冷温帯林の斜面におけるトビムシ群集について

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A Preliminary Study on Collembolan Communities in a Deciduous Forest Slope.

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冷温帯林の斜面におけるトビムシ群集について

——予　報——

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Résumé

An investigation was carried out to assess the relative importance of soil meso-fauna in three forest plots situated on a forest slope in ASHIU Experimental Forest of Kyoto University. Population density of Collembola, Cryptostigmata, Mesostigmata, and Prostigmata was estimated in the three plots. Vertical distributions of these aminal groups showed a similar pattern in the three plots and individuals were more numerous in the top soil of 4 cm in depth. The changes in population density along the slope and the vertical distirubiton suggest the importance of the amount of A_0 layer in the determination of abundance of the meso-fauna. Community structure of Collembolan species was compared between the three plots in terms of the diversity, evenness, and species richness and the three communities showed a similar pattern in the structures. But size distribution of Collembola was different among the plots and biomass was higher in the bottom than in the ridge plot. There was an inverse relation between the biomass and population density and this was related to the habitat structure of the soil.

要　　旨

冷温帯林内の一斜面の上部，中部と下部に調査プロットを設け，土壌小型節足動物の比較を行なった。

斜面の上部から下部へと，トビムシ，ダニ類は密度の減少を示した。いずれのプロットにおいても，土壌中での垂直分布は類似した傾向を示し，多くの個体は表層 0 ～ 4 cm に分布していた。密度，垂直分布の傾向は，トビムシ，ダニ類の多さが，住み場所としての A_0 層量に関係していることを示唆した。

トビムシ類について，三つのプロット間での群集構造を，多様性，均一度，種の多さ，の３つの測度を用いて比較した結果，３つの群集は類似した構造を持っていた。しかし，各々の群集を構成する個体の平均体長は，斜面上部から下部へと増大し，その結果，生物量は，密度とは逆に，斜面上部から下部へと増加の傾向を示した。トビムシの個体数，生物量の斜面地上での変化は，住み場所である A_0 層の構造の差違と関連していると推察された。

Introduction

This is a preliminary report of an investigation into the Collembolan communities in forest slopes being used by a group of workers for the study of mineral cycling and the soil macro-fauna in the breakdown of plant litter[3),4),5),10)].

The fauna of the soil may vary considerably along the environmental gradients developed on forest slopes, of which soil conditions may be particulary important for the soil fauna. Collembola together with mites are usually the most abundant soil meso-fauna and play an important role in the breakdown of plant litter and the soil formation processes[2)]. The relative importance of Collembolan populations among the soil arthropods was studied on a deciduous forest slope in Ashiu Experimental Forest of Kyoto University.

Study Area and Methods

This study was carried out on a forest slope which is covered with a matured deciduous broad leaved natural forest dominated by *Fagus crenata* (BLUME) and *Quercus mongolica* (FISCH). This slope is located in Ashiu Experimental Forest of Kyoto University being about 40 km north of Kyoto City.

Sampling plots were established on the ridge, middle and bottom of a forest slope and the distance from the ridge to the bottom was about 70 m. The details of study area have been published previously[3)]. Soil conditions are important for the interpretation of the present results and thus are briefly described.

In the ridge plot, the organic soil layer (A_0) is well developed and the mean depth of L, F, and H layer was 1.25 ± 0.17, 4.05 ± 0.54 and 1.65 ± 0.46 cm in thickness respectively. In the bottom plot, there is no well developed A_0 layer, where L layer is in immediate contact with the mineral soil layer and the mean thickness of L layer was 0.95 ± 0.24 cm. The top part of the mineral soil layer in the bottom plot contained a lot of gravel being 83.9% of the total volume of the soil[10)]. In the middle part, the soil shows a mosaic of the two types of humus accumulation.

Sampilng was carried out on 3rd, November 1978. Ten soil samples of each 25 cm^2 in area and 12 cm in depth were taken from each plot of $5 \times 5 m^2$ in area. The soil samples collected were divided into three layers of each 4 cm in thickness. Soil animals were extracted by a high gradient canister extractor at a constant temperature of 35°C in cabinet. The extraction process and efficiency of this extractor have been given in TAKEDA[8)]. The extracted animals were collected into a solution of saturated picric acid and then preserved in alchool. The identification, counting and mesurement were undertaken under a binocular microscope with a micrometer Individuals of Collembola were separated into ten size classes and biomass was estimated by using the tables prepared by PERSSON & LOHM[9)].

Results and Discussion

Population Abundance of Soil Micro-Arthropods

Population densities of each animal group are given in Table 1 with standard errors. For every animal group, population density was higher in the ridge than in the bottom plot. The results showed a change in population density from the ridge to the bottom along the slope. This change is certainly due to the amounts of A_0 layer in each plots. For the ridge plot, the relation between the numbers of Collembola, Cryptostigmaat, Mesostigmata and Prostigmata per soil core and the amounts of A_0 layer was examined by calculating rank correlation coefficients. Significant coefficient was obtained for Collembola, Mesostigmata, and Prostigmata ($P<0.05$). Vertical distributions of Collembola, Cryptostigmata, Mesostigmata, and Prostigmata are shown in Fig. 1. For every animal group, vertical distribution was concentrated to the upper soil layer and population density decreased with the increase ol the depth of the soil layer. The variation of population density along the slope together with the vertical distribution patterns suggests the importance of A_0 layer for a determinant for the abundance of soil micro-arthropods[6),7)].

Species Composition of Collembolan populations

The lists of Collembolan species in each plot are given in Table. 2. A total 44 species

Table 1. Population densities of Collembola, Cryptostigmata, Mesostigmata, and Prostigmata. Mean density per 1 m^2± standard errors.

Population density

	Ridge	Middle	Bottom
Collembola	41,120±4,326	29,480±3,685	16,500±2,536
Cryptostigmata	47,000±4,346	38,000±3,629	20,720±6,877
Mesostigmata	7,680±1,323	6,640±1,102	2,240±1,132
Prostigmata	3,120± 710	4,000± 363	480± 199

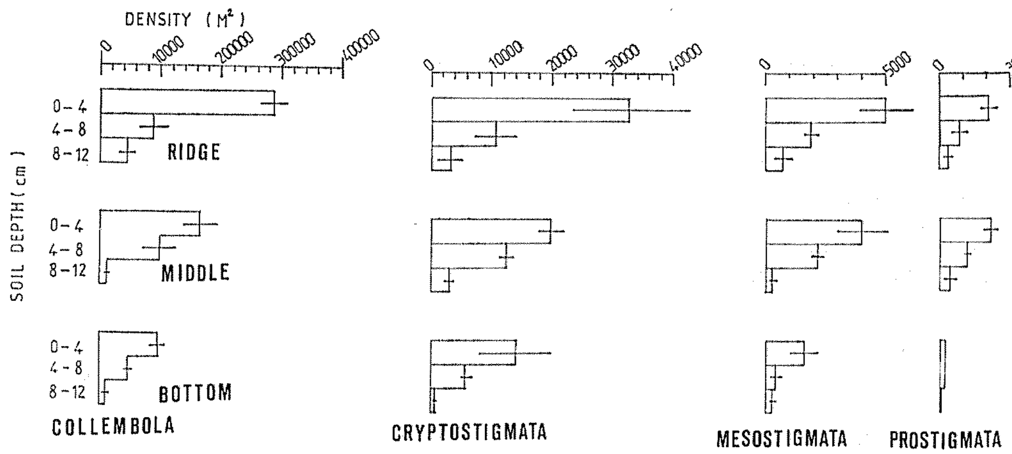

Fig. 1 Vertical distribution of Collembola, Cryptostigmata, Mesostigmata, and Prostigmata in the three plots. Bars indicate the standard errors. Errata-Density of Collembola, 200,000, 300,000, 400,000 →20,000, 30,000, and 40,000.

Table 2. Species list of Collembola in the study area. Numbers indicate the percentages.

	Ridge	Middle	Bottom
PODURIDAE			
Friesea sp.	8.1	1.0	0.3
Hypogastura sp. 1.	0.7	2.8	3.6
H. sp. 2	0.1	0.2	0.3
Pseudoachorutes sp.	0.4	0.2	0.8
Branchstomella sp.	0.7	0.4	0
Neanura sp. 1.	0.3	1.9	0.3
N. sp. 2.	0.1	0	0
N. sp. 3.	1.1	0	0
Anurida sp.	0	0.6	3.6
Odontella sp.	0	0.7	0.8
ONYCHIURIDAE			
Onychiurus flavescence KINOSHITA	4.1	24.7	15.2
Onychiurus sibiricus TULLBERG	1.5	0.6	4.7
Onychiurus folsomi SCHAFFER	4.9	4.4	1.9
Onychiurus yodaii YOSII	0	0.4	0
Onychiurus sp.	0	0.4	0
Tullbergia yosii RUSEK	32.5	1.3	6.6
ISOTOMIDAE			
Folsomia octoculata HANDSCHIN	12.9	26.5	25.3
Folsomia inoculata STACH	14.0	8.2	6.1
Isotoma sp. 1.	0.7	0.9	0
Isotoma carpenteri DENIS	1.8	6.6	0.8
Isotoma viridis BOULLET	0.3	0.2	0
Isotoma sp. 2.	0	0.4	0
Isotoma sp. 3.	0	0.2	0
Isotoma sensibilis TULLBERG	0	0	3.6
Isotomiella minor SCHAFFER	1.0	0.2	0.6
Isotomiella sp.	2.2	0	0
Proisotoma sp.	4.0	1.6	1.9
Folsomina onychiurina DENIS	0.6	0	0
Micoroistoma achromata BELLIGER	1.2	0	0
Folsomides paruus STACH	0	0	0.8
Tetracanthella sylvatica YOSII	0	0	0.3
TOMOCERIDAE			
Tomocerus varius FOLSOM	2.0	3.3	6.8
Tomocerus ocreatus DENIS	0	0.5	3.0
Lepidocyrutus sp. 1.	0.1	0.3	2.9
L. sp. 2.	0.2	0.6	2.6
Oncopodura caassicornis SCHOEB.	0.1	8.9	2.6
Halowmillsia ocellata MILLS	0	0	0
SMINTHURIDAE			
Sminthuridae sp.	0.1	0	0.2
S. sp. 1	0.2	0	0.2
Dychiritoma sp.	0.1	0	0
Arphopalites sp.	0	0.2	2.1
Ptenothrox sp.	0	0.2	0
Neelus minium S	0.1	1.5	0.2
Sminthuridae sp.	0	0.1	0.2

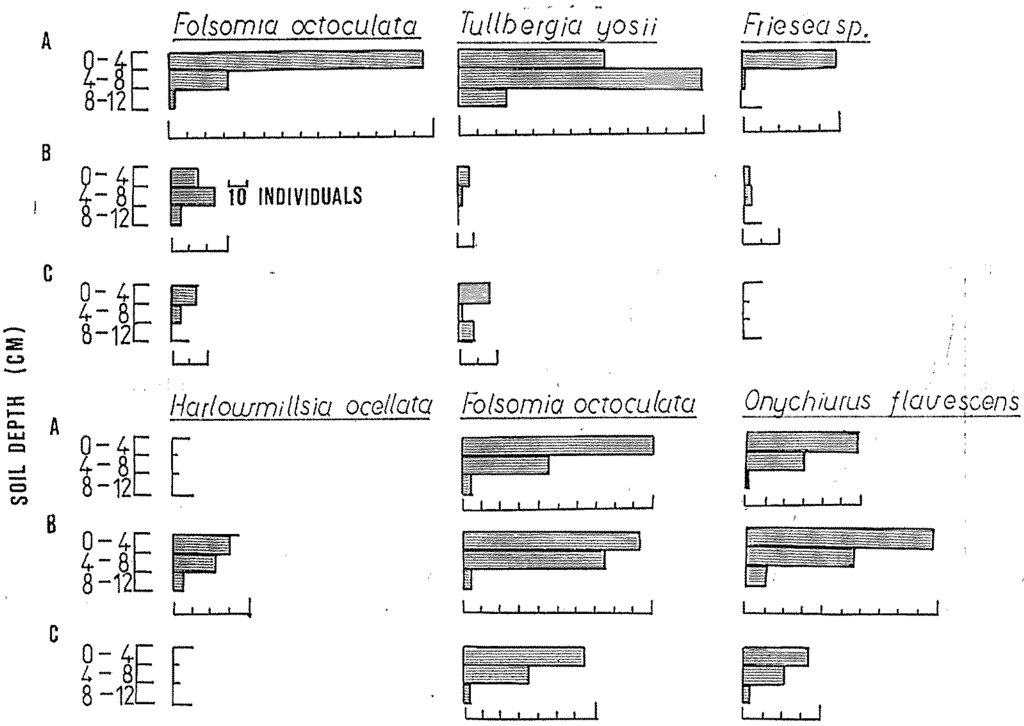

Fig. 2 Vertical distributions of some dominant species of Collembola.
A, B, and C indicate the ridge, middle, and bottom plots. respectively.

were found in this slope and 18 species were common to the three plots. Number of species in each plot was 30, 31, and 29 species in the ridge, middle, and the bottom plots respectively.

In the ridge plot, *Tullbergia yosii, Folsomia octoculata, F. inoculata, Onychiurus flavescence* and *Friesea sp.* were dominant species and they accounted for 71.6% of total numbers. In the middle, *Folsomia octoculata, O. flavescence* and *Halowmillsia ocellata* were dominant and accounted for 60.1% of total numbers. In the bottom plot, *Folsomia octoculata, O. flavescence* and *Tomocerus varius* were dominant and accounted for 47.3% of total numbers. *Folsomia octoculata* and *Onychiurus flaveseence* were commonly dominant in the three plots and the other dominant species showed a habitat selection among the three plots. The vertical distributions of the dominant species are shown in Fig. 2. The changes in abundance and vertical distribution of each species along the slope indicate the habitat preference of each species.

Community Structure

To compare community structure between the plots, the diversity, evenness, species richness were calculated for each plot by the following formulas.

$$H' = -\sum_i \hat{p}_i \log_2 \hat{p}_i,$$

$$J' = \log H'/\log S,$$

where $\hat{p}_i$ is the observed relative abundance of the i th species and S the number of

Table 3. Components of diversity of Collembolan communities in the study area.

	Ridge	Middle	Bottom
Number of species	30	31	29
Diversity (H′)	3.420	3.332	3.588
Evenness (J′)	0.360	0.350	0.379

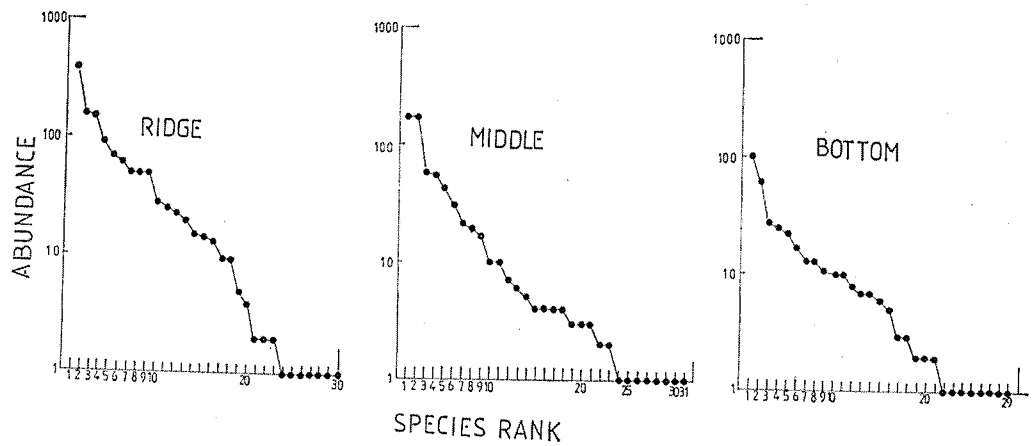

Fig. 3 Patterns of relative abundance of Collembolan communities in the study area. For each species, relative abundance is plotted against rank order from most to least abundant.

species and the results are given in Table. 3. To visualize the distribution of individuals into species, the species abundance curves are shown for the three communities (Fig. 3.). A steep slope at the left side indicates the dominance of few species in each community as mentioned in the species composition. These results showed that the three communities have a common structure in terms of the diversity, evenness, and species richness.

Biomass of Collembola was estimated for each plot by using the distribution of body length of individuals of Collembola (Fig. 4.). Biomass estimated was 66.2, 67.8 and 71.4 mg per 1 m^2 in the ridege, the middle and the bottom respectively. Comparing the biomass with population density there was an inverse relation between the biomass and population density. The lower biomass in the ridge plot was due to the dominance of

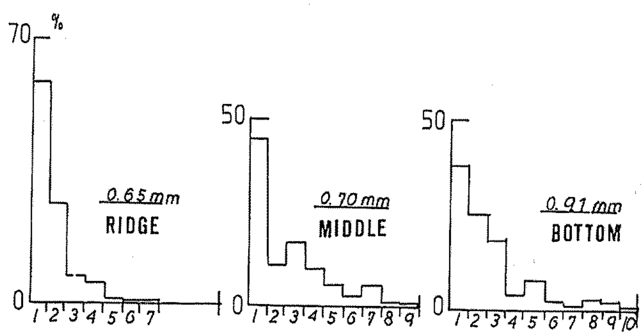

Fig. 4 Body length distributions of Collembola in the ridge, middle, and bottom plot.

Tullbergia yosii which constituted a large part of the first size class in the body length distribution. The abundance of the surface dwelling form species, such as *Tomocerus varius,* and *T. ocreatus* may be contributed to the higher biomass in the bottom. In the ridge plot, A_0 layer is well developed and may provides a large amount of living space which consists of a lot of small cavities, whereas the L layer in the bottom plot directly contacts on the top soil and provides a lot of large space between two layers. These structural differences in the A_0 layer may be related to the size distribution of Collembola.

The cycling of mineral elements have been studied in this forest slope by KATAGIRI & TSUTSUMI[4),5)]. They found that there were differences in the patterns of mineral circulation between the ridge and the bottom plot and the rate of turn-over of some mineral elements was higher in the bottom than in the ridge plots. The relation of soil fauna to the decomsition have been studied by TSUKAMOTO[11)] and he showed that the biomass of macro-fauna was higher in the bottom than in the ridge plots. The present results together with those of macro-fauna support the view presented by Bornebush[1)], who stated that "The soil in which decomposition is most active contains the greatest weight of animals but the lowest number, where decomposition is low so that a heavy layer of raw humus is formed, we find the greatest number of animals but on average these are very small and their total weight is lower than that of the best soil"[1)].

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