Résumé

Titre de l'article: Proportion *des sexes et* caracteres *liés* au sexe chez Populus deltoides.

On a etudie dans 10 peuplements naturels de Populus deltoides de la Basse Vallee du Mississippi la proportion des sexes et les caracteres eventuellement lies au sexe. On a observe au total 551 arbres en floraison; 54% etaient mâles et 46% femelles. Un échantillon stratifie de 50 miiles et 50 femelles a montre que les mâles étaient légèrement (mais pas de façon significative) plus gros en diametre et significativement plus hauts que les femelles. On n'a trouve aucune relation entre le sexe et la forme, la rectitude, le type de branches, la densité du bois. On a pu identifier correctement a la loupe binoculaire au mois de Décembre 87% des arbres comme mâle ou femelle.

Zusammenfassung

Titel der Arbeit: *Geschlechterverhältnis* und *geschlechts*gebundene Merkmale bei *Populus* deltoides.

Das Geschlechterverhältnis und möglicherweise vorhandene geschlechtsgebundene Merkmale wurden in 10 natürlichen *Populus-deltoides-Beständen* im unteren Mississippi-Tal untersucht. Dazu wurden insgesamt 551 blühfähige Bäume herangezogen; 54% waren ♂ und 46% ♀. Bei einer geeigneten Teilprobe von 50 ♂ und 50 ♀ Bäumen zeigte sich, daß die ♂♂ etwas (nicht signifikant) dicker, dagegen signifikant höher waren, als die ♀♀. Aber keine Beziehungen wurden gefunden zwischen dem Geschlecht und der Form, der Geradheit des Stammes, der Verzweigung oder dem spezifischen Gewicht des Holzes. 87% aller dieser später blühenden Bäume konnte man bereits im Dezember vorher durch die Prüfung der Blütenknospen mit dem Fernglas korrekt als ♂ oder ♀ identifizieren.

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Rooting, Shoot Development, and Flowering of Jack Pine Needle Fascicles

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Vegetative propagation has found wide application in tree improvement work. The technique is a useful tool, not only for preserving and multiplying valulable tree germ plasm but also in analyzing the inherent characteristics of individual trees, establishing breeding arboreta where controlled pollinations can be made on a large scale, developing seed orchards, and conducting a wide range of experiments where it is desirable or essential to use clonal lines.

The present study was prompted by a need for a technique whereby large clones of jack pine (Pinus banksiana LAMB.) could be established in a relatively short time. The technique desired should provide not only a way of producing ramets on their own roots but also a means of vegetatively propagating the smallest possible unit of a jack pine. The smallest part of a pine tree which can be propagated in vivo is the needle fascicle. The ability to propagate individual trees by rooting fascicles would provide a most useful technique for isolating somatic mutations in our present studies of induced mutation.

Previous Studies

Needle fascicles of the genus Pinus have been rooted previously by numerous investigators including DELISLE (1), THIMANN and DELISLE (5), TODA (6, 7, 8), JECKALEJS (3), ZAK and MCALPINE (9), ISIKAWA and KUSAKA (2), and REINES and MCALPINE (4).

DELISLE (1) noted that in eastern white pine *(Pinus strobus* L.) rooted needle fascicles failed to survive unless adventitious buds had previously been caused to develop in them. THIMANN and DELISLE (5) later reported that white pine fascicles rooted at least as well as cuttings. Because of the inability of the rooted fascicles to survive without an active bud, these investigators concluded that the application of this technique in tree propagation would be limited.

TODA (6, 7) found that over one-half of the fascicles of Japanese red pine (Pinus densiflora SIEB. & ZCCC.) and of Japanese red pine-black pine (Pinus thunbergii PARL.) hybrids rooted when taken from 1-year-old trees but none rooted from 13-year-old trees. He does not rnention shoot development on the rooted fascicles. In some cases roots were formed from the fascicular buds in the position where shoots normally develop. TODA (8) was later able to improve the rootability of the fascicles by subjecting the twigs to red light during the summer previous to propagation.

JECKALEJS (3) was able to root up to 70% of the fascicles from 2-year-old red pine (Pinus resinosa AIT.). He speculated on the possibility of inducing shoot development from the fascicles but provided no data showing such development. To induce fascicular buds to develop, he suggested excision of the distal portions of new shoots at the beginning of the growth period.

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Shortleaf pine (*Pinus echinata* MILL.) and slash pine (*Pinus elliottii* ENGELM.) needle fascicles from seedlings were rooted by ZAK and MCALPINE (9) with up to 18 percent success in shortleaf pine and 58 percent in slash pine. However, only one fascicle produced a shoot after 3 months. REINES and MCALPINE (4) found that, although buds developed on slash pine needle fascicles, rarely did the proliferated buds result in the formation of new stems on rooted shoots.

ISIKAWA and KUSAKA (2) attempted to force advanced development of fascicular buds in Japanese black pine by pruning the terminal branch buds in April and August. The latent fascicular buds that were forced into development in this manner were left on the trees until the following March when they were cut from the trees and placed in a rooting medium. Fascicles of this type obtained from 12-year-old trees and treated with indolebutyric acid gave up to 54% rooting in a soil medium. The rooted fascicles developed into upright trees.

Thus, except for the ISIKAWA and KUSAKA study, vegetative propagation of needle fascicles has been limited not only by the difficulty of obtaining rooting but more severely by the difficulty of obtaining bud development and shoot development.

Shearing Experiments

The ortets used in this study were 2- and 5-year-old jack pines growing in the Hugo Sauer Nursery at Rhinelander, Wisconsin. To stimulate development of fascicular buds, the terminal bud of the main stem and five lateral terminal buds were removed on 40 five-year-old trees, and the terminal bud was removed on 140 two-year-old trees on July 8, 1960. An equal number of trees in the same nursery beds were left unsheared. Fascicular bud development following shearing was evident by the first week in August on the 2-year-old trees, but not until about 2 weeks later in the 5-year-old trees.

The influence of shearing in stimulating fascicular bud development was studied in 10-tree samples in both 2- and 5-year-old trees. A larger number of fascicular buds developed on the main stem of 2-year-old than of 5-year-old trees. This was true both in trees in which the terminal bud was sheared and in trees left unsheared. Shearing of the terminal bud on five lateral branches in the 5-year-old trees added an average of more than 9 fascicular buds per tree. Including buds formed on the lateral branches, up to 30 fascicular buds per sheared 5-year-old seedling were obtained. The maximum number of fascicular buds obtained per 2-year-old seedling was 21. No fascicular buds developed on unsheared lateral branches on 5-year-old trees. An average of only one fascicular bud developed on the stem of an unsheared 5-year-old tree.

Rooting Experiments

Following the shearing tests, three rooting experiments were carried out. These used plant material at different stages of the annual physiological cycle and compared different bench conditions in the greenhouse.

The twelve treatment combinations used in the three experiments were as follows:

Ortet treatment	Ortet age (years)	Indolebutyric acid (IBA) (Conc.-percent)	Treatment symbol
Sheared	2	.1	S_2.1
		.8	S_2.8
		0	S_2 0
	5	.1	S_5.1
		.8	S_5.8
		0	S_5 0
Not sheared	2	.1	NS_2.1
		.8	NS_2.8
		0	NS_2 0
	5	.1	NS_5.1
		.8	NS_5.8
		0	NS_5 0

Fascicles with predeveloped buds were used from the sheared trees. Normal fascicles without such buds were used from the unsheared trees.

Ten trees from each age and shearing class were randomly selected from those available for use in each experiment. Ten fascicles were used per treatment. Treatments were replicated twice within each experiment and were randomized within replications.

In all experiments the fascicles were placed in a natural, fine sand rooting medium in a greenhouse immediately following removal from the seedlings and application of the appropriate hormone treatment. A razor blade was used to sever the fascicles. A shield-shaped piece of bark was removed with each to help maintain the fascicles in an upright position in the rooting medium. The rooting hormones used were "Hormodin No. 1" and "Hormodin No. 3"

Table 1. — Rooting and survival of jack pine needle fascicles from unchilled trees as affected by shearing versus no shearing, by age of ortet, and by IBA treatment.

Experiment I — Established September 1, 1960[1])

Treatment[2])	Nov. 17, 1960; No. of Fascicles				June 12, 1961; No. of Fascicles				Dec. 6, 1961, No. of Fascicles	
	Living		Rooted		Living		Rooted		Rooted and Developing Shoots	
	Block I	Block II	Block I	Block II	Block I	Block II	Block I	Block II	Block I	Block II
S_2.1	10	10	0	0	8	8	1	3	2	4
S_2.8	10	10	1	0	10	10	3	0	3	2
S_2 0	10	10	0	0	8	7	0	1	3	3
S_5.1	9	8	0	0	9	7	0	0	0	0
S_5.8	4	5	0	0	2	5	0	0	0	0
S_5 0	7	9	0	0	6	9	0	0	0	0
NS_2.1	10	10	0	0	7	10	0	2	0	0
NS_2.8	10	10	0	0	8	8	1	2	0	0
NS_2.0	10	10	0	0	5	8	1	1	0	0
NS_5.1	10	10	0	0	9	6	0	0	0	0
NS_5.8	3	8	0	0	2	8	0	0	0	0
NS_5 0	10	10	0	0	10	9	0	0	0	0

[1]) There were 10 fascicles in each treatment within each replicate.

[2]) Code explanation in text.

or 0.1 percent and 0.8 percent IBA, respectively. These were applied by dipping the freshly cut ends of the fascicles into the homone powder.

Experiment I

On September 1, 1960, the first experiment was established according to the above design. At this time the fascicular buds on the sheared trees appeared to be still enlarging. Elongation growth in the unsheared trees had ceased.

The fascicles were placed into the sand rooting medium in a greenhouse bench to a depth that left the buds exposed to light. Natural daylength was supplemented with fluorescent and incandescent light to provide a 20-hour photoperiod. An intermittent overhead mist system maintained a moist medium and high humidity. Temperature was maintained at approximately 70° F. during the day and 60° F. at night until mid-June, 1961. Subsequent maximum temperature ranged up to 15° higher.

About 11 weeks later, on November 17, 1960, the fascicles were examined for survival and rooting *(Table 1)*. Survival was good except in treatments S_5.1, S_5.8, $S_5$0 and NS_5.8. All of these involved fascicles from 5-year-old trees. The particularly poor survival in treatments S_5.8 and NS_5.8 suggests that 0.8 percent IBA treatment on fascicles from 5-year-old trees may be detrimental to their survival. Although only one fascicle had rooted in the 11-week period, all surviving fascicles showed callous formation on the cut end at the base of the fascicles.

Following this first examination, the fascicles were potted in 2-1/4" square peat pots and placed in a cold room operated at 36° F. This was an attempt to provide the cold exposure that would permit the fascicles to break dormancy in the greenhouse. After about 10 weeks in the cold room, the fascicles were again moved to the greenhouse maintained under the same temperature, photoperiod, and mist conditions as before.

On June 12, 1961, 41 weeks after initiation of the experiment, the fascicles were again examined *(Table 1)*. Survival was reduced from that in the previous examination, probably partially as a result of dry conditions during the cold treatment. Some fascicles in all treatments involving 2-year-old trees rooted. None rooted in the 5-year-old group. Following this examination the fascicles were transplanted into 2-1/2" clay pots and were removed from the mist system and watered as required.

The final evaluation of the fascicles in Experiment I was made on December 6, 1961, approximately 65 weeks after initiation of the experiment. At this time only those fascicles that rooted and developed shoots remained alive *(Table 1)*. This included 30 percent of the fascicles in treatments S_2.1 and $S_2$0 and 25% in treatment S_2.8, all treatments involving fascicles taken from sheared 2-year-old trees. Fascicles from unsheared trees of this age, which had roots at the time of the previous examination, failed to develop shoots and died. This indicates that fascicles without buds may be rooted but predeveloped buds are necessary to obtain shoot growth. The results further show that rooting was more frequent in 2- than in 5-year-old trees and occurred more frequently in fascicles from sheared than from unsheared trees. No effect of the hormone treatments on rooting was evident.

Experiment II

The second experiment, established on January 26, 1961, was carried out in the same manner as the first except that fascicles were collected from trees exposed to winter chilling. The exposure of the trees in the nursery until this date was believed to be sufficient to provide the cold treatment necessary for buds to break dormancy when favorable growing conditions were provided. Thus, no further chilling treatments were provided, and the fascicles were kept in the greenhouse throughout the experiment. Environmental conditions were the same as those in Experiment I.

Examination of the fascicles on April 6, 1961, 10 weeks after placement in the rooting medium, showed 90 percent survival *(Table 2)*. None of the living fascicles had rooted, but all had formed callous tissue at their base. A possible detrimental effect of IBA on fascicles from 5-year-old trees was again evident, although not as strongly as in Experiment I. Following this examination the fascicles were potted in 2-1/4" square peat pots and replaced under the mist on a greenhouse bench.

A second examination on June 13, 1961, about 20 weeks after initiation of the experiment, showed that rooting had begun in fascicles from 2-year-old trees. None from 5-year-old trees had formed roots. No other difference between treatments was evident. Survival was reduced from that

Table 2. — Rooting and survival of jack pine needle fascicles from chilled trees as affected by shearing versus no shearing, by age of ortet, and by IBA treatment.
Experiment II — Established January 26, 1961[1])

Treatment[2])	April 6, 1961; No. of Fascicles — Living[3]) Block I	Block II	June 13, 1961; No. of Fascicles — Living Block I	Block II	Rooted Block I	Block II	Dec. 6, 1961, No. of Fascicles — Rooted and Developing Shoots Block I	Block II
S_2.1	10	10	7	9	0	0	0	1
S_2.8	10	8	10	5	0	1	2	0
S_2 0	10	10	10	9	0	1	3	4
S_5.1	7	10	4	7	0	0	0	0
S_5.8	7	8	3	3	0	0	0	0
S_5 0	9	9	9	8	0	0	0	0
NS_2.1	10	10	10	10	1	0	0	0
NS_2.8	10	7	9	5	0	0	0	0
NS_2 0	10	10	10	10	0	0	0	0
NS_5.1	9	6	9	6	0	0	0	0
NS 8	10	10	8	9	0	0	0	0
NS_5 0	10	10	9	8	0	0	0	0

[1]) There were 10 fascicles in each treatment within each replicate.
[2]) Code explanations in text.
[3]) No fascicles had rooted by this date.

at the first examination. The fascicles from sheared 5-year-old trees treated with 0.8 percent IBA showed lowest survival followed closely by similar fascicles treated with 0.1 percent concentration of the hormone. Upon completion of this examination the fascicles were potted in 2-1/2" clay pots. The pots were subsequently watered by hand rather than with the mist system.

Final examination of the fascicles on December 6, 1961, showed that the best rooting, 35 percent, was obtained in the fascicles from sheared 2-year-old trees receiving no hormone treatment. The 0.8 and 0.1 percent hormone concentration treatments resulted in 10 and 5 percent rooting. Fascicles in other treatments showed some root development but none survived, apparently as a result of failure to produce shoot growth.

Experiment III

The third experiment was made with fascicles collected at the same time as those in the second experiment. The fascicles were placed into the sand rooting medium on January 27, 1961. This experiment, however, was installed in a heated greenhouse bench to study the influence of a heated rooting medium on rooting of fascicles, by comparison with Experiment II.

Thermostatically controlled heating cables, installed 4 inches below the surface of the sand, maintained the sand temperature ¼ inch below surface at 72° F. during the day, and 65° F. at night. This heating schedule was continued until the first examination of the fascicles for rooting on April 6, 1961. Other greenhouse conditions were the same as those in the first two experiments.

Examination of the fascicles on April 6, 1961, 10 weeks after their placement in the sand medium, showed that survival was lower than in Experiment II at the same time (*Table 3*). Since the only difference in conditions between these experiments was the heated rooting bed in Experiment III, the higher rooting medium temperatures may have played a role in the increased mortality in Experiment III. As in the first two experiments, survival among treatments was poorest in fascicles from sheared 5-year-old trees treated with 0.8 percent IBA; only 10 percent survived. Survival of fascicles in this treatment was, in fact, even poorer in this experiment than in the first two experiments. This suggests that the detrimental influence of the more concentrated hormone treatment was increased in the heated medium. None of the fascicles had rooted during the 10-week period, but all showed some callous formation. Following the examination, the fascicles were transplanted into peat pots as in the other experiments.

The second examination on June 14, 1961, after 20 weeks, revealed that survival had decreased slightly from 10 weeks earlier. Rooting had begun in fascicles from sheared 2-year-old trees but in no others. Best rooting at this time occurred in fascicles from sheared 2-year-old trees treated with 0.1 percent IBA where 20 percent of the fascicles had already rooted. The surviving fascicles were transplanted into clay pots at this time as in the other experiments.

The final examination of the fascicles in this experiment was made on December 6, 1961. None of the fascicles failing to develop both roots and shoots survived. The only survivors were those from sheared trees. Among these, best rooting — 70 percent — was obtained in fascicles from 2-year-old trees treated with 0.1 percent IBA. Other treatments of fascicles from sheared trees showed 5- to 15 percent rooting. Fascicles from sheared 5-year-old trees treated with 0.8 percent IBA were exceptions; none of these rooted.

Discussion

Shoot Development

Not all fascicles that rooted developed shoots. Apparently a well-developed bud formed before the fascicles are removed from the ortet is necessary to insure shoot development when the fascicle has formed roots. This was evident in treatments $NS_2.1$, $NS_2.8$ and NS_20 in Experiment I. Fascicles without preformed buds rooted and remained alive for at least 9 months, but they died during the next 3 months without forming a bud or shoot. Only fascicles from sheared trees, all of which had preformed buds, developed shoots during the course of these experiments.

The shoots that arose from the rooted fascicles developed into fairly normal seedling-like stems (*Fig. 1*). Frequently, the first foliage appearing on the shoots was simple, scale-like leaves, but gradually normal needle fascicles were produced. With few exceptions, the newly developed shoots exhibited a uniform tendency to develop normal vertical stems and showed strong apical dominance. If desired, these shoots could be sheared at this stage of development to again force fascicular bud development.

Table 3. — Rooting and survival in a heated greenhouse bench of jack pine needle fascicles from chilled trees as affected by shearing versus no shearing, by age of ortet and by IBA treatment. Experiment III — Established January 27, 1961[1])

Treatment[2])	April 6, 1961; No of Fascicles		June 14, 1961; No. of Fascicles				Dec. 6, 1961, No. of Fascicles	
	Living[3])		Living		Rooted		Rooted and Developing Shoots	
	Block I	Block II	Block I	Block II	Block I	Block II	Block I	Block II
$S_2.1$	9	10	9	10	4	0	6	8
$S_2.8$	10	6	9	3	0	0	1	1
$S_2 0$	7	10	6	10	0	1	0	3
$S_5.1$	3	7	3	6	0	0	2	0
$S_5.8$	1	1	1	1	0	0	0	0
$S_5 0$	7	6	6	6	0	0	1	0
$NS_2.1$	10	9	8	8	0	0	0	0
$NS_2.8$	7	9	4	8	0	0	0	0
$NS_2 0$	10	10	10	9	0	0	0	0
$NS_5.1$	10	7	9	7	0	0	0	0
$NS_5 8$	5	8	5	7	0	0	0	0
$NS_5 0$	9	8	6	8	0	0	0	0

[1]) There were 10 fascicles in each treatment within each replicate.
[2]) Code explanations in text.
[3]) No fascicles had rooted by this date.

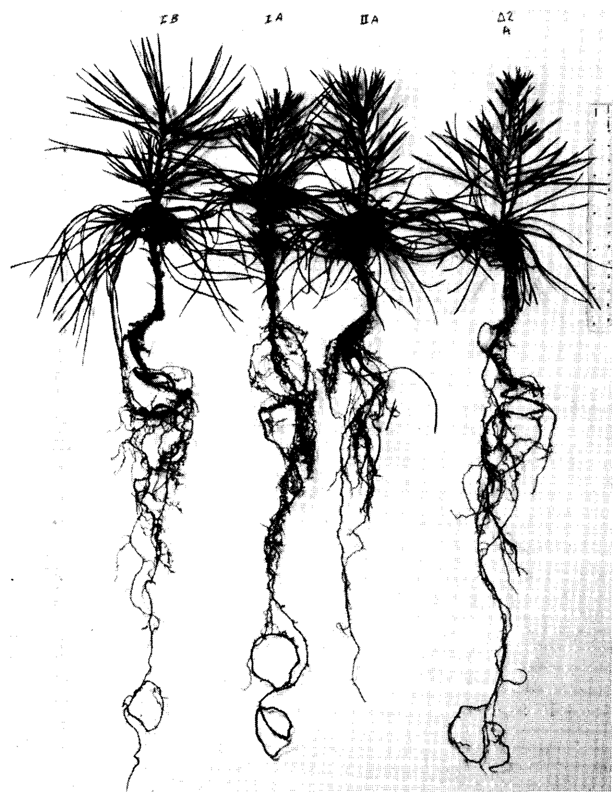

Figure 1. — Jack pine needle fascicles 15 months after placement in rooting medium. Normal, vertical shoots and extensive root systems developed on most rooted fascicles.

By repeating the propagation procedure large clones could be readily established as needed.

The relatively rapid shoot development of the rooted fascicles was undoubtedly related to the extensive root system formed by the end of the first year while the roots were confined to a 2-1/2 inch pot.

Flowering of Rooted Fascicles

A most unusual phenomenon noted in this study was the production of male strobili on two rooted fascicles *(Fig. 2)*. Both fascicles originated from sheared 2-year-old trees, and both were found in Experiment III in which the rooting bed was heated. One of the fascicles had been treated with 0.1% IBA; the other had received no hormone treatment.

Jack pine seedlings are known occasionally to produce strobili precociously. Three-year-old and, very rarely, two-year-old seedlings have been noted with both male and female strobili. For example, in an examination of 100,000 three-year-old jack pine seedlings in a dense nursery bed, approximately 0.3 percent of the seedlings were found to bear first-year conelets[2]). Although no count was made of the seedlings bearing male strobili in the seedbed used in the present study, they appeared to occur with about equal frequency.

The strobili observed on the rooted fascicles are unusual, not only because they occurred on fascicles from 2-year-old seedlings, but because differentiation of the strobili apparently occurred following the removal of the fascicles from the ortet, and during the root initiation period. The strobili became evident during October 1961 about 10 months after initiation of the propagation procedure in the rooting bed. Each ramet had three strobili at the same position on the plant, but they did not mature simultaneously. Pollen from the earliest was shed in early January and from the last not until late in March. Since normally the strobili are differentiated nearly a year previous to the time they shed pollen, it appears that in the present study differentiation must have begun shortly after shoot development was initiated. A definite explanation of the causes of the strobilus production in this experimental material cannot be offered, but the possibility cannot be discounted that the method of handling the fascicles during the study may have resulted in a stimulus to strobilus development. This possibility needs to be explored further.

[2]) Rudolph, T. D., 1962: Unpublished report on file at the Institute of Forest Genetics, Rhinelander, Wisconsin.

Conclusions

The results of the three experiments in this study provide preliminary information and permit conclusions about the propagation of jack pine by rooting needle fascicles:

1. Shearing the terminal buds from seedlings in early July, about the time elongation growth is completed, results in the development of numerous fascicular buds potentially capable of developing into normal vegetative long shoots.
2. Fascicles without preformed buds, taken from unsheared trees, do not develop shoots although they may form roots.
3. Cold exposure is desirable to hasten the breaking of dormancy in the fascicular buds.
4. Fascicles from 2-year-old trees root more readily than those from 5-year-old trees.
5. The application of 0.8 percent IBA was detrimental to the survival of fascicles, particularly those taken from 5-year-old trees.
6. Best rooting was obtained in fascicles from 2-year-old trees when propagated under 20-hour photoperiod in a heated rooting medium, and treated with 0.1 percent IBA. Without bottom heat, application of rooting hormone did not increase rooting.

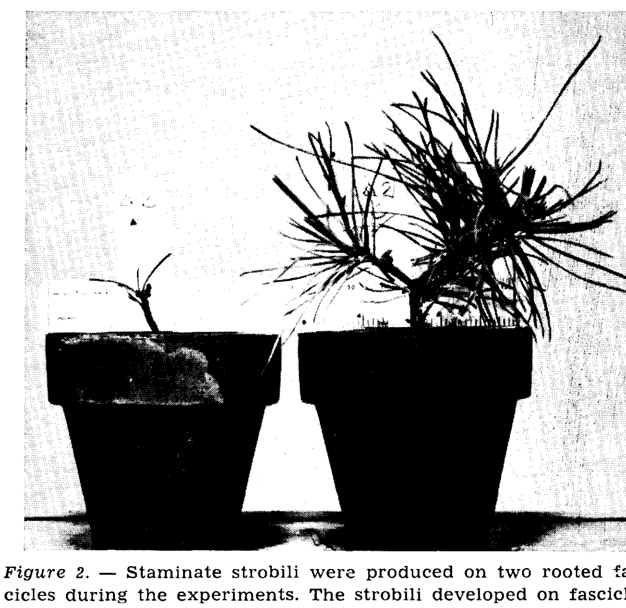

Figure 2. — Staminate strobili were produced on two rooted fascicles during the experiments. The strobili developed on fascicles from 2-year-old seedlings and became evident about 10 months after placement in the rooting medium. Viable pollen was shed from individual strobili beginning about 3 months later, and the last strobiles shed their pollen more than 5 months after the strobili were first descernible.

7. In the best treatment 70 percent of the fascicles rooted and produced shoots. This success in rooting fascicles makes the technique practical in vegetatively propagating young jack pine ramets on their own root systems. This technique is now being used for the isolation of somatic mutations.
8. Shoots formed on rooted fascicles develop into normal, vertical stems.
9. Sexual buds can occasionally develop on newly rooted fascicles. The possibility of stimulating such early strobilus production needs to be studied further.
10. The results of this study indicate the need for further research on such problems as (a) the tree-age effect in rooting fascicles, (b) the stimulation of well-developed fascicular buds, (c) the environmental requirements for optimum rooting of fascicles, and (d) a means of rapidly breaking the dormancy in fascicular buds.

Résumé

Titre de l'article: *Enracinement, développement et floraison de boutures de fascicules d'aiguilles de Pinus banksiana.*

Les résultats des trois expériences de cette étude donnent une information préliminaire et permettent de tirer quelques conclusions sur la multiplication végétative de *Pinus banksiana* par bouturage de fascicules d'aiguilles:

1. Le pincement des bourgeons terminaux sur des semis, au début de Juillet, à peu près au moment où la croissance en longueur est terminée, aboutit au développement de nombreux bourgeons fasciculaires capables de se développer en rameaux longs végétatifs normaux.
2. Les fascicules sans bourgeons préformés, pris sur des arbres non pincés, ne développent pas de pousses, bien qu'ils puissent former des racines.
3. L'exposition au froid facilite la levée de dormance des bourgeons fasciculaires.
4. Les fascicules pris sur des semis de 2 ans s'enracinent plus rapidement que ceux pris sur des plants de 5 ans.
5. L'application d'une solution d'acide indol butyrique à 0,8% est défavorable à la survie des fascicules, en particulier ceux pris sur des plants de 5 ans.
6. Le meilleur enracinement a été obtenu avec des fascicules d'aiguilles pris sur des plants de 2 ans, mis en végétation sous une photopériode de 20 heures avec chaleur de fond, et traités avec une solution à 0,1% d'acide indol butyrique. Sans chaleur de fond, l'application de phyto-hormone n'améliore pas l'enracinement.
7. Dans le meilleur traitement, 70% des fascicules d'aiguilles se sont enracinés et ont produit des pousses. Il est donc possible dans la pratique de multiplier par voie végétative de jeunes *Pinus banksiana* sur leurs propres racines. Cette technique est actuellement employée pour l'isolement de mutations somatiques.
8. Les rameaux formés sur les fascicules d'aiguilles enracinés se développent en plants verticaux tout à fait normaux.
9. Des bourgeons florifères peuvent parfois apparaître sur des fascicules récemment enracinés. La possibilité de stimuler une telle floraison précoce demande de nouvelles études.
10. Les résultats de cette étude indiquent le besoin pour de nouvelles recherches sur des problèmes tels que:
    a) l'effet de l'âge sur l'enracinement,
    b) la stimulation de bourgeons fasciculaires bien développés,
    c) les exigences écologiques pour le meilleur enracinement des fascicules d'aiguilles,
    d) les moyens de lever rapidement la dormance des bourgeons fasciculaires.

Zusammenfassung

Titel der Arbeit: *Über Bewurzelung, Sproßbildung und Blühen von Nadelbündeln der Pinus banksiana.*

Drei Experimente erlauben vorläufige Schlüsse über die Vermehrungsmöglichkeiten durch die Bewurzelung von Nadelbündeln. — Anfang Juli von Sämlingen entnommene Terminalknospen bilden zahlreiche Nadelbündelknospen aus, die normale Langtriebe entwickeln können. Nadelbündel ohne vorgebildete Knospen tun dies nicht. Kältebehandlung beschleunigt die Beendigung der Knospenruhe. Bündel von 2 Jahre alten Pflanzen bewurzeln sich leichter als solche von 5 Jahre alten. Die Anwendung von 0,8% Indolylbuttersäure (IBS) wirkte sich nachteilig auf das Überleben der Bündel aus. Die beste Bewurzelung wurde erhalten, wenn die Bündel von 2jährigen Pflanzen im 20-Stunden-Tag in einem erwärmten Medium mit 0,1% IBS behandelt worden waren. Unter den günstigsten Behandlungsbedingungen konnten 70% der benutzten Nadelbündel bewurzelt und zur Sproßbildung gebracht werden. Solche Sprosse wachsen normal aufrecht. Bewurzelte Bündelpflanzen entwickeln fallweise schon früh Blütenknospen, eine Erscheinung, die weiter untersucht werden soll. — Zu klären ist ferner noch: (a) der Einfluß des Baumalters auf die Bewurzelung, (b) Möglichkeiten zur Stimulation gut entwickelter Bündelknospen, (c) Umweltbedingungen für die beste Bewurzelung dieser Bündel, (d) geeignetste Möglichkeiten für die rasche Beendigung der Knospenruhe bei den Bündelknospen.

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