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論 文

Measurement of Litterfall in a Japanese Larch (*Larix leptolepis* GORDON) Plantation by the Cloth-Trap Method

Tomiyasu MIYAURA* and Kazuo HOZUMI*

MIYAURA, Tomiyasu and HOZUMI, Kazuo: **Measurement of litterfall in a Japanese larch (*Larix leptolepis* GORDON) plantation by the cloth-trap method. J. Jpn. For. Soc. 70: 11〜19, 1988** Litterfall of individual trees were measured monthly from 1981 to 1985 in a 15-year-old *Larix leptolepis* GORD. plantation (as of 1982) of the Nagoya University Forest at Inabu, Aichi Prefecture. The cloth-trap method, enclosing a sample tree in a bag of cotton netting, was adopted for the measurement. The relationship between the litterfall rate of a tree and its diameter at breast height was approximated by the power-form equation. The annual litterfall-rate of the stand estimated by this relationship was 2.8-4.1 t/ha•yr (2.6-3.1 for leaves, 0.9-1.4 for branches, and 0.05-0.07 for other litter) on a dry-weight basis. Leaf fall culminated in late autumn, branch fall-rate was greater in winter, and the falling of other litter (including insects and feces) was observed mainly in summer and autumn. Annual leaf-fall-rates of sample trees were observed to be proportional to their leaf weights; an approximate proportional relationship was realized between the annual litterfall-rates of trees and their estimated above-ground weight. In relation to the measurement of currently attached dead-branch weights, newly defined branch death-rates were measured.

宮浦富保・穂積和夫：**単木被覆法によるカラマツ人工林のリターフォール量の測定 日林誌 70：11〜19, 1988** 名古屋大学稲武演習林内の15年生（1982年現在）のカラマツ人工林において，個体ごとのリター量を単木被覆法を用いて1981年から1985年までほぼ1カ月ごとに測定した。単木のリターは胸高直径のべき乗式で近似された。この関係から推定された林分の年間総リター量（乾量）は2.8-4.1 t/ha•yr（このうち，葉2.6-3.1，枝0.9-1.4，その他0.05-0.07）であった。落葉は秋に集中しており，落枝量は冬に多かった。また，その他のリター量（虫遺体，虫糞を含む）は夏から秋に多くみられた。単木の年間落葉量および総リター量と単木の葉量および地上部重量との間には，それぞれほぼ正比例関係が認められた。新付着枯枝量を測定することにより，枝の枯死量を新たに定義し，測定した。

I. Introduction

In the preceding paper (MIYAURA and HOZUMI, 1985), a new method, the cloth-trap method, was described to measure the litterfall rates of individual trees in a forest stand. By using the method, litterfall rates of individual hinoki (*Chamaecyparis obtusa* S. and Z.) trees and their dependency on tree sizes were measured and analyzed.

In this study, litterfall in a Japanese larch (*Larix leptolepis* GORD.) plantation was estimated by the cloth-trap method. The principal objects of this paper are to clarify the relationship between the litterfall rate of a tree and its size and to assess the litter production of a forest stand. Furthermore, a death rate for branches was measured and is discussed.

II. Materials and Methods

1. *Study site*

Measurements were made in a 15-year-old Japanese larch plantation (as of 1982) of the Nagoya University Forest at Inabu, Aichi Prefecture. The study site had an inclination, exposure, altitude, area, density, mean tree-height, and mean stem-diameter at breast height (1.3 m above the ground) of 6°, S45° W, 1,040 m above

* Fac. of Agric., Nagoya Univ., Nagoya 464 名古屋大学農学部

sea level, 215 m^2, 2,654 trees/ha, 6.88 m, and 7.48 cm, respectively, in July 1982. Cultural treatments, such as thinning or pruning, had not been conducted since planting.

2. Litterfall

The study was made monthly from September 1981 to July 1985 by the cloth-trap method (MIYAURA and HOZUMI, 1985). Figure 1 shows an outline of the equipment.

The litter-trap (A) and the correction trap (B) were used in Periods I (from Sep. 1981 to Aug. 1982) and II (from Aug. 1982 to Jul. 1983). Five trees (Tree Nos. 1-5) were chosen as sample trees on the study site. Above-ground parts of the sample trees were enclosed by a litter-trap (A). The general features of the sample trees are given in Table 1.

The upper part of litter-trap (A) was made of cotton netting (20 meshes), and the lower part was made of plastic netting (33 meshes) to catch fine litter. The trap was supported by a round frame joined to a ladder (mono-pole, knockdown type) made of aluminum, by four or five plastic ropes. The bottom of the trap was secured around the stem at about 1.3 m above the ground level. The mouth of the trap (1 m^2 in area) was supported horizontally from about 0 to 2 m above the sample-tree top.

A correction trap (B) consisting of a funnel of plastic netting (33 meshes, 1 m^2 mouth area) was supported at about the same height as the trees growing around it and was used to correct the rate of litter falling into the litter-traps (A).

The litterfall rate (l) of a sample tree was corrected by the equation

$$l = l_\alpha - l_\beta, \tag{1}$$

where l_α and l_β are the fall rates of litter caught by Trap A and B, respectively.

The litter-trap of Tree No. 2 was broken by strong winds in August 1982, so that the measurements in Period II were made on only four sample trees.

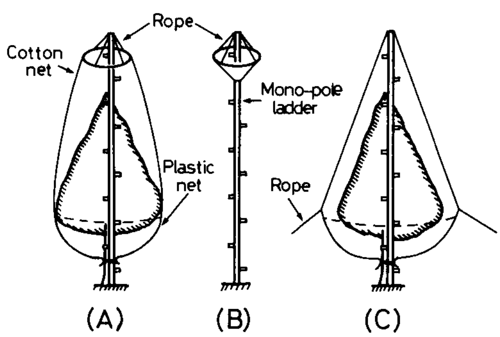

Fig. 1 The cloth-trap method
Traps A and B were used in Periods I and II, Trap C in Periods III and IV.

Litter-trap (C) was used in Periods III (from Jul. 1983 to Jul. 1984) and IV (from Jul. 1984 to Jul. 1985). Five trees (Tree Nos. 6-10) were newly chosen as samples on the study site, and their above-ground parts were enclosed in litter-traps (C). Trap C had almost the same structure as Trap A. However, two modifications were made: the mouth of Trap C was closed and tied around the ladder top, and the trap was pulled outward by four to six plastic ropes to prevent it from touching the sample tree.

The light transmissibilities of the cotton netting and the plastic netting used in this study were 82 and 86 %, respectively.

Table 1. The general features of sample trees

Feature		Measured in									
		Aug. 1981					Aug. 1983				
		Tree No.					Tree No.				
		1	2	3	4	5	6	7	8	9	10
DBH	(D)[cm]	10.85	10.09	6.18	4.62	3.60	12.83	8.59	5.98	4.30	3.21
Stem diameter*	(D_B)[cm]	13.31	9.36	6.59	5.25	3.50	12.25	8.09	6.11	4.07	3.34
Height**	(H_B)[m]	0.58	2.01	1.46	0.87	1.44	2.23	1.87	1.51	2.12	1.17
Tree height	(H)[m]	7.76	8.40	6.29	5.70	4.60	8.98	7.66	7.07	4.75	4.43

* At the height just below the lowest living-branch.

** Of the lowest living-branch.

All organic materials accumulating in the traps were collected monthly, air-dried, and sorted into three fractions : leaves, branches, and other litter. Sorted litter samples were oven-dried at 85°C for 24 hr and then weighed.

3. Death of branches

Attached dead-branches (ADB), which are defined as branches bearing no leaves in the growing season, of the sample trees were removed at the beginning of Period III and the ends of Periods III and IV. In this study, ADB of the sample trees at the ends of Periods III and IV are called "currently attached dead-branches" (CADB) because they were considered to have died during these periods. Furthermore, branch death-rate (BDR) is defined as the sum of CADB and the branch fall-rate during the period.

4. Size and biomass of individual trees

Tree height (H), stem diameter at breast height (D), height of trunk at which the lowest living-branch was connected (H_B), and stem diameter at $H_B(D_B)$ of the all trees on the study site were measured annually from 1981 to 1984. Of these dimensions, D, D_B, and H in July 1981, July 1982, August 1983, and September 1984 were used as measures of tree sizes in Periods I, II, III, and IV, respectively.

In the neighborhood of the study site, six trees were felled, and their organ biomasses, such as leaf weight, branch weight, and so forth, were measured in July 1982 to determine the dependency of litterfall rates on these biomasses. Sample trees were chosen so as to include the range of D found on the study site.

III. Results

1. Litterfall rates of individual trees

Annual litterfall-rates of the sample trees are shown in Table 2. For Periods I and II, their values were corrected by Eq. (1). Annual litter amounts of leaves, branches, and other litter caught by the correction trap (B) were 0.4, 0.03, and 0.2 g/m^2•yr, respectively, in period I, 1.1, 0, and 0.1 g/m^2•yr, respectively, in Period II, and were negligible compared with those caught by Trap A. Leaves, branches, and other litter accounted

Table 2. Annual litterfall-rates and weight of currently attached dead-branches of the sample trees

[g (dry wt)/tree • yr]

Components	Periods									
	I *1 (Sep. 1981 to Aug. 1982)					II *1 (Aug. 1982 to Jul. 1983)				
	Tree No.					Tree No.				
	1	2	3	4	5	1	2 *2	3	4	5
Leaves	2608	1820	563	393	208	1311	—	227	135	119
Branches	618	1376	595	249	132	564	—	325	146	38
Other	35	48	21	26	10	32	—	13	15	5
Total	3261	3244	1179	668	350	1907	—	565	296	162

Components	Periods									
	III (Jul. 1983 to Jul. 1984)					IV (Jul. 1984 to Jul. 1985)				
	Tree No.					Tree No.				
	6	7	8	9	10	6	7	8	9	10 *3
Leaves	2338	1360	436	238	159	1620	1090	367	169	130
Branches	239	383	211	15	6	224	21	13	3	0.5
Other	53	27	13	6	5	42	16	15	3	9
Total	2360	1770	660	259	170	1886	1127	395	175	140
CADB *4	649	44	448	154	120	1379	260	371	87	213

*1 The values were corrected by Eq. (1).
*2 Litter-trap of the sample tree was broken by strong winds in August 1982.
*3 Death of the sample tree was confirmed at the end of the period.
*4 Currently attached dead-branches weight.

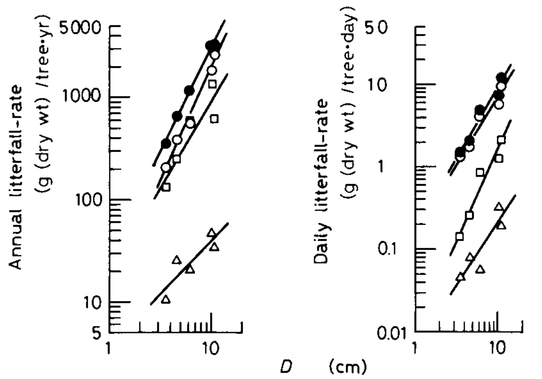

Fig. 2. Relationships between annual litterfall-rates and diameters at breast height (D) in Period I (Sep. 1981 to Aug. 1982) and between mean daily litterfall-rates and D during the period from Sep. 16, 1981 to Oct. 13, 1981

r^2-values for leaves, branches, other litter, and the total in Period I were 0.986, 0.809, 0.766, and 0.994, respectively, and those for the period from Sep. 16, 1981 to Oct. 13, 1981 were 0.944, 0.939, 0.780, and 0.952, respectively.
○, leaves; □, branches; △, other litter; ●, total.

for an average of 59, 38, and 3 %, respectively, of the total litter during Periods I and II, and 88, 9, and 3 %, respectively, during Periods III and IV. The removal of ADB from the sample trees at the beginning of Periods III and IV presumably reduced the branch fall-rates during these periods.

The relationshp between the annual or daily litterfall-rate (l, g/tree·yr or g/tree·day) and the stem diameter at breast height (D, cm) was approximated by the following power-form equation:

$$l = a \cdot D^b, \tag{2}$$

where a and b are coefficients determined for each litter component, each season, and each year. Several examples are shown in Fig. 2. The exponent b in Eq. (2) for the annual falling of leaves, branches, other litter, and the total litter ranged between 2.0–2.2, 1.7–2.2, 1.1–1.8, and 2.0–2.1, respectively, excepting that for the branch fall-rates in Periods III and IV it varied from 3.0–3.6.

2. Litterfall rates of the stand

We can estimate the daily stand litterfall-rate (L, g/ha·day) by using the relationship of Eq. (2) as follows:

$$L = \sum_{i=1}^{N} a \cdot D_i^{\,b} / Q, \tag{3}$$

where the subscript i denotes the tree number, D_i the diameter at breast height of the individual tree, Q the area of the stand, and N the number of trees in the stand which was 57 in Periods I -III and 56 in Period IV. Data for Tree No. 10 in Period IV were excluded from the calculation because the tree died at the end of the period.

Seasonal changes in the daily fall-rates of leaves, branches, other litter, and the total litter of the stand are shown in Fig. 3. The leaf fall-rate had a remarkable seasonal change, about 80 % of the annual litter falling in late autumn. The branch fall-rate arose irregularly from November to April. The fall-rate of other litter was greatest from August to December when insect bodies and feces were its major components. The seasonal trend of the total litterfall had a peak in late autumn and an irregular rise in the winter season. The concentrated leaf-litter accounted for the peak in autumn, and the branch litter resulted in the irregular rise in winter.

The annual litterfall-rate of the stand also can be estimated in the same manner as the daily litterfall-rates. The present estimates are given in Table 3. The branch fall-rates in Periods III and IV were somewhat smaller than those in Periods I and II because of the removal of the ADB at the beginning of Periods III and IV. OHMASA and MORI (1937) reported that the average leaf-fall-rate of 10- to 28-year-old Japanese larch plantations ranged from 0.26 to 4.35 t (air-dry wt)/ha·yr, and TORII (1981) showed that the leaf and branch fall-rates of 13- to 24-year-old plantations were 2.05–3.09 and 0.03–3.84 t/ha·yr, respectively. The presently estimated annual stand litterfall-rates of leaves and branches lie within these ranges, and especially, are closer to those of TORII (1981).

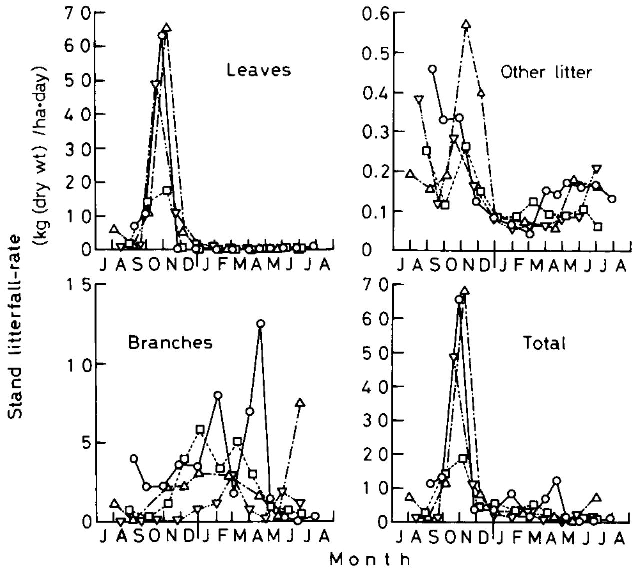

Fig. 3. Seasonal changes in stand litterfall-rates
○, Period I ; □, Period II ; △, Period III ; ▽ Period, IV.

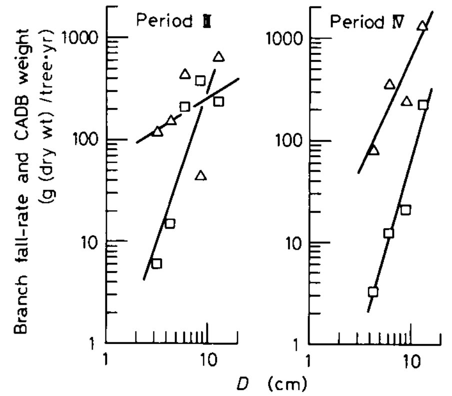

Fig. 4. Regressions of branch fall-rates and CADB weights in Periods III and IV on diameter at breast height (D)

Data for Tree No. 10 in Period IV were excluded because the tree died at the end of the period. r^2-values for branch fall in Period III, CADB in Period III, branch fall in Period IV, and CADB in Period IV were 0.763, 0.105, 0.962, and 0.805, respectively.
□, branch fall-rate ; △, CADB weight.

3. Branch death-rates

Figure 4 shows the relationships between the dry weights of CADB and diameters at breast height (D) in Periods III and IV. The relationship is nearly linear on the log-log coordinates, and thus it is approximated by a power-form equation similar to Eq. (2). The amount of CADB of the stand can be estimated by the same procedure as done for litterfall rates. The stand value of BDR was estimated as the sum of the CADB and the branch litterfall-rate of the stand in Periods III and IV. Death of Tree No. 10 was confirmed at the end of Period IV so that the CADB weight of this tree was excluded from the calculations for this period.

As shown in Table 3, the BDR of the stand ranged from 1.3 to 1.6 t/ha·yr, and 50-90 % of these dead-branches remained on the trees as CADB. Note that BDRs in Periods III and IV have much the same order of magnitude as the branch fall-rates in Periods I and II.

IV. Discussion

1. Problems of the method

The cloth-trap method adopted in this study is the technique of enclosing a sample tree in a bag of cotton netting. Thus, the environmental conditions, such as light, wind, and so forth of the sample tree may change with the enclosing.

As seen in Tables 2 and 3, the leaf fall-rates in Periods II and IV are smaller than those in the previous

Table 3. Stand litterfall-rates, weight of currently attached dead-branches, and branch death-rates [t (dry wt)/ha·yr]

Periods	Litterfall rates				CADB*	BDR**
	Leaves	Branches	Other	Total		
I (Sep. '81-Aug. '82)	2.64	1.38	0.07	4.09	—	—
II (Aug. '82-Jul. '83)	1.38	0.93	0.05	2.36	—	—
III (Jul. '83-Jul. '84)	3.13	0.66	0.07	3.86	0.59	1.25
IV (Jul. '84-Jul. '85)	2.56	0.19	0.06	2.81	1.41	1.60

* Currently attached dead-branches weight.
** Branch death-rate = sum of branch fall-rate and CADB.

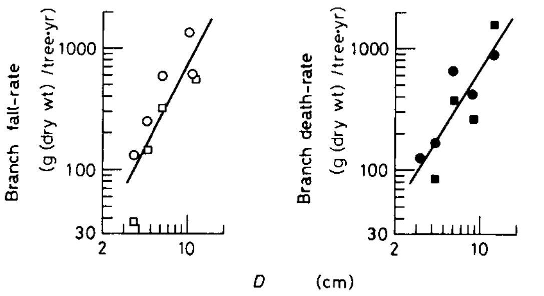

Fig. 5 Regressions of branch fall-rates in Periods I and II and BDRs in Periods III and IV on diameter at breast height (D).

BDR of Tree No. 10 in Period IV was excluded because death of the tree was confirmed at the end of the period. r^2-values for branch fall-rate and BDR were 0.719 and 0.737, respectively.

○, branch fall-rate in Period I ; □, branch fall-rate in Period II ; ●, BDR in Period III ; ■, BDR in Period IV.

periods (I and III) by about 50 to 20 %, respectively. The reduction in fall-rates probably is due to the fact that leaf expansion of the sample trees was depressed by the changes in the environmental conditions of the trees induced by the enclosing, but as far as Periods I and III are concerned, the sample trees had fair amounts of leaves because the traps were set after leaf expansion was almost finished.

Reduction in leaf litter in Period IV was much smaller than that in Period II. This phenomenon presumably is due to the fact that the physical contact of the netting with the sample trees was prevented by the outward suspension of the netting with ropes.

The branch fall-rate in Period II was smaller than that in Period I as seen in Table 2 and Fig. 5. Physical contact of the netting with the sample trees might have affected the branch fall-rates of the sample trees.

For the long-term observation of the litterfall-rates of Japanese larch trees, it is necessary to improve the netting materials of the traps to minimize changes in the environmental conditions. Especially, the light condition may be the most important because Japanese larch is a conspicuous shade-intolerant tree species (TSUTSUMI, 1978).

Wind, rainfall, and snowfall are the important factors affecting the fall-rate of branches (BRAY and GORHAM, 1964; HAGIHARA and others, 1978; SAITO, 1981). The extent to which the netting disturbs or modifies the natural roles of these factors in litterfall should be examined further.

2. Death and fall of branches

Based on systems analysis concerning the flow and storage of nutrients and energy in a biological system, the BDR is considered to be input to the ADB compartment, and the branch fall-rate and decomposition rate of ADB (YONEDA and KIRITA, 1978) is termed to be output from the compartment.

The mean BDR in Periods III and IV (1.43 t/ha·yr) is somewhat similar to the mean branch fall-rate in Periods I and II (1.16 t/ha·yr) as stated earlier. This fact affords a basis for ordinary field-work to measure the fall-rate of branches instead of the BDR (OGAWA, 1977).

In Fig. 5, the branch fall-rate of a tree in Periods I and II and the BDR of a tree, that is, the sum of the CADB and the branch fall-rate of the tree, in Periods III and IV are plotted against the diameter at breast height (D). The figure shows that the BDR also can be approximated by a power-form equation of D. There was no significant difference (at the 5 % significance level) between two regression lines which related the branch fall-rate with D in Periods I and II and BDR with D in Periods III and IV. This means that in each sample tree the BDR approximated the fall-rate of branches.

In this study, pre-fall decomposition of ADB was considered to be small in comparison with the branch fall-rate. Further discussions, based on the direct measurement of the decomposition rate, should be held.

3. Size dependency of the litterfall rates

The main source of leaf and branch litter of Japanese larch is the living leaves and ADB, respectively. It is, therefore, important to examine the relationships between leaf fall-rate and living-leaf weight of a tree and between branch fall-rate and ADB weight of a tree. The effect of how much litter a tree sheds on the tree-weight basis is also of great significance for the energy budget of the tree.

In Figs. 6 and 7, leaf fall-rate (l_L) and total litterfall-rate (l_T), respectively, of a tree are plotted against the estimated dry-weight of leaves (w_L) and the above-ground parts (w_T), respectively, of the tree. The weights

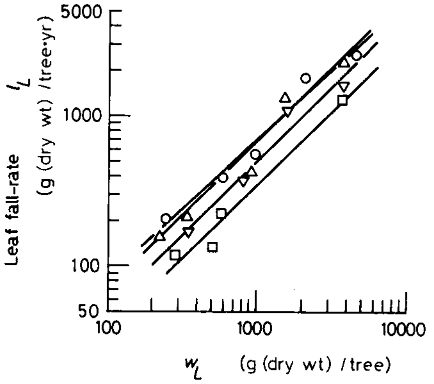

Fig. 6. Relationship between annual leaf fall-rate (l_L) and estimated dry-weight of leaves (w_L) of a tree.

r^2-values for Periods I, II, III, and IV were 0.970, 0.967, 0.971, and 0.957, respectively.

○, Period I ; □, Period II ; △, Period III ; ▽, Period IV.

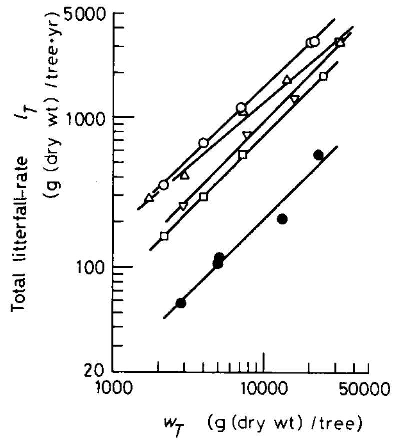

Fig. 7. Relationship between annual fall-rate of total litter (l_T) and estimated dry-weight of above-ground parts (w_T) of a tree

Tree No. 10 in Period IV was excluded because death of the tree was confirmed at the end of the period. r^2-values for larch trees in Periods I, II, III, IV, and hinoki trees were 0.999, 1.000, 0.992, 0.996, and 0.964, respectively.

○, larch tree in Period I ; □, larch tree in Period II ; △, larch tree in Period III ; ▽, larch tree in Period IV ; ●, hinoki tree (MIYAURA and HOZUMI, 1985).

of CADB measured at the end of Periods III and IV were added to the total litterfall-rates in these Periods on the assumption that the branch fall-rates were nearly equal to BDRs. Total litterfall-rates of hinoki (*Chamaecyparis obtusa* S. and Z.) trees (MIYAURA and HOZUMI, 1985) also are plotted in Fig. 7 for a comparison between the two species. Values of w_L and w_T were estimated by the following allometric relationships obtained from the field surveys:

In the larch stand:

$$w_L = 16.5 \cdot D_B^{2.16}, \quad [\mathrm{g/tree, cm}],$$

and

$$w_T = 70.7 \cdot (D^2 H)^{0.837}, \quad [\mathrm{g/tree, cm^2 \cdot m}].$$

In the hinoki stand:

$$w_T = 62.9 \cdot (D^2 H)^{0.843}, \quad [\mathrm{g/tree, cm^2 \cdot m}],$$

where D, D_B, and H are the diameter at breast height, the diameter at the height just below the lowest living-branch, and tree height, respectively.

As seen in Figs. 6 and 7, there are linear relationships on the log-log coordinates between l_L and l_T, respectively, and estimated w_L and w_T, respectively. The gradient of the regression lines in the larch stand is 0.94-1.00 for $l_L - w_L$ (Fig. 6), 0.86-1.04 for $l_T - w_T$ (Fig. 7), and for the hinoki stand 1.01 for $l_T - w_T$ (Fig. 7). These gradient values suggest that l_L and l_T are approximately in direct proportion to w_L and w_T, respectively.

The values of l_L/w_L calculated from the regression lines in Fig. 6 for Periods I, II, III, and IV are 0.61-0.80, 0.34-0.36, 0.67-0.69, and 0.50-0.51 yr^{-1}, respectively, within the range of D_B on the study site. Weight loss in leaves by recovery, retranslocation, and leaching are reported for many tree species as being 10-40 %

(OLAND, 1963; BRAY and GORHAM, 1964; SAITO, 1977; KAWAHARA, 1978). The presently estimated leaf-weight losses are close to this range, except for Period II.

The l_T/w_T values calculated from the regression lines in Fig. 7 fluctuate between 0.07-0.19 yr^{-1} for the larch and 0.02 yr^{-1} for the hinoki. The larch sheds 4-9 times as much litter as the hinoki on the same above-ground tree-weight basis.

The ratio of branch fall-rate to ADB weight (w_{DB}) can be considered to give the turnover rate of ADB, and is calculated to be 0.24-0.71 yr^{-1}. Here, the value of w_{DB} was estimated by the following allometric relationship obtained from the field survey:

$$w_{DB}=42.5\cdot D^{1.51}, \qquad [\mathrm{g/tree, cm}].$$

The mean longevity of ADB ranges between 1.4-4.2 yr and is much shorter than that of hinoki of 24-31 yr (MIYAURA and HOZUMI, 1985). These figures suggest that the ADB of larch fall more easily than those of hinoki.

In this study, litterfall rates of a tree were showed to be related closely to its size, and were approximated by a power-form equation of the measure of tree size, such as diameter at breast height, above-ground tree-weight, and so forth (Eq. (2), Figs. 2, 6, and 7). Thus, the litterfall rate of a tree belongs to a functional amount of the allometric tribe (HOZUMI and SHINOZAKI, 1974). These litterfall tree-size relationships are important to estimate the litterfall rates of a tree and of a stand. Moreover, they can be considered to give fundamental information on the dynamics of the forest ecosystem. Further examination should be made on litterfall tree-size relationships under various conditions, such as tree species, stand age, tree density, and so forth.

Acknowledgments

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論 文

A Stochastic Model of Height Growth in an Even-Aged Pure Forest Stand—Why is the Coefficient of Variation of the Height Distribution Smaller than That of the Diameter Distribution?—*

Kazuhiro TANAKA**

TANAKA, Kazuhiro: **A stochastic model of height growth in an even-aged pure forest stand—Why is the coefficient of variation of the height distribution smaller than that of the diameter distribution?— J. Jpn. For. Soc. 70: 20～29, 1988** This study analyzed tree increments in even-aged pure forest stands and detected a significant difference between the mechanisms of diameter growth and height growth. As already reported, in the case of diameter growth, there was a positive linear relationship between periodic diameter increment and diameter at a given forest age. However, in the case of height growth, there was no correlation between periodic height increment and height at a given forest age. Based on this result, a stochastic model of height growth in an even-aged pure stand is proposed, and an equation showing the increase of the variance of the height distribution is derived analytically. This model can explain the widely accepted phenomenon that the coefficient of variation of the height distribution is smaller than that of the diameter distribution.

田中和博：**同齢単純林の樹高生長に関する一確率論的モデル—なぜ樹高分布の変動係数は直径分布の変動係数よりも小さいのか— 日林誌 70：20～29, 1988** 同齢単純林の生長を解析した結果，直径生長と樹高生長とでは生長のメカニズムがまったく異なることが明らかとなった。すでに報告したように，直径生長では定期直径生長量と期首直径との間に線形関係が存在していたが，樹高生長では定期樹高生長量と期首樹高との間には相関関係は認められなかった。こうした知見をもとに同齢単純林の樹高生長に関する確率論的モデルを構築し，樹高分布の分散の増加式を誘導した。一般に，樹高分布の変動係数は直径分布の変動係数よりも小さいことが認められているが，今回構築したモデルは，この現象をよく説明することができた。

I. Introduction

In an even-aged pure forest stand the coefficient of variation of the diameter distribution is generally about twenty percent and tends to rise gradually with an increase in forest age. However, the coefficient of variation of the height distribution is generally about ten percent, about half that of the diameter distribution (YOSIDA and HIRATA, 1956). For the diameter growth in an even-aged pure stand, the author already has presented a stochastic model (TANAKA, 1986) which was an expansion of SLOBODA's model (1976, 1977, 1984). In this study, the growth of height in even-aged pure forest stands was analyzed by the same technique as the analysis of diameter growth, and a stochastic model of height growth is proposed. An equation showing the increase of variance of the height distribution was derived from this model, and the relationship between the coefficient of variation of the height distribution and that of the diameter distribution is discussed.

II. Outline of a Stochastic Diameter Growth Model

The stochastic diameter growth model presented in the previous paper (TANAKA, 1986) consisted of the following six hypotheses (Fig. 1 illustrates the model in question at a given forest age):

Hypothesis 1: There is a positive linear relationship between periodic D. B. H. increment and D. B. H. at a given forest age.

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** Fac. of Bioresources, Mie Univ., Tsu 514 三重大学生物資源学部