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Research Article

Atmospheric Concentrations of *Cladosporium* Link and *Alternaria* Nées Spores in Ankara and the Effects of Meteorological Factors

Nazmiye ŞAKIYAN*, Özden İNCEOĞLU
Biology Department, Science Faculty, Ankara University, 06100, Tandoğan, Ankara - TURKEY

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Abstract: *Cladosporium* Link and *Alternaria* Nées known as the most allergenic spores, were first collected by means of a Burkard seven-day recording volumetric trap from the Ankara atmosphere from January 1990 to January 1991. The daily, monthly and annual variations in spores/m^3 of *Cladosporium* and *Alternaria* were recorded. The effects of some climatological factors such as rainfall, temperature, relative humidity and wind speed on variations in spore concentrations have been investigated.

Key Words: *Cladosporium*, *Alternaria*, Aeropalynology, Airborne spore, Allergy

Ankara Havasında Bulunan *Cladosporium* ve *Alternaria* Sporlarının Konsantrasyonu ve Meteorolojik Faktörlerin Etkisi

Özet: En çok alerjik spor olarak bilinen *Cladosporium* Link ve *Alternaria* Nées sporları ilk kez Ankara havasından Burkard aleti ile toplanıp analizleri yapılmıştır. Bu sporların havanın 1 m^3'deki günlük, aylık ve yıllık miktarları hesaplanmıştır. Sıcaklık, yağış, rüzgar ve nispi nem gibi meteorolojik faktörlerin spor konsantrasyonlarının değişimi üzerine etkileri araştırılmıştır.

Anahtar Sözcükler: *Cladosporium*, *Alternaria*, Aeropalinoloji, Spor, Alerji

Introduction

Data on the composition and concentration of airborne fungal spores are important in terms of allergies and plant pathology. It is known that inhalation of mould spores can produce allergic respiratory symptoms (Gravesen, 1979; Salvaggio et al., 1981). Moulds are common aeroallergens and both *Cladosporium* Link and *Alternaria* Nées are considered to be the most prevalent of these aeroallergens (D'amato et al., 1984; Tee et al., 1987). *Cladosporium* species live, like *Alternaria*, as saprophytes or as parasites on many kinds of plants. *Cladosporium* is reported to be the most common airborne fungus in temperate zones (Solomon, 1978). *Alternaria* also has a world wide distribution. Sporulation and spore dispersal depend on biological, climatic and physical processes (Hjelmroos, 1993).

There have been many investigations in various parts of the world to determine the presence and sources of allergenic species of fungi and to evaluate their seasonal variations (Hirst, 1953; Barkai-Golan, 1958; Kramer et al., 1959; Palmas et al., 1990; Hjelmroos, 1993; Li et al., 1994).

Studies on the presence of spores in the atmosphere of Ankara were started by Ozkaragoz in 1966 using Durham samplers (Ozkaragoz, 1968). Since 1966 no spore counts of the Ankara atmosphere have been carried out.

The aim of this investigation was to examine *Cladosporium* and *Alternaria* spores found in the Ankara air and to compare them in relation to seasonal changes. This work is also a part of a project which has been included in the preparation of a 10-year pollen calendar for the Ankara atmosphere. In this project we collected atmospheric pollen grains and spores using a Burkard seven-day recording volumetric trap between 1990 and 2000. Most of the pollen analyses on these slides had

*Author to whom correspondence should be addressed. E- mail: nazosakiyan@hotmail.com

been completed at the time of writing and for the first five years pollen concentrations compared with meteorological factors are given in three articles (Inceoglu et al., 1994; Pınar et al., 1999; Pınar et al., 2000); the other analyses were continuing. In addition to this research we started spore analyses using the same slides for 1990. In this work we present spore analyses and the influence of meteorologic factors for this year. This work is the first research on spore analyses in Ankara air to give the definition of these spores and measurements in 1 m^3 of air and compare them with meteorological factors.

Materials and Methods

The Burkard seven-day recording volumetric trap was placed on the roof of the Geology Department, Ankara University, 15 m above the ground. The air was sucked at a flow rate of 10 l per minute, and pollen grains impacted onto tapes which were coated with a thin film of vaseline paraffin wax in toluene. The tape was then mounted in glycerin jelly (Hirst, 1953). Twelve transverses were counted on each slide, at a magnification of X400. Spore counts were done at 2-h intervals and total daily counts were converted to numbers per cubic metre of air (Ogden et al., 1974). Meteorological data were obtained from the Meteorological Station in Ankara.

Results and Discussion

During 1990 *Cladosporium* and *Alternaria* spores were highly abundant in the Ankara atmosphere; of *Cladosporium* a total of 511,232 spores/m^3 was counted and of *Alternaria* 59,735 spores/m^3 (Fig. 1). *Cladosporium* and *Alternaria* spores form the majority of airborne spores in the air (Kramer et al., 1959).

In Stockholm, the annual totals for *Cladosporium* in 1980-89 ranged from 220,000 to 300,000 spores/m^3. In 1989 the total of the average daily concentrations reached 450,000 spores/m^3, which is more than 30% above the 10-year average. The yearly totals of average daily concentrations for *Alternaria* normally range from 1000 to slightly over 2000 spores/m^3. In 1989 the yearly total of average daily counts was over 4200 spores/m^3, which is 50% higher than the 10-year average (Hjelmroos, 1993).

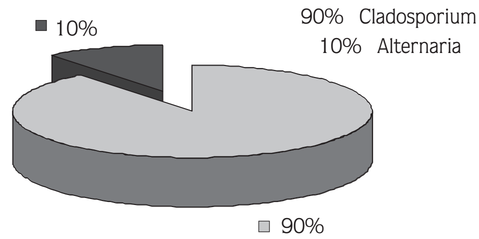

Figure 1. Percentage of Cladosporium spores and Alternaria spores in the Ankara atmosphere for the period from 1990 to 1991.

The concentration variations of *Cladosporium* and *Alternaria* are given with climatic parameters, such as temperature, rainfall, relative humidity and wind speed (Fig. 2).

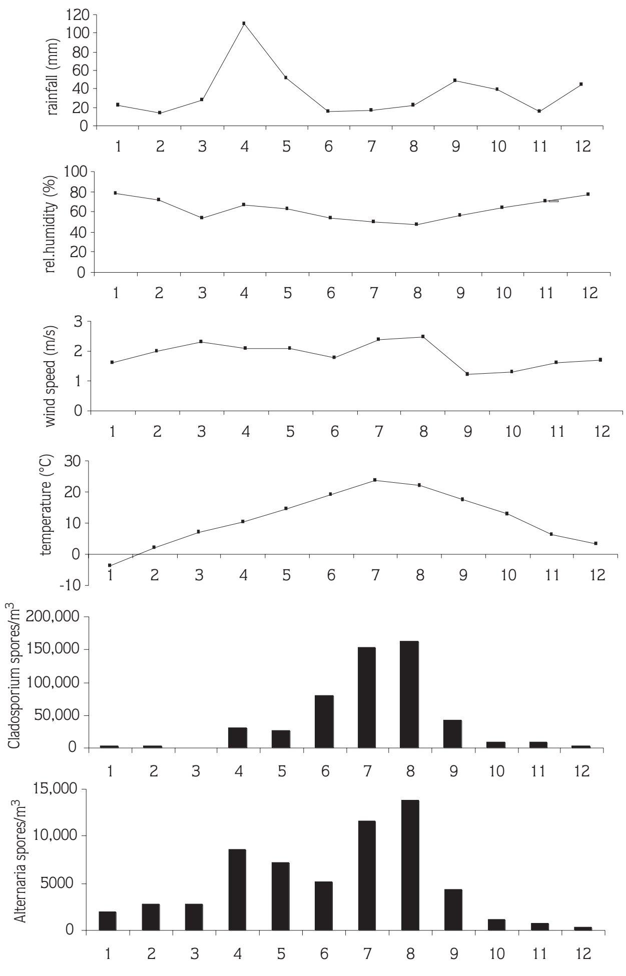

Figure 2. Monthly mean values of the meteorological parameters and Cladosporium and Alternaria spore counts in the Ankara atmosphere from Jan. 1990 to Jan. 1991.

In the first three months *Cladosporium* and *Alternaria* spore concentrations were low. Since temperature and rainfall were low, spore concentrations were very low. There was a significant correlation between temperature and total spore concentration (Palmas et al., 1990; Hjelmroos, 1993).

In April there was an important increase in spore concentration. While temperature continued to increase, the heaviest rainfall (110 mm) seemed to occur during this month. High temperature when combined with a sufficient amount of precipitation seemed to optimize the sporulation conditions for *Cladosporium* and *Alternaria* spores.

Day-to-day variations in spore concentration were chiefly due to the effects of rainfall. A significant increase in spore concentration after precipitation was determined (Kramer et al., 1959).

In the first week of May not only did daily temperature drop below 3 ºC but also precipitation was lower than in April. This caused a decrease in the spore concentration of both *Cladosporium* and *Alternaria*. During the last week the temperature seemed to be above 15 ºC. When the mean temperature rises above 15 ºC the number of spores in the air increases. Often the daily temperatures are high but the nights are rather cold and the low temperatures prevent mould growth (Hjelmroos, 1993).

During June, when temperature continued increasing there was also a small increase in *Cladosporium* concentration; but an increase in *Alternaria* spore concentration was not detected. Wind, rainfall and relative humidity were lower than in May. When the relative humidity rises above 45% and the wind is rather strong *Alternaria* concentrations increase. *Alternaria* seems to be more sensitive to variations in relative humidity than *Cladosporium* (Hjelmroos, 1993).

In July both *Cladosporium* and *Alternaria* concentrations increased to 100%. Mean temperature was above 24 ºC and the relative humidity was generally 50%, precipitation was 17.1 mm and wind speed was 2.4 m/s. These climatic factors were optimal for microfungal growth and sporulation.

In August both *Cladosporium* and *Alternaria* spore concentrations were at their highest. Temperature and relative humidity levels were similar to those in July, but precipitation was slightly higher. Rain influences the air spora both by removing spores from the air and by dislodging spores from conidiophores (Hirst et al., 1963). The highest wind speed of the whole year occurred during this month. The changes in wind speed had a large influence on the spore concentration, especially when the other climatic factors were optimal.

These climatic conditions caused spores to reach maximum values. The maximal daily concentrations of *Alternaria* and *Cladosporium* spores were recorded on August 9. In this month the highest daily count of *Cladosporium* was 24,794/m^3 and the monthly count was 162,681/m^3; the counts of *Alternaria* were 2178/m^3 daily and 13571/m^3 monthly. The highest *Cladosporium* spore concentration in Stockholm over a one year period occurred on July 29 1986 when the number of spores/m^3 of air during one day was over 34,800. The highest daily *Alternaria* spore concentration during the period investigated was counted on August 7 1984 (560) (Hjelmroos, 1993).

As a result of a decrease in wind speed on August 17, spore concentration also decreased quickly.

Spore concentrations in September were very different from those in August. Very low temperatures and wind caused a decrease in spore concentrations during this month. In October, November and December mean temperature was lower than in the previous months. Although humidity and wind were high enough, low temperatures caused a decrease in spore concentrations during these months.

In conclusion, *Cladosporium* and *Alternaria* were affected by climatic factors such as temperature, rainfall, wind and relative humidity. Moreover, *Alternaria* seemed to be more sensitive to variations in relative humidity than *Cladosporium*.

Alternaria and *Cladosporium* spores are present throughout the year in the atmosphere of Ankara, although they show important seasonal variations (Fig. 3). The highest concentrations of airborne *Cladosporium* and *Alternaria* spores were recorded during summer. Both spore types are present in lower levels in winter.

The peak period starts during the second half of June and lasts until the middle of August for *Cladosporium*. The peak period starts in week 25. The highest weekly concentration was recorded in week 32. *Cladosporium* spore concentration decreased quickly in week 33.

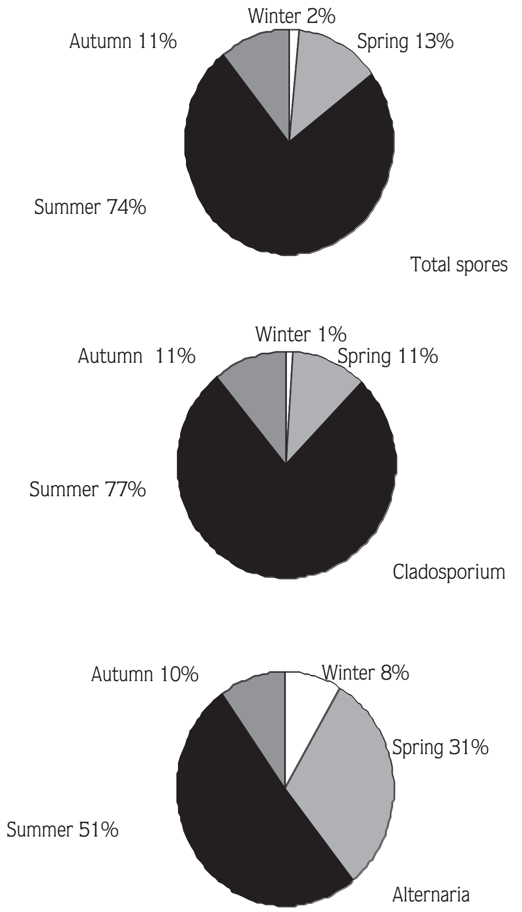

Figure 3. Charts showing seasonal distribution of spores in Ankara for 1990. Data include total spores of Cladosporium and Alternaria based on total daily counts/m^3 of air.

Alternaria spore concentrations were maximal in spring (April-May) and summer (July-August). The initial seasonal peak occurred between weeks 14 and 22 with secondary peaks between weeks 26 and 34. Maximum counts were recorded during week 32 (Fig. 4).

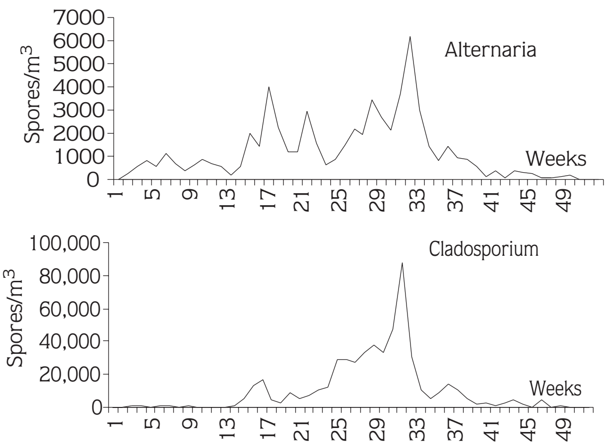

Figure 4. Weekly mean values (from daily counts) of Cladosporium and Alternaria spores/m^3 of air recorded in the Ankara atmosphere during 1990.

The concentrations of 3000 *Cladosporium* spores/m^3 of air and 100 *Alternaria* spores/m^3 of air were determined as threshold values for clinical significance (Bagni et al., 1977). In our research we observed *Cladosporium* and *Alternaria* to be in these amounts in the Ankara air for 54 and 164 days respectively. *Cladosporium* and *Alternaria* cause allergic reactions in people from April to September. These months are most likely to be high risk for mould sensitive patients.

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