

Net Production in Several Mature Plants Grown at Different Altitudes

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Summary

The net productions of *Polygonum reynoutria* L. ssp. *asiatica*, *Solidago virga-aurea* L. ssp. *asiatica*, and *Prunella vulgaris* L. ssp. *asiatica* were measured by the leaf-half method modified monthly in several native habitats of different altitude.

With *P. reynoutria*, the net productivity was decreased from late July to late September, and also was decreased in higher habitats. The productivities of *S. virga-aurea* and *P. vulgaris*, however, were increased from late July to late August, and from about 600m to about 1500m elevation in the same season, and then decreased in both cases. The temperature that showed the maximum productivity was lower in *S. virga-aurea* than in *P. vulgaris*.

It was suggested that the plants distribution of these 3 species may be related to the difference in their productivities.

Introduction

The horizontal and vertical distributions of plants are mainly limited by air-temperature, and a specific vegetation zone is formed with climate zone. plants in the vegetation zone grow poorly when transplanted into the other zones, and it has been found that the temperature in their native habitat is most fitted for some physiological activities and for growth (2).

The authors (6) have found that *Polygonum reynoutria* L. ssp. *asiatica* has a decreased photosynthetic ability with increase in the altitude of their habitats. Such decrease may constitute a great physiological factor which limits the distribution of the plants into high altitude or cooler place.

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In the present paper, a relation between plant habitats and net production will be reported in plants of the same species grown at different altitudes.

Materials and Methods

Mature plants of *Polygonum reynoutria* L. ssp. *asiatica*, *Solidago virga-aurea* L. ssp. *asiatica*, and *Prunella vulgaris* L. ssp. *asiatica*, grown in fields at about 600m above sea-level (the campus of Shinshu University, Matsumoto) and at 1500m and 1900m (Mt. Yatsugatake), were used as experimental materials. These fields were situated at practically the same (about 34° N.). The areas, which have similar environmental conditions except for altitude and air temperature, were prepared in these elevations, and the experimental plants were found in such areas; so that, a main difference in environmental conditions among these areas seems to be shown in air-temperature.

Although the plants of these 3 species have grown in the same area, they, phytogeographically, bear a little difference to each other on their horizontal distribution; generally, *S. virga-aurea* and *P. reynoutria* belong to from warm-temperate to temperate zone, and *P. vulgaris* belongs to from temperate to arctic zone.

Net production by photosynthesis was measured at their habitats, using mature plants by the leaf-half method modified (3). Measurements were simultaneously taken on the same day in late July of 1970 and 1971 in all areas. Measurements at 600m habitat were also taken in late August and late September. The measurements were taken on very fine days, and 5 hours of sun-exposure time were required from 9:00 a.m. on. After such treatment, experimental leaves were killed instantly by hot steam, and were brought to the laboratory after a treatment to keep some soluble substances in the leaves, and their dry matters were weighted. The measurement was taken for 2 days continuously, and the total number of experimental plants in each species was 20.

Results and Discussion

Net production measured in late July at each habitat differing in altitude (*P. reynoutria* alone was measured also at a habitat of 2100m) is shown in Fig. 1.

From the results shown in Fig. 1, a characteristic difference was found that the net productions in *S. virga-aurea* and *P. vulgaris* were greater at 1500m than at 600m and 1900m, while in *P. reynoutria* it was decreased with the increased elevation of their habitats. Although *S. virga-aurea* and *P. vulgaris* had a similar relation between the net production and the altitude of their habitat, the former plants had greater production than the latter, especially at 1500m

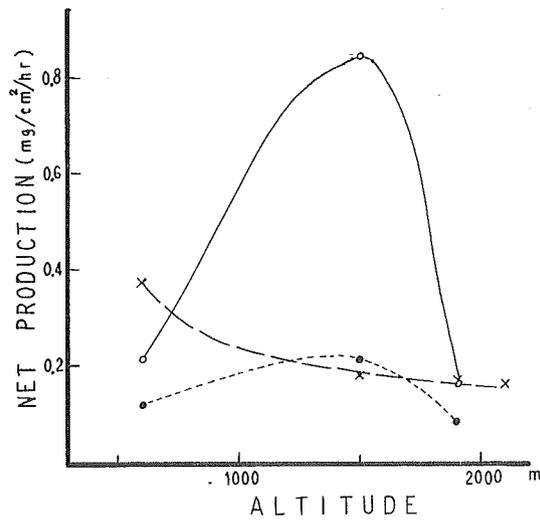


Fig. 1. Net productivities varied by altitude of habitat (measurement in late July). *Solidago virga-aurea* L. ssp. asiatica; —○—, *Prunella vulgaris* L. ssp. asiatica; ...●..., *Polygonum reynoutria* L. ssp. asiatica; —x—.

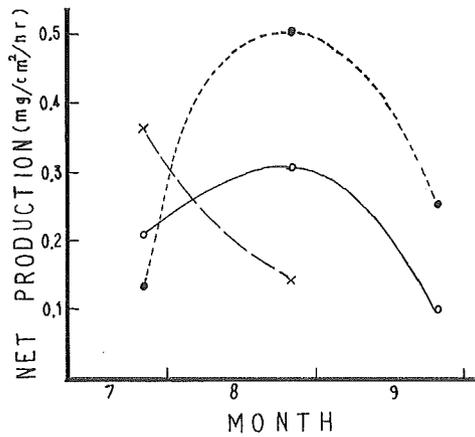


Fig. 2. Seasonal variation of net productivities in 600m elevation. *Solidago virga-aurea* L. ssp. asiatica; —○—, *Prunella vulgaris* L. ssp. asiatica; ...●..., *Polygonum reynoutria* L. ssp. asiatica; —x—.

elevation.

Air-temperatures during the experimental period decreased on late July, late

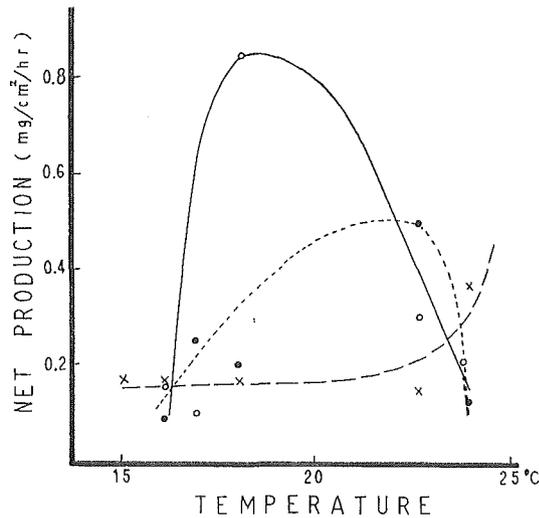


Fig. 3. A relation between net productivity and air-temperature during experimental period. *Solidago virga-aurea* L. ssp. *asiatica*; —○—, *Prunella vulgaris* L. ssp. *asiatica*; ···●···, *Polygonum Reynoutria* L. ssp. *asiatica*; —×—. The air-temperatures were determined from the data reported before (5).

August, and late September in that order (5). With such changes of air-temperature, *P. Reynoutria* showed a decrease of the net production, whereas the net production of other 2 species was increased in late August more than in late July when the air-temperature was higher than in late August (Fig. 2). These facts indicate that *P. Reynoutria* shows the optimum growth under the relatively high temperature, and *S. virga-aurea* and *P. vulgaris* do so when the temperature is relatively low. Such seasonal variation of the net production measured monthly at 600m elevation was parallel to the relation between the net production and the altitude of their habitats, and it appears that the net productivity controlled by the altitude was caused by the difference of air-temperature in their habitats.

As shown in Fig. 3, *S. virga-aurea* required lower optimum temperature than *P. vulgaris* for the net production. This fact, though they occupy a similar zone on their distribution, seems to show that the optimum temperature for their growth is lower with the former plants than with the latter.

It is known that plants distribution is influenced by many environmental factors (1, 4), but the environmental conditions of the experimental areas in the present study differ little except for air-temperature. From these facts, it is suggested that the difference among the net production made in each habitat is

caused by the difference of air-temperature, and that such productivity constitutes a main limiting factor for the distribution of plants. It may be concluded that three plant species presented here have different optimum-temperature to give the maximum net-production.

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