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Fungal Spore Calendar of Yalova Province (2005)

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Abstract: The aim of this study is to determine the fungi, the concentration and distribution of fungi in the Yalova atmosphere in 2005 to create fungal spore calendar of the province. As a result of the study, totally 264984 s/m^3 belonging to 47 fungal species and 3 fungal groups were determined. *Cladosporium* (55.36%) was determined as the dominant taxon of Yalova atmosphere and was observed during all months of the study period. *Agrocybe* (13.61%), *Ustilago* (7.72%), *Alternaria* (7.59%) and *Ganoderma* (5.13%) were identified as common fungi. The highest spore concentration was recorded in July, the lowest spore concentration in February.

Key words: Atmospheric Fungal Spores, Fungal Spore Calendar, Fungus, Yalova

Yalova İli Fungal Spor Takvimi (2005)

Öz: Bu çalışmanın amacı 2005 yılında Yalova atmosferinde dağılım gösteren fungusları, bu fungusların konsantrasyonları ve dağılımlarını belirleyerek ilin fungus spor takvimini oluşturmaktır. Yapılan çalışma sonucunda 47 fungus cinsi ve 3 fungal gruba ait toplam 264.984 spor/m^3 tespit edilmiştir. *Cladosporium* (%55.36) Yalova atmosferinin dominant taksonu olarak belirlenmiş ve çalışma süresince tüm aylarda gözlemlenmiştir. *Agrocybe* (%13.61), *Ustilago* (%7.72), *Alternaria* (%7.59) ve *Ganoderma* (%5.13) yaygın funguslar olarak tespit edilmiştir. En yüksek spor konsantrasyonu Temmuz, en düşük spor konsantrasyonu Şubat ayında kaydedilmiştir.

Anahtar kelimeler: Atmosferik Fungus Sporları, Fungus Spor Takvimi, Fungus, Yalova

Introduction

Most of the atmospheric aerosol is of biological origin. Bioaerosols have biological effects like infectivity, allergenicity, toxicity etc. on plants, animals and humans. (Grinn-Gofroń et al., 2011). The fungi, which form an important part of the bioaerosol distributed in the atmosphere, are cosmopolitan organisms and their composition and concentration in the atmosphere is shaped by the complex relationship between biological and environmental factors such as geographic location, air pollution, weather, human activity and vegetation (Grinn-Gofroń and Bosiacka, 2015).

Determining the presence and distribution of fungi in a particular region is important for plant, animal and human health. Aerobiological monitoring guides to investigate the life cycle of parasites and to develop plant protection plans in agriculture; to realize extreme concentrations of allergic taxon and to help in the diagnosis and treatment of inhaled allergens in medicine. Fungi affect human life adversely especially with their allergen properties today. The international allergen

nomenclature sub-committee identified 112 allergens in 28 fungi (Levetin et al., 2015). *Alternaria* sp., *Aspergillus* sp., *Penicillium* sp., *Cladosporium* sp., *Botrytis* sp., *Drechslera* sp., *Epicoccum* sp., *Leptosphaeria* sp., *Pithomyces* sp., *Pleospora* sp. and *Stemphylium* sp. are the leading allergen taxa in this list (Sadyś et al., 2016). Fungus spore calendars are prepared for this purpose. Fungus spore calendars are considered due to the increased prevalence of allergic diseases, including *Cladosporium* and *Alternaria*, which are more than three times greater than 30 years, particularly in terms of allergenic spores. The aim of this study was to determine the fungi and their concentrations in the atmosphere of Yalova and to establish the 2005 spore calendar.

Materials and Methods

Yalova is located in the southeastern part of Marmara region, in the northwest of Turkey (40°39'32"N; 29° 16'26.06"E). The altitude of the province is 2 m height above sea level. The vegetation is composed of maquis and forests. Forests cover about 5% of the province, and generally consist of beech, oak, hornbeam, cranberry, chestnut and linden trees. The climate of the province has the characteristics of transition between Mediterranean and Black Sea climates (Anonymous, 2017).

Materials were collected by using Hirst-type pollen and spore trap (Lanzoni VPSS 2000, Bologna, Italy), placed 25 mm above ground level in the city center in 2005 (Figure 1). The device absorbs 10 L of air per minute equivalent to the human lung (Sánchez Reyes et al., 2016). The air sucked through the 2×14 mm wide hole, then enters the spore trap. The hand-held sampling cylinder with a mechanical watch on it travels 2 mm per hour to 48 mm per day and completes its full cycle in one week. 336 mm transparent tape is applied around the sampling cylinder and silicone oil solution is applied on it. The air entering the spore trap strikes the transparent tape on which adhesive is applied and the contents adhere to the tape. The band which is taken from the cylinder after completing its cycle is cut on the cutting board and then turned into daily preparations. Sampling and analysis were performed according to the guidelines of the European Association of Aerobiology (Galán et al., 2014). The number of fungal spores was multiplied by the calculated conversion factor and the average daily spore concentration in the cubic meter was determined (spore/m^3). Fungi detected in the atmosphere above 5% were accepted as common elements of the atmosphere (Mallo et al., 2011). Fungus spore calendar was prepared according to Spieksma (1991).

Figure 1. Hirst-type pollen and spore trap (Lanzoni VPSS 2000)

Results and Discussion

As a result of the aeromycological monitoring, 264984 s/m3 belonging to 47 fungus genera and 3 fungal groups were determined in Yalova province in 2005 (Table 1). 37 of the identified spores belonging to Ascomycota, 9 to Basidiomycota and 1 to Oomycota divisions. The groups are consisted of *Aspergillus/Penicillium*, one-septate ascospores and Myxomycota.

Table 1. Fungus spores, concentrations (s/m^3) and percentages of Yalova atmosphere in 2005

Taxa/Groups	Total	Percentage
Cladosporium	146707	55.364%
Agrocybe	36069	13.612%
Ustilago	20463	7.722%
Alternaria	20122	7.594%
Ganoderma	13590	5.129%
Leptosphaeria	4554	1.719%
Boletus	3244	1.224%
Coprinus	3107	1.173%
Periconia	2454	0.926%
Epicoccum	2332	0.880%
Fusarium	2281	0.861%
Botrytis	1590	0.600%
Pleospora	1313	0.496%
Stemphylium	717	0.271%
***Asper./Peni* type spores**	662	0.250%
Bovista	615	0.232%
Drechslera	529	0.200%
Exosporium	525	0.198%
Didymella	475	0.179%
Torula	440	0.166%
Paraphaeosphaeria	332	0.125%
Peronospora	328	0.124%
Antennularia	318	0.120%
Oidium	295	0.111%
Laccaria	286	0.108%
One-septate ascospores	183	0.069%
Tilletia	180	0.068%
Pithomyces	178	0.067%
Helicomyces	138	0.052%
Curvularia	135	0.051%
Puccınia	128	0.048%
Arthrinium	87	0.033%
Bipolaris	81	0.031%
Chaetomium	79	0.030%
Polythrincium	65	0.025%
Myxomycota	65	0.025%
Cercospora	59	0.022%
Melanomma	59	0.022%
Sporormiella	43	0.016%
Diplodia	34	0.013%
Pestalotiopsis	34	0.013%
Dictyosporium	22	0.008%
Ulocladium	16	0.006%
Ascobolus	12	0.005%
Xylaria	10	0.004%
Trichothecium	9	0.003%
Nigrospora	8	0.003%
Helminthosporium	5	0.002%
Erysiphe	4	0.002%
Tetracoccosporium	2	0.001%
Total	**264984**	**100.00%**

The majority of atmospheric fungi captured in the Yalova atmosphere were included in the Ascomycota division with 70.22%. Ascomycota division is followed by Basidiomycota division with 29.32%, *Aspergillus/Penicillium* with 0.25%, Oomycota division with 0.12%, one-septate ascospores with 0.07% and Myxomycota with 0.02%.

Ascomycota division is mainly represented by *Cladosporium* and *Alternaria* and peak concentration was recorded in July with 62118 s/m^3 for *Cladosporium* and 9316 s/m^3 for *Alternaria*. Basidiomycota division reached higher concentrations especially with the contribution of *Agrocybe* and *Ustilago* spore density; *Agrocybe* peak recorded in October with 16932 s/m^3 and *Ustilago* reached peak concentration in May with 6085 s/m^3. Only one genus was identified from the Oomycota division in the study and peak concentration was recorded in June with 139 s/m^3. Peak concentration was recorded with 252 s/m^3 in January for *Aspergillus/Penicillium*; with 45 s/m^3 for one-septate ascospores in July; with 35 s/m^3 in October for Myxomycota.

The dominant fungal spore of Yalova atmosphere was determined as *Cladosporium. Cladosporium* dominance was observed in many studies conducted worldwide (Almaguer et al., 2015; Mallo et al., 2011; O'Connor et al., 2014; Pyrri and Kapsanaki-Gotsi, 2015; Sánchez Reyes et al., 2016; Ščevková and Kováč, 2019; Songnuan et al., 2018; Sadyś et al., 2016; Sousa et al., 2016; Vélez-Pereira et al., 2016). *Cladosporium* determined as dominant taxa in studies conducted in Turkey (Akgül et al., 2016; Asan et al., 2004; Ataygül et al., 2007; Ayvaz et al., 2008; Bıçakçı et al., 2001; Bican Süerdem and Yıldırım, 2009; Bülbül et al., 2011; Çeter et al., 2006; Çeter and Pınar, 2009; Erkan et al., 2006; İmalı et al., 2008; Kalyoncu, 2010; Otağ et al., 2014; Potoğlu Erkara et al., 2008; Tatlidil et al., 2000, 2001). Spore concentrations of 3000 s/m^3 and above for *Cladosporium* and 100 s/m^3 for *Alternaria* and above were determined as risky values for allergy in the atmosphere (Durugbo, 2013). In our study, the limit of 3000 s/m^3 for *Cladosporium* was exceeded in the last three days of July and the first day of August. The 100 s /m^3 limit for *Alternaria* was exceeded for 8 days in June, 28 days in July, 23 days in August and 5 days in September.

The highest spore concentration was recorded in summer; followed by autumn, spring and winter (Figure 2), whereas the lowest spore concentrations were observed in February and March. The spore concentration started to increase with the increasing temperatures starting from April and the highest spore concentration was recorded in July (Figure 3). The spore concentration, which was started to decrease from August, showed an increase again in October and the spore concentration decreased rapidly as the temperature dropped below 15 ° C in November (Figure 3).

Cladosporium spores reached the highest exponential class (11th class; spore concentration 1600<) in the first 10-day mean of May, the last 10-day mean of May-the third 10-day mean of August period and the second and third 10-day mean of September. *Agrocybe* reached the 11th class in the last 10-day mean of September - the last 10-day mean of October period. *Alternaria* reached the highest exponential in the first 10-day mean of July. *Ustilago* reached the 10th step during May and in the second 10-day mean of June; *Ganoderma* only reached up to the 9th class (Table 2).

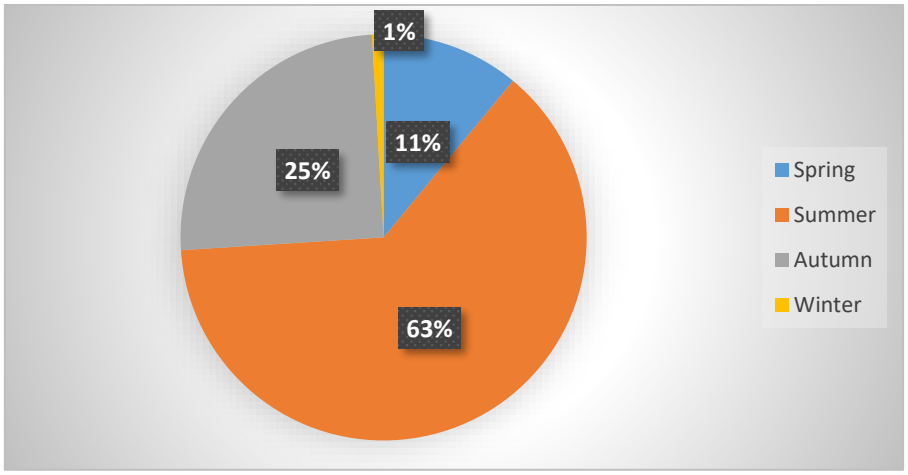

Figure 2. Seasonal distribution of fungus spores detected in Yalova atmosphere in 2005

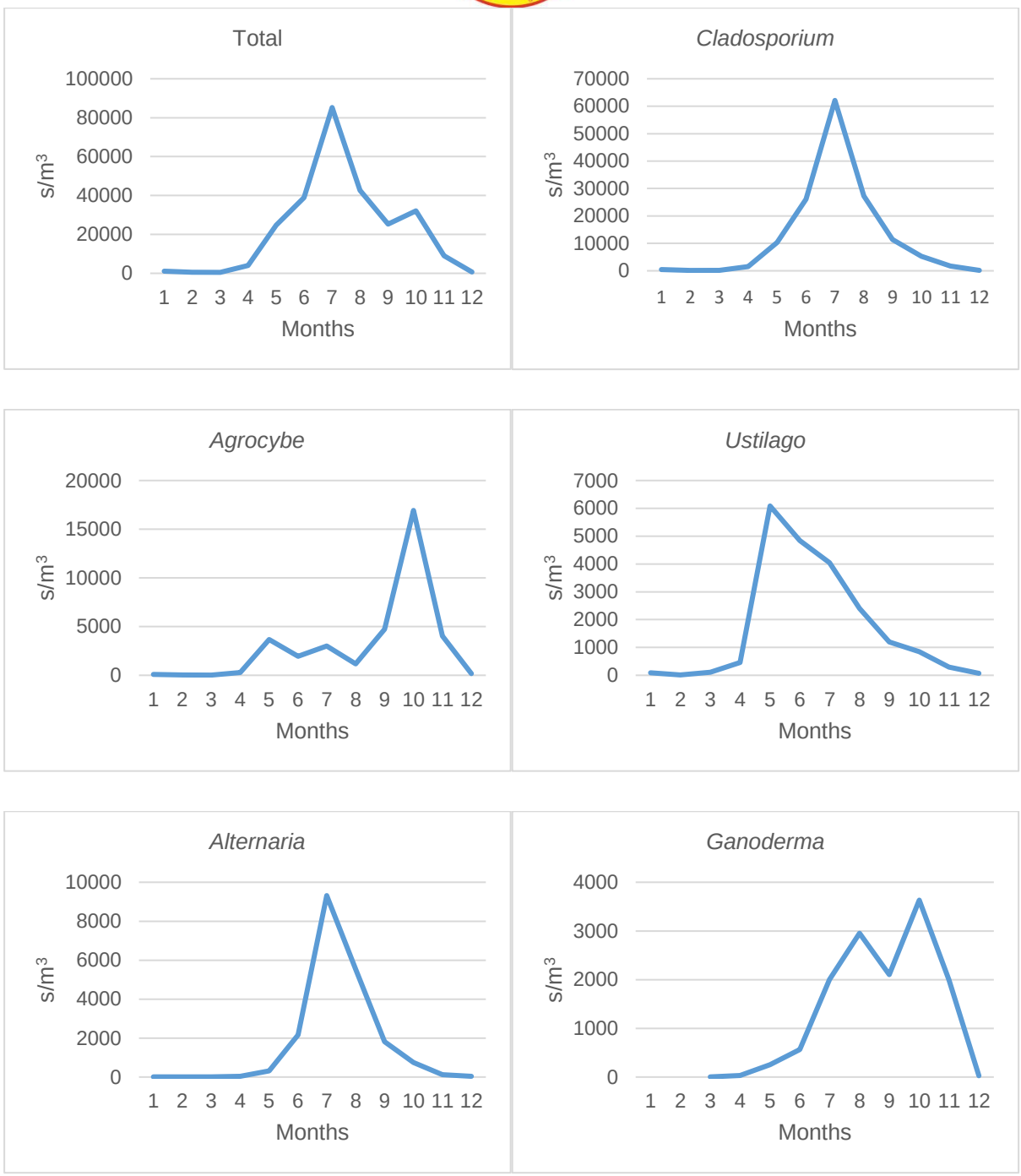

Figure 3. Distribution of dominant and common fungus spores and total spore concentration in Yalova atmosphere in 2005

Table 2. Fungal spore calendar of Yalova atmosphere in 2005

Months	January			February			March			April			May			June			July			August			September			October			November			December		
Periods	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Agrocybe																																				
Alternaria																																				
Antennularia																																				
Arthrinium																																				
Ascobolus																																				
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Boletus																																				
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Polythrincium																																				
Puccinia																																				
Sporormiella																																				
Stemphylium																																				
Tetracoccosporium																																				
Tilletia																																				
Torula																																				
Trichothecium																																				
Ulocladium																																				
Ustilago																																				
Xylaria																																				
Myxomycota																																				
One-septate ascospores																																				

Conclusion

As a result of the study, it was determined that the fungi distributed in Yalova atmosphere throughout the year. The highest spore concentrations were seen in July and August and *Cladosporium* was determined as the dominant taxon. *Cladosporium* exceeded the danger limit for 4 days and *Alternaria* exceeded for 64 days during the study period. It is clearly seen that both the periods in which the concentrations of allergens and plant pathogen fungi start to increase and the periods in which the maximum spore concentrations are reached in the prepared spore calendar. These data can help farmers and agriculturists to determine the amount and time of fungicide use. For patients suffering from allergies, the calendar can be a guide when planning daily activities and holiday times during peak periods. The prepared spore calendar will help to allergy specialists to diagnose sensitive patients.

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