Çankaya University Journal of Science and Engineering
Volume 8 (2011), No. 2, 277–289

Seasonal and Vertical Distribution of Acarina Fauna of Grassland

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Özet. Bu çalışmada; Mayıs 2001-Nisan 2002 tarihleri arasında Manisa ilinde çayırlıktan alınan döküntü ve topraktan ayıklanan akarların mevsimsel ve vertikal dağılımları incelendi. Araştırma bölgesinden her ay döküntü ve hemen altından 0-5 cm, 5-10 cm ve 10-20 cm'den toprak örnekleri alındı. Mesostigmata, Prostigmata, Oribatida ve Astigmatina arasında vertikal ve mevsimsel dağılımları bakımından farklar olduğu gözlemlendi. En fazla sayıda akar döküntü tabakasında (% 43) bulundu. Bunu sırasıyla 10-20 cm (% 36,2), 5-10 cm (% 12,8) ve 0-5 cm (%7,8) izledi. Prostigmata ve Astigmatina'ya ait türler ilkbahar mevsiminde, Oribatida ve Mesostigmata'ya ait türler ise kış mevsiminde bol olarak tespit edildi. Oribatida ve Prostigmata'nın ödafik ve hemidafik, Mesostigmata'nın ise hemidafik olduğu bulundu.

Anahtar Kelimeler. Çayırlık akar faunası, mevsimsel dağılım, vertikal dağılım, toprak özellikleri, Manisa, Turkey.

Abstract. The seasonal and vertical distribution of the mites extracted from the soil and litter at a grassland site in Manisa was investigated for the period of May 2001-April 2002. The soil was sampled at four depths (litter, 0-5 cm, 5-10 cm and 10-20 cm). The vertical and seasonal distributions of mites were significant among Mesostigmata, Prostigmata, Oribatida and Astigmatina. The mites were found to be most numerous in litter (43%), then 10-20 cm depth (36.2%), 5-10 cm depth (12.8%) and 0-5 cm depth (7.8%), respectively. Among mite orders, the Prostigmata and the Astigmatina were found in greatest abundance in spring, the other two groups were found in greatest abundance in winter. The individuals of Oribatida and Prostigmata were considered hemiedaphic and eudaphic; individuals of Mesostigmata were considered predominantly hemiedaphic.

Keywords. Grassland acarina fauna, seasonal fluctuations, vertical distribution, soil properties, Manisa, Turkey.

1. Introduction

Grasslands are one of the major biomes in Turkey, representing about 15.9% of the land [1]. Grassland soil mites are the most diverse and abundant among arthropods

Received November 4, 2011; accepted December 6, 2011.

[2]. The seasonal and vertical distribution of the acarine population in the soil has been studied by many researchers [3-10].

Most soil arthropods are found in the upper layers of soil profiles in close association with the litter and organic horizons [4,11-14]. There are a number of soil conditions affecting the distribution and abundance of soil animals. Some factors, such as organic matter content and porosity, remain relatively constant with time for a particular soil at a particular depth, while others, such as soil water content and soil temperature, show seasonal changes [14]. Some researchers have demonstrated a relationship between numbers of arthropods and soil moisture or temperature [11,12,15,16].

The mite fauna of grassland soils in Turkey is poorly known. The present study provides additional information on the seasonal and vertical distribution of soil mites at the grassland site, and three components of their environment: organic matter, soil temperature and soil moisture. This paper follows Krantz and Walter's classification [17].

2. The Study Site

The study site is located near the Celal Bayar University campus, 38°40´47″ N, 27°18´59″ E. The elevation is 25 m. The climate is cold and wet in winter, hot and dry in summer conditions.

The soil profile of the study site is given in Figure 1. Four soil horizons were determined in the study site. They are shown below, respectively:

L: Litter layer consisting of the remnant of herbaceous plants (0.5-1 cm).

A: Light brown (2.5 y 7/2), extensive fibrous and thin root system, sandy soil (0-40 cm).

AC: Yellow-brown (2.5 y 8/2), moderate and weak root system, sandy soil (40-60 cm).

C1: Medium brown (2.5 y 6/2), no root system, argillaceous sandy soil (60-90 cm).

C2: Dark brown (2.5 y 6/2), no root system (90 cm and deeper).

3. Material and Methods

The soil samples were collected each month over a 12 month sampling period (May 2001-April 2002). Samples of litter and soil were taken by using a sampling cube

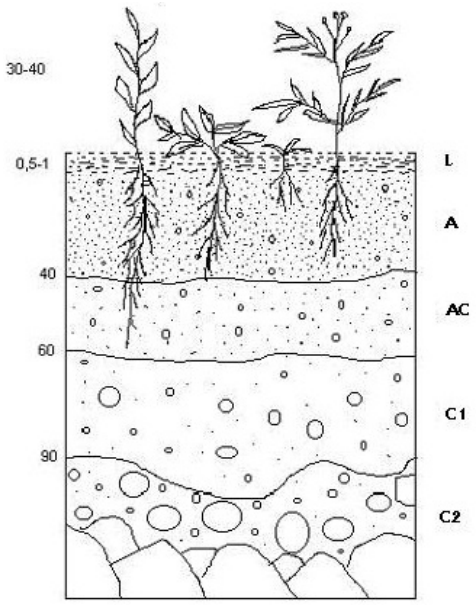


FIGURE 1. Soil profile of study.

(dimensions of 10×10×10 cm). Litter and soil layers of 0-5 cm, 5-10 cm and 10-20 cm at three different depths were collected, then they were put in plastic bags and were brought to the laboratory. The second sampling was done at each of the soil depths to determine some of the physico-chemical properties of the soil.

The soil samples were extracted separately in Tullgren funnels for a period of seven days. The mites were deposited in 70% alcohol bottles. After this, the mites were poured into petri dishes, and examined under the stereomicroscope using pipettes and needles. Adult mites from different soil layers were collected and labeled.

The soil moisture was determined gravimetrically. The organic matter content was measured by burning. The soil temperature was determined with a soil thermometer at different depths.

4. Results

The percentage distribution of individuals within orders collected from the study site is given in Figure 2. The maximum number of individuals was found in both litter and in 10-20 cm depth. Figure 3 indicates the numbers of individuals in orders according to layers. Mesostigmata were found in maximum numbers in litter (Figure 5). Oribatida were found most abundance in litter and in 10-20 cm depth (Figure 5). Astigmatina and Trombidiformes were found in almost all layers of the soil (Figure

5). Astigmatina were found in autumn, winter and spring but not in summer. The space and time locations of Astigmatina were as below: 10-20 cm depth in May, 5-10 cm depth in September and litter in December (Figures 6, 8). Trombidiformes were found at lower depth in summer but found at the highest in winter, autumn and spring. This order represents the vertical distribution from May 2001 to April 2002 (Figures 6, 8).

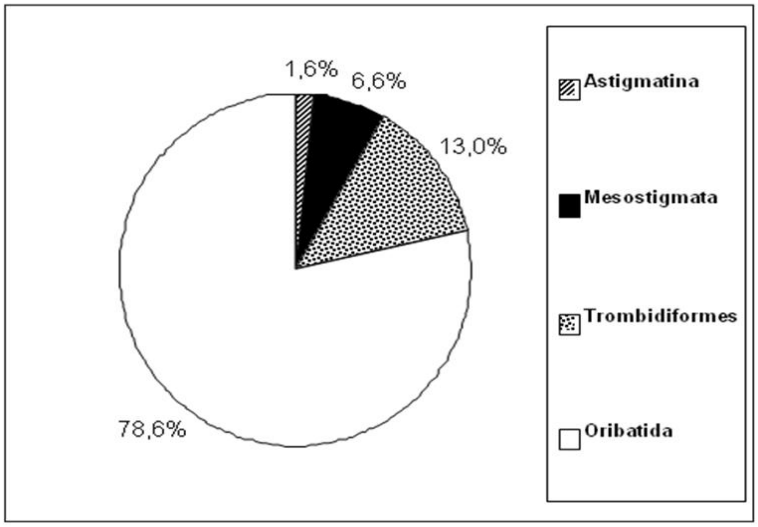


FIGURE 2. Percentage distribution of four acari.

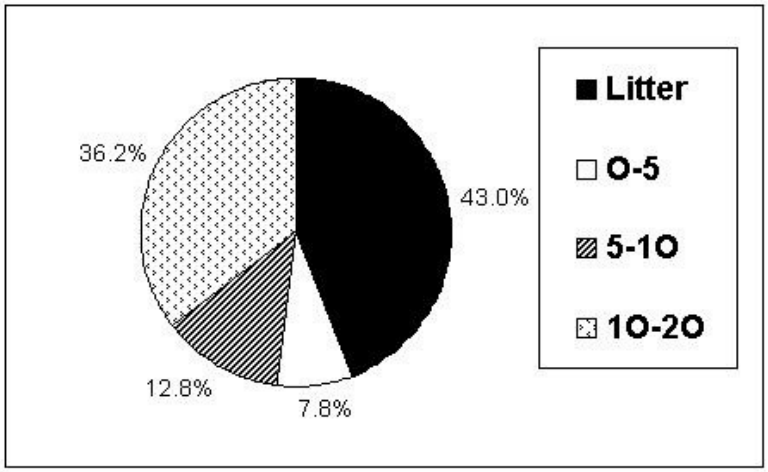


FIGURE 3. Percentage distribution at four layers of total individuals.

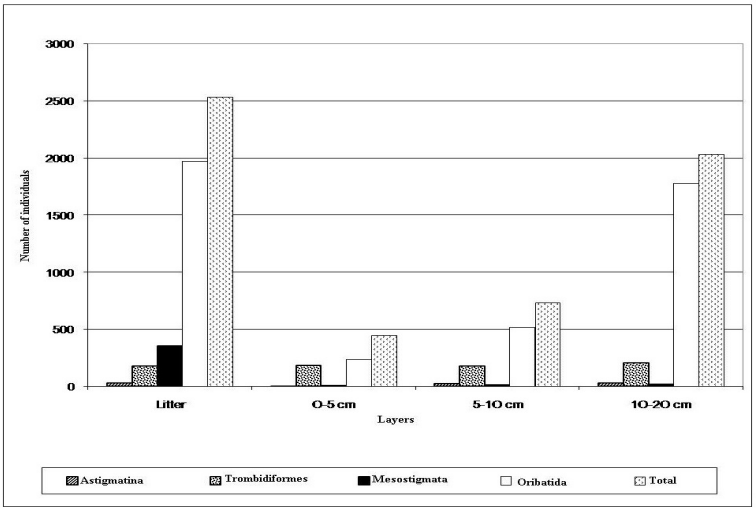


FIGURE 4. Vertical distribution of four acari.

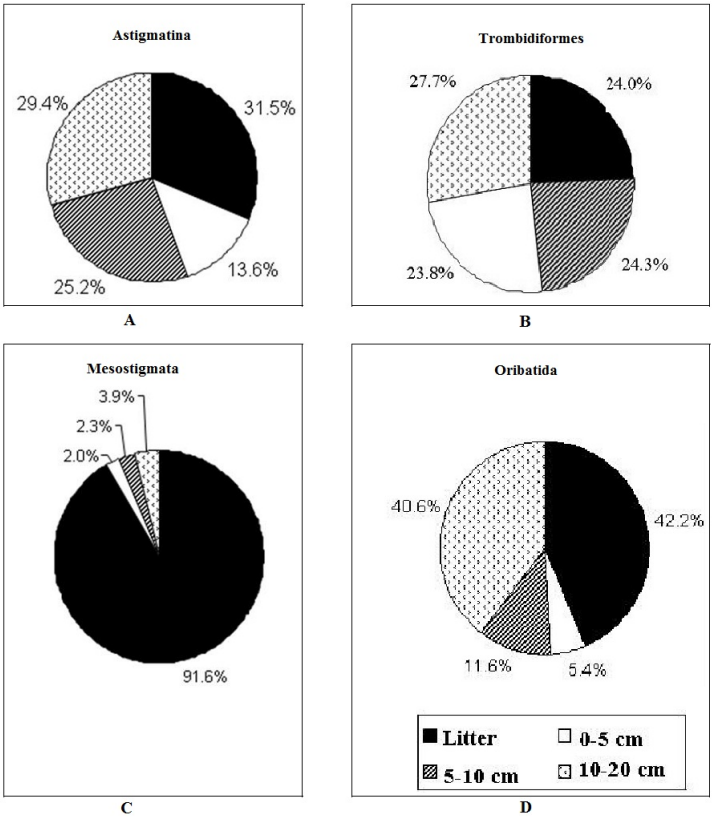
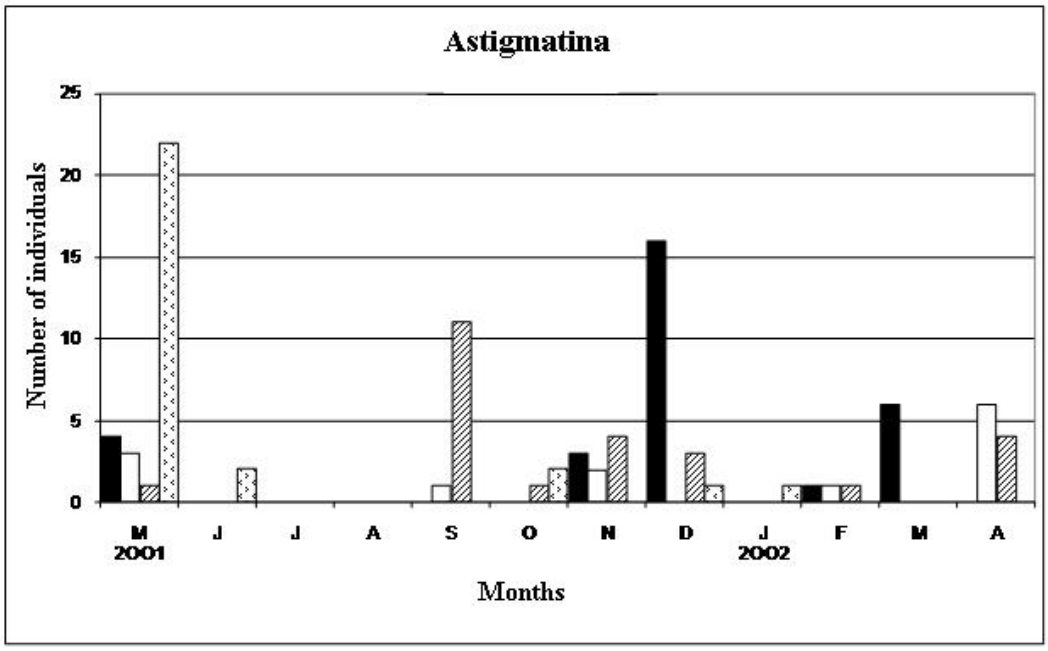
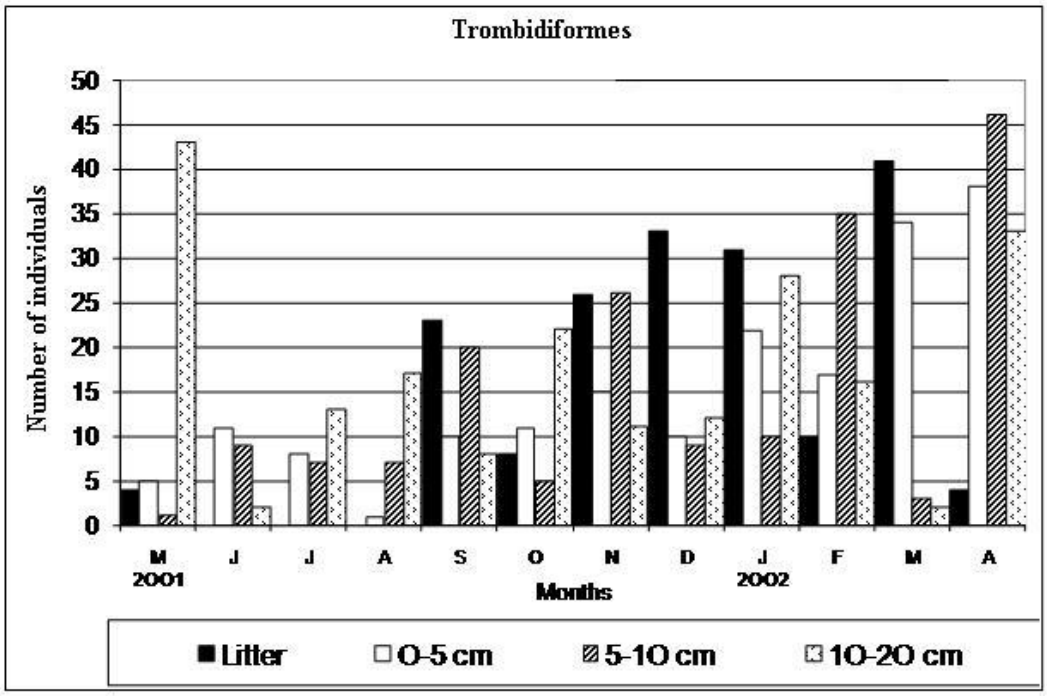


FIGURE 5. Vertical distibution of A,B,C,D.

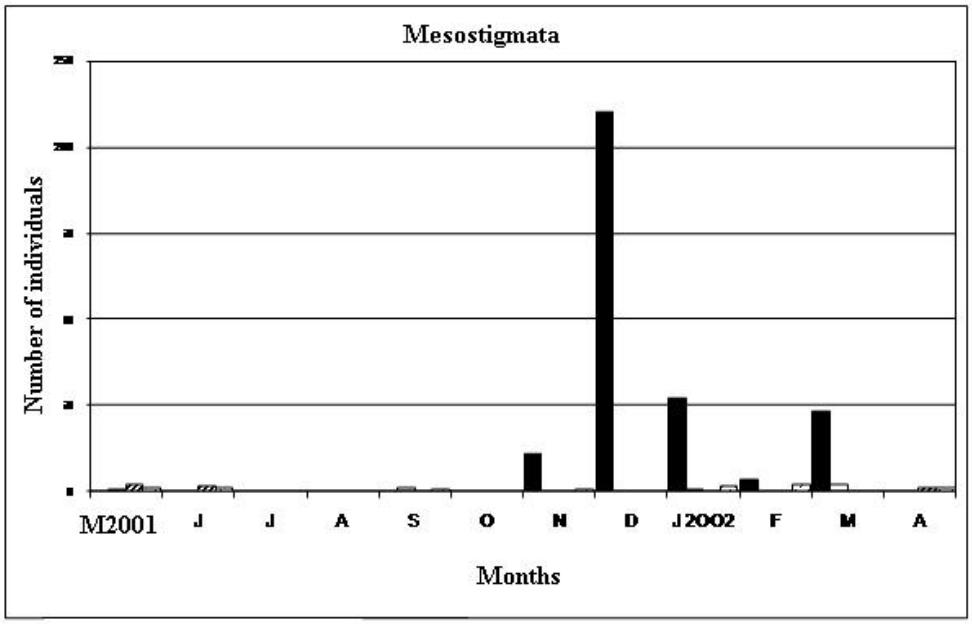


A

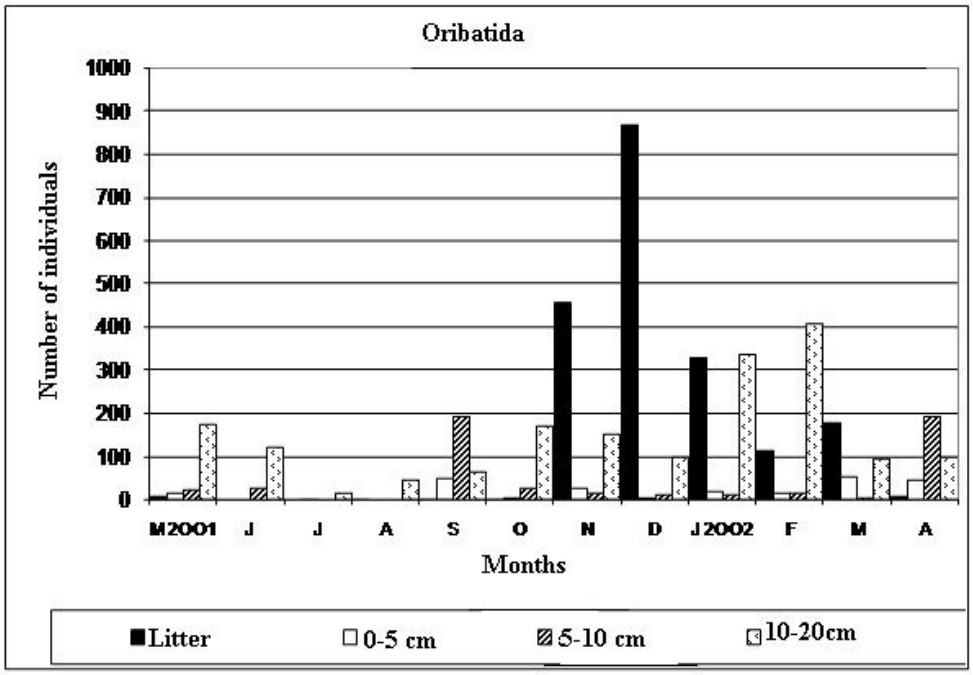


B

FIGURE 6. Vertical distribution of monthly fluctuations of A and B.



A



B

FIGURE 7. Vertical distribution of monthly fluctuations of A and B.

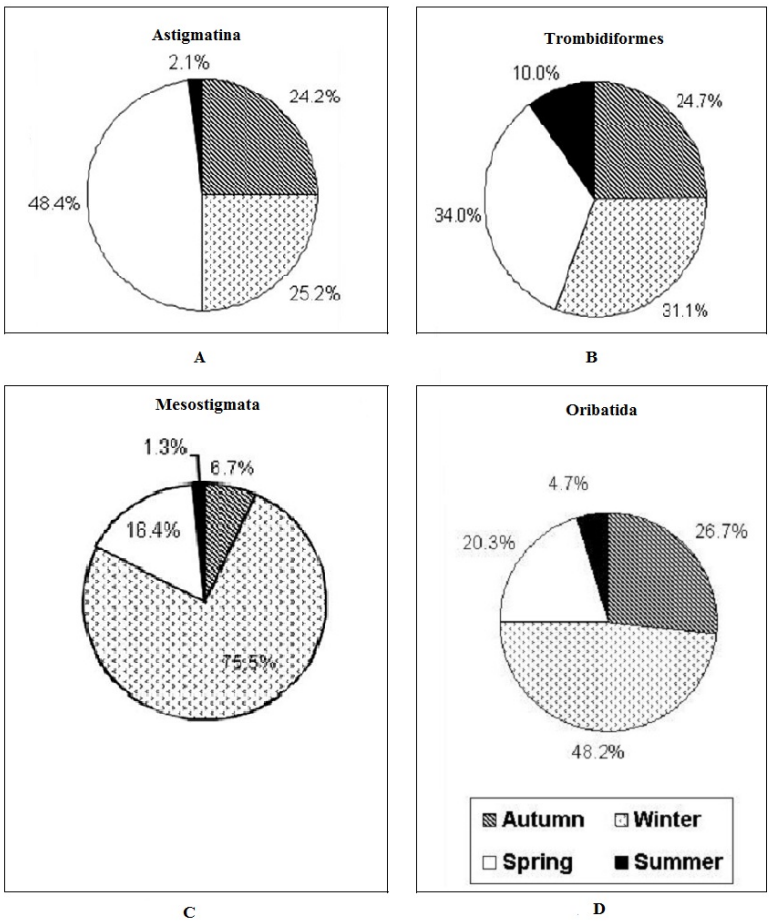


FIGURE 8. Seasonal distribution of A, B, C, D.

Mesostigmata were found at higher depth during the winter, but not during the other months (Figures 7, 8). Oribatida were abundant in the litter and 10-20 cm depth. This order is dominant in litter in autumn and winter, but it is dominant in 10-20 cm depth in spring and summer (Figures 7, 8). When all depths were considered, seasonal differences in soil mite abundance were evident for all four orders. Winter samples contained the largest number of Oribatida and Mesostigmata while the same samples contained lower numbers of Trombidiformes and Astigmatina. A lower number in all orders were found only in the summer season.

The soil moisture, organic matter and temperature of the soil during the sampling period are displayed in Tables 1, 2, 3, respectively.

TABLE 1. Variation in organic matter of soil cores taken at three depth zones.

	2001								2002			
Layers\Months	M	J	J	A	S	N	O	D	J	F	M	A
0-5 cm	12.6	12.0	8.6	9.2	12.5	12.1	6.0	9.1	7.5	11.0	9.5	8.3
5-10 cm	15.0	12.2	9.2	11.0	14.7	11.8	6.0	9.4	7.2	9.5	8.4	6.7
10-20 cm	14.9	10.9	11.0	12.6	12.3	13.7	8.0	13.7	6.5	11.8	9.0	8.3

TABLE 2. Variation in soil temperature (°C) of soil cores taken at three depth zones.

	2001								2002			
Layers\Months	M	J	J	A	S	N	O	D	J	F	M	A
0-5 cm	23.3	31.2	38.1	36.6	27.6	21.5	12.0	6.5	5.0	9.8	12.8	16.3
5-10 cm	22.8	30.1	35.4	35.1	27.7	21.5	12.3	6.8	4.9	9.4	12.4	15.9
10-20 cm	22.3	29.1	33.3	33.4	27.7	21.8	13.2	7.5	5.2	9.1	12.4	15.7

TABLE 3. Variation in moisture (%) of soil cores taken at three depth zones.

	2001								2002			
Layers\Months	M	J	J	A	S	N	O	D	J	F	M	A
0-5 cm	7.7	6.7	4.2	4.5	9.0	7.4	27.6	26.8	25.7	20.0	24.6	13.4
5-10 cm	11.4	10.0	5.4	6.2	7.4	9.2	24.5	26.8	26.2	22.2	23.4	17.2
10-20 cm	12.7	11.6	8.0	8.8	14.1	11.1	24.4	27.1	25.4	22.3	23.0	18.4

5. Discussion

During the sampling period, only about 43.0% of the total Acari fauna was found in the litter. The upper litter layer is exposed to more rapid fluctuations and extremity of temperature and humidity than the lower layers [18]. In most habitats the arthropod fauna of the soil is concentrated in the uppermost layers, with both population densities and species diversity declining rapidly with increasing depth [19]. Soil fauna is largely confined to a discrete organic layer of litter and humus which overlies the mineral subsoil [12,20,21,22].

Price [23] found that changes in soil moisture is more important as a factor influencing vertical distribution patterns than soil temperatures. Sheals [24], in a grassland habitat, found 12 species of Cryptostigmata, 18 species of Mesostigmata, and only a single species of Prostigmata. Wood [4] found 58 species of Cryptostigmata, 50 species of Prostigmata, and 33 species of Mesostigmata in four grassland and two moss sites. Wood [4] in a study of four grassland sites in England found over 76% of the Collembola and Acarina in the upper 4 cm and 90% or more of the total fauna

in the upper 6 cm. Pande and Berthet [18] found oribatids most abundant in the upper 3 cm of a woodland soil by using a soil sectioning technique. Schenker [25] found that the largest proportion of the oribatids occurred in the uppermost 5 cm of the soil profile. In the present study, we found 43% in litter, 7.8% at 0-5 cm depth, 12.8% at 5-10 cm depth and 36.2% at 10-20 cm depth of the total acarine fauna.

Wallwork [26] states that the Cryptostigmata occur in greatest numbers in coniferous forest soils where they may represent as much as 75.0% of the total acarine fauna. Price [27] found the suborder Oribatida were the most numerous of the Acarina with 78.6%. Madge [28] found that in four different habitats the Oribatida averaged 90%. Pande and Berthet [18] found that Oribatei were most abundant in the upper 3 cm due to the greater abundance of suitable food in this region. We found Oribatida to be 43.0% in litter and 5.3% at 0-5 cm depth, 11.4% at 5-10 cm depth and 39.4% at 10-20 cm depth.

Vertical changes have generally been attributed to vertical migration in response to adverse weather conditions. Temperature is more important than soil water in influencing the distribution of the fauna [29]. Pande and Berthet [18] found that the most important factor influencing the vertical distribution of Cryptostigmata appeared to be the presence of suitable food. Seasonal migrations have been demonstrated for mites [15]. Marshall [29] found that seasonal soil-faunal fluctuations in temperature regions are characterized by spring and autumn peaks, in some cases with a peak during the winter. In the present study, seasonal soil-faunal fluctuations are evident in winter, autumn and spring, respectively.

Parasitiformes: Order: Mesostigmata. During the sampling period 91.6% were found in the litter. Only 8.2% of the Mesostigmata occurred in the mineral layer (Figure 5). In these layers, 2.0% at 0-5 cm depth, 2.3% at 5-10 cm depth and 3.9% at 10-20 cm depth, respectively. It is difficult to make comments about the vertical distribution of this order. Observed seasonal changes in abundance are indicated in Figure 7. This group is dominant in winter (75.5%), with 16.4% in spring, 6.7% in autumn and 1.3% in summer (Figure 8). Mesostigmatic mites disappeared almost entirely during the dry season. Since these forms do not penetrate into the soil during this period, and they probably pass through the dry season in a quiescent state (Tables 2 and 3). Wallwork [26] considers that many species of Mesostigmata are found in each of the epigeal (vegetation), hemiedaphic (surface organic) and euedaphic (deeper mineral) zones of the soil profile.

Acariformes: Order Trombidiformes: Suborder Prostigmata. This order was found 24.0% in the litter and 76.0% in the mineral layers (Figure 5). Individuals were found except in summer (Figure 6). In the autumn, winter and early spring (from September to March) numbers were greater (95.5%) than in other months (Figures 6,8). This indicates that probably soil temperature and soil moisture are related in these months. No specimens were found in the litter in summer. The distribution of mineral layers of this group was as below: 23.8% at 0-5 cm depth, 24.3% at 5-10 cm depth and 27.7% at 10-20 cm depth (Figure 8). The numbers Prostigmata were greater during the wet period than the dry part of year. This indicated that vertical movement between litter and mineral layers was affected by soil moisture and soil temperature (Tables 2 and 3). Price [27] found only 39% of Prostigmata in litter and humus during the dry season, and 56.0% occurred in wet season. Seasonal distribution of this group was dominant in spring with 34.0%, 31.1% in winter, 24.7% in autumn and 10.0 in summer, respectively (Figure 7).

Order Sarcoptiformes: Suborder Oribatida. 40.6% of this order were found in litter (Figure 5). The distribution of individuals collected from litter was as below: 93.8% November, December, January, February and March and 6.2% were found in other months (Figure 7). Only one individual was found in litter in summer. This finding indicates that the distribution of oribatids in litter was affected by soil moisture. 57.6% of oribatids were found in mineral soil, while the most abundant numbers (42.2%) were in litter. There was no correlation between the amount of organic matter and vertical distribution of oribatids (Table 1).

The lowest numbers of oribatids (5.4%) are at 0-5 cm depth, when the soil temperature is high (annual mean 20 °C) and soil moisture is low (annual mean 14.8%). However, a higher number of oribatids (11.6%) was found in locations with 5-10 cm depth and its soil temperature is lower (annual mean 19.5 °C) and soil moisture is higher (annual mean 15.8%). The highest number (40.6%) was in locations with 10-20 cm depth and its soil temperature is the lowest (annual mean 19.2 °C) and soil moisture is the highest (annual mean 17.2%). All these data strongly imply that soil moisture plays a significant role in the vertical distribution of soil mites. There is an increase in individuals' numbers in dry summer as the soil deepens. There is a migration from below to above based on the decrease of soil temperature and increase of soil moisture in the autumn. However, there is a reverse migration from above to below in the spring.

Chort: Astigmatina. Only 31.5% were found in litter, 13.6% at 0-5 cm depth, 25.2% at 5-10 cm depth and 29.4% at 10-20 cm depth, respectively (Figure 4). In the seasonal distribution, the greatest abundance was found in spring (48.4%), with 25.2% in winter, 24.2% in autumn and 2.1% in summer (Figure 8). This suggests an upward movement in response to increased soil moisture in the surface layers (Figure 6). This group is dominant in 10-20 cm depth in May. It is shown, however, that these apparent seasonal changes are due to vertical movements of populations into and out of the sampling zone. The vertical movements are effected by organic matter (14.9%), soil temperature (22.3 °C) and soil moisture (12.7%) (Tables 1,2,3).

In conclusion, Astigmatina were found in soil mineral (68.7%), and in litter (91.8%); Trombidiformes were found in soil mineral (75%) and in litter (25%); Oribatida were found in soil mineral (56.2%), and litter (43.7%). Therefore these groups were euedaphic and hemiedaphic. However, Mesostigmata was hemiedaphic, since it was found in litter (91%).

Acknowledgment. This study was a part of the MSc thesis of Özlem Önen.

References

[1] E. Tanrıvermis and S. Erkul, *Çayır ve Meralarımız*, Tarım ve Köyişleri Bakanlığı Yayınları 2008.

[2] V. M. Behan-Pelletier and D. Kanashiro. Acari in grassland soils of Canada. In: *Arthropods of Canadian Grasslands. Volume 1: Ecology and Interactions in Grassland Habitats*. `http://www.biology.ualberta.ca/bsc/english/grasslandsbook/Chapter7_ACG.pdf`, 2010. Online; accessed 12-December-2011.

[3] W. Block, Seasonal fluctuations and distribution of soil mite populations in moorland soils, with a note on biomass, *Journal of Animal Ecology* **35** (1966), 487–503.

[4] T. G. Wood, Acari and Collembola of moorland soils from Yorkshire, England. Vertical distribution in four grassland soils. *Oikos* **18** (1967), 137–140.

[5] J. P. Curry, Seasonal and vertical distribution of the arthropod fauna of an old grassland soil, *Scientific Proceedings of the Royal Dublin Society* **3** (1971), 49–71.

[6] M. Luxton, Studies on the astigmatic mites of a Danish beech wood soil, *Pedobiologia* **22** (1981), 29–38.

[7] M. Luxton, Studies on the prostigmatic mites of a Danish beech wood soil, *Pedobiologia* **22** (1981), 277–303.

[8] M. Luxton, Studies on the oribatid mites of a Danish beech wood soil: V. Vertical distribution, *Pedobiologia* **21** (1981), 359–380.

[9] M. Luxton, Studies on the oribatid mites of a Danish beech wood soil: VI. Vertical distribution, *Pedobiologia* **21** (1981), 387–409.

[10] J. Whelan, Seasonal fluctuations and vertical distribution of the acarine fauna of three grassland sites in Co. Kildare, Ireland, *Pedobiologia* **28** (1985), 191–201.

[11] J. van der Drift, Analysis of the animal community in a beech forest floor, *Tijdschrift voor Entomologie* **94** (1951), 1–168.

[12] J. A. Wallwork, The distribution and dynamics of some forest soil mites, *Ecology* **40** (1959), 557–563.

[13] B. N. K. Davis, A study of micro-arthropod communities in mineral soils near Corby, Northants, *Journal of Animal Ecology* **32** (1963), 49–71.

[14] J. A. Holt, The vertical distribution of cryptostigmatic mites, soil organic matter and macroporosity in three North Queensland rainforest soils, *Pedobiologia* **22** (1981), 202–209.

[15] P. Lebrun, Ecologie et biocénotique de quelques peuplements d'Arthropodes édaphiques, *Memoires de l'Institut Royal des Sciences Naturelles de Belgique* **163** (1971), 1–203.

[16] M. B. Usher, Seasonal and vertical distribution of soil arthropods: Cryptostigmata, *Pedobiologia* **15** (1975), 364-374.

[17] G. W. Krantz and D. E. Walter, *A Manual of Acarology*, Texas Tech University Press 2009.

[18] Y. D. Pande and P. Berthet, Observations on the vertical distibution of soil Oribatei in a woodland soil, *Transactions of the Royal Entomological Society, London* **127** (1975), 259–275.

[19] J. A. Wallwork, *Ecology of Soil Animals*, McGraw-Hill Book Co., Inc., London 1970.

[20] P. W. Murphy, The biology of forest soils with special reference to the mesofauna or meiofauna, *Journal of Soil Science* **4** (1953), 155–193.

[21] P. W. Murphy, Ecology of the fauna of forest soils. In: D. K. McE. Kevan (ed.), *Soil Zoology*, Butterworths, London (1955), 99–124.

[22] G. O. Evans, J. G. Sheals and D. Macfarlane, *The terrestrial Acari of the British Isles*, Alden Press, Oxford, England 1961.

[23] D. W. Price, Vertical distribution of small arthropods in California pine forest soil, *Annals of the Entomological Society of America* **68** (1975), 174-180.

[24] J. G. Sheals, The Collembola and Acarina of uncultivated soil, *Journal of Animal Ecology* **26** (1957), 126–134.

[25] R. Schenker, Spatial and seasonal distribution patterns of oribatid mites (Acari: Rebate) in a forest soil ecosystem, *Pedobiologia* **27** (1984), 133–149.

[26] J. A. Wallwork, Acari. In: A. Burges and F. Raw (eds.), *Soil Biology*, Academic Press, London and New York (1967), 363–395.

[27] D. W. Price, Abundance and vertical distribution of microarthropods in the surface layers of a California pine forest soil, *Hilgardia* **42** (1973), 121–148.

[28] D. S. Madge, A study of the arthropod fauna of four contrasting environments, *Pedobiologia* **5** (1965), 289–302.

[29] V. G. Marshal, Seasonal and vertical distribution of soil fauna in a thinned and urea-fertilized Douglas-fir forest, *Canadian Journal of Soil Science* **54** (1974), 491–500.