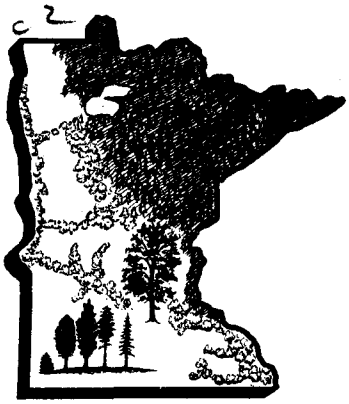

MINNESOTA FORESTRY NOTES

No. 78
April 15, 1959

RESULTS OF ONE-PARENT PROGENY TESTS RELATING TO THE INHERITANCE OF OPEN AND CLOSED CONES IN JACK PINE[1]

T. D. Rudolph, R. E. Schoenike, and T. Schantz-Hansen[2]

The cones of jack pine (Pinus banksiana Lamb.) are usually described as serotinous or closed, but open cones appear frequently on trees in the southern portion of the range.[3] Although variation in this character has been noted, the mode of inheritance is not known. The observations summarized here provide some evidence on the inheritance of closed and open cones.

In Minnesota the closed-cone character is predominant on jack pine in the northeast but is believed to show a clinal change to the open-cone type in the south.[4] On the Cloquet Forest, the closed-cone condition is predominant, but trees with open cones are widely scattered over the area. Hence, open-pollinated seeds from trees with either cone type are available on the same site.

In 1939 individual tree collections of open-pollinated cones were made from ten closed-cone and eighteen open-cone trees scattered through the Cloquet Forest. The seeds were sown in the Cloquet Research Center nursery in 1940 and 1941, grown for two years, and transplanted to an open area, formerly a nursery site. The progenies were transplanted in randomized square plots of 25 trees, at a spacing of 5 x 5 feet. One block of 28 plots was planted in 1942, and a second block of 23 plots was planted in 1943. Five of the progenies from the open-cone trees were not included in the second block. These plantings were part of a seed source study including over 30 jack pine seed sources.[5]

During the summer of 1957, all surviving trees on the two plots of each of the 28 progenies were examined and the cone type determined. The trees were classified as follows: (1) closed, trees with all or practically all closed cones; (2) open, trees with all or practically all open cones; (3) mixed, trees with approximately equal frequency of open and closed cones. Tables 1 and 2 give for each mother tree the total number of surviving, cone-bearing offspring of each cone type.

The progenies derived from open pollinated, open-cone mother trees showed an approximate overall cone type ratio of 1 closed: 2 open: 1 mixed. However, the progenies from individual mother trees varied widely from this ratio indicating a probable heterozygous condition in the parent trees. The progenies of the open pollinated, closed-cone mother trees showed an overall cone-type ratio of 5 closed:

1/ This study was made possible by a grant from the Charles K. Blandin Foundation, Grand Rapids, Minnesota.

2/ Respectively, Research Forester, Lake States Forest Experiment Station; Research Assistant, and Professor, School of Forestry, University of Minnesota.

3/ Schoenike, R. E., T. D. Rudolph, and T. Schantz-Hansen. 1959. Some Cone Characteristics in a Jack Pine Seed Plantation. Minnesota Forestry Notes, No. 76.

4/ Rudolph, T. D., W. J. Libby, and S. S. Pauley, 1957. Jack Pine Variation and Distribution in Minnesota. Minnesota Forestry Notes No. 58.

5/ Schantz-Hansen, T. and R. A. Jensen. 1954. A Study of Jack Pine Source of Seed. Minnesota Forestry Notes No. 25.

Published by the School of Forestry, University of Minnesota, St. Paul 1, Minnesota, cooperating with the Division of Forestry, Minnesota Conservation Department, and Forest Industries of Minnesota

1 open: 2 mixed. With the exception of the progeny derived from mother tree No. 8, the ratios of individual progenies were remarkably consistent. (Excluding the progeny of tree No. 8, a chi-square test against the overall ratio as the expected value resulted in a p value of .75). This suggested that the closed-cone mother trees may be relatively homozygous for this character. The progeny of tree No. 8 also showed an approximate 5:1:2 ratio in one plot but a 1:2:1 ratio in the other. No explanation can be given for the difference between plots in this case.

A chi-square test applied to the progeny of open-cone mother trees and the progeny of the closed-cone mother trees, using the ratio in the total of both groups as the expected value, resulted in a highly significant difference between the ratios in the two progeny groups. Because the progenies have been grown on a reasonably uniform site this difference is evidence in support of the hypothesis that the open- or closed-cone characteristic is under strong genetic control.

Since the closed-cone condition in the Cloquet Forest is more common, the assumption may be made that the greatest amount of pollen comes from closed-cone trees. Under this assumption, the ratios observed in the progenies could not result if the expression of this cone character was controlled by a single pair of genes, whether dominance is present or not. Hence, the results support the hypothesis that more than one pair of genes is involved in the inheritance of this character. The mixed-cone type, an intermediate class, could then be interpreted as resulting from genotypes that are intermediate between open and closed. In this case the phenotypic expression of the character would fluctuate with changes in environmental conditions.

Again assuming that available pollen is predominantly of the closed-cone type, the presence of approximately twice as many open-cone as closed-cone trees in the progeny derived from the open-cone mother trees suggests that the open-cone is, in some way, dominant to the closed-cone condition. On this assumption, the small proportion of open-cone progeny derived from closed-cone mother trees would be obtained by crosses with open-cone type pollen; and the large proportion of closed-cone progeny derived from these trees would be obtained by crosses with closed-cone type pollen. This suggests that the closed-cone mother trees are both recessive and relatively homozygous for this cone character. The mixed-cone type could result from crosses of infrequent heterozygous closed-cone mother trees with heterozygous open-cone or mixed-cone pollen parents.

Another possible interpretation of the results is suggested because the wind-pollinated progeny of open- and closed-cone types are mainly those shown by the female parent. The condition is more pronounced in the closed-cone progeny than in those having open-cones. A possible explanation of this maternal influence may be that extra-genic or cytoplasmic transmission of the hereditary material controlling the expression of this characteristic is involved. Actually none of the hypotheses are subject to being tested.

Suggestive as the data may be, inferences are limited by a small sample size in some of the progenies due to mortality and a failure of some trees to produce cones, and by a design established primarily for other purposes.

TABLE 1

Cone characteristics of the progenies from open-cone mother trees.

Tree No.	Closed	Open	Mixed	Total
	No. of individuals			
1	1	26	8	35
2	4	27	5	36
3	7	25	12	44
4	6	22	4	32
5	2	13	4	19
6	12	12	4	28
7	6	14	10	30
8	2	20	15	37
9	0	15	6	21
10	5	3	1	9
12	19	11	5	35
14	1	3	0	4
15	2	9	4	15
16	3	19	9	31
17	4	15	3	22
18	12	12	6	30
19	15	5	6	26
20	31	6	4	41
Total	132	257	106	495

TABLE 2

Cone characteristics of the progenies from closed-cone mother trees.

Tree No.	Closed	Open	Mixed	Total
	No. of individuals			
1	20	5	8	33
2	21	4	9	34
3	28	4	10	42
4	17	2	7	26
5	23	3	3	29
6	17	1	6	24
7	16	4	9	29
8	15	14	14	43
9	26	1	5	32
10	21	4	9	34
Total	204	42	80	326

Published as Sci. Jour. Ser. Paper No. 4099 of the Minn. Agr. Expt. Sta.