FIRST TECHNICAL SESSION

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NATURAL VARIATION IN CATKIN AND FRUIT CHARACTERISTICS OF YELLOW BIRCH

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Yellow birch (Betula alleghaniensis Britt.), an important hardwood species in northeastern and north-central United States and in eastern Canada, produces valuable timber and is therefore a logical candidate for genetic improvement. Basic to any improvement program, however, is an understanding of the variation pattern in the species.

In 1963 the Institute of Forest Genetics, Rhinelander, Wisconsin, initiated a study of natural variation in yellow birch. The present paper is based on a portion of the material collected for this study and will only be concerned with phenotypic variation in catkin and fruit characteristics.

METHODS

The study material was assembled in 1963 and 1964 from throughout the range of yellow birch (fig. 1, table 1) with the generous assistance of many cooperator: in the United States and Canada. Fruiting catkins were collected from 7-15 tree sin each stand (table 1). The catkins, 25 or more from each tree, were kept separate by trees. Five catkins from each tree were randomly selected for measurements.

Since the catkins varied greatly in degree of ripeness and some had begun to disintegrate upon arrival in Rhinelander, dimensions of intact catkins could not be measured. Instead, the bracts and fruits[2] were removed, and the length of the central axis, or rachis, of the catkins was measured. One bract and one fruit were randomly selected from near the center of each catkin. Bract characteristics measured (fig. 2) included: length, base length, width, base length as a percent of total length, and length/width ratio. Fruit characteristics measured were: length and width of nutlet (excluding the wings) and length/width ratio.

RESULTS AND DISCUSSION

Only mean rachis and bract length for 52 collections and mean fruit length for 53 collections are shown in table 1. These three characteristics were chosen as examples because rachis length is uncorrelated with all other characteristics, and ract length is only weakly correlated with fruit length (r = .44). Since bract length is correlated with bract base (r = .83)and bract width (r = .75), the data for the other bract characteristics are not shown. The three fruit characteristics are also correlated with each other, particularly fruit length and length/width ratio (r = .78); hence, only fruit length is included in the table.

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[2] Birch fruits are winged nutlets but are commonly called seeds.

Table 1.--Origin and mean rachis, bract, and fruit lengths of 53 yellow birch collections

Stand no.	State or Province	Degrees of-- Lat.	Long.	Elev. (ft.)	No. trees	Length (mm) Rachis	Bract	Fruit
3243	Newfoundland	47.2	53.4	50	11	15.8	5.5	2.65
3244	"	48.6	58.2	400	9	15.2	8.0	3.41
3241	Nova Scotia	46.6	60.5	100	10	17.8	7.5	3.04
3063	"	44.1	65.8	350	10	19.1	8.6	3.43
3066	New Brunswick	47.4	65.2	300	10	18.4	8.6	3.37
3067	"	47.5	67.4	925	9	10.6	7.8	3.47
3001	Prov. of Quebec	49.2	65.1	300	8	18.0	7.9	3.26
2998	"	48.2	70.2	1000	14	17.1	7.6	2.97
2997	"	47.0	70.3	400	12	16.6	8.7	3.31
2999	"	47.4	72.6	1000	15	16.4	8.1	3.16
3000	"	47.5	75.0	1500	15	18.0	8.3	3.32
3002	Ontario	45.1	76.9	1000	10	13.6	7.7	3.01
3003	"	46.1	79.0	1000	10	13.7	6.6	2.84
3004	"	46.7	79.6	1000	10	15.7	8.4	3.14
3311	"	45.0	81.4	625	10	21.9	8.0	3.22
3309	"	47.5	84.8	1000	10	17.1	6.4	3.35
2977	Maine	44.8	68.6	250	11	17.4	8.2	3.15
2956	"	43.7	70.9	1000	14	18.9	8.6	3.46
2985	New Hampshire	44.0	71.4	1900	15	15.3	7.7	3.32
2986	"	43.5	71.4	1300	13	18.0	7.9	3.51
2982	Vermont	44.7	72.6	1250	13	17.0	8.3	3.39
2971	Massachusetts	42.7	73.2	1610	15	18.0	8.3	3.32
2980	New York	44.2	74.9	1620	12	15.8	7.9	3.28
2996	"	42.5	74.2	2100	8	15.7	7.8	2.91
2976	"	42.3	77.3	1300	10	17.5	7.8	2.85
2979	Pennsylvania	41.3	76.3	2300	10	19.6	8.4	3.76
3312	"	41.6	78.7	1800	12	18.2	7.6	3.44
2969	West Virginia	39.0	79.7	2200	10	16.3	8.7	3.45
2970	Virginia	37.9	79.1	2300	11	17.3	8.0	3.37
3299	"	37.8	79.1	3000	11	19.0	8.7	3.24
2959	North Carolina	35.7	82.3	5160	10	15.6	7.9	3.62
2973	Georgia	34.8	83.8	4700	10	15.4	7.6	3.42
2953	Tennessee	35.2	85.7	1740	12	20.9	8.3	3.10
2954	"	35.7	85.3	1420	11	19.5	7.3	3.35
3294	Kentucky	36.9	82.9	3600	10	18.4	7.4	3.53
2955	Ohio	39.5	82.5	830	10	18.5	9.7	3.53
2958	Indiana	38.3	86.5	700	7	25.3	9.0	3.54
2983	Illinois	41.9	89.4	680	10	26.4	7.8	2.85
3295	Iowa	42.4	93.1	1050	10	23.3	8.2	3.16
2961	Michigan	45.0	85.0	1000	10	18.0	7.7	3.21
2960	"	45.9	84.8	625	10	15.3	7.9	3.08
2978	"	46.7	87.9	1675	11	16.4	8.0	2.86
2987	"	47.0	88.7	1250	10	--1/	--1/	2.98
2968	Wisconsin	46.5	92.1	1150	15	18.5	8.4	3.21
3298	"	45.7	89.0	1710	10	20.4	9.0	3.39
3297	"	44.5	90.4	1100	10	20.6	8.8	3.13
2962	"	44.9	87.2	600	10	18.0	8.0	3.21
2963	"	43.1	88.4	900	15	21.2	8.2	3.39
2964	Minnesota	44.2	94.1	800	12	19.4	8.2	2.88
2965	"	47.2	95.2	1480	10	21.7	7.4	2.99
2966	"	47.6	92.5	1700	10	18.5	6.3	3.16
2967	"	47.8	90.2	1400	10	18.2	6.5	3.02
2957	Isle Royale, Mich.	47.9	89.1	750	10	20.0	8.1	2.88

1/ Only fruits were available from this stand.

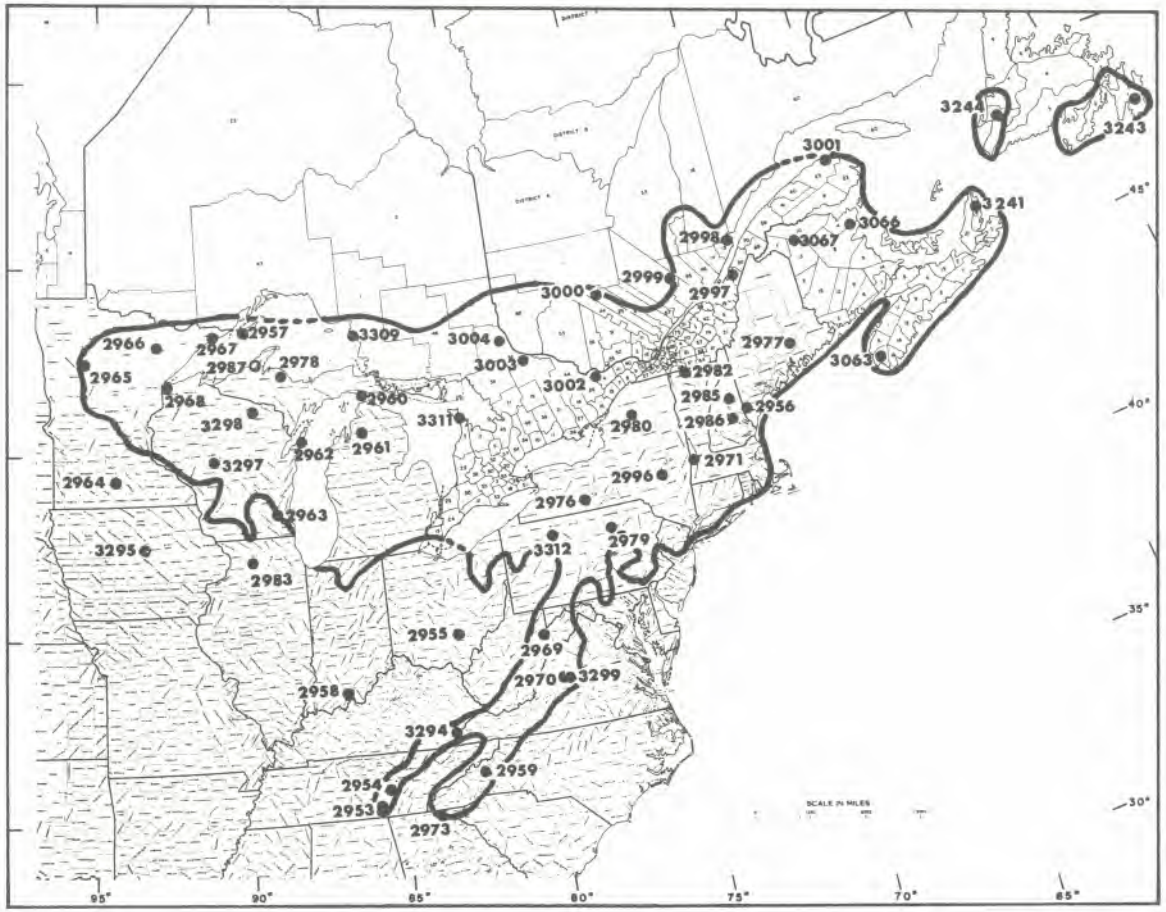

Figure 1.--Natural range of yellow birch adapted from maps in Fowells (1965) and Dansereau and Pageau (1966) and location of collections. The open circle indicates a stand from which only fruits were measured.

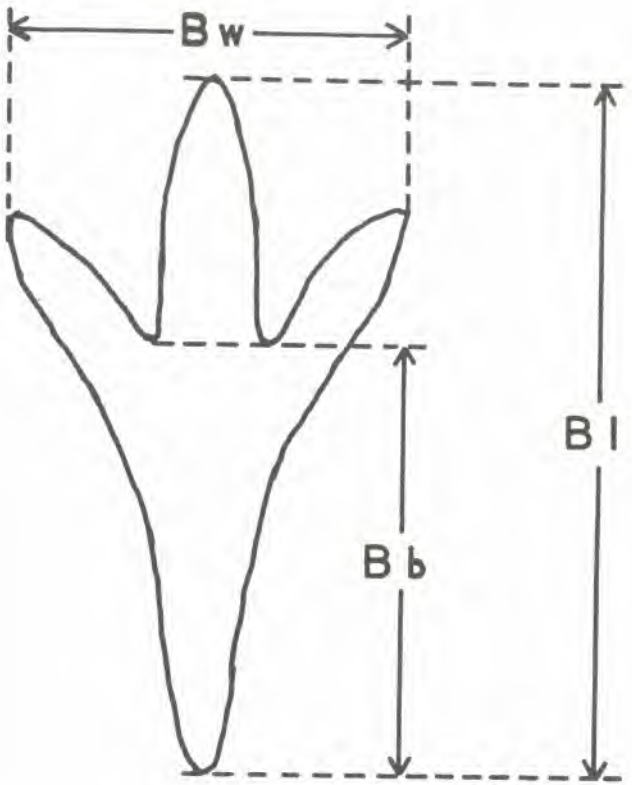

Figure 2.--Key to bract measurements: Bl--length; Bb--base length; Bw--width. In addition, relative length of bract base (Bb/Bl x 100) and length/width ratio (Bl/Bw) were calculated.

Some idea of the variation in all characteristics can, however, be gained from table 2, which shows the range in stand means and overall means for each characteristic. While there is no obvious pattern in the variation of any characeristic, some consistencies, which probably reflect the correlation between individual characteristics, are apparent. Wisconsin stand 3298, for example, not only has the longest bract base but also has a relatively narrow bract (large bract length/width ratio). Similarly, the stand from eastern Newfoundland (3243) has short and narrow bracts but short and relatively broad fruits. The Kentucky stand (3294), on the other hand, has relatively broad bracts with relatively short bases and narrow fruits.

Table 2.--Mean and range of stand averages for 9 morphological characteristics of yellow birch

Characteristic	Mean and standard error	Extreme stand means and their origin			
		Maximum		Minimum	
		Mean	Origin	Mean	Origin
Rachis length mm	18.0 ± 0.162	26.4	2983 Ill.	10.6	3067 N.B.
Bract length (Bl), mm	8.0 ± 0.052	9.7	2955 O.	5.5	3243 Nfld.
Bract base (Bb), mm	5.5 ± 0.041	6.4	3298 Wis.	3.5	2966 Minn.
Bract width (Bw), mm	5.9 ± 0.038	7.1	2956 Me.	4.2	3243 Nfld.
Bb/Bl x 100	68.7 ± 0.300	75.2	2961 Mich.	54.9	3294 Ky.
Bl/Bw	1.36 ± 0.009	1.60	3298 Wis.	1.22	3294 Ky.
Fruit length (Fl), mm	3.22 ± 0.016	3.76	2979 Pa.	2.65	3243 Nfld.
Fruit width (Fw), mm	1.77 ± 0.007	2.05	3244 Nfld.	1.57	3294 Ky.
Fl/Fw	1.84 ± 0.008	2.27	3294 Ky.	1.54	3243 Nfld.

While there are highly significant differences between stands in all characteristics measured (table 3), the within-stand variation is larger than the variation among stands in most characteristics. Only the relation of bract base length to total bract length, fruit length, and fruit length/width ratio had less variation between trees within a stand than among stands. The variation within trees was small for all nine characteristics. Galoux and Falkenhagen (1965), who studied variation in fruiting characteristics of Acer pseudoplatanus L. in Belgium, also found more variation between trees than between populations and little within-tree variation.

All catkin, bract, and fruit characteristics are either independent of or, at best, weakly correlated with latitude, longitude, and length of growing season at the location of the collections (table 4). Galoux and Falkenhagen (1965) similarly reported samara length of A. ps eudoplatanus to be uncorrelated with length of growing season and several other environmental factors. Catkin and fruit characteristics in yellow birch thus do not exhibit any obvious trends in geographic variation but instead appear to vary in a random manner. Although differences between trees in a stand and between various stands can be demonstrated, the catkin and fruit characteristics studied seem to be relatively uniform throughout the range of this species.

Table 3.--Results of analysis of variance for nine morphological characteristics of yellow birch

Characteristic	Variance ratio (F)	
	Among stands	Among trees within stands
Rachis length	7.30	13.87
Bract length (Bl)	3.24	16.71
Bract base (Bb)	2.58	12.88
Bract width (Bw)	5.52	10.05
Bb/Bl x 100	16.41	7.27
Bl/Bw	3.84	5.93
Fruit length (Fl)	8.13	5.27
Fruit width (Fw)	3.61	9.33
Fl/Fw	10.21	2.55
Tabular $F_{.01}$	1.52	1.15

Table 4.--Correlation between catkin, bract, and fruit characteristics of yellow birch and environmental variables of collection origins

Characteristic	Latitude	Longitude	Length of growing season
Rachis length	-.225	.474*	.425*
Bract length (Bl)	-.238	.058	.256
Bract base (Bb)	-.095	-.031	.105
Bract width (Bw)	-.306*	.057	.441*
Bb/Bl x 100	.085	-.143	-.155
Bl/Bw	.150	-.009	-.232
Fruit length (Fl)	-.403*	-.120	.202
Fruit width (Fw)	.198	-.344*	.221
Fl/Fw	-.548*	.008	.354*

* = Significant at the 5% level.

CONCLUSION

This biosystematic study provides no evidence of either clinal or ecotypic variation in catkin and fruit characteristics of yellow birch. Absence of clinal variation in fruiting characteristics was also noted by Galoux and Falkenhagen (1965) who found only a slight tendency for samara length of A. pseudo latanus to decrease with increasing altitude in certain localities. More intensive studies of local variation are needed to determine whether some of the variation in these characteristics is associated with elevation or other factors of the environment. The apparent random pattern of variation would otherwise indicate that there is very little selection pressure on any of the characteristics studied in yellow birch.

LITERATURE CITED

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