

THE HYBRID (POPULUS DELTOIDES X P. BALSAMEIFERA) X P. NIGRA  
VAR. BETULIFOLIA IN MANITOBA

ABSTRACT

In poplar breeding, information on segregation of various traits will improve and facilitate selection procedures. In this study, results observed on segregation in leaf shape, time of flush, sex, and height growth are presented and discussed. A clear break in time of flush was recorded between the early and late trees, resulting in a bimodal array over time. In sex segregation, the ratio of males to females suggests that the male character is at least partially dominant. A t-statistic indicates no significant deviation of the individual heights, from the total height mean.

It is evident from this study that the hybrid population is a valuable mixture of genetically different trees, and proper selection should lead to the production of more valuable commercial types.

INTRODUCTION

There is a great demand for poplar varieties in the Canadian prairies. Desirable features are rapid, early-height growth that gives advantage over weed competition, small-leaf trees for shelterbelts, early flushing trees for farm-yards, male or sterile female clones to avoid the debris of fluffy cotton on the ground, clones resistant to pest infestation, etc.

One way to produce varieties and new forms for identical ecotypic and geographic range is hybridization. Many seemingly incredible results of poplar hybridization have been observed, but few reports have been published on the segregation of parental characteristics in the progeny. Pauley (1950) found that the age of first flowering in native *Populus* species shows considerable inter- and intra-specific variation. Chiba (1966) pointed out that the morphological characters of the leaf of white poplar (*P. alba*) was dominant in hybrid progeny when crossed with aspen (*P. tremuloides*), especially when white poplar was used for female parent. Zufa (1969) studied the heritability of stem form of European black poplar (*P. nigra*) and showed that straight stem form is highly heritable and dominant.

Information on segregation of various traits is important for a tree improvement program with *Populus*. Such information will greatly improve and facilitate selection procedures. In this study, results observed on segregation in leaf shape, sex, time of flushing, and height growth are presented and discussed.

MATERIALS AND METHODS

In 1957, the late F. L. Skinner, owner of a private nursery and arboretum at Dropmore, Manitoba, produced a hybrid poplar population by control pollination of a selected *P. deltoides* X *P. balsamifera* hybrid with *P. nigra* var. *betulifolia*. The female parent has proved to be an early flushing, fast grower, with white wood, and seems to be more resistant to both leaf rust and aphids than other

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poplars bred at Dropmore. The male parent was a variety of the European black poplar introduced by Skinner from Kew, England, in 1946. This male clone exhibited late flushing and favorable features for farmstead planting such as a straight, white trunk and columnar crown with whitish leaves; however, it is slightly susceptible to Melampsora rust (Schreiner and Stout, 1934). Both parents can be propagated easily by stem cutting.

In 1958, 110 one-year-old hybrid seedlings were planted. A total of 88 trees survived until 1966 when my observations started. Leaf shape, flushing time, sexual maturity, and health were recorded for 6 consecutive years.

Two long-shoots were selected from the west side of the upper crown of each tree for collecting leaves each year. When the yearly collections were compared, their average shapes agreed so closely that it was decided to measure only the 1970 leaves. The botanical classification of leaves of hybrid poplars is complex, but identification was based on morphometric coefficients and diagrams of leaves for analysis (Gambi, 1965). Tangents of the leaf outline were measured at 13 identical points of the leaf margin, then the measurements were converted to logarithms from a table of natural trigonometric functions. The sum of the 13 measurements, called rotundity by Gambi, represents the total area of a leaf and characterizes its shape.

Height growth was assessed in the spring of 1971, before the leaf-flush.

Chi-square as for Pauley's equation (1950), t-test, and correlation statistics were used to analyze the compiled data of the above traits.

In addition, the incidence of bark and leaf diseases such as canker and leaf rust, aphid and rabbit damage, and bark lesions were checked yearly.

## RESULTS

The rotundity coefficients of the leaves occurred in a wide but evenly screened array between the parent trees as well as out of the range of the parent trees with high interaction of the parent characteristics on sex distribution, i.e. female-like leaves on male trees and vice versa. Rotundity data were split into subgroups corresponding to the expected differences between the rotundity coefficients of the parental leaves. An arbitrary probability at the 95 percent level was applied to estimate the intervals for the coefficients of the leaf of the female parent and the male parent. It was found that 31 coefficients belonged to the female group and 29 to the male group. In addition, two fractions of the coefficients contributed 28 clones, 10 of them with characteristics of balsam poplar and 18 with those of European black poplar (P. nigra). (The leaf characteristics of the male parent, P. nigra var. betulifolia, are not identical with the European black poplar leaf.) Thus, four subgroups were established in a ratio of 10 balsam poplar-like : 31 female parent-like : 29 male parent-like : 18 European black poplar-like. The small number of distinct subgroups suggests that leaf characteristics are controlled by only a few genes. Unfortunately, the size of the population rather limits the effective testing of the observed ratio against any hypothetical ratio.

Year-to-year variations in time of leaf-flush were observed over the 6-year period of observation. However, the sequence of flushing dates for the different trees did not alter over this period; 37 trees flushed earlier and

51 trees later than average. A clear break was recorded between the dates of the early flushing and late flushing trees resulting in a bimodal array over time. The bimodal distribution over time would suggest simple control and possibly a 1:1 ratio (Chi-square = 2.23; not significant at the 10 percent level). Flushing time of the hybrids showed no relationship to the sex of the parent trees.

Of the 56 trees that produced catkins between 1968 and 1971, 35 were males and 21 females. This difference was significant at the 10 percent level (Chi-square = 3.50; df = 1) and suggests that the male character is at least partially dominant among the hybrids. On the other hand, there were no correlations observed between maleness and other characteristics investigated. Apparently, 32 hybrids were dilatory in reaching sexual maturity.

Neither stem cankers nor leaf pests were found on the hybrids, although cankers and pests are common on other poplar trees in the Arboretum. Bark lesions, due to sunscald, occurred near to the ground on almost every tree. It is probable that some of the hybrids will be infected by canker through these lesions.

Only 3 trees of 88 were damaged by rabbits during the time of observation despite the large number of rabbits that inhabit the area. The low incidence of rabbit browsing may indicate that most of the hybrids are resistant to rabbit damage due to hereditary biochemical factors, since neither parental clone is browsed.

The height of hybrids (85 trees) ranged from 3.36 to 8.55 m, with a mean of  $5.81 \pm 0.12$  m. (The terminal shoots of three trees were broken and they were omitted from the height measurements.) A t-statistic indicated no significant deviations of the individual heights from the total height mean ( $t = 5.01$ ;  $df = 84$ ). No correlation was found between rotundity (leaf area) and height growth ( $r = 0.123$ ;  $df = 84$ ). The absence of replications imposed restriction upon the method of analysis for vigor data.

## DISCUSSION

The purpose of this study was to determine the segregation on certain characteristics of parental trees in their progeny. The data obtained in this study suggest that an asymmetry of distribution frequencies exists in favor of rotundity and maleness, and that symmetry exists in flushing time and height growth in the hybrids. The 88 hybrid combinations provide some indication of single gene inheritance. It appears that features such as maleness, European black poplar-like leaf form, and tree size result from complex interaction and are influenced by factors in the external, internal and genetic environment. As the above characters appear to be determined by the male parent, it would indicate a certain superiority of the male over the female parent. Nevertheless, positive correlation was not found between maleness and important economic traits; such as vigor, disease resistance, and good stem form (F.A.O., 1958). Farmer (1964) found in a *P. deltooides* natural population of 551 trees that males were slightly but insignificantly larger in diameter and significantly taller than females but there was no relationship between sex and form class, stem straightness, branchiness, or specific gravity of wood. Jokela (1964) emphasized that differences in height were not statistically significant between male and female trees in a trial with 1,165 trees. He also concluded there is no reason to favor male trees in forestry practice.

It is evident from this study that the hybrid population is a valuable mixture of genetically different trees. Selection within this population should lead to the production of some valuable commercial types. Selected clones which demonstrate superior growth and resistance to canker and pests should be further evaluated.

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#### DISCUSSION

ROLLER - Do any of you have an explanation for the limiting factors of the range of the bigtooth aspen? I understand that the bigtooth aspen does not grow west of the Manitoba-Ontario border. I haven't found natural hybrids between bigtooth aspen and trembling aspen in this area where the two aspen species overlap each other. But, there are some authors who did mention the existence of such natural hybrids at the lower limit of the bigtooth aspen and in the Maritimes.

VALENTINE - I can't answer it. It must be at about the northwestern limit of the grandidentata, isn't it? It's part of the natural range.

ROLLER - Yes, it is the upper geographic limit of the species. However, the ecological factors in the neighboring areas along the border limit are very similar; there are no obvious reasons why the range of bigtooth aspen is limited along this border line.

VALENTINE - I haven't really done very much work with *grandidentata*. We have made hybrids and back crosses which we have in the field, some of them three years. So far, in terms of hybrids, we have no notion if there is any greater susceptibility to disease. From casual observations of the late Dr. Pauley's plots at The Harvard Forest, I don't think there is much more susceptibility in the hybrids than in some of the parents. Maybe Ernie can comment on this matter of hybridization.

SCHREINER - Our hybridization work did not include the aspens, but we did make a successful cross between *deltoides* and *andidentata* (described in the Journal of The New York Botanical Garden). Although the female parent was *deltoides*, the progeny trees resembled *grandidentata*; on this basis, we decided that we did have a hybrid. This progeny was not particularly promising. There is evidence for introgression between the largetooth and the trembling aspen; and there is also evidence for natural hybridization between eastern *Leuce*, *Aigeiros*, and *Tacamahacca* poplars.