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Isolation, identification and seasonal distrubution of airborne and waterborne fungi in Terkos Lake (Istanbul-Turkey)

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This paper focuses on isolation and identification of airborne and waterborne fungi from different parts of Terkos Lake located in Istanbul (Turkey). The quantitative and qualitative fungal composition of the air and water of the Lake was surveyed monthly for a year (August 2000–July 2001). Water samples were taken at five different stations at Terkos Lake. Airborne fungal spore levels were estimated by exposing a petri dish containing Rose-Bengal streptomycin agar medium to air for 15 minutes. A total of 2372 fungal colonies (1032 from air and 1340 water) was counted on 216 petri plates. We isolated twenty mould species belonging to 9 genera. *Scopulariopsis brevicaulis, Penicillium expansum* and *Cladosporium herbarum* were the most abundant species (22.0%, 13.4% and 12.9%, respectively). *Cladosporium herbarum* and *sphaerospermum* are very common in air samples (29.7% and 27.0%, respectively). Many of the species isolated are rarely in the atmospheric and water environment such as *Aspergillus niger* and *Cladosporium variabile*. Statistical analysis revealed a positive correlation between total CFUs and a number of environmental factors.

Located near the Black Sea coast of Turkey, Lake Terkos is one of the six main drinking water reservoirs for the Istanbul metropolitan area, providing 25% of the water demand. The area around the lake has limited industrial activity (BAYKAL *et al*. 1999).

Cladosporium, Alternaria, Aspergillus, Penicillium and *Fusarium* species are widespread in air environments, with *Cladosporium* species predominating in many studies (e.g. REN *et al*. 1999, KHAN *et al*. 1999). Common fungal species in air include: *Cladosporium cladosporioides, C. herbarum, Aspergillus flavus, A. vitis (= amstelodami), A. fumigatus, A. niger, A. reptans (= repens), A. terreus, A. versicolor, Penicillium citrinum, P. oxalicum, P. chrysogenum, P. crustosum,* and *P. purpurogenum* (ADHIKARI *et al*. 1999, LI *et al*. 1995, SINGH and SINGH 1994, ABDEL-FATTAH and SWELIM 1982, RAGAB-SAAD and AWAD-EL-GINDY 1990).

Predominant fungal genera and species in treated and untreated water are: *Aspergillus, Cladosporium, Epicoccum, Penicillium, Trichoderma, Arthrinium phaeospermum, Aspergillus flavus, Cladosporium cladosporioides, Fusarium culmorum, Mucor hiemalis* and *Trichoderma harzianum* (KINSEY *et al*. 1999). Many other fungal genera have been isolated from water in Europe including: *Mortierella, Absidia, Rhizopus, Acremonium, Beauveria, Doratomyces, Monilia, Rhizopus arrhizus, Acremonium strictum, Fusarium oxysporum* and *Stemphyllium botryosum* in Danube river (TOTHOVA 1999); *Rhizophydium keratinophilum, Blastocladiopsis parva, Catenophlyctis variabilis, Aphanomyces irregularis* and *Saprolegnia ferax* in springs and lakes in Poland (CZECZUGA and MUSZYNSKA 2001); *Heliscus lugdunensis* and *Tetracladium marchalianum* in hyperpolluted waters in Central Germany (KRAUSS *et al*. 2001); *Phoma, Verticillium, Achlya americana, Saprolegnia ferax* and *Saprolegnia monica* in three larger reservoirs in Serbia (RANKOVIC 1998). ABDULLAH *et al*. (1997), found five aero-aquatic conidial fungi from ponds and streams in Northern Catalonia,

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Spain. Some Oomycetes and Chytridiomycetes such as *Saprolegnia, Aqualinderella* and *Pythium* have been recorded by ELHISSY (1994) in different aquatic sites in the Tubingen region (Baden-Württemberg, Germany). In addition, many new water fungi are still being found (WONG *et al*. 1998, HYDE 1995; for example).

Some fungi such as *Aspergillus flavus* LINK may produce aflatoxins in water (PATERSON *et al*. 1997). Aflatoxins are carcinogenic to animals and humans. Phytoplankton such as Cyanobacteria, Dinomastigota, Chrysophyceae etc. living in waters may be infected by fungal parasites (HOLFELD 1998). ELSHAROUNY and BADRAN (1995) found that some fish are more susceptable to fungal infection than others. Water and airborne fungi may be pathogens of aquatic and terrestrial plants, and may be pathogens of humans and animals. Some microfungi cause allergies, spoilage of foods and many other adverse effects. Their mycotoxins can adversely affect human and animal health. Outdoor allergens may play a role in allergic rhinitis in humans (BURGE and ROGERS 2000). Zoosporic fungi are parasites of plants, fishes, insects, and other fungi, and are vectors some phytopathogenic viruses (ISLAM and TAHARA 2001).

Airborne fungi originate from different environments such as soil, plants and water. Fungal spores in aquatic environments may be transferred to air by wave action. Concentration of airborne fungal spores has been related to wind, humidity, temperature, rainfall, altitude, vegetation, and some specific reservoirs of contamination. Also, fungal propagative units may be dispersed in the air by insects (KERSSIES 1993). The prevalence of airborne and waterborne fungi is highly variable and determined by many factors. WONG *et al*. (1998) indicated that there is no comprehensive work dealing with the biogeography of all groups of freshwater fungi. Generally, most species of aquatic hyphomycetes are capable of colonizing a wide range of subtrates and play role in decaying leaves (GULIS 2001).

Water fungi of Turkey are very poorly known. According to the our records, there has been only one study (YESILYURT 1997) conducted on water fungi in Turkey. This study was carried out in Aras River, in eastern Turkey. This is the first study of occurrence and seasonal distribution of lake water fungi in Turkey.

Materials and methods

Location and site descriptions: The Terkos Lake is located on the north-west coast of Istanbul metropolitan City (Turkey) (Fig. 1). It lies between latitudes 40°19′N and 41°42′N, and longitudes 28°29′E and 28°32′E. The Terkos Lake is a small 14 km long freshwater reservoir. Its greatest width is 6 km and it has a maximum depth of 11 m. The area of the Lake is 25–32 km^2 and the elevation is varies between the –1–+4 m. There are locks on the lake that allow the level to vary from below sea level to 4 m above sea level. The sampling of waterborne fungi was performed in the 5 different parts of the Lake (Table 3), and sampling of airborne fungi was performed at one location, the center of the Lake. Plant cover of the environs of the lake consists of damp forest, with broad-leafed trees and pseudo-maquis areas. There are oak (80%), beech and hornbeam trees together 20% in the damp forest. In addition, there are hydrophytes in shallow areas of the lake.

Sampling and isolation methods: Samples were taken between 09.30 a.m. and 12.00 a.m. PETRI plates were put at the height of 1.5 m above the water level during sampling for fifteen minutes. At sampling site and date, some meteorological parameters such as water and air temperature were recorded.

Concentration of airborne and waterborne fungi were monitored over a period of 12 months between the August 2000–July 2001. In addition, 5 water samples (for one month, totally we took 60 water samples for 12 months), sent to the Hydrobiology and Microbiology Laboratory in Edirne (Turkey) for routine microbiological analysis, were assayed for microfungal species. Three petri plates were inoculated from each water sample. Water samples were collected monthly during the period of experiment at five different stations on Terkos Lake. We also measured some limnological characteristics of the lake (Table 4, see below for methods). The PETRI Plate Gravitational Settling Method (ABDALLA 1988, ROSAS *et al*. 1993) was employed for the isolation of fungi. "Rose-Bengal-

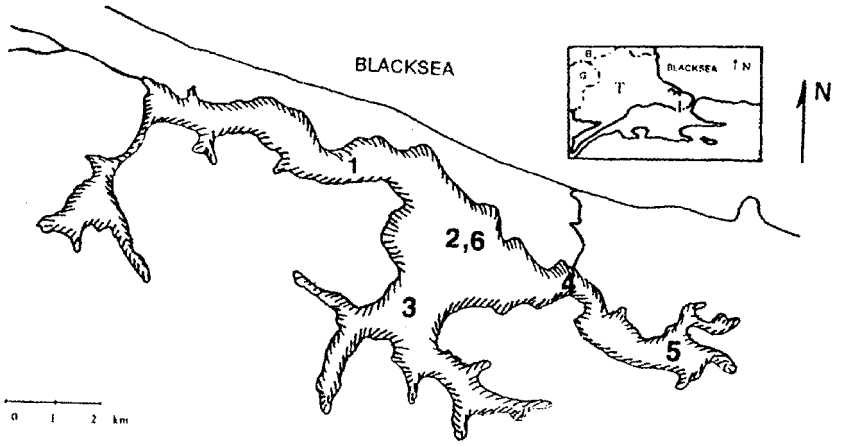

Fig. 1
Map of investigation sites on Terkos Lake, Istanbul (Turkey). 1–6 numerals placed in map indicate the research stations (Water samples were taken at locations 1–5 and air samples from location 6) (Inset: B: Bulgaria, G: Greece and I: Istanbul-Turkey, T: Thrace Region, Turkey)

Streptomycin Agar" adopted as collection and the medium petri dishes were exposed to the air. (Procedure: 1 g powdered streptomycin (DEVA Inc., Turkey) dissolved in 33 ml sterile-pure water; 2 ml from this mixture was added to 1000 ml of medium. 0.5 gr powdered Rose-Bengal stain (FLUKA Chemika-BioChemika, Switzerland) dissolved in 150 ml sterile-pure water; 10 ml from this mixture was added to 1000 mL of medium). After incubation and identification, concentrations of airborne fungi were calculated as CFU (= colony forming unit) (cfu/plate/15 min).

Water samples (1 l) were obtained from 4 m. depth by using a sterile Ruthner sampling bottle. The direct plating method (CZECZUGA *et al*. 1990, KINSEY *et al*. 1999) was used for sampling waterborne fungi in our study, using 2 mL of water taking from the sterile bottle poured to petri plate containing Rose-Bengal streptomycin agar medium. Growing colonies were transferred to PETRİ dishes containing one of three different culture media [malt extract agar (MEA) (Acumedia, USA), czapek's solution agar (CZ) (MERCK, Germany) and potato dextrose agar (PDA) (MERCK, Germany)] for identification, and then transferred everything to PDA for stock cultures. Fungi were incubated at 25 °C–27 °C for one week in the dark. As soon as the fungal growth appeared, colonies transferred PDA to obtain pure cultures and maintain them. Colony diameters were measured at 7 days in the all mentioned media. Stereomicroscope and light microscopes were used to determine the colonial features and the morphological structures of the fungi. The determination of the morphological structures of fungi was carried out on material mounted in lactophenol.

Identification: Identification of fungi was performed mainly on the basis of the micro- and macromorphological features, reverse and surface coloration of colonies grown on CZ, MEA and PDA media. Fungi were identified to genus level using BARNETT and HUNTER's work (1999). Cultures were identified to species level using the following mycological texts: *Penicillium* LINK species were identified using colony diameters, macro- and micromorphology according to the standardized conditions of PITT's monograph (1979). These species were grown on three different media all prepared according to the recipes of PITT (1979). So, CZAPEK Yeast Exctract agar (CYA), MEA, and 25% glycerol nitrate agar (G25N) were used for cultivation of *Penicillium* species and prepared according to PITT (1979). Each *Penicillium* culture was inoculated in triplicate on each medium and incubated at three different temperatures (5 °C, 25 °C and 37 °C) for a period of 7 days in the dark.

The monograph by RAPER and FENNELL (1965) was used for identification of *Aspergillus* species. CZ and MEA media used for cultivation of *Aspergillus* species. The *Cladosporium* LİNK, *Scopulariopsis* BAİN and *Alternaria* NEES were identified according to the descriptions of ELLIS (1971) and ELLIS and ELLIS (1997). *Scopulariopsis fusca* and *S. parva* species were identified according to the HASENEKOGLU (1991).

Citation of the author names presented in this paper are standardized according to the "*Authors of Fungal Names*" (KIRK and ANSELL 1992). "List of accepted species and synonyms in the family Trichocomaceae" article (PITT *et al*. 2000) is followed for acceptability names of *Penicillium* and *Aspergillus* species.

Measurement of water and air temperature and the other parameters: We measured air and water temperature using thermometer and hygrometer device (*TFA-Dostmann* GmbH*,* Germany) in the lake. Also following parameters were determined in water: pH (by land type device SCHOTT CG 837 brand), turbidity (by SECCHI disc with 20 cm diameter), depth of the Lake (by meter), dissolved oxygen (by WINKLER Method), water hardness of the Lake (by classic chemical method), various heavy metals such as Cr, Cd, Fe, Pb, Ni, Mn, Co and Zn (by 50 fold enrichment method) and electrical permeability (by conductivity meter WPA CM 35 brand, UK).

Statistical analysis: Statistical analysis was performed to determine the effects of parameters, such as pH, turbidity, depth and electrical permeability of water on CFUs using a PC. Multiply regression analysis (backward method) applied to the data using "Minitab program, release 13 for windows".

Results

A total of 2372 fungal colonies in 216 petri dishes were isolated, quantified to determine the frequency of occurrence and then identified (Table 1). The prevalent genera were: *Penicillium, Cladosporium* and *Scopulariopsis*. The dominant species identified were: *Scopulariopsis brevicaulis* which occurred at the maximum percentage (22%), followed by *Penicillium expansum* (13.4%) and *Cladosporium herbarum* (12.9%) (Table 1). The most frequently isolated taxa in Terkos Lake water were *Penicillium expansum* (23.7%), *Scopulariopsis brevicaulis* (19.4%), *Penicillium chrysogenum* (16.0%), *Trichoderma* sp. (15.8%) and *P. puberulum* (10.4%). The predominant fungal species in the air were *Cladosporium herbarum* (29.7%), *C. sphaerospermum* (27.0%) and *S. brevicaulis* (25.3%). Micromorphological structures of the predominant fungi are illustrated in Figs. 2–7.

The maximum fungal concentration in water was observed at location 5 (23.7%). The largest mean number of waterborne fungal species was observed in November and July (40.0% and 32.2%, respectively) and the largest number of airborne colonies were isolated

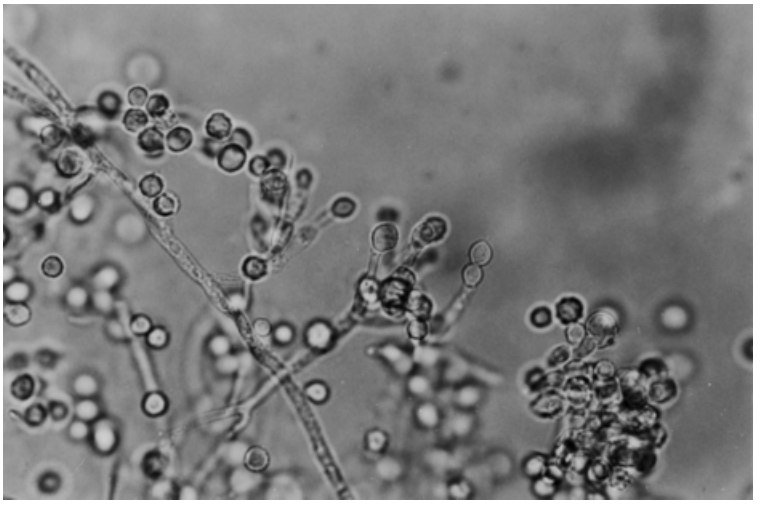

Fig. 2
Micromorphological structure of *S. brevicaulis* (X 400)

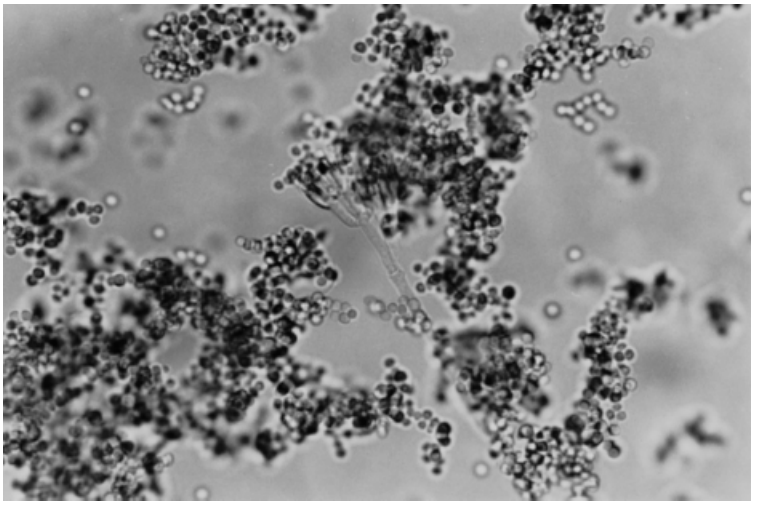

Fig. 3
Micromorphological structure of *P. expansum* (Spores and penicilli structures) (X 400)

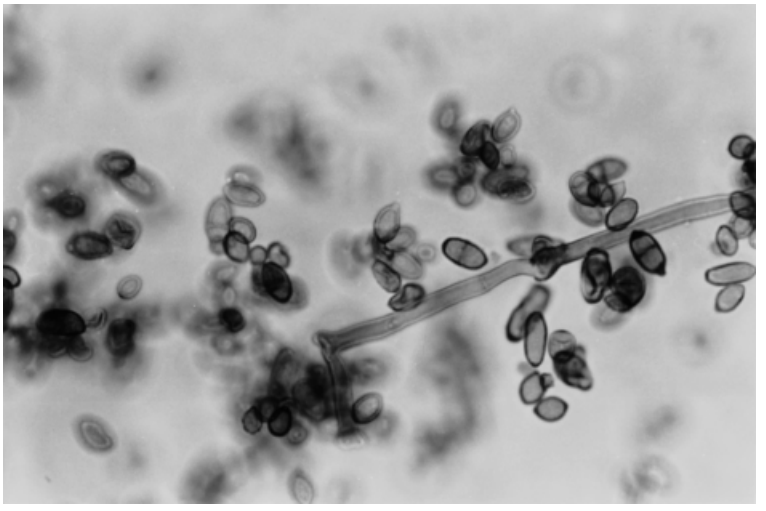

Fig. 4
Micromorphological structure of *C. herbarum* (typical spores) (X 400)

in May and July (59.4% and 29.0%, respectively) (Table 2). The Lake water temperature ranged from 8.5 °C to 13.9 °C (average: 9.4 °C) in the December–March period and ranged from 25.1 °C to 25.3 °C (average: 26.1 °C) during the summer months. The maximum mean monthly temperature was 28.0 °C in July.

Multiple regression analysis (backward method) was applied to the data. We found a positive correlation between the number of waterborne fungi and water pH, Cr, Zn, depth, electrical permeability, oxygen, Cd, Pb, Ni and Co (overall p value = 0.011, R^2 = 1.00; p values for each parameters separately: Cr = 0.016, pH = 0.018, Zn = 0.031, depth = 0.043, electrical permeability = 0.036, oxygen = 0.015, Cd = 0.008, Pb = 0.011, Ni = 0.011 and

Fig. 5
Micromorphological structure of *A. citri* (typical spores) (X 200)

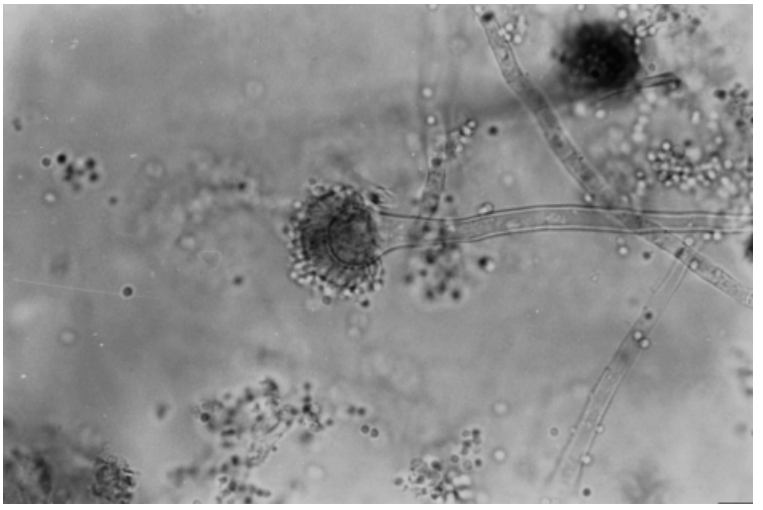

Fig. 6
Micromorphological structure of *A. fumigatus* (aspergilli structure) (X 400)

CO = 0.045). Total fungal colony numbers in water did not significantly correlate with the other parameters. Total airborne fungal colony numbers did not significantly correlate with air temperature.

Discussion

It is well known that microfungi can live in extreme conditions in almost all regions and all climates. In recent years, aerobiologists have shown a great interest in airborne fungi due to both their constant existence in the air and the increase of allergies caused by them (LARSEN

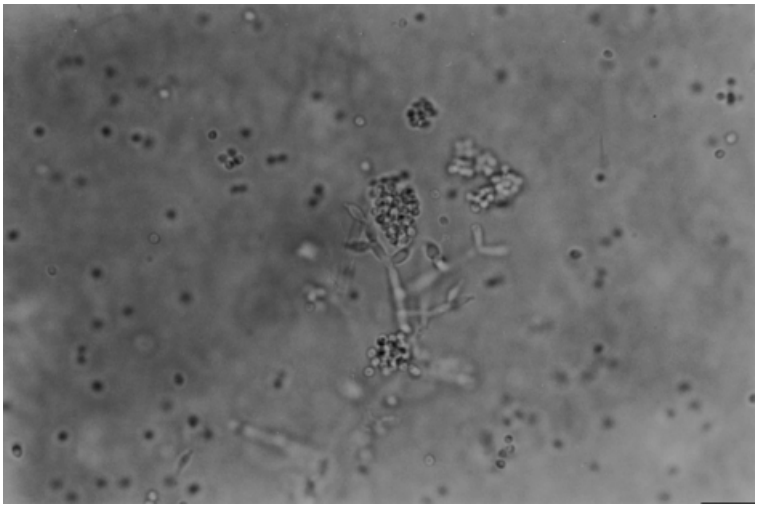

Fig. 7. Micromorphological structure of *Trichoderma* sp. (X 400)

Table 1
Colony numbers, percentage (%), and sampling stations of fungal species isolated between the August 2000–July 2001

Genera and species	Number of colonies	%	Sampling months and stations
***Alternaria* NEES**	103	4.3	
A. alternata (FR.) KEISSL.	37	1.6	S (A-2), C (A-35)
A. citri ELLIS & N. PIERCE	66	2.8	M (W2-46), Y (A-1); L (W1-1), N (A-11), D (A-7)
***Aspergillus* LINK**	24	1.0	
A. fumigatus FRESEN.	22	0.9	D (W1-22)
A. niger TIEGH.	1	0.04	N (A-1)
***Cladosporium* LINK**	622	26.2	
C. cladosporioides (FRESEN.) G. A. DE VRIES	13	0.6	M (W3-1), M (A-1), Y (W3-1), Y (A-2), L (W3-1), L (A-1), G (A-2), S (A-4)
C. cucumerinum ELLIS & ARTHUR	9	0.4	Y (W4-9)
C. herbarum (PERS.) LINK	306	12.9	M (A-4), L (A-5), S (A-39), C (A-258)
C. sphaerospermum PENZ.	293	12.4	F (W3-2), C (A-278), D (A-1), D (W5-12)
C. variabile (COOKE) G. A. de VRIES	1	0.04	S (A-1)
***Penicillium* LINK**	762	32.1	
P. brevicompactum DIERCKX	5	0.2	S (W2-5)
P. chrysogenum THOM	214	9.0	D (W1-214)
P. expansum LINK	317	13.4	P (W5-264), D (W5-53)
P. glabrum (WEHMER) WESTLING (Basionym: *Citromyces glaber* WEHMER) (PITT *et al*. 2000)	17	0.7	M (W1-13), L (W1-4)
P. griseoroseum DIERCKX (This species is accepted as asynonym of *Penicillium chrysogenum* THOM by PITT *et al*. (2000)	17	0.7	J (W3-17)
P. miczynskii K. M. ZALESSKY	12	0.5	J (W2-12)

Table 1
(continued)

Genera and species	Number of colonies	%	Sampling months and stations
P. puberulum BAINIER (This species is accepted as asynonym of *Penicillium aurantiogriseum* DIERCKX by PITT *et al*. (2000)	153	6.4	P (W4-139), G (A-14)
P. verrucosum DIERCKX	3	0.1	G (W5-3)
***Scopulariopsis* BAINIER**	536	22.6	
S. brevicaulis (SACC.) BAINIER	521	22.0	P (W2-130), P (W4-1), N (A-5), D (A-256), D (W4-6), D (W5-123)
S. fusca ZACH	1	0.04	D (A-1)
S. parva (BROWN & SMITH) SAMSON	4	0.2	S (W1-4)
Some species identified to the genus and subgenus level			
Aspergillus sp.	1	0.04	J (W4-1)
Fusarium LINK sp.	1	0.04	F (A-1)
Paecilomyces BAINIER sp.	1	0.04	G (A-1)
Rhizopus EHRENBERGER sp.	1	0.04	Y (W2-1)
Scopulariopsis sp.	10	0.4	J (W4-1), P (A-1), D (A-8)
Trichoderma PERS. sp.	211	8.9	N (W4-211)
Subgenus *Biverticillium*	2	0.1	S (W1-2)
Subgenus *Furcatum*	4	0.2	J (A-1), F (A-1), F (W2-1), Y (A-1)
Subgenus *Penicillium* 1	3	0.1	P (A-1), U (W1-1), D (W5-1)
Subgenus *Penicillium* 2	11	0.5	U (W5-9), S (W5-2)
Subgenus *Penicillium* 3	4	0.2	F (A-1), F (W2-2), Y (W2-1)
Dematiaceus Hyphomycetes	36	1.5	P (W1-1), P (W2-1), Y (A-2), S (W3-5), S (W3-5), C (A-1), N (A-2), D (A-13)
Unidentified	75	3.2	F (W2-1), Y (W1-1), Y (W4-15), S (W1-2), S (W2-1), C (A-41), N (A-1), D (A-13)

Letters indicate: **J**: January, **F**: February, **M**: March, **P**: April, **Y**: May, **U**: June, **L**: July, **G**: August, **S**: September, **C**: October, **N**: November, **D**: December; **A**: Air, **W**: Water

and GRAVESEN 1991, PASANEN 1992). *Aspergillus* and *Penicillium* spores are the most widespread aeroallergens in the world. According to qualitative and quantitative reports, the former is the dominant species in tropical regions whilst the latter is dominant all over the world (ROSAS *et al*. 1992). *Aspergillus fumigatus,* found in our study, is one the most ubiquitous of the airborne saprophytic fungi. Water fungi can play a vital role in the decomposition of some organic materials such as dead leaf and stem litter. The decomposition of fallen leaves and other detritus in streams is dominated by fungi (GARNETT *et al*. 2000). Some zoosporic fungi such as *Aphanomyces cochlioides* Drechsler infect some plants (ISLAM *et al*. 2001). KINSEY *et al*. (1999) indicated that the significance of fungi in water systems is poorly understood, many of the species isolated from water are known to be capable of producing toxic secondary metabolites. Our results demonstrated that the Terkos Lake has diverse aquatic fungi which indicates a need for studies of the role of water fungi in the lake.

We found positive correlation between concentration of waterborne fungi and water pH, depth, electrical permeability, oxygen, Cr, Zn, Cd, Pb, Ni and Co. These factors may influence fungal growth.

Table 2
Total fungal colony numbers found in research stations and their distributions to the months

Month	Fungal Colony Number in water (c.f.u./2 ml)	%	Fungal Colony number in air (c.f.u./plate/15 min.)	%
Aug '00	31	2.3	32	3.1
Sept. '00	6	0.4	3	0.3
Oct. '00	60	4.5	5	0.48
Nov. '00	536	40	2	0.2
Dec. '00	28	2.1	6	0.6
Jan. '01	10	0.7	0	0
Feb. '01	6	0.4	6	0.6
Mar. '01	3	0.2	17	1.3
Apr. '01	21	1.6	57	5.5
May '01	0	0	613	59.4
June '01	211	15.7	20	1.9
July '01	431	32.2	299	29.0
Average	111.9		88.3	
Total	1340		1032	

Table 3
Characteristics of the sampling stations

Sampling Station Number	Characteristics of station
1	Catchment area from streams
2	The center of the lake
3	The rea of maximum depth of the lake
4	The area of discharge of overload lake water to Blacksea
5	The front of pump station that provide drinking water for Istanbul metropolitan city

The PETRI Plate Gravitational Settling Method was used for the isolation of airborne fungi because of its practical usage and low cost. This method is useful for the enumeration of fungal spores, but gives only a rough approximation of the types and numbers of airborne fungi (PELCZAR *et al*. 1993). Rose Bengal-Streptomycin agar medium was used for sampling. According to MADAN *et al*. (1982), this medium is the most suitable for sampling fungi from air. Also according to the MORRING *et al*. (1983), Rose Bengal-Streptomycin Agar can be used for isolation of a broad spectrum of airborne fungi. Streptomycin antibiotic was used to control reproduction of bacteria and Rose-Bengal stain was used to limit the growth of fast-growing molds (e.g., *Rhizopus* and *Trichoderma* spp.). Although there are many methods such as filtration, direct plating, baiting etc. for sampling fungi from water (KINSEY *et al*. 1999), we used direct plating method for isolation of fungi in water.

Penicillium was the most frequent and predominant genus detected in our study, followed by *Cladosporium, Scopulariopsis,* and *Trichoderma* genera (Table 1). According to the KINSEY *at al*. (1999), certain fungi such as *Aspergillus*, *Cladosporium*, *Epicoccum*, *Penicillium* and *Trichoderma* species appear more frequently than others in water. Our results concur with theirs except that we did not find *Epicoccum*. *Cladosporium* is the most common fungus living as saprophyte, mainly on dying and/or dead herbaceous plants and other organic matter. In nature it is a ubiquitous fungus. It produces dry conidia in chains easily carried through the air. It is thus the dominant fungus in air. The many molds, especi-

Table 4
Some features of water and air temperature in research area

Sampling Month	Water temp. (°C)	Turbidity* (cm)	Depth* (m)	Electrical permeability* (μmho/cm)	pH*	Air temp.	Dissolved Oxygen* (mg/l)	Water hardness* (FS)
Aug '00	25.3	113.0	7.5	309.0	8.3	26.9	9.4	13.5
Sept. '00	18.1	65.0	6.7	229.0	7.6	21.0	10.0	14.4
Oct. '00	12.3	204.0	8.3	188.0	8.1	13.4	10.7	13.2
Nov. '00	13.1	141.4	5.5	239.0	8.6	14.3	10.5	16.7
Dec. '00	8.5	178.2	5.8	260.0	8.4	9.2	11.0	19.9
Jan. '01	8.0	120.0	6.1	257.0	8.4	9.8	11.0	20.1
Feb. '01	7.3	136.2	7.3	217.0	7.8	7.8	11.2	17.2
Mar. '01	13.9	155.6	7.5	243.6	7.6	16.8	9.6	18.0
Apr. '01	17.4	220.8	7.4	285.6	7.8	20.0	10.3	12.5
May '01	21.2	118.6	8.4	283.0	8.1	23.1	11.0	12.5
June '01	25.1	139.0	8.1	300.0	8.0	21.0	10.2	12.7
July '01	28.0	58.0	7.4	303.4	8.1	20.1	8.9	12.6
Average	16.5	137.5	7.2	259.5	8.0	17.0	10.3	15.3

* Source: CAMUR-ELIPEK (2002).

Sampling Month	Cr*	Cd*	Fe*	Pb*	Ni*	Mn*	Co*	Cu*	Zn (Units are μg/l)
Aug '00	0	7.9	61.4	42.0	0	4.4	3.8	0.3	0
Sept. '00	0	0	24.2	0	4.0	3.5	0	0.2	0
Oct. '00	0	2.2	25.9	0	10.4	4.0	0	1.6	2.3
Nov. '00	0	0	22.7	10.0	8.5	3.4	0.3	0.4	0
Dec. '00	15.1	0	23.2	8.8	0	11.5	21.6	2.9	18.0
Jan. '01	14.2	0	18.5	13.9	0	7.7	0	0	0
Feb. '01	0	0	31.3	21.9	0	0	0	0.2	1.4
Mar. '01	16.2	0	25.0	21.7	0	2.9	0	0	4.5
Apr. '01	0.5	0	21.1	7.9	0	2.3	0	0.2	2.1
May '01	0.3	0.2	27.6	0	4.0	3.5	0.6	1.0	0.7
June '01	4.5	1	39.3	10.5	3.8	0	0	0.5	60.9
July '01	0	4.3	26.0	11.9	10.8	7.3	1.7	2.1	13.0
Average	8.5	3.1	28.9	16.5	6.9	5.1	5.6	0.9	12.9

* Source: CAMUR-ELIPEK (2002).

ally *Cladosporium* and *Aspergillus* species can occur naturally in the exterior environment and enter the indoor environment as spores or active fungi attached to dust particles. According to GAMBALE *et al.* (1985), a genus *Alternaria* has strong allergenic potential, and *A. alternata* a risk factor for respiratory arrest in the children and young adults with asthma (O'HOLLAREN *et al.* 1991). *Alternaria* made up spores 4.3% of our samples. Spore numbers of *Alternaria* are lower than those of *Cladosporium* in some sudies (DIXIT *et al.* 2000, SEN and ASAN 2001, TAKAHASHI 1997), but the spore volume of *Alternaria* is greater, so they are comparable in biomass. According to the CORDEN and MILLINGTON (2001), *Alternaria* spore concentrations may be responsible for increasing levels of respiratory disease, especially during harvest time. *Alternaria, Penicillium, Aspergillus* and *Fusarium* were found to be the dominant types in some studies such as SAVINO and CARETTA (1992). These genera were also dominant (37.5%) in our study.

Some waterborne fungi were identified to species level in our study. Certain fungi appear more frequently than others, in particular, the species *Scopulariopsis brevicaulis* and *Penicillium expansum* appear to be very common (Table 1).

Multiple factors may affect to dispersal of fungal spores into the air and water at the same time. Some parameters such as water pH, depth, oxygen and some heavy metals etc. (Table 4) determined in our study affect concentrations of water fungi. The prevalence of water fungi is variable and determined by many factors.

Aspergillus fumigatus, A. niger, Penicillium expansum and *P. chrysogenum* identified in our study are widespread in Turkey and have been reported in many studies (ASAN 2000).

AUGER *et al*. (1994) reported that *Penicillium brevicompactum* and *Trichoderma* sp. (also isolated in our study) were isolated from residences of individuals with chronic fatigue syndrome. So, outdoor airborne fungal spore monitoring in Terkos Lake may be useful from the allergological point of view. Future investigations are needed to further examine the effects of mould exposures on the related health problems.

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