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Full Length Research Paper

Fungi in the atmospheric air of Çanakkale province in Turkey

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In this study, the variability of airborne fungal flora and their monthly distribution in the atmosphere in 5 different locations of Çanakkale Province (Turkey) were investigated by means of the petri plate gravitational method from April 1, 2000 to March 31, 2001. Samples were taken from air by exposing petri dishes with malt extract agar (MEA) and rose bengal chloramphenicol (RBCA) media for 15 min. Then growing colonies were enumerated. Fungi were isolated in 360 petri dishes used and 4105 colonies were counted. By identification of these isolations, 19 genera (*Cladosporium, Alternaria*, *Penicillium*, *Phoma*, *Aspergillus*, *Botrytis*, *Chaetomium*, *Chrysosporium*, *Didymocladium*, *Doratomyces*, *Drechslera*, *Fusarium*, *Humicola*, *Mucor*, *Rhizoctonia*, *Rhizopus*, *Sporotricum*, *Trichoderma*, *Ulocladium*), 21 species blonging to 10 genera and *Mycellia sterilia* were determined. The most predominants were *Cladosporium* (27.5%), *Alternaria* (18.5%), *M. sterilia* (13.5%), *Phoma* (7.9%), *Penicillium* (6.7%) and *Aspergillus* (5.9%). In addition most of fungi isolated were important aeroallergens and phythopathogens.

Key words: Aeroallergen, Çanakkale, fungi, outdoor air, phythopatogen.

INTRODUCTION

Fungi are eukaryotic, filamentous and mostly spore-producing organisms, saprophyte or parasite in animals and humans, which may be found everywhere. The intensity of fungi spores increases depending on air pollution (Asan et al., 2002). Nevertheless, fungal density in the air varies in accordance with geographical regions and seasons. Besides, climatic parameters such as wind, humidity, temperature and precipitation, and altitude and flora combination may also affect the type and amount of fungi in the air (Asan et al., 2002; Di Giorgio et al., 1996; Menezes et al., 2004).

Cladosporium and *Alternaria* exist more commonly in the atmosphere in periods of warm air, while *Aspergillus* and *Penicillium* exist more intensively in cool periods (Kaarakainen et al., 2008; Topbaş et al., 2006). In addition, agricultural activities in immediate surroundings constitute a significant factor affecting the type and density of fungi in the air (Sneller et al., 1979). *Alternaria*, *Cladosporium*, *Aspergillus* and *Penicillium* are found frequently both in cultivated areas and city centers (Kaarakainen et al., 2008; Şen and Asani, 2001). On the other hand, *Aspergillus* and *Penicillium* may be detected in a greater density in dumping areas (Kaarakainen et al., 2008).

Generally, *Alternaria*, *Penicillium*, *Aspergillus* and *Cladosporium* are the dominant fungi found in the atomspheric air (İhsan and Asan, 2001; Menezes et al., 2004; Şimşek et al., 1997).

The fungi transported in the atmospheric air are highly important, since they are responsible from significant fungal disease epidemics in plants and allergic rhinitis and allergic asthma in humans (Martínez-Girón et al., 2004). *Alternaria*, *Penicillium*, *Aspergillus* and *Cladosporium*, which are dominantly found in the atmospheric air, are known as fungal allergy sources (Peat et al., 2006). Among the phythopathogen fungi, *Alternaria* causes leaf spot and leaf bunt diseases in plants, *Cladosporium* causes tomato blight, scabious in almond and peach, *Penicillium* causes blue and green mould in fruits, and *Aspergillus* causes bread mould and seed rot (Agrios, 2005).

Determining the types, prevalence and monthly distri-

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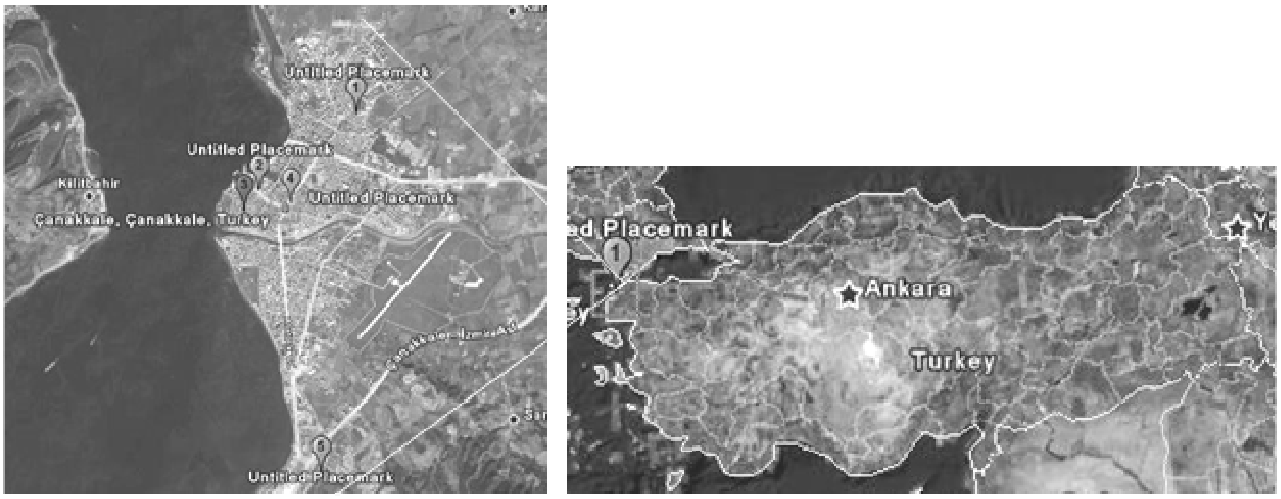

Figure 1. Map of Çanakkale where the research was performed.

Table 1. Monthly climatic data of Çanakkale.

Month	Temperature (°C)			Insolation (h)		Total precipitation (mm)	Average humidity (%)	Average wind (m/sec)
	Minimum	Maximum	Average	Total	Average			
January	-0.4	17.5	8.7	94.5	3.0	60.1	86.5	3.4
February	-1.2	19.0	8.6	149.0	5.3	68.7	82.1	4.6
March	4.5	24.2	13.0	169.3	5.5	7.7	82.9	7.1
April	3.7	25.4	14.6	197.2	6.6	26.5	83.8	2.2
May	6.1	27.6	17.8	331.7	10.7	11.8	81.4	1.2
June	10.4	34.2	22.4	345.8	11.5	8.3	71.3	4.7
July	15.6	37.5	25.9	374.9	12.1	0.0	66.4	3.8
August	15.0	36.4	25.6	353.1	11.4	5.3	66.9	2.4
September	11.3	31.0	21.2	286.4	9.5	0.0	74.2	3.2
October	3.9	25.3	15.7	186.2	6.0	131.1	81.5	3.3
November	5.2	24.6	13.7	147.2	4.9	18.2	85.4	4.4
December	-3.8	18.6	9.5	99.1	3.2	30.3	83.4	2.5

butions of aeroallergens and phythopathogens found in the atmospheric air of the city of Çanakkale will contribute to the information obtained from similar research carried out in different regions. Furthermore, in the light of the data obtained from research findings, patients who are affected from aeroallergen fungi and those whose plants can be damaged by phythopathogenic fungi may be warned beforehand thereby taking precautions.

MATERIALS AND METHODS

Sampling locations

Çanakkale is a city located in the northwest of Turkey, between 25° 40' - 27° 30' east longitude and 39° 27' - 40° 45' north latitude and most of its territory covering an area of 9.737 km² remains within the borders of Marmara Region (Figure 1). The city lends its name to the strait, which divides the city and whose shores touch both Europe and Asia. Its population is 70 - 80 thousands, altitude is 2 m and it is surrounded by rich forests and flora. The primary livelihood of the city people is agriculture and products such as cereals, fruit, vegetable and olive are grown in the in nearby regions around the city.

Çanakkale reflects the characteristics of mediterranean climate, which is hot and dry in summers and warm and rainy in winters and it is windy almost everyday throughout the year. Annual data received from Çanakkale (Turkey) meteorological station (station no: 17112) were used in order to determine the relationship between aerial fungal flora and climatic parameters (Table 1).

Fungal sampling was performed in 5 different locations of Çanakkale city center taking into consideration the distance, altitude, population and traffic density (Table 2).

Sampling method

Samplings were performed in monthly periods from April 1, 2000

Table 2. Sampling locations and some characteristics.

Location no	Location	Environmental Characteristics	Geographical position*	
			Altitude (m)	Coordinates
1	Social Security Hospital	Prevailing north winds, surrounded by trees, medical and house waste is stored	**55**	X 4505563 Y 4445488
2	Cumhuriyet Square	City center, density of population and traffic is high	**7**	X 449104 Y 4444602
3	Banks Street	Dense and active population	**13**	X 449077 Y 4444209
4	Garage	Dense population	**10**	X 49703 Y 4444252
5	Terzioğlu Campus	University campus in the outskirts of the city, close to the city dumping ground	**32**	X 450056 Y4440743

*GPS: Determined by Garming-GPS12XL.

to March 31, 2001, in the afternoons (1 pm and 4 pm) and on an altitude of 1.5 m (Şen and Asan, 2001). In the isolation of fungi, petri plate gravitational method was used due to its practicality, cost-efficiency and common usage (Ayata, 1990; Rosas et al., 1993; Şen and Asan, 2001; Takatori et al., 1994; Topbaş et al., 2006). Petri dishes (9 cm in diameter) exposed to malt extract agar (MEA, Merck) and rose Bengal chloramphenicol agar (RBCA, Merck) media were used in the samplings, which were performed by removing the caps of petri dishes placed on a flat surface 1.5 cm above the ground in the locations and exposing them to air for 15 min. Six petri dishes were used in each sampling. After the sampling, petri dishes were incubated at 25°C for 3 to 7 days. Fungal colonies grown at the end of incubation are transferred into an Inclined agar medium containing potato-dextrose agar (PDA). Inoculated tubes were enumerated and isolation place and date was recorded.

Identification

Aspergillus and *Penicillium* stocked in inclined agar medium were transferred to MEA and CzDA (Czapek Dox Agar) growth media, while other fungi were transferred to PDA medium. The fungi grown in the medium were identified according to their morphological and microscopic characteristics and identification was based on the literature including the identification keys (Barnet and Hunter, 1972; Booth, 1971; Domsch et al., 1980a,b; Ellis, 1971; Hasenekoğlu, 1991; Joffe, 1974; Nirenberg, 1981; Samson et al., 1981; Von Arx, 1981).

Statistical analysis

"PC using Statica Kérnel 5.5.A 99'Edition statically program" was used in order to determine the correlation between total fungal colony count, location and meteorological parameters. Variation between months and locations was determined by LSD test and the effect of climatic parameters on fungal colony density was determined by recreation analysis using "Minitab R14" pc program.

RESULTS

In the surveys carried out once a month for 12 months using petri plate method, 4105 fungal colonies were isolated from a total of 360 petri dishes and colonies were counted and identified in order to detect the incidence frequencies of fungi. Together with *M. sterilia*, 10 genera and 21 species belonging to 10 genera were determined. The most dominant one among the isolated fungi was found to be *Cladosporium* (27.5%), which was followed by *Alternaria* (18.5%), *M. sterilia* (13.5%), *Phoma* (7.9%), *Aspergillus* (5.9%) and other fungi, respectively (Table 3).

According to the data obtained from 5 different locations in the city of Çanakkale, a statistically significant change was observed in the density of fungi in the atomspheric air depending on the months ($P = 0.05$; $F = 74.295$) (Figure 2). Fungal density in the atmospheric air reached the highest level in June and October and this density was determinant on the seasonal fungal density (Figures 2 and 3).

Fungal density reached the highest level in October in social security hospital (Loc. no: 1) and in June in other locations (Loc. nos: 2, 3, 4 and 5) (Figure 3). The lowest fungal density in the atmospheric air was obtained in August, January and December.

The average monthly fungal density between locations was found to be statistically different ($P = 0.05$; $F = 9.345$) (Figure 4). Monthly fungal density in Terzioğlu Campus (Loc. no: 5) and social security hospital (Loc. no: 1) was higher than the one in other locations and this density continued throughout the year.

In the study, correlation analyses were performed between the density of species and some meteorological parameters such as temperature, average and total insolation, rain, average proportional humidity and wind volume (Table 4). In the analysis, some fungus types were determined to have positive correlation with meteorological factors.

DISCUSSION

It is well known that fungi can survive in almost every

Table 3. Locations where fungi were isolated, colony numbers and rates.

Type and species	Colony number	%	Month and location of sampling
Alternaria sp.	556	13.54	Ş(1-15, 2-11, 3-1, 4-6, 5-2), M(2-1), Y(1-2, 3-1, 4-4, 5-6), H(1-68, 2-47, 3-36, 4-36, 5-66), T(1-46, 2-17, 3-9, 4-4, 5-9), A(1-3, 2-1, 3-10, 5-8), E(1-15, 2-6, 3-14, 4-6, 5-8), R(1-53, 2-6, 3-11, 4-7, 5-21)
Alternaria alternata (Fr.) Keissl.	90	2.19	M(1-12, 2-2, 3-4, 4-2, 5-3), N(1-1), H(1-2, 2-3, 3-4, 4-7, 5-2), T(1-2, 2-2, 3-1, 5-1), E(4-3), K(1-4, 2-2, 3-4, 4-4, 5-25)
Alternaria raphani J.W. Groves and Skolko	114	2.78	O(1-4, 2-6, 3-2, 4-1), Ş(1-5, 3-3, 4-1, 5-3), M(3-6, 4-3, 5-2), T(2-1), R(3-3), K(1-14, 2-1, 3-4, 5-11), B(1-15, 2-7, 3-13, 4-9)
Aspergillus sp.	8	0.19	O(5-3), T(3-2, 4-1), E(4-2)
Aspergillus candidus Link.	2	0.04	K(3-1,) B(4-1
Aspergillus fumigatus Fresen.	43	1.04	T(1-23, 2-13, 3-2, 4-2, 5-3)
Aspergillus niger Tiegh	54	1.31	Ş(1-1, 2-1, 4-2), M(1-4), H(4-1), T(1-1, 3-2, 4-7, 5-2), A(4-5), E(1-14, 3-4), R(1-2, 2-1, 4-1), K(4-1), B(3-2, 4-3)
Aspergillus niveus Blochwitz	1	0.02	T(4-1)
Aspergillus ochraceus G.Wilh.	88	2.14	N(3-1, 4-1), Y(1-1, 2-4, 3-6, 4-2, 5-3), H(1-1, 2-27, 3-5, 4-12, 5-9), T(1-1, 2-1, 3-6, 4-2, 5-2), R(3-2), K(3-2)
Aspergillus parasiticus Speare	47	1.14	M(1-3, 2-1, 3-2, 4-5, 5-1), B(1-2, 3-27, 5-6)
Botrytis cinerea Pers.	14	0.34	Ş(1-2, 3-1, 4-2), H(2-2, 4-2), K(3-3, 4-2)
Chaetomium sp.	68	1.65	Y(3-1), T(5-1), E(1-6, 2-14, 3-7, 4-33, 5-6)
Chrysosporium sp.	25	0.61	Ş(1-2, 2-11, 3-3, 4-6, 5-1), Y(1-2)
Cladosporium sp.	13	0.32	O(1-1), N(2-1, Y(2-1, 3-1, 4-3, H(3-1, 4-1, T(3-1, 5-1), B(2-2)
Cladosporium acaciicola M.B. Ellis	447	10.89	O(1-8, 2-3, 3-6, 4-10, 5-21), Ş(1-17, 2-13, 3-11, 4-8, 5-17), M(1-19, 2-12, 3-14, 4-27, 5-23), N(2-4, 3-2, 4-3, 5-2), Y(2-2, 3-1, 5-1), E(1-2, 2-2, 3-1, 5-3), R(1-32, 2-12, 3-24, 4-24, 5-63), K(1-6, 2-7, 3-3, 4-2, 5-13), B(1-14, 3-2, 4-7, 5-6)
Cladosporium aecidiicola Thüm.	240	5.85	O(3-1, 4-3), M(1-49, 2-1, 3-14, 4-1, 5-4), Y(1-10, 2-5, 3-2, 4-10, 5-13), H(2-2, 4-4, 5-3), T(1-1), E(5-1), R(2-1), K(1-11, 2-14, 3-12, 4-19, 5-51), B(2-8)
Cladosporium herbarum (Pers) Link	30	0.73	O(4-3), Ş(2-2, 3-1, 4-1, 5-1), N(1-4, 2-2, 3-1, 4-4), Y(2-1, 4-2), H(1-1), R(1-1, 3-1), K(2-1, 3-1, 5-1), B(2-2)
Cladosporium sphaerospermum Penz.	398	9.70	N(1-3, 2-6, 3-3, 5-8), Y(1-3, 2-2, 3-2, 4-4, 5-2), H(1-6, 2-12, 3-1, 4-56, 5-17), T(1-6, 2-5, 3-5, 4-8, 5-5), A(2-5, 3-4, 5-10), E(2-12, 3-6, 4-4, 5-22), R(1-57, 2-6, 3-21, 4-15, 5-29), K(1-1, 2-1, 3-2, 5-15), B(2-9, 3-18, 4-1, 5-6)
Didymocladium sp.	23	0.56	Ş(1-2, 4-1, 5-1), M(1-6, 2-2, 3-2, 4-4, 5-5)
Doratomyces sp.	7	0.17	M(4-2, 5-1), E(1-4)
Drehcslera sp.	19	0.46	N(1-2), Y(1-1, 5-1), H(2-1), T(1-1, 2-2, 3-1, 4-1, 5-1), E(2-1), R(1-5, 4-1, 5-1)
Fusarium sp.	30	0.73	Ş(1-4, 2-3, 3-1, 4-3, 5-5), M(1-1), N(3-1), H(1-2, 2-1, 3-1, 5-1), T(2-1, 4-2), R(3-1), B(2-1, 3-1, 4-1)
Fusarium oxysporum E.F.Sm. and Swingle	16	0.39	E(3-1, 4-12), R(1-1, 3-1), B(5-1)
Humicola sp.	10	0.24	N(1-3, 2-1, 3-1, 4-1), Y(1-1, 2-2), T(4-1)
Mucor sp.	166	4.04	O(2-3, 4-1, 5-2), Ş(2-31, 4-9, 5-1), M(1-2, 2-14, 3-2, 4-10), H(2-8), T(1-3, 2-1, 3-1, 4-8), A(3-1, 4-6), R(2-4, 3-2, 4-6), K(2-10, 3-13, 4-7, 5-3), B(2-1, 3-11, 4-6)
Mycelia sterilia	553	13.47	O(2-1, 3-2, 4-1, 5-4), Ş(1-5, 2-25, 3-8, 4-6, 5-7), M(1-6, 2-5, 3-3, 4-4, 5-3), N(1-52, 2-14, 3-18, 4-15, 5-58), Y(1-3, 2-2, 3-4, 4-3, 5-2), H(1-37, 2-34, 3-36, 4-43, 5-56), T(1-7, 2-5, 3-4, 4-8, 5-4), A(1-2), E(2-5, 3-6, 4-1, 5-1), R(1-17, 2-5, 3-9, 4-1, 5-9), K(3-2, 4-1), B(2-1, 3-3, 4-4, 5-1)
Penicillium sp.	188	4.58	O(2-1, 3-7, 4-12, 5-4), Ş(1-13, 2-12, 3-19, 4-17, 5-12), M(1-4, 2-3, 3-5, 4-6, 5-3), N(3-1, 4-1, 5-1), Y(1-1, 2-3, 3-1, 4-1, 5-6), H(3-1, 4-1, 5-2), T(1-1, 2-3, 3-2, 5-3), A(2-1), E(2-1, 3-1), R(1-1, 2-1, 3-4, 4-19, 5-2), K(2-1, 3-3, 4-6, 5-2)

Table 3. contd.

Penicillium canescens Sopp	1	0.02	O(5-1)
Penicillium crustosum Thom	78	1.90	O(3-3, 4-5), N(4-4), Y(3-2, 4-2), T(1-1, 2-1, 3-1, 4-4, 5-2), A(2-1, 3-1, 4-1), E(2-5, 3-3, 4-10, 5-2), R(1-1, 3-1, 4-2), K(1-1, 2-3, 3-6, 4-3, 5-2), B(2-1, 3-9, 4-1)
Penicillium simplicissimum (Ouden.) Thom	7	0.17	0(5-2), N(3-1), Y(4-2), B(2-1, 4-1)
Phoma sp.	325	7.92	O(1-2, 2-1, 3-1, 5-1), Ş(3-5), M(2-1, 3-3), N(3-2, 4-1, 5-2), Y(1-9, 2-2, 3-4, 4-1, 5-14), H(1-14, 2-8, 3-19, 4-8, 5-16), T(1-4, 2-4, 3-5, 4-2, 5-4), A(1-5, 2-36, 3-10, 5-28), E(2-1, 3-1, 4-4, 5-2), R(1-32, 2-3, 3-7, 4-8, 5-27), B(2-28)
Rhizoctonia solani J.G. Kühn	82	2.00	O(1-2, 2-1), M(2-1), N(2-1, 5-1), Y(1-9, 2-3, 3-3, 5-24), H(1-5, 2-4, 3-1, 4-2, 5-4), T(1-6, 2-5, 3-3, 4-2, 5-2), E(2-3)
Rhizopus oryzae Went and Prins. Geerl	73	1.78	Ş(2-1), Y(4-1), H(1-3, 2-1, 3-4, 4-4, 5-2), T(1-7, 2-5, 3-4, 4-3, 5-3), A(1-1, 2-1, 4-12, 5-1), R(2-2, 4-3, 5-2), K(2-1, 3-1, 4-3), B(1-1, 3-7)
Sporotrichum dimorphosporum Arx	66	1.61	Ş(3-1, 5-3), N(4-1, 5-2), H(1-6, 2-5, 4-1, 5-2), T(1-3, 2-5, 4-2, 5-1), A(2-6, 3-2, 4-1, 5-5), E(5-1), R(1-5, 3-2, 4-1), K(1-1, 2-2, 3-2, 5-3), B(1-1, 2-1, 5-1)
Trichoderma sp.	208	5.07	O(1-1, 2-1, 4-1, 5-1), Ş(1-1, 3-1, 4-1), M(3-3), N(3-1, 4-1), Y(1-19, 3-1, 4-1), H(2-20, 3-32, 4-31, 5-33), T(2-1, 3-4, 4-2), A(2-7, 3-5, 5-1), E(4-1), R(4-2), K(1-4, 2-1, 3-2, 4-13, 5-8), B(3-5, 4-2, 5-1)
Trichoderma harzianum Rifai	8	0.19	O(2-1, 3-2, 4-2), M(3-3)
Ulocladium sp.	17	0.41	Ş(5-1), N(5-1), Y(1-1), A(1-3, 5-1), E(2-1), R(5-1), K(2-1, 3-7, 4-2)
Toplam	4105		

O: January, Ş: February, M: March, N: April, Y: May, H: June, T: July, A: August, E: September, R: October, K: November, B: December; 1: Social Security Hospital, 2: Port area, 3: Banks area, 4: Garage area, 5: Terzioğlu Campus; First numbers indicate the station, and second numbers indicate the colony number.

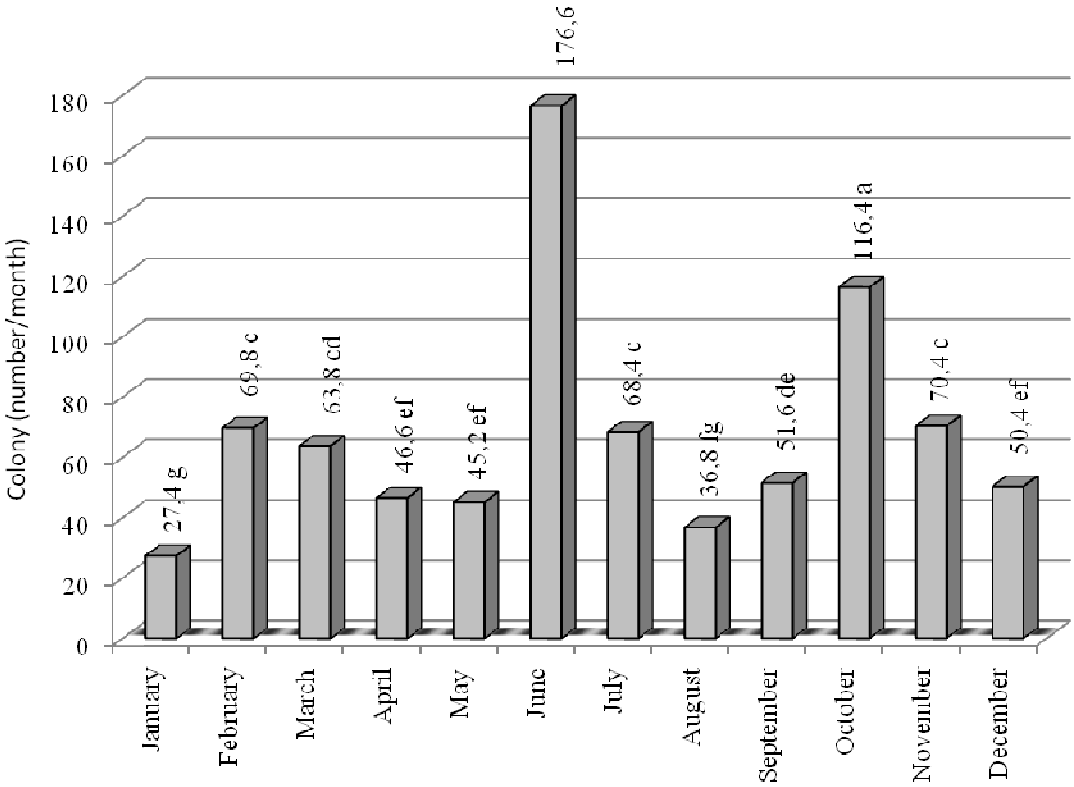

Figure 2. Monthly fungal density in the atmospheric air of Çanakkale (P= 0.05; F= 74.295).

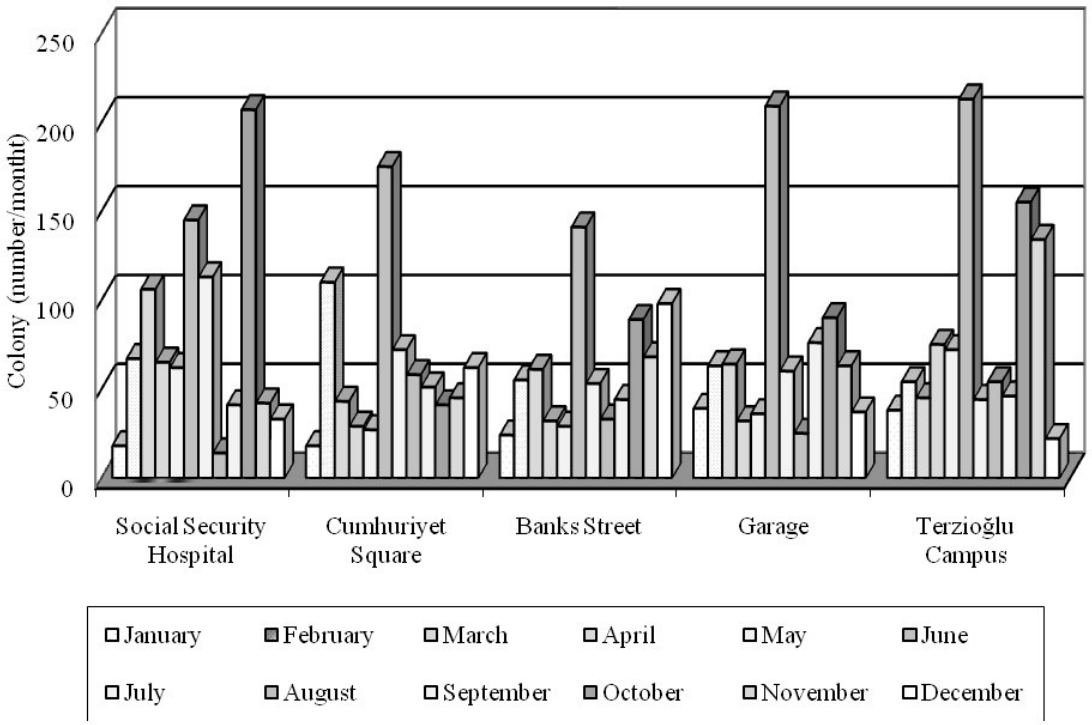

Figure 3. Monthly fungal density in different locations of Çanakkale from April 1, 2000 to March 31, 2001.

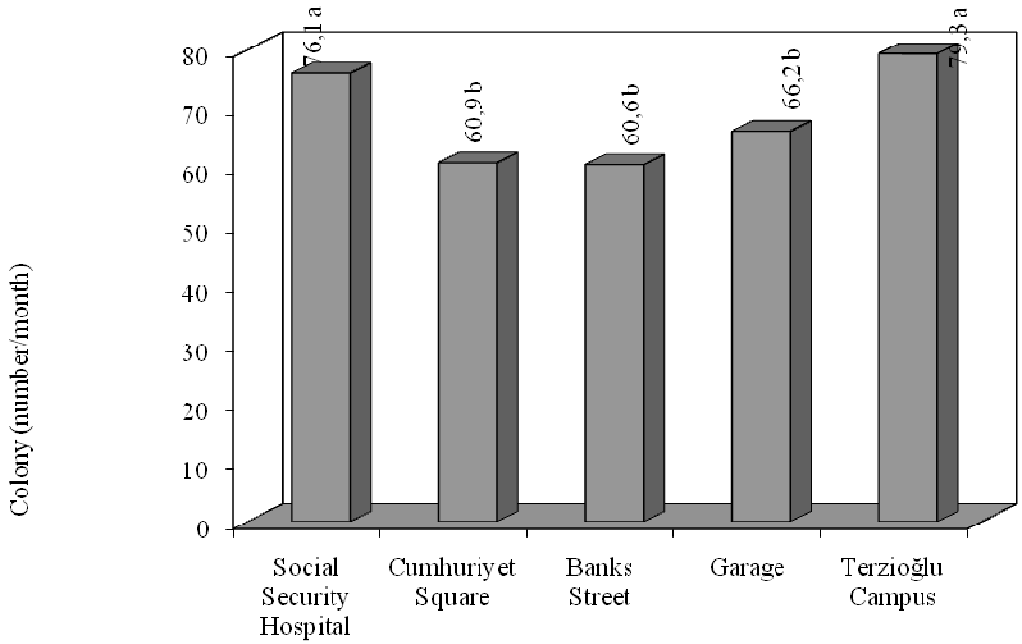

Figure 4. Fungal density in different locations of Çanakkale (colony/month; P = 0.05; F = 9.345).

region and climate (Asan et al., 2002; Carpenter, 1977). Many fungus spores can survive in difficult conditions like low temperatures in winter and high temperatures in summer and can be transported by air. Fungi generally grow as saprophyte in the soil and facultative parasite on its hosts and they spread into the atmospheric air by means of several factors. It is important for phytopathologists that a large proportion of the fungi transported in the atmospheric air are phythopathogens. Over 10,000 types of fungi in nature are pathogens in plants (Agrios,

Table 4. Correlation coefficient (r) between colony numbers and meteorological factors.

Genus	Correlation with Meteorological Factors					
	Temperature (°C)	Average insolation (h)	Total insolation (h)	Precipitation (mm)	Average relative humidity (%)	Wind volume (m/s)
Alternaria	0.371	0.378	0.361	-0.024	-0.408	0.329
Aspergillus	0.482	0.483	0.487	-0.413	-0.586	0.112
Botrytis	-0.195	-0.097	-0.134	0.047	0.115	0.387
Chaetomium	0.252	0.202	0.190	-0.256	-0.210	-0.082
Chrysosporium	-0.390	-0.178	-0.213	0.304	0.155	0.171
Cladosporium	-0.249	-0.340	-0.334	0.634	0.371	0.384
Doratomytes	0.096	0.043	0.037	-0.327	-0.057	0.393
Didimocladium	-0.254	-0.228	-0.227	-0.120	0.209	0.769
Drechlera	0.374	0.314	0.329	0.404	-0.276	-0.175
Fusarium	-0.106	0.006	-0.033	0.128	-0.112	0.170
Humicola	0.024	0.132	0.130	-0.143	0.173	-0.483
Mucor	-0.477	-0.459	-0.477	0.198	0.300	0.651
M. strelia	0.154	0.249	0.221	-0.038	-0.130	0.084
Penicillium	-0.583	-0.460	-0.482	0.547	0.408	0.276
Phoma	0.506	0.448	0.460	0.241	-0.508	-0.252
Rhizoctonia	0.376	0.596	0.605	-0.332	-0.234	-0.352
Rhizopus	0.695	0.588	0.600	-0.227	-0.795	-0.033
Sporotrichum	0.652	0.546	0.543	-0.086	-0.708	0.035
Trichoderma	0.306	0.382	0.366	-0.257	-0.288	0.190
Ulocladium	0.030	-0.088	-0.090	-0.116	0.120	0.007

2005). Besides being plant pathogens, most of the fungi cause pneumonia, hay fever and allergic diseases. This fact draws the attention of aerobiologists due to the increase in recent years in the density of fungi in the atmospheric air and the allergic diseases they cause (Larsen and Gravesen, 1991; Pasanen, 1992; Şen and Asan, 2001).

In this study, *Cladosporium* was found to be the most predominant fungus with the highest isolation frequency and is followed by *Alternaria*. *Cladosporium* was detected to be predominant also in studies carried out in different periods, regions and locations in the world (Khan et al., 1999; Ren et al., 1999; Takahashi, 1997; Waisel et al., 1997). These 2 dominant fungi were followed by *M. sterilia*, *Phoma*, *Penicillium*, *Aspergillus* and others. The fungal density ranking, except for *Phoma*, shows parallelism with the findings obtained by Şimşekli et al. (1997). In other studies, this ranking varies as *Alternaria*, *Penicillium*, *Cladosporium, Aspergillus* (Asan et al., 2002; Atik, 1993; Ayata, 1990; Ayata et al., 1991; Kumar, 1983; Pateria and Sahu, 1982; Singh and Babu, 1983; Yuluğ and Kuştimur, 1977). Intensively isolated *Cladosporium*, *Alternaria*, *Phoma*, *Penicillium* ve *Aspergillus* are pathogens in cultivated plants besides being important fungal allergens and they are the most common fungus species found in the atmospheric air (Agrios, 2005; Kaarakainen et al., 2008; Topbaş et al., 2006). Although it is thought that the spores of especially *Alternaria*, *Aspergillus* and *Cladosporium* in the air may play a significant role in allergic rhinitis and allergic asthma (Kurup et al., 2000), *Penicillium, Curvularia, Cladosporium, M. sterilia, Fusarium, Rhizopus, Drechslera, Absidia, Alternaria* revealed positive results in the allergy tests on humans (Menezes et al., 2004).

Prevailing winds, vegetation, medical and house waste storage areas, active population structure and high altitude are thought to be contributory effect to the higher fungal density in the locations of social security hospital (Loc. no: 1) and Terzioğlu Campus (Loc. no: 5) compared to other locations (Asan et al., 2002; Bandyopadhyay et al., 1991; Di Giorgia et al., 1996; Pasanen, 1992; Şimşekli et al., 1997). *Cladosporium* species may be found in agricultural areas where vegetation is more intense, while the density of *Penicillium* and *Aspergillus*

may be higher in locations closer to dumping areas (Kaarakainen et al., 2008).

While the fungal density in the atmospheric air reaches the highest level in autumn and summer, it is found to be the lowest in winter and spring. Similar results were obtained in another study carried out in Bursa for determining the fungi in the atmospheric air (Şimşekli et al., 1997). The increase in fungal density in June and October plays a significant role in seasonal distribution and the highest fungus isolation was observed in these months. On the other hand, fungal density the lowest in January and August. In the study, in compliance with the ecology of the fungi, *Cladosporium* was isolated intensively in spring and autumn, *Alternaria* in summer and autumn, *M. sterilia* in winter and spring, *Phoma* and *Trichoderma* in spring, summer and autumn, *Aspergillus* in summer and *Penicillium* in all seasons. Climatic conditions were effective in the seasonal distribution of fungi. It was considered significant that the correlation was positive between *Cladosporium*'s density and precipitation (r = 0.634), positive between *Phoma* and temperature (r = 0.506), negative between *Phoma* and relative humidity (r= -0.508), negative between *Penicillium* and temperature (r = -0.583), positive between *Penicillium* and precipitation (r = 0.547), negative between *Aspergillus* and relative humidity (r = -0.586), positive between *Didimocladium* and wind volume (r = 0.769), positive between *Mucor* and wind volume (r = 0.651), positive between *Rhizopus* and total temperature and insolation (r = 0.695, r = 0.600, respectively), negative between *Rhizopus* and mean relative humidity (r = -0.795), positive between *Rhizoctonia* and total insolation (r= 0.605), positive between *Sporotrichum* and temperature and total insolation (r = 0.652, r = 0.543, respectively) and negative between *Sporotrichum* and mean relative humidity (r = -0.708). The relationship between fungal density and climatic data shows similarity with the correlation between *Aspergillus*- precipitation and mean relative humidity, *Cladosporium*-precipitation, *Penicillium*-temperature obtained by Şen and Asan (2001). *Cladosporium* spends the winter on rotten substances or offshoots, produces its conidia in the spring after the high humidity period and infects the leaves, offshoots and fruits of plants by being transported through air and water (Agrios, 2005). Conidia, which develop in the lesions on plants, constitute the source of fungal density in the atmospheric air.

Some of fungi isolated intensively in the research are allergens and cause serious health problems in humans and animals due to the mycotoxin they produce. Among these, some species of *Penicillium* may cause degeneration in liver and kidneys in domestic animals by the ochratoxin they produce, edema and bleeding in lungs and brain, degeneration in kidneys and paralysis in motor nerves by the patulin they produce and may trigger the formation of cancer in high organisms (Agrios, 2005). Aflatoxin produced by a few species of *Aspergillus* (that is, *A. flavus*) causes aminotoxicity in humans and domestic animals, weight loss, intestinal bleeding, fatigue, growth retardation, loss of appetite, rapid weight loss and liver cancer in pregnant cows fed with low-dose mycotoxin, calves, adult cattle and sheep and disease and death in young ducks and turkeys. Vomitoxin produced by *Fusarium* in corn and cereals may cause loss of appetite and weight loss and zearalenon may cause toxicity, abnormalities and degeneration in reproduction systems, and miscarriage (Agrios, 2005).

The fungi isolated in the air are significant due to the diseases they cause in humans and animals, as well as efficiency and quality loss in plants. Predominantly detected *Cladosporium* causes fractures and burns in the needle-shaped leaves of conifers, leaf blight in tomato (*C. fulvum*), scaby and offshoot blight in peach (*C. cladosporioides*), scaby and gumnosis in cucumber (*C. cucumerinum*), root decay and blights in pea (Agrios, 2005). The spores of *Alternaria*, which comes the second, exist in the air and soil and cause leaf blots, blights, damping off, trunk decays, burl and fruit decays especially in vegetables and foliage plants. *Phoma*, another fungus intensively isolated in the study, exists together with other weak parasitic pathogens and causes blackleg disease and root decay in zucchini (telemorph *Leptosphaeria maculans*) and phoma disease in tomato. *Penicillium* causes rots in damaged and ripe post-harvest fruits and several infections in cereals and legume stored under high humidity and low temperature. *Aspergillus* is responsible for mold and decays in cereals and legume and rots in fruits like peach and strawberry.

In this study carried out for the first time in order to determine the fungi in the atmospheric air and their density in Çanakkale, it is significant for aerobiologists and pythopathologists that isolated fungi are consistently followed due to the diseases, especially allergy, they cause in humans and animals and the loss they cause in the efficiency and quality of plants.

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