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Some Ecological Observations on Collembola in Sapporo, Northern Japan[1]

By

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(With 12 Text-figures and 4 Tables)

Introduction

The ecological study of Collembola in Japan has so far relatively been ignored. But recently some basic information on the ecological distribution of this group were reported by Morikawa *et al.* (1954), Niijima (1966a, b) and Uchida and Kojima (1966). In this circumstance the author made some ecological observations in Hokkaido. In the present paper, the result, taken in 1965 in Sapporo, is preliminarily reported. Various useful stimulators have hitherto been deviced for the extraction of soil meso-fauna. In the present study Para-Dichlorobenzene was used for extraction. Among certain defects by this method as given in the later discussion, the most serious one is the inefficiency in extraction which does not always favor to sampling certain groups. But the results, though still incomplete, seem to show more or less unbiased picture of the collembolan fauna in the area studied. The main aims of the present paper are: (1) to show the basic structure of the faunal makeup of Collembola in Sapporo, especially as to the dominant species; (2) to compare the community structure among certain different vegetation types; (3) to study the population changes in relation to seasonal and vertical distribution; and (4) to obtain any other information useful for further studies.

Stations studied

The samples were taken periodically from the following five stations of different vegetation types (Fig 1): (1) Station Be (broad leaf wood): A primary stand of elm (*Ulmus Davidiana* var. *japonica*) in the Botanical Garden, Hokkaido University. Besides the elm, *Kalopanax* is sparsely found. Undergrowth is a mixture of *Sasa*, *Oenanthe*, *Heracleum*, etc. Insolation is strongly prevented by the trees. Ground surface is covered with litter of about 1 cm thick, almost entirely consisting of

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decaying leaves and twigs of elm. Humus layer is over 30 cm deep. (2) Station Ba (broad leaf wood): A secondary stand of pseudacacia (*Robinia Pseudoacacia*) in the same Botanical Garden, with an admixture of a few other trees. Undergrowth mostly consists of *Heracleum* with a slight mixture of *Sasa*. Penetration of light is relatively well. Litter layer is about 1.5 cm thick and humus layer more than 30 cm deep. (3) Station Mj (coniferous wood): A Japanese cedar wood in the Maruyama Park, virtually no mixture of other tree species. Undergrowth is dominanted by *Torilis* and *Plantago*, not tall but very dense. Insolation does not sufficiently reach to the ground and the surface is relatively humid. Thickness of litter is about 1 cm, and of humus over 30 cm. (4) Station Th (herbaceous field): A secondary herbaceous field at Taniguchi Farm, Barato. The dominant plants are *Erigeron*, etc. Both surface litter and humus layer are very thin and well decomposed, perhaps caused by good ventilation and insolation. (5) Station Tg (grassland): A secondary grassland at Teine. The dominant plants are *Dactylis*, *Phleum*, *Carex*, etc. Litter is thick, 2.5 cm in average and humus layer is thinner than in Station Th. The upper 3 cm soil is occupied by dense root system.

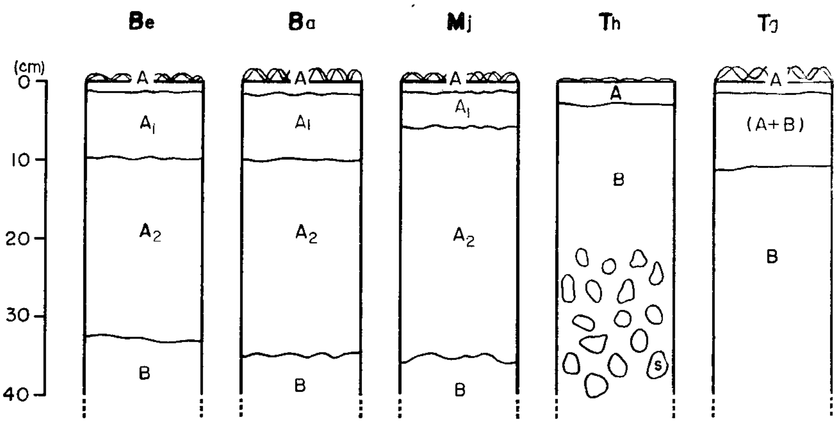


Fig. 1. Soil profile of each station studied.
A : A_0(=L+F+H)-layer in Be, Ba, Mj and $A_0+A_1+A_2$-layer in Th and Tg; s: stones.

At sampling, temperature was measured both in air (1 m above the ground) and at depths of 2, 5, 10 and 15 cm of soil in each station, using the rod and soil thermometers (Fig. 2). The abundance of soil fauna is affected by the soil moisture as well as quantity and quality of organic materials involved. In this preliminary study, however, the measurements of these factors were not undertaken. The temperature changes of air and soil at each station during the sampling period are shown in Fig. 2. In general the temperature is maximum in August, declining in

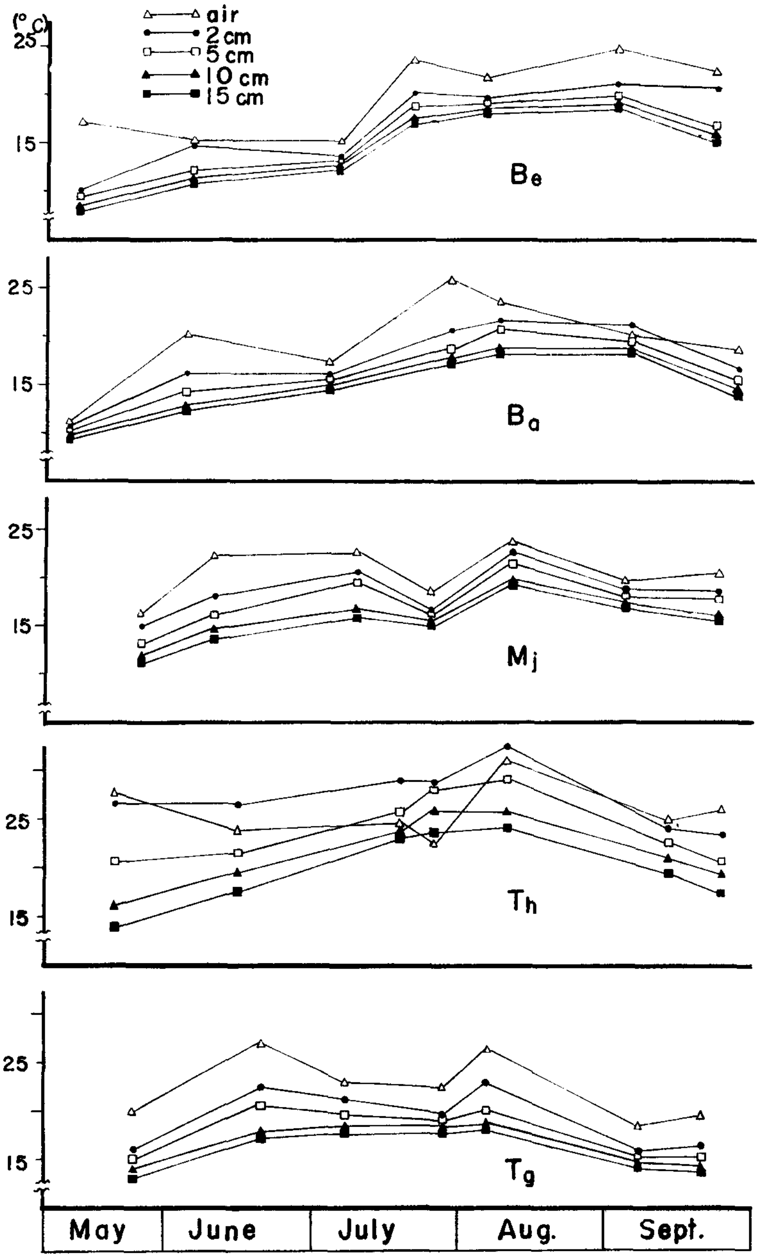


Fig. 2. Change of air and soil (2–15 cm below surface) temperatures at the stations studied (1965).

September. A special case was observed at Th, where the air temperature was lower than the soil temperature during summer, probably due to good insolation on the soil surface and very thin litter layer. The soil surface of Th was indeed very dry during summer.

Method employed

The survey was carried out during five months from May to September in 1965. The sampling was made twice per month in July and September and once in other months at 10:00–12:00 on the day after, at least, two successive days of fine weather. A single sample consists of a soil block of 10×10 sq. cm and 15 cm deep. Each block was subdivided vertically in order to observe the difference in vertical distribution into the following layers: litter layer not containing soil (L), soil of 0–2 cm (S_2), 2–5 cm (S_5), 5–10 cm (S_{10}), and 10–15 cm (S_{15}) in depth. Three plots were taken at random from every station, hence 15 subsamples (3×5) and one test sample (for determination of species) were obtained on each sampling date. Each subsample was separately put into a polyethylene bag and the extraction was performed in the laboratory. The extraction was made by Berlese-Tullgren's funnel improved by Aoki (1961) and modified by the author. In order to accelerate the extraction, Para-Dichlorobenzene was used instead of heating. After the chemical agent was scattered over the sample surface, the apparatus was left for 24 hours and the animals extracted were collected in the stylole vial filled with 70% alcohol. The specimens from each subsample were counted for each species.

Results

1. **Faunal makeup**: In total 43 species of Collembola belonging to 21 genera and 9 families were obtained in this study. The number is quite large in comparison with that so far known from Hokkaido (34 species, Uchida and Tamura, 1966). The individual number collected during the sampling period is shown at generic level in Table 1 together with the species number sampled in each genus. The genera with relatively abundant species are *Onychiurus* (8 species), *Folsomia* (5 species) and *Isotoma* (3 species), which are also overwhelmingly dominant in the individual number. Genera with individual number more than 10% of the total number in each station are as follows: Be: *Isotoma* (37.8%), *Folsomia* (35.2%), *Onychiurus* (14.7%); Ba: *Isotoma* (44.0%), *Folsomia* (35.5%); Mj: *Folsomia* (64.5%), *Isotoma* (17.9%); Th: *Folsomia* (80.6%); and Tg: *Onychiurus* (18.8%), *Isotoma* (26.6%), *Isotomiella* (35.5%). Consequently three genera mentioned above are dominant in all stations studied, though variable in their relative dominance. One exception is *Isotomiella* in Tg, which is dominant only there together with *Isotoma* and *Onychiurus*. The faunal makeup of each station is shown in Fig. 3 together with the relative abundance of various species. The scientific names of many species are not yet accurately determined, so that each species is expressed by number,

Table 1. Faunal makeup at generic level in five stations, by total individual number sampled (May-September, 1965)

Genus	No. of species	Be	Ba	Mj	Th	Tg	Total
Onychiurus	8	511	141	221	3	147	1023
Tullbergia	1	32	51	4	71	20	178
Schaefferia	1	0	0	6	0	0	6
Xenylla	2	69	15	17	13	0	114
Neogastrura	2	155	0	0	0	0	155
Beckerellodes	1	0	0	0	6	0	6
Anura	2	0	0	5	0	0	5
Isotoma	3	1313	1442	518	28	207	3508
Isotomiella	1	24	15	0	22	280	341
Isotomina	2	0	0	0	68	52	120
Proisotoma	1	0	0	6	0	0	6
Folsomia	5	1223	1165	1862	1247	0	5497
Spinisotoma	1	1	2	69	0	0	72
Entomobrya	2	14	26	27	79	14	160
Cyphoderus	1	15	6	0	0	0	21
Tomocerus	1	13	84	55	0	8	160
Megalothorax	1	76	44	27	0	0	147
Sminthurinus	1	22	283	59	1	10	375
Bourletiella	1	0	0	1	3	6	10
Katiannini	1	0	0	7	0	0	7
Sminthuridae	5	0	0	0	6	34	40
Total	43	3468	3274	2884	1547	778	11951

grouped according to genus. The degree of relative abundance was classified according to Brockmann-Jerosch's standard (after Aoki, 1962). The dominant species, each occupying more than 5% of total individual number in each station, are as follows: Be: 1 (*Onychiurus octopunctatus* (Tullberg)), 18 (*Isotoma trispinata* MacGillivray), 25 (*Folsomia diplophthalma* Kseneman) and 26 (*Folsomia quadrioculata* (Tullberg)); Ba: 1, 18, 25 and 26; Mj: 1, 18 and 25; Th: 29 (*Folsomia* sp. an undescribed species); and Tg: 2 (*Onychiurus orthacanthus* Handschin), 18, 21 (*Isotomiella minor* (Schäffer)) and 22 (*Isotomina thermophila* (Axelson)). The dominant species are common among Be, Ba and Mj except for 26 which is not dominant in Mj, suggesting the similar faunal makeup in these woodland stations. On the other hand, Th and Tg, openland stations, have no dominant species common to the woodland station except for *Isotoma trispinata* in Tg, indicating the different faunal makeup from the woodland. The number of species in each station forms the following order: Be (22)≫Ba(19)>Mj(18)>Tg(16)>Th(15). But qualitatively the faunal makeup at specific level is quite different among stations. There are only four species common to all stations: 9 (*Tullbergia krausbaueri* Börner), 18, 31 (*Entomobrya corticalis* Nicolet) and 36 (*Sminthurinus* sp.) and only nine species common to four of five stations: 1, 21, 25, 32 (*Entomobrya* sp.) and 34 (*Tomocerus* *minutus* Tullberg) except for 4 species mentioned above. On the other hand, 22 species are found only in one station, among which the two following species are dominant in respective station: 2 at Tg and 29 at Th. It is therefore conceivable that most species show patch distribution, besides their preference to particular

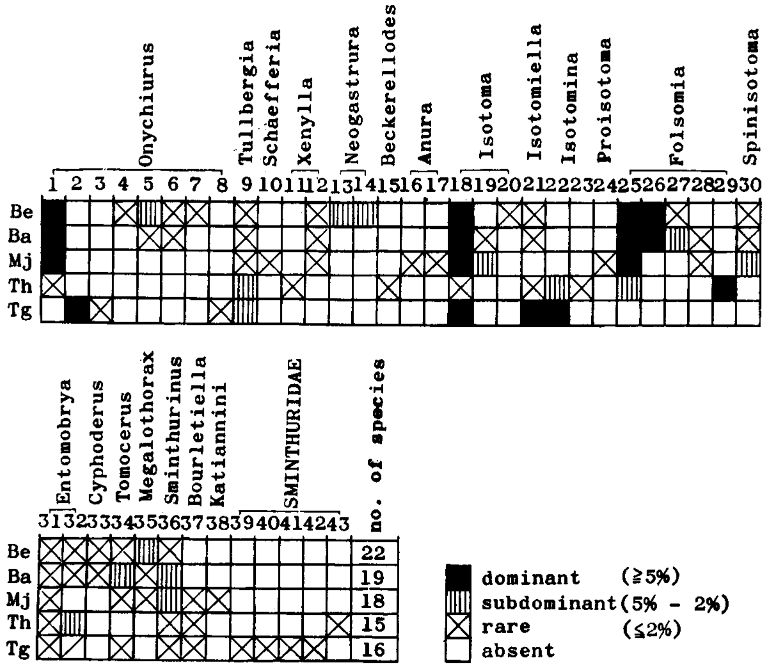
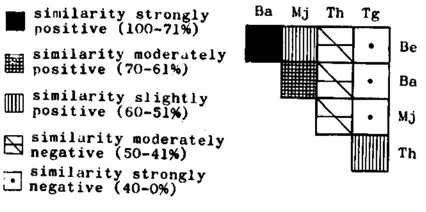


Fig. 3. Relative dominance of each species in various stations (Degree of dominancy after Brockmann-Jerosch, 1907).



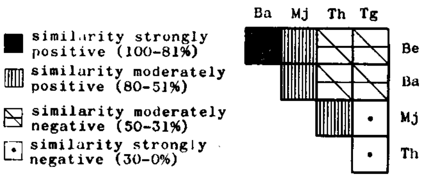


Fig. 4.

Fig. 5.

Fig. 4. Qualitative similarity between each pair of 5 stations studied at specific level using Sørenson's quotient.

Fig. 5. Qualitative and quantitative similarity between each pair of 5 stations at generic level using Renkonen's index.

vegetation. Closer analysis of the similarity of faunal makeup between each pair of five stations is given in Figs. 4 and 5. Fig. 4 shows the qualitative similarity between each pair of five stations studied, based upon Sørenson's quotient (after Davis, 1963) as follows:

$$S_1 = \frac{2c}{a+b} \times 100\,(\%)$$

where a and b are, the number of species found respectively in two stations. and c the number of species common to both stations. The similarity or difference in community structure was estimated by the following criterion: distinctly similar (≧71%), moderately similar (61–70%), slightly similar (51–60%), moderately dissimilar (41–50%) and strongly dissimilar (≦40%). Be and Mj or Ba and Mj are slightly and moderately similar respectively. Be and Th, Ba and Th or Mj and Tg are almost independent in species composition for each other, and Th and Tg are slightly similar. Consequently the woodland habitats, Be, Ba and Mj, are more or less similar to each other in the collembolan community as the openland habitats, Th and Tg, and two basically different vegetations, woodland and openland, have more or less the independent collembolan community for each other. Fig. 5 shows both qualitative and quantitative similarities of the generic composition between each pair of five stations studied, based upon Renkonen's index (after Aoki, 1962) as follows:

$$S_2 = a + b + c + d \cdots\cdots\cdots (\%)$$

where a, b, c, d,.... are the smaller individual percentage between two stations of each genus common to both stations, giving the percentage of individual number of each genus to the total individual number in each station. The degrees of similarity are standarized as follows: strongly similar (≧ 81%), moderately similar (51–80%), moderately dissimilar (31–50%) and strongly dissimilar (≦30%). From the figure, the woodland habitats, Be, Ba and Mj, are more or less similar to each other, but differ from the openland habitats, Th and Tg, except for the relationship between Mj and Th, which are moderately similar to one another in the community structure. Th (herbaceous) and Tg (gramineous) are strongly different from each other. Comparing Figs. 4 and 5, it is remarkable that the relationships between Mj and Th or Th and Tg differ between two different analyses. These differences are mainly caused by the genus *Folsomia.* The similarity between Mj and Th in Fig. 5 depends on the quantitative resemblance of the ratio occupied by the genus *Folsomia* to the total individuals in each station, namely, *Folsomia* occupies 64.5% or 80.6% in Mj or Th respectively, so the similarity value between these stations is at least over 64.5% (moderately similar). On the other hand, the difference between Th and Tg in Fig. 5 depends on the absence of *Folsomia* in Tg, so the similarity value does not exceed 19.4% (strongly dissimilar). In general it is concluded that faunal makeup of Collembola is different, first of all, between woodland and openland habitats. Within these two major habitat types, there is also found a little difference, probably due to the difference in vegetation types, which governs certain environmental factors such as the quality and quantity of humus and soil-pH, etc. Further characterization of the five stations was performed by Motomura's law of geometric series, using the formula $\log y + ax = b$ (Motomura, 1938). From the values shown in Fig. 6 (at generic level) and Fig. 7 (at specific level), the stations in this series resemble each other in complexity, but differ slightly. They can be arranged in the following order: $\mathrm{Be} \doteqdot \mathrm{Ba} \geqq \mathrm{Mj} > \mathrm{Tg} \geqq \mathrm{Th}$, that is, the woodland communities seem to be more complex in composition and to be richer in number of individuals than the openland ones.

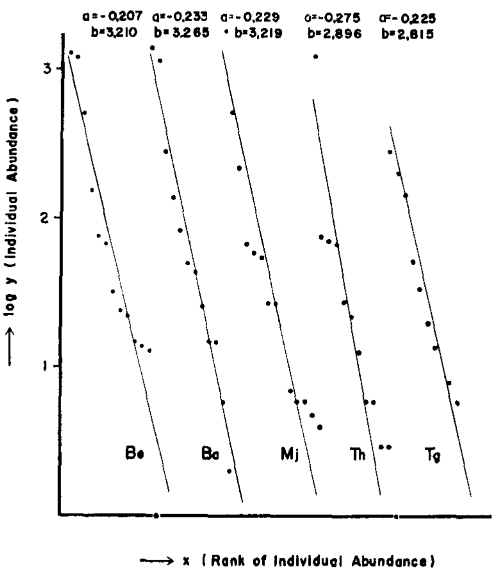


Fig. 6.

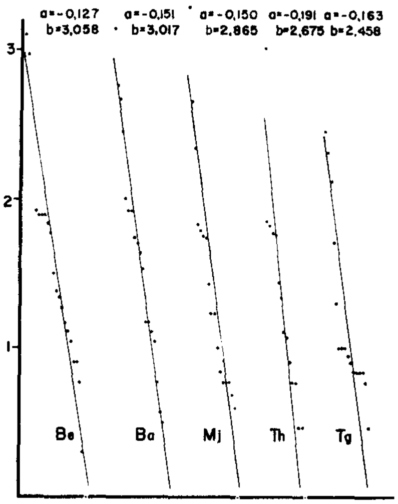


Fig. 7.

Fig. 6. Comparison of assemblage complexity at generic level among five stations studied by the Motomura's law of geometric series.

Fig. 7. Comparison of assemblage complexity at specific level in five stations studied by the law of the geometric series.

2. **Seasonal fluctuation of representative species**: Although the sampling during winter under the snow-cover was not undertaken, the data in other seasons show some phenological trends. Besides the total individual number of all species sampled, 13 representative species were selected and the seasonal trends were traced by the monthly inidividual number sampled in five stations. Fig. 8 gives the seasonal trend of the total individuals of all species sampled. It is remarkable that the collembolan community as a whole keeps the same level, except slight drops in cool seasons (early spring and autumn). But each

species has its own phenology which are grouped in three basic types. The species belonging to the first type (Fig. 9) increase from spring to summer, keep the plateau during summer and slightly decrease in autumn. The following 5 species show this type: *Onychiurus octopunctatus, Folsomia diplophthalma, Megalothorax minimus, Tullbergia krausbaueri* and *Tomocerus minutus.* In *Tomocerus,* the summer population mostly consists of relatively small individuals (juveniles), though no exact measurement of body length was undertaken. The second type (Fig. 10) has the peak in spring to early summer, then gradually decrease to mid or late summer. The following 3 species are included into this type: *Folsomia quadrioculata, Folsomia* sp. and *Isotomiella minor,* though the phenological pattern is rather different among them. The third type (Fig. 11) is characterized by the gradual increase from spring to summer, and the decrease to autumn, including the following three species *Onychiurus orthacanthus, Isotoma trispinata* and *Isotomina thermophila.*

3. **Vertical distribution**: It is well known that collembolan community is rich in upper soil layer, gradually decreasing in individual number in deeper layer,

Fig. 8.

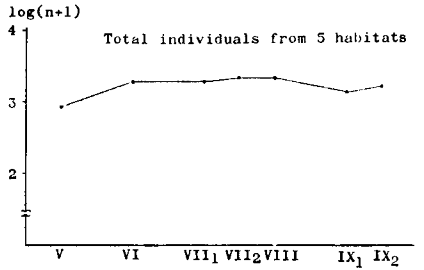
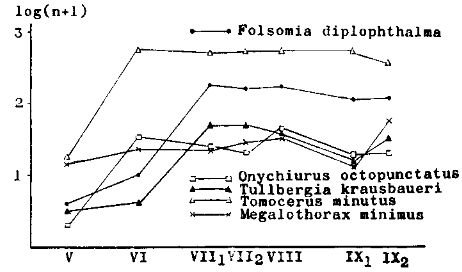


Fig. 9.



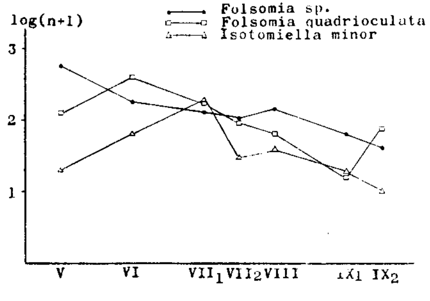


Fig. 10.

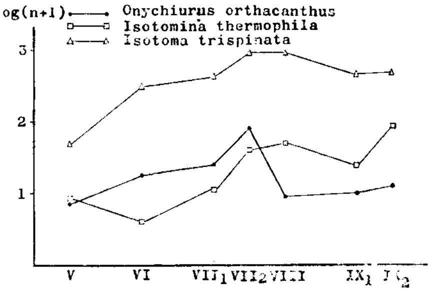


Fig. 11.

Fig. 8–11. Seasonal changes of the numbers of total individuals. Ordinate log $(n+1)$, where n is the individual number sampled. Fig. 8 (upperleft) Total individual number. Fig. 9. (upper right). Species with high individual number throughout summer. Fig. 10. (lower left). Species gradually decreasing from spring to autumn. Fig. 11 (lower right). Species with the peak at mid-summer.

parallel to the diminution of organic material. But the rate of decrease differs among species (Poole, 1964). This phenomenon was also noticed in this study and some patterns of the vertical distribution were recognized. As already mentioned the sample of soil was divided into the following subsamples: L, S_2, S_5, S_{10} and S_{15}. In 13 dominant species, the individuals from all stations were combined as to these vertical layers. The density for each subsample except for L were converted to the number per 1 cm in depth. L-layer was variable according to station, sampling date and minor difference in sampling site so that the thickness could not exactly be standarized. In this case the density was determined conveniently without converting to unit depth. The percent vertical distribution of 13 dominant species is briefly given as follows (Fig. 12): *Tomocerus minutus* (obtained from Be, Ba, Mj and Tg) and *Sminthurinus* sp. (from all stations) showing nearly same trend, more than 90% of the individuals from L and no individual from below S_5. *Entomobrya corticaris* (all stations) mostly in L (ca. 60%) but though gradually decreasing down to S_{15}. *Isotoma trispinata* (all stations) ca. 40% from L, and only 30% from below S_2. *Megalothorax minimus* (Be, Ba and Mj) more than 30% from L but more than 70% above S_5 as in *I. trispinata*. *Folsomia diplophthalma* (Be, Ba, Mj and Th) 30% from L, but about 60% above S_5. *Folsomia quadrioculata* (Be and Ba) approximately as in *F. diplophthalma*.

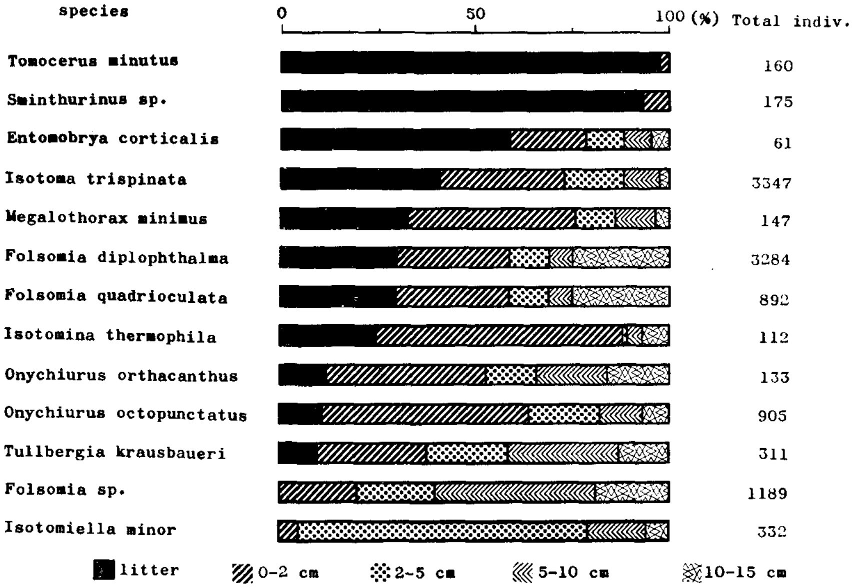


Fig. 12. Vertical distribution of 13 representative species in the five soil layers. Percentage calculated converting to the density of 1 cm deep for each layer.

Isotomina thermophila (Th and Tg) 25% from L but more than 90% above S_5. *Onychiurus octopunctatus* (Be, Ba, Mj and Th) only 10% from L, but more than 60% above S_5. *Onychiurus orthacanthus* (Tg) approximately as in O. *cotopunctatus*, a little more than 50% above S_5. *Tullbergia krausbaueri* (all stations) ca. 90% in the soil layers, only slightly less than 40% above S_5. *Isotomiella minor* (Be, Ba, Th and Tg) not seen in L as in *F.* sp. Table 2 expresses the ratio of individuals sampled of each species in each soil layer from the rearrangement of Fig. 12. It is clear that all species are found in S_2 (0–2cm) and there is no species sampled only from below 2 cm in depth. As mentioned by Poole (1961), the preference to definite layers may be characteristic in certain families or sometimes in genera, for instance ISOTOMIDAE--L- or S_2-layer, ONYCHIURIDAE--S_2-layer, *Folosomia*--L- or S_2-layer and Onychiurus-S_2--layer in mode. The exception is *Folsomia* sp., which was not found in L-layer, nevertheless many other species of *Folsomia* are abundant in this layer. But *F.* sp. was so far been obtained only from Th, so that further sampling in other vegetations is required.

Table 2. Vertical distribution of 13 representative species, expressed by the cumulative ratio of individual number

Species	L	S_2	S_5	S_{10}	S_{15}
Tomocerus minutus	97.5	100			
Sminthurinus sp.	93.1	100			
Entomobrya corticalis	59.0	78.6	87.4	93.9	100
Isotoma trispinata	40.8	72.4	87.5	96.9	100
Megalothorax minimus	32.6	75.4	85.6	96.8	100
Isotomina thermophila	25.0	86.6	87.4	90.9	100
Folsomia quadrioculata	30.1	59.1	69.1	75.4	100
Folsomia diplophthalma	30.1	59.1	69.1	75.4	100
Onychiurus octopunctatus	1.3	54.2	72.6	83.2	100
Onychiurus orthacanthus	12.0	53.5	66.2	84.2	100
Isotomiella minor	0	4.5	78.2	92.9	100
Tullbergia krausbaueri	9.9	37.5	58.7	86.9	100
Folsomia sp.	0	20.1	40.4	80.8	100

Discussion

1. **Efficiency of the extraction procedure**: In the present study, Para-Dichlorobenzene (PD) was used as the stimulator instead of the heating Tullgren funnel with electric lamp (EL) which is generally used for the extraction of soil mesofauna. The use of PD is inefficient and recommended only when the use of EL is impossible, for instance, in the field survey made remote from the laboratory. To compare the relative efficiency by EL and PD, the sampling was made in May, 1966 at Tg, and the material was extracted by EL. The result was compared with that in 1965, sampled at the same place, in the same month and using the same sampler, but extracted by PD instead of EL. In 1965 3 plots and in 1966 10 plots were

taken. The results were converted into the density per 1m^2 and given in Table 3. As seen in the table, the results by PD are far inefficient than that by EL with the ratio 1/13.2 Even the maximum yield obtained in Tg during 1965 by PD is 10,270/m^2 (16 species) that is, far less than the mean yield in May, 1966. Moreover, the relative efficiency of these two stimulators varies according to the life-form of various genera. To demonstrate this differential efficiency, the samples given in Table 3 were rearranged each genus separately, and the results were presented in Table 4. Judging from the results given in the table, in which the genera are arranged in the descending order of the relative efficiency, by two stimulators. *Tomocerus* and *Entomobrya*, including relatively large and active species, are relatively well extracted by PD, whereas *Isotomina* and *Isotoma* with smaller and less active species, or *Tullbergia* with minute and inactive species are not well extracted by PD. The low efficienct of PD is probably caused by the high mortality

Table 3. Comparison of the efficiency by two different stimulators judged by the density of individuals per 1 m^2 (compared by the samples obtained from the same station at same date in two different years)

Stimulator (date)	Density per 1 m^2 in plot			No. of species extracted
	maximum	minimum	mean	
Electric lamp (20-V-1966)	135,700	5,000	42,350	15
Para-Dichlorobenzene (25-V-1965)	6,300	1,100	3,200	12

Table 4. Comparison of efficiency by two different stimulators at generic level (based upon the rearrangement of the data given Table 3)

Genus	Individual number extracted (converted to density per 300 cm^2)		Ratio (1965/66)
	Para-Dichlorobenzene (1965)	Electric lamp (1966)	
Tomocerus	10	3	3/1
Entomobrya	20	6	3/1
Bourletiella	60	192	1/3
Isotomiella	500	1662	1/3
Onychiurus	260	2022	1/7
SMINTHURIDAE	30	306	1/10
Isotoma	30	2262	1/75
Isotomina	20	2472	1/123
Tullbergia	30	3765	1/125
Anura	—	15	—
Total	960	12705	1/13.2

especially in the inactive groups as indicated by Agrell (1965, personal communication). In spite of such inefficiency of PD as a stimulator, however, the results obtained by PD are not always meaningless. For instance, the relation between Ba and Be is similar between Fig. 4 and Fig. 5, where one was analysed at specific level alone, while the other both at generic and individual levels. Moreover Be and Ba are similar to each other not only in the species composition but also in the member of dominant species (Fig. 3). The stimulation by PD may be inefficient and sometimes kill the highly sensitive individuals differentially, but in general most species in a sample appears to be extracted roughly proportional to the populaion size of each species. In other words, the ratio of the individuals extracted of each species by PD (R), would be a function of the population size (P) and specific succeptibility to PD (S), $R=\mathrm{f}(P,S)$. The unbiased extraction might be disturbed by S but not so seriously to completely invalidate the significance of P. Therefore, a perspective of faunal makeup will be obtained by using PD, to a certain degree, even if incompletely, especially when the use of the electric heating is impossible at the localities remote from the laboratory.

2. **Seasonal Fluctuation**: It is difficult to draw a general conclusion concerning the seasonal fluctuation from the sampling undertaken during favorable seasons of only one year. But it is interesting that the total number obtained in each month was nearly constant throughout the sampling period, though slightly higher in summer (mid-June to late August). As shown in Figs. 9–11, the seasonal fluctuation is quite variable among species. But there is no single species with definite minimum population in summer except for *Onychiurus orthacanthus*. Bellinger (1954, Connecticut) records Collembola had the maximum in summer (especially August) and the minimum in winter (especially January) in total individuals. Poole (1961, North Wales) found two maxima (mid-August and early February) and two minima (May and early December) respectively in total individuals. These results coincide with that of this study at least in the occurrence of the maximum in summer. But Glasgow (1939, Slough near London) reports the minimum in summer (August) and the maximum in winter months in total individuals and in ONICHIURIDAE examined in detail in his study. Poole (1961) asserts that the summer peak occurs at the localities where moisture is not the limiting factor. In the present study, the species with summer peak were obtained from the woodland, being not too dry in summer. On the other hand, *Onychiurus orthacanthus*, *Folsomia* sp. and *Isotomina thermophila*, all without peak in mid-August, were obtained only from openlands (Th and Tg), being dry in summer. These facts suggest the validity of the opinion by Poole cited above.

3. **Vertical distribution**: The specific difference in vertical distribution was given in the present paper. Here the result is compared to those obtained by the other authors. Poole (1961) described the vertical distribution of the Collembola inhabiting coniferous forest soil in Wean Wen, North Wales. Among

12 species observed by him, three species, *Tullbergia krausbaueri, Folsomia quadrioculata* and *Isotomiella minor* are also sampled in the present study (cf. Fig. 12). The vertical distribution of *T. krausbaueri, F. quadrioculata* and *Entomobrya* (*E. corticalis* in the present study) is nearly the same between Waen Wen and Sapporo. On the other hand, *I. minor*, the third species common to both studies, behaves differently: In Waen Wen, about 25–30% of the sampled individuals are found in the litter layer, while in Sapporo this species is completely subterranean, not represented in the litter layer. Further, 3 species of *Isotoma* cited by Poole (*I. notabilis, I. olivacea* var. *neglecta* and *I. viridis*) showed approximately the same distribution pattern to that of *Isotoma trispinata* in this study: *Tomocerus longicornis* in Poole was mostly found in litter layer, thus closely resembling *Tomocerus minutus* in this study. The survey by Bellinger (1954, Connecticut) contains a single species common to this study: *Isotomiella minor.* According to him, this species is typical surface dweller, more than 90% of individuals were sampled from litter and humus layers, only less than 10% from mineral soil. This pattern nearly coincided with the result in this study. Among 4 onychiurid species reported by Glasgow (1939, Slou) *Tullbergia krausbaueri* is common to this study. According to him, this species dwells down to 16 inches (40.6 cm) in depth, but so far as to 9 inches in depth, mostly in 0–4.5 inches layer (64%) and less in 4.5–9 inches (11.4–12.9 cm) layer (34%), thus resembling the pattern observed in this study. In the present study, it was confirmed that in most species, 70% or more of individuals were sampled down to soil of 5 cm in depth except for a few examples. Therefore sampling from ($L+S_2$)-layers may be sufficient to have a general perspective of faunal makeup in a given habitat. But the quantitative analysis must be performed at least by sampling from ($L+S_2+S_5$)-layers, i.e. down to 5 cm in depth.

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Summary

The present study deals with the structure of collembolan communities in five stations, representing different vegetation types in Sapporo, Northern Japan during five months (May to September, 1965).

Three woodland habitats (elm stand, pseudacacia stand and Japanese-cedar stand) possess more or less similar faunal makeup, whereas two openland habitats

(grassland and herbaceous field) differ in faunal makeup both from the woodland habitats and between themselves. The degree of complexity of the collembolan community among five stations is ordered: elm stand ≒ pseudacacia stand ≧Japanese-cedar stand>grassland≧herbaceous field. Total individuals of Collembola and many dominant or subdominant species had the summer peak in population fluctuation. The vertical distribution showed some patterns characteristic at familial or occasionally generic levels. In most species, more than 70% of individuals were sampled from the litter and upper soil layer, above 5 cm in depth.

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