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**The influence of defoliation on flowering in pine**  
*Pinus silvestris* L.

INTRODUCTION

If strobile initiation in pine is under the control of nutritional mechanisms, the removal of needles will influence this process through local starvation of the growing point. Defoliation of *Pinus banksiana* Lamb. caused by insects has been known to affect the production of staminate strobiles, either negatively, (Heron 1956, Kulman and Hodson 1963) or positively if slight (Kulman and Hodson 1963). Removal of needles may prove to be a procedure that could be of practical use in seed orchards, where the treatment could be easily applied since crowns of grafts are maintained low, and where the probable reduction in growth the treatment could induce will not only be unimportant but may play a useful role in the control of graft size.

MATERIALS AND METHODS

For the experiment ten 15-year old Scots pine trees have been selected. They all had well developed branches from one side. As edge trees of a small forest they have from the exposed, west side, live branches to the very ground. During the course of the experiment three of the trees were brushed while a small path was being made, and as a result they had to be excluded from the experiment. The results presented below are therefore based on 7 trees only.

On each tree 12 branches were selected of more or less equal size, and these were marked with labels and paint directly on the bark. In the period from the 15th of February to the 5th of July 1966 every two weeks one branch was defoliated on each of the trees. At each time the branch to be defoliated on each tree was selected at random. Until the 10th of May 1966 only old needles were being removed since the new needles have not yet appeared. Starting from the 24th of May 1966 also the needles of the current season were being removed. Flower initials form in the first

weeks of July, (Giertych 1967) thus any treatment performed later would not have any influence on the flowering. One year old conelets present on the shoots were removed so that the metabolic effort needed for their nurture would not obscure the results.

In May 1966 the position of all new strobiles on the branches under investigation was observed. In the spring of 1967 on each of the branches new shoots have been counted as well as the number of female strobiles and number of shoots with male strobiles. The results have been subjected to an analysis of variance treating each tree as a replicate.

### RESULTS

In the spring of 1966 all female strobiles appeared on shoot apices and all male strobiles in the position of short shoots. This indicates that the defoliation has not caused a sex transformation in any of the strobiles already present in the buds. Such a treatment performed shortly before reduction division in *P. thunbergii* Parl. (in Scots pine it takes place in

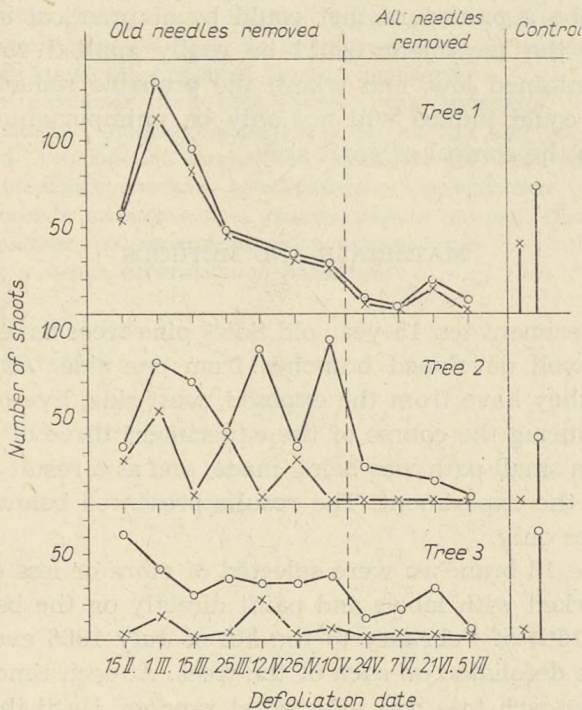


Fig. 1. Three types of relationships between the number of shoots (o) on a branch and the number of shoots with male strobiles (x) as affected by defoliation on different dates

late April (Giertych 1967)) has caused a transformation of male strobiles into female (Hashizume 1961).

Branches that have been deprived of all leaves, including those of the current season, proved incapable of further development. They tended to dry out, and the shoots that did form on them were short, weak and many of them did not expand out of buds in the spring of 1967. Thus there was a very substantial difference between the branches defoliated up to the 10th of May and those defoliated from the 24th of May onwards. Within the periods 15th of February to May the 10th and 24th of May to July the 5th no significant differences were found in the results between the defoliation dates. Each tree had a typical for it pattern of responses to defoliation (fig. 1). Furthermore differences in branch size have complicated the interpretation of results. It is noteworthy that the number of shoots with male strobiles was, depending on the tree, either correlated positively, or negatively or not at all with the total number of shoots (fig. 1). These differences in physiological responses of different trees have made it impossible to compare the effects of the time of defoliation.

On the other hand it is still possible to compare the control branches with those that have been deprived of old needles only (15 II - 10 V) and with those that have been defoliated completely (25 V - 5 VII). The results obtained are presented in table 1.

The removal of all needles (from the 24th of May onwards) has resulted in a reduction of the number of new shoots appearing on a branch and consequently also in a reduction of the number of shoots with male strobiles, however it has not affected the percentage of shoots with the strobiles. The defoliation performed before the appearance of new need-

Table 1

The effect of defoliation performed before and after the emergence of new needles in 1966 on the strobile production in 1967

	Control	Defoliation	
		till 10 V	from 24 V
Mean number of shoots per branch	55	56	12
Mean number of shoots with male strobiles	15	25	3
Mean % of shoots with male strobiles	21	45	20
Mean % of shoots with female strobiles	1,31	0,94	0

les (till the 10th of May) has not affected the number of new shoots forming on a branch but has significantly increased the number and percentage of shoots with male strobiles. The number of female strobiles that has appeared in 1967 on both control and experimental branches was so small, that it is not possible to evaluate the effect of the defoliation on the initiation of female strobiles.

## DISCUSSION

The experiment described above has shown that defoliation including the removal of needles of the current season is a harmful treatment since it makes it almost impossible for branches to develop. On the other hand removal of old needles only up to the 10th of May does not reduce the development of the branches and significantly increases the initiation of male strobiles. This is a very important result for forest tree seed production, since the treatment could be readily employed in a seed orchard. It has been often reported that in a pine seed orchard lack of pollen is the limiting factor to seed production (L ü c k e 1962, L e s t e r 1964). On seed orchards grafts usually stand at a wide spacing to permit easy access and to favour female strobile production. Open growth does not favour the production of male strobiles since these are most readily formed in shaded parts of the crown. Through defoliation performed early in the season (before the emergence of new needles) it may be possible to force certain grafts or parts of the graft crowns to produce male strobiles. In a mature tree there are zones in the crown specialized in the production of male or female strobiles and these could be induced on grafts growing in seed orchards. The extent to which this treatment would have to be employed would depend on the age of the seed orchard and on the observed natural productivity of male and female strobiles in order to obtain as early as possible sufficient pollen production for the effective pollination of all conlets.

When searching for reasons why pine reacts in such a fashion to defoliation it is not possible to ignore the impression that male strobile initiation takes place under conditions of localized malnutrition. This is also suggested by the localization of male strobiles within the crown of a tree and by the fact that shoots with male strobiles are generally shorter than vegetative ones or those with female strobiles (D a m i a n et al. 1965) and have few needles since the sites for short shoots are taken up by the male strobiles.

One may also suspect that, when a pine shoot finds itself in unfavourable nutritional conditions, as for example may happen in consequence of the almost geometric increase in the number of shoots per branch (as suggested by Moorby and Wareing 1963) or as a result of shading by other branches or adjacent trees, then male strobiles will become initiated in it. This will tend to reduce the number of needle bundles per shoot which will even further worsen the nutritional conditions. As a result when a shoot once starts to produce male strobiles it is generally unable to resume intensive growth or ability to produce female strobiles at any time in the future. Thus defoliation could prove to be a treatment that even though applied only once will have a long lasting influence. It may permanently increase male strobile production

and at the same time reduce the vegetative growth of the grafts both of which effects could be considered as beneficial in a seed orchard.

#### SUMMARY

The removal of old needles up till the 10th of May did not reduce the number of new long shoots developing on a branch in the following year and has increased the production of male strobiles. Defoliation performed later, including the removal of needles of the current season inhibited both the vegetative and generative development of the shoots (table 1). Individuals have specific for themselves correlations between the number of new shoots and the number of shoots with male strobiles per branch. It is suggested that defoliation of old needles could be used in seed orchards for the stimulation of pollen production.

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#### *Wpływ defoliacji na kwitnienie u Pinus silvestris L.*

#### Streszczenie

Na 7 drzewach w różnych terminach badano wpływ usuwania igieł na zawiązywanie kwiatów. Usuwanie do 10 maja igieł starych nie redukuje liczby nowych pędów na gałęzi w przyszłym roku, a zwiększa zawiązywanie kwiatów męskich, na-

tomiast defoliacja późniejsza obejmująca również igły bieżącego sezonu, hamuje rozwój gałęzi zarówno wegetatywny jak i generatywny (tabela 1). Poszczególne drzewa posiadają specyficzne zależności między liczbą pędów na gałęzi a liczbą pędów z kwiatami męskimi (ryc. 1).

МАЦЕЙ ГЕРТЫХ

*Влияние удаления хвои на цветение  
Pinus silvestris L.*

Резюме

На семи деревьях сосны исследовано влияние удаления хвои (в разные сроки) на завязывание цветков. Удаление старой хвои до 10 мая не редуцирует количества новых побегов на ветвях в следующем году, но усиливает образование мужских цветков. В то же время более поздняя дефолиация, захватывающая также хвою текущего сезона, тормозит как вегетативное, так и генеративное развитие ветви (таблица 1). У отдельных деревьев наблюдаются специфические связи между количеством побегов на ветви и числом побегов с мужскими цветками (рисунок 1).