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Studies on the Nutrient Circulation in the Forest Ecosystem

1. On the Decomposition of Sexual Organ-*Salix babylonica*

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森林生態系에 있어서 養分순환에 관한 硏究

1. 生殖器管의 分解—수양버들

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ABSTRACT

This study was carried out to investigate the changes of flower properties due to decomposition in the course of time and results obtained are as follows;

1. The flower shape of *Salix babylonica* changed so rapid that it was difficult to recognize fragments after 40 days.
2. Total weight decreased by 50% after about 40 days. Loss on ignition changed rapidly for 40 days and then steadily.
3. Remaining carbon content decreased by a half only for first 20 days, then did steadily.
4. The content of phosphorus and total nitrogen decreased slowly during the early period and then rapidly.
5. Above phenomena are supposed to be responsible for higher water content, nitrogen, and phosphorus.

INTRODUCTION

In a forest ecosystem, nutrient circulations are continuously taking place. Organic matters of litter supplied to soils are changed into either minerals or smaller particles by small soil animals and microorganisms including mold and bacteria. The process of the decomposition also plays important role for the nutrient circulation.

Nutrient elements are available finite quantities and in varying ratios to one another in soils and sediments in weathering parent materials, and in precipitation or other water that enters ecosystem.

In general, flowers as sexual organ have been regarded as trifle ones in mineral nutrient cycling because of a little production.

Ovington (1963) reported that a source of error in estimating woodland production, energy flow and mineral cycling was due to flower and seed production. Flower is very rich in nitrogen and phosphorus compared with other vegetative organs, because flowers are a agency of heredity, DNA which is composed of base and phosphorus.

Most flowers are produced during the warm and hot season and they are rich in phosphorus and nitrogen. In general, decomposition rate is accelerated by the presence of nitrogen and phosphorus, and by comparatively high temperature.

This study deals with the flower decomposition of *Salix baylonica* with time. Especially changes of total weight, remaining carbon, phosphorus, and total nitrogen were analyzed.

MATERIALS AND METHODS

At a *Salix babylonica* forest, litter traps consisting simply of squares (approx, $1m^2$) of polythene

screen were placed flat on the ground at random along a transect through the center of each sample plot. To each corner of the square was attached a rubber band, the free end of which was looped over a metal peg pressed into the ground until its top was level with the ground surface. The pegs were positioned so that the tension of the rubber bands prevented the mesh squares being lifted from the ground surface by the wind. At intervals, sometimes weekly, the flowers an each screen was collected. Flowers of *Salix babylonica* collected from the study sites and oven dried at 100°C for one week was placed into 2-dm-square mesh bags.

A total of 21 litter-bags was used and a litter-bag contains 20 gms of dried flowers. Three locations in each field were chosen at random. The bags were placed on the surface of the mineral soil, exposed by removal of the natural litter cover.

Sampling was carried out 3-week intervals from June 1 to August 21, monthly from August 22 to October 20 and last on April 16, 1980.

In each sampling three sets of litter-bags were picked up from the field and placed in plastic bags, which were brought to the laboratory for analyzing.

Collected samples oven dried at 100°C were weighed. Remaining carbon, loss on ignition, phosphorus, and nitrogen were analyzed from the samples.

RESULTS AND DISCUSSION

Several methods have been used to estimate rates of breakdown of dead organic matter. This breakdown is an important process for maintaining cycles of nutrients in ecological systems.

Rates of breakdown of forest litter influence the rates at which nutrient elements in litter become available for renewed uptake by the vegetation and the amount of litter and thus of nutrients which accumulate in the forest floor. The rates of breakdown of leaf litter have been estimated from weight loss of leaves in mesh bags(Bocock & Gilbert 1957, Shanks & Olson 1961), and of leaves that were not confined (Witkamp & van der Drift 1961).

In this study, confined method has been introduced as it has advantages over other known methods. Confinements of litter in bags allows observation of known amounts of litter of known history and recovery of all materials except for some of the fragments smaller than the mesh size and dissolved matter removed by gravity, water, or soil fauna. Materials that remain in a bag can be periodically weighed.

The shape of *Salix babylonica* flower changed with time due to decomposition. Fig. 1 shows that after being placed for 40 days on the forest floor, it was difficult to recognize the fragments of *Salix babylonica* flowers.

About 80 days' placing on the forest floor leads to humus state, while leaves of *Salix babylonica* showed only fermented. Namely decomposition rate of the flower is higher than that of leaves(Fig. 1).

The fraction remaining in litter-bags decreased rapidly through the period June 1, 1979-July 10, then did steadily after July 10.

In case of leaves the linear trend of the regression lines on the semilog scale suggests an exponential decrease in the fraction of weight remaining during the first year of decay(Olson 1963).

The rate of weight loss as seen in oak leaves in bags can be expressed as the constant fraction of current weight loss per unit time(Jenny, Bingham & Gessel 1949, Olson 1963).

Loss on ignition decreased rapidly during the decay period and became slower later in the course of time elapsed. Thus, decrease rate was 14% during the period between first and 20th of June, and followed 7 and 3% during the period up to 10th of July and to first of August, respectively. The loss of ignition value reached 60% during the period up to 20th of October, which was maintained as it is until the termination of the experiment, April, 1980.

Fig. 4 shows percentage of remaining carbon at each decay period. Remaining carbon in fresh flowers decreased to 18.7% from 32% during 20 days and decrease rate became slower afterwards. The change in decrease rate in remaining carbon is in accordance with that in total weight loss or in loss

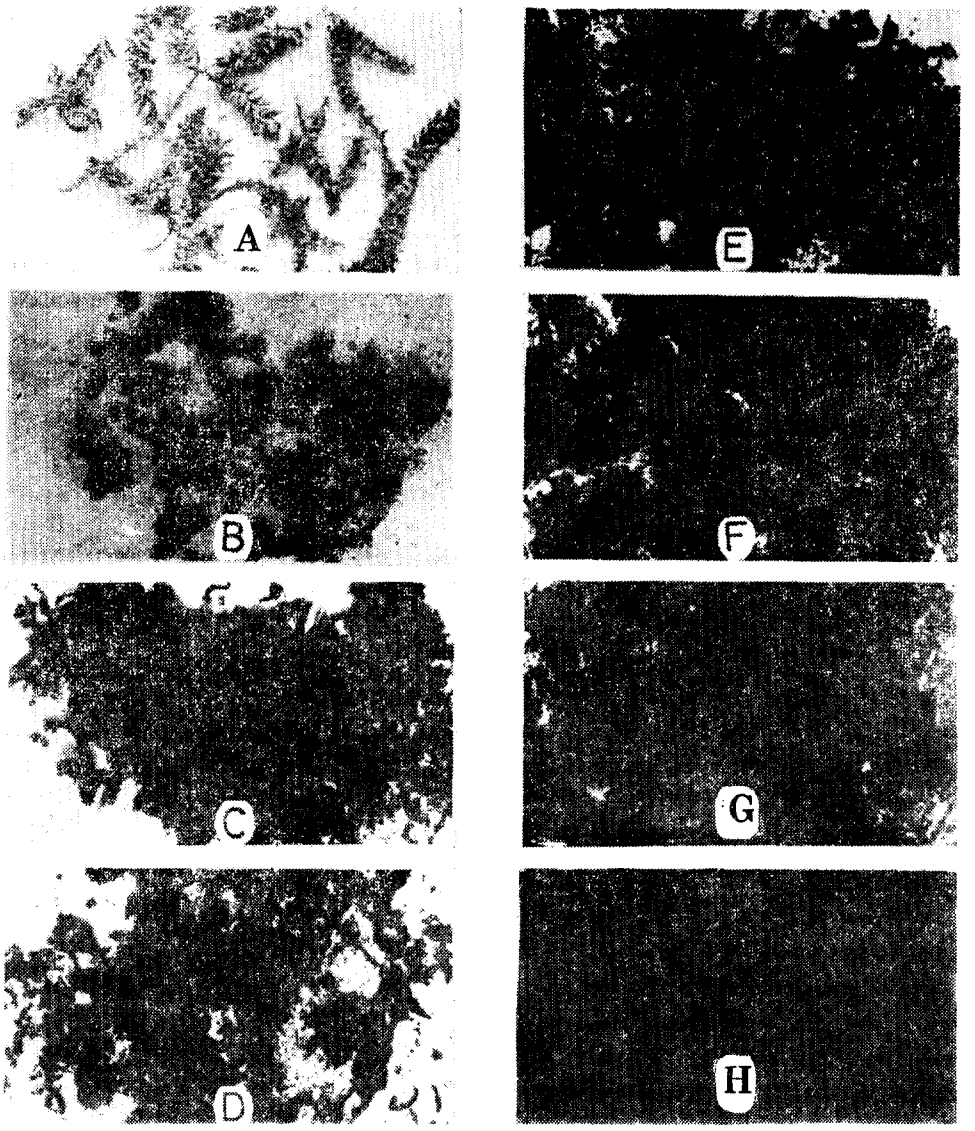

Fig. 1. Changes of *Salix babylonica* flowers due to decomposition.
A: 1 June(fresh flower), B:20 June, C:10 July, D:1 Aug,
E: 21 Aug., F:21 Sep., G:20 Oct., H:16 April, 1980

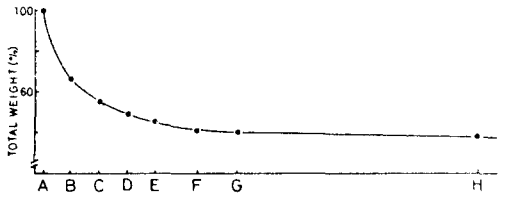

Fig. 2. Changes of total weight of *Salix babylonica* flowers due to decomposition.
A: fresh flowers(1 June, 1979), B:20 June, C:10 July,
D:1 Aug., E:21 Aug., F:21 Sep., G:20 Oct., H:16 April, 1980

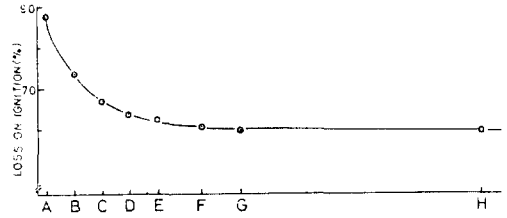

Fig. 3. Changes of loss on ignition due to decompositon of *Salix babylonica* flowers.

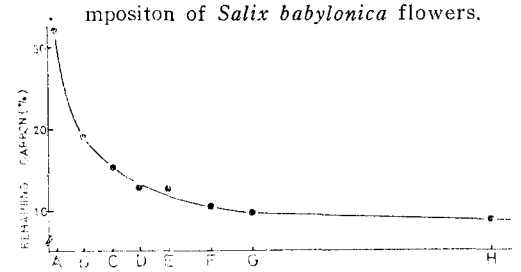

Fig. 4. Changes of remaining carbon due to decomposition of *Salix babylonica* flowers.

on ignition. Thus it appears that the three factors are influenced by carbon.

Analysis of *Pinus rigida* for phosphorus content revealed 0.002% in stem(heart wood), 0.047 in stem bark, 0.04 in branch, 0.12 in current twigs, 0.043 in leaves, and 0.2 in flowers. Phoshorus in flowers was five times more than in leaves. This result indicate that majority of phosphorus is contained in current twigs, leaves and flowers.

In case of *Salix babylonica* fresh leaves contained 0.056% of phosphorus, while fresh flowers contained 0.22% which is 3.9 times more than fresh leaves. Phosphorus content in fallen flowers was 0.07%, was much lower compared to that in fresh flowers. The reason for the difference may be that majority of pollen in the former was released from the flowers. As the results of Fig. 5 suggest, high phophorus content in flowers is due to the high content of it in pollen.

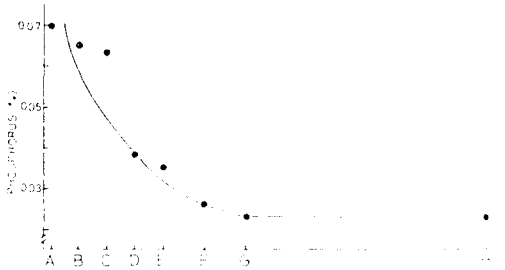

Fig. 5. Changes of phosphorus due to decomposition of *Salix babylonica* flowers.

Fig. 5 shows the change in phosphorus content during the decomposition of flowers. Fresh flowers had 0.22% which flowers fallen in litter trap had only 0.07 which stands one third of fresh flowers. Little change was noticed in phosphorus content in fallen flowers for 40 days. However, sudden drop was recorded during the period between 40 and 60 days. This trend continued up to 110 days, followed y steady curve.

Analysis for nitrogen content in *Salix babylonica* xhibited 0.16% in stem(heart wood), 0.36 in stem bark, 0.31 in branch(wood bark), 0.52 in current twigs and 0.68 in leaves. Flowers showed the highest nitrogen content with 3.54%.

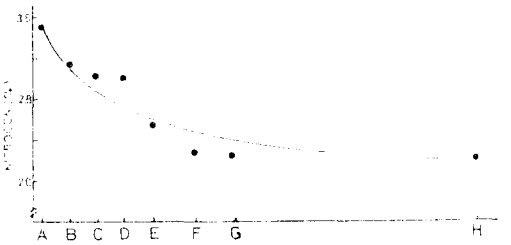

Fig. 6. Changes of nitrogen due to decomposition of *Salix babylonica* flowers.

The reason of the high nitrogen in flowers than in other vegetative organs could be attributed to higher amount of DNA, a genetic materials as it consists of high ratio of both nitrogen and phosp-

horus.

Change in nitrogen content in the course of flower decomposition is shown in Fig. 6. In the first step it changes similarly to phosphorus. It decreased slowly during the first 60 days and followed moderate change for 20 days afterwards. After 110 days remaining nitrogen value remained nearly constant. C/N ratio value in fresh flowers was 9.03 and lowered as the flowers decomposed. The above results on the whole suggest that in flowers different types of decay model is operating when compared with leaf litters.

The decomposition of litter is affected by various factors such as water content, environmental factors including temperature, leaf litter and its chemical and structural characteristics.

The decay of organic matters in soil, i.e. soil respiratory rate conforms a exponential relations with temperature, in which the decay rate reduced by one half to one third when temperature drops by 10 degree in a certain range.

This experiment was carried out in summer months. Since the temperature maintained high(average temp. of June, July and August; 20°C, 23.6 and 24.8), it can be easily assumed taht decay would be taking place very quickly. Practically it takes only 20 days to reduce remaining carbon content to a half.

It can be considered that decay rate in flowers must be fast for they have higher water content. Ino and Monsi(1969) have reported that in case of leaf litter soil respiratory rate increased to some extent as water content increased.

On the other hand Wittich(1939) analyzed leaf litter to determine nitrogen content and decay rate and reported that decay rate increased as nitrogen content became higher.

The present study indicates that sudden decrease in total weight is due to higher nitrogen content. Flowers produced in either spring or summer decomposed rapidly and in turn mineral nutrients produced can be utilized in part by plant.

要　約

本 硏究는 수양버들 꽃의 分解에 따르는 成分變化를 調査하기 爲하여 行하였으며 얻어진 結果는 다음과 같다.

1. 수양버들 꽃의 分解는 매우 빠르기 때문에 分解 40日에는 그 完全한 形態를 알아보기 어려웠다.

2. 分解 40日後의 試料의 무게는 50%의 감소를 나타냈으며 灼熱消失量도 초기에는 急減하였다가 점차로 감소하였다.

3. 炭素含量은 初期 20日間에 半減하였으며 그 후 20日間도 急減하였다.

4. 總窒素와 燐의 含量變化는 初期에 완만하였으나 (初期 20日間) 그 후에는 急減하였다.

以上과 같은 現象은 수양버들 꽃이 水分·窒素·燐의 含量이 높을뿐 아니라 比較的 溫度가 높기때문에 分解가 빠른것으로 思料된다.

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