Ekoloji 24, 95, 23-31 (2015)
doi: 10.5053/ekoloji.2015.02

Community Structure and Seasonal Changes of Soil Microarthropods in a Native Oak Stand and Scots Pine Plantation

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Abstract
The community structures and seasonal changes of soil microarthropods were investigated in a natural Sessile Oak (*Quercus petraea*) stand and adjacent Scots Pine (*Pinus sylvestris*) plantation located in the Belgrad Forest of Istanbul. Soils for microarthropods were sampled monthly using steel soil corers between November 2008 and October 2009. Soil fauna samples were extracted with a modified Berlese-Tullgren funnel and stored in 70% ethanol. A total of 26 taxons of microarthropods were identified in the oak stand and Scots pine plantation. The mean annual number of microarthropods per square meter was 42.851 for the oak stand versus 42.276 for the Scots pine plantation. The Collembola and Acarina are the two dominant taxa in numbers constituting 94% and 93% of all soil microarthropods of the native oak and Scots pine plantation, respectively. The Shannon diversity index (H') of microarthropods in the Scots pine site (1.72) was found significantly (P=0.008) higher than those of the native oak (1.57). This result implies that even though conversion of Sessile oak land to a Scots pine plantation may decrease the abundance but increased the diversity of soil microarthropods.
Keywords: Biodiversity, collembola, community, microarthropods, oak, scots pine.

Toprak Mikroeklembacaklılarının Doğal Meşe ve Sarıçam Ağaçlandırma Alanındaki Komünite Yapıları ve Mevsimsel Değişimleri

Özet
Bu çalışmada, toprak mikroeklembacaklılarının komünite yapıları ve mevsimsel değişimleri İstanbul Belgrad ormanında doğal Sapsız meşe (*Quercus petraea*) ve sarıçam (*Pinus sylvestris*) ağaçlandırma alanlarında Kasım 2008 ile Ekim 2009 tarihleri arasında incelenmiştir. Her iki çalışma alanından mikroeklembacaklılar için çelik silindirler ile aylık olarak 3 tekrarlı örnek alınmıştır. Örneklenen toprak faunası modifiye Berlese-Tullgren hunisi ile çıkarılmış ve %70'lik etil alkol içerisinde saklanmıştır. Araştırma sonucunda meşe alanında metrekarede yıllık ortalama 26 taksona ait 42.851 birey, sarıçam alanında ise 42.276 birey sayılmıştır. Collembola ve Acarina taksonları sayıca baskın gruplar olup meşe ve sarıçam alanlarında sırası ile toprak mikroeklembacaklılarının %94 ve %93'ünü oluşturmaktadırlar. Mikroeklembacaklılara ait Shannon çeşitlilik değeri (H') sarıçam meşceresinde (1,72) meşe meşceresine (1,57) kıyasla önemli derecede (P=0,008) yüksek bulunmuştur. Meşe sahalarına yapılan sarıçam ağaçlandırması mikroeklembacaklı sayısını azaltmasına rağmen çeşitliliğini arttırmıştır.
Anahtar Kelimeler: Biyoçeşitlilik, collembola, komünite, mikroeklembacaklılar, meşe, Sarıçam.

Cakir M, Makineci E (2015) Microarthropods in a Native Oak Stand and Scots Pine Plantation. Ekoloji 24(95): 23-31.

INTRODUCTION

Human disturbance of natural ecosystems such as reforestation and land use changes may have a significant effects on biodiversity (Vitousek et al. 1997, Sala et al. 2000). It is known that biodiversity exerts profound effects on ecosystem functions and studies conducted in recent years have focused on the interactions between biodiversity and ecosystem processes (Balvanera et al. 2006). Various studies have emphasized the positive relationship between plant diversity and aboveground biomass production (Naeem et al. 1994, Roscher et al. 2005). Although the relationship between above and belowground diversity is not really known (Koricheva et al. 2000, Gastine et al. 2003, Hedlund et al. 2003), some studies suggest that soil arthropod diversity may be affected by aboveground plant diversity (Salmon et al. 2008, Sabais et al. 2011).

Aboveground primary production affects the soil organisms in the rhizosphere via increased carbon

Received: 15.06.2012 / Accepted: 21.02.2015

allocation (Wardle 2002, Wardle et al. 2004). Organic matter decomposition may be accelerated with the mixture of litter from different sources (Spehn et al. 2000), with different nutrient content (Oelmann et al. 2007) and the abundance and diversity of decomposers (Spehn et al. 2000, Balvanera et al. 2006, Milcu et al. 2008). However, evidence that the belowground diversity positively affects the aboveground plant diversity is scarce (Wardle et al. 1999, Gastine et al. 2003, Porazinska et al. 2003).

The diversity and abundance of soil fauna which play crucial roles in the aboveground and belowground systems are regulated by regional factors such as climate conditions, parent material, altitude, forest type and succession (Grossi and Brun 1997, Materna 2004), and local factors such as canopy, light intensity, predators, humus form, nutrient availability, soil pH, and moisture content (Salmon et al. 2008). Soil arthropods have an important effect on the ecosystem processes (Cragg and Bardgett 2001, Cole et al. 2006, Çakır and Makineci 2009) like litter decomposition, mineralization of nutrients, and primary production (Birkhofer et al. 2011).

Terrestrial biodiversity is very closely linked with forest ecosystems. Biodiversity is threatened as a result of various factors such as the fragmentation of forest and a decrease in habitat quality (Hartmann et al. 2010). Afforestation is the most effective and efficient method used in the rehabilitation and restoration of forest lands that were lost as a result of anthropogenic factors and natural disturbances. The size of the land to be afforested, selection of tree species to be planted, and potential impacts on the ecosystem are essential (Ürgenç 1998). The land use history and the selection of tree species for reforestation or afforestation may have negative or positive effect on biodiversity (Hartmann et al. 2010).

Therefore the aim of the current study is to compare the effects of the conversion of a natural oak stand to a pine plantation on community structures and diversity of soil microarthropods in the Istanbul Belgrad Forest.

MATERIALS AND METHODS

The Belgrad Forest is located in the Istanbul province in the Marmara Region between 41° 09' - 41° 12' N latitude and 28° 54' - 29° 00' E longitude in Turkey. According to the (long-term) data provided the by Bahcekoy Meteorology Station, the nearest meteorology station to the study area, the mean annual precipitation (MAP) is 1074 mm, the mean annual temperature (MAT) is 12.8°C, mean high temperature is 17.8°C and the average low temperature is 9°C. The climate of the Istanbul Belgrad Forest is a maritime climate with a medium water deficiency in summers (Akburak et al. 2013).

According to the World Reference Base for Soil Resources (WRB), the soil group in the research area is Luvisol (Anonymous 2006) and the soils are well-drained. The general texture type of the soils is loam. The vegetation period is maintained for 7.5 months (230 days) on average. The altitude is 140 m, and the slope is 10-15% with a southern aspect (Akburak et al. 2013).

The study site was selected in the Scots pine stand converted from an original oak stand about 60 years ago and the control plot was sampled from an adjacent primary natural Sessile oak (*Quercus petraea* L.) stand as common garden experiments without replications. Common garden experiments provide an opportunity to minimize confounding effects since the same tree species are planted in adjacent blocks so that climate, parent material, time, hydrology, and previous land use are almost the same (to keep other site-related factors similar between tree species). However, common garden experiments are rare (Binkley and Giardina 1998) and often without replication (Vesterdal et al. 2008). The study sites were established in 1950 by introducing coniferous tree species instead of the natural Sessile Oak forest. The soil was left relatively undisturbed. Any forest management such as weed control, silvicultural treatment, and agricultural practices, such as fertilization, were not applied after the establishment (Sevgi et al. 2011, Akburak et al. 2013).

The age of the oak and pine stand was 84 and 62 years respectively, determined by counting annual year rings taken from 3-5 sample trees randomly from each plot. The natural oak forest is coppice originated. The average tree diameter was 27.2 cm, average tree height was 18 m, and the stand density was 1005 trees/ha in the Scots pine stand. In the oak stand, the average tree diameter, average tree height, and stand density were 26.6 cm, 20.0 m, and 444 trees/ha, respectively.

Three sampling plots on each stand were randomly established. On each plot three spots were randomly located for monthly sampling (Fig. 1).

Soil and litter samples were taken every month from November 2008 to October 2009. After determining the thickness of the forest floor, litter samples were collected from a 25 cm^2 area including leaves-needles, branches, cones, and acorns. Litter samples were dried at for two days at 55°C and then weighted and ground for analysis. The humus forms were classified in the field according to the classification system based on the European Humus Research Group (Zanella et al. 2009, Zanella et al. 2011).

During each sampling, 3 replicates of soil core samples for microarthropods were taken randomly from each plot (2x3x12 total 72 cores) (Fig. 1). The samples were taken randomly in a range of approximately 5 m within each stand. The samples represent soil cores 5 cm in diameter and a 5 cm depth. Soil and litter dwelling microarthropods were extracted using modified Berlese-Tullgren funnels equipped with 25 W bulbs (Murphy 1962, Coleman et al. 2004). The extraction process was finished when the soil was completely dried (4-5 days). All arthropods extracted from each sample were preserved in 70% ethanol. These were later sorted, identified and counted under stereoscopic binoculars (Leica S8 APO) to orders or families according to Dindal (1990).

The total carbon and nitrogen contents were measured using a CN analyzer (LECO Corporation, St. Joseph, MI). The bulk density (D_b) was determined by the core method (Blake and Hartge 1986). Soil pH was measured by placing 10 g subsamples of air-dried soil in 25 ml of deionized water, mixing this slurry, and then using a pH meter. The electrical conductivity (EC) was measured by adding deionized water to a certain amount of air-dried soil subsamples, then the conductivity of this paste was measured using a conductivity meter. Moisture was calculated as a difference between the weights of fresh and dried soil samples (dried at 105ºC for min. 24 hours) (Karaöz 1989).

The nonparametric "Independent samples t-test" was used to determine the effects of the two tree species on humus characteristics and soil properties. To test microarthropods' differences in distribution and diversity, species richness, index of diversity, and evenness were calculated. Abundance (A), species richness (S), Shannon's diversity index, and (H') were used as community parameters (Shannon and Weaver 1949). The effects of the

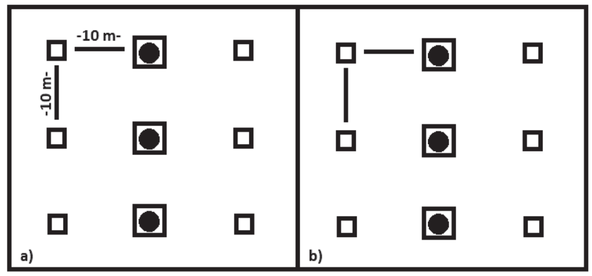

Fig. 1. Sampling design of microarthropods (●), litter and soil corers (□) on Oak (a) and adjacent Scots Pine (b) plots.

investigated variables on the soil microarthropod community composition was estimated using the Redundancy Analysis (RDA) ordination technique with the CANOCA software program (Hill and Gauch 1980).

RESULT

The humus types were determined as transition forms between mull and moder. The developing humus tends to mull under oak and moder under Scots pine. The forest floor litter mass (2757 g m^{-2}) in the Scots pine plantation was significantly (p=0.001) higher than that of oak stand (1951 g m^{-2}). The litter thickness (2.5 cm) under the oak was significantly (p=0.003) lover than the Scots pine (3.5 cm) (Table 1).

There is no significant difference in the carbon concentration of the litter between the oak stand (33.5 %) and Scots pine plantation (33.9 %). While the N concentration of oak litter was about 36% higher than that of the Scots pine (p= 0.001). As a result, the C/N ratio of litter between the sites was significantly different (p=0.000) (Table 1).

Soil bulk density for the first 5 cm of soil depth did not significantly differ between the sites. The soil pH in the Scots pine site was about 9% lower than that of the oak stand (p=0.019) (Table 1). No calcium carbonate ($CaCO_3$) was detected in the soil in any of the sampling plots.

The carbon concentration of the mineral soil was 36% higher than that of the Scots pine site (p=0.000). The C/N ratios of the same mineral soil samples were also significantly different between the sites (p=0.000) (Table 1).

The mean abundance of microarthropods in the oak stand and pine plantation was 42,276 and 42,851 per m^2, respectively. Species diversity (H') of the soil arthropods was significantly (p=0.008) higher in the oak stand (1.72) than those of the pine

Table 1. Some properties of the litter and soil in the oak and Scots pine stands.

		Scots pine	Oak	*p*
Litter	Mass (g/m²)	2757.43 ± 126.85	1951.06 ± 82.36	0.004★★
	Thickness (cm)	3.55 ± 0.68	2.55 ± 0.39	0.003★★
	C_{Total} (%)	33.91 ± 3.00	33.58 ± 2.23	0.757 ^{NS}
	N_{Total} (%)	1.13 ± 0.12	1.51 ± 0.15	0.001★★
	C/N	30.27 ± 5.87	22.25 ± 1.68	0.000★★★
Mineral Soil (0-5 cm)	C_{Total} (%)	6.03 ± 0.25	8.26 ± 0.53	0.000★★★
	N_{Total} (%)	0.13 ± 0.19	0.12 ± 0.002	0.690 ^{NS}
	C/N	45.36 ± 6.01	64.51 ± 4.11	0.000★★★
	D_b (g/l)	1158.2 ± 120.64	1072.5 ± 110.39	0.113 ^{NS}
	pH	5.11 ± 0.35	5.62 ± 0.43	0.019★
	EC (µs/cm)	219.16 ± 77.44	221.33 ± 77.95	0.724 ^{NS}
	T (°C)	13.27 ± 1.56	13.90 ± 1.55	0.779 ^{NS}
	W (%)	39.02 ± 4.25	35.89 ± 3.05	0.555 ^{NS}
Litter and Soil Invertebrates	*A* (m²)	42,276 ± 20,843	42,851 ± 22,678	0.911 ^{NS}
	H'	1.72 ± 0.20	1.57 ± 0.24	0.008★★
	S	10.08 ± 2.55	9.38 ± 2.34	0.205 ^{NS}

Db, Bulk density; T, soil temperature; W, soil moisture; EC, Electrical conductivity; A, Abundance; H', Shannon's diversity index; S, Species diversity. ★★★, P<0.001; ★★, P<0.01; ★,P<0.05 and NS, non-significant. Means ± standard error.

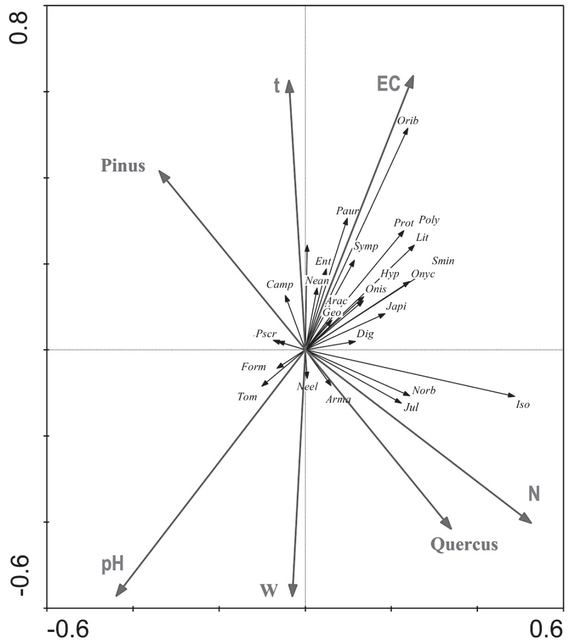

Fig. 2. RDA analysis of the species, N of the litter, pH, EC of soil, soil temperature (t), and soil moisture (W) according to axes 1 and 2. For abbreviations see Tables 3 and 5.

plantation (1.57).

A total of 26 microarthropods taxons were collected during the study period. Among the soil microarthropods, Acarina and Collembola were the dominant groups, accounting for 39 % and 55 % in the oak and 44 % and 49 % in the pine of the total number of soil microarthropods, respectively. Other microarthropod groups constitute 6 % in the oak and 7 % in the Scots pine (Table 2-3).

At the end of the RDA analysis, explanation rates of the axes on variance were determined as; first axis=52%, second axis=28%, and third axis=10.9 %. Total of first and second axes has a main importance with the rate of 80 % on variance despite the third axis which has a little importance on the explanation ratio. For this reason, all evaluations were made according to the first two axes (first and second axes).

Soil pH, EC, and N ratio, were determined as the most effective variables on the distribution of microarthropods (Fig. 2). Especially N which had the highest correlation with axis 1, whereas, EC and pH had the highest correlation with axis 2 (Fig. 2). According to the annual changes of the variables investigated with RDA analysis, the EC and soil temperature under the Scots pine, and N and soil moisture under the oak had higher values (Fig. 2). The abundance of Oribatida was higher under the Scots pine and positively correlated with the EC. In addition, the amounts of predator taxa (Arachnida and Pseudoscorpionida) were higher under the Scots pine (Fig. 2, Table 3). The existing Isopoda (Armadillidiidae), Diplopoda (Julida) and Collembola (Isotomidae) taxa had a positive correlation with the N content in the oak stand. Increasing soil acidity resulted in a decrease in the amount of Protura and Polidesmidae and an increase in the Tomoceridae. The abundance of the Neelidae family was directly related with the soil moisture (Fig. 2).

The seasonal changes of some soil dwelling microarthropods are presented in Figure 3. The seasonal changes of Collembola in the oak stand affected the populations of predator taxa (Pseudoscorpionida and Arachnida). While amount of Collembola decreased, the amount of predators (especially pseudoscorpions) increased.

DISCUSSION

Different tree species found in the same habitat exert important effects on the physical and chemical properties of the soil (Binkley and Giardina 1998, Göl et al. 2010). The changes created by these species are realized in the microclimate, litter, and rhizosphere (Fisher and Binkley 2000). Our results support that, there are differences between oaks and Scots pines in terms of canopy and the chemical components of litter (Irmak and Çepel 1974). The litter and humus form affect the soil's physical and chemical properties (Ponge and Chevalier 2006) as well as the nutrients for plants and community structures of soil dwelling arthropods (Ponge 2003,

Table 2. Seasonal abundance of microarthropods (x 10^3 ind./m^2) in the Sessile oak stands.

CLASS/ORDER	Suborder/Family	Code	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Acari	*Oribatida*	Orib	8.3	0.6	3.5	1.4	0.8	8.0	4.6	3.3	7.5	13.6	7.5	7.4
	Nonoribatida	Norb	14.9	8.5	24.2	10.1	12.1	11.1	7.4	7.5	10.3	17.1	3.7	8.6
Collembola	*Entomobryidae*	Ent	10.6	1.8	9.4	4.5	3.7	5.7	8.5	12.7	17.3	7.4	3.2	2.8
	Tomoceridae	Tom	-	0.1	0.5	0.2	0.6	0.6	2.6	0.7	0.7	0.1	0.4	0.9
	Isotomidae	Iso	13.3	6.4	26.2	13.4	10.6	25.8	7.2	4.5	23.2	9.1	3.2	15.3
	Sminthuridae	Smin	2.7	1.1	0.6	0.1	-	0.6	0.2	-	0.5	-	1.4	1.1
	Neelidae	Neel	6.8	0.9	1.8	0.6	1.2	1.5	0.4	-	1.2	-	2.6	3.7
	Neanuridae	Nean	0.1	-	0.1	-	-	-	-	-	-	-	-	-
	Onychiuridae	Onyc	-	-	-	0.1	0.4	0.6	0.1	-	0.2	0.2	-	-
	Hypogastruridae	Hyp	-	-	-	-	-	-	-	-	-	-	0.1	0.2
Diplopoda	*Julida*	Jul	0.2	0.1	-	0.1	-	0.2	0.1	-	-	-	0.2	0.5
	Polydesmida	Poli	-	-	-	-	-	-	-	-	-	-	0.2	-
	Polyxenida	Poly	0.2	-	-	-	-	-	-	-	-	-	-	-
Chilopoda	*Lithobiomorpha*	Lit	0.1	-	-	-	-	-	-	-	0.4	0.1	-	-
	Geophilomorpha	Geo	0.1	-	-	-	-	-	-	-	-	0.2	-	-
Isopoda	*Oniscidae*	Onis	-	-	0.1	-	-	-	-	-	0.5	0.2	-	-
	Armadillidiidae	Arma	0.5	0.2	-	-	-	-	-	-	-	-	-	-
Protura		Prot	1.9	0.5	0.1	0.1	-	0.6	0.4	0.4	1.9	0.2	0.4	1.5
Pauropoda		Paur	-	-	-	0.1	-	-	0.5	0.4	-	-	-	0.5
Arachnida	*Araneae*	Arac	-	-	-	-	-	-	-	-	0.6	0.1	0.1	-
Diplura	*Campodeidae*	Camp	-	-	-	0.4	-	-	-	0.2	0.2	0.1	0.2	-
	Japigidae	Japi	-	-	-	-	-	0.1	0.1	-	-	-	-	0.4
Pseudoscorpionida		Pscr	0.1	0.2	-	0.1	-	0.1	-	-	-	0.1	-	-
Sympyla	*Scolopendrellidae*	Symp	-	-	-	-	-	-	-	-	-	0.4	-	0.4
Hymenoptera	*Formicidae*	Form	-	-	0.2	0.2	-	-	0.2	0.2	-	0.1	-	-
Others		Dig	0.9	-	0.7	0.7	0.2	0.6	0.8	0.7	0.8	0.9	1.2	1.1

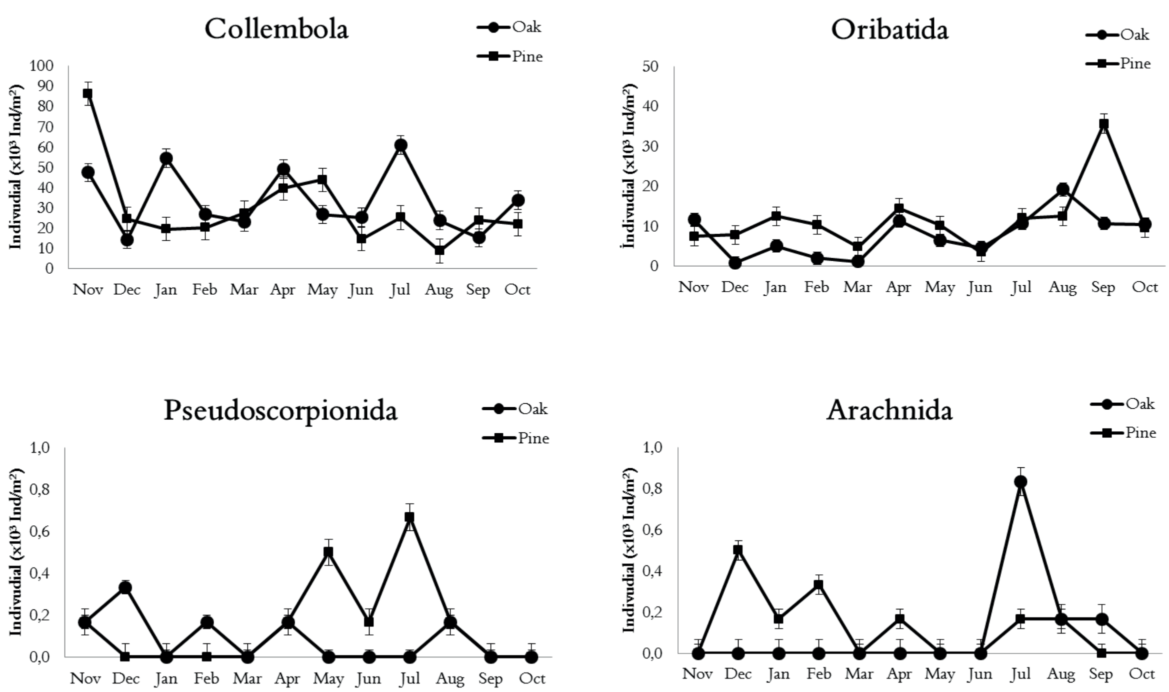

Fig. 3. Seasonal changes of some soil microarthropods (Collembola, Oribatid, Arachnida, and Pseudoscorpionida) in the oak and Scots pine stands. Bars indicate standard errors.

Salmon et al. 2008).

Both physical and chemical properties of humus forms add nutritional diversity and ecological niches for living organisms within the soil, thus affecting their abundance and diversity (Mori et al. 2009). In the current study, the humus form likely tends to be

Table 3. Seasonal abundance of microarthropods (x 10^3 ind./m^2) in the Scots pine plot.

CLASS/ORDER	Suborder/Family	Code	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Acari	*Oribatida*	Orib	5.3	5.5	8.8	7.3	3.4	10.3	7.2	2.5	8.5	8.8	25.2	6.7
	Nonoribatida	Norb	16.2	14.7	9.6	11.6	8.4	9.4	8.7	5.9	14.3	5.8	14.3	6.5
Collembola	*Entomobryidae*	Ent	21.2	4.5	3.1	2.7	2.1	5.9	10.1	5.5	5.5	1.4	3.5	4.0
	Tomoceridae	Tom	-	2.4	3.3	0.9	1.5	1.8	2.4	0.1	0.4	-	0.4	0.6
	Isotomidae	Iso	23.7	5.1	2.9	7.3	6.0	14.5	8.4	4.1	10.5	4.8	9.1	7.2
	Sminthuridae	Smin	1.3	0.5	0.4	0.1	-	0.1	0.2	-	-	-	2.1	0.8
	Neelidae	Neel	14.9	5.0	3.8	2.6	8.7	3.8	9.4	-	1.5	-	0.7	2.5
	Neanuridae	Nean	-	-	-	-	-	0.6	0.5	0.4	-	-	-	-
	Onychiuridae	Onyc	-	-	0.5	0.7	1.1	1.4	-	0.2	-	-	1.1	0.5
	Hypogastruridae	Hyp	-	-	-	-	-	-	-	-	-	-	0.1	-
Diplopoda	*Julida*	Jul	-	-	-	-	-	-	0.2	-	-	0.2	-	-
	*Polydesmida**	Poli	-	-	-	-	-	-	-	-	-	-	-	-
	Polyxenida	Poly	0.5	0.2	-	0.6	0.4	0.9	0.4	-	0.6	0.4	0.4	0.2
Chilopoda	*Lithobiomorpha*	Lit	0.1	-	0.1	-	0.1	0.4	0.1	-	-	-	0.1	0.1
	Geophilomorpha	Geo	-	-	-	0.1	-	0.1	-	-	-	-	-	-
Isopoda	*Oniscidae*	Onis	-	-	-	-	-	-	-	-	0.1	-	-	-
	*Armadillidiidae**	Arma	-	-	-	-	-	-	-	-	-	-	-	-
Protura		Prot	1.9	0.7	-	-	0.5	0.6	0.6	0.5	0.8	0.7	1.3	0.1
Pauropoda		Paur	-	0.4	-	0.1	-	0.1	-	-	0.5	-	1.1	-
Arachnida	*Araneae*	Arac	-	0.4	0.1	0.2	-	0.1	-	-	0.1	0.1	-	-
Diplura	*Campodeidae*	Camp	0.1	0.2	0.2	0.1	0.1	0.2	0.1	0.4	0.5	-	0.2	-
	Japigidae	Japi	-	-	-	-	-	-	-	-	-	0.1	0.1	0.2
Pseudoscorpionida		Pscr	0.1	-	-	-	-	0.1	0.4	0.1	0.5	0.1	-	-
Sympyla	*Scolopendrellidae*	Symp	-	-	-	-	-	0.4	-	-	0.4	0.2	0.1	0.2
Hymenoptera	*Formicidae*	Form	-	-	0.1	-	-	-	0.2	-	-	-	0.1	-
Others		Dig	0.2	0.6	0.7	0.5	0.5	0.8	0.6	0.4	0.7	1.1	0.4	0.6

* Nonexistent taxon in plot.

mull type under the oak, and moder type under the Scots pine. Mull type humus with a faster decomposition has little accumulation on the forest floor and it is low in phenolic and lignin content and rich in living organisms. However, moder type humus with a low decomposition rate may accumulate on the forest floor and it has a higher phenolic and lignin content and poorer soil dwelling organisms (Irmak and Çepel 1968, Ponge 2003). The low C/N ratio of the oak litter may have a faster decomposition rate which means an enhanced palatability for decomposers (David and Gillon 2002). This can explain the higher abundance of microarthropods in the oak stand. The litter of the Scots pine decomposes at a slower rate and has a thick litter accumulation (Sariyildiz 2003). The thick litter with a distinct O_L, O_F, and O_H layer may create new ecological niches for living organisms within the soil and increase the diversity of the microarthropods. The Scots pine plantations enrich the litter diversity in the ecosystem, which increases the diversity of microarthropods with new food sources (Gartner and Cardon 2004).

The Scots pine plantation can be considered as a small island within the natural oak ecosystem of the Belgrad Forest. According to the theory of island biogeography developed by MacArthur and Wilson (1967), extinction and immigration rates have not reached equilibrium in the Scots pine island, which differs from the surrounding ecosystem in terms of ecological and evolutionary processes (Fig. 3). The absence of certain microarthropod species (Polidesmida and Armadillidiidae) in the Scots pine plantation (Table 3) may suggest that they have not migrated to the area yet or they have become extinct in the area (Losos et al. 2010). There is a balance between springtails (Collembola) and predator taxa (Arachnida and Pseudoscorpionida) in the oak ecosystem. Although there is a predator-prey cycle, the seasonal changes of arthropods in the Scots pine seem not to be balanced. Figure 3 shows an increase in the quantity of springtails (Collembola) in the oak ecosystem in November, January, April, and July and a decrease in other months. The rise in the quantity of springtails is followed by an increase in the number of predators. In the Scots pine area, on the other hand, there is no balance between competitions of prey and predator taxa. The decrease in the number of springtails between November and April shows that they are exposed to high levels of predation (Arachnida). Similarly, there is a decrease in the abundance of springtails in the Scots pine plantation between May and August, accompanied with a rise in the abundance of Pseudoscorpionida (Fig. 3).

The high abundance of springtails found in the oak area can be explained by a low abundance of predators. Lawrence and Wise (2000) determined that the abundance of springtails increases by 60% in areas where there were no predator taxa. Thus we can conclude that springtails form an important source of nutrients for predator taxa. In terms of life strategies, springtails are r-selected, able to reproduce quickly with rapidly increasing and decreasing population sizes. Oribatid mites are, on the other hand, K-selected with low reproduction ability, but relatively stable population sizes (Coleman et al. 2004). This explains the parallelism between fluctuations in seasonal changes of Oribatid mites in both the oak and Scots pine plantation (Fig. 3).

In the present study, there is no difference between the oak and Scots pine plantation in terms of the total amount of microarthropods. However, there is a difference between their community structures and biodiversity. There are great differences between the dispersal rates of soil and litter dwelling arthropods. The dispersal rate of those soil dwelling arthropods is accepted as about 30 m in 30 years (Ojala and Huhta 2001). Oribatida, constituting majority of the mites identified in the study, are organisms generally dwelling in the litter and moving quickly with a rather high dispersal rate (1 m in 2 weeks) (Ojala and Huhta 2001, Coleman et al. 2004). This explains the similar amount of mites found in both areas (Fig. 3).

In conclusion, the Scots pine plantation in the Istanbul Belgrad Forest habitat has had certain impacts on both the amount and properties of litter and some of the soil properties, creating a local habitat. It can be concluded that these differences resulted in nutrient availability, community structures, seasonal changes in population, and the prey-predator cycle. Conversion of the Sessile oak stand to a Scots pine plantation decreased the abundance but increased the diversity of the soil microarthropods.

ACKNOWLEDGMENTS

This work was supported by the Scientific Research Projects Coordination Unit of Istanbul University (project no: 3122). We especially thank Prof. Dr. Oktay Yıldız and Dr. Süleyman Çoban for their help and support on the manuscript.

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