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# Ecological Studies of *Stellaria media* and *S. neglecta**

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*ABSTRACT* Ecological differences between *Stellaria media* and *S. neglecta*, being closely related with each other, were studied.

Their habitats and lives for each season were investigated in the field. Laboratory experiments were made on germination of seeds, photosynthetic rate and chlorophyll content.

Habitat investigation showed that *S. media* is dominant in cultivated fields, while *S. neglecta* scarcely occurs there. This may be ascribable to the difference of physiological nature between the two species. *S. media* has the characteristics adapted to life in cultivated fields, that is, short after-ripening, germinating several times in a year and early attaining to the reproductive phase. Rare presence of *S. neglecta* in cultivated field is mainly due to its longer vegetative growth period.

## Introduction

*Stellaria media* and *S. neglecta* are annual or biennial weeds, which distribute all over the world. They have many similarities in the external morphology and the mode of life. In the papers concerning the chick weeds, therefore, strict distinction between *S. media* and *S. neglecta* was not made so far[1),2),3)]. And in their taxonomy they are classified as a species[4)], two variants belonging to a species[5)], or different species[6),7)].

Peterson[5)], who regarded them as different species, referred three closely related species (*S. neglecta*, *S. media* and *S. apetala*) to *media*-group. He investigated the *media*-group from the view points of cytology, genetics, ecology and systematics. But ecologically he discussed only about the ecotype as to the germination of *S. media*.

This paper will deal with conditions of habitats and physiological characteristics of *S. media* and *S. neglecta*. And ecological differences between them

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will be explained.

## Materials and Methods

The field investigation was carried out mainly in Kyoto City and its environs. In the experimental researches *S. media* was collected from the farm of Kyoto University and *S. neglecta* from the attached Botanical Garden.

Table 1 shows ordinary taxonomic criteria to identify these two species.

Table 1. Comparison of criteria between the two species

| | *S. media* | *S. neglecta* |
|---|---|---|
| stem | brown | pale green, seldom brown |
| leaf | smaller & deeper green | larger & paler green |
| stamen | 2-5 (-8) | (3-) 8-10 |
| seed | 1.0-1.2 mm across<br>process hemispherical | 1.5 mm across<br>process conical, subacute |
| whole size | smaller | larger |

In these characteristics only the shape of processes on the surface of seed is the most stable for environmental changes. Although individuals bearing intermediate process form are rarely found, it is not so difficult to identify them judging from other features (stamen number ; color, form or size of the leaf, etc.) and mode of life.

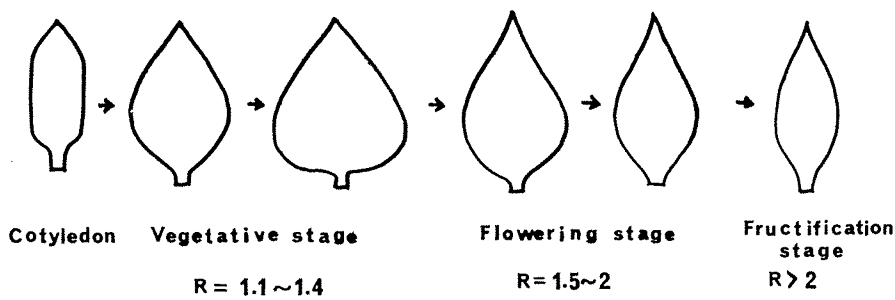


Fig. 1. Developmental stages and leaf forms of *S. neglecta*.

$$R = \frac{\text{length}}{\text{width}}$$

As shown in Fig. 1, *S. neglecta* alters the leaf form transitionally from seedling to fructification stage. In *S. media*, however, it was observed to flower bearing the young leaf form (R=1.1) and no definite relationship between the leaf form and the developmental stage was revealed.

Their habitats were investigated at 77 places in the suburbs of Kyoto late in autumn, 1966. In this time *S. media* had already flowered and the leaves of *S. neglecta* were young form yet, which made it easy to distinguish them. In each investigated area (2-10m$^2$) coverage of *S. media* and *S. neglecta*, and the conditions of environment were recorded.

In order to examine the most suitable germination temperature and the critical one, the seeds were set under the following temperatures: 5°, 10°, 15°, 20°, 25° and 30° (±1°, respectively). In the experiments to examine the effect of high temperature treatment on the after-ripening of seeds, they were laid under 35° expediently for six days, and then incubated under 14°, optimal germination temperature, with control seeds having been kept in room temperature (18° ±2°).

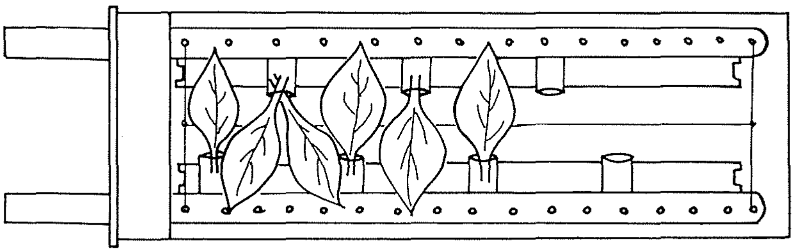

Fig. 2. Assimilation chamber (upper view).

The plants used for the measurement of photosynthesis and chlorophyll content were grown outdoors for 40 days in four experimental plots under 11%, 47%, 88% and 100% relative light intensities, respectively. Then 17-28 leaves were harvested from each plot, set in an assimilation chamber (Fig. 2), and photosynthetic rates were measured with infra-red gas analyser (URAS) at 20° and at a flow rate of 30 *l*/hour. Chlorophyll was extracted from the leaves with 80% acetone and the total chlorophyll content (mg/100cm$^2$ leaf area) was determined spectrophotometrically by the method of Arnon[9].

## Results

### 1. Field investigations

1) *Habitat*

The investigated habitats may be classified into five categories, namely,

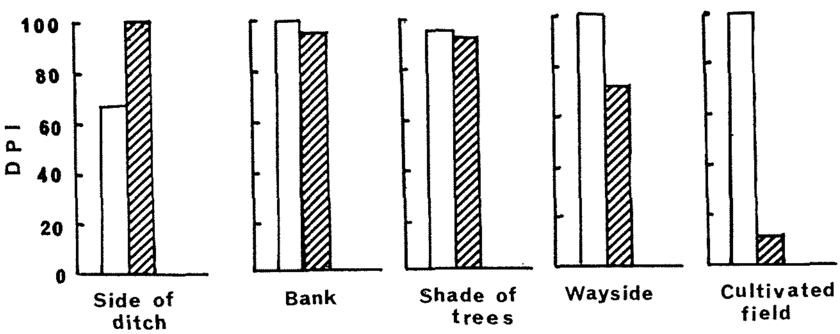


Fig. 3. Dominance-Presence Index (DPI) of *S. media* and *S. neglecta* measured at different habitats in Nov. -Dec., 1966. Blank. *S. media* ; hatched, *S. neglecta*.

side of ditch, bank, shade of trees, wayside and cultivated field. Dominance-Presence indices[10] of both species were computed for each habitat category (Fig. 3). Both species are found with nearly equal DPI in the first four categories. In the last one, however, there is a prominent difference in their dominancy, *S. media* being superior to *S. neglecta*.

2) *Life cycle*

As shown in Fig. 4, in Kyoto *S. neglecta* usually germinates in the term extending over September and October, flowers from March to April next year

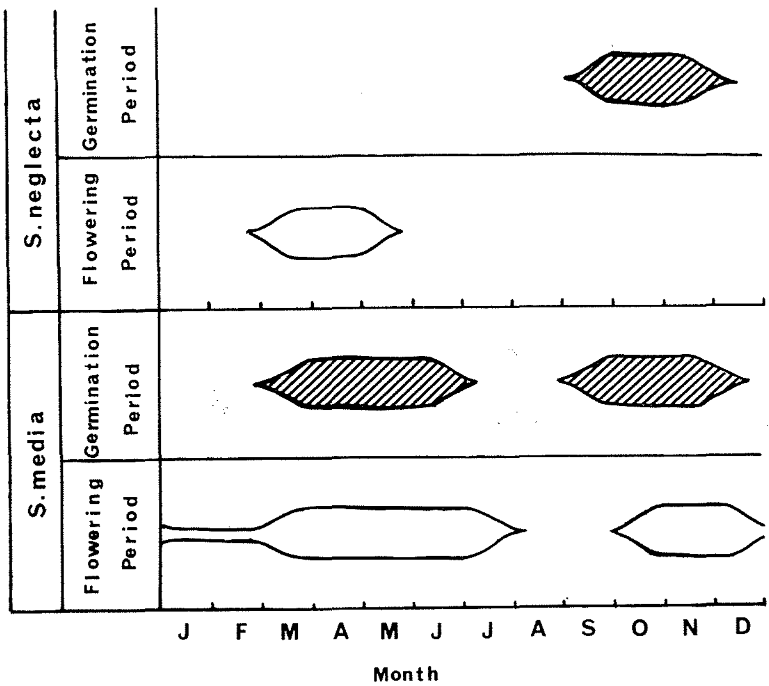


Fig. 4. Diagram showing germination and flowering Period (Kyoto).

and dies late in May. The majority of *S. media* seeds germinate in autumn, but they often germinate also from spring to early summer. The flowering period of *S. media* is not so restricted as that of *S. neglecta*, and under the natural condition, *S. media* begins to flower at about a month after germination, continuing to produce seeds for two to three months.

3) *Cold resistance*

It was observed that in winter the leaf spongy tissue of these species is split, making a large space of intercellular cavity (Fig. 5, A). But in these species growing in spring or autumn, or in a greenhouse even in winter, no such phenomenon was observed (Fig. 5, B).

Hatakeyama[11] has already explained the same phenomenon as an adaptation

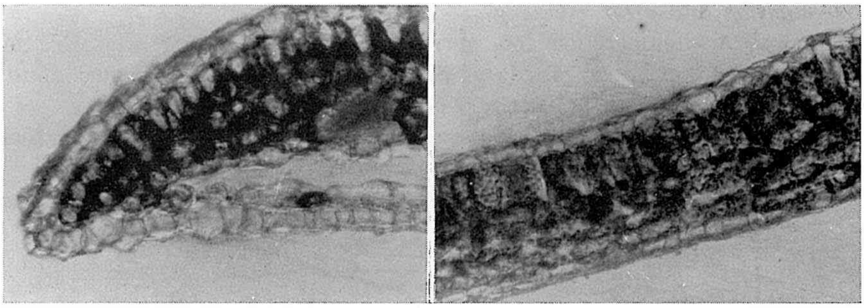

Fig. 5. Cross sections of *S. media* leaves in winter; (A) a leat in the field, (B) a leaf in the greenhouse.

to freezing in frozen *Buxus* leaves. That is, as the air temperature goes down, ice pieces grow larger in the intercellular space of the spongy tissue taking the intracellular water. In consequence the resistance against freezing of the cell content increases and the intracellular space is not frozen. In fact it was observed that in early morning when the air temperature strikingly dropped leaves of *S. media* in the field were frozen, but that as the air temperature rose the ice pieces were thawed and they did not suffer any damage.

## 2. Experiments

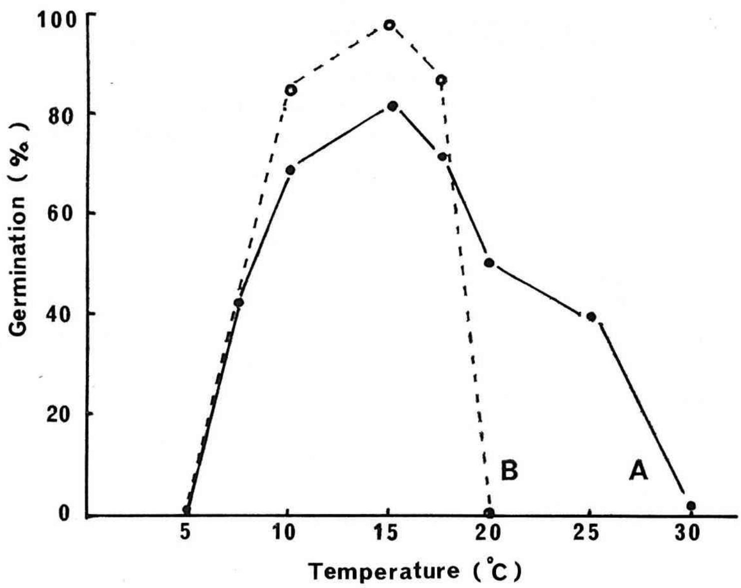


Fig. 6. Correlation between germination and temperature. A, *S. media* ; B, *S. neglecta.*

1) *Germination and after-ripening*

The optimum temperature for germination of these species was 15°, or so, and the lower limit was 5°. Seeds of *S. media*, however, germinated up to 30°, while those of *S. neglecta* did not above 20° (Fig. 6).

As for the seeds of *S. neglecta* treated with high temperature it took 14 days to attain 60% germination, but the control seeds 30 days (Fig. 7). For

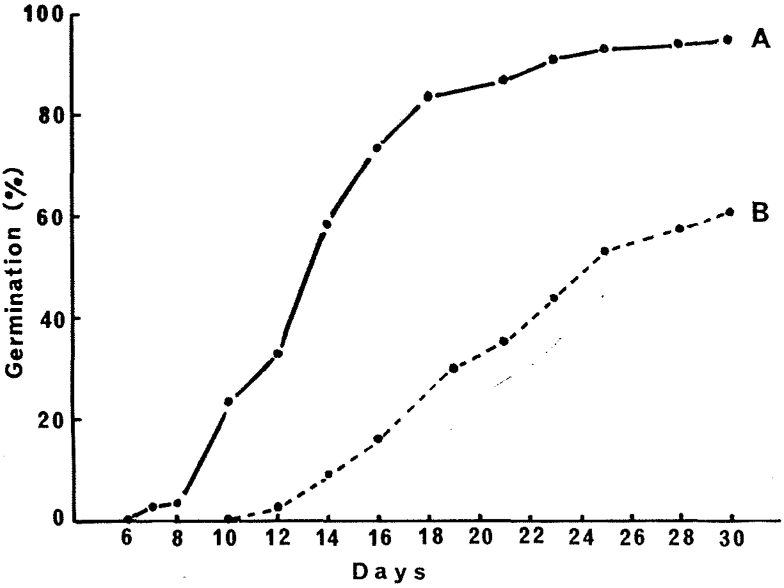


Fig. 7. Germination of *S. neglecta* seeds treated with high temperature (35°). A, treated ; B, control.

*S. media*, on the other hand, both treated and untreated seeds collected from the plants grown under 25°-27° in the laboratory germinated 100% during 5 days, but the seeds collected in the field early in December required about a month under the room temperature for completion of after-ripening.

2) *Photosynthesis and chlorophyll content*

Any appreciable difference was not observed between the two species of each experimental plot in either compensation point or light saturation point (Fig. 8). In any light condition, however, the photosynthetic efficiency of *S. media* was higher than that of *S. neglecta*.

The chlorophyll content of *S. media* was higher than that of *S. neglecta* in any experimental plot. And the differences of thickness of their leaves were small, so *S. media* contains more chlorophyll in a unit volume of the leaf than *S. neglecta* (Fig. 9).

## Discussion and Conclusion

*S. media* and *S. neglecta* are nearly related with each other phytotaxonomi-

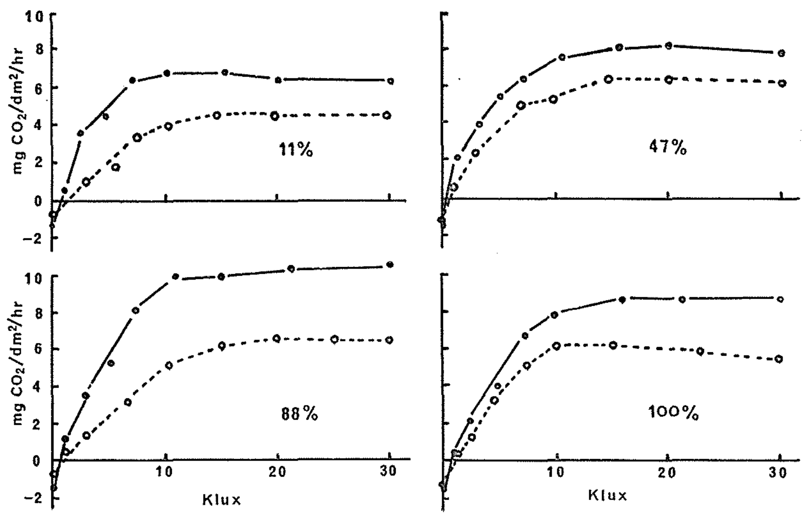


Fig. 8. Light-photosynthesis curves of *S. media* and *S. neglecta* grown at various relative light intensities indicated. ●——●, *S. media*; ○------○, *S. neglecta*.

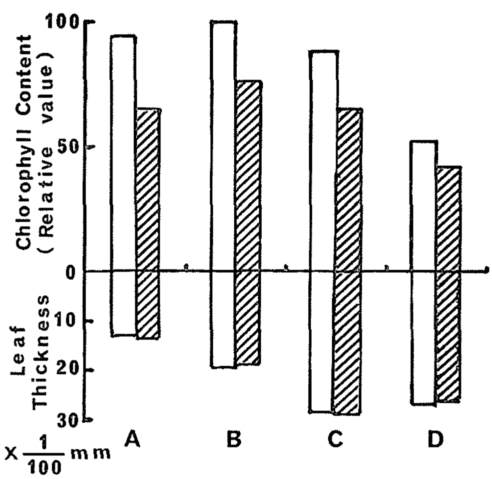


Fig. 9. Chlorophyll content (mg/100cm² leaf) and leaf thickness at different light conditions: 11%(A), 47%(B), 88%(C) and 100%(D) relative light intensities. Blank, *S. media*; hatched, *S. neglecta*.

cally and have the same life-form. Although they have many similarities in their physiological characteristics, there are some differences responsible for the ecological differences between them.

*S. media* seeds produced under low temperatures require after-ripening for a month or so, and while those under high temperatures do not. It is, therefore, thought that the temperature condition during the seed production is an important factor for the after-ripening of *S. media* seeds. And it may be suggested that *S. media* seeds are matured on the mother plants when the air temperature is favorable for proceeding seed ripening.

Most of *S. neglecta* seeds require after-ripening for about a month, and it is distinct from Fig. 7 that the after-ripening is promoted by higher temperatures.

About the after-ripening of seeds collected from many countries in the world, Peterson[8] has classified *S. media* into the following three ecotypes : 1) almost never need it, 2) require its period for 40 to 50 days, 3) longer than type 2).

More detailed investigations will be shortly conducted to decide if the after-ripening of *S. media* and *S. neglecta* is genetic, as Peterson reported, or variable by the temperature condition during the seed production.

The physiological differences between the two species are as follows. The difference in the flowering period is very important. The flowering period of *S. media* having short vegetative growth period is not so restricted as that of *S. neglecta*, being longer than the latter. It may imply that the seed output of *S. media* is large in comparison with *S. neglecta*.

Since *S. media* seeds germinate at 5°-30°, they can germinate almost all the year round in Japan. When *S. neglecta* seeds produced in spring are after-ripened, the air temperature has already become too high to germinate because they can germinate only at 5°-20°. In 1967, late in May when the air temperature dropped unusually many seedlings of *S. neglecta* were found. However, because of high temperature and drying in summer they died without flowering. Like this the seedlings of *S. neglecta* are sometimes found in spring but they scarcely flower.

The photosynthetic efficiency of *S. media* is higher than that of *S. neglecta* and this may be due to chlorophyll content. As for compensation point and light saturation point, no difference is detected between the two species. The dominancy of *S. media* in photosynthetic efficiency may contribute to its rapid growth.

Usually the plant known as weed of cultivated fields has the following characteristics : to have short after-ripening period, to germinate through the year and to have precocious tendency. Of course, these characteristics are well adapted to life in farm lands being often weeded and cultivated. Evidently *S. media* has these characteristics as farm weeds. *S. neglecta* is disadvantageous to grow in such a place because of a longer vegetative growth period. This is also showed by the investigation of habitat (Fig. 3). And generally both *S. media* and *S. neglecta* are almost absent in mountains but, so far as the author's observation concerned, even there (e. g. Mt. Hiei, Mt. Ohdaigahara) at the cultivated fields and at the surroundings of houses *S. media* is often found with other weeds. Thus ecologically it is the most important difference that *S. media* is a weed of cultivated fields and *S. neglecta* not so, and it may be said that the former is more advantageous than the latter concerning distribution. According to Hitzer,[3] *S. media* occurs all over the world, because the climate factor restricting its distribution is drying only. But he did not discussed about the relation between the farm weed characteristics and distribution.

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