Korean J. Ecol., 23(2): 107~112, 2000

Comparison of Oribatid Mite (Acari: Oribatida) Communities among City, Suburban, and Natural Forest Ecosystems: Namsan, Kwangreung, and Mt. Jumbong

Lee, Joon-Ho, Hong-Hyun Park, Banghun Kang, Chul-Eui Jung and Seong-Sik Choi*

Entomology Program, Department of Agricultural Biology, School of Applied Biology and Chemistry, Seoul National University, Suwon 441-744, Korea

*College of Life Science and Natural Resources, Wonkwang University, Iksan 570-749, Korea**

ABSTRACT: Comparison of oribatid mite community structures among Namsan, Kwangreung, and Mt. Jumbong, which receive different levels of environmental stress from severe to almost none, was made in coniferous and deciduous forests, respectively. The number of species of oribatid mites was significantly lower in Namsan and Mt. Jumbong than in Kwangreung in the coniferous forest ($p<0.05$). In the deciduous forests, the number of species of oribatid mites was significantly lower in Namsan than in Kwangreung and Mt. Jumbong. Dominant species in 3 regions were remarkably different. Similarity of the oribatid community between Namsan and Kwangreung was much higher (ca. 2 times) than similarities between Namsan and Mt. Jumbong, and Kwangreung and Mt. Jumbong. Diversity index (H') value of oribatid communities in deciduous forests in Namsan, Kwangreung and Mt. Jumbong was 2.74, 2.78, and 2.87, respectively. Diversity (H') value of oribatid communities in coniferous forests in Namsan, Kwangreung and Mt. Jumbong was 2.83, 2.62, and 2.38, respectively. Namsan and Kwangreung were characterized as O-type in both coniferous and deciduous forests. On the contrary, Mt. Jumbong was characterized as MG-type in MGP-I analysis.

Key Words: Diversity, MGP analysis, Oribatid mite community, Similarity.

INTRODUCTION

The oribatid mites play an important role such as decomposition of organic materials, changing of physical and chemical textures of soil, cycling of nutrients, and conservation of sound soil environment (Wallwork 1983). Various studies of oribatid mite community have been conducted at various ecosystems of different geographical property, vegetation, altitude, and soil profile such as desert, forest, grassy plain, grass and lincheon (Wallwork 1972, Price 1975, Wauthy *et al.* 1989, Askidis and Stamou 1992). Many factors are influencing the oribatid mite community. Some of those are habitat complexity and soil micropore size (Anderson 1975), microfaunal activity, soil humidity, and soil organic materials (Cepeda and Whitford 1989), soil temperature (Kwak *et al.* 1989), vegetation (Tousignant and Coderre 1992), precipitation (Choi 1983), and air pollution (Seniczak *et al.* 1994). Therefore, analysis of the oribatid mite community in the soil could provide better understanding of ecosystems and a better guideline for environmental quality assessment.

In this study, we compared the orbatid mite community structures in Namsan,. Kwangreung, and Mt. Jumbong. Namsan is the typical city forest in Korea. It is located in the center of the Seoul and is being received by heavy environmental pressure such as air pollution, acid rain, and so on. Kwangreung is the typical suburban forest from the Seoul, and a relatively well conserved forest ecosystem. However, it is increasingly receiving environmental pressure because of rapid urbanization of its surrounding area. Mt. Jumbong is the typical natural forest ecosystem in Korea. It is a very well reserved natural forest.

MATERIALS AND METHODS

Study sites

Namsan is located in 37°32′N and 125°58′E. The coniferous forest site was located in the southwestern slope from the Namsan Tower (200~230 m altitude), and was dominated by *Pinus rigida* and *Pinus koraiensis*. The deciduous forest site was located in the southeastern slope from the Namsan Tower (200~230 m altitude), and was dominated by *Quercus mongolica*, *Sorbus alnifolia*, and *Acer* spp.

Kwangreung is located in Pocheon-gun, Kyunggi-do, 37°45′N and 127°10′E. The deciduous forest site was the 45 stand natural deciduous forest (140~180 m altitude) in the southeastern aspect from the Soribong-peak, and was dominated by *Carpinus laxiflora*, *Quercus aliena*, *Quercus mon-*

golica, and *Acer* spp. The coniferous forest site was the 45 stand coniferous forest (140~180 m altitude) in the southeastern aspect from the Soribong-peak, and was dominated by *Pinus koraiensis*.

Mt. Jumbong is located in Inje-gun, Kangwon-do, 38°~38°05′ N and 128° 20′~128° 30′ E. The deciduous forest site was located at 1,000 m altitude, and was dominated by *Quercus mongolica*, *Kalopanax pictus*, *Acer pseudo-sieboldianum*, and *Carpinus cordata*. The coniferous forest site was located at 900 m altitude, and was dominated by *Pinus koraiensis*.

Sampling

Sampling for soil mites in Namsan and Kwangreung was conducted from 1993 to 1995. Sampling for soil mites in Mt. Jumbong was conducted from 1994 to 1996. Sampling was taken each season except for winter for all the sites every year. The sampling unit was same between Namsan and Kwangreung, but different from that conducted in Mt. Jumbong. For sampling in Namsan and Kwangreung, three quadrats (1 × 1 m) were randomly selected in each plot (20 × 20 m). In each quadrat, ca. 300 ml of litter was sampled, and soil was sampled in 5 spots (4 corners, and 1 middle point) using a cylindrical soil sampler (5 cm dia., 5 cm height). Samples were taken in 6 plots for study sites. Thus, total 18 samples of litter and soil were taken in each site each season. For sampling in Mt. Jumbong, the site was divided into 10 plots. In each plot, 2 soil samples (1,000 cm^3) were taken using a rectangular soil sampler (10 × 10 × 5 cm). Thus, total 20 samples of soil were taken in each site each season. Further detailed sampling methods in these studies were well described in Park *et al.* (1996) and Kang and Lee (1997).

Extraction of soil mites was carried out using a modified Berles and Tullgren funnel (Gorny and Grum 1993) for 48~72 hours. Oribatid mites were stored at 70% ethanol solution (Wallwork 1970) and were later identified under optical microscope (× 400).

Data analysis

(1) Oribatid mite community structure analysis: The community structure of oribatid mites was analyzed using abundance and species number of adult mites. The diversity of oribatid mite communities was expressed by the Shannon-Wiener index (H′), and the evenness of community was calculated by Pielous J′ index (Pielou 1984). The analysis of similarity of species composition between oribatid mite communities in those regions used Sørenson similarity index (Southwood 1966). These values range from 0 to 1 according to the presence of common species.

(2) MGP analysis: Also, comparison of Oribatid mite communities among three forest ecosystems was made using MGP analysis (Aoki 1983), which defines the status of forest ecosystems. Oribatid mites are classified into two major groups, Macropylina and Brachypylina (Balogh 1972). In Macropylina, anal plate and genital plate are contiguous, but are separate in Brachypylina. Brachypylina is further subdivided into Gymnonota and Poronota depending on the presence of pteromorph (Balogh 1972). Then, Aoki (1983) valued species composition and their densities into ecological meaning describing the status of forest ecosystems. The criteria are as follows:

-> 50% individual number of Macropylina to total individual number (or total species number): M type
-> 50% individual number of Gymnonota to total individual number (or total species number): G type
-> 50% individual number of Poronota to total individual number (or total species number): P type
-> 20% and <50% of each 3 groups to total individual number (or total species number): O type
-> 20% and <50% of each M and G groups, and <20% of P group to total individual number (or total species number): MG type
-> 20% and <50% of each M and P groups, and <20% of G group to total individual number (or total species number): MP type
-> 20% and <50% of each G and P group, and <20% of M group to total individual number (or total species number): GP type

There are 2 methods in MGP analysis. MGP-I analysis is conducted based on the numbers of species (i.e. species richness data) using above criteria. MGP-II analysis is conducted based on the individual numbers (i.e. abundance data) using above criteria.

RESULTS AND DISCUSSION

Oribatid mite community structure

The number of species of oribatid mites was significantly lower in Namsan and Mt. Jumbong than in Kwangreung in the coniferous forest ($p < 0.05$) (Table 1). In the deciduous forests, the number of species of oribatid mites was significantly lower in Namsan than in Kwangreung and Mt. Jumbong. Dominant species in 3 regions were remarkably different (Table 2). In deciduous forests, *Oppia* sp. was a common dominant species of 3 regions, and other dominant species were all

Table 1. Number of species of oribatid mites in the coniferous and coniferous and deciduous forests in Namsan, Kwangreung and Mt. Jumbong

	Namsan	Kwangreung	Mt. Jumbong
Coniferous forest	33 fam. 52 gen. 74 spp.	41 fam. 71 gen. 103 spp.	33 fam. 48 gen. 76 spp.
Deciduous forest	32 fam. 53 gen. 87 spp.	40 fam. 67 gen. 114 spp.	46 fam. 74 gen. 124 spp.

Table 2. List of dominant species in the coniferous and deciduous forests in Namsan, Kwangreung and Mt. Jumbong

	Namsan	Kwangreung	Mt. Jumbong
Coniferous forest	*Scheloribates latipes* (11.8) *Peraglumna altera* (8.9) *Eohypochthonius. crassisetiger* (7.6) *Scheloribates* sp. (6.9) *Suctobelbella yezoensis* (5.0)	*Ceratozetes japonicus* (25.7) *Punctoriates punctum* (14.2) *Pergalumna duplicata* (11.0) *Ramusella sengbuschi* (5.1)	*Oppiella nova* (33.4) *Oppia* sp. (10.2) *Trichoggalmuna nipponica* (9.9) *Hypochtoniella minutissima* (7.0) *Flaggosuctobelba naginata* (5.5)
Deciduous forest	*Oppia* sp. 3 (14.6) *Lohmannia coreana* (14.5) *Ceratozetes japonicus* (13.1) *Rostrozetes pulcherrimus* (5.4)	*Boreozetes* sp. (22.4) *Oppia* sp. 3 (16.6) *Boreozetes donghaksaensis* (10.0)	*Oppiella nava* (12.6) *Flagrosuctobelba nahinata* (7.3) *Oppia* sp. (6.0)

different among 3 regions. In coniferous forests, no common dominant species were found among 3 regions.

Table 3 shows the number of common species among 3 regions, and similarity between 2 regions. More number of common species was found between Namsan and Kwangreung. Mt. Jumbong had less common species. Thus, similarity between Namsan and Kwangreung was much higher (ca. 2 times) than similarities between Namsan and Mt. Jumbong, and Kwangreung and Mt. Jumbong. Oribatid mite communities were relatively stable between seasons in both coniferous and deciduous forests in 3 regions (similarity index, $C_s >$ 0.6) according to the criteria of Rahel (1990).

Diversity index (H′: Shannon-Weaver index: Magurran 1988) value of oribatid communities in deciduous forests in Namsan, Kwangreung and Mt. Jumbong was 2.74, 2.78, and 2.87, respectively. Diversity (H′) value of oribatid communities in coniferous forests in Namsan, Kwangreung and Mt. Jumbong was 2.83, 2.62, and 2.38, respectively. Evenness index (J′ : Pielou's evenness index: Pielou 1984) value of oribatid communities in deciduous forests in Namsan, Kwangreung and Mt. Jumbong was 0.72, 0.69, and 0.87, respectively. Evenness index (J′) value of oribatid communities in coniferous forests in Namsan, Kwangreung and Mt. Jumbong was 0.78, 0.67, and 0.71, respectively. Even though there was significantly lower in abundance and species richness in oribatid mites in Namsan than in Kwangreung and Mt. Jumbong, the H′ value was not much different in deciduous forests among 3 regions. Further, in coniferous forests, the H′ value was highest in Namsan, and was lowest in Mt. Jumbong. It may be partly explained by the characteristics of diversity index, H′ and J′. H′ and J′ are highly inter-related. In other words, H′ is very sensitive to relative evenness of all species distribution, and is less sensitive to species abundance and richness. Thus, it is highly influenced by species evenness (J′). Fig. 1 shows the oribatid mite species abundance patterns in 3 regions in coniferous (Fig. 1A), and deciduous forests (Fig. 1B). In general, number of rare species was much higher in Kwangreung and Mt. Jumbong compared to in Namsan. Also, density of a few

Table 3. The numbers of total and common species and similarity values in the coniferous and deciduous forests in Namsan, Kwangreung and Mt. Jumbong

	Coniferous forests		Deciduous forests	
Total	164		220	
Common	21		38	
Similarity values				
	Kwangreung	Mt. Jumbong	Kwangreung	Mt. Jumbong
Namsan	0.62	0.32	0.72	0.37
Kwangreung		0.33		0.39

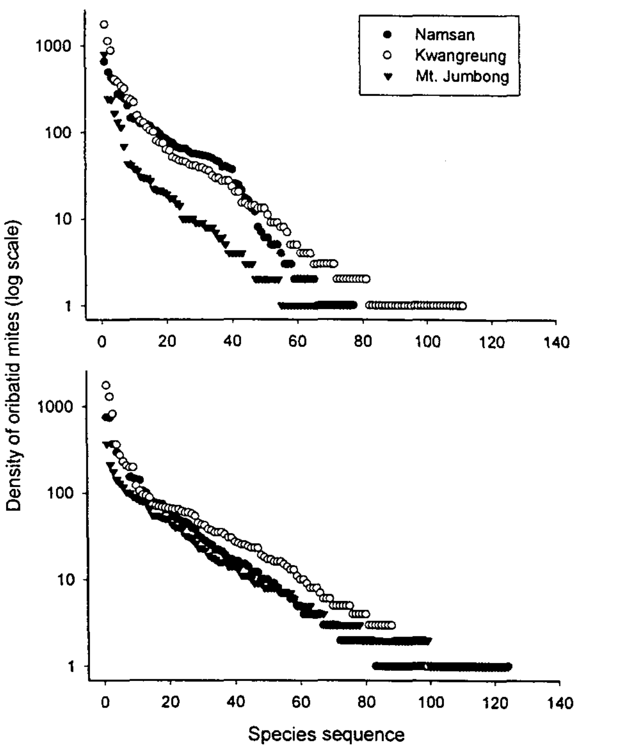

Fig. 1. Density (log scale) of oribatid mites according to species sequence in the coniferous (A) and deciduous (B) forests in Namsan, Kwangreung and Mt. Jumbong.

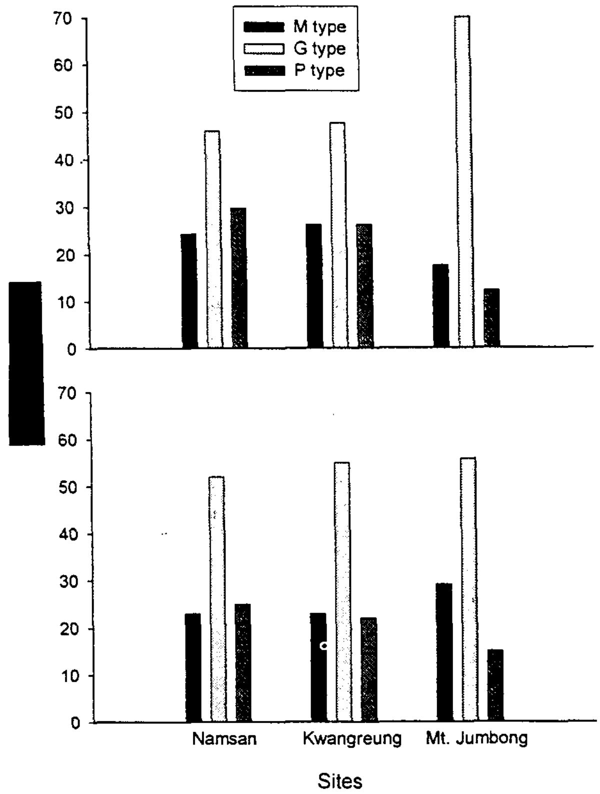

Fig. 2. MGP-I analysis of oribatid mite communities in the coniferous (A) and deciduous (B) forests in Namsan, Kwangreung and Mt. Jumbong.

abundant species was much higher in Kwangreung and Mt. Jumbong compared to in Namsan. These rank/abundance trends in Kwangreung and Mt. Jumbong are characterized as high peak in abundance of high ranked mite species (i.e., higher portion of abundant species) and a longer tail of lower ranked species sequence. Thus, although species richness was much lower in Namsan than other regions, the relative evenness was higher in Namsan, resulting in higher or similar values of H′. Weigmann (1984) argued that the Shannon-Weaver index (H′) might not be proper to describe the species diversity of the oribatid mite community in the ecosystem that is suffering from environmental pollution through the urbanization. He also reported values of H′ in the city forest and suburban forest were 2.6~2.9, and 1.6~2.2, respectively. This was consistent with our results. It also implies that selection and interpretation of diversity index should be carefully made.

MGP analysis

The result of MGP-I analysis is shown in Fig. 2. M:G:P ratios in both coniferous and deciduous forests were approximately 1:2:1, 1:2:1, and 2:2:1 in Namsan, Kwangreung, and Mt. Jumbong, respectively. In overall, Namsan and Kwangreung were characterized as O-type in both coniferous and deciduous forests. On the contrary, Mt. Jumbong was characterized as MG-type. Aoki (1983) and Kwon and Choi (1992) reported more proportions of M and G groups of oribatid mites were found in natural forest soils. Our results seemed to be consistent with those reports.

The result of MGP-II analysis is shown in Fig. 3. The result is more complicated than MGP-I analysis. The pattern was different between coniferous and deciduous forests. However, the general pattern between Namsan and Kwangreung was similar, but different from that in Mt. Jumbong. Proportion of abundance of the G group was very high and that of the P group was very low in Mt. Jumbong in both coniferous and deciduous forests. On the contrary, proportion of abundance of the P group was very high in the coniferous forest, and relatively high in the deciduous forest in Namsan and Kwangreung. Overall, in the coniferous forest, Namsan and Kwangreung were characterized as P-type, and Mt. Jumbong was characterized as G-type. In the deciduous forest, Namsan was O-type, Kwangreung was GP-type, and Mt. Jumbong was G-type.

Since Aoki (1983) proposed the MGP analysis

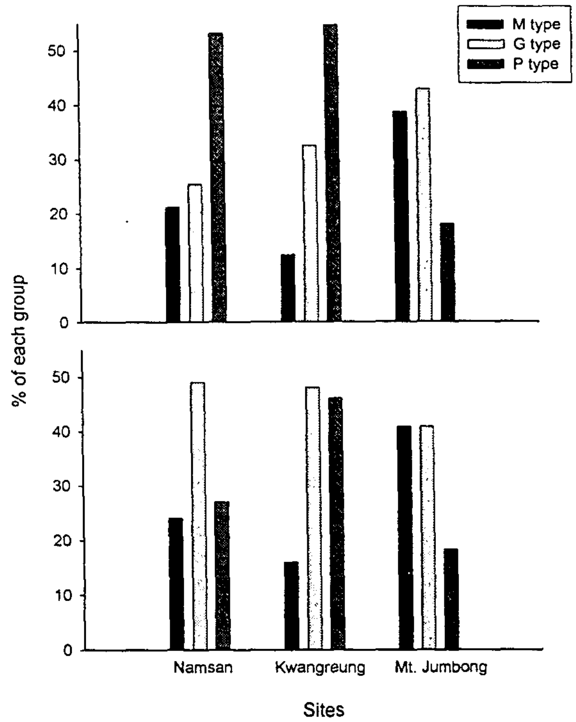

Fig. 3. MGP-II analysis of oribatid mite communiteis in the coniferous (A) and deciduous (B) forests in Namsan, Kwangreung and Mt. Jumbong.

to describe and interpret the ecological status of forest systems based on soil oribatid mite community, some researches have been conducted for further application for general ecological interpretation of forest systems. It is considered that P group species are early colonizers, and G and M groups are the middle and the last colonizers, respectively, in the forest succession process (Aoki 1983, Kwon and Choi 1992). Although MGP analysis methods need to be elaborated further, these MGP-analyses results seemed to relatively well portray the status of 3 forest systems. Mt. Jumbong is in the more stabilized succession process. Namsan is more frequently disturbed, especially in the coniferous forests. Kwangreung is in between Namsan and Mt. Jumbong, but closer to the biological characteristics of Namsan.

ACKNOWLEDGEMENTS

This work was partially supported by Korea Science and Engineering Foundation (KOSEF 94-0401-01-01-3).

LITURATURE CITED

Anderson, J.H. 1975. Succession, diversity and trophic relationships of some soil animals in decomposing leaf litter. J. Animal Ecol. 44: 475-495.

Aoki, J. 1983. Analysis of oribatid communities by relative abundance in the species and individual numbers of the three major groups (MGP analysis). Yokohama National University Env. Res. Rep. 10: 171-176. (In Japanese with an English abstract)

Asikidis, M.D. and G.P. Stamou. 1992. Phenological patterns of oribatid mites in an evergreen-sclerophyllous formation (Horitiatis, Greece). Pedobiologia. 36: 359-372.

Balogh, J. 1972. The oribatid genera of the world. Akademicai Kiado, Hungari Budapest. 330 p.

Cepeda, J.G. and W.G. Whitford. 1989. The relationships between abiotic factors and the abundance patterns of soil microarthropods on a desert watershed. Pedobiologia. 33: 79-86.

Choi, S.S. 1983. Studies on the analysis of soil-microarthropod community on Gwangreung area. Wonkwang Univ. 18: 254-268. (In Korean)

Gorny, M. and L. Grum. 1993. Methods in soil zoology. Elsevier, London. 459 p.

Kang, B.H. and J.-H. Lee. 1997. Soil microarthropod fauna at Mt. Jumbong, natural reserve area. Korean J. Ecol. 20: 329-337. (In Korean with an English abstract)

Kwak, J.S., J.S. Choi, N.P. Park, S.S. Choi, T.H. Kim and T.Y. Kim. 1989. Soil microarthropods at the Kwangyang experiment plantation, 4. Diversity of soil microarthropods in relation to environmental factors. Korean J. Ecol. 12: 203-208. (In Korean with an English abstract)

Kwon, Y.R. and S.S. Choi. 1992. Soil micro-arthropods fauna in plantations of the Korean white pine (*Pinus koraiensis*), 1. Composition of oribatid mites (Acari: Crystostigmata). Korean J. Appl. Entomol. 31: 10-22. (In Korean with an English abstract)

Magurran, A.E. 1988. Ecological diversity and its measurement. Cambridge University Press, London. 179 p.

Park, H.H., C.E. Jung, J.-H. Lee and B.Y. Lee. 1996. Soil microarthropod fauna at the Namsan and Kwangreung. Korean J. Soil Zoology. 1: 37-47. (In Korean with an English abstract)

Pielou, E.C. 1984. The interpretation of ecological data. A primer on classification and ordination. John Wiley & Sons. Singapore. 263 p.

Price, D.W. 1975. Vertical distribution of small arthropods in a California pine forest soil. Annu. Ent. Soc. Am. 68: 174-180.

Rahel, F.J. 1990. The hierarchical nature of community persistence: A problem of scale. Amer. Nat. 136: 328-344.

Seniczak, S., A. Klimek and S. Kaczmarek. 1994. The mites (Acari) of an old Scots pine forests polluted by a nitrogen fertilizer factory at Wloclawek (Poland). II. Zool. Beitr. (N.F.) 35: 199-216.

Southwood, T.R.E. 1966. Ecological methods, with particular reference to the study of insect populations. Methuen & Co Ltd., London. 391 p.

Tousignant, S. and D. Coderre. 1992. Niche partitioning by soil mites in a recent hardwood plantation in southern Quebec, Canada. Pedobiologia. 36: 287-294.

Wallwork, J.A. 1970. Ecology of soil animals. McGraw

-Hill Book Company, New York. 283 p.
Wallwork, J.A. 1972. Distribution patterns and population dynamics of the microarthropods of a desert soil in southern California. J. Anim. Ecol. 41: 291-310.
Wallwork, J.A. 1983. Oribatids in forest ecosystems. Ann. Rev. Entomol. 28: 109-130.
Weigmann, G. 1984. Structure of oribatid mite communities in the soils of urban areas. *In* D.A. Griffiths and C.E. Bowman. (eds.). Acarology VI. Vol. 2. Ellis Horwood Ltd., Chichester. pp. 917-923.
Wauthy, G.M., M. Noti and M. Dufrene. 1989. Geographic ecology of soil oribatid mites in deciduous forests. Pedobiologia 33: 399-416.

(*Received October 11, 1999*)