

Phenotypic Variation in River Birch (*Betula nigra* L.)

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Abstract

Seventeen geographic sources of river birch (*Betula nigra* L.) from Indiana, Illinois, and Kentucky were analyzed for variation in ten parent tree and site characteristics.

An analysis of variance of parent tree leaf size indicated significant differences among trees and among locality groups, but no clinal variation was indicated.

Seed from the 17 sources were analyzed for size, shape, and color. No clinal variation was detected in either seed characteristics or in progeny height growth.

A heritability test for first-year height growth of the progeny and annual diameter growth of the parent trees gave an h^2 of 0.388 ± 0.566 , indicating that it might be possible to breed fast growing trees from parents with fast diameter growth.

River birch, *Betula nigra* L., has been a neglected species both from a standpoint of economic utilization and scientific investigation. Several authors (1, 2, 3) have reported wide variation in other birch species and the occurrence of natural hybrids. In the only published information directly relating to river birch, Fritts and Kirkland (4) found river birch common along stream banks with predominately acid soils and lacking along those with alkaline soil materials.

River birch is unique among the native American birch species in its more southern range, its preference for low wet sites, and its vernal flowering and fruiting habit. Natural stands are generally restricted to stream banks and other moist places at low to medium elevations. Although river birch has rather specific site requirements, it does have a wide range; extending on the north from southern New Hampshire to southeastern Minnesota; thence on the west through extreme eastern Kansas to eastern Texas; then across the south to northern Florida (5). In many areas river birch grows in nearly pure stands.

Accurate data concerning the acreage and volume of river birch growing stock are not available. River birch is one of a number of species which might well be more effectively utilized to meet the increasing demand for forest products. It has been used to a limited extent in strip mine reforestation, for ornamental plantings, cutting for sawlogs and veneer logs, and for pulpwood.

Seed collection for this study¹ was limited to portions of Illinois, Indiana, and Kentucky (Fig. 1). Parent trees were placed into seven geographic groups, based upon their presence on a single watershed or in a relatively homogeneous topographic area. Insufficient seed

¹ Portions of the data for this paper were taken from a masters degree thesis (7).

production on many pre-selected collection trees limited seed collection in late May and early June to 17 trees. All collection trees were native and not of planted origin. Herbarium specimens were collected from each parent tree.

Parent tree data included height, diameter, age, form, and apparent vigor. An increment borer was used to obtain a sample core for determining parent tree age and annual growth rate. Site data included soil factors, the nature of the plant community, and evidence of disturbance or use.

The seed was placed in perforated plastic bags and stored at 38°F until field planting on June 9, 1969. The seeds were analyzed prior to planting for variation in size, shape, structure, and color. The seed was hand-sown by source in a randomized nested design in the Illinois Union State Nursery.

An analysis of variance was made for all appropriate data at the 95% level. Heritability tests for selected parent tree-progeny characteristics were calculated using procedures developed by Snyder (6).

$$h^2 = 2r$$

$$r = \frac{\sum xy}{\sqrt{(\sum x^2)(\sum y^2)}}$$

$$s.e. h^2 = \frac{2\sigma_x}{\sigma_y} \sqrt{\frac{1}{N-2} \left(\frac{\sigma_y^2}{\sigma_x^2} - b^2 \right)}$$

All parent trees were found on bottomland sites. Latitude ranged from 37° 10' to 38° 59'; longitude ranged from 86° 13' to 89° 12' (Fig. 1); and elevation ranged from 115.9 m to 173.8 m. No significant correlation was found between latitude, longitude, or elevation with age, diameter, height, crown area, percent live crown, tree vigor, foliage color, overstory or understory associates, or soils. The differences among trees in age, dbh, and height were attributable primarily to the stage of stand growth in which the parent tree occurred.

Silty clay loam was the most prevalent soil texture on the parent tree sites. The soil pH ranged from 4.00 to 7.45, with soil samples tending to become more acidic at lower depths in the profile. Only tree 036 occurred on a site with above neutral soils, being slightly basic at 3 and 12 inches and slightly acidic at 36 inches. There were more large trees with good vigor on the more acidic unglaciated soils than on other soil types. Heights up to 78 feet and diameters as large as 23.1 inches were recorded.

Sycamore (*Platanus occidentalis* L.) was the most common overstory associate of river birch. Other common overstory associates were sugar maple (*Acer saccharum* Marsh.), northern red oak (*Quercus rubra* L.), and pin oak (*Quercus palustris* Muenchh.). In the under-

story, American elm (*Ulmus americana* L.), sugar maple, and young river birch were most frequently represented. On some sites river birch comprised as much as 60% of the stem count.



FIGURE 1. Location of 17 parent trees of river birch by groups in Illinois, Indiana, and Kentucky.

There was no significant variation between trees in crown area, percent live crown, or percent free crown. All parent trees had at least 80% live crown. All trees except 019, 032, and 037 had forked at least once.

For leaf width, leaf length, and leaf area, variation among parent trees was greater than the variation among groups, but not significantly so. Variation was random among sources. The leaf area of the parent trees ranged from 22.5 to 56.3 cm². Parent trees of good vigor located on good sites had leaves averaging 47.5 cm². Trees of poorer vigor on less desirable sites had leaves which averaged 24.4 cm².

Approximately 30 days after sowing, seed from 17 sources had germinated in sufficient numbers for weekly height measurements of the progeny to commence.

Significant differences in leaf characteristics were also found in the progeny. Leaf area for progeny ranged from 7.5 to 14.9 cm². Although progeny variation was also random among sources, the progeny did not show the same pattern of variation as did their parent trees. However first-year progeny data may not accurately reflect such variations or indicate a correlation. No significant clinal variation (continuous variation associated with latitude or longitude) in leaf width, leaf length, leaf area, or petiole length was found in either parent trees or progeny.

A heritability test (6) was calculated for parent tree annual height growth and progeny first-year height growth (Table 1). The heritability (h^2) was estimated at only 0.02. However, the lack of correlation in this test could well be due to other factors such as variation in parent tree site quality, early history of the parent trees, or varying amounts of competing vegetation affecting parent tree growth form. Heritability was also estimated for first-year height growth of progeny as related to annual diameter growth of parent trees. This test gave a heritability of $h^2 = 0.388 \pm .566$, a range of 0.0 to 0.954. This is a wide range; however, the number of sampled sources was small. The data indicate that it may be possible to select for fast growing progeny from parent trees having fast diameter growth.

TABLE 1. *Parent tree age, dbh, and annual diameter growth and progeny first-year height growth.*

Source	Group	Parent Tree			Progeny
		Age yrs.	Diameter Breast Height	Annual Diameter Growth in.	Average Height cm.
006	1	46	16.5	0.36	24.4
007		55	19.9	0.36	— ¹
008		38	17.0	0.45	22.8
015	2	23	8.3	0.36	24.0
017	3	40	21.0	0.52	26.0
018		39	14.8	0.38	17.7
019		37	8.8	0.24	22.3
029	4	41	17.9	0.44	14.1
030		9	2.4	0.27	16.0
031		5	2.6	0.52	22.4
032		10	4.6	0.46	24.4
034	5	47	18.4	0.39	17.0
035		27	12.9	0.48	17.5
036	6	78	23.1	0.30	18.2
037	7	43	14.1	0.33	23.5
038		26	11.1	0.43	5.5
039		45	15.0	0.33	— ¹

¹ Insufficient seed germination.

The seeds from each source were analyzed for possible differences in size, shape, structure, color, and relative germination. Size ranged from 5.0 mm by 3.0 mm to 7.5 mm by 4.0 mm. There were significant variations within and between sources in seed characteristics but they were random and not clinal.

Variation in height growth of the progeny was recorded among families within groups and between groups. The variation was random among groups and was not clinal.

Since the samples for this pilot study were taken from a relatively small part of the natural range of river birch, wide or extreme variations in tree form or growth were not expected. The investigation is being expanded to include a larger portion of the species range and a provenance outplanting is planned.

Literature Cited

1. CLAUSEN, K. E. 1965. Studies of compatibility in *Betula*. U.S.D.A. Forest Service Research Paper NC-6. July 1966. 110 p.
2. ———, and P. W. GARRETT. 1969. Progress in birch genetics and tree improvement. Birch Symp. Proc. Univ. N.H., Durham, N.H. 183 p.
3. DANCEK, BRUCE P. 1970. Multivariate analysis of populations of *Betula*. First N. Amer. Forest Biol. Workshop Abstr. East Lansing, Mich. 52 p.
4. FRITTS, H. C., and B. J. KIRKLAND. 1960. The distribution of river birch in Cumberland County, Illinois. Trans. Ill. Acad. Sci. 53:68-70.
5. HARLOW, W. M., and E. S. HARRAR. 1968. Textbook of Dendrology. Fifth Ed. McGraw-Hill. New York. 512 p.
6. SNYDER, E. BAYNE. 1969. Parental selection versus half-sib selection of longleaf pine. Proc. Tenth Southern Conf. Forest Tree Improvement. Houston, Texas. 235 p.
7. WENDLING, ROBERT C. 1970. Genetic variation in river birch (*Betula nigra* L.) for 17 geographic sources. Unpublished M.S. Thesis; Southern Illinois Univ. Carbondale. 63 p.