FOREST GENETICS RESEARCH AT THE UNIVERSITY OF MICHIGAN

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Tree Genetics

(Burton V. Barnes)

The purpose of the research program, as evidenced by results as well as current research and future direction, is to add to the knowledge of the ecology and genetics of forest trees. Although we are interested in the practical gains that are possible and being realized in practical tree improvement, our contribution is in basic studies that stimulate and challenge young scientists and provide the basis for silviculture and tree improvement practice. Our main interests lie in genecology and evolution of woody plants.

Major emphasis is placed on the aspens (*Populus tremuloides Michx.*, trembling aspen and P. *grandidentata Michx.*, bigtooth aspen) and birches (primarily *Betula alleghaniensis Britton*, yellow birch but also associated species *B. papyrifera Marsh.*, paper birch; *B. lenta L.*, sweet birch; *B. nigra L.*, river birch; and *B. pumila L.*, bog birch). Studies of natural variation and hybridization have been or are being conducted in other hardwood genera; *Prunus, Fraxinus, Acer,* and *Quercus.*

We have emphasized the clonal growth habit of aspens (Barnes 1966) as the basis of ecological and genetic studies. This was used effectively in a study supported by the North Central Forest Experiment Station by Copony (1969) who found significant differences among clones in the incidence of hypoxylon canker of trembling aspen. The range in canker incidence for all clones was 10 to 90 percent; the range was wide in all five sites studied. In many cases, nearby or adjacent clones showed significant and striking differences. The marked phenotypic differences between clones and low variability within clones suggests a relatively strong genetic control.

Natural hybridization between bigtooth and trembling aspen is relatively common in southeastern Michigan, but apparently much rarer farther north. We are studying hybridization and hope to learn if introgression is subtly changing the genetic composition of the southeastern Michigan areas and away from it. Five hybrids were recently found by Andrejak (1968) in a seedling population in Washtenaw County. Analysis of leaf and bud characters indicated they were F_1 hybrids. Considerable overlap was observed in flowering of the parent species, so it is clear that flowering time is not a complete isolating barrier. Seeds of hybrids were highly germinable. Although introgression has not been adequately demonstrated there does not seem to be any genetic barrier to hybridization or backcrossing. We have found hybrids competing successfully with both parents well into fruiting age.

We are also investigating the possibility that trembling aspen in certain areas of the West is of ancient hybrid origin. Barnes (1967) hypothesized that *P. grandidentata,* or an Asian aspen such as *P. tremula* var. *Davidiana Schneid.*, which are likely members of the mid-Cenozoic forests of western North America, may have hybridized with trembling aspen.

Other active aspen research includes a study of clonal structure and suckering behavior of trembling aspen in Manitoba, Canada, by doctoral student G. A. Steneker, and a study of the significance of corticular photosynthesis by doctoral student Robert K. Shepard.

Intensive investigations of natural variation and hybridization of yellow birch and associated species are being conducted in the Lake States and the Appalachian Mountains. Dark and tight-barked birches, often observed in southern Michigan and elsewhere at the southern edge of the

range of yellow birch (Dancik 1969), were investigated (Dancik 1967). Despite reports of their being sweet birch, they are closely related to the classically described yellow birch in chromosome number (6x = 84) and foliage characters. Studies in other portions of the range of yellow birch are underway to establish the pattern of phenotypic variation along ecological gradients and between widely separated populations such as those in northern and southern Michigan.

As the basis for these studies and companion ones, populations of yellow birch and sweet birch were sampled in various regions of the Appalachians exhibiting different climate, topography, soils, and vegetation. For example, in the Appalachian Mountains collections of foliage, fruit, pollen, and wood cores were made by doctoral student Terry L. Sharik along altitudinal transects in each of 5 physiographic regions from southwest North Carolina to northern Vermont. Currently, phenotypic variation is being related to site types and ecological gradients. Based upon this framework the mechanisms of genetic differentiation along certain environmental gradients will be investigated in the next phase of the study.

Hybridization in birches is also under study. Hybrids of yellow birch and bog birch are frequent in southeastern Michigan. However, evidence of intogression was not found (Dancik and Barnes, in press). Approximately 15 natural hybrids of yellow birch and paper birch have been found in Michigan, and others located in New Hampshire and Minnesota. We are studying the amount of gene flow between these species. Two individuals, putative allopolyploides of *B. X. purpusii* Schneid. (yellow birch and bog birch) have been found.

Since 1958 we have participated in an international provenance test of European larch organized by Professor R. Schober, University of Göttingen, Germany. Two test plantations were established in 1960 and 1961 in Washtenaw County involving 12 and 20 sources respectively. Survival of all sources was satisfactory to excellent. The best height growth was by plantation sources such as Schlitz, Dobris, and Neumünster. Sudeten larch sources from Czechoslovakia have done about as well. Poorest growth was exhibited by high elevation sources in the French alps. Average total height for the fastest growing source (Schlitz) was 24 feet in 11 years from seed; the slowest growing source averaged only 9.5 feet in 10 years. Results of these tests are encouraging and it is now time to test the fastest growing sources on a commercial basis.

Tree Physiology

(Robert Zahner, Professor)

Research in wood formation at the University of Michigan is centered around the influence of site and weather on cambial growth in hardwoods. Before the true effects of these external factors can be assessed, much remains to be learned about intrinsic growth patterns in both ring porous and diffuse porous types. Thus, in several studies we are attempting to sort out the effects of poor soils and adverse weather conditions on the relative production of fibers and vessels as compared with normal annual ring growth. We are working with three species of ring porous trees (*Quercus rubra L.*, *Fraxinus americana L.*, and *Carya glabra Mill. Sweet*), and with three of diffuse porous types (*Populus grandidentata*, *Betula papyrifera*, and *Acer rubrum L.*). Studies include numbers, sizes, and distribution of vessels and fibers currently produced in trees preconditioned the year before by drought, and in trees on dry, infertile sites; both as compared with those produced in "normal" trees. Results indicate that the ratio of fiber to vessel production in some species (e.g., pignut hickory and paper birch) is far more sensitive to environmental influence than in others (e.g., red oak and bigtooth aspen).

Entomology

(Fred B. Knight, Professor)

Stem Borers in Aspen

The work on two *Cerambycid* borers of small aspen stems has continued during 1968-69. We have completed partial life tables on both species *(Oberea schaumi and Saperda inornata)* and have identified the critical periods in their life cycles. These periods are associated with the adult and egg stages of the beetles. The adults appear to be sensitive to many mortality factors. Then when eggs are laid, many fail to hatch or if hatching does occur, the larvae often

fail to become established. We are concentrating our biological research on these critical times in the life cycles.

This year we have been doing some specialized research on clonal relationships. Early and purely tentative results show that the faster growing clones are resistant. Adults readily lay eggs on all clones but larval establishment may be directly related to these clonal characteristics. We plan to continue this work during the next few years.

Insects on Sugar Maple

This summer (1969) we began studying some of the insects causing deformities in sugar maple. We will concentrate first on those feeding early in the season on buds and later in the summer causing leaf rolls on the trees. The species are known, but little is understood of their host preferences and bionomics. We know that a large portion of bud mortality is insect caused and that therefore much of the deformity in trees may be insect related. Further research on these insects may contribute much to the improvement of sugar maple.

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