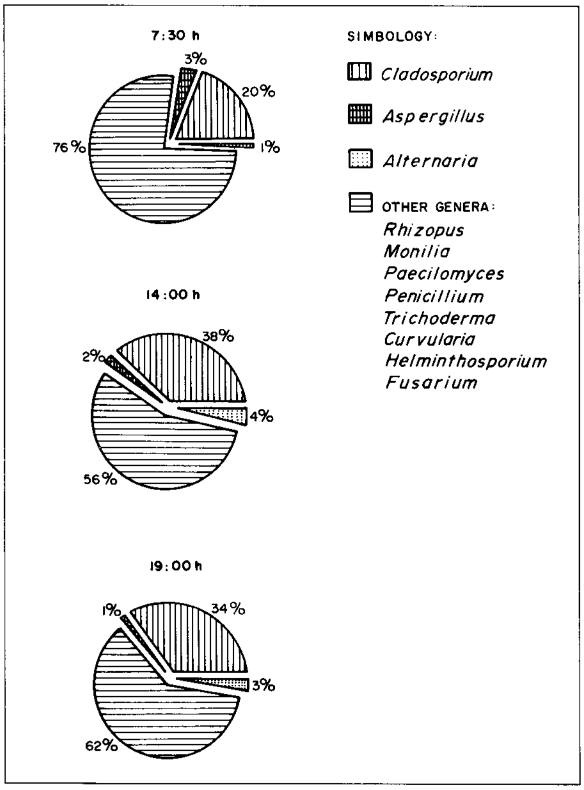

Figure 3. Relative abundance of selected fungi recorded at different time of the day and the fungal genera identified.

Fifteen *Aspergillus* species were isolated; some of them are shown in Fig. 4. The most common were *A. niger*, *A. fumigatus* and *A flavus*.

DISCUSSION

Aeromycological researches carried out in different climate zones are important for determining spore concentrations in the atmosphere and relative abundance among species (Abdel-Hafez and El-Said, 1989; Pineau and Comtois, 1989).

Diurnal variation of air temperature in the tropics, being less than the annual one, characterizes two types of climatic seasons. In Mexico City they are the rainy season from May to October, and the dry season from November through April. This explains the air moisture variation from one season to the other (Mosiño and Garcia, 1973).

The above mentioned climatic regimes determined the temporal changes found in the mold counts. A large variability among the different sampling times of the day was recorded, while only a significant seasonal variation was found in the evening samples. The seasonality in the mold counts was very scarcely perceived in general. However, temperature and vapour pressure are clearly different from one season to another. This fact was reflected in the monthly mold counts, August being the month with lowest counts, and October, the end of the rainy season, with the maximum counts registered. Because the latter is a transitional month, it is still humid and it shows an increase in air temperature, so ambient conditions are favorable for the putrefying sustrates where molds grow. It is also important to consider the dispersion of the fungal particles through the atmosphere in which meteorological parameters play a district role (Rich and Waggoner, 1962; Hawke and Meadows, 1989). The lowest mold counts were recorded at 14:00 h, apparently due to the atmospheric instability caused by the ground's high temperature, which generates thermal turbulence on the vertical motion, moving the spores to great heights. In the evening the counts' increase associated to the opposite meteorological process, seemingly due to air subsidence through the cooling of the surface (Pedgley, 1982).

The above results agree with the values and signs

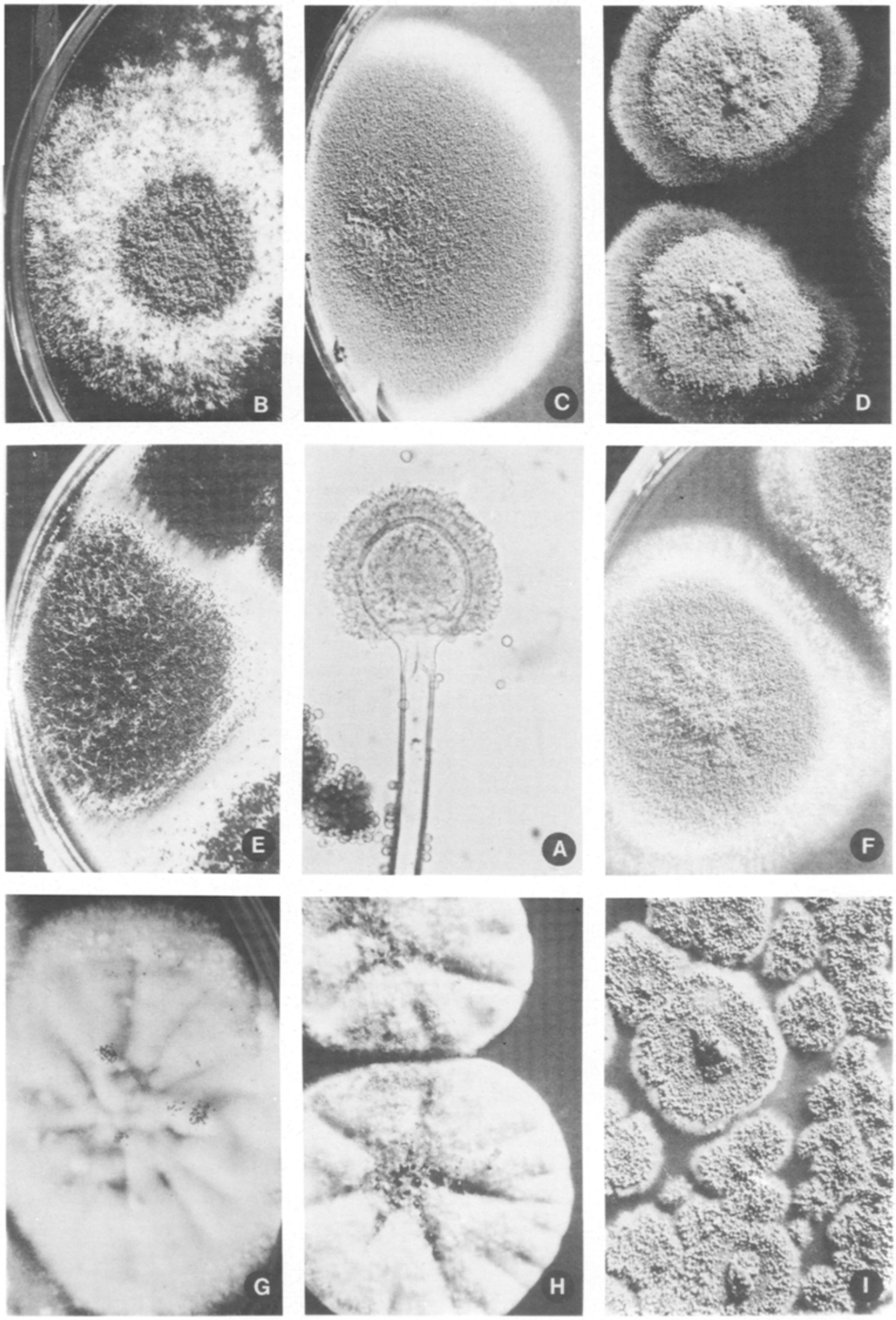

Figure 4. Aspergillus species. (A) Conidiophore of *A. flavus* (L M, x 1000). Colonies of: (B) *A. flavus*, (C) *A. fumigatus*, (D) *A. nidulans* (group), (E) *A. niger*, (F) *A. petrakii*, (G) *A. tamarii*, (H) *A. versicolor*, (I) *Emericella variecolor*.

of the correlation coefficients for air temperature and vapour pressure related to mold counts. These parameters are main factors in the dispersion of airborne fungal particles and have been significantly correlated with dry-spore mold counts (Atluri *et al.*, 1988; Hawke and Meadows, 1989).

From the 11 isolated spores of airborne fungal genera, *Cladosporium* was the dominant one, usually accompanied by *Alternaria*, *Aspergillus* and others, in agreement with the well known cosmopolitan distribution (Burge, 1986). This saprobic fungi did not present a clear seasonal prevalence pattern in the Mexico City sampling area. However, the abundance of *Cladosporium* in the atmosphere was high at the end of the rainy season, but only in the morning and evening sampling times.

Fifteen *Aspergillus* species were isolated and most of them have been reported to be opportunistic pathogens (Raper and Fennel, 1977; Youssef and Karam El-Din, 1988). The most common species were *Aspergillus niger*, *A. flavus* and *A. fumigatus*. Future research will be oriented to identify airborne fungi at species level and to culture them for its use in the preparation of allergenic extracts.

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