Litterfall and Decomposition Process in Sub-arctic Forest Zone in Northern Hokkaido, North Japan*

By

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北海道北部の亜寒帯林におけるリターフォールとその分解過程*

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Abstract

The amounts of litterfall were trapped by a litter trap method in a sub-arctic forest zone in northern Hokkaido, as shown in Figure 2. The study plot was taken with a 100 m×100 m quadrat (1 hectare) in the forest composed of *Abies sachalinensis* Fr. SCHMIDT and *Picea glehnii* MAST. trees.

The amounts of litterfall and the decomposition process a year in the plot were calculated by a mean value (from June 3, 1984 to June 3, 1986). The litterfall amounted to 3.00 ton/ha/year(100%), and the weight loss was 0.35 ton/ha/year(11.7%). Accordingly, annual decomposition rate ($K_L Yr^{-1}$) was estimated at 6.8%. The time taken for 95% of decomposition rate ($3/K_L Yr^{-1}$) was also calculated at about 44 years from the input of dead organic matter.

In this plot, the amounts of litterfall and the weight loss were affected by the season and climate, namely rain, wind and the weight of snow. Especially the rate of the weight loss became higher in the long period when the organic matter was kept on the forest floor (Ao layer) than in the short period.

Key words: Litterfall, Decomposition, Weight loss, Components, Fractions.

CONTENTS

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Introduction

Forest ecosystems have a higher sustained productivity than other natural terrestrial ecosystems. This high productivity is achieved and maintained through effective recycling of nutrient elements by allocating a significant part of the energy captured by primary producers to heterotrophic organisms. It is absolutely necessary for the analysis and understanding as the above mentioned self maintenancesystem and the evolutional system to investigate the amount of litterfall and the decomposition process of the dead organisms in natural forest ecosystem. In terrestrial ecosystems, much of the energy fixed by photosynthesis finds its way to the soil in the form of dead organic matter and is decomposed there by a host of soil organisms releasing nutrients. The rate of breakdown of forest litter influences renewed nutrients which accumulate on the forest floor[5,6,8,19,86~92,105]. Because of its role in nutrients cycling and in supporting the saprophagic component of the ecosystem, decomposition has received growing attention in recent years.

The living organisms require at least 40 elements of nutrient for growth and development. Most important elements of these are carbon, hydrogen, oxygen phosphorous, potassium, nitrogen, sulphur, calcium, iron, magnesium, boron, zinc, chlorine, molybdenum, cobalt, iodine, and fluorine. These materials flow from the non living to the living and back to the non living again. Decomposers make up the final feeding group. They are chiefly micro-organisms (bacteria, yeast and fungi), which break down the remains and wastes of organisms into simpler substances. These decomposers render organic matter soluble and break it down chemically. This material is then utilized by transformers, bacteria that change organic compounds into inorganic forms used by photosynthetic plants. The decomposers that work on plant material are functional herbivores, and those that break down animal tissue are functional carnivores[6,88,90~92]

The amount of energy shunted down by the two routes varies among communities. In an intertidal salt marsh, less than 10 per cent of living plant material is consumed by herbivores and 90 per cent goes by the way of the detritus feeders and decomposers[6,8,88,90~92]. All food chains, directly or indirectly, related back to living plants is shown in Figure 1. Therefore, the analysis of litterfall and components which were trapped and decomposition rate are the best problem for analysing ecosystem in natural forest. The litterfall meaning a layer of dead plant material and insect which might be present on the soil surface (in the litter trap), and decomposition was the action or process of decomposing on the soil surface (in the litter bag), which could be applied to the plant litter. This was the subject of the dissertation.

The author chose natural/primary sub-arctic forest zone in northern Hokkaido, north Japan as study area, because the information of the forest science had been very rarely collected.

In this dissertation, the amount of litterfall and the pattern of litterfall trapped by 432 traps from June 3, 1984 to June 3, 1986 were discussed and sorted per trap into six components and some also of them per fraction and per species. The weight loss of some part of litterfall was measured in 1100 litter bags from June 3, 1984 to June 3, 1986, placed

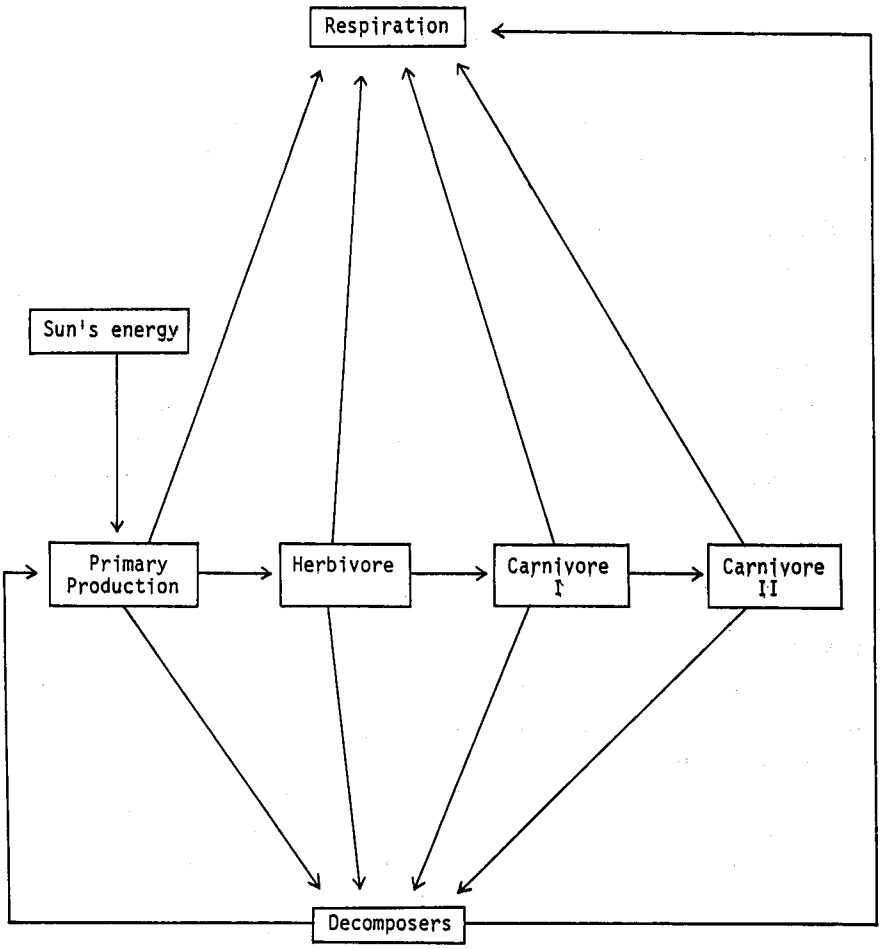

Fig. 1. The flow of energy and the cycling of nutrients, through an ecosystem.

by 10 g samples per each material and prepared of the ten materials.

Study site and Plot

The study plot is located on Moshiri in northern Hokkaido, north Japan as shown in Figure 2. The first larger experimental forests of Hokkaido University, namely Uryu Experiment Forest is situated on 44°3′-29′ north latitude and 142°1′-20′ east longitude and administratively belongs to Horokanai Town, the most northern part of Sorachi province in Hokkaido. The experimental forest having an area of 23,800 ha spreads surrounding Lake Shumarinai, with the topographical features being comparatively gentle, showing the elevations varying from 180 to 855 m above sea level. Widely distributing bed rocks are andesite and sedimentary rocks derived from Tertiary system, while serpentine intruded into lower Yezo group is locally seen in the southern part of the forest. As for the climate, mean annual temperature is 3.5℃ with the maximum of +34.2℃ and minimum temperature of −41.2℃ (from 1965 to 1985). It is shown that the indices of warmth and

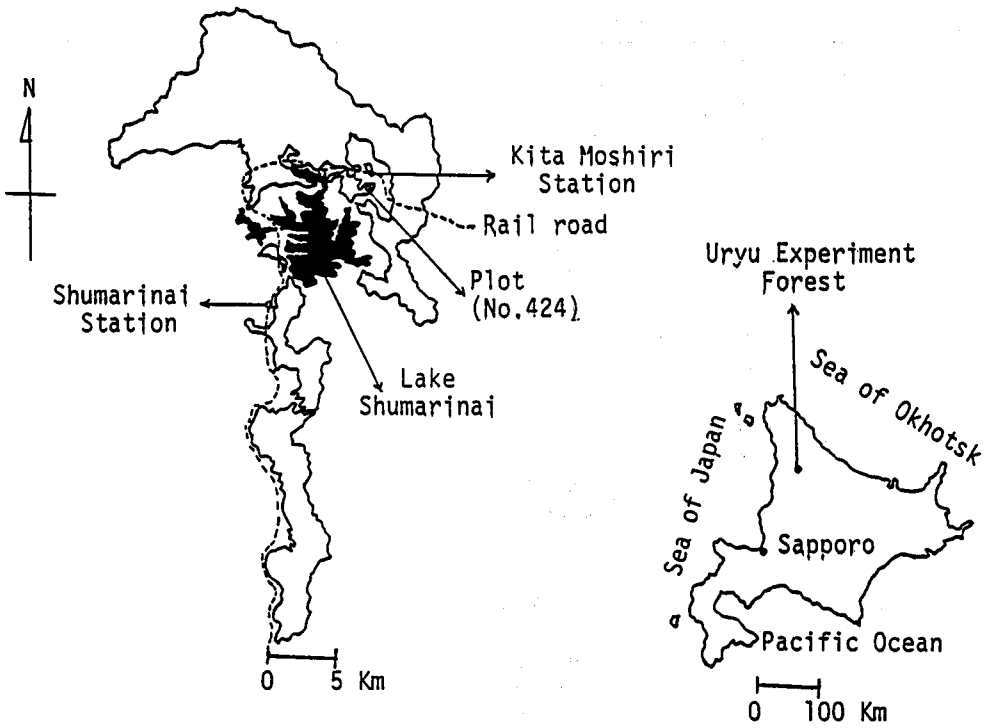

Fig. 2. Location of the study plot on Kita Moshiri of Uryu Experiment Forest in Northern Hokkaido, North Japan.

coldness are +46.7℃ and −66.0℃ respectively, calculated by the accumulation of mean monthly temperatures substracted from a basis of +5℃. Meanwhile, annual precipitation is 1,410 mm mainly as snow which falls from late October to the end of April, holding the maximum snow depth of 2.75 m at the observatory site of Moshiri branch station. Therefore, this district is said to be one of the heavy snow and coldest regions in Japan. However, the forests are on the whole sparse and are often changed to a wide treeless land covered densly with *Sasa kuriensis* MAK. & SHIBATA in the high elevation or to an opened bare land composed of *Sasa senanensis* REHD. among the tree groups. The reason why such lands appear must be probably attributed to the fact of over cutting during and after World War II and the damage caused by the Typhoon no. 15 occurring in 1954. The forest belong to sub-arctic zone and coniferous trees consist mostly of *A. sachalinensis* and *P. glehnii* which sometimes forms pure forest on serpentine soils at the southern part on peat soils at the northern part of Lake Shumarinai and broadleaved trees are *Quercus mongolica* var. *grosseserrata* REHD. & WILLS, *Tilia japonica* SIMONKAI, *Betula ermanii* CHAM., etc. at the higher altitudes and at the lower altitudes *Fraxinus mandshurica* var. *japonica* RUPR., *Alnus hirsuta* TURCZ, *Ulmus davidiana* var. *japonica* NAK., etc. The greater part of this experimental forest is natural, mixed forest of coniferous and broadleaved trees. The forest land is thickly covered with *sasa*, and the forest land is covered with deep snow for about 6 months of a year and accumulated about 2.75 m. The plot

Table 1. The ecological characteristics of the forest stand in the study plot.

No. Layer	Japanese name	Scientific name
I. Tree	Todomatsu	*Abies sachalinensis* Fr. SCHMIDT
	Akaezomatsu	*Picea qlehnii* MAST.
	Mizunara	*Ouercus mongolica* Fischer var, *grosseserrata* REHD.
	Dakekanba	*Betula ermanii* Cham.
	Shirakanba	*Betula platyphylla* SUKATCHEV var. *Japonica* HARA
	Itayakaede	*Acer mono* MAXIM.
	Shinanoki	*Tilia japonica* SIMONKAI
II. Sub-tree	Todomatsu	above-mentioned
	Akaezomatsu	〃
	Dakekanba	〃
	Shirakanba	〃
	Itayakaede	〃
	Shinanoki	〃
	Kihada	*Phellodendron amurense* RUPR, var. *sachalinense* Fr. SCHM.
	Koshiabura	*Acanthopanax sciadophylloides* FRANCH, et SAVAT.
	Azukinashi	*Sorbus alnifolia* K. KOCH.
	Harigiri	*Kalopanax pictus* HAK.
	Ezonobakkoyanagi	*Salix hultenii* FLOD. var. *angustifolia* KIMURA
	Udaikanba	*Betula maximowicziana* REGEL.
	Nanakamado	*Sorbus commixta* HEDL.
III. Shrub	Todomatsu	above-mentioned
	Akeezomatsu	〃
	Mizunara	〃
	Shirakanba	〃
	Itayakaede	〃
	Shinanoki	〃
	Kihada	〃
	Koshiabura	〃
	Azukinashi	〃
	Harigiri	〃
	Ezonobakkoyanagi	〃
	Nanakamado	〃
	Hoonoki	*Magnolia obovata* THUNB.
	Ookamenoki	*Viburnum frucatum* BLUME
	Noliutsugi	*Hydrangea paniculata* SIEB.
IV. Herb	Todomatsu	above-mentioned
	Akaezomatsu	〃
	Dakekanba	〃
	Nanakamado	〃
	Ookamenoki	〃
	Ezoichigo	*Rubus idaeus* LINN. var. *aculeatissimus* REGEL et TILING
	Yamabudou	*Vitis coignetiae* PULLIAT
	Chishimaazami	*Cirsium kamtschaticum* LEDEK.
	Tsurushikimi	*Skimmia japonica* THUNB. var. *intermedia* KOMATSU f. *repens* HARA
	Tsutaurushi	*Rhus ambigua* LAVALLEE
	Oshida	*Dryopteris crassirhizoma* NAKAI
	Kumaizasa	*Sasa senanensis* REHD.
V. Moss	Some parts of the forest fioor was covered with some species of moss.	

located on Moshiri was taken in a 100 m×100 m quadrat in the *P. glehnii* and *A. sachalinensis* forest at the compartment number 424 of the Experiment Forest. The ecological characteristics of the forest stand is shown in Table 1. The tree species in each grade of height(m) and diameter at breast height ≧5 cm in the places where the litter traps was set are shown in Tables 2～3, and Figure 3. In the plot, the density of standing trees with

Table 2. The standing trees in each grade of height (m) and diameter at breast height (cm) in the study plot.

Sp.	Height (m) / D. B. H. (cm)	2>	7>	12>	17>	22>	27>	32>	37>														Total
		5>	10>	15>	20>	25>	30>	35>	40>	45>	50>	55>	60>	65>	70>	75>	80>	85>	90>	95>	100>	105>	
A		120	110	66	39	25	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	365
		138	89	42	35	9	11	13	9	7	3	8	–	–	1	–	–	–	–	–	–	–	365
Pg		12	9	1	5	7	7	5	1	–	–	–	–	–	–	–	–	–	–	–	–	–	47
		13	6	2	2	2	1	–	3	2	–	–	1	2	5	1	1	2	1	1	1	1	47
Q		17	8	2	5	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	37
		23	3	–	1	–	1	–	–	1	1	2	1	–	–	1	1	2	–	–	–	–	37
B		13	24	11	12	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	63
		31	7	4	4	4	4	1	2	2	–	–	–	1	–	1	–	–	2	–	–	–	63
Bp		2	7		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
		6	2	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
Am		6	3	2	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
		5	4	–	–	2	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	13
T		2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
		2	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
K		13	4	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
		15	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
S		6	12	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
		15	5	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
As		6	8	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16
		10	4	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16
Sh		1	5	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
		2	2	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
Sa		14	3	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
		16	1	–	–	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	20
Pa		23	39	14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	76
		36	25	8	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	76
Bm		–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
		–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
M		1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
		1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Total		236	232	105	66	40	12	6	1	–	–	–	–	–	–	–	–	–	–	–	–	–	698
		313	151	60	50	20	20	15	17	12	4	10	2	3	6	3	2	4	3	1	1	1	698

Note; Sp.: Tree species.

A.: *A. sachalinensis*; Pg: *P. glehnii*; Q; *Q. mongolica* var. *grosseserrata*; B: *B. ermanii*; B: *B. platyphylla* var. *japonica*; Am: *A. mono*; T: *T. japonica*; K.: *K. pictus*; S: *S. commixta*; As: *A. sciadophylloides*; Sh: *S. hultenii* var. *angustifolia*; Sa: *S. alnifolia*; Pa: *P. amurense* var. *sachalinense*.

Table 3. Relation of standing trees/ha, with diameter at breast height (≧5 cm), and height (≧2.7 m), and volume (m^2) in the study plot.

Tree species	Standing trees	Mean height (m)	Mean D. B. H. (cm)	Volume (m^3)	: (%)
P. glehnii	47	17.8 (3~37)	39.2 (5~110)	120.9792	39.3
A. sachalinensis	365	11.0 (2.7~30)	16.1 (5~ 72)	104.0874	33.8
B. ermanii	63	12.0 (4.7~32)	19.4 (5~ 92)	33.6907	10.9
Quercus mongolica var. *grosseserrata*	37	11.0 (4.2~26)	22.8 (5~ 88)	34.0266	11.1
Others*	186	8.6 (2.7~22)	10.7 (5~ 42)	15.1303	4.9
Total	698			307.9142	100

* Others (Including *P, amurense* var. *sachalinense* 76 trees or 10.9%, *S. commixta* 21 trees or 3.0%, *S. alnifolia* 20 trees or 2.9%, *K. pictus* 18 trees or 2.6%, *A. mono* 13 trees or 1.9%, *A. sciadophylloides* 16 trees or 2.3%, *B. platyphylla* var. *japonica* 10 trees or 1.4%, *S. hultenii* var. *angustifolia* 7 trees or 1.0%, *T. japonica* 3 trees or 0.4%, *M. obovata* 1 tree or 0.1%, and *B. maximowicziana* 1 tree or 0.1%).

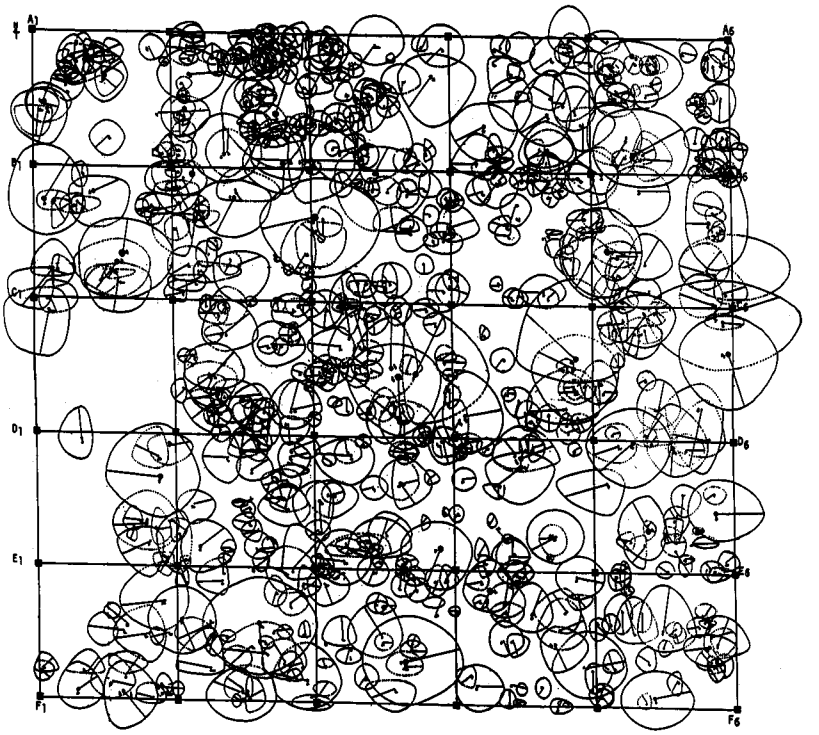

Fig. 3. Arrangement of crowns and distribution of standing trees with diameter at breast height≧5cm and litter trap place in the study plot.

Note; A: *A. sachalinensis*; Pg: *P. glehnii*; Q: *Q. mongolica* var. *grosseserrata*; B: *B. ermanii*; Bp: *B. platyphylla* var. *japonioa*; Am: *A. mono*; T: *T. japonica*; K: *K. pictus*; S: *S. commixta*; As: *A. sciadophylloides*; Sh: *S. hultenii* var. *angustifolia*; Sa: *S. alnifolia*; Pa: *P. amurense* var. *sachalinense*; Bm: *B. maximowicziana*; M: *M. obovata*;

■——■ : Litter trap interval (20m); Altitude: 290m (a, s, l,); Orientation: N26°W.

diameter at breast height(D. B. H.) ≧5 cm was 698 trees/ha, in which the number of the coniferous trees was 412 trees/ha(59.0%), and broadleaved trees 286 trees/ha(41.0%), with the recapitulation per species and the inventories of the standing trees are shown in Table 2, and Figures 3-5. However, the trees of the small diameter at breast height (< 5 cm) are not surveyed.

In sub-arctic forest, coniferous trees might be expected to be more productive than deciduous broadleaved trees, because coniferous trees in this study plot are evergreen nature. Mean annual temperature in sub-arctic zone spanned by the climatic zone is from below freezing to about 25℃. The growing season may be considerably shorter because the winter season has daily temperature below freezing for about 6 months, and in this period, the trees can not find a photosynthesis function[19,23,67,71,81~88,92].

In spring, summer and autumn, this area is always cool. From early November until late May the depth of snowfalls is about 2.75 m. The plot is located at 290 m of altitude (a. s. l.), and direction of N26°W. Mean annual temperature is 3.5℃, and soil type is dark brown forest soil, while the precipitation is 1,410 mm a year. The plot is natural/primary forest, dominated by *A. sachalinensis* and *P. glehnii*, mixed forest of coniferous and broadleaved trees, and forest floor is thickly covered with *S. senanensis*, and some part is composed of *D. crassirhizoma* and *S. japonica* var. *intermedia* f. *repens* with *H. paniculata* as shown in Photo 1. The environmental condition in sub-arctic forest zone is too hard for growth of plants, because of low temperature and short growing season with heavy snowing.

The recapitulation of standing trees with diameter at breast height ≧5 cm in the study plot are as follows:

1. Coniferous trees;
   a. *P. glehnii* numbered 47 trees (6.7%), mean height was 17.8 m (3~38 m), and mean diameter at breast height was 39.2 cm (5~110 cm), with the volume of 120.9792 m^3 (39.3%);
   b. *A. sachalinensis* numbered 365 trees (52.3%), mean height was 11.1 m (2.7~30 m), and mean diameter at breast height was 16.1 cm (5~71 cm), with the volume of 104.0874 m^3 (33.8%);
2. Broadleaved trees;
   c. *Q. mongolica* var. *grosseserrata* numbered 37 trees (5.3%), mean height was 11.0 m (4.2~26 m), and mean diameter at breast height was 22.8 cm (5~88 cm), with the volume of 34.0266 m^3 (11.1%);
   d. *B. ermanii* numbered 63 trees (9.0%), mean height was 12.0 m (4.7~32 m), and mean diameter at breast height was 19.4 cm (5~92 cm), with the volume of 33.6907 m^3 (10.9%);
   e. Others* numbered 186 trees (16.7%), mean height was 8.6 m (2.7~22 m), and mean diameter at breast height was 10.7 cm (5~42 cm), with the volume of 15.1303 m^3 (4.9%);

Total standing trees numbered 698 trees and the volume of 307.9142 m^3.

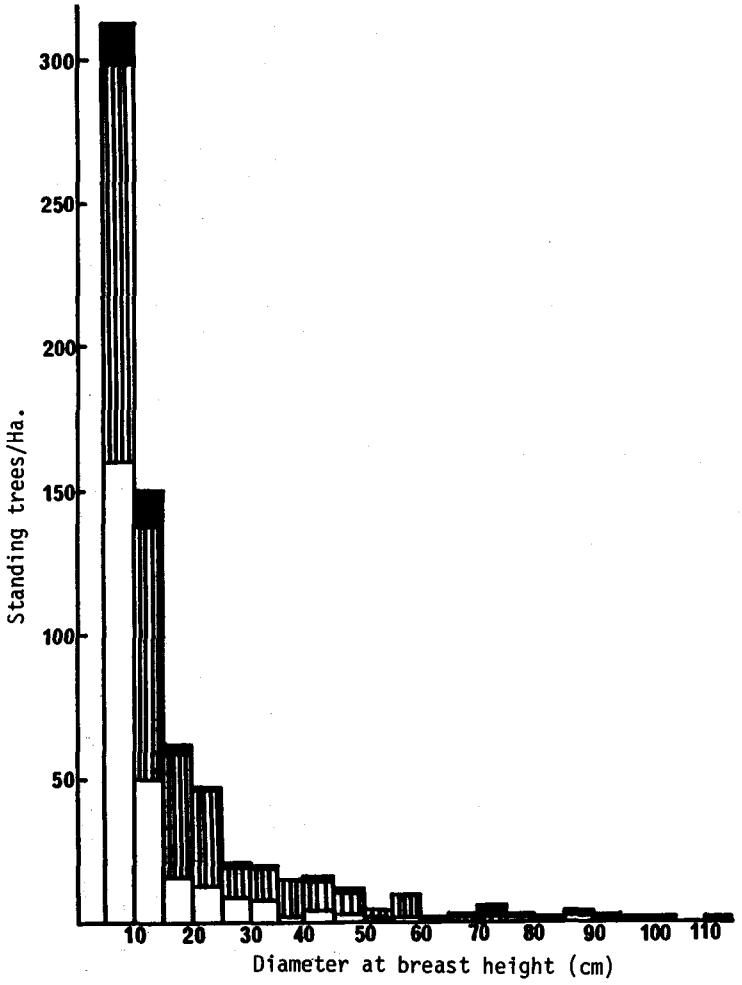

Fig. 4. The standing trees in each grade of diameter at breast height (≧5cm) in the study plot.
Note; See Fig. 5.

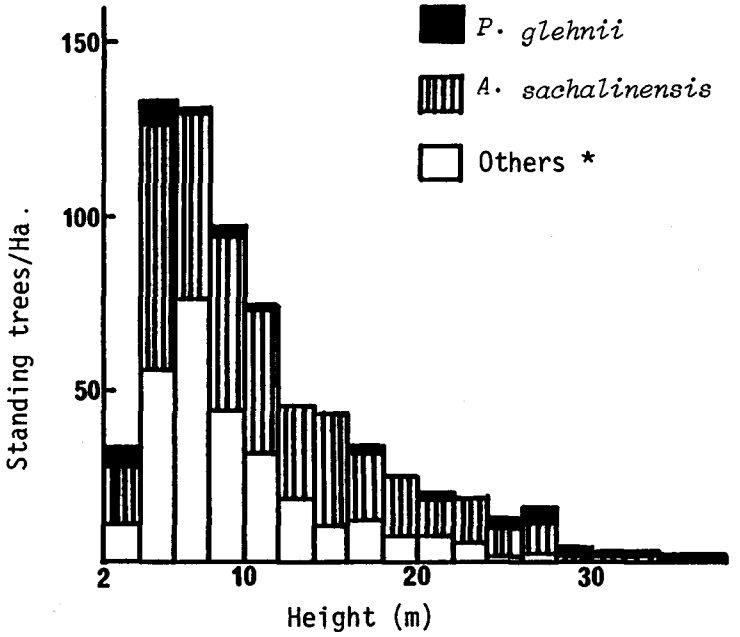

Fig. 5. The standing trees in each grade of height (≧2m) in the study plot.
Note; See Tab. 3.

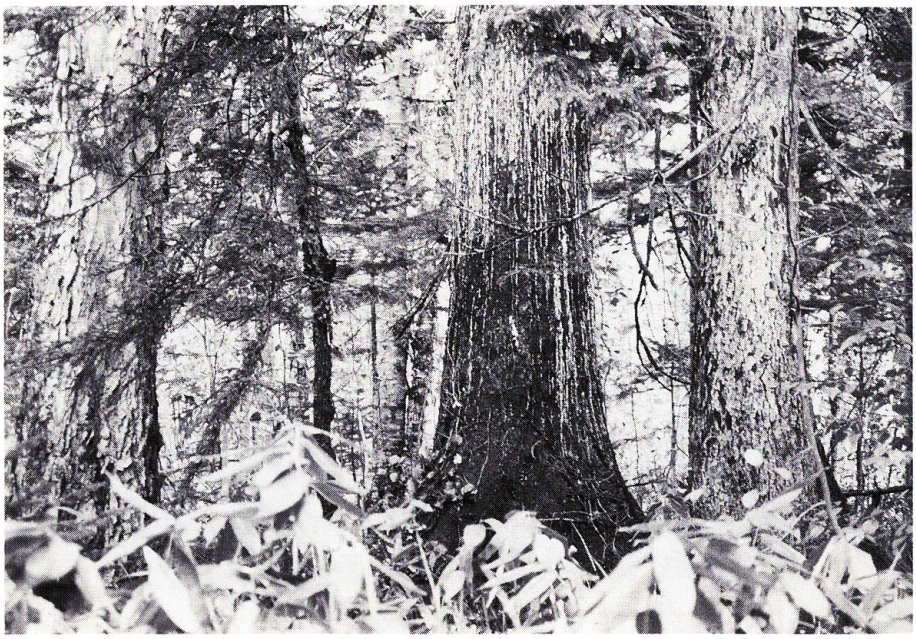

Photo 1. The situation of the study plot during snow-uncovered season.

Method and Data collecting

In the research plot with 100 m×100 m quadrat (1 ha), are shown in Figures 2~3., the litterfall tapped by variation in times, was weighed by oven drived level at 105℃ during 24 hours to constant weight in the laboratory. The litterfall was trapped by each trap, taken by monthly from June 3 to November 1, 1984 and June 3 to November 1, 1985 (snow-uncovered season), and from November 1, 1984 to June 3, 1985 and November 1, 1985 to June 3, 1986 (snow-covered season) were set and taken in once at traps recovering time. In this term, the litterfall was not able to be weighed by monthly, because this area was covered with snow about 2.75 m depth as shown in Photo 2. The first set of a trap was on June 3, 1984 with 36 traps and then taken on July 1, 1984 and their contents were emptied at the beginning of each period. The size of trap in this study used is 0.85 m×0.85 m and 30 cm depth (above the ground) made from wood as shown in Photo 3, with interval/trap to be set up in 20 meters. From June 3, 1984 to June 3, 1986, 432 traps was taken. In the laboratory after oven dried level, the litter trapped per trap were sorted into six components and then some of them per fractions and per species also were as follows:

1. Leaves (coniferous and broadleaved fractions and species);
2. Branches (coniferous and broadleaved fractions);
3. Barks (coniferous and broadleaved fractions);
4. Seeds (coniferous and broadleaved fractions and species);
5. Insect residues;
6. Others (including hares faeced, bud scales, cones, herbaceous plants, etc.).

In this research, especially seeds and insects also were counted by grain and individual

Photo 2. The situation of the study plot during snow-covered season.

numbers. The weight loss study were also collected from the plot, and the collections were brought to the laboratory and oven dried level at 105℃ for 24 hours to constant weight. Litter bags of nylon hair net with 1mm×1 mm apertures were used and 10 g samples per material kept in each litter bag. From June 3, 1984 to June 3, 1986 were prepared 1100 litter bags of the ten materials as follows:

1. Leaf of *P. glehnii*; 2. Branch of *P. glehnii*; 3. Bark of *P. glehnii*; 4. Leaf of *A. sachalinensis*; 5. Branch of *A. sachalinensis*; 6. Leaf of *B. ermanii*; 7. Branch of *B. ermanii*; 8. Bark of *B. ermanii*; 9. Leaf of *S. senanensis*; 10. Culm of *S. senanensis*.

The litter bag were set and recovered by variation in times. The litter traps were placed at the interval of 20 meters, and litter bags was randomly placed on the

Photo 3. The size of litter trap in the study plot.

Photo 4. The size of litter bag in the study plot.

forest floor (Ao layer) on June 3, 1984 in such a manner that they were in contact with soil, being taken care to disturb the floor vegetation as possible. Each litter bag covered an area of 20 cm×20 cm as shown in Photo 4. The weight loss was measured in five steps as under:

First; From June 3 to November 1, 1984 and from June 3 to November 1, 1985, five litter bags of each material were placed and recovered by monthly (respectively);

Second; From June 3 to November 1, 1984 and from June 3 to November 1, 1985, five litter bags of each material were placed and recovered at once time (respectively);

Third; From November 1, 1984 to June 3, 1985 and from November 1, 1985 to June 3, 1986, five litter bags of each material were placed and recovered at once time (respectively);

Fourth; From June 3, 1984 to June 3, 1985 and from June 3, 1985 to June 3, 1986, ten litter bags of each material were placed and recovered at once time (respectively);

Fifth; From June 3, 1984 to June 3, 1986, twenty litter bags of each material were placed and recovered at once time.

The litter bags were made of same sized mesh nylon (1 mm×1 mm), through which invertebrates and all micro organisms except earthworms freely entered[6,8,10,42,44,60,64,72~74,88,90,91,96,97,100,108].

Selection and Presentation of Data

1. Analysis of the amount of litterfall.

The amount of litterfall per trap was weighed by oven dried level (O. D. W.) at 105℃ for 24 hours to constant weight in the laboratory and then forted into six components with fractions and species. The pattern of litterfall was calculated by mean value in metric gram/0.85 m×0.85 m, especially seeds and insect residues were counted by grain and individual numbers, and then converted into metric ton/ha as shown in Tables 4~17, 24~30, and Figures 6~15, 22~26.

2. Analysis of the weight loss.

For the weight loss also collected from the plot, the collection was brought to the laboratory and weighed by oven dried level (O. D. W.) as well as litterfall at 105 ℃ for 24 hours to constant weight. The litter bags were prepared of the ten materials, in which 10 g sample were kept in each bag (one material). These bags were set on the forest floor (Ao layer) and taken at five steps. The weight loss was measured in once and calculated by mean value in metric gram/0.20 cm×0.20 cm, and then converted into metric ton/ha, as shown in Tables 18~23, 31~32, and Figures 16~21, 27~28.

The arithmetic mean of ungrouped data equation was used in the amount of litterfall and the weight loss as under;

$$\bar{x}=\sum_{i=1}^{n} \times i/n$$

3. Density of standing trees.

In the study plot, the density of standing trees with diameter at breast height ≧5 cm was already identified at 698 trees/ha in which conifer species numbered 412 trees/ha (59.0%) and the broadleaved species numbered 286 trees/ha (41.1%). The composition are shown in Tables 2~3, and Figures 3~5, but the trees of smaller diameter (<5 cm) were not identified.

Within closed canopy forests, litter production appears to be little affected by differences in tree density[19,21,29,38,86,87,89]. Coniferous trees might be expected to be more productive than deciduous broadleaved trees, because coniferous trees in this study plot are evergreen. The difference for litterfall a year between coniferous and broadleaved fractions was 0.60 ton/ha (9.9%), and 33,930 grains/ha (2.4%), but the difference for weight loss a year between broadleaved and coniferous fractions was 0.04 ton/ha (1.7%).

4. Environment.

Mean annual temperature in sub-alpine zone spanned by the climatic zone below freezing to about 25℃. The growing season may be considerably shorter because of mean daily temperature below freezing about 6 months in winter season, and in this period the trees can not find a photosynthesis function. In parts of northern fennoscandia, the growing season for gymnosperm forest may be as short as 3 months per annum, while in cool temperate forest it is often about 6 to 7 months in duration[19,86~92]. In this area, the climate is more extreme with distinctly cold winters.

At the study plot placed at 290 m of altitude (a. s. l.), annual mean temperature is 3.5℃, and precipitation is 1,410 mm. Soil type is dark brown forest soil. Orientation:

N26°W[39,91].

5. The time factor.

The pattern of litterfall and the weight loss vary greatly throughout the year, but with a tendency for slightly greater deposition during snow-uncovered season (From June to October). Monthly changes of total litterfall and weight loss were measured as follows :

A. In 1984-1985 (from June 3, 1984 to June 3, 1985).

1. The amount of litterfall.

For total litterfall by monthly proportion, the maximum was in October (46.3%), the second in September (10.8%), with lows in July (1.0%). For seed grains by monthly proportion, the maximum was in October (28.1%), which were contained the conifer at 12.0% and the broadleaved at 16.1% and the second in September (17.3%), which were contained the conifer at 9.0% and the broadleaved at 8.3% with lows during snow-covered season (from November to May) (21.0%), which were contained the conifer at 6.0% and the broadleaved at 15.0% or 3.0% per month (conifer 1.0% and broadleaved 2.0%). For insect residues by monthly proportion, the maximum individuals were in July (26.7%), and the second in June (20.0%), with lows during snow-covered season (20.0%) or 2.9% per month. The maximum component proportion in annual was 61.7% of leaf, in which were contained the conifer at 34.7% and the broadleaved at 27.0%, and the second was 21.8% of branch, which were contained the conifer at 15.5% and the broadleaved at 6.3%, with lows 0.0% of insect.

2. The weight loss.

For total weight loss and fractions by monthly proportion, the maximum was in August (2.5%), which were contained the conifer at 0.9%, and the broadleaved at 1.3%, and the other (leaf and culm of *S. senanensis*) at 0.2%, and the second in September (1.6%),which were contained the conifer at 0.7%, and the broadleaved at 0.8%, and the other at 0.1%, with low during snow-covered season (3.0%), which were contained the conifer at 1.1%, and the broadleaved at 1.6%. and the other at 0.3% or 0.4% per month (conifer 0.1%, broadleaved 0.3%, and other 0.0%). From the four steps of the above data a little differentiation was found about the weight loss per step as follows:

First; By monthly during snow-uncovered season (from June 3 to November 1, 1984) was 0.18 t/ha (6.5%);

Second; During snow-uncovered season (from June 3 to November 1, 1984) in once at recovering time was 0.20 t/ha (7.2%);

Third; During snow-covered season (from November 1, 1984 to June 3, 1985) in once at recovering time was 0.08 t/ha (2.8%);

Fourth; In once at recovering time a year (from June 3, 1984 to June 3, 1985) was 0.29 t/ha (10.4%).

The differentiation of the weight loss in the second step was 0.02 t/ha (0.7%) more than in the first step. In the fourth step was 0.01 t/ha (0.4%) more than in the second, followed by the third step.

The amount of litterfall was 2.83 ton/ha/year (O. D. W.), and the weight loss was 0.29 ton/ha/year (10.4%).

B. In 1985-1986 (from June 3, 1985 to June 3, 1986).

1. The amounts of litterfall.

For total litterfall by monthly proportion, the maximum was in October (40.4%), the second during snow-covered season (49.2%) or 7% per month, with lows in July (1.2%). For seed grains by monthly proportion, the maximum was in October (78.3%), which were containing the conifer at 42.1%, and the broadleaved at 36.2%, and the second in September (15.8%), which were contained the conifer at 7.3%, and the broadleaved at 8.5%, with lows in August (0.3%), which were contained the conifer at 0.0%, and the broadleaved at 0.3%. For insect residues by monthly proportion, the maximum individuals were in June amd August (20.0% ; respectively), the second were in July, September and October (10.0% ; respectively), with lows during snow-covered season (30.0%) or 4.3 % per month. The components proportion in annual was 53.1% of leaf, which were contained the conifer at 30.2% and the broadleaved at 22.9%, and the second was 29.3% of branch, which were contained the conifer at 22.3%, and the broadleaved at 7.0%, with lows 0.0% of insect.

2. The weight loss.

For total weight loss and fractions by monthly proportion, the maximum was in August (2.7%), which were contained the conifer at 1.0%, and the broadleaved at 1.5%, and the other at 0.2%, and the second in September (1.6%),which were contained the conifer at 0.6%, and the broadleaved at 0.9%, and the other at 0.1%, with low during snow -covered season (3.1%), which were contained the conifer at 1.2%, and the broadleaved at 1.6%, and the other at 0.3% or 0.5% per month (conifer 0.2%, broadleaved 0.3%, and other 0.0%). From the four steps of the above data a little differentiation was found about the weight loss per step as follows:

First; By monthly during snow-uncovered season (from June 3 to November 1, 1985) was 0.21 t/ha (6.8%);

Second; During snow-uncovered season (from June 3 to November 1, 1985) in once at recovering time was 0.23 t/ha (7.4%);

Third; During snow-covered season (from November 1, 1985 to June 3, 1986) in once at recovering time was 0.34 t/ha (10.8%);

Fourth; In once at recovering time a year (from June 3, 1985 to June 3, 1986) was 0.34 t/ha (10.8%).

The differentiation of the weight loss in the second step was 0.02 t/ha (0.6%) more than in the first step. In the fourth step was 0.02 t/ha (0.7%) more than in the second, followed by the third step.

The amount of litterfall was 3.16 ton/ha/year (O. D. W.), and the weight loss was 0.34 ton/ha/year (10.8%).

The weight loss in 1984-1985 (from June to May) and in 1985-1986 (from June to May) of the fourth step was 0.63 ton/ha/2 years (21.2%), but in the fifth step in 1984-1986 (from June to May, set and taken in once at recovering time) that was 0.70 ton/ha/2 years (23.3%). The differentiation in the fifth step was 0.07 ton/ha/2 years (2.1%) more than in the fourth step (from June to May in 1984-1985 and in 1985-1986 or which was set and taken in twice at recovering times).

C. In a year (from June 3, 1984 to June 3, 1986).

1. The amounts of litterfall.

For total litterfall by monthly (in annual proportion), the maximum was in October (42.9%), and the second in September (7.7%), with lows in July (1.2%). For seed grains by monthly (in annual proportion), the maximum was in October (70.5%), which were containing the conifer at 37.5%, and the broadleaved at 33.0%, and the second in September (16.0%), which were contained the conifer at 7.5%, and the broadleaved at 8.5%, with lows duiring snow-covered season (7.0%), which were contained the conifer at 4.2%, and the broadleaved at 2.8% or 1.0% per month (conifer 0.6% and broadleaved 0.4%). The maximum grains proportion per fraction in annual was 51.2% of conifer and broadleaved 48.8%. For insect residues proportion by monthly (in annual proportion), the maximum individuals were in June and July (20.0%; respectively), and the second in August (16.0%), with lows during snow-covered season (24.0%) or 3.4% per month. The maximum components proportion in annual was 57.1% of leaf, which were contained the conifer at 32.1% and the broadleaved at 25.0%, and the second was 25.7% of branch, which were contained the conifer at 19.0%, and the broadleaved at 6.7%, with lows 0.0% of insect.

2. The weight loss.

For total weight loss and fractions by monthly (in annual proportion), the maximum was in August (2.8%), which were contained the conifer at 1.0%, and the broadleaved at 1.6%, and the other at 0.2%, and the second in September (1.7%),which were contained the conifer at 0.7%, and the broadleaved at 0.9%, and the other at 0.1%, with low during snow-covered season (3.5%), which were contained the conifer at 1.3%, and the broadleaved at 1.8%. and the other at 0.4% or 0.5% per month (conifer 0.2%, broadleaved 0.2%, and other 0.1%). For the weight loss per fraction in annual proportion, the maximum was 6.1% of broadleaved, followed by conifer 4.5%, and other 1.1%. For the weight loss per material in annual proportion, the maximum was 4.2% of *B. ermanii* leaf, and the second was 1.4% of *B. ermanii* branch, with lows 0.2% of *P. glehnii* bark.

The amount of litterfall was 3.00 ton/ha/year (O. D. W.), and the weight loss was 0.35 ton/ha/year (11.7%). Total seedfall was 1,493,566 grains/ha/year (100%), and insectfall was 173,013 individuals/ha/year (100%). The decomposition rate was calculated by the following formula:

$$K_L Y r^{-1} \text{ and } 3/K_L Y r^{-1}$$

Where; K : The decay constant;
3/K : Turnover constant;
L : litterfall;
K_L : The litter turnover ratio;
x_L : The standing crop corresponding to the litterfall above ground.

Results and Discussion

The amount of litterfall and the components as shown in Tables 4~17, 24~30 (in metric ton/ha at oven dried level) were taken by mean value after separating into each component and fraction, with species per trap. The weight loss of the ten materials as shown in Tables 18~23, 31~32 (in metric ton/ha at oven dried level) also were taken by mean value as well as computation in litterfall. The pattern of the litterfall and the

weight loss varies greatly are shown in Figures 6~9, 16~17, and Figures 10~15, 18~19, and continuous throughout the year but, with a tendency for slightly greater deposition during snow-uncovered season (from early June to early November).

The pattern of litterfall and the weight loss in each period are given as follows:

1. The amounts of litterfall.

a. The pattern of litterfall from June 3, 1984 to June 3, 1985.

1) It was recognized that the monthly fluctuation/pattern of seasonal change had two peaks type, and these peaks were measured in October (1.31 t/ha ; 46.3%), the second in September (0.31 t/ha ; 10.8%), with lows on July (0.03 t/ha ; 1.0%). The proportion of coniferous and broadleaved fractions by monthly divided with annual total litter, and the maximum was in October. The conifer is 0.57 : 2.83 t/ha (20.1%), and the second during snow-covered season (from November to May) was 0.71 : 2.83 t/ha (25.1%) or 3.6% per month ; broadleaved was 0.64 : 2.83 t/ha (22.6%), and the second in September was 0.16 : 2.83 t/ha (5.7%). Litter fraction was also separated, from the maximum weight per fraction by monthly divided with annual total litterfall. Leaf was in October, in which the conifer was contained at 0.52 : 2.83 t/ha (18.5%), and the broadleaved was 0.60 : 2.83 t/ha (21.3%) ; branch, in which the conifer was contained at 0.44 : 2.83 t/ha (15.5%) during snow-covered season or 2.2% per month, and the broadleaved was 0.03 : 2.83 t/ha in October (1.1%) ; bark was in October, in which the conifer was contained at 0.01 : 2.83 t/ha (0.4%), and the broadleaved was 0.004 : 2.83 t/ha (0.1%) ; Seed, in which the conifer was contained at 0.0001 : 2.83 t/ha (0.0%) in October, and the broadleaved was 0.024 : 2.83 t/ha (0.8%) in September. The maximum weight per fraction (species) of conifer and broadleaved trees were divided with total by monthly proportion. Coniferous leaf was 0.52 : 1.31t/ha in October (18.5%), the second in September was 0.09 : 0.31 t/ha (3.1%) ; broadleaved leaf was 0.60 : 1.31 t/ha in October (21.3%), and the second in September was 0.13 : 0.31 t/ha (4.5%), coniferous seed of *P. glehnii* was 0.0001 : 1.31 t/ha in October, the second *A. sachalinensis* was 0.00004 : 1.31 t/ha also in October and *P. glehnii* in September 0.00004 : 0.31 t/ha (0.0% ; respectively); broadleaved seed of *Q. mongolica* var. *grosseserrata* was 0.02 : 0.31 t/ha (0.8%) on September, and the second also of *Q. mongolica* var. *grosseserrata* was 0.009 : 1.31 t/ha (0.3%) in October. The maximum grain of seed per fraction of conifer and broadleaved trees divided with total by monthly proportion was in October. The conifer was 55,342 grains/ha (12.0%), and the second was 41,506 grains/ha (9.0%) in September ; the broadleaved was 74,249 grains/ha (16.1%), and the second was 45,194 grains/ha (9.8%) in August. But, In the maximum seed grains per species of coniferous and broadleaved trees, the conifer of *A. sachalinensis* was 27,671 grains/ha in September and October also, *P. glehnii* was 27,671 grains/ha (6.0% ; respectively) ; broadleaved was 41,506 grains/ha of *B. ermanii* in October (9.0%), and the second of *Q. mongolica* var. *grosseserrata* in September and *B. ermanii* in June was 27,671 grains/ha (6.0% ; respectively). The maximum weight per component divided with total litterfall by monthly proportion are as follows :

1. Leaves were 1.13 : 1.31 t/ha in October (39.9%) ;

2. Branches were 0.49 : 0.97 t/ha during snow-covered season (17.3%) or 2.5% per month ;

3. Barks were 0.02 : 1.31 t/ha in October (0.7%) ;
4. Seeds were 0.02 : 0.31 t/ha in September (0.8%) ;
5. Insects were 0.00006 : 0.12 t/ha in June (0.0%) ;
6. Others were 0.10 : 1.31 t/ha in October (3.5%).

The maximum grains and proportion of seed component numbered 129,591 grains/ha in October (28.1%), and the second was 79,784 grains/ha in September (17.3%), with lows during snow-covered season 96,847 grains/ha (21.0%) or 13,835 grains/ha (3.0%) per month. For insect residues proportion, the maximum individual numbered 55,363 individuals/ha in July (26.7%), and the second was 41,523 individuals/ha in June (20.0%), with lows 41,523 individuals/ha during snow-covered season (20.0%) or 5,932 individuals/ha (2.9%) per month. For the proportion per component weight in annual to annual total litter, the maximum was 1.74 : 2.83 t/ha (61.7%) of leaves, and the second was 0.62 : 2.83 t/ha (21.8%) of branches, with lows of insects 0.0002 : 2.83 t/ha (0.0%). The maximum weight per component divided with total litterfall by monthly proportion was in October 1.13 : 1.31 t/ha of leaves (39.3%), and the second was in September 0.22 : 0.31 t/ha (7.7%) also of leaves, with lows of insects in June 0.00006 : 0.12 t/ha (0.0%). The maximum grains of seed per species divided with total by monthly proportion was in October of *B. ermanii* 41,506 : 129,591 grains/ha (9.0%), the second of *A. sachalinensis* and *P. glehnii* 27,671 : 129,591 grains/ha (respectively) in October also, and *Q. mongolica* var. *grosseserrata,* with *A. sachalinensis* 27,671 : 79,784 grains/ha (respectively) in September, and *B. ermanii* 27,671 : 51,190 grains/ha in June (6.0% ; respectively). The maximum grains of seed component by monthly divided with annual grains proportion were 129,591 grains/ha in October (28.1%), the second 79,784 grains/ha in June (17.3%), with lows 96,847 grains/ha during in snow-covered season (21.0%) or 13,835 grains/ha (3.0%) per month.

2) The litter components. For leaves, the maximum during snow-uncovered season was 1.43 t/ha (50.7%), with lows during snow-covered season 0.31 t/ha (11.0%); Branches, the maximum was 0.49 t/ha (17.4%) during snow-covered season, with lows during snow-uncovered season 0.13 t/ha (4.4%) ; Barks, the maximum during snow-covered season was 0.05 t/ha (1.8%), with lows during snow-uncovered season 0.03 t/ha (1.1%) ; Seeds, the maximum during snow-uncovered season was 0.04 t/ha (1.2%), with lows during snow-covered season 0.0005 t/ha (0.0%) ; Insects residues, the maximum during snow-uncovered season was 0.0002 t/ha (0.0%), with lows during snow-covered season 0.00004 t/ha (0.0%) ; Others, the maximum snow-covered season was 0.23 t/ha (8.2%), with lows during snow-covered season 0.12 t/ha (4.2%). The maximum seedfall during snow-uncovered season was 364,328 grains/ha (79.0%), with lows during snow-covered season 96,847 grains/ha (21.0%). The maximum insectfall during snow-uncovered season was 166,091 individuals/ha (80.0%), with lows during snow-covered season 41,523 individuals/ha (20.0%). The proportion of coniferous and broadleaved fractions to annual total litterfall, from the maximum to the lowest was as under :

1. Conifer; 1.48 t/ha (52.3%), during snow-uncovered season was the maximum 0.77 t/ha (27.2%), with lows during snow-covered season of 0.71 t/ha (25.1%).

2. Broadleaved; 1.00 t/ha (35.3%), during snow-uncovered season was the maximum 0.86 t/ha (30.4%), with lows during snow-covered season of 0.14 t/ha (4.9%).

For the proportion of total litterfall in snow-uncovered season and during snow-covered season to annual total litterfall, the maximum was 1.86 t/ha (65.7%) during snow-uncovered season, with lows during snow-covered season of 0.97 t/ha (34.3%).

3) The maximum grains of seed per species in annual divided with annual total seedfall were 155,878 grains/ha/y of *B. ermanii* (33.8%), and the second 110,682 grains/ha/y of *A. sachalinensis* (24.0%), with lows of *B. platyphylla* var. *japonica* 11,068 grains/ha/y (2.4%). Total seedfall were 461,175 grains/ha/year. The pattern of litter per component and fraction are shown in Tables 4~10, and Figures 6~7. The proportion of each litter component to annual total litterfall, from the maximum to the lowest was as under:

1. Leaves were 1.74 t/ha/y (61.7%) which of;
   conifer 0.98 t/ha/y (34,7%), broadleaved 0.76 t/ha/y (27.0%).
2. Branches were 0.62 t/ha/y (21.8%) which of;
   conifer 0.44 t/ha/y (15.5%), broadleaved 0.18 t/ha/y (6.3%),
3. Barks were 0.08 t/ha/y (2.9%) which of;
   conifer 0.06 t/ha/y (2.2%), broadleaved 0.02 t/ha/y (0.7%).
4. Seeds were 0.04 t/ha/y (1.2%) which of;
   conifer 0.001 t/ha/y (0.0%), broadleaved 0.04 t/ha/y (1.2%).
5. Insects were 0.0002 t/ha/y (0.0%).
6. Others were 0.35 t/ha/y (12.4%).

Total grains of seed numbered 461,175 grains/ha/year, which the maximum seedfall during snow-uncovered season were 364,328 grains/ha (79.0%), and the lowest during snow-covered season 96,847 grains/ha (21.0%) or 13,835 grains/ha (3.0%) per month. The maximum grains of seedfall for coniferous and broadleaved trees are as follows:

a. Conifer; 179,397 grains/ha/y (38.9%) which of;
   a) *A. sachalinensis* 110,682 grains/ha/y (24.0%),
   b) *P. glehnii* 68,715 grains/ha/y (14.9%),
b. Broadleaved; 281,778 grains/ha/y (61.1%) which of;
   c) *B. ermanii* 155,878 grains/ha/y (33.8%),
   d) *A. mono* 59,491 grains/ha/y (12.9%),
   e) *Q. mongolica* var. *grosseserrata* 55,341 grains/hay (12.0%),
   f) *B. platyphylla* var. *japonica* 11,068 grains/ha/y (2.4%).

Total insect residue is 207,614 individulas/ha/year.

Table 4. Leaf component and fractions a year (from June 3, 1984 to June 3, 1985) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
CL	346 t (2.0%)	89 t (0.5%)	195 t (1.2%)	884 t (5.1%)	5,217 t (30.0%)	3,051 t (17.4%)	9,782 t (56.2%)
A	213	54	134	603	3,762	2,352	7,119 (40.9)
Pg	133	35	61	281	1,455	699	2,663 (15.3)
BL	62 (0.3)	45 (0.3)	142 (0.8)	1,301 (7.5)	6,030 (34.6)	48 (0.3)	7,628 (43.8)
Q	19	5	14	329	2,476	22	2,865 (16.5)
B	14	23	73	357	1,560	12	2,039 (11.8)
Bp	5	4	15	44	205	—	273 (1.6)
Am	1	0.3	4	21	1,067	3	1,096 (6.3)
T	3	1	—	1	65	0.5	71 (0.4)
K	3	—	—	111	93	3	210 (1.1)
S	0.4	0.3	1	3	25	0.4	30 (0.2)
As	12	4	3	84	306	1	410 (2.4)
Sh	1	1	1	35	22	1	61 (0.3)
Sa	1	1	1	17	122	1	143 (0.8)
Pa	1	3	29	299	95	3	430 (2.4)
Total	408 (2.3)	134 (0.8)	337 (2.0)	2,185 (12.6)	11,247 (64.6)	3,099 (17.7)	17,410 (100)

Note; *: Leaf components;
CL: Conifer leaf; *A: sachalinensis*; Pg: *P. glehnii.*
BL: Broadleaved leaf; Q: *Q. mongolica* var. *grosseserrata*; B: *B. ermanii*; Bp: *B. platyphylla* var. *japonica*; Am: *A. mono*; T: *T. japonica*; K: *K. pictus*; S: *S. commixta*; As: *A. sciadophylloides*; Sh: *S. hultenii* var. *angustifolia*; Sa: *S. alnifolia*; Pa: *P. amurense* var. *sachalinense.*

Table 5. Branch component and fractions a year (from June 3, 1984 to June 3, 1985) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
C	137 t (2.3%)	5 t (0.1%)	174 t (2.8%)	25 t (0.4%)	316 t (5.1%)	3,731 t (60.5%)	4,389 t (71.2%)
B	82 (1.3)	3 (—)	196 (3.2)	25 (0.4)	289 (4.7)	1,182 (19.2)	1,777 (28.8)
Total	219 (3.6)	8 (0.1)	371 (6.0)	50 (0.8)	605 (9.8)	4,913 (79.7)	6,166 (100)

Note; *: Branch fractions; C: Conifer branch; B: Broadleaved branch;

Table 6. Bark component and fractions a year (from June 3, 1984 to June 3, 1985) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
C	35 t (4.3%)	14 t (1.7%)	40 t (5.0%)	32 t (4.0%)	123 t (15.3%)	331 t (41.1%)	574 t (71.4%)
B	8 (1.0)	3 (0.4)	8 (1.0)	14 (1.7)	41 (5.2)	155 (19.3)	230 (28.6)
Total	43 (5.3)	17 (2.1)	48 (6.0)	46 (5.7)	165 (20.5)	486 (60.4)	804 (100)

Note; *: Bark fractions; C: Conifer bark; B: Broadleaved bark;

Table 7. Seed component and fractions a year (from June 3, 1984 to June 3, 1985) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
CS	— (—)	— (—)	— (—)	0.1% (0.4 t)	0.3% (1.2 t)	0.2% (0.8 t)	0.6% (2.4 t)
A	— (—)	— (—)	(—)	— (—)	0.1 (0.4)	— (—)	0.1 (0.4)
Pg	— (—)	— (—)	— (—)	0.1 (0.4)	0.2 (0.8)	0.2 (0.8)	0.5 (2)
BS	0.4 (1)	— (—)	8.4 (30)	66.0 (239)	23.5 (89)	1.1 (4)	99.4 (363)
Q	— (—)	— (—)	7.6 (27)	65.6 (238)	22.4 (85)	— (—)	95.6 (350)
B	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)
Bp	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)
	0.4 (1)	— (—)	0.8 (3)	0.4 (1)	1.1 (4)	1.1 (4)	3.8 (13)
Total	0.4 (1)	— (—)	8.4 (80)	66.1 (240)	23.8 (90)	1.3 (5)	100 (366)

Note; *: Seed components;
CS: Conifer seed; A: *A. sachalinensis*; Pg: *P. glehnii.*
BS: Broadleaved seed; Q: *Q. mongolica* var. *grosseserrata*; B: *B. ermanii*; Bp: *B. platyphylla* var. *japonica*; Am: *A. mono.*
Conifer seed on June was taken from cone.

Table 8. Seed component and fractions a year (from June 3, 1984 to June 3, 1985) in percentage/ha (grains)

*	Time						Annual
	June	July	August	September	October	Nov.—May	
CS	3.8% (17,524)	3.7% (17,063)	4.4% (20,292)	9.0% (41,506)	12.0% (55,342)	6.0% (27,670)	38.9% (179,397)
A	3.0 (13,835)	3.0 (13,835)	3.0 (13,835)	6.0 (27,671)	6.0 (27,671)	3.0 (13,835)	24.0 (110,682)
Pg	0.8 (3,689)	0.7 (3,228)	1.4 (6,457)	3.0 (13,835)	6.0 (27,671)	3.0 (13,835)	14.9 (68,715)
BS	7.3 (33,666)	4.6 (21,214)	9.8 (45,194)	8.3 (38,278)	16.1 (74,249)	15.0 (69,177)	61.1 (281,778)
Q	— (—)	— (—)	3.0 (13,835)	6.0 (27,671)	3.0 (13,835)	— (—)	12.0 (55,341)
B	6.0 (27,671)	3.0 (13,835)	3.0 (13,835)	0.8 (3,689)	9.0 (41,506)	12.0 (55,342)	33.8 (155,878)
Bp	— (—)	— (—)	0.8 (3,689)	0.5 (2,306)	1.1 (5,073)	— (—)	2.4 (11,068)
Am	1.3 (5,995)	1.6 (7,379)	3.0 (13,835)	1.0 (4,612)	3.0 (13,835)	3.0 (13,835)	12.9 (59,491)
Total	11.1 (51,190)	8.3 (38,277)	14.2 (65,486)	17.3 (79,784)	28.1 (129,591)	21.0 (96,847)	100 (461,175)

Note: See tab. 7. Conifer seed on June and July was taken from cone.

Table 9. Insect component a year (from June 3, 1984 to June 3, 1985) in individuals/ha and %, with in metric ton/ha ($\times 10^{-4}$) (O. D. W.).

Individual and Weight	Time						Annual
	June	July	August	September	October	Nov. -May	
Individual (%)	41,523 (20.0)	55,363 (26.7)	27,682 (13.3)	27,682 (13.3)	13,841 (6.7)	41,523 (20.0)	207,614 (100)
Weight (%)	0.6 t (36.8)	0.4 t (24.6)	0.1 t (6.1)	0.1 t (6.1)	0.03 t (1.8)	0.4 t (24.6)	1.63 t (100)

Table 10. The amount of litterfall and component a year (from June 3, 1984 to June 3, 1985) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
L	410 t (1.5%)	130 t (0.5%)	340 t (1.2%)	2,190 t (7.7%)	11,250 t (39.8%)	3,100 t (11.0%)	17,400 t (61.7%)
Br	220 (0.8)	10 (—)	370 (1.3)	50 (0.2)	600 (2.1)	4,910 (17.4)	6,200 (61.8)
B	40 (0.1)	20 (0.1)	50 (0.2)	50 (0.2)	160 (0.6)	490 (1.7)	800 (2.9)
S	1 (—)	— (—)	30 (0.1)	240 (0.8)	90 (0.3)	5 (—)	400 (1.2)
I	0.6 (—)	0.4 (—)	0.1 (—)	0.1 (—)	0.03 (—)	0.4 (—)	2 (—)
O	550 (1.9)	110 (0.4)	140 (0.5)	540 (1.9)	990 (3.5)	1,190 (4.2)	3,500 (12.4)
Total	1,230 (4.3)	270 (1.0)	930 (3.3)	3,070 (10.8)	13,090 (46.3)	9,690 (34.3)	28,300 (100)

Note; *: Litter components; L: Leaf; Br: Branch; B: Bark; S: Seed; I: Insect; O: Other (Including hares faeces, bud scales, cones, herbaceous plants, etc.). Conifer seed on June and July was taken from cone.

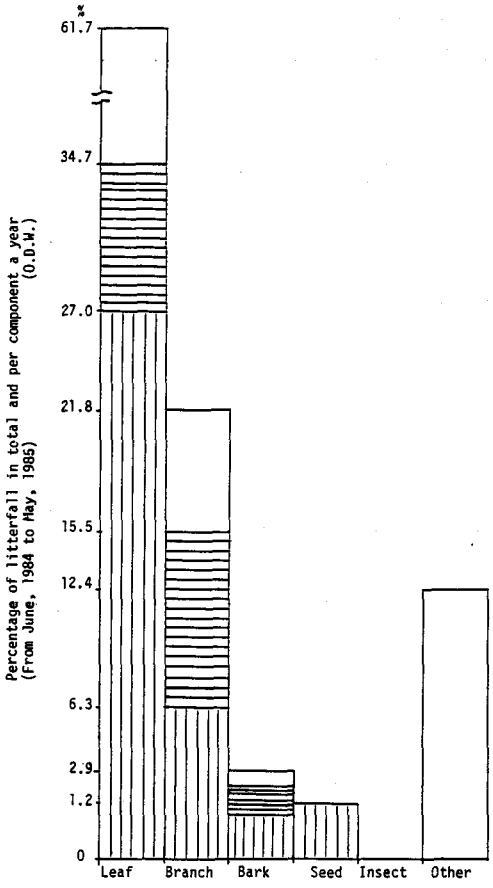

Fig. 6. Litterfall per component and fractions a year (from June, 1984 to May, 1985).
Hote; □ : Total per component; □ : Coniferous fraction; □ : Broad-leaved fraction.

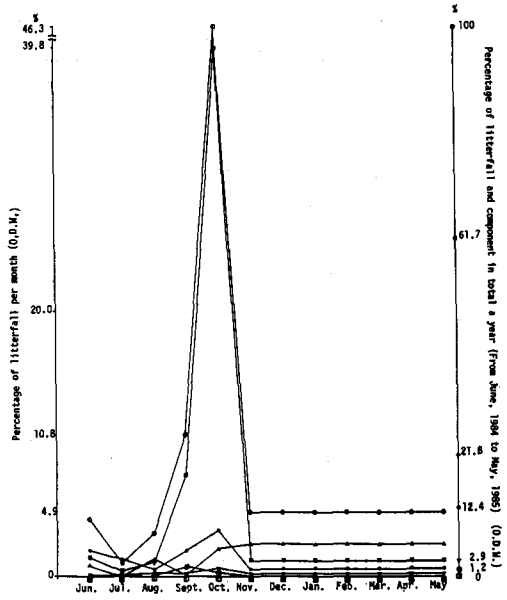

Fig. 7 Seasonal litterfall and components a year (From June, 1984 to May, 1985).
Note; ○ : Total litterfall; ■ : Leaf; △ : Branch; ▽ : Bark; ● : Seed; □ : Insect; ✱ : Other.

b. The pattern of litterfall from June 3, 1985 to June 3, 1986.

1) The peak of monthly fluctuation/pattern of seasonal change was measured in October (1.27 t/ha; 40.4 %), the second 1.56 t/ha during snow-covered season (49.2%), or 7.0% per month, with lows in July (0.04 t/ha; 1.2 %). In the proportion of coniferous and broadleaved fractions by monthly divided with annual total litterfall, the maximum was in October. Conifer was 0.43 : 3.16 t/ha (13.6%), the second during snow-covered season was 1.20 : 3.16 t/ha (38.0%) or 5.4% per month; broadleaved was 0.67 : 3.16 t/ha (21.2%), the second during snow-covered season was 0.20 : 3.16 t/ha (6.3%) or 0.9% per month. Litter fraction was also separated, from the maximum weight by monthly divided with annual total litterfall. Leaf was in October, in which the conifers was contained at 0.41 : 3.16 t/ha (13.0%), and the broadleaved was 0.63 : 3.16 t/ha (19.9%); branch, in which the conifers was contained at 0.97 : 3.16 t/ha during snow-covered season 30.7% or 4.4% per month, and broadleaved was 0.03 : 3.16 t/ha (0.9%) in October; bark, in which the conifers was contained at 0.01 : 3.16 t/ha during snow-covered season 0.3%, and broadleaved was 0.007 : 3.16 t/ha (0.2%); Seed, in which the conifers was contained at 0.002 : 3.16 t/ha (0.1%), and broadleaved was 0.002 : 3.16 t/ha (0.1%) in October. The maximum weight

per fraction (species) of coniferous and broadleaved trees divided with total by monthly propotion was as follows. Conifer leaf was 0.41 : 1.27 t/ha in October (13.0%), and the second was 0.02 : 0.05 t/ha (0.7%) in August; broadleaved leaf was 0.63 : 1.27 t/ha (19.9 %) in October, and the second was 0.08 : 0.15 t/ha (2.6%) in September; coniferous seed of *A. sachalinensis* was 0.002 : 1.27 t/ha, and the second of *P. glehnii* was 0.0003 : 1.27 t/ha in October (0.0%; respectively); broadleaved seed of *A. mono* was 0.0005 : 1.27 t/ha in October, and the second *A. mono* also was 0.0002 : 0.04 t/ha in July (0.0%; respectively). The maximum grain of seed per fraction of coniferous and broadleaved trees divided with total by monthly proportion was in October. Conifer was 1,064,360 grains/ha (42.1%), and the second was 184,084 grains/ha (7.3%) in September; broadleaved was 913,495 grains/ha (36.2%), and the second 214,533 grains/ha (8.5%) in September. But, the maximum seed grains per species of coniferous and broadleaved trees was as follows. Conifer of *A. sachalinensis* was 941,177 grains/ha (37.3%) in October, and the second also of *A. sachalinensis* was 142,561 grains/ha (5.5%) in September; broadleaved was 739,100 grains/ha of *B. ermaii* in October (29.3%), and the second *B. ermaii* also was 170,242 grains/ha in September (6.7%). The maximum weight per component divided with litterfall by monthly proportion are as follows:

1. Leaves were 1.04 : 1.27 t/ha in October (33.1%);
2. Branches were 0.87 : 1.56 t/ha during snow-covered season 27.1% or 3.9% per month;
3. Barks were 0.09 : 1.56 t/ha during snow-covered season 2.8% or 0.4% per month;
4. Seeds were 0.002 : 1.27 t/ha in October (0.1%);
5. Insects were 0.00003 : 0.09 t/ha in June and 0.00003 : 0.05 t/ha in August (0.0%; respectively);
6. Others were 0.18 : 1.27 t/ha in October (5.7%).

The maximum grains and proportion of seed component numbered 1,977,855 grains/ha in October (78.3%), and the second was 398,617 grains/ha in September (15.8%), with lows in August 6,920 grains/ha (0.3%). For insect residues proportion, the maximum individual number were 27,682 individuals/ha in June and August (20.0%; respectively), with lows 41,522 individuals/ha during snow-covered season (30.0%) or 4.3% per month. For the proportion per component weight in annual to annual total litter, the maximum was 1.67 : 3.16 t/ha (53.1%) of leaves, and the second was 0.92 : 3.16 t/ha (29.3%) of branches, with lows of insects 0.0001 : 3.16 t/ha (0.0%). The maximum weight per component divided with total litterfall by monthly proportion was in October 1.04 : 1.27 t/ha (33.1%) of leaves, and the second of others was 0.00004 : 1.56 t/ha (0.0%) during snow -covered season. The maximum grains of seed per species divided with total seedfall by monthly proportion was in October 941,177 : 1,977,855 grains/ha (37.3%) of *A. sachalinensis,* and the second of *B. ermanii* 739,100 : 1,977,855 grains/ha (29.3%) in October also. The maximum grains of seed component by monthly divided with annual total seedfall were 1,977,855 grains/ha (78.3%) in October, and the second 398,617 grains/ha in September (15.8%), with lows 6,920 grains/ha (0.3%) in August.

2) The litter components. For leaves, the maximum during snow-uncovered season was 1.22 t/ha (38.7%), with lows during snow-covered season of 0.85 t/ha (14.4%);

Branches, the maximum during snow-covered season was 0.85 t/ha (27.1%), with lows during snow-uncovered season of 0.07 t/ha (2.2%) ; Barks, the maximum during snow-covered season was 0.09 t/ha (2.8%), with lows during snow-uncovered season of 0.03 t/ha (0.8%) ; Seeds, the maximum during snow-uncovered season was 0.003 t/ha (0.1%), with lows during snow-covered season of 0.0001 t/ha (0.0%) ; Insect residues, the maximum during snow-uncovered season was 0.00009 t/ha (0.0%), with lows during snow-covered season of 0.00004 t/ha (0.0%) ; Others, the maximum during snow-uncovered season was 0.29 t/ha (9.0%), with lows during snow-covered season of 0.15 t/ha (4.9%). The maximum seedfall during snow-uncovered season was 2,415,226 grains/ha (95.7%), with lows during snow-covered season of 110,727 grains/ha (4.3%). The maximum insect residues during snow-uncovered season was 96,887 individuals/ha (70.0%), with lows during snow-covered season of 41,522 individuals/ha (30.0%). The proportion of coniferous and broadleaved fractions to annual total litter, from the maximum to the lowest was as under :

1. Conifer ; 1.73 t/ha (54.7%), during snow-covered season was the maximum 1.20 t/ha (37.9%), with lows during snow-uncovered season of 0.53 t/ha (16.8%).

2. Broadleaved ; 0.98 t/ha (31.0%), during snow-uncovered season was the maximum 0.79 t/ha (25.0%), with lows during snow-covered season of 0.19 t/ha (6.0%).

For the proportion of litterfall during snow-uncovered season and during snow-covered season to annual total litterfall, the maximum was 1.60 t/ha (50.8%) during snow-uncovered season, with lows during snow-covered season of 1.56 t/ha (49.2%).

3) The maximum grains of seed per species in annual divided with annual total seedfall were 1,152,942 grains/ha/year (45.6%) of *A. sachalinensis,* and the second 949,481 grains/ha/year of *B. ermanii* (37.6%), with lows of *Q. mongolica* var. *grosseserrata* 0 grains/ha/year (0.0%). Total seedfall were 2,525,953 grains/ha/year. The pattern of litterfall per component and fraction are shown in Tables 11～17, and Figures 8～9. The proportion of each litter component to annual total litterfall, from the maximum to the lowest was as under:

1. Leaves were 1.67 t/ha/y (53.1%) which of;
   conifer 0.95 t/ha/y (30.2%), broadleaved 0.72 t/ha/y (22.9%).
2. Branches were 0.92 t/ha/y (29.3%) which of;
   conifer 0.70 t/ha/y (22.3%), broadleaved 0.22 t/ha/y (7.0%).
3. Barks were 0.12 t/ha/y (3.6%) which of;
   conifer 0.08 t/ha/y (2.4%), broadleaved 0.04 t/ha/y (1.2%).
4. Seeds were 0.003 t/ha/y (0.1%) which of;
   conifer 0.002t/ha/y (0.1%), broadleaved 0.001 t/ha/y (0.0%).
5. Insects were 0.0001 t/ha/ya (0.0%).
6. Others were 0.44 t/ha/y (13.9%).

Total grain of seed numbered 2,525,953 grains/ha/year, which the maximum seedfall during snow-uncovered season was 2,415,226 grains/ha (95.7%), and the lowest during snow-covered season 110,727 grains/ha (4.3%) or 15,818 grains/ha (0.6%) per month. The maximum grains of seedfall for coniferous and broadleaved trees are as follows :

a. Conifer ; 1,348,098 grains/ha/y (53.4%) which of ;

a) *A. sachalinensis* 1,152,942 grains/ha/y (45.6%),
b) *P. glenhnii* 195,156 grains/ha/y (7.8%).

b. Broadleaved; 1,177,855 grains/ha/y (46.6%) which of;
c) *B. ermanii* 949,481 grains/ha/y (37.6%),
d) *B. platyphylla* var. *japonica* 214,533 grains/ha/y (8.5%),
e) *A. mono* 13,841 grains/ha/y (0.5%).

Total insect residue is 138,409 individuals/ha/year.

Table 11. Leaf component and fractions a year (from June 3, 1985 to June 3, 1986) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
CL	342 t (2.0%)	86 t (0.5%)	185 t (1.1%)	180 t (1.1%)	4,143 t (24.8%)	4,529 t (27.1%)	9,465 t (56.6%)
A	219	58	130	134	3,348	3,718	7,607 (45.5)
Pg	123	28	55	46	795	811	1,858 (11.1)
BL	68 (0.4)	22 (0.1)	51 (0.3)	848 (5.1)	6,255 (37.4)	17 (0.1)	7,261 (43.4)
Q	19	4	14	90	2,655	4	2,786 (16.6)
B	14	10	17	255	799	4	1,099 (6.6)
Bp	7	1	3	28	257	—	296 (1.8)
Am	1	—	3	76	1,225	2	1,307 (7.8)
T	3	1	—	1	48	1	54 (0.3)
K	3	—	—	79	195	—	277 (1.7)
S	1	—	1	3	26	1	32 (0.2)
As	14	3	1	84	436	2	540 (3.2)
Sh	4	1	1	138	210	1	355 (2.1)
Sa	1	1	1	8	51	1	63 (0.4)
Pa	1	1	10	86	353	1	452 (2.7)
Total	410 (2.4)	108 (0.6)	236 (1.4)	1,028 (6.2)	10,398 (62.2)	4,546 (27.2)	16,725 (100)

Note; See Tab. 4.

Table 12. Branch component and fractions a year (from June 3, 1985 to June 3, 1986) in metric t/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
C	7 t (0.1%)	86 t (0.9%)	24 t (0.3%)	18 t (0.2%)	84 t (0.9%)	6,819 t (73.8%)	7,038 t (76.2%)
B	32 (0.3)	26 (0.3)	39 (0.4)	25 (0.3)	341 (3.7)	1,737 (18.8)	2,200 (23.8)
Total	39 (0.4)	112 (1.2)	63 (0.7)	43 (0.5)	425 (4.6)	8,556 (92.6)	9,238 (100)

Note; See Tab. 5.

Table 13. Bark component and fractions a year (from June 3, 1985 to June 3, 1986) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
C	1 t (0.1%)	7 t (0.6%)	30 t (2.6%)	11 t (1.0%)	32 t (2.8%)	688 t (60.5%)	769 t (67.6%)
B	4 (0.3)	10 (0.9)	70 (6.2)	10 (0.8)	55 (4.9)	219 (19.3)	368 (32.4)
Total	5 (0.4)	17 (1.5)	100 (8.8)	21 (1.8)	87 (7.7)	907 (79.8)	1,137 (100)

Note; See Tab. 6.

Table 14. Seed component and fractions a year (from June 3, 1985 to June 3, 1986) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
CS	— (—)	— (—)	— (—)	7.9% (2.3 t)	62.9% (18.3 t)	4.8% (1.4 t)	75.6% (22 t)
A	— (—)	— (—)	— (—)	7.6 (2.2)	52.9 (15.4)	3.4 (1.0)	63.9 (18.6)
Pg	— (—)	— (—)	— (—)	0.3 (0.1)	10.0 (2.9)	1.4 (0.4)	11.7 (3.4)
BS	1.4 (0.4)	5.2 (1.5)	— (—)	0.3 (0.1)	17.5 (5.1)	— (—)	24.4 (7.1)
Q	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)
B	— (—)	— (—)	— (—)	0.3 (0.1)	1.4 (0.4)	— (—)	1.7 (0.5)
B	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)
Am	1.4 (0.4)	5.2 (1.5)	— (—)	— (—)	16.1 (4.7)	— (—)	22.7 (6.6)
Total	1.4 (0.4)	5.2 (1.5)	— (—)	8.2 (2.5)	80.4 (23.4)	4.8 (1.4)	100 (29.1)

Note; See Tab. 8.

Table 15. Seed component and fractions a year (from June 3, 1985 to June 3, 1986) in percentage/ha (grains)

*	Time						Annual
	June	July	August	September	October	Nov.—May	
SC	0.2% (2,768)	— (—)	— (—)	7.3% (184,084)	42.1% (1,064,360)	3.8% (96,886)	53.4% (1,348,098)
A	0.2 (2,768)	— (—)	— (—)	5.5 (142,561)	37.3 (941,177)	2.6 (66,436)	45.6 (1,152,942)
Kg	— (—)	— (—)	— (—)	1.8 (41,523)	4.8 (123,183)	1.2 (30,450)	7.8 (195,156)
BS	0.6 (15,225)	0.5 (13,841)	0.3 (6,920)	8.5 (214,533)	36.2 (913,495)	0.5 (13,841)	46.6 (1,177,855)
Q	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)
B	(0.5 (12,841)	0.4 (9,689)	0.3 (6,920)	6.7 (170,242)	29.3 (739,100)	0.4 (9,689)	37.6 (949,481)
Bp	— (—)	— (—)	— (—)	1.8 (44,291)	6.6 (166,090)	0.1 (4,152)	8.5 (214,533)
Am	0.1 (1,384)	0.1 (4,152)	— (—)	— (—)	0.3 (8,305)	— (—)	0.5 (13,841)
Total	0.8 (17,993)	0.5 (13,841)	0.3 (6,920)	15.8 (398,617)	78.3 (1,977,855)	4.3 (110,727)	100 (2,525,953)

Note; See Tab. 8.

Table 16. Insect component a year (from June 3, 1985 to June 3, 1986) in individuals/ha and %, with in metric ton/ha ($\times 10^{-4}$) (O. D. W.).

Individual and Weight	Time						Annual
	June	July	August	September	October	Nov. -May	
Individual (%)	27,682 (20.0)	13,841 (10.0)	27,682 (20.0)	13,841 (10.0)	13,841 (10.0)	41,522 (30.0)	138,409 (100)
Weight (%)	0.3 t (23.1)	0.1 t (7.7)	0.3 t (23.1)	0.1 t (7.7)	0.1 t (7.7)	0.4 t (30.7)	1.3 t (100)

Table 17. The amount of litterfall and component a year (from June 3, 1985 to June 3, 1986) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
L	410 t (1.3%)	110 t (0.3%)	240 t (0.8%)	1,030 t (3.3%)	1,400 t (33.0%)	4,550 t (14.4%)	16,700 t (53.1%)
Br	40 (0.1)	110 (0.3)	60 (0.2)	40 (0.1)	430 (1.5)	8,560 (27.1)	9,200 (29.3)
B	10 (—)	20 (0.1)	100 (0.3)	20 (0.1)	90 (0.3)	910 (2.8)	1,200 (3.6)
S	0.4 (—)	1.5 (—)	— (—)	2.4 (—)	23.4 (0.1)	1.4 (—)	29.1 (0.1)
I	0.3 (—)	0.1 (—)	0.3 (—)	0.1 (—)	0.1 (—)	0.4 (—)	1.3 (—)
O	400 (1.3)	170 (0.5)	130 (0.4)	410 (1.3)	1,750 (5.5)	1,540 (4.9)	4,400 (13.9)
Total	860 (2.7)	410 (1.2)	470 (1.7)	1,500 (4.8)	12,690 (40.4)	15,560 (49.2)	31,600 (100)

Note; See Tab. 10.

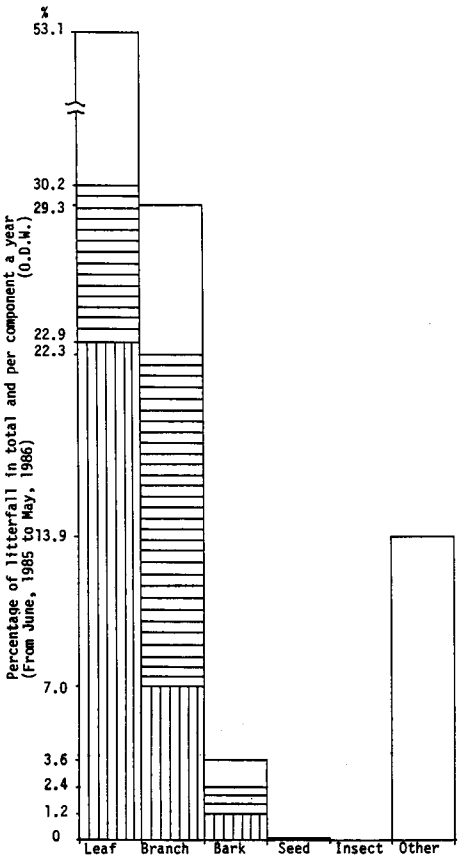

Fig. 8 Litterfall per component and fractions a year (from June, 1985 to May, 1986).

Note; See Fig. 7.

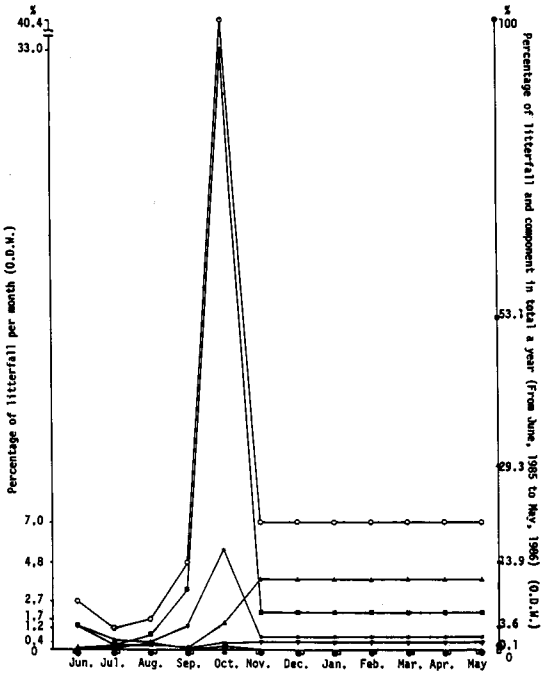

Fig. 9. Seasonal litterfall and components a year (from June, 1985 to May, 1986).

Note; See Fig. 6.

2. The weight loss.

a. The weight loss from June 3, 1984 to June 3, 1985.

1) The weight loss of the ten materials by monthly during snow-uncovered season.

a) The weight loss of the ten materials in June, 1984 was 0.23 t/ha (100%).

b) The weight loss of the ten materials in July, 1984 was 0.30 t/ha (100%).

c) The weight loss of the ten materials in August, 1984 was 0.30 t/ha (100%).

d) The weight loss of the ten materials in September, 1984 was 0.34 t/ha (100%).

e) The weight loss of the ten materials in October, 1984 was 0.20 t/ha (100%).

2) The weight loss of each material per period.

a. The weight loss of the ten materials during snow-uncovered season (from June to October, 1984) was 1.80 t/ha (100%).

3) The weight loss of each material per period.

a. The weight loss of the ten materials during snow-uncovered season (from November, 1984 to May, 1985) was 0.70 t/ha (100%).

4) The weight loss of each material a year.

a. The weight loss of the ten materials a year (from June, 1984 to May, 1985) was 2.61 t/ha/y (100%). The proportion weight loss per each material was as under:

1. Leaf of *P. glehnii* was 0.22 t/ha/y (8.4%),
2. Branch of *P. glehnii* was 0.19 t/ha/y (7.3%),
3. Bark of *P. glehnii* was 0.05 t/ha/y (1.9%),
4. Leaf of *A. sachalinensis* was 0.29 t/ha/y (11.1%),
5. Branch of *A. sachalinensis* was 0.25 t/ha/y (9.6%),
6. Leaf of *B. ermanii* was 0.97 t/ha/y (37.2%),
7. Branch of *B. ermanii* was 0.32 t/ha/y (12.3%),
8. Bark of *B. ermanii* was 0.11 t/ha/y (4.2%),
9. Leaf of *S. senanensis* was 0.12 t/ha/y (4.6%),
10. Culm of *S. senanensis* was 0.09 t/ha/y (3.4%).

The weight loss of the ten materials a year (from June, 1984 to May, 1985) divided with total weight which were kept on the forest floor (Ao layer), was 2.61 t/ha/y (10.4%), and then the proportion of each material was as under:

1. Leaf of *P. glehnii* was 0.22 t/ha/y (0.88%),
2. Branch of *P. glehnii* was 0.19 t/ha/y (0.76%),
3. Bark of *P. glehnii* was 0.05 t/ha/y (0.20%),
4. Leaf of *A. sachalinensis* was 0.29 t/ha/y (1.16%),
5. Branch of *A. sachalinensis* was 0.25 t/ha/y (1.00%),
6. Leaf of *B. ermanii* was 0.97 t/ha/y (3.88%),
7. Branch of *B. ermanii* was 0.32 t/ha/y (1.28%),
8. Bark of *B. ermanii* was 0.11 t/ha/y (0.44%).
9. Leaf of *S. senanensis* was 0.12 t/ha/y (0.48%),
10. Culm of *S. senansis* was 0.09 t/ha/y (0.36%).

This data and then computed with the same material (component)of litterfall a year (from June, 1984 to May, 1985) was 0.29 t/ha/y (10.4%) as shown in Tables 18~19, and Figures 10~11. The weight loss per each material proportion was as under:

1. Leaf of *P. glehnii* was 0.02 t/ha/y (0.88%),
2. Branch of *P. glehnii* was 0.02 t/ha/y (0.76%),
3. Bark of *P. glehnii* was 0.006 t/ha/y (0.20%),
4. Leaf of *A. sachalinensis* was 0.03 t/ha/y (1.16%),
5. Branch of *A. sachalinensis* was 0.03 t/ha/y (1.00%),
6. Leaf of *B. ermanii* was 0.11 t/ha/y (3.88%),
7. Branch of *B. ermanii* was 0.04 t/ha/y (1.28%),
8. Bark of *B. ermanii* was 0.01 t/ha/y (0.44%),
9. Leaf of *S. senanensis* was 0.01 t/ha/y (0.48%),
10. Culm of *S. senanensis* was 0.01 t/ha/y (0.36%).

For the proportion annual weight loss per material to annual total weight loss, the maximum was 3.88% of *B. ermanii* leaf, and the second was 1.28% of *B. ermanii* branch, with lows 0.20% of *P. glehnii* bark. The maximum weight loss of each material per month was in August 0.90% of *B. ermanii* leaf, and the second was 0.54% in September of *B. ermanii* leaf also. The maximum weight loss of the ten materials by monthly was 2.5% in August, and the second was 1.6% in September, with lows during snow-covered season 3.0% or 0.4% per month. The weight loss per material in annual divided with

annual total weight loss, from the maximum to the lowest was as under;

1. Leaf of *B. ermanii* was 0.11 t/ha/ya (3.88%),
2. Branch of *B. ermanii* was 0.04 t/ha/y (1.28%),
3. Leaf of *A. sachalinensis* was 0.03 t/ha/y (1.16%),
4. Branch of *A. sachalinensis* was 0.03 t/ha/y (1.00%),
5. Leaf of *P. glehnii* was 0.02 t/ha/y (0.88%),
6. Branch of *P. glehnii* was 0.02 t/ha/y (0.76%),
7. Leaf of *S. senanensis* was 0.01 t/ha/y (0.48%),
8. Bark of *B. ermanii* was 0.01 t/ha/y (0.44%),
9. Culm of *S. senanensis* was 0.01 t/ha/y (0.36%),
10. Bark of *P. glehnii* was 0.006 t/ha/y (0.20%).

In the proportion of the weight loss during snow-uncovered season and during snow-covered season of the ten materials, the maximum was 0.21 t/ha (7.4%) during snow-uncovered season, with lows during snow-covered season 0.08 t/ha (3.0%). In this case too, the monthly fluctuation/pattern of seasonal change had two peaks type as like as litterfall but, the peaks were measured in August (0.07 t/ha ; 2.5%), and the second in September (0.04 t/ha ; 1.6%), with lows during snow-covered season (0.08 t/ha ; 3.0%) or 0.01 t/ha (0.4%) per month.

The amount of litterfall by monthly divided with annual total litterfall, from the maximum proportion to the lowest was as under :

1. In October, 1.31 t/ha : 2.83 t/ha (46.3%),
2. In September, 0.31 t/ha : 2.83 t/ha (10.8%),
3. In November-May, 0.97 t/ha : 2.83 t/ha (34.3%),
4. In June, 0.12 t/ha : 2.83 t/ha (4.3%),
5. In August, 0.08 t/ha : 2.83 t/ha (3.3%),
6. In July, 0.03 t/ha : 2.83 t/ha (1.0%).

The proportion weight loss of the ten materials by monthly divided with annual total weight loss, from the maximum to the lowest was as under :

1. In August, 0.07 t/ha : 0.29 t/ha (2.5%),
2. In September, 0.04 t/ha : 0.29 t/ha (1.6%),
3. In July, 0.04 t/ha : 0.29 t/ha (1.4%),
4. In June, 0.03 t/ha : 0.29 t/ha (1.0%),
5. In October, 0.03 t/ha : 0.29 t/ha (0.9%),
6. In November-May, 0.08 t/ha : 0.29 t/ha (3.0%) or 0.01 t/ha (0.4%) per month.

The amount of litterfall rate was accounted to 2.83 ton/ha/year (O. D. W.), and the weight loss rate was accounted to 0.29 ton/ha/year (10.4%).

Table 18. The weight loss of the ten materials a year (from June 3, 1984 to June 3, 1985) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
Pa. L	22 t	36 t	59 t	36 t	22 t	67 t	242 t (0.88%)
Pg. Br	14	28	56	42	14	61	215 (0.76)
Pg. B	3	8	17	11	3	17	59 (0.20)
A. L	36	50	73	50	25	89	323 (1.16)
A. Br	22	36	59	50	25	78	271 (1.00)
B. L	125	139	251	151	100	312	1,078 (3.88)
B. Br	33	47	103	47	33	89	352 (1.28)
B. B	6	14	28	14	6	33	101 (0.44)
Ss. L	11	17	32	17	11	46	134 (0.48)
Ss. C	6	13	28	6	6	33	100 (0.36)
Total	280 (1.0)	390 (1.4)	710 (2.5)	430 (1.6)	250 (0.9)	820 (3.0)	2,900 (10.4)

Note: *: The materials; Pg. : *P. glehnii* leaf; Pg. Br: *P. glehnii* branch; Bg. B: *P. glehnii* Bark; A. L: *A. Sachalinensis* leaf; A. Br:*A. sachalinensis* branch; B. L: *B. ermanii* leaf; B. Br: *B. ermanii* branch; B. B: *B. ermanii* bark; Ss. L: *S. senanensis* leaf; Ss. C: *S. senanensis* culm.

Table 19. The weight loss of the ten materials a year (from June 3, 1984 to June 3, 1985) in percentage/ha (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov. -May	
Pg. L	0.08%	0.13%	0.21%	0.14%	0.08%	0.24%	0.88%
Pg. Br	0.05	0.10	0.20	0.15	0.04	0.22	0.76
Pg. B	0.01	0.03	0.06	0.04	0.01	0.06	0.20
A. L	0.13	0.18	0.26	0.18	0.09	0.32	1.16
A. B8	0.08	0.13	0.21	0.18	0.09	0.28	1.00
B. L	0.45	0.51	0.90	0.54	0.36	1.12	3.88
B. B8	0.12	0.17	0.37	0.17	0.12	0.32	1.28
B. B	0.03	0.06	0.12	0.06	0.03	0.14	0.44
Ss. L	0.04	0.06	0.12	0.06	0.04	0.16	0.48
Ss. C	0.02	0.04	0.12	0.02	0.02	0.14	0.36
Total	1.0	1.4	2.5	1.6	0.9	3.0	10.4

Note; See Tab. 18.

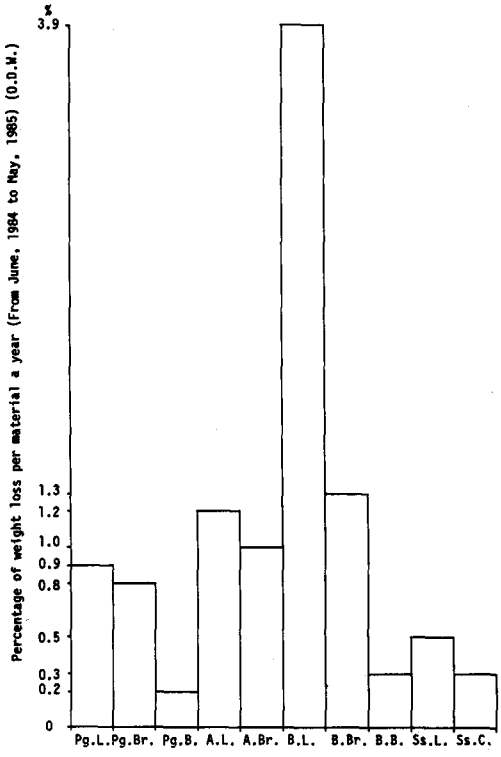

Fig. 10. The weight loss of the material a year (from June, 1984 to May, 1985).
(O. D. W.)

Note; Pg. L.: *P. glehnii* Leaf; Pg. Br.: *P. glehnii* Branch; Pg. B.: *P. glehnii* Bark; A. L.: *A. sachalinensis* Leaf; A. Br.: *A. sachalinensis* Branch; B. L.: *B. ermanii* Leaf; B. Br.: *B. ermanii* Branch; B. B.: *B. ermanii* Bark; Ss. L.: *S. senanensis* Leaf; Ss. C.: *S. senanensis* Culm.

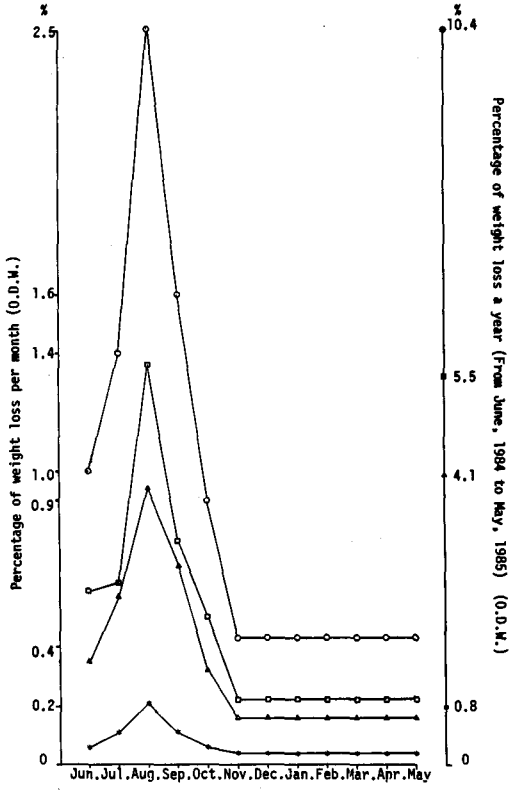

Fig. 11. Seasonal weight loss of the material a year (from June, 1984 to May, 1985).
(O. D. W.)

Note; ○ : Total materials; △ : Coniferous material (Leaf, Branch, Bark of *P. glehnii* and Leaf, Branch of *A. sachalinensis*; □ : Broadleaved material (Leaf, Branch, Bark of *B. ermanii*); ✱ : Other (Leaf, Culm of *S. senanensis*).

b. The weight loss from June 3, 1985 to June 3, 1986.

1) The weight loss of the ten materials by monthly during snow-uncovered season.

a) The weight loss of the ten materials in June, 1985 was 0.25 t/ha (100%).

b) The weight loss of the ten materials in July, 1985 was 0.29 t/ha (100%).

c) The weight loss of the ten materials in August, 1985 was 0.58 t/ha (100%).

d) The weight loss of the ten materials in September, 1985 was 0.35 t/ha (100%).

e) The weight loss of the ten materials in October, 1985 was 0.22 t/ha (100%).

2) The weight loss of each material per period.

a) The weight loss of the ten materials during snow-uncovered season (from June

to October, 1985) was 1.85 t/ha (100%).

3) The weight loss of each material per period.

a) The weight loss of the ten material during snow-covered season (from November, 1985 to May, 1986) was 0.68 t/ha (100%).

4) The weight loss of each material a year.

a. The weight loss of the ten materials a year (from June, 1985 to May, 1986) was 2.71 t/ha/y (100%). The proportion weight loss per each material was as under:

1. Leaf of *P. glehnii* was 0.24 t/ha/y (8.9%),
2. Branch of *P. glehnii* was 0.22 t/ha/y (8.1%),
3. Bark of *P. glehnii* was 0.05 t/ha/y (1.8%),
4. Leaf of *A. sachalinensis* was 0.31 t/ha (11.5%),
5. Branch of *A. sachalinensis* was 0.25 t/ha/y (9.2%),
6. Leaf of *B. ermanii* was 0.99 t/ha/y (36.5%),
7. Branch of *B. ermanii* was 0.32 t/ha/y (11.8%),
8. Bark of *B. ermanii* was 0.11 t/ha/y (4.1%),
9. Leaf of *S. senanensis* was 0.12 t/ha/y (4.4%),
10. Culm of *S. senanensis* was 0.10 t/ha/y (3.7%).

The weight loss of the ten materials a year (from June, 1985 to May, 1986) divided with total weight which were kept on the forest floor (Ao layer) was 2.71 t/ha/y (10.8%), and then the proportion of each material was as under:

1. Leaf of *P. glehnii* was 0.24 t/ha/y (0.96%),
2. Branch of *P. glehnii* was 0.22 t/ha/y (0.88%),
3. Bark of *P. glehnii* was 0.05 t/ha/y (0.20%),
4. Leaf of *A. sachalinensis* was 0.31 t/ha/y (1.24%),
5. Branch of *A. sachalinensis* was 0.25 t/ha/y (1.00%),
6. Leaf of *B. ermanii* was 0.99 t/ha/y (3.96%),
7. Branch of *B. ermanii* was 0.32 t/ha/y (1.28%),
8. Bark of *B. ermanii* was 0.11 t/ha/ya (0.44%),
9. Leaf of *S. senanensis* was 0.12 t/ha/y (0.48%),
10. Culm of *S. senanensis* was 0.10 t/ha/y (0.40%).

This data and then computed with the same material (component) of litterfall a year (from June, 1985 to May, 1986) was 0.34 t/ha/y (10.8%) as shown in Tables 20~21, and Figures 12~13. The weight loss per each material proportion was as under:

1. Leaf of *P. glehnii* was 0.03 t/ha/y (0.96%),
2. Branch of *P. glehnii* was 0.03 t/ha/y (0.88%),
3. Bark of *P. glehnii* was 0.006 t/ha/y (0.20%),
4. Leaf of *A. sachalinensis* was 0.04 t/ha/y (1.24%),
5. Branch of *A. sachalinensis* was 0.03 t/ha/y (1.00%),
6. Leaf of *B. ermanii* was 0.12 t/ha/y (3.96%),
7. Branch of *B. ermanii* was 0.04 t/ha/y (1.28%),
8. Bark of *B. ermanii* was 0.01 t/ha/y (0.44%),
9. Leaf of *S. senanensis* was 0.02 t/ha/y (0.48%),
10. Culm of *S. senanensis* was 0.01 t/ha/y (0.40%).

For the proportion annual weight loss per material to annual total weight loss, the maximum was 3.9% of *B. ermanii* leaf, and the second was 1.28% of *B. ermanii* branch, with lows 0.20% of *P. glehnii* bark. The maximum weight loss of each material per month was in August 1.06% of *B. ermanii* leaf, and the second was in September 0.57% of *B. ermanii* leaf also. The maximum weight loss of the ten materials by monthly was 2.7% in August, and the second was in September 1.6%, with lows during snow-covered season 3.1% (0.4%) per month. The weight loss per material in annual divided with annual total weight loss, from the maximum to the lowest was as under:

1. Leaf of *B. ermanii* was 0.12 t/ha/y (3.96%),
2. Branch of *B. ermanii* was 0.04 t/ha/y (1.28%),
3. Leaf of *A. sachalinensis* was 0.04 t/ha/y (1.24%),
4. Branch of *A. sachalinensis* was 0.03 t/ha/y (1.00%),
5. Leaf of *P. glehnii* was 0.03 t/ha/y (0.96%),
6. Branch of *P. glehnii* was 0.03 t/ha/y (0.88%),
7. Leaf of *S. senanensis* was 0.02 t/ha/y (0.48%),
8. Bark of *B. ermanii* was 0.01 t/ha/y (0.44%),
9. Culm of *S. senanensis* was 0.01 t/ha/y (0.40%),
10. Bark of *P. glehnii* was 0.006 t/ha/y (0.20%).

For the proportion of the weight loss during snow-uncovered season and during snow-covered season of the ten materials, the maximum was 0.24 t/ha (7.7%) during snow-uncovered season, with lows during snow-covered season 0.10 t/ha (3.1%). In this case too, the monthly fluctuation/pattern of seasonal change had two peaks type as like as litterfall but, the peaks were measured in August (0.08 t/ha; 2.7%), and the second in September (0.05 t/ha; 1.6%), with lows during snow-covered season (0.10 t/ha; 3.1%) or 0.01 t/ha (0.4%) per month.

The amounts of litterfall by monthly divided with annual total litterfall, from the maximum proportion to the lowest were as under:

1. In October, 1.27 t/ha : 3.16 t/ha (40.4%);
2. In November-May, 1.56 t/ha : 3.16 t/ha (49.2%) or 0.22 t/ha (7.0%) per month;
3. In September, 0.15 t/ha : 3.16 t/ha (4.8%);
4. In June, 0.09 t/ha : 3.16 t/ha (2.7%);
5. In August, 0.05 t/ha : 3.16 t/ha (1.7%);
6. In July, 0.04 t/ha : 3.16 t/ha (1.2%);

The proportion weight loss of the ten materials by monthly divided with annual total weight loss, from the maximum to the lowest was as under:

1. In August, 0.08 t/ha : 0.34 t/ha (2.7%);
2. In September, 0.05 t/ha : 0.34 t/ha (1.6%);
3. In July, 0.04 t/ha : 0.34 t/ha (1.3%);
4. In June, 0.04 t/ha : 0.34 t/ha (1.1%);
5. In October, 0.03 t/ha : 0.34 t/ha (1.0%);
6. In November-May, 0.10 t/ha : 0.34 t/ha (3.1%) or 0.01 t/ha (0.4%) per month.

Table 20. The weight loss of the ten materials a year (from June 3, 1985 to June 3, 1986) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
Pg. L	30 t	45 t	75 t	45 t	230 t	75 t	300 t (0.96%)
Pg. Br	28	28	60	41	15	94	266 (0.88)
Pg. B	3	7	18	10	3	23	64 (0.20)
A. L	45	45	91	61	45	102	389 (1.24)
A. Br	39	39	64	51	26	94	313 (1.00)
B. L	139	152	334	179	126	321	1,251 (3.96)
B. Br	40	54	108	54	40	107	403 (1.28)
B. B	7	19	39	19	19	35	138 (0.44)
Ss. L	14	19	34	19	14	57	157 (0.48)
Ss. C	14	15	19	19	7	50	124 (0.04)
Total	360 (1.1)	420 (1.3)	840 (2.7)	500 (1.6)	330 (1.0)	960 (3.1)	3,400 (10.8)

Note; See Tab. 18.

Table 21. The weight loss of the ten materials a year (from June 3, 1985 to June 3, 1986) in percentage/ha (O. D. W.)

*	Time						Annual
	June	July	August	September	October	Nov. -May	
Pg. L	0.10%	0.14%	0.24%	0.14%	0.10%	0.24%	0.96%
Pg. Br	0.09	0.09	0.18	0.13	0.05	0.30	0.88
Pg. B	0.01	0.02	0.05	0.03	0.01	0.07	0.20
A. L	0.14	0.14	0.29	0.19	0.14	0.32	1.24
A. Br	0.12	0.12	0.20	0.16	0.08	0.30	1.00
B. L	0.44	0.48	1.06	0.57	0.40	1.01	3.96
B. Br	0.13	0.17	0.34	0.17	0.13	0.34	1.28
B. B	0.02	0.06	0.12	0.07	0.06	0.11	0.44
Ss. L	0.04	0.06	0.11	0.06	0.04	0.17	0.48
Ss. C	0.04	0.05	0.06	0.06	0.02	0.16	0.40
Total	1.1	1.3	2.7	1.6	1.0	3.1	10.8

Note: See Tab. 18.

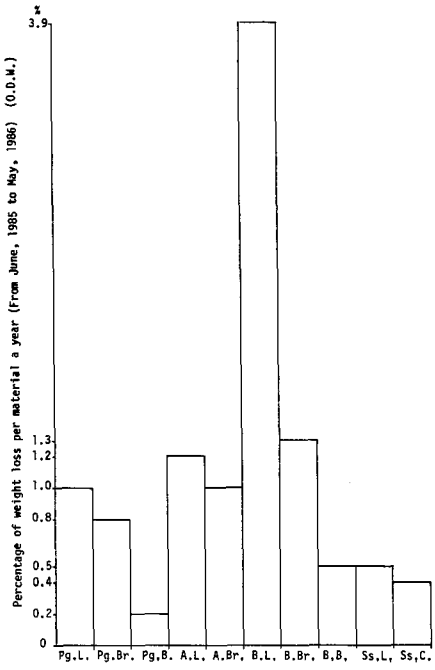

Fig. 12. The weight loss of the material a year (from June, 1985 to May, 1986). (O. D. W.)
Note; See Fig. 10.

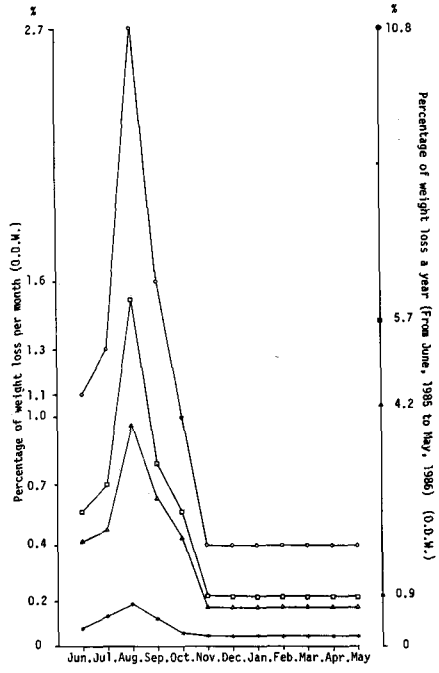

Fig. 13. Seasonal weight loss of the material a year (from June, 1985 to May, 1986) (O. D. W.)
Note; See Fig. 11.

The amount of litterfall rate was accounted to 3.16 ton/ha/year (O. D. W.), and the weight loss rate was accounted to 0.34 ton/ha/year (10.8%).

c. The weight loss in two years (from June 3, 1984 to June 3, 1986) of the ten materials was 5.63 t/ha (100%). The proportion weight loss per each material was set and taken in once at recovering time as under:

1. Leaf of *P. glehnii* was 0.48 t/ha/2 ys (8.5%),
2. Branch of *P. glehnii* was 0.47 t/ha/2 ys (8.4%),
3. Bark of *P. glehnii* was 0.12 t/ha/2 ys (2.1%),
4. Leaf of *A. sachalinensis* was 0.61 t/ha/2 ys (10.8%),
5. Branch of *A. sachalinensis* was 0.51 t/ha/2 ys (9.1%),
6. Leaf of *B. ermanii* was 2.03 t/ha/2 ys (36.1%),
7. Branch of *B. ermanii* was 0.67 t/ha/2 ys (11.9%),
8. Bark of *B. ermanii* was 0.25 t/ha/2 ys (4.4%),
9. Leaf of *S. Senanensis* was 0.27 t/ha/2 ys (4.8%),
10. Culm of *S. Senanensis* was 0.22 t/ha/2 ys (3.9%),

The weight loss of the ten materials in two years (from June 3, 1984 to June 3, 1986) divided with total weight which is kept on the forest floor (Ao layer), were set and taken in once at recovering time is 5.63 t/ha/2 ys. The weight loss of the ten materials also in two years, which were set and taken twice at recovering time (from June 3, 1984 to June

3, 1985 and from June 3, 1985 to June 3, 1986) was 5.32 t/ha/2 ys (21.2%). The differentiation of weight loss which were set and taken in once and twice at recovering time was 0.31 t/ha. In this case, the weight loss of the ten materials in two years, which were set and taken in once at recovering time was 0.31 t/ha more than in twice at recovering time (0.07 t/ha/2 ys) in computation with a same material (component) of litterfall in two years (4.17 t/ha/2 ys). Therefore, the weight loss of the ten materials in two years (from June 3, 1984 to June 3, 1986), which were set and taken in once at recovering time and then computed with total litterfall in two years (5.99 t/ha) was 0.70 t/ha/2 ys (23.3%) as shown in Tables 22~23, and Figures 14~15. The proportion weight loss per each material was as under;

1. Leaf of *P. glehnii* was 0.06 t/ha/2 ys (2.01%),
2. Branch of *P. glehnii* was 0.06 t/ha/2 ys (1.99%),
3. Bark of *P. glehnii* was 0.01 t/ha/2 ys (0.48%),
4. Leaf of *A. sachalinensis* was 0.07 t/ha/2 ys (2.44%),
5. Branch of *A. sachalinensis* was 0.06 t/ha/2 ys (2.04%),
6. Leaf of *B. ermanii* was 0.25 t/ha/2 ys (8.39%),
7. Branch of *B. ermanii* was 0.08 t/ha/2 ys (2.81%),
8. Bark of *B. ermanii* was 0.03 t/ha/2 ys (1.00%),
9. Leaf of *S. senanensis* was 0.03 t/ha/2 ys (1.13%),
10. Culm of *S. senanensis* was 0.03 t/ha/2 ys (0.97%).

For the proportion per material to total weight loss in 2 years, the maximum was 8.39% of *B. ermanii* leaf, and the second also of *B. ermanii* branch was 2.81%, with lows of *P. glehnii* bark 0.48%. The weight loss per material divided with total weight loss in 2 years, from the maximum to the lowest proportion was as under:

1. Leaf of *B. ermanii* was 0.25 t/ha/2 ys (8.39%),
2. Branch of *B. ermanii* was 0.08 t/ha/2 ys (2.81%),
3. Leaf of *A. sachlinensis* was 0.07 t/ha/2 ys (2.44%),
4. Branch of *A. sachalinensis* was 0.06 t/ha/2 ys (2.04%),
5. Leaf of *P. glehnii* was 0.06 t/ha/2 ys (2.01%),
6. Branch of *P. glehnii* was 0.06 t/ha/2 ys (1.99%),
7. Leaf of *S. senanensis* was 0.03 t/ha/2 ys (1.13%),
8. Bark of *B. ermanii* was 0.03 t/ha/2 ys (1.00%),
9. Culm of *S. senanensis* was 0.03 t/ha/2 ys (0.97%),
10. Bark of *P. glehnii* was 0.01 t/ha/2 ys (0.48%).

The weight loss proportion of the ten materials by monthly (two times) divided with total weight loss in two years, which were set and taken in once at recovering time, from the maximum to the lowest was as under:

1. In August, 0.17 t/ha : 0.70 t/ha/2 ys (5.6%) of two times,
2. In September, 0.10 t/ha : 0.70 t/ha/2 ys (3.4%) of two times,
3. In July, 0.09 t/ha : 0.70 t/ha/2 ys (3.0%) of two times,
4. In June, 0.07 t/ha : 0.70 t/ha/2 ys (2.4%) of two times,
5. In October, 0.06 t/ha : 0.70 t/ha/2 ys (2.0%) of two times,
6. In November-May, 0.21 t/ha : 0.70 t/ha/2 ys (6.9%) of two times or 0.03 t/ha

(1.0%) in two months.

For the proportion of the weight loss during snow-uncovered season of two times (from June to October in 1984 and in 1985) and during snow-covered season of two times (from November to May in 1984-1985 and 1985-1986) of the ten materials, the maximum was 0.49 t/ha (16,4%) during snow-uncovered season, with lows during snow-covered season 0.21 t/ha (6.9%).

The amount of litterfall rate was accounted to 5.99 ton/ha/2ys. (O. D. W), and the weight loss rate was accounted to 0.70 ton/ha/2ys (23.3%).

Table 22. The weight loss of the ten materials in two years (from June 3, 1984 to June 3, 1986) in metric ton/ha ($\times 10^{-4}$) and % (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
Pg. L	55 t	86 t	142 t	86 t	55 t	203 t	627 t (2.01%)
Pg. Br	51	68	142	102	35	175	573 (1.99)
Pg. B	8	19	45	27	8	31	138 (0.48)
A. L	83	97	168	114	72	201	735 (2.44)
A. Br	63	77	127	113	52	184	616 (2.04)
B. L	279	304	614	347	237	710	2,491 (8.39)
B. Br	78	107	225	117	78	232	837 (2.81)
B. B	6	40	81	40	30	112	319 (1.00)
Ss. L	30	42	80	42	30	139	363 (1.13)
Ss. C	25	36	59	42	16	120	298 (0.97)
Total	690 (2.4)	880 (3.0)	1,680 (5.6)	1,010 (3.4)	610 (2.0)	2,110 (6.9)	6,980 (23.3)

Note; See Tab. 18.

Table 23. The weight loss of the ten materials in two years (from June 3, 1986) in percentage/ha (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov. -May	
Pg. L	0.21%	0.28%	0.49%	0.29%	0.19%	0.65%	2.01%
Pg. Br	0.16	0.23	0.48	0.32	0.11	0.58	1.99
Pg. B	0.03	0.07	0.16	0.09	0.02	0.11	0.48
A. L	0.27	0.32	0.56	0.37	0.23	0.67	2.44
A. Br	0.21	0.26	0.42	0.37	0.17	0.61	2.04
B. L	0.95	1.02	2.13	1.15	0.77	2.38	8.39
B. Br	0.29	0.37	0.78	0.45	0.26	0.76	2.81
B, B	0.04	0.12	0.24	0.12	0.09	0.39	1.00
Ss. L	0.11	0.13	0.25	0.15	0.08	0.41	1.13
Ss. C	0.08	0.11	0.22	0.13	0.05	0.38	0.09
Total	0.4	3.0	5.6	3.4	2.0	6.9	23.3

Note; See Tab. 18.

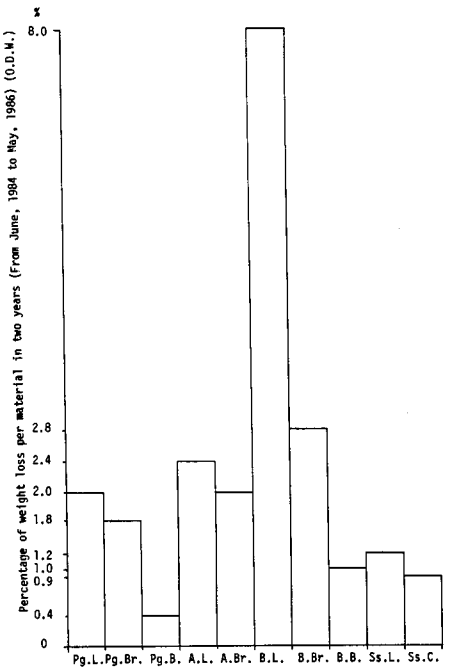

Fig. 14 The weight loss of the material in two years (from June, 1984 to May, 1986). (O. D. W.)
Note; See Fig. 10.

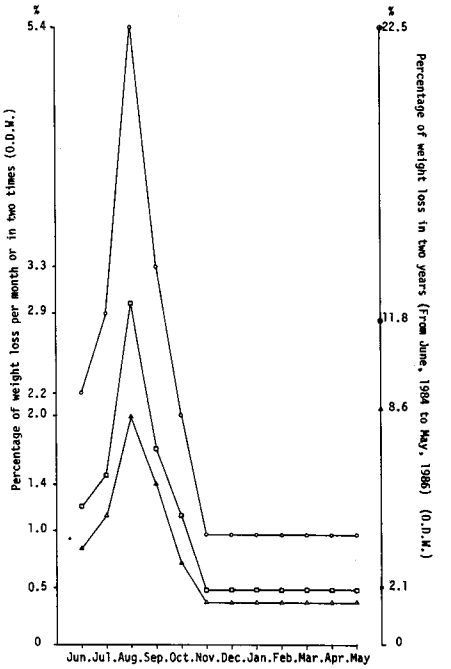

Fig. 15. Seasonal weight loss of the material in two years (from June, 1984 to May, 1986). (O. D. W.)
Note; See Fig. 11.

3. The pattern of litterfall a year (from June 3, 1984 to June 3, 1986).

a. It was recognized that the monthly fluctuation of seasonal change has two peaks type and these peaks was measured in October (1.29 t/ha ; 42.9%) and the second in September (0.23 t/ha ; 7.7%), with lows in July (0.03 t/ha ; 1.2%). For the proportion of coniferous and broadleaved fractions by monthly divided with annual total litterfall, the maximum was in October. Conifer was 0.50 : 3.00 t/ha (16.7%), and the second during snow-covered season was 0.96 : 3.00 t/ha (32.0%) or 4.6% per month ; broadleaved was 0.65 : 3.00 t/ha (21.7%), and the second in September was 0.12 : 3.00 t/ha (4.0%). Litter fraction was also separated, from the maximum weight per fraction by monthly divided with annual total litterfall. Leaf was in October, in which the conifer was contained at 0.47 : 3.00 t/ha (15.7%), and the broadleaved was 0.61 : 3.00 t/ha (20.4%), branch, in which the conifer was contained at 0.53 : 3.00 t/ha (17.7%) during snow-covered season or 2.5% per month, and the broadleaved was 0.03 : 3.00 t/ha (1.0%) in October ; bark was in October, in which the conifer was contained at 0.008 : 3.00 t/ha (0.3%), and the broadleaved was 0.005 : 3.00 t/ha (0.1%) ; Seed, in which the conifer was contained at 0.001 : 3.00 t/ha (0.0%) in October, and the broadleaved was 0.012 : 3.00 t/ha (0.4%) in September. The maximum weight per fraction (species) of coniferous and broadleaved trees divided with total by monthly proportion was in October. Conifer ous leaf was 0.47 : 1.29 t/ha (15.7%), and the second during snow-covered season was 0.38 : 1.26 t/ha (12.7%) or 1.8% per

month ; broadleaved leaf was 0.61 : 1.29 t/ha (20.4%), and the second was 0.11 : 0.23 t/ha (3.7%) in September ; coniferous seed was 0.001 : 1.29 t/ha, and the second was 0.0001 : 0.23 t/ha on September (0.0% ; respectively) ; broadleaved seed was 0.012 : 0.23 t/ha (0.4%), and the second was 0.005 : 1.29 t/ha (0.2%) in October also ; coniferous seed of *A. sachalinensis* was 0.0008 : 1.29 t/ha, and the second of *P. glehnii* was 0.0002 : 1.29 t/ha in October also (0.0% ; respectively) ; broadleaved seed in September of *Q. mongolica* var. *grosseserrata* was 0.012 : 0.23 t/ha (0.4%), the second also of *Q. mongolica* var. *grosseserrata* was 0.004 : 1.29 t/ha (0.1%) in October. The maximum seed grain per fraction of coniferous and broadleaved trees divided with seed grain total per month was in October. Conifer were 559,851 grains/ha (37.5%), and the second 112,705 grains/ha (7.5%) in September ; the broadleaved were 493,872 grains/ha (33.0%), and the second 123,406 grains/ha (8.5%) in September. The maximum grains of seed per species of coniferous and broadleaved trees were as follows. Coniferous seed of *A. sachalinensis* were 484,424 grains/ha (32.4%), and the second in September of *A. sachalinensis* also 85,116 grains/ha (5.7%) ; broadleaved seed of *B. ermanii* were 390,303 grains/ha (26.1%), and the second in September of *B. ermanii* also 86,965 grains/ha (5.8%). The maximum weight per component divided with total litterfall by monthly proportion are as follows:

1. Leaves were 1.08 : 1.29 t/ha (36.1%) in October;
2. Branches were 0.67 : 1.27 t/ha (22.5%) during snow-covered season or 3.2% per month;
3. Barks were 0.01 : 1.29 t/ha (0.4%) in October;
4. Seeds were 0.01 : 0.23 t/ha (0.4%) in September;
5. Insects were 0.00005 : 0.10 t/ha (0.0%) in June;
6. Others were 0.14 : 1.29 t/ha (4.5%) in October.

The maximum grains and proportion of seed component numbered 1,053,723 grains/ha (70.5%) in October, and the second was 239,201 grains/ha (16.0%) in September, with lows 103,787 grains/ha (7.0%) during snow-covered season or 14,827 grains/ha (1.0%) per month. For Insect residues proportion, the maximum individual number were 34,603 individuals/ha in June and July (20.0% ; respectively), with lows 41,523 individuals/ha (24.0%) during snow-covered season or 5,932 individulas/ha (3.4%) per month. For the proportion per component in annual to annual total litterfall, the maximum was 1.71 : 3.00 t/ha (57.1%) of leaves, the second was 0.77 : 3.00 t/ha (25.7%) of branches, with lows of insects 0.0002 : 3.00 t/ha (0.0%). The maximum weight per component divided with total litterfall by monthly proportion was in October 1.08 : 1.29 t/ha (36.1%) of leaves, and the second of leaves also 0.16 : 0.23 t/ha (5.4%) in September, with lows of Insects 0.0004 : 1.27 t/ha (0.0%) during snow-covered season. The maximum grains of seed per species divided with total seedfall by monthly proportion was in October 484,424 : 1,053,723 grains/ha (32.4%) of *A. sachalinensis,* and the second of *B. ermanii* was 390,303 : 1,053,723 grains/ha (26,1%) in October also. The maximum grains of seed component in total per month divided with annual total seedfall were 1,053,723 grains/ha (70.5%) in October, and the second of 239,201 grains/ha (16.0%) in June, with lows of 103,787 grains/ha (7.0%) during snow-covered season or 14,827 grains/ha (1.0%) per month.

b. The litter components. Leaves, the maximum during snow-uncovered season was

1.33 t/ha (44.3%), with lows during snow-covered season 0.38 t/ha (12.8%) ; Branches, the maximum during snow-covered season was 0.67 t/ha (22.5%), with lows during snow-uncovered season 0.10 t/ha (3.2%) ; Barks, the maximum during snow-covered season was 0.07 t/ha (2.3%), with lows during snow-uncovered season 0.03 t/ha (0.9%) ; Seeds, the maximum during snow-uncovered season was 0.02 t/ha (0.7%), with lows during snow-covered season 0.0003 t/ha (0.0%) ; Insect residues, the maximum during snow-uncovered season was 0.0001 t/ha (0.0%), with lows during snow-covered season 0.00004 t/ha (0.0%) ; Others, the maximum during snows-uncovered season was 0.26 t/ha (8.7%) with lows during snow-covered season 0.14 t/ha (4.6%). The maximum grains of seedfall during snow-covered season were 1,389,779 grains/ha (93.0%), with lows during snow-covered season 1,389,779 grains/ha (7.0%). The maximum individuals of insectfall during snow-uncovered season were 131,490 individuals/ha (76.0%), with lows during snow-covered season 41,523 individuals/ha (24.0%). The proportion of coniferous and broadleaved fractions to annual total litterfall, from the maximum to the lowest was as under :

1. Conifer ; 1.60 t/ha (53.3%), during snow-covered season was the maximum 0.96 t/ha (32.0%), with lows during snow-uncovered season 0.64 t/ha (21.3%).

2. Broadleaved ; 1.00 t/ha (33.4%), during snow-uncovered season was the maximum 0.83 t/ha (27.7%), with lows during snow-covered season 0.17 t/ha (5.7%).

For the proportion of litterfall during snow-uncovered season and during snow-covered season to annual total litterfall, the maximum was 1.73 t/ha (57.8%) during snow-uncovered season, with lows during snow-covered season 1.27 t/ha (42.2%).

c. The pattern of litterfall per component and fraction a year are shown in Tables 24 ~30, and Figures 16~17. The proportion of each litter component and fraction to annual total litterfall, from the maximum to the lowest was as under :

1. Leaves were 1.71 t/ha/y (57.1%) which of ;
   conifer 0.96 t/ha/y (32.1%), broadleaved 0.75 t/ha/y (25.0%).
2. Branches were 0.77 t/ha/ya (25.7%) which of ;
   conifer 0.57 t/ha/y (19.0%), broadleaved 0.20 t/ha/y (6.7%).
3. Barks were 0.10 t/ha/y (3.2%) which of ;
   conifer 0.07 t/ha/y (2.2%), broadleaved 0.03 t/ha/y (1.0%).
4. Seeds were 0.02 t/ha/y (0.7%) which of ;
   conifer 0.001 t/ha/y (0.0%), broadleaved 0.02 t/ha/y (0.7%).
5. Others were 0.40 t/ha/y (13.3%).

The maximum grains of seedfall per species in annual divided with annual total seedfall were 631,814 grains/ha/year (42.4%) of *A. sachalinensis,* and the second 552,679 grains/ha/year (37.0%) of *B. ermanii,* with lows 27,672 grains/ha/year (1.9%) of *Q. mongolica* var. *grosseserrata.* The maximum grains of seedfall of coniferous and broadleaved trees are as follows :

a. Conifer ; 763,748 grains/ha/y (51.2%) which of ;
   a) *A. sachalinensis* 631,814 grains/ha/y (42.2%),
   b) *P. glehnii* 131,93f4 grains/ha/y (8.8%).

b. Broadleaved ; 729,818 grains/ha/year (48.8%) which of ;

c) *B. ermanii* 552,679 grains/ha/y (37.0%),
d) *B. platyphylla* var. *japonica* 112,800 grains/ha/y (7.5%),
e) *A. mono* 36,667 grains/ha/y (2.4%),
f) *Q. mongolica* var. *grosseserrata* 27,672 grains/ha/y (1.9%).

Total grain of seed numbered 1,493,566 grains/ha/year, which the maximum seedfall during snow-uncovered season were 1,389,779 grains/ha (93.0%), with lows during snow-covered season of 103,787 grains/ha (7.0%) or 14,827 grains/ha (1.0%) per month. Total insect residues were 173,013 individuals/ha/year, which the maximum during snow-uncovered season of 131,490 individuals/ha (76.0%), with lows during snow-covered season of 41,523 individuals/ha (24.0%) or 5,932 individuals/ha (3.4%) per month.

Table 24. Leaf component and fractions a year (in metric ton/ha or $\times 10^{-4}$ and %) (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
CL	344 t (2.0%)	88 t (0.5%)	190 t (1.1%)	532 t (3.1%)	4,680 t (27.4%)	3,790 t (22.2%)	9,624 t (56.3%)
A	216	56	132	369	3,555	3,035	7,363 (43.1)
Pg	128	32	58	163	1,125	755	2,261 (13.2)
BL	65 (0.4)	34 (0.1)	98 (0.5)	1,076 (6.3)	6,148 (36.2)	34 (0.2)	7,455 (43.7)
Q	19	5	14	210	2,566	13	2,827 (16.6)
B	14	17	46	306	1,180	8	1,571 (9.2)
Bp	6	3	9	36	231	—	285 (1.7)
Am	1	0.2	4	48	1,146	3	1,202 (7.0)
T	3	1	—	1	57	1	63 (0.4)
K	3	—	—	95	144	2	244 (1.4)
S	1	0.2	1	3	26	1	32 (0.2)
As	13	4	2	84	371	2	476 (2.8)
Sh	3	1	1	87	116	1	209 (1.2)
Sa	1	1	1	13	87	1	104 (0.6)
Pa	1	2	20	193	224	2	442 (2.6)
Total	410 (2.4)	120 (0.6)	290 (1.6)	1,610 (9.4)	10,830 (63.4)	3,820 (22.4)	17,100 (100)

Note; See Tab. 4.

Table 25. Branch component and fractions a year (in metric ton/ha or $\times 10^{-4}$ and %) (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
C	72 t (1.1%)	46 t (0.5%)	99 t (1.5%)	22 t (0.3%)	200 t (3.0%)	5,275 t (67.2%)	5,714 t (73.6%)
B	57 (0.8)	15 (0.2)	118 (1.8)	25 (0.4)	315 (4.2)	1,460 (19.0)	1,990 (26.4)
Total	130 (1.9)	60 (0.7)	220 (3.3)	50 (0.7)	520 (7.2)	6,740 (86.2)	7,700 (100)

Note; See Tab. 5.

Table 26. Bark component and fractions a year (in metric ton/ha or $\times 10^{-4}$ and %) (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
C	18 t (1.9%)	10 t (1.0%)	35 t (3.6%)	22 t (2.3%)	78 t (8.0%)	510 t (52.3%)	673 t (69.1%)
B	6 (0.6)	7 (0.7)	39 (4.0)	12 (1.2)	48 (4.9)	190 (19.5)	302 (30.9)
Total	20 (2.5)	2 (1.7)	70 (7.6)	30 (3.5)	130 (12.9)	700 (71.8)	1,000 (100)

Note; See Tab. 6.

Table 27. Seed component and fractions a year (in metric ton/ha or $\times 10^{-4}$ and %) (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov. -May	
CS:	— (—)	— (—)	— (—)	0.7% (1.4 t)	5.0% (9.8 t)	0.6% (1.1 t)	6.3% (12.3 t)
A	— (—)	— (—)	— (—)	0.6 (1.1)	4.0 (7.9)	0.3 (0.5)	4.9 (9.5)
Pg	— (—)	— (—)	— (—)	0.1 (0.3)	1.0 (1.9)	0.3 (0.6)	1.4 (2.8)
BS	0.3 (0.7)	0.4 (0.8)	7.6 (15.0)	60.6 (119.6)	23.8 (47.1)	1.0 (2.0)	93.7 (185.2)
Q	— (—)	— (—)	6.8 (13.5)	60.2 (119.0)	21.5 (42.5)	— (—)	88.5 (175.0)
B	— (—)	— (—)	— (—)	0.1 (0.1)	0.1 (0.2)	— (—)	0.2 (0.3)
Bp	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)	— (—)
Am	0.3 (0.7)	0.4 (0.8)	0.8 (1.5)	0.3 (0.5)	2.2 (4.4)	1.0 (2.0)	5.0 (9.9)
Total	0.3 (1.0)	0.4 (1.0)	7.6 (15.0)	61.3 (121.0)	28.8 (57.0)	1.6 (3.0)	100 (200)

Note; See Tab. 8.

Table 28. Seed component and fractions a year (in percentage/ha) (grains)

*	Time						Annual
	June	July	August	September	October	Nov. -May	
CS	0.7% (10,146)	0.6% (8,532)	0.7% (10,146)	7.5% (112,795)	37.5% (559,851)	4.2% (62,278)	51.2% (763,748)
A	0.6 (8,302)	0.5 (6,918)	0.5 (6,918)	5.7 (85,116)	32.4 (484,424)	2.7 (40,136)	42.4 (431,814)
Pg	0.1 (1,844)	0.1 (1,614)	0.2 (3,228)	1.8 (27,679)	5.1 (75,427)	1.5 (22,142)	8.8 (131,934)
BS	1.6 (24,446)	1.2 (17,528)	1.7 (26,057)	8.5 (126,406)	33.0 (493,872)	2.8 (41,509)	48.8 (729,818)
Q	— (—)	— (—)	0.5 (6,918)	0.9 (13,836)	0.5 (6,918)	— (—)	1.9 (27,672)
B	1.4 (20,756)	0.8 (11,762)	0.7 (10,377)	5.8 (86,965)	26.1 (390,303)	2.2 (32,516)	37.0 (552;679)
Bp	— (—)	— (—)	0.1 (1,844)	1.6 (23,299)	5.7 (85,581)	0.1 (2,076)	7.5 (112,800)
Am	0.2 (3,690)	0.4 (5,766)	0.4 (6,918)	0.2 (2,306)	0.7 (11,070)	0.5 (6,917)	2.4 (36,667)
Total	2.3 (23,592)	1.8 (26,060)	2.4 (36,203)	16.0 (239,201)	70.5 (1,053,723)	7.0 (103,787)	100 (1,493,566)

Note; See Tab. 8.

Table 29. Insect component a year (in individuals/ha and %, with in metric ton/ha or $\times 10^{-4}$) (O. D. W.).

Individual and Weight	Time						Annual
	June	July	August	September	October	Nov. -May	
Individual (%)	34,603 (20.0)	34,602 (20.0)	27,682 (16.0)	20,762 (12.0)	13,841 (8.0)	41,523 (24.0)	173,013 (100)
Weight (%)	0.5 t (33.3)	0.2 t (13.3)	0.2 t (13.3)	0.1 t (6.7)	0.1 t (6.7)	0.4 t (26.7)	1.5 t (100)

Table 30. The amount of litterfall and component a year (in metric ton/ha or $\times 10^{-4}$ and %) (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov.—May	
L	410 t (1.4%)	120 t (0.4%)	290 t (1.0%)	1,610 t (5.4%)	10,830 t (36.1%)	3,820 t (12.8%)	17,080 t (57.1%)
Br	130 (0.4)	60 (0.2)	220 (0.7)	50 (0.2)	520 (1.7)	6,740 (22.5)	7,720 (25.7)
B	20 (0.1)	20 (0.1)	70 (0.2)	40 (0.1)	130 (0.4)	700 (2.3)	980 (3.2)
S	1 (—)	1 (—)	20 (0.1)	120 (0.4)	60 (0.2)	3 (—)	205 (0.7)
O	480 (1.6)	140 (0.5)	140 (0.5)	480 (1.6)	1,370 (4.5)	1,390 (4.6)	4,000 (13.3)
Total	1,042 (3.5)	341 (1.2)	740 (2.5)	2,300 (7.7)	12,910 (42.9)	12,654 (42.2)	29,987 (100)

Note; See Tab. 10.

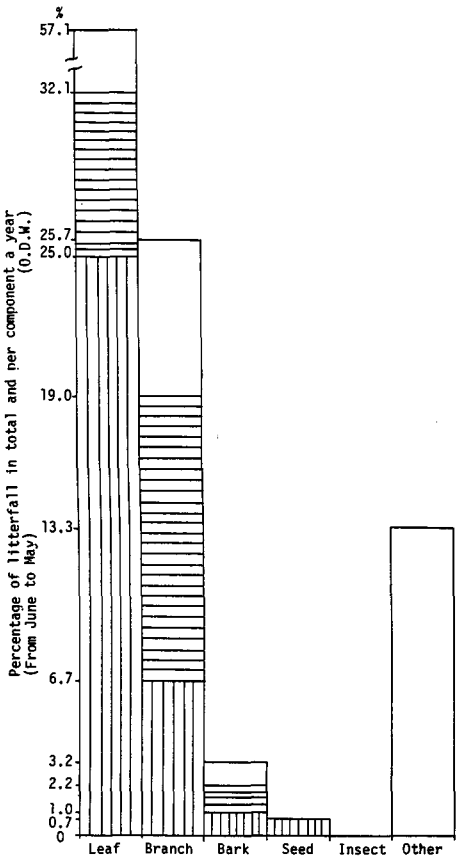

Fig. 16. Litterfall per component and fractions a year (from June to May).
Note; See Fig. 6.

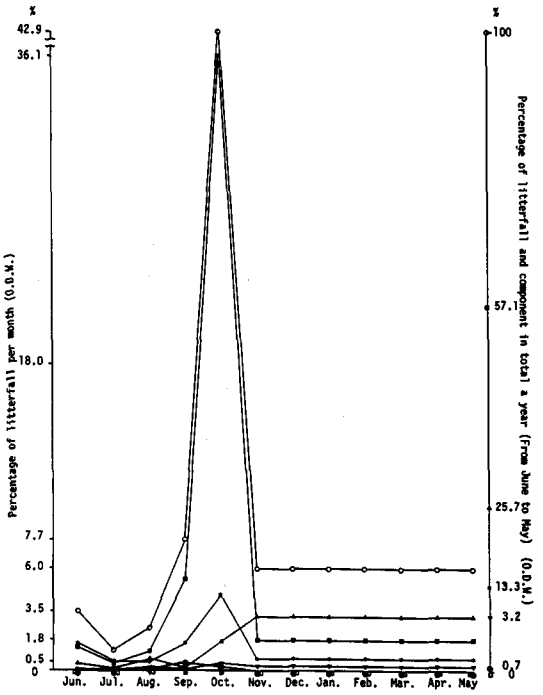

Fig. 17. Seasonal litterfall and components a year (from June to May).
Note; See Fig. 7.

4. The weight loss per material a year (from June 3, 1984 to June 3, 1986).

a. The weight loss of the ten materials by monthly during snow-uncovered season was computed with total litterfall a year (from June to May) as follows:

a) The weight loss of the ten materials in June was 0.04 t/ha (1.1%). The proportion weight loss per each material was as under:

1. Leaf of *P. glehnii* was 0.003 t/ha (0.1%),
2. Branch of *P. glehnii* was 0.003 t/ha (0.1%),
3. Bark of *P. glehnii* was 0.0004 t/ha (0.0%),
4. Leaf of *A. sachalinensis* was 0.004 t/ha (0.1%),
5. Branch of *A. sachalinensis* was 0.003 t/ha (0.1%),
6. Leaf of *B. ermanii* was 0.014 t/ha (0.5%),
7. Branch of *B. ermanii* was 0.004 t/ha (0.1%),
8. Bark of *B. ermanii* was 0.001 t/ha (0.0%),
9. Leaf of *S. senanensis* was 0.002 t/ha (0.1%),
10. Culm of *S. senanensis* was 0.001 t/ha (0.0%).

b) The weight loss of the ten materials in July was 0.04 t/ha (1.4%). The proportion weight loss per each material was as under:

1. Leaf of *P. glehnii* was 0.004 t/ha (0.1%),
2. Branch of *P. glehnii* was 0.003 t/ha (0.1%),
3. Bark of *P. glehnii* was 0.001 t/ha (0.0%),
4. Leaf of *A. sachalinensis* was 0.005 t/ha (0.2%),
5. Branch of *A. sachalinensis* was 0.004 t/ha (0.1%),
6. Leaf of *B. ermanii* was 0.015 t/ha (0.5%),
7. Branch of *B. ermanii* was 0.005 t/ha (0.2%),
8. Bark of *B. ermanii* was 0.002 t/ha (0.0%),
9. Leaf of *S. senanensis* was 0.002 t/ha (0.1%),
10. Culm of *S. senanensis* was 0.002 t/ha (0.1%).

c) The weight loss of the ten materials in August was 0.08t/ha (2.7%). The proportion weight loss per each material was as under:

1. Leaf of *P. glehnii* was 0.007 t/ha (0.2%),
2. Branch of *P. glehnii* was 0.007 t/ha (0.1%),
3. Bark of *P. glehnii* was 0.002 t/ha (0.1%),
4. Leaf of *A. sachalinensis* was 0.008 t/ha (0.3%),
5. Branch of *A. sachalinensis* was 0.006 t/ha (0.2%),
6. Leaf of *B. ermanii* was 0.031 t/ha (1.0%),
7. Branch of *B. ermanii* was 0.011 t/ha (0.4%),
8. Bark of *B. ermanii* was 0.004 t/ha (0.1%),
9. Leaf of *S. senanensis* was 0.004 t/ha (0.1%),
10. Culm of *S. senanensis* was 0.003 t/ha (0.1%).

d) The weight loss of the ten materials in September was 0.05 t/ha (1.7%). The proportion weight loss per each material was as under:

1. Leaf of *P. glehnii* was 0.004 t/ha (0.1%),
2. Branch of *P. glehnii* was 0.005 t/ha (0.2%),
3. Bark of *P. glehnii* was 0.001 t/ha (0.0%),
4. Leaf of *A. sachalinensis* was 0.006 t/ha (0.2%),
5. Branch of *A. sachalinensis* was 0.006 t/ha (0.2%),
6. Leaf of *B. ermanii* was 0.017 t/ha (0.6%),
7. Branch of *B. ermanii* was 0.006 t/ha (0.2%),
8. Bark of *B. ermanii* was 0.002 t/ha (0.0%),
9. Leaf of *S. senanensis* was 0.002 t/ha (0.1%),
10. Culm of *S. senanensis* was 0.002 t/ha (0.1%).

e) The weight loss of the ten materials in October was 0.03 t/ha (1.0%). The proportion weight loss per each material was as under:

1. Leaf of *P. glehnii* was 0.003 t/ha (0.1%),
2. Branch of *P. glehnii* was 0.002 t/ha (0.1%),
3. Bark of *P. glehnii* was 0.0004 t/ha (0.0%),
4. Leaf of *A. sachalinensis* was 0.004 t/ha (0.1%),
5. Branch of *A. sachalinensis* was 0.003 t/ha (0.1%),
6. Leaf of *B. ermanii* was 0.012 t/ha (0.4%),
7. Branch of *B. ermanii* was 0.004 t/ha (0.1%),

8. Bark of *B. ermanii* was 0.002 t/ha (0.0%),
9. Leaf of *S. senanensis* was 0.002 t/ha (0.1%),
10. Culm of *S. senanensis* was 0.001 t/ha (0.0%).

b. The weight loss of each material per period was computed with total litterfall a year (from June to May) as follows:

a) The weight loss of the ten materials during snow-uncovered season (from June to October) was 0.24 t/ha (8.2%). The proportion weight loss per each material was as under:

1. Leaf of *P. glehnii* was 0.021 t/ha (0.7%),
2. Branch of *P. glehnii* was 0.020 t/ha (0.7%),
3. Bark of *P. glehnii* was 0.005 t/ha (0.2%),
4. Leaf of *A. sachalinensis* was 0.027 t/ha (0.9%),
5. Branch of *A. sachalinensis* was 0.022 t/ha (0.7%),
6. Leaf of *B. ermanii* was 0.089 t/ha (3.0%),
7. Branch of *B. ermanii* was 0.030 t/ha (1.0%),
8. Bark of *B. ermanii* was 0.010 t/ha (0.3%),
9. Leaf of *S. senanensis* was 0.011 t/ha (0.4%),
10. Culm of *S. senanensis* was 0.009 t/ha (0.3%).

c. The weight loss of each material per period was computed with total litterfall a year (from June to May) as follows:

a) The weight loss of the ten materials during snow-covered season (from November to May) was 0.11 t/ha (3.5%). The proportion weight loss per each material was as under:

1. Leaf of *P. glehnii* was 0.010 t/ha (0.3%),
2. Branch of *P. glehnii* was 0.009 t/ha (0.3%),
3. Bark of *P. glehnii* was 0.002 t/ha (0.1%),
4. Leaf of *A. sachalinensis* was 0.010 t/ha (0.3%),
5. Branch of *A. sachalinensis* was 0.009 t/ha (0.3%),
6. Leaf of *B. ermanii* was 0.036 t/ha (1.2%),
7. Branch of *B. ermanii* was 0.012 t/ha (0.4%),
8. Bark of *B. ermanii* was 0.006 t/ha (0.2%),
9. Leaf of *S. senanensis* was 0.007 t/ha (0.2%),
10. Culm of *S. senanensis* was 0.006 t/ha (0.2%).

d. The weight loss of each material a year was computed with total litterfall a year (from June to May) as follows:

a) The weight loss of the ten materials a year (from June to May) was 0.35 ton/ha/year (11.7%) as shown in Tables 31~32, and Figures 18~19. The proportion weight loss per each material was as under:

1. Leaf of *P. glehnii* was 0.03 t/ha (1.1%),
2. Branch of *P. glehnii* was 0.03 t/ha (1.0%),
3. Bark of *P. glehnii* was 0.007 t/ha (0.2%),
4. Leaf of *A. sachalinensis* was 0.04 t/ha (1.2%),
5. Branch of *A. sachalinensis* was 0.03 t/ha (1.0%),

6. Leaf of *B. ermanii* was 0.12 t/ha (4.2%),
7. Branch of *B. ermanii* was 0.04 t/ha (1.4%),
8. Bark of *B. ermanii* was 0.02 t/ha (0.5%),
9. Leaf of *S. senanensis* was 0.02 t/ha (0.6%),
10. Culm of *S. senanensis* was 0.01 t/ha (0.5%).

For the proportion per material in annual weight loss to annual total weight loss, the maximum was 4.2% of *B. ermanii* leaf, and the second was 1.4% of *B. ermanii* branch, with lows of *P. glehnii* bark 0.2%. The maximum weight loss of each material per month proportion was in August 1.0% of *B. ermanii* leaf, and the second of *B. ermanii* leaf also in September was 0.6%. The maximum weight loss of the ten materials by monthly was in August 0.08 : 0.35 t/ha (2.8%), and the second in September was 0.05 : 0.35 t/ha (1.7%), with lows during snow-covered season 0.11 : 0.35 t/ha (3.5%) or 0.02 t/ha (0.5%) per month. The weight loss per material in annual divided with annual total weight loss was computed with the same material (component) of litterfall a year (from June to May), from the maximum to the lowest was as under:

1. Leaf of *B. ermanii* was 0.12 t/ha (4.2%),
2. Branch of *B. ermanii* was 0.04 t/ha (1.4%),
3. Leaf of *A. sachalinensis* was 0.04 t/ha (1.2%),
4. Branch of *A. sachalinensis* was 0.03 t/ha (1.0%),
5. Leaf of *P. glehnii* was 0.03 t/ha (1.1%),
6. Branch of *P. glehnii* was 0.03 t/ha (1.0%),
7. Leaf of *S. senanensis* was 0.02 t/ha (0.6%),
8. Bark of *B. ermanii* was 0.02 t/ha (0.5%),
9. Culm of *S. senanensis* was 0.01 t/ha (0.5%),
10. Bark of *P. glehnii* was 0.01 t/ha (0.2%).

For the proportion of the weight loss during snow-uncovered season and during snow-covered season of the ten materials, the maximum was 0.24 t/ha (8.2%) during snow-uncovered season, with lows during snow-covered season 0.11 t/ha (3.5%). In this case too, the monthly fluctuation/pattern of seasonal change had two peaks type as well as litterfall, but the peaks was measured in August (0.08 t/ha ; 2.8%), and the second in September (0.05 t/ha ; 1.7%), with lows during snow-covered season (0.11 t/ha ; 3.5%) or 0.02 t/ha (0.5%) per month. The weight loss during in snow covered season was very low.

The amount of litterfall by monthly divided with annual total, from the maximum proportion to the lowest was as under:

1. In October, 1.29 : 3.00 t/ha (42.9%) ;
2. In September, 0.23 : 3.00 t/ha (7.7%) ;
3. In November-May, 1.27 : 3.00 t/ha (42.2%) or 0.18 t/ha (6.0%) per month
4. In June, 0.10 : 3:00 t/ha (3.5% ;
5. In August, 0.08 : 3.00 t/ha (2.5%) ;
6. In July, 0.03 : 3.00 t/ha (1.2%).

The proportion weight loss of the ten materials by monthly divided with annual total weight loss, from the maximum to the lowest was as under:

1. In August, 0.08 : 0.35 t/ha (2.8%);
2. In September, 0.05 : 0.35 t/ha (1.7%);
3. In July, 0.04 : 0.35 t/ha (1.5%);
4. In June, 0.04 : 0.35 t/ha (1.2%);
5. In October, 0.03 : 0.35 t/ha (1.0%);
6. In November-May, 0.11 : 0.35 t/ha (3.5%) or 0.02 t/ha (0.5%) per month.

The amount of litterfall rate was accounted to 3.00 ton/ha/year (O. D. W.), and the weight loss rate was accounted to 0.35 ton/ha/year (11.7%).

Table 31. The weight loss of the ten materials a year (in metric ton/ha or $\times 10^{-4}$ and %) (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov. -May	
Pg. L	28 t	43 t	71 t	43 t	27 t	102 t	314 t (1.1%)
Pg. Br	26	34	71	51	18	88	288 (1.0)
Pg. B	4	10	22	14	4	15	69 (0.2)
A. L	41	48	84	57	36	101	367 (1.2)
A. Br	32	38	64	56	26	92	308 (1.0)
B. L	140	152	307	173	119	355	1,246 (4.2)
B. Br	39	54	113	58	39	116	419 (1.4)
B. B	8	20	41	20	15	56	160 (0.5)
Ss. L	15	21	40	21	15	70	182 (0.6)
Ss. C	13	18	30	21	8	60	150 (0.5)
Total	386 (1.2)	428 (1.5)	842 (2.8)	514 (1.7)	307 (1.0)	1,055 (3.5)	3,532 (11.7)

Note; See Tab. 18.

Table 32. The weight loss of the ten materials a year (in metric ton/ha or $\times 10^{-4}$ and %) (O. D. W.).

*	Time						Annual
	June	July	August	September	October	Nov. -May	
Pg. L	0.10%	0.14%	0.25%	0.15%	0.09%	0.33%	1.1%
Pg. Br	0.08	0.11	0.24	0.16	0.06	0.29	1.0
Pa. B	0.01	0.03	0.07	0.04	0.01	0.08	0.2
A. L	0.14	0.16	0.28	0.19	0.12	0.34	1.2
A. Br	0.11	0.13	0.21	0.19	0.09	0.31	1.0
B. L	0.48	0.51	1.07	0.58	0.39	1.19	4.2
B. Br	0.15	0.18	0.39	0.22	0.13	0.38	1.4
B. B	0.02	0.06	0.12	0.06	0.05	0.20	0.5
Ss. L	0.06	0.07	0.13	0.08	0.04	0.21	0.6
Ss. C	0.04	0.06	0.11	0.07	0.03	0.19	0.5
Total	1.2	1.5	2.8	1.7	1.0	3.5	11.7

Note; See Tab. 18.

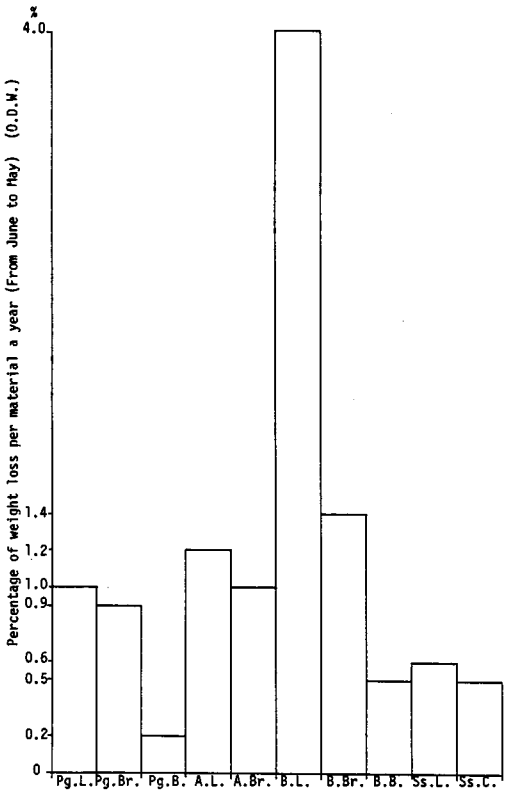

Fig. 18. The weight loss of the material a year (from June to May).
Note; See Fig. 10.

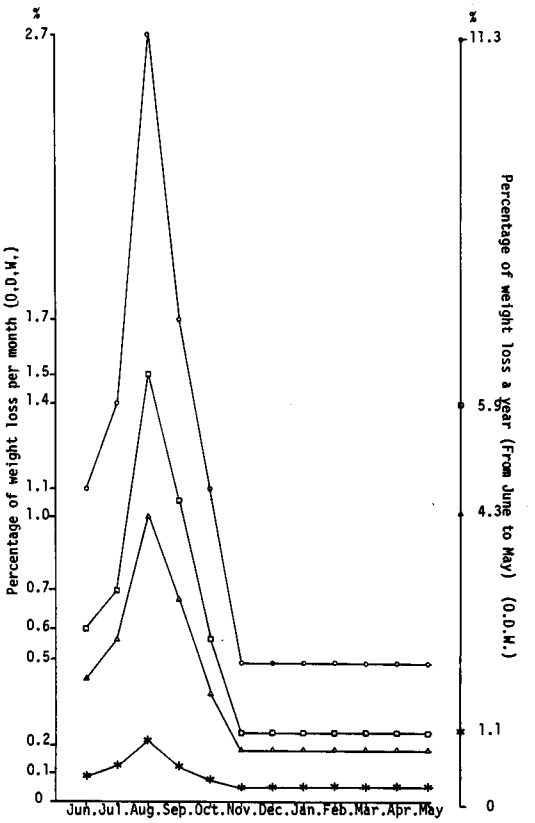

Fig. 19. Seasonal weight loss of the material a year (from June to May).
Note; See Fig. 11.

5. Compared with data of litterfall and decomposition process in sub-alpine coniferous evergreen forest on the north slope of peak Mamako in Mt. Ontake, central Japan a year (from 1980 to 1983). The amounts of litterfall and decomposition process a year in central Japan and in northern Japan are as follows:

a. The amounts of litterfall.

The amounts of litterfall and the components as shown in Tables 33~35 (in metric ton/ha at oven dried level) were taken by mean value after separating into each component per trap. The pattern of litterfall varies greatly are shown in Figures 20~21, continuous throughout the year but, with a tendency for slightly greater deposition during snow-uncovered season. The maximum component by monthly divided with total litterfall per month proportion was 1.19 : 1.45 t/ha (26.9%) of leaf in October, the second was 0.65 : 0.74 t/ha (14.7%) in September of leaf also, with lows 0.05 : 0.40 t/ha (1.1%) of bark during snow-covered season (from January to May) or 0.01 t/ha (0.2%) per month in central Japan, and in northern Japan, the maximum was 1.08 : 1.29 t/ha (36.1%) of leaf in October, the second was 0.16 : 0.23 t/ha (5.4%) in September of leaf also, with lows of bark in June and July of 0.002 t/ha (0.1%; respectively). The amounts of litterfall per

month (in annual proportion) in central and northern Japan are as follows:

1. In central Japan;

a) In June, 1.01 t/ha (22.8%), b) In July, 0.14 t/ha (3.2%), c) In August, 0.14 t/ha (3.2%), d) In September, 0.74 t/ha (16.7%), e) In October, 1.45 t/ha (5.2 %), f) In November, 0.32 t/ha (7.2%), g) In December, 0.23 t/ha (5.2%), h) In January-May, 0.40 t/ha (9.0%) or during snow-covered season (0.08 t/ha; 1.8% per month).

2. In northern Japan;

a) In June, 0.10 t/ha (3.5%), b) In July, 0.03 t/ha (1.2%), c) In August, 0.08 t/ha (2.5%), d) In September, 0.23 t/ha (7.7%), e) In October, 1.29 t/ha (42.9 %), f) In November-May, 1.27 t/ha (42.2%) or during snow-covered season (0.18 t/ha; 6.0% per month).

For the amount of litter by monthly divided with annual total litterfall, the maximum was 1.45 : 4.43 t/ha (32.7%) in October, the second 0.74 : 4.43 t/ha (16.7%) in September, with lows 0.40 : 4.43 t/ha (9.0%) during snow-covered season or 0.08 t/ha (1.8%) per month in central Japan, and in northern Japan, the maximum was 1.29 : 3.00 t/ha (42.9%), the second was 0.23 : 3.00 t/ha (7.7%) in September, with lows 0.03 : 3.00 t/ha (1.2%) in July. The amounts of litterfall per period (during snow-uncovered season and during snow-covered season) in central Japan and in northern Japan are as follows:

1. In central Japan;

The maximum was 4.03 t/ha (91.0%) during snow-uncovered season (from June to December), with lows 0.40 t/ha (9.0%) during snow-covered season (from January to May).

2. In northern Japan;

The maximum was 1.73 t/ha (57.8%) during snow-uncovered season (from June to October), with lows 1.27 t/ha (42.2%) during snow-covered season (from November to May).

The amounts of litterfall per component per period (during snow-uncovered season and during snow-covered season) in central Japan and in northern Japan are as follows:

1. In central Japan; during snow-uncovered season and during snow-covered season are as under:

a) Leaf was 2.58 t/ha (58.2%) and 0.15 t/ha (3.4%) which of;
conifer 1.62 t/ha (36.5%) and 0.15 t/ha (3.4%), broadleaved 0.96 t/ha (21.7%) and 0.0 t/ha (0.0%),

b) Branch was 0.48 t/ha (10.8%) and 0.10 t/ha (2.3%);

c) Bark was 0.32 t/ha (7.3%) and 0.05 t/ha (1.1%);

d) Other was 0.65 t/ha (14.6%) and 0.10 t/ha (2.3%).

2. In northern Japan; during snow-uncovered season and during snow-covered season are as under:

a) Leaf was 1.33 t/ha (44.3%) and 0.38 t/ha (12.8%) which of;
conifer 0.58 t/ha (19.3%) and 0.38 t/ha (12.8%), broadleaved 0.75 t/ha (25.0%) and 0.0 t/ha (0.0%).

b) Branch was 0.10 t/ha (3.2%) and 0.67 t/ha (22.5%);

c) Bark was 0.03 t/ha (0.9%) and 0.07 t/ha (2.3%);
d) Other was 0.28 t/ha (9.4%) and 0.14 t/ha (4.6%).

The maximum litter component in annual divided with annual total litterfall was 2.73 : 4.43 t/ha (61.6%) of leaf, the second was 0.74 : 4.43 t/ha (16.9%) of other, with lows 0.37 : 4.43 t/ha (8.4%) of bark in central Japan, and in northern Japan was 1.71 : 3.00 t/ha (57.1%) of leaf, the second was 0.77 : 3.00 t/ha (25.7%) of branch, with lows 0.10 : 3.00 t/ha (3.2%) of bark.

Seed grains proportion by monthly divided with annual total seedfall in central Japan and in norther Japan are as follows:

1. In central Japan;
   a) In June, 714,000 grains/ha (3.5%) which of;
      conifer 357,000 grains/ha (1.8%), broadleaved 357,000 grains/ha (1.7%),
   b) In July, 153,000 grains/ha (0.7%) which of;
      conifer 102,000 grains/ha (0.5%), broadleaved 51,000 grains/ha (0.2%),
   c) In August, 255,000 grains/ha (1.2%) which of;
      conifer 153,000 grains/ha (0.7%), broadleaved 102,000 grains/ha (0.5%),
   d) In September, 1,172,000 grains/ha (5.7%) which of;
      conifer 510,000 grains/ha (2.5%), broadleaved 662,000 grains/ha (3.2%),
   e) In October, 7,083 grains/ha (34.3%) which of;
      conifer 4,127,000 grains/ha (20.0%), broadleaved 2.956,000 grains/ha (14.3%),
   f) In November, 9,325,000 grains/ha (45.2%) which of;
      conifer 4,739,000 grains/ha (23.0%), broadleaved 4,586,000 grains/ha (22.2%),
   g) In December, 1,936,000 grains/ha (9.4%) which of;
      conifer 1,019,000 grains/ha (4.9%), broadleaved 917,000 grains/ha (4.5%),
   h) In January-May, 0 grains/ha (0.0%) or none during snow-covered season.
2. In northern Japan;
   a) In June, 34,592 grains/ha (2.3%) which of;
      conifer 10,146 grains/ha (0.7%), broadleaved 24,446 grains/ha (1.6%),
   b) In July, 26,060 grains/ha (1.8%) which of;
      conifer 8,532 grains/ha (0.6%), broadleaved 17,528 grains/ha (1.2%),
   c) In August, 36,203 grains/ha (2.4%) which of;
      conifer 10,146 grains/ha (0.7%), broadleaved 26,057 grains/ha (1.7%),
   d) In September, 239,201 grains/ha (16.0%) which of;
      conifer 112,795 grains/ha (7.5%), broadleaved 126,406 grains/ha (8.5%),
   e) In October, 1,053,723 grains/ha (70.5%) which of;
      conifer 559,851 grains/ha (37.5%), broadleaved 493,872 grains/ha (33.0%),
   f) In November-May, 103,787 grains/ha (7.0%) or during snow-covered season (14,827 grains/ha; 1.0% per month) which of;
      conifer 62,278 grains/ha (4.2%), or 8,897 grains/ha (0.6%) per month, broadleaved 41,509 grains/ha (2.8%), or 5,930 grains/ha (0.4%) per month.

The maximum grains of seedfall by monthly (in annual proportion) were 9,325,000 grains/ha (45.2%) in November, and the second were 7,083,000 grains/ha (34.3%) in October, with lows or none during snow-covered season in central Japan, and in northern

Japan were 1,053,723 grains/ha (70.5%) in October, and the second were 239,201 grains/ha (16.0%) in September, with lows 103,787 grains/ha (7.0%) during snow-covered season or 14,827 grains/ha (1.0%) per month. Seed grain per fraction in annual proportion in central Japan and in northern Japan are as follows:

1. In central Japan were 20,637,000 grains/ha/y (100%) which of;
   conifer 11,007,000 grains/ha/y (53.3%), broadleaved 9,630,000 grains/ha/y (46.7 %).
   These seed grains was found during snow-uncovered season only or none during snow-covered season.
2. In northern Japan were 1,493,566 grains/ha/y (100%) which of;
   conifer 763,748 grains/ha/y (51.2%), broadleaved 729,818 grains/ha/y (48.8%).
   These seed grains were 1,389,779 grains/ha (93.0%) during snow-uncovered season which of;
   conifer 701,470 grains/ha (47.0%), broadleaved 688,309 grains/ha (46.0%), and during snow-covered season were 103,787 grains/ha (7.0%) which of;
   conifer 62,278 grains/ha (4.2%), broadleaved 41,509 grains/ha (2.8%).

Total seed grains were 20,637,000 grains/ha/year in central Japan, and in northern Japan were 1,493,566 grains/ha/year.

Insect residues by monthly of individual number in central Japan and in northern Japan are as follows:

1. In central Japan;
   a) In June, 51,000 individuals/ha (9.1%), b) In July, 51,000 individuals/ha (9.1 %), c) In August, 102,000 individuals/ha (18.2%), d) In September, 51,000 individuals/ha (9.1%), e) In October,102,000 individuals/ha (18.2%), f) In November, 153,000 individuals/ha (27.2%), g)In December, 51,000 individuals/ha (9.1%) h) In January-May, 0 individuals/ha (0.0%) or none during snow-covered season.
2. In northern Japan;
   a) In June, 34,603 individuals/ha (20.0%), b) In July, 34,602 individual/ha (20.0 %), c) In August, 27,682 individuals/ha (16.0%), d) In September, 20,762 individuals/ha (12.0%), e) In October, 13,841 individuals/ha (8.0%), f) In November-May 41,523 individuals/ha (24.0%) or during snow-covered season (5,932 individuals/ha; 3.4% per month).

The maximum individual number of insect residues by monthly (in annual proportion) were 153,000 individuals/ha (27.3%) in November, and the second in August and October were 102,000 individuals/ha (18.2%; respectively), with lows or none during snow-covered season in central Japan, and in northern Japan were 34,603 individuals/ha (20.0%) in June, the second were 34,602 individuals/ha (20.0%) in July with lows were 41,523 individuals/ha (24.0%) during snow-covered season or 5,932 individuals/ha (3.4%) per month. Insect residues of individual number in annual proportion in central Japan and in northern Japan are as follows:

1. In central Japan were 561,000 individuals/ha/y (100%);
   These insect residues was found during snow-uncovered season only or none during

snow-covered season.

2. In northern Japan were 173,013 individuals/ha/y (100%);
during snow-uncovered season were 131,490 individuals/ha (76.0%), and during snow-covered season were 41,523 individuals/ha (24.0%).

Total individual number of insect residues were 561,000 individuals/ha/year in central Japan, and in northern Japan were 173,013 individuals/ha/year.

The amounts of litterfall per component in annual proportion in central Japan and in northern Japan are as follows:

1. In central Japan;
   a) Leaf was 2.73 t/ha (61.6%) which of;
      conifer 1.77 t/ha (39.9%), broadleaved 0.96 t/ha (21.7%),
   b) Branch was 0.58 t/ha (13.1%);
   c) Bark was 0.37 t/ha (8.4%);
   d) Other was 0.75 t/ha (16.9%).
2. In northern Japan;
   a) Leaf was 1.71 t/ha (67.1%) which of;
      conifer 0.96 t/ha (32.1%), broadleaved 0.75 t/ha (25.0%),
   b) Branch was 0.77 t/ha (25.7%);
   c) Bark was 0.10 t/ha (3.2%);
   d) Other was 0.42 t/ha (14.0%).

The litterfall of other component above (Including hares faeces, bud scales, cones, herbaceous plants, seeds, insects, etc.).

The amounts of litterfall were accounted to 4.43 ton/ha/year in central Japan, and in northern Japan were accounted to 3.00 ton/ha/year.

Table 33. The amount of litterfall and component a year in Central Japan and Northern Japan (in metric ton/ha or $\times 10^{-4}$ and %) (O. D. W.).

***	Time								Annual
	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	S. C. S.*	
Leaf;									
1.	3,800 t (8.6%)	800 t (1.8%)	700 t (1.6%)	6,500 t (14.7%)	11,900 t (26.8%)	1,700 t (3.8%)	400 t (0.9%)	1,500 t (3.4%)	27,300 t (61.6%)
C.	3,700	600	500	2,700	6,900	1,500	300	1,500	17,700 (39.9)
B.	100	200	200	3,800	5,000	200	100	—	9,600 (21.7)
2.	400 (1.4)	100 (0.4)	300 (1.0)	1,600 (5.4)	10,900 (36.1)	*	*	3,800 (12.8)	17,100 (57.1)
C.	300	100	200	500	4,700	*	*	3,800	9,600 (32.1)
B.	100	—	100	1,100	6,200 t	*	*	—	7,500 (25.0)
Branch;									
1.	2,600 (5.9)	200 (0.4)	200 (0.4)	200 (0.4)	660 (1.4)	300 (0.7)	700 (1.6)	1,000 (2.3)	5,800 (13.1)
2.	100 (0.4)	100 (0.2)	200 (0.7)	100 (0.2)	500 (1.7)	*	*	6,700 (22.5)	7,700 (25.7)
Bark;									
1.	1,700 (3.8)	200 (0.5)	200 (0.5)	100 (0.2)	200 (0.5)	200 (0.5)	600 (1.3)	500 (1.1)	3,700 (8.4)
2.	— (0.1)	— (0.1)	100 (0.2)	100 (0.1)	100 (0.4)	*	*	700 (2.3)	1,000 (3.2)
Other**;									
1.	2,000 (4.5)	200 (0.5)	300 (0.7)	600 (1.4)	1,800 (4.0)	1,000 (2.2)	600 (1.4)	1,000 (2.2)	7,500 (16.9)
2.	500 (1.6)	100 (0.5)	200 (0.5)	600 (1.6)	1,400 (4.5)	*	*	1,400 (4.6)	4,200 (14.0)
Total;									
1.	10,100 (22.8)	1,400 (3.2)	1,400 (3.2)	7,400 (16.7)	14,500 (32.7)	3,200 (7.2)	2,300 (5.2)	4,000 (9.0)	44,300 (100)
2.	1,000 (3.5)	300 (1.2)	800 (2.5)	2,300 (7.7)	12,900 (42.9)	*	*	12,700 (42.2)	30,000 (100)

Note; *: Snow-covered season in central Japan (from January to May) and in northern Japan (from November to May);
**: Including hares faeces, bud scales, cones, harbaceous plants, seeds, insects, etc.;
***: Litter component; 1,: In central Japan; 2.: In northern Japan.

Table 34. Seedfall a year in central Japan and northern Japan (in grains/ha and %) (O. D. W.).

Seed fraction	Time								Annual
	June	July	August	September	October	November	December	S. C. S.*	
1. C.	357,000 (1.8%)	102,000 (0.5%)	153,000 (0.7%)	510,000 (2.5%)	4,127,000 (20.0%)	4,739,000 (23.0%)	1,019,000 (4.9%)	—	11,007,000 (53.3%)
B.	357,000 (1.8)	51,000 (0.2)	102,000 (0.5)	662,000 (3.2)	2,956,000 (14.3)	4,586,000 (22.2)	917,000 (4.5)	—	9,630,000 (46.7)
2. C.	10,146 (0.7)	8,532 (0.6)	10,146 (0.7)	112,795 (7.5)	559,851 (37.5)	*	*	62,278 (4.2)	763,748 (51.2)
B.	24,446 (1.6)	17,528 (1.2)	26,057 (1.7)	126,406 (8.5)	493,872 (33.0)	*	*	41,509 (2.8)	729,818 (48.8)
Total;									
1.	714,000 (3.5)	153,000 (0.7)	255,000 (1.2)	1,172,000 (5.7)	7,083,000 (34.3)	9,325,000 (45.2)	1,936,000 (9.4)	—	20,637,000 (100)
2.	34,592 (2.3)	26,060 (1.8)	36,203 (2.4)	239,201 (16.0)	1,053,723 (70.5)	*	*	103,787 (7.0)	1,493,566 (100)

Note; See Tab. 33. C.: Coniferous seed: B.: Broadleaved seed.

Table 35. Insectfall a year in central Japan and Northern Japan (in individuals number/ha and %) (O. D. W.).

Plot	Time								Annual
	June	July	August	September	October	November	December	S. C. S.*	
1.	51,000 (9.1%)	51,000 (9.1%)	102,000 (18.2%)	51,000 (9.1%)	102,000 (18.2%)	153,000 (27.2%)	51,000 (9.1%)	—	516,000 (100%)
2.	34,603 (20.0)	34,602 (20.0)	27,682 (16.0)	20,762 (12.0)	13,841 (8.0)	*	*	41,523 (24.0)	173,013 (100)

Note; See Tab. 33.

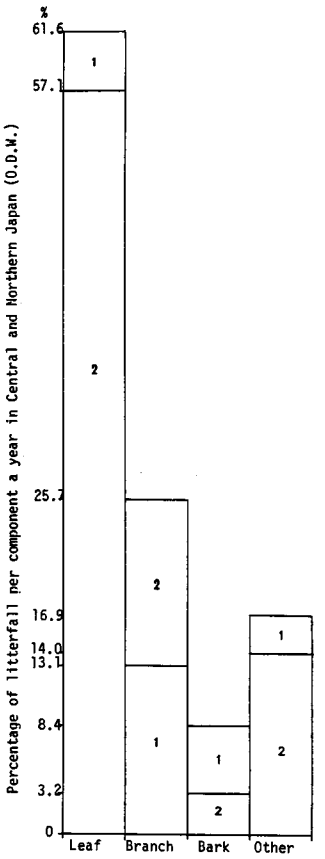

Fig. 20. Litterfall per component a year in central Japan and northern Japan.

Note; 1. In central Japan;
2. In northern Japan;

Other (Including hares faeces, bud scales, cones, herbaceous plants, seeds, insects, etc.).

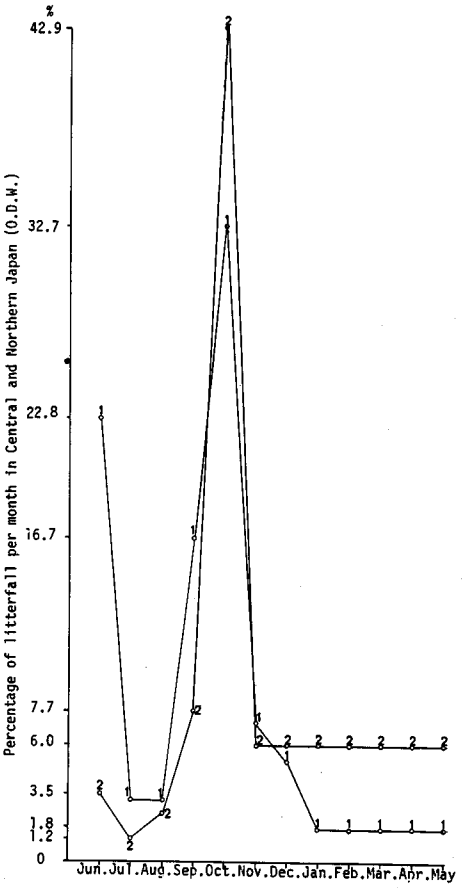

Fig. 21. Seasonal litterfall a year in central and northern Japan.

Note; 1. In central Japan;
2. In northern Japan.

b. The weight loss.

The weight loss proportion are shown in Table 36, and Figures 22~23 also computed as well as litterfall computation. The weight loss by monthly proportion (in annual proportion) in central Japan (leaf of coniferous and broadleaved trees), and in northern Japan (leaf, branch, bark of coniferous and broadleaved trees) are as follows:

1. In central Japan;
   a) In June, 0.04 t/ha (0.8%) which of; conifer 0.01t/ha (0.2%), broadleaved 0.03 t/ha (0.6%),
   b) In July, 0.04 t/ha (1.0%) which of;
   conifer 0.01 t/ha (0.2%), broadleaved 0.03 t/ha (0.8%),
   c) In August, 0.06 t/ha (1.2%) which of;
   conifer 0.02 t/ha(0.2%), broadleaved 0.04 t/ha (0.9%),
   d) In September 0.04 t/ha (1.0%) which of;
   conifer 0.01 t/ha (0.2%), broadleaved 0.03 t/ha (0.8%),
   e) In October, 0.04 t/ha (1.0%) which of;
   conifer 0.01 t/ha (0.2%), broadleaved 0.03 t/ha (0.8%),
   f) In November, 0.04 t/ha (0.8%) which of;
   conifer 0.01 t/ha (0.2%), broadleaved 0.03 t/ha (0.6%),
   g) In December, 0.03 t/ha (0.7%) which of;
   conifer 0.01 t/ha (0.2%), broadleaved 0.02 t/ha (0.5%),
   h) In January-May, 0.03 t/ha (0.8%) or during snow-covered season (0.01 /ha; 0.2% per month) which of;
   conifer 0.01 t/ha (0.2%) or none per month, broadleaved 0.02 t/ha (0.6%) or (0.1%) per month.
2. In northern Japan;
   a) In June, 0.04 t/ha (1.1%) which of;
   conifer 0.01 t/ha (0.4%), broadleaved 0.02 t/ha (0.6%),
   b) In July, 0.04 t/ha (1.4%) which of;
   conifer 0.03 t/ha (1.0%), broadleaved 0.05 t/ha (1.5%),
   c) In August, 0.08 t/ha (2.7%) which of;
   conifer 0.03 t/ha (1.0%), broadleaved 0.05 t/ha (1.5%),
   d) In September, 0.05 t/ha (1.7%) which of;
   conifer 0.02 t/ha (0.7%), broadleaved 0.03 t/ha (0.9%),
   e) In October, 0.03 t/ha (1.0%) which of;
   conifer 0.01 t/ha (0.4%), broadleaved 0.02 t/ha (0.6%),
   f) In November-May, 0.11 t/ha (3.4%) or during snow-covered season (0.02 t/ha; 0.5% per month) which of;
   conifer 0.04 t/ha (1.3%) or (0.2%) per month, broadleaved 0.06 t/ha (1.7%) or (0.2%) per month.

For the weight loss by monthly (in annual proportion), the maximum was 0.06 t/ha (1.2%) in August, the second were in July, September and October of 0.04 t/ha (1.0%; respectively), with lows 0.03 t/ha (0.8%) during snow-covered season or 0.01 t/ha (0.2%) per month in central Japan, and in northern Japan was 0.08 t/ha (2.7%) in

August, and the second in September was 0.05 t/ha (1.7%), with lows 0.11 t/ha (3.4%) during snow-covered season or 0.02 t/ha (0.5%) per month. The weight loss proportion during snow-uncovered season and during snow-covered season of coniferous and broad-leaved material in central and northern Japan are as follows:

1. In central Japan;
   a) During snow-uncovered season was 0.29 t/ha (6.5%) which of; conifer 0.08 t/ha (1.5%), broadleaved 0.21 t/ha (5.0%),
   b) During snow-covered season was 0.03 t/ha (0.8%) which of; conifer 0.01 t/ha (0.2%), broadleaved 0.02 t/ha (0.6%).
2. In northern Japan;
   a) During snow-uncovered season was 0.22 t/ha (7.3%) which of; conifer 0.09 t/ha (3.1%), broadleaved 0.13 t/ha (4.2%),
   b) During snow-covered season was 0.10 t/ha (3.0%) which of; conifer 0.04 t/ha (1.3%), broadleaved 0.06 t/ha (1.7%).

The weight loss proportion a year of coniferous and broadleaved materials was 0.32 t/ha/y (7.3%), in which the conifer was contained 0.09 t/ha/y (1.7%) and the broadleaved was 0.23 t/ha/y (5.6%) in central Japan, and in northern Japan was 0.32 t/ha/y (10.3%), in which the conifer was contained 0.13 t/ha/y (4.4%) and the broadleaved was 0.19 t/ha/y (5.9%).

In these research, the weight loss during in snow-covered season was very low.

The amounts of litterfall and the weight loss a year in these study were found not so far differentiation as follows:

1. In central Japan;
   The amounts of litterfall were accounted to 4.43 ton/ha/year (O. D. W.), and the weight loss was 0.32 ton/ha/year (7.3%);
2. In northern Japan;
   The amounts of litterfall were accounted to 3.00 ton/ha/year (O. D. W.), and the weight loss was 0.35 ton/ha/year (11.7%).

The weight loss during in winter season is very low (IGARASHI, T. 1986).

These research can not direct to comparing with data in Indonesia (Tropical Rain Forest Zone), because a difference of many factors as like as climatic, edaphic, temperature, humidity, tree species, etc. The litterfall and decomposition rate in Indonesia is greater than in these research. In Indonesia, the amounts of litterfall are from 12 to 30 t/ha/y, and the time taken for 95.0% ($3/K_L Yr^{-1}$) is 0.5[6,19,96,97]. This research let us comparing with others observed data in which the similar forest types of sub-alpine zone, and it was found out that the amounts of litterfall and the weight loss were not so far differentiation; e. g.: For litterfall; OUCHI, Y. and ANDO, T. *et al.*, 1969[71] (2.66, 4.52 and 3.35 t/ha/y); KIMURA, M., 1963[51] (3.5, 4.9 t/ha/y); SAITO, H. 1974[81] (2.59t/ha/y), SIMARANGKIR, B. D. A.S., 1984[87~89] (4.43 t/ha/y); OSHIMA, Y. and KOBAYASHI, K. *et al.*, 1977[70] (3.9 t/ha/y); SIMARANGKIR, B. D. A. S. and IGARASHI, T. 1986[91] (2.83 t/ha/y). For the weght loss; annual decomposition rate ($K_L Yr^{-1}$) is 7.8%, and the time taken for 95.0% ($3/K_L Yr^{-1}$) is 38.5 (ANDO, T. and SIMARANGKIR, B. D. A. S., 1983); The weight loss is 10.4% a year (SIMARANGKIR, B. D. A. S. and IGARASHI, T., 1986[91];

annual decomposition rate ($K_L Yr^{-1}$) is 9.9%, and the time taken for 95.0% ($3/K_L Yr^{-1}$) is 30.4 (SIMARANGKIR, B. D. A. S., 1984[88]; and annual decompositiond rate ($K_L Yr^{-1}$) was 6.8%, and the time taken for 95% ($3/K_L Yr^{-1}$) was 44.0 or 44 years in this research (northern Japan).

Conclusion

1. The amounts of litterfall were 3.00 ton/hectare/year.

The amounts of litterfall by monthly were as under:

a. In June, 0.10 t/ha (3.5%);
b. In July, 0.03 t/ha (1.2%);
c. In August, 0.08 t/ha (2.5%);
d. In September, 0.23 t/ha (7.7%);
e. In October, 1.29 t/ha (42.9%);
f. From November to May, 1.27 t/ha (42.2%) or 0.18 t/ha (6.0%) per month.

The peak was in October 1.29 t/ha (42.9%), and the second in September was 0.23 t/ha (7.7%), with lows in July 0.03 t/ha (1.2%).

The pattern of litterfall a year, from the maximum to the lowest was as under:

a. Leaves were 1.71 t/ha/y (57.1%) which of;
conifer 0.96 t/ha/y (32.1%), broadleaved 0.75 t/ha/y (25.0%),
b. Branches were 0.77 t/ha/y (25.7%) which of;
conifer 0.57 t/ha/y (19.0%), broadleaved 0.20 t/ha/y (6.7%),
c. Barks were 0.10 t/ha/y (3.2%) which of;
conifer 0.07 t/ha/y (2.2%), broadleaved 0.03 t/ha/y (1.0%),
d. Seeds were 0.02 t/ha/y (0.7%) which of;
conifer 0.0 t/ha/y (0.0%), broadleaved 0.02 t/ha/y (0.7%),
e. Insects were 0.0 t/ha/y (0.0%);
f. Others were 0.40 t/ha/y (13.3%).

The pattern of litterfall which were contained the conifer at 1.60 t/ha/y (53.3%), and the broadleaved was 1.00 t/ha/y (33.4%), and other was 0.40 t/ha/y (14.3%) is shown. Seedfall numbered 1,493,566 grains/ha/y which were contained the conifer of 763,748 grains/ha/y (51.2%), and the broadleaved of 729,818 grains/ha/y (48.8%). The peak was in October 1,053,723 grains/ha (70.5%), and the second in September 239,201 grains/ha/(16.0%), with lows during snow-covered season 103,787 grains/ha (7.0%) or 14,827 grains/ha (1.0%) per month. Insectfall were 173,013 individuals/ha/y. The peak were 34,603 individuals/ha in June and 34,602 individuals/ha in July (20.0%; respectively), and the second were 27,682 individuals/ha in August (16.0%), with lows during snow-covered season 41,523 individuals/ha (24.0%) or 5,932 individuals/ha (3.4%) per month.

2. The weight loss was 0.35 ton/ha/year.

The weight loss by monthly was under:

a. In June, 0.03 t/ha (1.2%);
b. In July, 0.05 t/ha (1.5%);
c. In August, 0.08 t/ha (2.8%);
d. In September, 0.05 t/ha (1.7%);

e. In October, 0.03 t/ha (1.0%);

f. From November to May, 0.11 t/ha (3.5%) or 0.02 t/ha (0.5%) per month.

The peak was in August 0.08 t/ha (2.8%), and the second in September was 0.05 t/ha (1.7%), with lows during snow-covered season 0.11 t/ha (3.5%) or 0.02 t/ha (0.5%) per month.

The pattern of weight loss a year, from the maximum to the lowest proportion was as under:

a. Leaves were 0.21 t/ha/y (7.0%) which of;
conifer 0.07 t/ha/y (2.3%),
broadleaved 0.12 t/ha/y (4.1%),
*other 0.02 t/ha/y (0.6%),

b. Branches were 0.12 t/ha/y (4.0%) which of;
conifer 0.07 t/ha/y (2.2%), broadleaved 0.04 t/ha/y (1.3%),
*other 0.01 t/ha/y (0.5%),

c. Barks were 0.02 t/ha/y (0.7%) which of;
conifer 0.01 t/ha/y (0.2%),
broadleaved 0.01 t/ha/y (0.5%).
*Other (*S. senanensis*).

The amount of litterfall rate was accounted to 3.00 t/ha/y, and the weight loss in annual decomposition rate ($K_L Yr^{-1}$) used in this study of sub-arctic or sub-alpine area was 6.8%. The estimate of the time taken for 95% respectively of the annual input of dead organic matter to decompose ($3/K_L Yr^{-1}$) was 44 years. It is usually estimated ($K_L Yr^{-1}$) in sub-arctic or sub-alpine area to be 1 to 3.0% for 70 cm in depth, and the time taken for 95.0% ($3/K_L Yr^{-1}$) was 100 years, but in this study of Ao layer and the standing crop of Ao layer was 44 t/ha. In the study plot of sub-arctic (sub-alpine) zone, usually the fluctuation in amounts of litterfall and weight loss were affected by the season and climate, namely rain, wind and the weight of snow. Especially the rate of the weight loss became higher in the long period when the organic matter was kept on the forest floor (Ao layer) than in the short period.

Table 36. The weight loss of coniferous and broadleaved materials a year in central Japan and northern Japan (in metric ton/ha or $\times 10^{-4}$ and %) (O. D. W.).

***	Time								Annual
	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	S. C. S.*	
1.									
C.	100 t (0.2%)	100 t (0.2%)	200 t (0.3%)	100 t (0.2%)	100 t (0.2%)	100 t (0.2%)	100 t (0.2%)	100 t (0.2%)	900 t (1.7%)
B.	300 (0.6)	300 (0.8)	400 (0.9)	300 (0.8)	300 (0.8)	300 (0.6)	200 (0.5)	200 (0.6)	2,300 (5.6)
2.									
C.	100 (0.4)	200 (0.6)	300 (1.0)	200 (0.7)	100 (0.3)	*	*	400 (1.3)	1,300 (4.3)
B.	200 (0.6)	200 (0.7)	500 (1.5)	300 (0.9)	200 (0.6)	*	*	600 (1.7)	1,900 (6.0)
Total;									
1.	400 (0.8)	400 (1.0)	600 (1.2)	400 (1.0)	400 (1.0)	400 (0.8)	300 (0.7)	300 (0.8)	3,200 (7.3)
2.	300 (1.0)	400 (1.3)	700 (2.5)	500 (1.6)	300 (0.9)	*	*	1,000 (3.0)	3,200 (10.3)

Note; See Tab. 34. ***: Material.

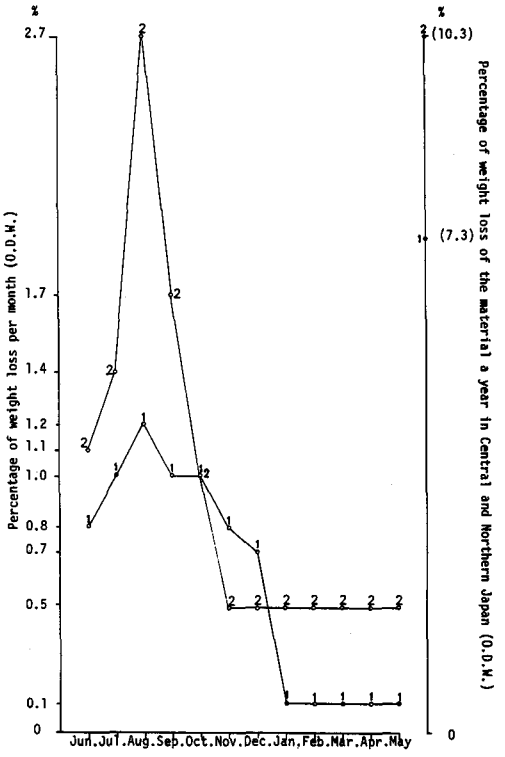

Fig. 22. The weight loss of the material a year in central and northern Japan (O. D. W.).
Note; 1. central Japan; 2. northern Japan.

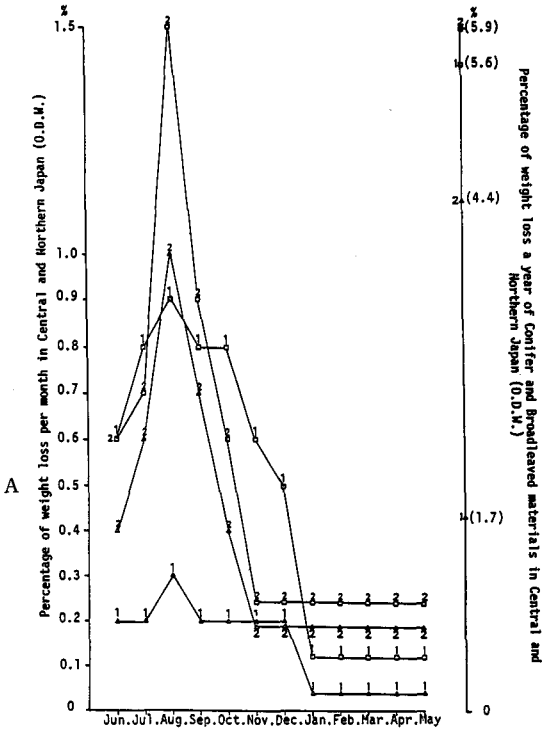

Fig. 23. Seasonal weight loss of the material a year in central and northern Japan (O. D. W.).
Note; 1. In central Japan; 2. In northern Japan; △: Coniferous material; □: Broadleaved material.

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要　　約

森林生態系は，他の陸地の生態系に比べて，高い生産性を持っている。この高い生産性は，生産者が獲得したエネルギーをいろいろな消費者に分配し，栄養素を効果的に循環させることによって維持されている。天然林の生態系におけるこれらの閉鎖系と開放系を理解して行くうえで，リターフォールの量とそれらの分解の過程を知ることは必要不可欠のことである。著者の母国，インドネシアの熱帯降雨林では12～30 t/hectare/年のリターフォールがあり，これらは一年以内に分解してしまう。熱帯林に比べ，寒冷地の森林のリターフォールと分解はどのようになっているのか，この種の情報が全くない北海道北部の亜寒帯性の森林でこの研究を行なった。本論文では，亜寒帯天然林におけるリターフォールの量とそのパターン，および分解について論じた。試験地は，北海道大学農学部附属雨龍地方演習林に設定した。過去20年間の

気象観測結果によると，年平均気温 3.5℃，最高気温 34.2℃，最低気温－41.2℃である。また，降水量は1,410 mm であるが，その多くは10月下旬から4月末まで見られる降雪で，最大積雪深は2.75 m である。これらのデータが示すように，この地域は日本における代表的な豪雪•寒冷地といえる。

調査プロットは，同演習林 424 林班，標高 290 m のアカエゾマツ，トドマツが優占する林分に設けたが，その大きさは 100 m×100 m であった。プロット内には，胸高直径 5 cm 以上の林木が 698 本あり，材積は 307.9142 m^3 であったが，針葉樹が本数で 59.0%，材積で 73.1%を占め，広葉樹としてはダケカンバ，ミズナラ，イタヤカエデ，ヒロハノキハダなどが生じていた。直径 60 cm 以上の大径木も樹高では 37 m に及ぶ最上層部はアカエゾマツに占められていた。

100 m×100 m の調査プロットを縦・横ともに 20 m の間隔で分割し，その交点 36 箇所に 85 cm 四方，深さ 30 cm の木製のリタートラップを設置した。リターフォールは，1984 年 6 月から 2 年間，6 月から 10 月までの無積雪期には 1 月ごとに，11 月から翌 5 月末までの積雪期 7 か月分は融雪後の 6 月に一括して回収した。回収したリターは，105℃で 24 時間乾燥し，葉，枝，樹皮，種子，昆虫，その他に分別し，乾燥重量を計測した。また，この 2 年間に，アカエゾマツの葉，枝，樹皮，トドマツの葉，枝，ダケカンバの葉，枝，樹皮，クマイザサの葉，稈の 10 種類の材料を用いて分解の試験を行なった。各材料とも乾燥重量で 10 g を，大きさ 20 cm 四方の，1 mm メッシュの寒冷紗で作ったリターバッグに入れ，L・F 層を除去した試験地の林床に一定期間静置したのち，回収して乾燥重量を測定した。リターバッグを試験地に置いた期間は，2 年間，1 年間，積雪期の 7 か月間，無積雪期の 5 か月間，及び無積雪期の 6 月から 10 月までの 5 か月間は 1 か月間であり，2 年間以外の試験期間については，それぞれ 2 回反復して試験を行なった。

1984 年 6 月から 2 年間の試験結果を述べると，リターフォールの合計は 3.00 t/ha/年であった。これを月別に見ると，1 ha あたり

6 月　0.10 t （3.5%）　7 月　0.03 t （1.2%）　8 月　0.08 t （2.5%）

9 月　0.23 t （7.7%）　10 月　1.29 t （42.9%）

11 月～5 月（積雪期）　1.27 t （42.2%）　（月平均では，0.18 t　6.0%）

であり，最も多いのは 10 月，ついで 9 月，最も少ないのは 7 月であった。

また，リターフォールを内容別にみると，1 ha あたり 1 年間の量は

葉	1.71 t （57.1%）	：	針葉樹　0.96 t	広葉樹　0.75 t
枝	0.77 t （25.7%）	：	針葉樹　0.57 t	広葉樹　0.20 t
樹皮	0.10 t （3.2%）	：	針葉樹　0.07 t	広葉樹　0.03 t
種子	0.02 t （0.7%）	：	針葉樹　0.00 t	広葉樹　0.02 t
昆虫	0.00 t			
その他	0.40 t （13.3%）			

であり，これを針葉樹・広葉樹別に分けると，針葉樹 1.60 t,

広葉樹 1.00 t，その他（兎の糞，芽鱗，球果，草本植物など）0.40 t となる。

種子落下粒数は，1 ha あたり 1 年間で 1,493,566 粒，このうち針葉樹は 763,748 粒，広葉樹は 729,818 粒であった。月別に見ると，10 月が 1,053,723 粒（70.5%），9 月が 239,291 粒（16.0%），積雪期（11 月～5 月）は 103,787 粒であった。

昆虫落下量は，1 ha あたり 1 年間 173,013 頭であり，月別では 6 月に 34,603 頭，7 月に 34,602 頭でともに前落下量の 20%を占め，8 月には 27,682 頭（16.0%）が落下し，積雪期の 7 か月間では 41,523 頭（24.0%）であった。

次に重量減少について述べると，1 ha あたり 1 年間 0.35 t であった。月別に，1 ha あたりの重量減少とリターフォール量に対する割合を示すと

6 月　0.035 t（1.2%）　7 月　0.044 t（1.5%）　8 月　0.08 t（2.8%）

9 月　0.05 t（1.7%）　10 月　0.03 t（1.0%）

11 月～5 月（積雪期）　0.11 t（3.5%）　（月平均では，0.016 t　0.5%）

となり，最大は 8 月，ついで 9 月，最少は積雪期の各月であった。

材料別の重量減少量とリターフォールに対する割合を見ると，1 ha あたり 1 年間では

葉	0.21 t（7.0%）	：	針葉樹　0.07 t	広葉樹　0.12 t	ササ　0.02 t
枝	0.12 t（4.0%）	：	針葉樹　0.07 t	広葉樹　0.04 t	ササ　0.01 t
樹皮	0.02 t（0.7%）	：	針葉樹　0.01 t	広葉樹　0.01 t	

本研究におけるリターフォールの合計は，3.00 t/ha/年であったが，亜寒帯・亜高山帯地域の年分解速度（$K_L Y_r^{-1}$）6.8%を用いると，有機物遺体が 95%分解されるに要する時間は，$3/K_L Y_r^{-1}$ から 44 年となる。なお，本研究では分解はA層の上で行い，また試験地の A_0 層の現存量は 44 t/ha であった。

気候，土壌，温度，湿度，樹種など多くの因子が異なるので，この試験結果とインドネシアの熱帯降雨林でのデータとを直接比較することはできない。インドネシアでは，12～30 t/ha/年のリターフォールがあり，95%が分解されるに要する時間は，僅かに 0.5 年であり，亜寒帯林における本研究と比べて，リターフォールは非常に多く，分解はきわめて速い。

森林のタイプが似ている本州の亜高山帯での，これまでの研究結果を見ると，リターフォールについては，大内ら（1969），木村（1963），斎藤（1974），シマランキル（1984）は，それぞれ 2.59～4.90 t/ha/年と報告している。また，分解については，安藤ら（1983）は年分解速度を 7.8%，有機物遺体が 95%分解するに要する時間を 38.5 年とし，シマランキル（1984）は年分解速度を 9.9%，95%分解するに要する時間を 30.4 年としている。

日本の北部で行なったこの研究では，本州の亜高山帯での研究結果とほぼ同様の結果を得た。すなわち，リターフォールは 3.00 t/ha/年であり，年分解速度を 6.8%とすると，有機物遺体の 95%が分解されるに要する時間は，44 年となる。