A Survey on the Quantity of Dead Leaves and Culms of *Sasa senanensis* in a Mixed Forest

By

Takashi YAJIMA*

針広混交林におけるクマイザサ枯葉・枯稈の地表堆積量

矢 島 崇*

Abstract

I investigated the relation between the growth of *Sasa senanensis* (hereafter, referred to as *Sasa*) and the natural regeneration of trees by comparing the actual conditions of its dead leaves and culms with those observed in a study of an open ground *Sasa* community.

There was litter less than 200g/m² in dry weight in a closed mixed stand where many tree seedlings had established; the sites where the litter quantity was under 100g/m², had an especially large number of seedlings.

Though the ratio of litter quantity to standing stocks varied, it was rather lower in the closed stand than the open stand; i. e., it is assumed that the leaves and culms have longer life-spans under low light conditions.

Key words: *Sasa senanensis*, Mixed forest, Litter, Natural regeneration.

Introduction

In Hokkaido, *Sasa* generally forms a pure community on open grounds, because of the exclusion of other vegetation. Since *Sasa* often grows on mixed forest floors with a high density, it disturbs the establishment of trees either directly or indirectly. Among the many factors resulting from *Sasa*'s exclusive character, it is well known that the accumulation (on the ground surface) of the dead leaves and culms is the most important factor, because of the hindrance to the germination of tree seeds and the establishment of the seedlings.

However, most of the information concerned are only theoretical, so more detailed

Received February 29, 1987.

* Laboratory of Silviculture, Faculty of Agriculture, Hokkaido University.
北海道大学農学部造林学講座

experimental research is required.

In this investigation, *Sasa* was studied in a mixed forest composed of *Abies sachalinensis* and other broad-leaved tree species. To determine the relation between the growth of *Sasa* and the natural regeneration of trees, the actual conditions of the litter, dead leaves and culms of *Sasa*, were compared with those obtained from the researches of an open ground *Sasa* community.[2)3)]

Method

The experiment was carried out in the compartment 208 of the Nakagawa Experiment Forest, Hokkaido University. In a fully closed stand two survey plots (A and B) were set up, each of which is a rectangle, 20 m long by 2 m wide, partitioned into 10 square quadrats, Q1-Q10. Then a survey was conducted for the upper canopy trees in an area of 20m long by 10 m wide centered about each plot: tree location, species, diameter at breast height, height and crown diameter. In this study, trees over 1.3 m in height were regarded as upper trees, while those under 1.3 m were regarded as seedlings. And species and height of the seedlings were also recorded in each quadrat.

In Q2 to Q10, all culms of *Sasa* were cut at ground level. Then in each quadrat, culm densities were estimated and number of living leaves were counted per culm. After measuring the fresh-cut weight, a portion was sampled (over 5% of fresh-cut stock) to determine the oven-dried weight in the laboratory. After cutting off the living stock, the litter of *Sasa* dead leaves and culms was gathered from an area of 2 m long by 1 m wide in each quadrat and the oven-dried weight was determined. The above survey was made in 1985.

The culms were not cut in Q1 of plots A and B, in which all the culms and leaves were marked with paints every September from 1985 to 1987; this allowed the estimates of the annual number of fallen leaves,fallen culms, new leaves and new culms.

Results and Discussion

1. Aboveground biomass and the quantity of *Sasa senanensis* litter

Both plots A and B were mixed forests of *Abies sachalinensis* and other broad-leaved tree species: *Quercus mongolica* var. *grosseserrata, Acer mono* and *Betula ermanii* (Figs. 1 and 2). Especially in plot B, the stand had a high tree density with no canopy gaps. The degree of *Sasa* cover ranged from 2 to 5; there was no clear distinction between them.

Also, these stands had comparatively large numbers of tree seedlings.

In plot A, *Sasa* appeared throughout all quadrats: culm densities of about $20/m^2$ and $30/m^2$ and leaf area indices of 1 to 3. The aboveground biomass, $300g/m^2$ to $600g/m^2$ in dry weight, was very low in comparison with that of $2,390g/m^2$ on the open ground. Litter stocks, the amount of dead leaves and culms accumulated on the ground surface, were also small, estimated at below $200g/m^2$, in comparison with $1,390g/m^2$ in the open ground plot (Fig. 3).

In plot B, *Sasa* also appeared in all quadrats: however, its culm densities and leaf area indices were both rather low, $10/m^2$ to $20m^2$ and 0.3 to 2, respectively. The living stock weights were below $400g/m^2$; thus, in comparison with plot A, the *Sasa* community in plot B was debilitated because of being under a lower light environment. The quantities of the litter were below $200g/m^2$, less than that of the open ground plot (Fig. 4).

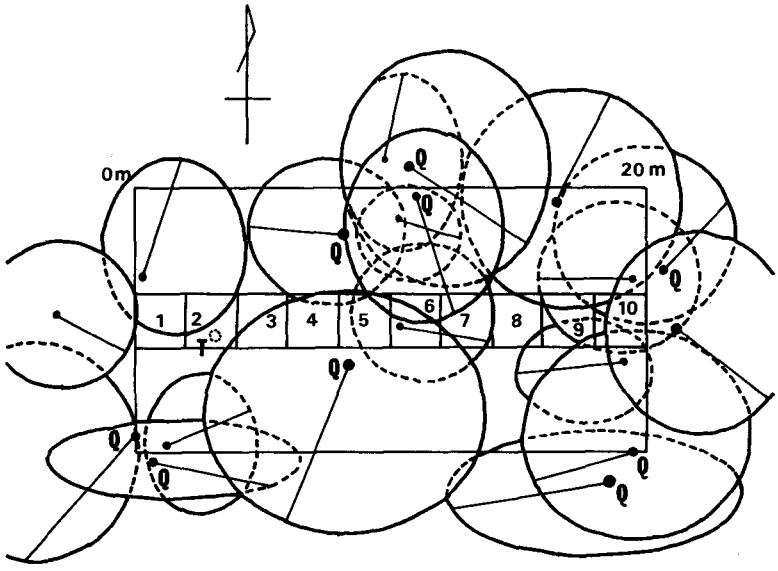

Fig. 1. Crowns of standing trees in plot A.
Notes; Q: *Quercus mongolica* var. *grosseserrata*
T: *Tilia japonica*
others: *Abies sachalinensis*

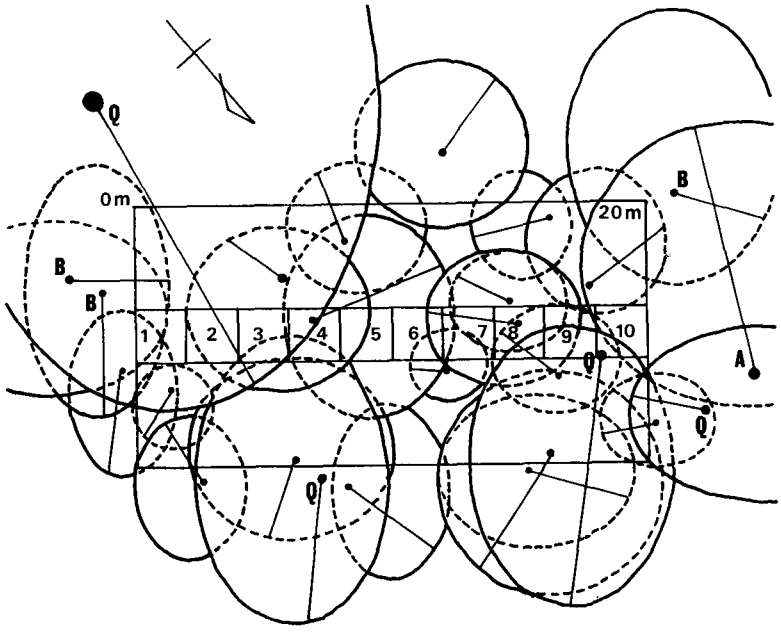

Fig. 2. Crowns of standing trees in plot B.
Notes; Q: *Quercus mongolica* var. *grosseserrata*
B: *Betula ermanii*
A: *Acer mono*
others: *Abies sachalinensis*

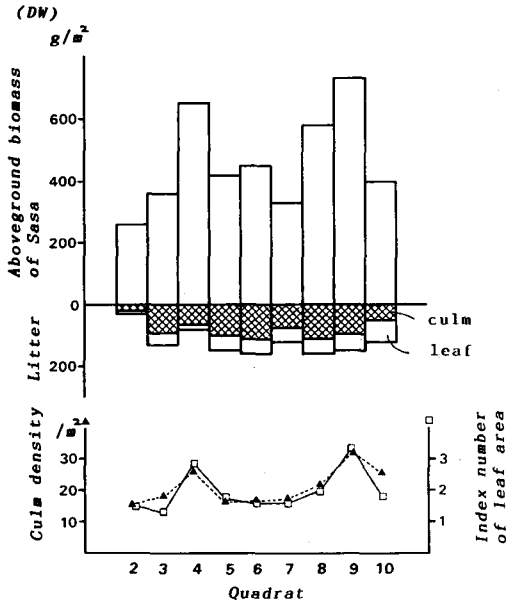

Fig. 3. Aboveground biomass and the litter quantity of *Sasa* in plot A.

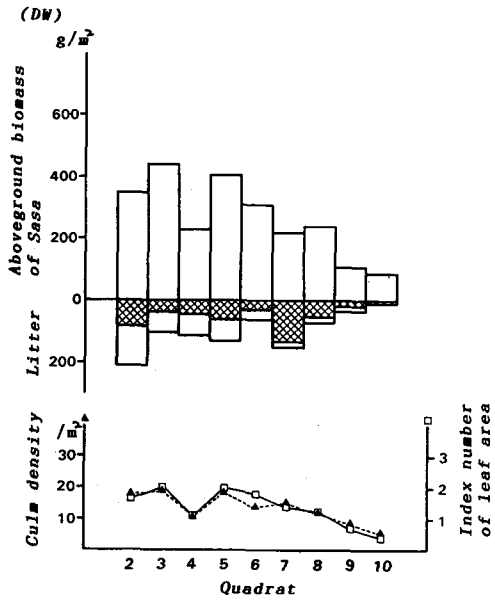

Fig. 4. Aboveground biomass and the litter quantity of *Sasa* in plot B.

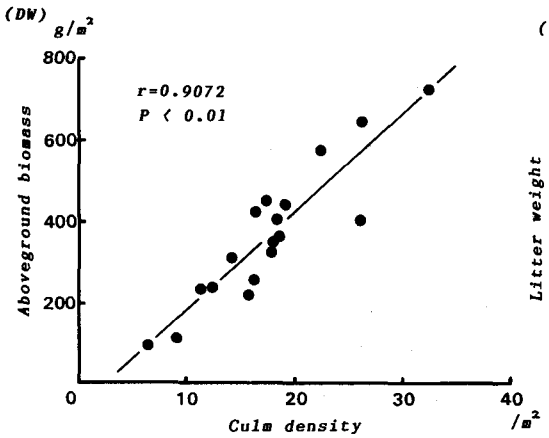

Fig. 5. Relation between culm density and aboveground biomass.

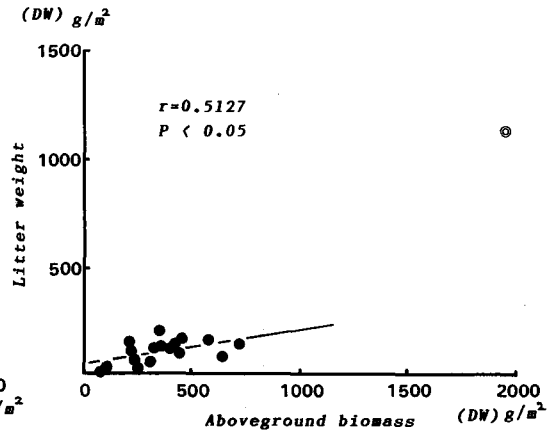

Fig. 6. Relation between aboveground biomass and the litter quantity Note: ◎ showes the average of open ground plots.

A strong correlation was observed between culm density and aboveground biomass (Fig. 5). It can be considered that the litter quantity is reflected by the aboveground biomass. Therefore, generally it is possible to regard culm density as an index of litter quantity. Clearly, the litter quantity closely relates to the aboveground biomass when estimating over a large area, but with a very small area as in this study, a direct relation is not always seen. In this study, however, a significant correlation was observed between aboveground biomass and litter quantity. This relation was not very direct (Fig. 6); the

litter accumulated on the ground surface was rather variable. Thus, the above relation is effected by topography, etc., which also effect the natural regeneration of trees.

Furthermore, the ratio of litter quantity to aboveground biomass appeared to differ between the plots in a closed forest and on open ground (Fig. 6). In a closed stand, where light was restricted, not only the living stock of *Sasa* but also the ratio of the litter quantity to aboveground biomass was reduced.

2. Litter quantity and seedling number

There were 11 tree species in the plots A and B; most individuals were shorter than the *Sasa*, in particular a large number of seedlings were below 20 cm in height.

The main tree species and number of individuals appearing in plots A and B were as follows: *Abies sachalinensis*, 169; *Acer mono* , 59; *Sorbus commixta*, 35; *Quercus mongolica* var. *grosseserrata*, 20; etc (Table 1).

Then the quadrats were classified by quantity of litter, and the relation between the litter quantity and the number of seedlings is shown in Fig. 7. As shown in this Figure, the seedlings (only those below 20 cm in height were included) appeared in all quadrats but one; thus, litter quantities below 200g/m^2 in oven-dried weight were not a definite impediment toward seedling establishment. However, the sites where the litter quantity was below 100g/m^2 had a larger number of seedlings.

3. Quantity of annual litter fall of *Sasa senanensis*

To confirm the results concerning the actual conditions of litter, the quantity of annual litter fall was estimated.

In quadrat A1, the number of living leaves ranged from 91.5/m^2 to 136.5/m^2 over a three year period. The number of fallen leaves from 1985 to 1986 was 72.8/m^2, and from 1986 to 1987, 46.0/m^2; the ratio of fallen leaves to total leaves was 64.0% and 50.3%,

Table 1. Number of seedlings in each grade of height in plots A and B

Species \ Height(cm)	0~20	20~	40~	60~	80~	100~	Total
Abies sachalinensis	125	31	10	2		1	169
Taxus cuspidata	1						1
Acer mono	36	5	5	5	4	4	59
Sorbus commixta	23	7			3	2	35
Quercus mongolica var. *grosseserrata*	11	8				1	20
Kalopanax pictus	3	1	3				7
Acanthopanax sciadophylloides	2		1				3
Prunus maximowiczii	1		1				2
Ulmus laciniata			1				1
Phellodendron amurense var. *sachalinense*		1					1
Tilia japonica		1					1
Total	202	54	21	7	7	8	299

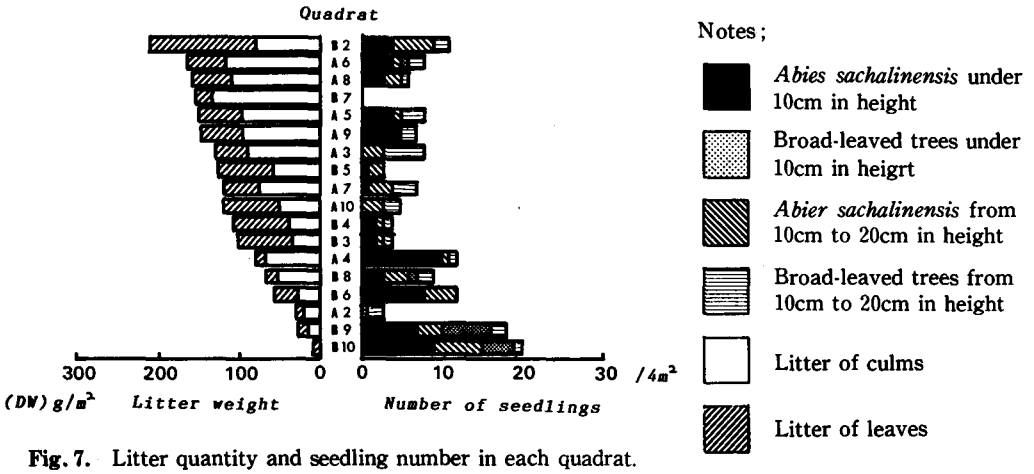

Fig. 7. Litter quantity and seedling number in each quadrat.

Table 2. Annual litter fall of *Sasa* in quadrats A1 and B1

Quadrat	Year	Leaves Fallen (/m²)	Ratio (%)	New (/m²)	Total (/m²)	Culms Fallen (/m²)	New (/m²)	Total (/m²)	* Life-span (years)
A1	1985	—	—	—	113.8	—	—	14.3	—
	1986	72.8	64.0	50.5	91.5	3.5	3.0	13.8	4.60
	1987	46.0	50.3	91.0	136.5	1.5	2.5	14.8	5.92
B1	1985	—	—	—	144.5	—	—	15.3	—
	1986	61.0	42.2	47.0	130.5	1.8	1.8	15.3	8.5
	1987	53.0	40.6	73.0	150.5	0.1	2.8	18.0	6.43
**Open	—		57		353			49.2	3.23

Notes; *Life-span: Reciprocal of the new culms ratio
**Open: Quoted from YAJIMA and MATSUDA, (1987)

respectively. The culm density was relatively constant: 13.8/m² to 14.8/m² over three years.

The estimated life-span of a culm, obtained by taking the reciprocal of the new culms ratio, was 4.60 years or 5.92 years.

In quadrat B1, the number of living leaves ranged from 130.5/m² to 150.5/m². The number of fallen leaves from 1985 to 1986 was 61.0/m², and from 1986 to 1987, 53.0/m²; the fallen leaves ratio was 42.2% and 40.6% respectively. The culm density was in the range of 15.3/m² to 18.0/m², and the life-span of a culm was 6.43 years or 8.50 years (Table 2).

The average fallen leaves ratio and the average life-span of a culm in the open ground plot were 57% and 3.23 years, respectively. As compared with these values, the fallen leaves ratio in mixed forests was low (except in 1986 in the quadrat A1) and the culm life-span was extremely long. Therefore when compared with an open ground plot, the smaller quantity of *Sasa* litter in a closed stand results not only from less living stock, but

also from the smaller annual litter fall caused by the longer life-span of both leaves and culms.

It has been suggested that the life-span of a culm of *Sasa nipponica* is longer in lower light than in higher conditions.[1] The present results support this suggestion concerning *Sasa senanensis*. This hypothesis explains the difference in the ratio of litter quantity to aboveground biomass found in the closed stand from that found in the open ground plot.

Further investigation is necessary for associated problems such as difference of decomposition speed in relation to enviroment type or plant organ sizes, measurements of light conditions, and a continuous survey.

Conclusion

From the above results, the following can be concluded:

Litter accumulation (on the ground surface) was as low as below 200g/m^2 in a closed mixed stand, and many tree seedlings had established; a larger number of seedlings were found on sites where litter quantities were under 100g/m^2.

The ratio of the litter quantity to aboveground biomass was rather varied: lower in a closed stand than in an open stand.

Based on the assumption that *Sasa* leaves and culms have a longer life-span in low light conditions, the marked reduction of *Sasa* litter quantity seen in the closed stand can be easily explained.

References

1) KAWAHARA, T. and TADAKI, Y.: Studies on *Sasa* communities (III) Relationship between light intensity and biomass of *Sasa nipponica*. *J. Jap. For. Soc.*, **60**: 244-248, 1978

2) YAJIMA, T.: Quantity of dead leaves and culms on a ground surface covered with *Sasa*. *Ann. Mtg. Jap. For. Soc.*, **96**: 373-374, 1985

3) YAJIMA, T. and MATSUDA, K.: Quantity of new leaves and dead leaves of *Sasa*. *Ann. Mtg. Jap. For. Soc.*, **98**: 295-296, 1987

摘　　要

本研究では，針広混交林の林床に堆積したクマイザサのリター量とリター供給量の実態を把握し，開放地で得られた結果と比較して，ササの生育実態と樹木の更新の関わりを考察した。

調査の対象としたのは北海道大学農学部附属中川地方演習林 208 林班の，トドマツを主体としミズナラ・イタヤカエデ・ダケカンバなどを交える針広混交林である。

林床には被度 2 ～ 5 でクマイザサが優先していたが，地上部の現存量は乾燥重量で概ね 600 g/m^{2}以下であり，平均で 2,390 g/m^{2}であった開放地のクマイザサと比べると少なかった。地表に堆積するササのリターは 200 g/m^{2}未満であり，開放地の調査結果である 1,390 g/m^{2}と比較すると相当小さな値を示した。稚樹はトドマツ・イタヤカエデなどがほぼ調査区全域に見られた。すなわち，少なくても 200 g/m^{2}程度以下のリター量では樹木の更新にとって決定的な阻害

要因にはなっていないことがわかる。また 100 g/m²以下の，よりリター量の少ない部分で稚樹個体数が多くなっていた。

また，うっ閉林内でのクマイザサでは開放地に比べて単に現存量やリター堆積量が少ないだけでなく，現存量に対するリター量の割合が小さくなっている傾向が見られた。すなわち林内では地上部現存量の減衰以上にササのリター堆積量が減少していた。

その原因は，林内のクマイザサでは葉と稈の寿命が開放地に比べて長く，その結果リターの供給量がより少なくなっていることにあると考えた。

すなわち，一年間の落葉数は前年の葉数の 40.6 %～64.0 % (平均 46.9 %) にあたり，一部を除くと開放地の平均落葉率である 57 %に比べて小さく，新稈発生率の逆数から求めた稈の平均寿命は 4.60～8.50 年(平均 6.36 年)となり，開放地の 3.23 年と比較するとうっ閉林内では，相当大きな値を示していた。