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Soil Oribatid Mite (Acari Settling in the Forest Litter in the Different Microenvironments in Mt. Jumbong, Korea

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ABSTRACT: Changes of the oribatid mite species composition during the litter decomposition was investigated in the north-facing and south-facing slopes with different lower vegetation (annual herbaceous plants in north and perennial *Sasa* in south) in the altitude 1,000 m of Mt. Jumbong, a nature reserve area in Korea, from August 1994 to September 1995. Total 58 species of oribatid mites were collected. The values of Olson's negative exponential index (*k*) were -0.56 in the south-facing slope and -0.49 in the north-facing slope, but there was no significant difference between them. The decomposition rate of litter increased rapidly until Oct. 1994, and decreased thereafter. Intensive settlement of the forest litter by oribatid mites was recorded in the autumn periods and it decreased in the next spring and summer. Species diversity index (H'), and species evenness (J') ranged from 1.74 to 2.69, and from 0.57 to 0.93, respectively, and the values were lowest in spring. In the successive periods of growing season, there followed great changes in the structure of species dominance. *Heminothrus minor* was one of the most dominant species in autumn in the first year when litter were placed, but was never recovered next seasons. In contrast, *Platynothrus yamasakii* was also dominant in the first autumn, then decreased very low in numbers in next spring and summer, but regained its number in autumn. On the other hand, an increase of the number during these periods was observed by *Epidamaeus* sp. 2. *Ceratopia bipilis* and *Epidamaeus* sp.1 were abundant both in the north- and south-facing slopes. *Trichogalumna nipponica* was only found in the south-facing slope, and *Nanhermannia elegantula* was only found in the north-facing slope.

Key words: Forest litter, Oribatid mites, Species diversity

INTRODUCTION

The litters are used for food of microorganism and animal and main material in circulation of ecosystem having functional and structural characteristics (Kitchell *et al.* 1979). The abundance of soil fauna and biomass of microorganism increased as processing of litter decomposition (Seastedt *et al.* 1983). In the process of litter decomposition, oribatid mites directly feed the litter and indirectly play important roles such as spread of microorganism, stimulation of microorganism's activities by breaking the litter, and control of microorganism population by feeding them (Douce and Crossely 1982). Thus, studies carried out on the settlement of the leaves of different tree species or in different vegetated soils have shown great differences in the dominant structure of mite species settling them, and provided insight to understand community structure dynamics.

The objective of the studies was determination of the changes in species composition and in the number of oribatid mites in the litter decomposition process in a natural deciduous forest.

MATERIALS AND METHODS

The study was carried out in Mt. Jumbong (38° -38°05"N and 128°20°'-128°30°'E), a natural reserve area, located in Kangwon-do in South Korea. The study site (north- and south-facing slopes) located in Alt. 1000m was a hill with natural deciduous stands of *Quercus mongolica, Kalopanax pictus, Acer pseudo-sieboldii* and *Carpinus cordata*. The slopes were adjacent to each other with similar meteorological condition and soil profile. But, the lower vegetation of north-facing slope was dominated by annual herbaceous vegetation, while the south-facing slope was dominated by the perennial *Sasa borealis*. The detailed botanical characteristics and the soil, meteorological and climatic conditions of this area were reported earlier (Kang 1996).

We collected herbaceous plants from the study site and dried

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under the shade in the laboratory for preparing litter bags in June 1994. Weight of litter for each bag was measured. On each of the slopes, a total of 40 bags of 400 cm^3 each, were distributed evenly with a 5 m interval on August 1994. From each slope 10 bags were collected on October 1994, April, June and September 1995. Soil mites were extracted for 3 days using a modified Tullgren funnel, and dry weight of litter was measured.

The index (*k*) of litter decomposition rate was expressed by Olson's negative exponential model (1963). The community structure of oribatid mites was analyzed using abundance and species number of adult oribatid mites. Species diversity was expressed by the Shannon-Wiener index (H') and the evenness was calculated by Pielou's J' index (Pielou 1984, Magurran 1988). The species were classified by dominant species (more than 5% of total individual numbers), influent species (2-5%), and recessive species (less than 2%).

RESULTS AND DISCUSSION

The values of Olson's negative exponential index (*k*) in the decomposition process of litter were -0.56 at south-facing slope and -0.49 at north-facing slope, but there were no significant difference between them (Table 1) (*t*-test: $P > 0.05$). The decomposition rate of litter increased rapidly until Oct. 1994, and decreased thereafter. The similar patterns were observed in the abundance and the species number of oribatid mites colonizing in the litter (Fig. 1), which was similar to Clossley and Hoglund's study (1962). Initially, weight loss of leaf litter was rapid, evidently due to loss of readily soluble materials, and microarthropods rapidly built up populations within the litter bags (Clossley and Hoglund 1962, Takeda 1988, Blair etc. 1990). Oribatid mites play an important role in litter decomposition by breaking into pieces and microorganism's role of litter decomposition. The value of Coefficient of Variability in litter decomposition among litterbags was increased until April 1995 but it was decreased thereafter. The value of Coefficient of Variability (CV) expressed the variability of litter decomposition among litter increased until April 1995, but it was slowly decreased thereafter.

Total 58 species of oribatid mites was collected, and the species and individual number were higher in the south-facing slope (42 species) than in the north-facing slope (37 species) during the one-year litterbag study (Table 2). The first and second dominant species in the north-facing slope were *Ceratoppia.*

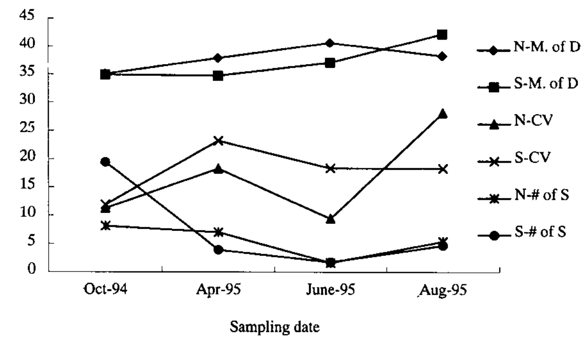

Fig. 1. The Coefficient Value (CV) for variability of litter decomposition and the species number (# of S) and mean density (M. of D) of oribatid mites colonizing in the litterbags at south- (S) and north-facing (N) slopes in Mt. Jumbong.

bipilis and *C. quadridentata*. The first and second dominant species in the south-facing slope were *Platynothrus yamasakii, Heminothrus minor, Ceratoppia bipilis* and *Epidamaeus* sp. 1 were common dominant species in both slopes. *Trichogalumna nipponica* was a dominant species found only in the south-facing slope. The influent species, *Nanhermannia elegantula* was found only in the north-facing slope. In total, dominant species comprised of 65% of total number. Their body size was mostly large and ranged 0.5 - 0.7mm. As compared with oribatid mites in the soil of the same site (Kang 1996), *T. nipponica* and *Epidamaeus* sp. 1 were the same dominant species, but *C. bipilis, H. minor,* and *P. yamasakii* were not. This indicates that these species may prefer litter as habitat.

The species appearance and diversity index to subscribe the organization process of oribatid mite communities in the forest litter are shown in Table 3. In the initial period of study 27 species colonized the litter. In next spring, 20 species found earlier disappeared and only 7 species were recollected. Also, 14 species were newly found. Two month later, 10 species were recollected and 8 species were newly collected. Fourteen species were recollected and 11 species were newly found on September 1, 1995. The frequency of new species' colonization and species moving-out gradually decreased together and the species composition was gradually stabilized during the process of leaf compost decay. The diversity of oribatid mites colonizing in the litterbags was lowest in April 1995. Species diversity index (H') ranged from 1.74 to 2.69 and species evenness (J') ranged from 0.57 to 0.93. Variability of species organization decreased con-

Table 1. Decomposition rates and percentage of initial mass of litter remaining after 1 year in litterbags in Mt. Jumbong

Site	Annual decomposition Rate (k)[a]	% of initial mass after 1 year	
		Calculated	Observed (N=10)
North-facing slope	−0.49	61.26%	61.81%
South-facing slope	−0.56	57.12%	57.84%

[a] Calculated from the formula Log_e (Collected mass/Initial mass) = kt (Olson 1963)

Table 2. Analysis of dominant oribatid species collected in the process of litter decay in the north- and south-facing slopes in Mt. Jumbong

	North-facing slope (Alt.1000m)			South-facing slope (Alt.1000m)		
	Species	#	%	Species	#	%
Dominant species*	*Ceratoppia bipilis*	59	30.4	*C. bipilis*	23	8.8
	C. quadridentata	26	13.4	*Epidamaeus* sp. 1	18	6.9
	Epidamaeus sp. 1	26	13.4	*Heminothrus minor*	47	18.1
	Epidamaeus sp. 2	15	7.7	*Trichogalumna nipponica*	20	7.7
				Platynothrus yamasakii	66	25.4
Influent species*	*Damaeus armatus*	4	2.1	*C. quadridentata*	12	4.6
	Defectamerus sungohi	5	2.6	*Epidamaeus* sp. 2	6	2.3
	H. minor	7	3.6	*O. nova*	9	3.5
	Nanhermannia elegantula	4	2.1			
	Oppiella nova	4	2.1			
	Oppia sp. 1	4	2.1			
	P. yamasakii	4	2.1			
Recessive species*	*Tectocepheus velatus*	3	1.5	*D. armatus*	9	1.9
	Phthiracarus clemens	3	1.5	*D. sungohi*	9	1.9
	and 24 species	30	15.5	*Hypochthoniella minutissima*	9	1.9
				and 31 species	32	12.3
Total	37	194	100.0	43	260	100.0

* Dominant species: more than 5%, Influent species: 2-5%, Recessive species: less than 2% of total individual numbers

Table 3. Succession, species diversity and evenness of Oribatid mite communities in the process of litter decay in Mt. Jumbong

Date	'94.10.7	'95.4.22	'95.6.27	'95.9.1
Total species	27	21	18	25
New species	27	14	8	11
Species lost	0	20	16	10
Species regained	0	0	5	6
Species diversity	2.319	1.739	2.685	2.672
Species evenness	0.704	0.571	0.929	0.830

Table 4. Total numbers and relative abundance of the 7 dominant oribatid species collected in the process of litter decay in Mt. Jumbong

Date	'94. 10. 7		'95. 4. 22		'95. 6. 27		'95. 9. 1		Total	
Species	No.	%	No.	%	No.	%	No.	%	No.	%
Ceratoppia bipils	22	8.84	54	50.9	1	3.85	5	6.76	82	18.0
C. quadridentata	8	3.21	24	22.6	1	3.85	6	8.11	39	8.57
Epidamaeus sp. 1	44	17.7	0	0	0	0	0	0	44	9.67
Epidamaeus sp. 2	0	0	1	0.94	6	23.1	14	18.9	21	4.62
Heminothrus minor	54	21.7	0	0	0	0	0	0	54	11.9
Trichogalumna nipponica	20	8.03	1	0.94	1	3.85	0	0	22	4.84
Platynothrus yamasakii	54	21.7	2	1.89	0	0	14	18.9	70	15.4
Total	202	81.1	82	83.4	9	34.6	39	52.7	332	73.0

tinuously, which described the stability of oribatid mite communities in the litterbags. The seasonal abundance of dominance species collected in litterbags is shown in Table 4. *Ceratoppia bipilis* and *C. quadridenta* were collected continuously. *Heminothrus minor* was one of the most dominant species in autumn in the first year when litter were placed, but was never recovered in next seasons. In contrast, *Platynothrus yamasakii* was also dominant in the first autumn, then decreased very low in numbers in next spring and summer, but regained its number in autumn. On the other hand, an increase of the number during these periods was observed by *Epidamaeus* sp. 2. *Ceratoppia bipilis* and *Epidamaeus* sp.1 were abundant both in the north-

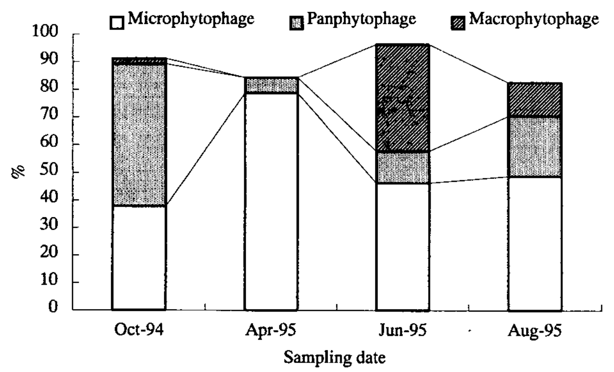

Fig. 2. The seasonal change of feeding type of oribatid mites (more than 2% of total numbers) colonizing in the litterbags in Mt. Jumbong.

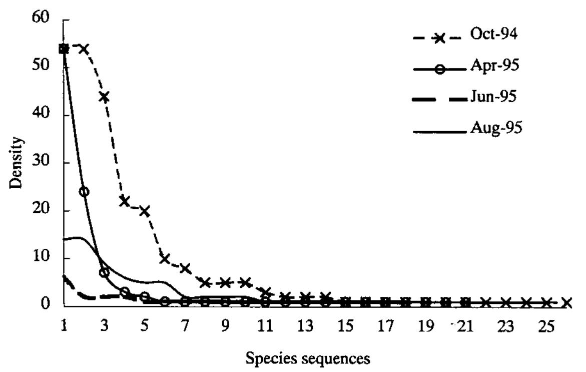

Fig. 3. The species abundance patterns of oribatid mites colonizing in the litter-bags in Mt. Jumbong.

and south-facing slopes.

Fig. 2 shows the seasonal change in feeding types of oribatid mites whose number is more than 2% of total mite numbers from our study. In the initial period of study, proportions of panphytophage and microphytophage were high while proportion macrophytophage was very low. The proportions of macrophytophage and panpytophage decreased to the very low level in the next spring. Then, their proportions increased during the next period. During that period, especially macrophytophage proportion increased significantly, and after that it decreased again. In contrast, proportion of panphytophage gradually increased after significant decrease in spring. Overall, except for in spring, panphytophage and microphytophage comprised of ca. half of oribatid mites in the litter, indicating forest soil of Mt. Jumbong is healthy. Wallwork (1983) stated that the forest soil with fluent panphytophage and macropytophage oribatid mites is relatively healthy.

Figure 3 shows the species abundance patterns of oribatid mites collected in the litterbags. The patterns in the first half period of study had the characteristics of Geometric series while those in the second half period of the study had the characteristics of Log series. This reflects that during the early period of litter decay a few dominant species colonize litter, then as litter decay progresses the participation of new species occur but overall number and densities of dominant species decrease, thus species evenness increases.

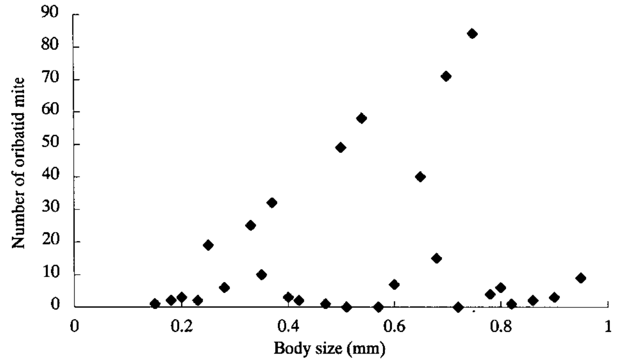

Fig. 4. The relationship between body size and number of oribatid mite individuals colonizing in the litterbags in Mt. Jumbong.

The relationship between oribatid mites' body size and density (Fig. 4) shows that species of oribatid mites with 0.5-0.8mm ranges of body size were abundant in the litter, while species of oribatid mites whose body size ranged 0.2-0.5mm were abundant in the soil (Kang, 1996). It is known that oribatid species, which feed on the dead materials of higher plant with strong chelicerae in the litter is relatively larger than those which feed on microorganisms in the soil.

In conclusion, an intensive settlement of the forest litter by oribatid mites on the north-facing and south-facing slopes was found in autumn season and it decreased in the period of spring and summer. Also, significant changes were observed in the dominant structure of oribatid mite species on both slopes. Significant differences in dominant and influent mite species composition in the litter were observed between north-facing and south facing slopes, mainly due to dramatic differences in vegetations.

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