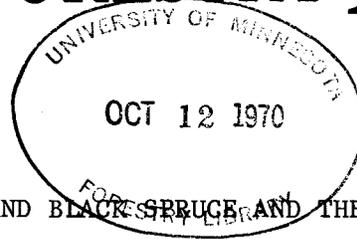




MINNESOTA FORESTRY NOTES

COPY 2



No. 154

October 15, 1964

MEIOSIS AND POLLEN RELEASE IN WHITE AND BLACK SPRUCE AND THEIR HYBRID ^{1/}

Lawson L. Winton ^{2/}

In the study of microsporogenesis in a white x black spruce hybrid and its parental species (Winton, 1964a, 1964b), the initiation of normal meiosis on the tree was apparently closely related to the average temperature and number of first consecutively warm days above freezing in spring. In 1961 and 1962 two white spruce trees planted at St. Paul began meiosis on April 22 and 21, respectively, after five days in both years in which the average daily temperature rose to ca. 50° F. (Table). In contrast, meiosis began on one white spruce tree near Cromwell, Minnesota, in the same two years, two days later than on those at St. Paul, but only after 7-8 consecutively warm days which averaged ca. 43° F. In 1963, although the white spruce near Cromwell began meiosis approximately two weeks earlier than in the previous two years, this did not take place until after a period of 10 days had passed in which the average daily temperature reached only ca. 40° F. Male buds were not found on white spruce trees at St. Paul in 1963.

These relationships indicate that white spruce growing naturally near Cromwell may have about the same heat requirement for the initiation of meiosis as those at St. Paul. A greater number of cooler days near Cromwell are required before the effects of an equivalent amount of heat are accumulated. This conclusion is reasonable, since the seed source of the trees planted at St. Paul is probably similar to the trees near Cromwell, and should be expected to have similar environmental requirements for reproductive development.

The Table also indicates that in the three years, one black spruce tree near Cromwell did not begin meiosis until after 16-17 days had passed in which the average daily temperature was about equal to, or slightly higher than, the near 40° F. reported for white spruce at the same location. The fact that up to twice as many warm days were observed for black spruce as for white spruce indicates that black spruce has a much higher heat requirement for the initiation of meiosis. The intermediate dates at which meiosis started, as well as the apparent intermediate heat requirement of the hybrid near Cromwell are also evident from the data given in the Table.

For all three taxa, the number of non-consecutively warm days of above 32°, above 50°, and above 70° F. (not shown in this paper), scattered throughout the months of March and April apparently were not directly related to the date of initiation of meiosis; but rather only those consecutively warm days immediately preceding meiosis. A continuous, critical temperature may be required for the production of auxins necessary for the initiation of meiosis. Also, a continuous heat requirement may be related to the rate of thawing of the soil and the subsequent availability of moisture to the tree. Such mechanisms would have the additional benefit of delaying meiosis until the threat of late-spring frosts was past.

For white spruce at St. Paul, 24 days elapsed between the initiation of meiosis and the shedding of pollen in 1961, in which the average daily temperature was 51° F. But in 1962, only 19-24 days were required, though at a higher average temperature of 58° F. (Table).

Male strobili were not observed on white spruce trees at St. Paul in 1963. On the other hand,

^{1/} This report is based on a portion of the author's Ph.D. thesis (Winton, 1964a). Support of this research was provided by the Charles K. Blandin Foundation, Grand Rapids, Minnesota.

^{2/} Research Assistant, School of Forestry, University of Minnesota.

during the three seasons, the white spruce tree near Cromwell required a longer interval (26-37 days) between the initiation of meiosis and pollen release when the daily temperature averaged 47°-51° F. The longest interval (37 days) occurred in 1963, when the average daily temperature was the lowest (47° F.).

Black spruce near Cromwell appeared to have a much higher heat requirement for pollen release in 1962 and 1963 than did nearby white spruce trees: a relationship similar to that indicated by the data for the initiation of meiosis for the same species. Although black spruce shed pollen 9 days later than white spruce at the same location, it also began meiosis 10 days late. For this reason, in 1962, the number of days between the initiation of meiosis and pollen release in white spruce (26 days) was about the same as that required for black spruce (25 days), with average temperatures for both species 51°-53° F. However, when the number of premeiotic, consecutively warm days were added, the total number of warm days until pollen release was 33, 39, and 42 days, respectively, for white, the hybrid, and black spruce. Also, in 1963, black spruce required about 20 percent more warm days than white spruce before pollen was shed. This represents 59 warm days for black spruce, compared to the 47 days for white spruce at the same location. The average temperature for both species during their periods of meiosis and pollen maturation was ca. 47° F.

The apparent differences in heat requirements between white and black spruce, both for the initiation of meiosis and ultimately in the difference in time of pollen release, illustrate the probable, primary isolating mechanism of these sympatric species. Based on the existence of at least one confirmed natural hybrid between white and black spruce (Little and Pauley, 1958), it seems reasonable to assume that this is not the first time such an event has occurred. As pointed out by Little and Pauley, the natural hybrid is located near the limit of the range of white and black spruce, where, for many sympatric plant species, the frequency of natural hybridization is sometimes the greatest. However, present evidence indicates that if natural hybrids between white and black spruce have been produced, they evidently were quickly eliminated before any general mixing of the species occurred. On the other hand, the hybrid in Minnesota is located in an abandoned pasture, on a site disturbed by man over 40 years ago. Thus it may be that natural hybrids produced in the past were not able to survive because a "hybridized" (Anderson, 1949) habitat was not available.

LITERATURE CITED

- Anderson, Edgar. 1949. Introgressive hybridization. John Wiley & Sons, Inc. New York. 109 pp.
- Little, E. L. and S. S. Pauley. 1958. A natural hybrid between black and white spruce in Minnesota. Amer. Midl. Nat. 60:202-211.
- Winton, L. L. 1964a. Microsporogenesis and early pollen forcing in a white x black spruce hybrid and its parental species. Ph.D. thesis, Univ. of Minnesota.
- _____. 1964b. Phenology of normal and forced microsporogenesis in white and black spruce and their F₁ hybrid. Minnesota For. Notes No. 153. School of Forestry, Univ. of Minn.

Table. The initiation and duration of meiosis as well as the date of pollen release for white spruce trees at St. Paul (#6 and #10), and white (W), the hybrid (H), and black (B) spruce trees near Cromwell. ^{3/}

| Year | Tree | Start | Days | Meiosis | | Pollen release | | | Ave. daily temp. |
|------|------|-------|------|---------|------|----------------|--|----------------------------------|------------------|
| | | | | No. | Ave. | Date | consecutively warm days prior to release | no. days from meiosis to release | |
| 1961 | #6 | 4/22 | 2 | 5 | 51.5 | 5/16 | 29 | 24 | 51.0 |
| | W | 4/24 | 12 | 8 | 42.5 | 5/22 | 36 | 28 | 51.0 |
| | H | 4/27 | 10 | 11 | 41.0 | 4/ | | | |
| | B | 5/2 | 12 | 16 | 40.5 | 4/ | | | |
| 1962 | #6 | 4/21 | 4 | 5 | 49.0 | 5/10 | 24 | 19 | 58.0 |
| | #10 | 4/21 | 4 | 5 | 49.0 | 5/11 | 25 | 20 | 58.0 |
| | W | 4/23 | 10 | 7 | 43.0 | 5/19 | 33 | 26 | 51.0 |
| | H | 4/27 | 7 | 11 | 46.5 | 5/25 | 39 | 28 | 53.0 |
| 1963 | B | 5/1 | 9 | 17 | 46.0 | 5/28 | 42 | 25 | 52.0 |
| | W | 4/10 | 8 | 10 | 39.5 | 5/17 | 47 | 37 | 47.0 |
| | B | 4/16 | 15 | 16 | 42.0 | 5/29 | 59 | 43 | 47.5 |

^{3/} The temperature data used to construct this table were obtained from the U. S. Weather Bureau's "Climatological Data--Minnesota" for the years 1961-1963 as reported by the weather stations at St. Paul and Cloquet. Data from 1962 from the Wright station (7 miles west of Cromwell) are not shown here, but are given in the paper by Winton (1964a). Cloquet is located 13 miles east of Cromwell, and has maintained long range weather records.

^{4/} Natural pollen release was not observed.