Litterの分解について (I)

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短　報

Decomposition of Litter in Forest Floor (I)
Study on the Decomposition Rate by Litter Bag Method

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Litter の分解について（I）
Litter bag 法による分解速度についての検討

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要　旨: 落葉を litter bag に入れて分解させた場合と自然状態で分解させた場合とで，その分解速度に違いが生じるかいなかを，ホオノキとアラカシの葉を用いて調べた。

林床から拾い集めた落葉は葉面積と重量を測定し，それぞれに番号をつけ，次の3つの処理方法で林床に設置した。（1）自然状態で放置，（2）上面だけをネットでおおう，（3）落葉をネットにはさんで放置。これらの落葉は定期的に回収し，重量と葉面積とを測定した。

両樹種とも分解が進むにつれて重量は減少した。分解初期では処理方法による減少率の違いはほとんどみられなかった。しかし，分解が進むにつれて，ホオノキ，アラカシとも自然状態で放置したものの重量減少が著しく大きく，ついで上面ネット，両面ネットの順に小さくなった。それらの1年間の減少率はホオノキでは 80, 70, 45% であり，アラカシでは 60, 57, 35% であった。

分解率を重量の減少率で表わした場合，自然状態で放置された葉は，分解が進むにつれて細かくなるため回収率が悪くなり，分解率は過大評価される。一方，ネットではさんだものでは，大型土壌動物の侵入が断たれ，それらによる摂食がないために重量の減少は小さくなり，分解率は過小評価されるおそれがある。従って，重量減少率だけから分解を求める場合は，上の2方法の中間である上面をネットでおおった方法で求めるのがより適当であるように思われる。

Introduction

The breakdown of dead organic matter is an important process in maintaining cycles of nutrients in forest ecosystems. Several methods have been used to estimate the rate of breakdown in organic matter: (1) weight loss of litter placed in bags in the field for a given period[1,2], (2) measurement of CO_2 production from the forest floor[3,4], and (3) calculation of the annual decomposition rate (k) by the formula $k=L/C$, where the weights of soil organic matter (C) and annual litter fall (L)[5~7] are compared.

The litter bag method has usually been used to estimate the decomposition rate. This method has the advantages of being able to observe the decomposition processes and to recover almost all the material, except for some of the fragments smaller than the mesh size and any dissolved matter removed by gravity, water, or soil fauna. However, bagged leaves under artificial conditions may decay at different rates from unconfined leaves.

There are a few reports concerning the effect of litter bags on the decomposition rate of litter. WITKAMP and OLSON[8] discussed the merits and limitations of the litter bag method. WITKAMP[9] reported that the use of litter bag tended to enhance the effects of tree species, and lessen the effects of weather and stand on the micro-organisms and their activities in decaying litter. ANDO[1] investigated the effects of mesh size of the litter bag on the decomposition rate, and found that the decomposition rate of leaf litter in the coarse meshes was much greater than that in the fine ones.

This paper reports the findings of a study on the comparison of breakdown rates for confined and unconfined leaves of *Magnolia obovata* and *Cyclobalanopsis glauca*.

Methods

The forests studied were *Magnolia obovata* and *Cyclobalanopsis glauca* plantations at Asakawa Experimental Forest in Tokyo.

Their leaves were collected from the forest floors in October 1972, and the weight and leaf area were measured for each leaf.

These leaves with number plates were placed by three treatments in each stand: (1) placed directly

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on mineral soil (unconfined), (2) covered with nylon nets (mesh size 2 mm), or (3) put between nylon nets.

From the leaves placed on the forest floors, ten were randamly removed from each group three to four times in one year, and their weights and leaf area were measured.

Results and Discussion

Fig. 1 shows the average percentages of weight remaining after periodic collection.

Magnolia obovata: The leaves put between nets decomposed at a surprisingly uniform rate throughout the year and lost 48% of their weight during one year. The unconfined leaves and those covered with nets decreased in weight at a comparable rate until May or July, 1973. After that time their breakdown became 2 to 3 times faster. By October the main residues were petioles and large veins, and after one year the weight losses of leaves placed by the latter two treatments were 65% and 78%.

Cyclobalanopsis glauca: Weight losses of leaves with the progress of decomposition showed similar trends for the three treatments. The rates of weight loss became smaller until March~July, 1973, accelerated in summer, and then the rates of breakdown decreased again. Average rates of weight loss in October, 1973, were 35%, 57% and 60% for leaves put between nets, covered with nets, and unconfined, respectively. These values were smaller than those of *Magnolia* leaves at each collection time.

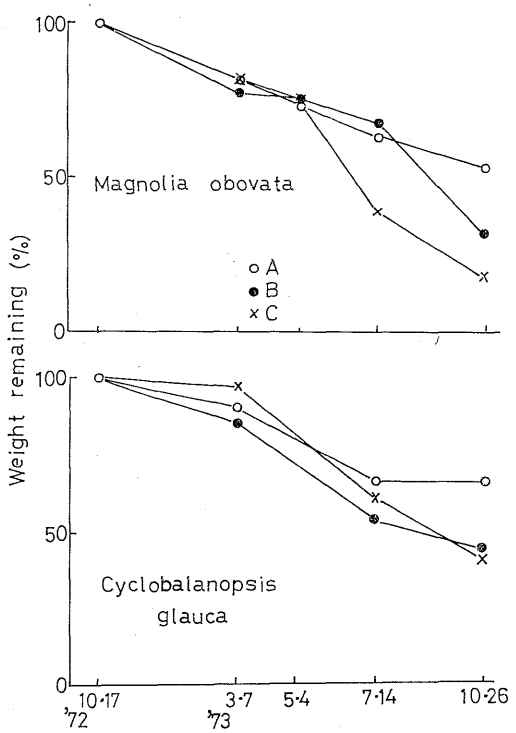

Fig. 1. The loss of weight during litter decomposition. Each point represents the mean value of samples. A: Put between nets, B: Covered with nets, C: Unconfined.

In general, the process of decomposition may be closely related to temperature, with the rate of decomposition high in summer and low in winter. This trend was found in *Cyclobalanopsis* stand, but was not distinct in *Magnolia* stand.

Differences among breakdown rates of leaves placed by these three treatments (Fig. 1) were greatly affected by the nets. The nets cause differences of environment (e.g. moisture condition), decomposers (e.g. soil animals and micro-organisms), and physical factors (e.g. wind and rain), which may influence the rate of leaf breakdown. Moreover, the litter bag method is strong enough to offer some protection against disturbances.

As shown in Table 1, the average moisture content of leaves differed among treatments. These amounts trended to increase with the progress of breakdown. The average moisture content of *Magnolia* leaves covered with nets was highest (22~54%) at every collection time, and leaves of other treatments contained about the same moisture. The same trend was found for leaves of *Cyclobalanopsis*, with the moisture content of leaves covered with nets highest (16~38%), and leaves put between nets lowest (4~12%). The fact that the leaves covered with nets were highest in both stands may be due to close contact with the soil.

In general, higher moisture content increases the activity of organisms which plays an important role in litter decomposition, or the rate of breakdown. However, weight losses of leaves were not clearly related to moisture content. This may be due to other factors.

Fragments were formed as the leaves were weakened, and could not be recovered completely. This

Table 1. Average moisture contents of leaf litter (%)

		'72 Oct.	'73 Mar.	May	July	Oct.
Magnolia obovata	A		18.9	18.8	21.2	33.7
	B	18.9	22.3	36.4	30.0	54.1
	C		7.1	22.4	25.7	39.9
Cyclobalanopsis glauca	A		12.3		7.9	3.7
	B	10.7	16.4		34.8	37.9
	C		11.3		27.6	11.1

A: Put between nets, B: Covered with nets, C: Unconfined

trend was especially evident in leaves which were unconfined or covered with nets. Fig. 2 shows the rates of decrease of leaf area. Leaf area of *Magnolia* leaves decreased little until May. However, after that time their decreases became greater. By July, unconfined leaf area decreased 50%, and by October most of them could not be recovered. On the other hand, the leaf area losses of *Cyclobalanopsis* were later than those of *Magnolia*, and became greater after July. The leaf area of unconfined leaves decreased about 45% by October. In both

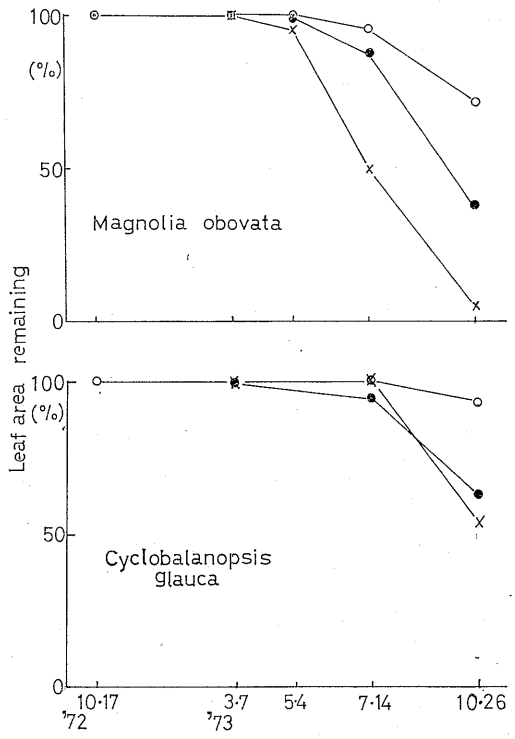

Fig. 2. Rates of decrease of leaf area during the decomposition. Marks are the same as Fig. 1

stands the order of leaf area loss among three treatments was the same as that of breakdown rate, and the decrease of leaf area was closely related to the breakdown rate of leaves.

Reduction of leaf area may result not only from incomplete collection of fragments, but also from feeding by soil animals such as earthworms and vertebrates. The number and biomasses of microanimals which played an important role in breakdown of leaf litter became larger in proportion to the average decomposition rate of leaf litter[10]. Litter bags do not permit the entry of larger soil animals, so the method may underestimate a true breakdown rate.

At each sampling time, litter sample weights varied considerably with the maximum ones weighing two to three times as much as the minimum ones. These were possibly caused by the qualitative and quantitative differences of initial decomposable substances in the earlier stages of decomposition, and by the difference of recovery rate in the later stages.

Weight and leaf area of all leaves were measured before they were placed on the forest floors. Leaf areas of *Magnolia* and *Cyclobalanopsis* were 100～400 cm^2 and 15～60 cm^2, and weights were 0.5～4.0 g and 0.25～1.0 g, respectively. The relationship between weight and leaf area is shown in Fig. 3. That is, the leaf area increases in proportion to increasing weight. But points are widely scattered in Fig. 3, indicating that the ratio of weight-leaf area differs among each leaf. As shown in Fig. 4, the rate of weight loss tended to increase with greater ratio of weight-leaf area. This tendency was remarkably noticeable during the initial stages of decomposition, but as the breakdown progressed, the effect of ratio of weight-leaf area on decomposition rate became smaller. These facts may show that the leaves with a larger ratio of weight-leaf area contain more easily decomposable and leachable substances.

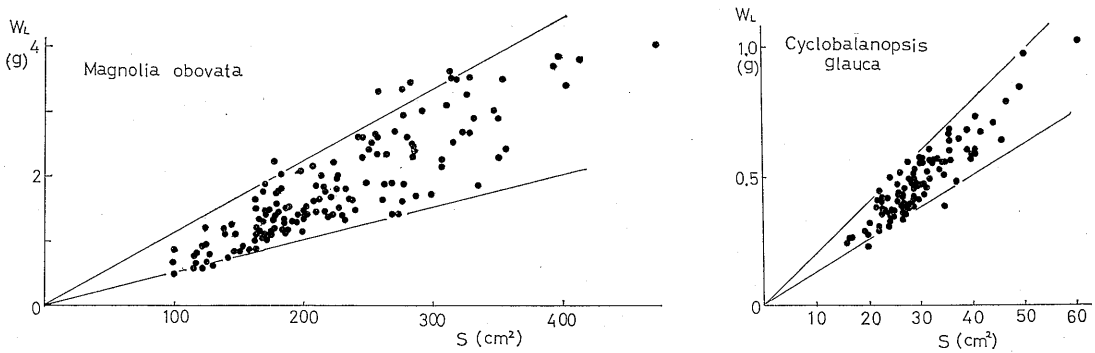

Fig. 3. Relationship between initial leaf weight (W_L) and leaf area (S)

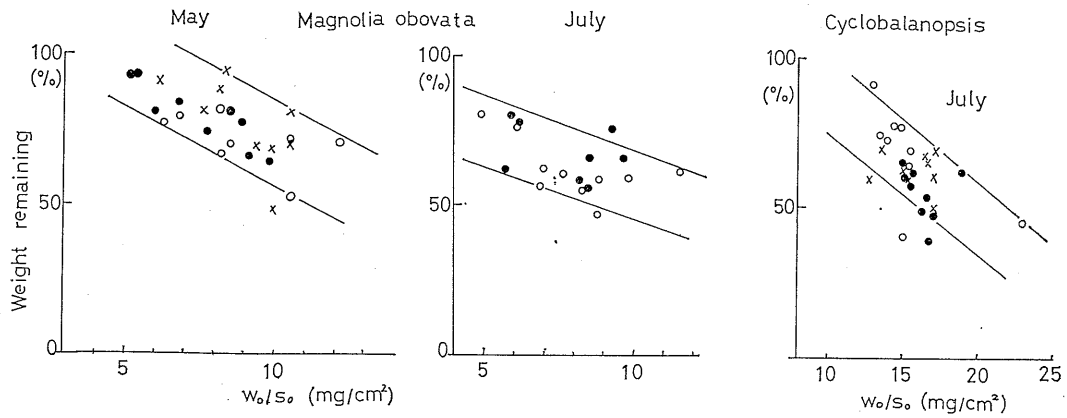

Fig. 4. Relationship between rate of weight loss and ratio of weight-leaf area (W_0/S_0). Marks are the same as Fig. 1.

Conclusion

The weights of leaves decreased with the progress of decomposition. In early stages of decomposition, the rates of weight loss did not differ significantly among the three treatments. It is supposed that the weight losses of leaves were caused by the decay of easily decomposable substances.

As the decomposition progressed, the differences of breakdown among treatments became remarkable in both stands. The breakdown rates of unconfined leaves may be overestimated because of lower collection rate of non-decomposed fragments, and those of bagged leaves may be underestimated because of lower moisture content and protection from larger soil animals. Consequently, the breakdown rates of broad leaves which were covered with nets are most likely to be the true rates of decomposition.

References

1) ANDO, M.: Litter fall and decomposition in some evergreen coniferous forests. Jap. J. Ecol. **20**: 170～181, 1970
2) KATAGIRI, S., CHIBA, K. and TSUTSUMI, T.: Changes in the amount of nutrient elements in decomposition litter. Bull. Kyoto Univ. For. **41**: 106～115, 1970
3) CHIBA, K. and TSUTSUMI, T.: A study on the soil respiration of forests (I). The relationship between the soil respiration and temperature. Bull. Kyoto Univ. For. **39**: 91～99, 1967
4) KIRITA, H.: Studies of soil respiration in warm-temperate evergreen broadleaf forests of southwestern Japan. Jap. J. Ecol. **21**: 230～244, 1971
5) JUNNY, H.: Cause of the high nitrogen and organic matter content of certain tropical forest soils. Soil Sci. **49**: 63～69, 1949
6) OLSON, J.S.: Energy stage and the balances of producers and decomposers in ecological systems. Ecology **44**: 322～331, 1963
7) KAWAHARA, T. and TSUTSUMI, T.: Studies on the circulation of carbon and nitrogen in forest ecosystems. Bull. Kyoto Univ. For. **44**: 141～158, 1972
8) WITKAMP, M. and OLSON, J.: Breakdown of confined and nonconfined oak litter. Oikos **14**: 138～147, 1963
9) WITKAMP, M.: Decomposition of leaf litter in relation to environment, microflora, and microbial respiration. Ecology **47**: 194～201, 1966
10) WATANABE, H.: Studies on the breakdown of leaf litter and ploughing by soil micro-animals in forest ecosystems (I). Individual numbers, biomasses and environmental factors. Bull. Kyoto Univ. For. **44**: 1～19, 1972

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