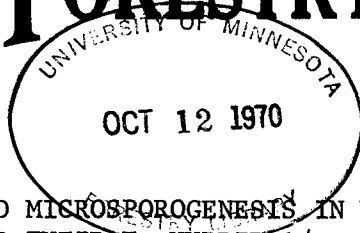


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## PHENOLOGY OF NORMAL AND FORCED MICROSPOROGENESIS IN WHITE AND BLACK SPRUCE AND THEIR F<sub>1</sub> HYBRID <sup>1/</sup>

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White and black spruce are found sympatrically in a transcontinental band extending from the northeastern United States and Nova Scotia, across Canada to Alaska. In Minnesota, these are both valuable pulp species. One natural hybrid tree was discovered between white and black spruce near Cromwell, Minnesota (Little and Pauley, 1958), flanked by a specimen of white spruce and one of black spruce. A study was initiated in 1961 to investigate the possible uses of the hybrid in future spruce improvement programs. Phenological and cytological characteristics of microsporogenesis were studied in white and black spruce and their F<sub>1</sub> hybrid, and the feasibility of obtaining viable pollen from each of these taxa by early forcing was determined (Winton, 1964a).

During the summer of 1963, male buds of white spruce trees planted at St. Paul were recognized in the third week of August by their large and plump shape as well as their smooth surface. In contrast, both female and vegetative buds were longer and had loosely appressed to reflexed scales. In this late-summer condition, male, female, and vegetative buds of the same tree were all about the same shade of brown. However, the color of buds observed on about 30 trees varied from light-tan to tan, brown, dark brown, and dark reddish-brown. By August 30, the pointed tips of the male buds had darkened, and during September and October the lower parts did also. By November the male buds on most trees were conspicuously darker than either the female or vegetative buds.

Among the trees near Cromwell, the winter color of the male buds was purplish-brown on white spruce, light reddish-tan on the hybrid, and light reddish-brown on black spruce. Male buds on white spruce and the hybrid were characteristically darker than female and vegetative buds; however, on black spruce they were distinctly lighter.

Male buds on white spruce were predominantly terminal; but were also found occasionally in lateral positions along 1-3 year old twigs, and even in whorls of three at the base of young twigs near the tops of older trees. Male buds on the hybrid were about equally represented in terminal and lateral positions.

Average bud sizes in fall condition are shown in the Table. An analysis of the original data showed that terminal male buds and lateral vegetative buds were generally shorter and smaller in diameter than terminal female buds of the same tree. The size of male buds did not significantly change between early-September and their enlargement the following spring. Male, female, and vegetative buds from the trees near Cromwell were also measured in December 1963. Their average dimensions (Table) show that male buds were significantly different for both length and diameter among the three taxa. With the return of warm weather in April, meiosis was initiated, accompanied by a significant increase in both the length and diameter of male buds. As male buds increased in size, they also turned slightly lighter in color and the tips of the bud

<sup>1/</sup> This report is based on a portion of the author's Ph.D. thesis (Winton, 1964a).

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scales became loosened. With the initiation of meiosis the microsporangiate scales of the strobilus turned progressively red from base to apex. The red color of the microsporangiate scales was darker for black than for white spruce, with the hybrid intermediate.

Before the initiation of meiosis, male buds averaged 4.4 mm in length and 2.5 mm in width on the white spruce tree #6 at St. Paul in 1962. On another nearby white spruce tree (#10), the average dimensions were 5.9 mm x 3.2 mm. After first division of meiosis occurred, male buds of trees #6 and #10, respectively, averaged 6.0 mm x 3.0 mm and 6.7 mm x 3.5 mm. Analysis of the original data showed that length was significantly different between trees as well as between stages of meiosis, and diameter was different between stages. This means that the onset of normal meiosis on white spruce at St. Paul was associated with a significant increase in both the length and diameter of male buds.

Several forcing tests were made during the period January-March, 1962, which are discussed elsewhere (Winton, 1964a, 1964b). There were no detectable effects of either the original height or directional aspect of male buds within a particular tree at St. Paul or near Cromwell on the time required to force pollen. Furthermore, there was no difference in time of forcing between individuals of a taxon from the same locality associated with height, aspect, or size of cutting. In one such test made March 21, the average number of days to force first-pollen was  $19.6 \pm 3.7$  for white,  $23.1 \pm 4.6$  for the hybrid, and  $25.3 \pm 3.2$  days for black spruce. During the three years of study (1961-1963), material collected at the same time from the three taxa forced in the greenhouse always shed in this same order.

Measurements made during forced development showed that the initiation of meiosis, as well as subsequent stages of microsporogenesis, were not associated with a significant increase in the size of male buds. However, during forcing, as during normal development, the length and diameter of the strobili as well as the length of individual microsporophylls on the strobilus increased significantly with the onset of meiosis. Evidently the male bud scales could not loosen during forcing at the same rate observed for normal microsporogenesis. Despite the fact that during forcing the stages of meiosis could not be determined by the size of male buds, the change in color of the microsporangiate scale from light green to light red was associated with the initiation of meiotic prophase, as was also observed during normal development.

#### LITERATURE CITED

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Table. Average length and diameter in mm of buds from white (W), the hybrid (H), and black (B) spruce in the fall of 1963.

Location	Tree	Male	Female	Vegetative
St. Paul	#6 W	4.5 x 2.5	5.4 x 2.7	5.6 x 2.5
	#10 W	4.0 x 2.4	6.6 x 3.6	4.4 x 2.3
Cromwell	W	5.0 x 2.7	4.9 x 3.2	4.8 x 2.6
	H	3.3 x 2.1	4.4 x 2.1	4.1 x 2.4
	B	2.7 x 1.9	4.0 x 2.0	3.4 x 2.2