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Research Article

Comparison of Soil Fungi Flora in Burnt and Unburnt Forest Soils in the Vicinity of Kargıcak (Alanya, Turkey)

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Abstract: Out of the 50 soil samples taken from burnt forest land in the vicinity of the village of Kargıcak in Alanya and from the adjacent normal forest soils by the Soil Dilution Plate Method 84 different species and 12 sterile microfungi taxa were obtained. Seventy-eight of them belong to Hyphomycetes, five to Mucorales and one to Coelomycetes. The richest taxa were *Penicillium* (34 species), *Aspergillus* (16 species) and *Cladosporium* (5 species).

As a result of quantitative analysis, it was determined that there was average of 43,780 propagules of microfungi in a bulk of fresh burnt forest soil equivalent to 1 g of oven dried soil and an verage 47,408 propagules of microfungi in the normal forest soil. The difference between the values taken from both lands was statistically insignificant.

Key Words: Burnt Forest, Soil, Microfungi, Alanya

Kargıcak Civarındaki Yanmış ve Yanmamış Orman Topraklarının Mikrofungus Florasının Karşılaştırılması

Özet: Alanya Kargıcak köyü civarı yanmış orman alanı ve bu alanın civarında bulunan normal orman alanından alınan toplam elli toprak örneğinden "Toprağı Sulandırma Metodu" ile yapılan kalitatif ve kantitatif analiz sonucu seksendört ayrı tür ve varyete ayrıca oniki ayrı steril mikrofungus elde edilmiştir. Bunların yetmişsekiz tanesi Hyphomycetes, beş tanesi Mucorales, bir tanesi Coelomycetes takımlarına aittir. Elde edilen taksonların tür sayısı bakımından en zenginleri sırasıyla *Penicillium* (34 tür), *Aspergillus* (16 tür) ve *Cladosporium* (5 tür)'dür.

Yapılan kantitatif analiz sonucu 1g fırın kuru toprağa karşılık gelen taze toprakta ortalama yangın alanında 43780, civardaki normal orman alanında 47408 birim mikrofungus bulunmuştur. İki alan arasındaki bu farklılık istatistiksel olarak önemsiz bulunmuştur.

Anahtar Sözcükler: Yangın ormanı, Toprak, Mikrofunguslar, Alanya

Introduction

Considering the crucial extent which environmental problems have reached today, it is quite obvious that any kind of ecological balance in nature should be preserved with maximum care. The destruction of green fields by fires and failure to carry out technical studies or take necessary protective measures in these fields within a short time are the causes of plantation failure in in these areas.

Micro-organism activity in the soil is one of the important links in the biochemical cycles in nature. If this activity is modified in any way or gains different dimensions, it will have a negative effect on other values in the ecosystem.

The first purpose of our study was to determine the negative results of fire as an environmental problem on the microfungi activity of forest soil and then to compare this activity with the activities of normal forest soil. We hope that a good database will be created to provide more awareness about the precautions to be taken.

Since the research carried out by Ademetz in 1886 it is known that microfungi are represented in the soil by many species (Ranzoni, 1968).

Wiclow et al. (1974) have compared microfungi of 40 years old forest soil composed pure alder (*Alnus*), pure needle type leaf and needle type leaf-alder and have totally isolated 92 species in Oregon.

Soderstrom (1978) researched the vertical distribution of microfungi in the soil of a spruce (Picea) forest in South Sweden and determined 90 different species. He reported that among these species *Penicillium*, *Mortierella* and *Trichoderma* formed 71% of total isolates.

Gams & Domsch (1969) researched the seasonal distribution of microfungi in agricultural soils and showed that the principle species are on organic particles.

Studies carried on soil mycology in Turkey have primarily concentrated on north-east Anatolia (Hasnekoğlu, 1982; Hasenekoğlu & Azaz, 1991; Hasenekoğlu & Sülün, 1991), the vicinity of İzmir (Ekmekçi, 1974 a, b; 1975; Öner, 1974; Türker, 1979) and Thrace (European Turkey) (Asan, 1997 a, b; Asan & Ekmekçi, 1994).

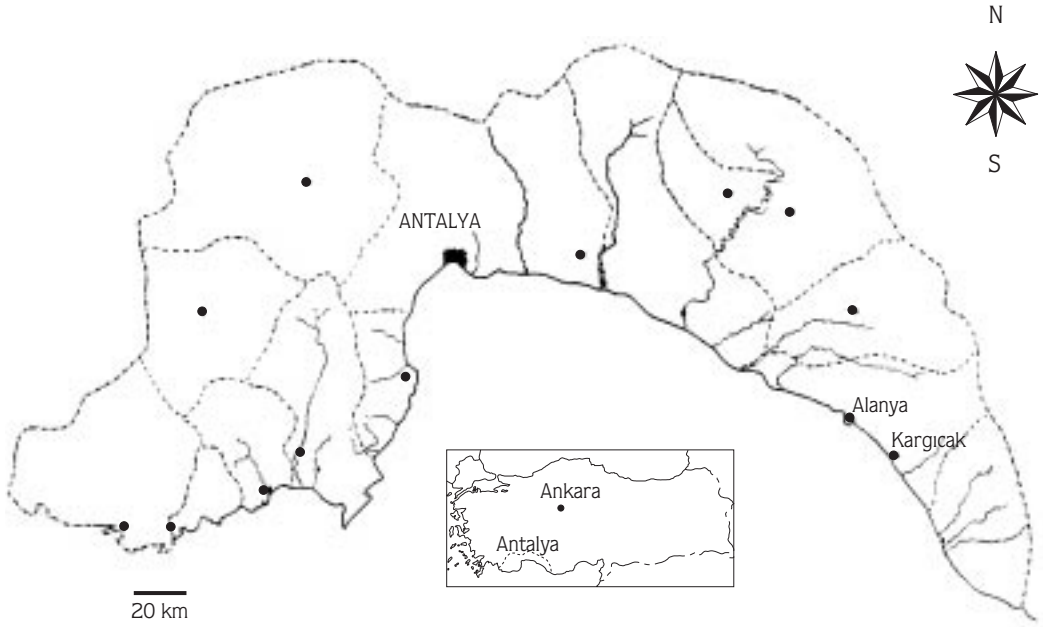
Description of the research area

The study area is located at longitude 37º27'N, latitude 32º10'E. The burnt forest land which is the main subject of our research is located to the south-east of Alanya in Antalya. The fire broke out in October 1997 and soil samples were taken in July 1998. When the soil samples were taken, the average soil surface temperature was 15. 9 ºC, the mean monthly precipitation was 1. 9 mm and the prevailing wind was from the south.

While the most common kinds of trees of the normal forest flora in the study area were *Pinus brutia* Ten. and *Quercus* L. sp., other less common kinds were *Phillyrea latifolia* L., *Juniperus* L. sp, *Myrtus communis* L. and *Crataegus* L. sp.

Materials and Methods

The stations from which samples were taken were chosen randomly. In sampling, first a soil profile was extracted and then the surface of the profile was cleaned (Brown,1958). Vertical samples were then taken from 10 cm depths with a disinfected spatula. The spatula was applied perpendicularly to the vertical surface of the profile. The samples were stored in a large sterilized and cooled thermos bottle until they reached the laboratory. In the laboratory, the samples underwent isolation using the Soil Dilution Plate method (Waksman, 1922). In this method, moisture content of a certain amount of soil was determined and fresh soil quantities corresponding to 25 g oven-dried soil were calculated (Öner, 1973). Then 1/10,000 dilutions of the samples were prepared (Warcup, 1960). Before the settling of organic matter and soil particles (Phara & Kommedahl, 1954), 1 mL of these solutions were inoculated to previously prepared



peptone dextrose agar plates (Papavizas & Davey, 1959). Then 10 petri dishes were prepared for every sample. These plates were incubated at 25 ºC for 10 days (Burges, 1967). In order to suppress bacterial growth 30 mg/L streptomycin and to restrict the colony size 30 mg/L rose-bengal were added to the isolation medium (Martin, 1950).

The colonies which developed on the petri plates were carefully counted and individual colonies were identified with the aid of a stereomicroscope and transferred to a separate agar plate. The isolates of *Aspergillus* Mich ex Fr. and *Penicillium* Link ex Gray genera were plated to Czapex Dox Agar and Malt Extract Agar and the others to Malt Extract Agar. In the identification procedure, the method of Smith was used (Smith, 1971). For this purpose, pure colonies of isolates were obtained in Czapex Dox and Malt Extract Agar. And then by regularly examining developed colonies, macroscopic (developing degree of cultures, colour of colonies and changes in colour, colour of colony reverse and changes in its colour, colour changes of medium, texture of colony surface, if there is odour, existence of exudates and its situation if so) and microscopic (habit of hypha, and its combination, development of fructification, and colour, dimension, and form of fructification, and details of its structure, and all details of spores) specifications were studied and identifications were made.

Identification of the isolates was performed according to Hasenekoğlu (1991), Subramanian (1983), Ellis (1971), Raper & Fennell (1965), Raper & Thom (1949), Nelson et al. (1983), Barron (1983), Gerlach & Nirenberg (1982), Zycha et al. (1969) and Samson & Pitt (1985).

For the chemical analysis, 25 soil samples from the burnt and normal forest land were grouped into five, and then they were re-coded after being united so as to provide at least 750 g in each sample. Then they were analysed according to Sezen & Aydın (1995).

Table 1. The colony numbers of genera and their proportion of the total number.

Isolate Name	Burnt Forest Soil		Normal Forest Soil	
	Colony Number	Proportion of Total Number (%)	Colony Number	Proportion of Total Number (%)
MUCORALES				
Cuninghamella Matr.	-	-	1	0. 178
Mucor Mich ex Fr.	7	1. 411	6	1. 069
Rhizopus Ehrenb.	-	-	1	0. 178
SPHAERIALES				
Chaetomium Kunze ex Fr.	6	1. 209	-	-
HYPHOMYCERES				
Acremonium Link ex Fr	7	1. 411	6	1. 069
Alternaria Nees ex Fr.	2	0. 403	14	2. 495
Aspergillus Mich ex Fr.	40	8. 064	161	28. 698
Beauveria Vuill .	-	-	2	0. 356
Botrytis Mich ex Fr.	1	0. 201	-	-
Cladosporium Link ex Fr.; Link	59	11. 895	23	4. 099
Curvularia Boedjin	-	-	1	0. 178
Fusarium Link ex Fr.	-	-	1	0. 178
Geomyces Traaen	11	2. 217	9	1. 604
Gliocladium Corda	8	1. 612	10	1. 782
Gliomastix Gueg.	2	0. 403	11	1. 960
Humicola Traaen	1	0. 201	-	-
Myrothecium Tode ex Fr.	-	-	15	2. 673
Paecilomyces Bainier	2	0. 403	12	2. 139
Penicillium Link ex Gray	200	40. 322	228	40. 641
Stachybotrys Corda	4	0. 806	8	1. 426
Trichoderma Pers ex Fr.	10	2. 016	1	0. 178
Ulocladium Preuss	3	0. 604	2	0. 356
Verticillium Nees ex Link	1	0. 201	2	0. 356

Table 2 . The colony numbers of the taxa and their proportion of their own genera, and of the total colony number.

Isolate Name	Nurnt Forest Soil			Normal Forest Soil		
	Colony Number	Proportion of own genus (%)	Proportion of total number (%)	Colony Number	Proportion of own genus (%)	Proportion of total number (%)
MUCORALES						
Cuninghamella elegans Lendn.	-	-	-	1	100	0. 178
Mucor hiemalis Wehmer f. hiemalis	-	-	-	6	100	1. 069
M. hiemalis Wehmer f. silvaticus Schipper	1	14. 285	0. 201	-	-	-
M. ramosissimus Samouts.	6	85. 714	1. 209	-	-	-
Rhizopus oryzae Went & Prins. Geerl.	-	-	-	1	100	0. 178
SPHAERIALES						
Chaetomium Kunze ex Fr. sp. 1	6	100	1. 209	-	-	-
HYPHOMYCETES						
Acremonium strictum Gams	4	57. 142	0. 806	6	100	1. 069
Acremonium Link ex Fr. sp. 1	3	42. 857	0. 604	-	-	-
Alternaria alternata Keissl.	2	100	0. 403	7	50	1. 247
A. citri Ellis & N. Pierce	-	-	-	7	50	1. 247
Aspergillus alliaceus Thom & Church	-	-	-	2	1. 242	0. 356
A candidus Link ex Link	3	7. 500	0. 604	22	13. 664	3. 921
A. carneus Blochwitz	1	2. 500	0. 201	10	6. 211	1. 782
A. ellipticus Raper & Fennell	1	2. 500	0. 201	4	2. 484	0. 713
A. flavus Link ex Gray	2	5	0. 403	5	3. 105	0. 891
A. foetidus var *pallidus* Naka	6	15	1. 209	15	9. 316	1. 069
A. fumigatus Fresen.	1	2. 5	. 201	-	-	-
A. heteromorphus Bat. & Maia	3	7. 5	0. 604	4	2. 484	0. 703
A. janus var. *brevis* Raper & Thom	4	10	0. 806	29	18. 012	5. 169
A. niger Tiegh.	-	-	-	7	4. 347	1. 247
A. sclerotiorum G. A. Huber	2	5	0. 403	6	3. 726	
A. sydowi Thom & Church	12	30	2. 419	31	19. 254	5. 525
A. terricola var. *americana* Marchal	2	5	0. 403	10	6. 211	1. 782
A. tubigensis (Schöber) Mosseray	2	5	0. 403	2	1. 242	0. 356
A. ustus Thom & Church	1	2. 5	0. 201	7	4. 347	1. 247
A. versicolor Tiraboschi	-	-	-	7	4. 347	1. 247
Beauveria bassiana Vuill	-	-	-	2	100	0. 356
Botrytis cinerea Pers. ex Nocca & Balb.	1	100	0. 201	-	-	-
Cladosporium cladosporoides de Vries	8	13. 559	1. 612	9	39. 130	1. 604
C. herbarum Link ex Gray	-	-	-	2	8. 695	0. 356
C. oxysporum Berk. & Curt	-	-	-	5	21. 739	0. 891
C. sphaerospermum Penz	50	84. 745	10. 080	7	30. 434	1. 247
Cladosporium Link ex Fries; Link sp. 1	1	1. 694	0. 201	-	-	-
Curvularia brachyspora Boedijn	-	-	-	1	100	0. 178
Fusarium Link ex Fr. sp. 1	-	-	-	1	100	0. 178
Geomyces pannorum (Link) Sigler & Carmich. var. *pannorum* van Oorschot	11	100	2. 217	9	100	1. 604
Gliocladium roseum Bain.	8	100	1. 612	10	100	1. 782
Gliomastix murorum (Corda) Hughes var. *felina* (Marchal) Hughes	2	100	0. 403	11	100	1. 960
Humicola grisea Traaen var. *grisea*	1	100	0. 201	-	-	-
Myrothecium carmichaelii Grev.	-	-	-	1	6. 666	0. 178
M. roridum Tode ex Fr.	-	-	-	14	93. 333	2. 495
Paecilomyces marquandii (Massee) Hughes	2	100	0. 403	12	100	2. 139

Table 2 . Continued.

Penicillium aeneum Smith	3	1. 5	0. 604	2	0. 877	0. 356
P. brevicompactum Dierckx	8	3. 40	1. 612	10	4. 385	1. 782
P. canescens Sopp.	29	14. 5	5. 846	31	13. 596	5. 525
P. chermesinum Biourge	4	2	0. 806	1	0. 438	0. 178
P. chrysogenum Thom	2	1	0. 403	6	2. 631	1. 069
P. citrinum Thom	-	-	-	10	4. 385	1. 782
P. claviforme Bainier	1	0. 5	0. 201	-	-	-
P. clavigerum Demelius	-	-	-	2	0. 877	0. 356
P. corylophilum Dierckx	37	18. 5	7. 459	17	7. 455	3. 03
P. crustosum Thom	-	-	-	3	1. 315	0. 534
P. decumbens Thom	6	3	1. 209	2	0. 877	0. 356
P. diversum Raper & Fennell	8	4	1. 612	16	7. 017	2. 852
P. diversum var. *aureum* Raper & Fennell	1	0. 5	0. 201	20	8. 771	3. 565
P. expansum Link ex Gray	6	3	1. 209	1	0. 438	0. 178
P. fennelliae Stolk	-	-	-	12	5. 263	2. 139
P. glabrum (Wehmer) Westling	-	-	-	3	1. 315	0. 534
P. italicum Wehmer var. *italicum* Samson, Stolk & Hadlok	20	10	4. 032	13	5. 701	2. 317
P. janthinellum Biourge	12	6	2. 419	7	3. 070	1. 247
P. jensenii Zalessky	17	8. 5	3. 427	6	2. 631	1. 069
P. lanosum Westling	3	1. 5	0. 604	5	2. 192	0. 891
P. madriti G. Smith	1	0. 5	0. 201	-	-	-
P. miczynskii Zalessky	-	-	-	2	0. 877	0. 356
P. multicolor Grig.-Mon. & Prod.	5	2. 5	1. 008	19	8. 333	3. 386
P. olsonii Bainier et Sartory	2	1	0. 403	1	0. 438	0. 178
P. purpurogenum Stoll.	1	0. 5	0. 201	1	0. 438	0. 178
P. resedanum McLetten., Ducker et Thrower	5	2. 5	1. 008	11	4. 824	1. 960
P. restrictum J.C.Gilman & E. V. Abbott	1	0. 5	0. 201	4	1. 758	0. 713
P. roquefortii Thom	2	1	0. 403	1	0. 438	0. 178
P. simplicissimum (Oudem) Thom	8	4	1. 612	1	0. 438	0. 178
P. spinulosum Thom	2	1	0. 403	2	0. 877	0. 356
P. steckii Zalessky	12	6	2. 419	16	7. 017	2. 852
P. sublateritium Biourge	-	-	-	3	1. 315	0. 534
P. variabile Sopp.	-	-	-	1	0. 438	0. 178
P. verrucosum (Dierckx) var. *cyclopium* Samson, Stolk & Hadlock	3	1. 5	1. 604	1	0. 438	0. 178
Stachybotrys cartarum (Ehrenb. ex Link) Hughes	4	100	0. 806	8	100	1. 426
Trichoderma harzianum Rifai	10	100	2. 016	1	100	0. 178
Ulocladium atrum Preuss	2	66. 666	0. 403	1	50	0. 178
Ulocladium tuberculatum Simmons	1	33. 333	0. 201	1	50	0. 178
Verticillium lecanii (Zimm.) Viégas	1	100	0. 201	2	100	0. 356
Sterile 1	79	100	15. 927	3	100	0. 534
Sterile 2	26	100	5. 241	7	100	1. 247
Sterile 3	12	100	2. 419	1	100	0. 178
Sterile 4	4	100	0. 806	2	100	0. 356
Sterile 5	5	100	1. 008	5	100	0. 891
Sterile 6	1	100	0. 201	5	100	0. 891
Sterile 7	-	-	-	2	100	0. 356
Sterile 8	1	100	0. 201	18	100	3. 208
Sterile 9	2	100	0. 403	3	100	0. 534
Sterile 10	-	-	-	1	100	0. 178
Sterile 11	1	100	0. 201	-	-	-
Sterile 12	1	100	0. 201	-	-	-

Soil moisture was determined by keeping 25 g soil samples at 105 ºC for 24 hours and by calculating the differences as percentages (Hasenekoğlu, 1985).

Soil reaction (pH) was determined using a pH meter with a glass electrode in a mixed soil-water 1: 1 ratio and lime content ($CaCO_3$) using a Schreiber calcimeter (Table 3). These data were evaluated as average degree acidic for burnt forest soil and slight acidic and rare limed for normal forest soil (Sezen & Aydın, 1995). Total salt value was obtained by measuring the electric conductivity of saturation extract obtained from the saturation mud and by converting this value to total salt (Demiralay, 1993).

Organic matter values of the soils were calculated by multiplying the organic carbon value by 1. 70 with the Smith-Weldon process (Nelson & Sommers, 1982).

The general averages of the result of the quantitative analysis of the burnt and normal forest land soils were compared by using a t-test of statistical analysis (Kutsal & Muluk, 1978). Citations of the authors' names presented are standardized according to Kirk & Ansell (1992).

Results

The aim of this study was to determine the microfungus flora of the burnt forest soil around Alanya and to make a comparison between this flora and the nearby normal forest soil flora and thus determine the influence of the fire. Six hundred and sixteen isolates were obtained from the analyses of the 50 soil samples taken from the burnt forest soil and normal forest soil in July 1998.

The identification of these isolates revealed 84 different microfungi species and varieties plus 12 sterile microfungi. Of these, 78 belong to Hyphomycetes, five to Mucorales and one to Coelomycetes.

The results of the statistical analysis were insignificant (t = 0. 53, p = 0. 6). Then the differences of the taxa between the two lands were compared and the result was significant. *Trichoderma* Pers ex Fr. (t = 6. 36, p = 0. 031) was obtained in higher density in the burnt land than in the normal forest land soil. *Aspergillus* (t = -3. 05, p = 0. 0072) and *Alternaria* Nees ex Fr. (t = -8. 49 ,p = 0. 0011) were obtained in higher density in normal forest soil than in the burnt forest soil.

The results of the chemical analysis of the soil samples revealed that there was no significant difference between the two places except that the normal forest soils had a higher amount of moisture. This situation was statistically significant (Table 3).

Discussion

The comparison between the microfungus flora of the burnt forest soil and that of the normal forest soil revealed that there was no statistically significant difference in the variation of species (Table 2). This may be due to the fact that the fire took place on the surface of the soil. Among the taxa obtained, cosmopolitan

Table 3. Physical characteristics of the study area.

Sample Number	Moisture (%)	pH	Lime ($CaCO_3$) (%)	Salt (%)	Organic Substance (%)
N1	3,820	6,20	0,161	0,029	3,889
N2	2,547	6,42	0,433	0,035	3,583
N3	3,734	6,53	0,449	0,037	4,016
N4	3,202	6,45	0,563	0,045	4,255
N5	3,248	6,65	0,176	0,022	2,669
F1	1,469	6,00	0,128	0,023	2,482
F2	1,503	5,82	0,097	0,020	3,277
F3	1,963	5,80	0,048	0,023	3,481
F4	2,259	6,20	0,081	0,031	4,181
F5	2,421	6,40	0,244	0,042	4,223

N: Normal Forest Soil F: Burnt Forest Soil

genera such as *Aspergillus*, *Penicillium* and *Alternaria* were found in greater densities while *Trichoderma*, *Cladosporium* and *Chaetomium* Kunze ex Fr. were obtained in lesser densities in normal forest soil.

Lucarotti (1981) obtained *Trichoderma*, *Penicillium*, *Mucor* Mich ex Fr. and *Mortierella* Coemans at higher frequencies in burnt forest soil in Canada. It can be postulated that these species do not show much sensitivity to ecological demands and are more resistant to negative conditions. Also Reaves et al. (1990) stated that they obtained *Trichoderma citrinoviride* Bissett more frequently in burnt forest soil. Chwalinski (1989) determined that the variety of species in the aftermath of a fire renewed itself within a year but the fungal density was not renewed completely in this period.

Hasenekoğlu & Azaz (1991) isolated 127 microfungi from 50 soil samples. The identification of these isolates resulted in 112 discrete species and strains and 15 sterile microfungi. The richest genera in terms of number of species were *Penicillium*, *Acremonium*, *Aspergillus*, *Trichoderma*, Cladosporium and *Mortierella*. The results they obtained from the soil dilution plate method show that a bulk of fresh soil equivalent to 1 g of oven-dried soils contains on average 235,440 microfungi propagules. And the average of the clear-cut area was 183, 270, and in the vicinity of the forest soils was 287, 160. This situation was statistically significant.

It has been reported by many researchers that the soil moisture, soil pH (Ramo Rao, 1970), salt amount (Hasenekoğlu & Sülün, 1991) and organic matter content (Behera & Mukerji, 1985) influence the activity of soil microorganisms.

The fact that the amount of organic matter is very high in all soils shows that the fire spread rapidly, did not do much harm under the soil and the fire was only on the surface (Kocataş, 1996). In addition, 20% of the organic matter is nitrogen and so these soils may be considered very rich in nitrogen. This may have a positive influence on microorganism activity in the soil. The fact that soils have a low rate of salt and lime (Ca^{+2}) may be noted as this does not have a negative effect on the activity of soil micro-organisms.

It can be concluded that there are no significant qualitative or quantitative differences between the flora of normal forest soil and that of burnt forest soil in terms of the soil microfungi a year after fire broke out in the forest in the vicinity of Alanya.

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