MORPHOLOGICAL DIFFERENCES BETWEEN BLACK MAPLE AND SUGAR MAPLE AND THEIR HYBRIDS

William J. Gabriel[1]

INTRODUCTION

Acer nigrum Michx. f. (black maple) and Acer saccharum Marsh. (sugar maple are often found in the same forest stand (Little 1950). Although the ranges of both maples extend over the northeastern quarter of the United States, nigrum has a larger representation in the North Central States and is relatively scarce in many parts of New England. Consequently, the differences between them may not be well known to many of the people in the Northeast.

There is a difference of opinion among botanists and foresters whether nigrum should be given specific rank or treated as a subspecies in the sugar maple complex, which would include floridanum and leucoderme in the South, schneckii in the Midwest, and grandidentatum in the West.

This is a report on the more obvious morphological differences between nigrum and saccharum and on the results of controlled pollinations made between these taxa.

BACKGROUND

In his descriptions of nigrum and saccharum, Rehder (1940) has pointed out differences in bark color and texture and in leaf characters such as lobing, pubescence, and fall coloration. He made no mention of stipules, which are usually present in nigrum but not in saccharum.

Bailey (1888) stated that the two taxa should be given specific rank, basing his opinion on conspicuous differences in fruit and foliage. He stated that he had never observed any intermediate forms between the two maples.

Anderson and Hubricht (1938) studied the phylogenetic relationships between nigrum and saccharum. From observations of leaf characters, they agreed with Bailey that the two maples maintain their distinctive features throughout much of their range.

Dansereau and Desmarais (1947), on the basis of a leaf study, reported that nigrum and saccharum were capable of hybridizing and that introgression occurred between them in central Quebec.

Desmarais (1952) studied herbarium specimens collected over the entire ranges of both taxa and reported that, although saccharum and nigrum had their own peculiar characteristics, they were united by a large intermediate population of sugar maples in which various combinations might be found. For this reason he treated nigrum and saccharum as subspecies in a broad sugar maple complex.

An extensive list of literature dealing with aspects of the genetics of sugar maple can be found in a report by Kriebel and Gabriel (1969).

[1] Research Geneticist, Forest Service, U.S. Dept. of Agriculture, Northeastern Forest Experiment Station, Burlington, Vermont.

OBSERVATIONS AND RESULTS

First I will deal with the more obvious morphological differences between typical specimens of the two taxa; then I will present some results of my hybridization work, particularly as they apply to the crossing ability and physical appearance of the hybrids.

Morphological differences.--The bark of saccharum is shallowly furrowed, somewhat irregularly plated, and silvery in color (fig. 1). The bark of nigrum is deeply furrowed, more or less uniformly divided, and dark in color (fig. 2).

Terminal buds of saccharum are sparsely covered by hairs and are quite exposed (fig. 3). The petioles are semi-fastigiate in habit, and the lenticels on the branchlets are relatively small. The buds of nigrum are covered by a heavy concentration of long hairs and are shielded by broad, concave petiole bases that are upright in habit (fig. 4). The branchlets are characterized by prominent lenticels.

The leaves of saccharum are relatively thin, having 5 pronounced acuminate lobes and 9 pairs of lobules (fig. 5). Upper sinuses are quite deep, lower sinuses somewhat shallower; the petioles and the undersides of the leaves are glabrous (fig. 6).

The leaves of nigrum are thick and heavy and usually have 3 prominent acute lobes and 3 lobules (fig. 7). The sinuses are shallow or lacking. The petioles and the undersides of the leaves are covered with a dense mat of pubescence (fig. 8) that also extends along the outside edge of the leaf.

I do not consider the droopiness of the leaf lobes in nigrum as a good character for the separation of the taxa, because I have often observed this characteristic in saccharum too. But the upright, tufted young leaves, distinct in newly opened nigrum buds, differ from leaves of similar age in saccharum.

The flowers of both taxa are comparable in appearance, being heavily pubescent immediately after bud burst and showing little difference in coloration. The stamens and pistils observed in the pseudo-hermaphroditic flowers of both maples were relatively uniform in appearance and number.

I point out that during the early part of the growing season there is a pair of stipules attached to the base of each leaf petiole in nigrum. As the growing season progresses, the stipules absciss. The broad character of the petiole base (fig. 4) is due partly to the attachment of the stipules.

Dansereau and Desmarais (1947) reported introgression of saccharum into nigrum, but it should be pointed out that the characters studied were those associated with leaves. My observations made in northern Vermont on characteristics of bark have shown no distinct introgression between the two taxa. This was illustrated in randomly selected groups of trees in two stands about 20 miles apart near Burlington, Vermont, where a gradation was found between bark typical of the two maples, rather than a predominance of one distinct type. Because of the similarity in size

and vigor and the proximity of several of the trees to one another, it would be difficult to attribute the observed differences in bark variation to differences in tree vigor (Carvell and Maxey 1970). However, the leaves of the trees showing the gradation in bark characters were all characteristic of the saccharum outline, which is in agreement with an opinion expressed earlier that introgression, at least in leaf characters, is present in the taxa.

A comparison of the wood properties of the two taxa has shown that saccharum scored consistently higher in all properties related to strength (U.S. Forest Service 1955). But the range in variation is not considered great enough to warrant their separation in the manufacture of lumber or other wood products.

In wood anatomy, the fiber and vessel lengths are very similar in the two maples. But saccharum has 15 percent more uniseriate rays than nigrum (Personal communication from Robert M. Maeglin, USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin, June 1972).

No experiments have been made to determine the difference between the taxa in sap-sugar content. However, tests made on unreplicated plots in Ohio showed no differences in sap sweetness between saccharum and nigrum (Kriebel, 1955).

Breeding results.--The results of our breeding program have shown that saccharum crosses readily with nigrum when the latter is used as a pollen parent (table 1). The reciprocal cross, thus far, has been a failure. These results are based on 1 year's data, and the three nigrum trees used in the experiment were protandrous in their blooming habit, which may have had an effect on their seed production.

This year, we repeated a number of the above crosses. In addition, we have added to our breeding roster a recently located nigrum parent that is protogynous in blooming habit. We will observe this tree closely, as well as the protandrous trees, for any relationship of blooming habit and seed set.

A comparison of the leaves of the hybrid with those of the parent in the saccharum x nigrum cross shows that the leaf outline of the hybrid favors the female parent (fig. 9), but its pubescent leaf underside and petiole favors the male parent (fig. 10).

In one cross of nigrum x nigrum the leaves of the progeny appear to be "good" nigrum. The petioles and the underside are densely pubescent, as one might expect, and the leaf outline satisfies the nigrum criteria (fig. 11). In another nigrum x nigrum cross in which the male parent was changed, the presence of more pronounced sinuses and lobules in the leaf outline suggests a possible saccharum ancestor in the background of the latter (fig. 12).

I plan to continue making observations on the current crop of hybrids and on those that are expected from this year's work. However, most of my attention will be directed toward the study of differences in sap-sugar content, with an eye toward improving syrup production in the maple industry.

SUMMARY

1. Botanical descriptions of typical specimens of nigrum and saccharum point up well-defined morphological differences between the two taxa.

Saccharum.--Bark shallowly furrowed, somewhat irregularly plated, and silvery gray in color: leaves of newly opened buds tufted, thin, and glabrous; 5-lobed with usually 9 pairs of lobules; upper sinuses of leaves relatively deep and narrow; lower sinuses rather prominent but somewhat more shallow. Terminal buds sparsely pubescent and exposed; leaf petioles semi-fastigate and glabrous; lenticels present on upper part of branchlets; flowers pseudo-hermaphroditic, densely pubescent immediately after bud burst.

Nigrum.--Bark deeply furrowed, more or less uniformly divided and dark in color: leaves thick and heavy, undersides heavily pubescent, 3 prominent lobes and lobules, upper and lower sinuses of leaves extremely shallow or lacking; terminal buds densely pubescent and protected by concave, upright petiole bases; lenticels prominent on upper part of branchlets; flowers pseudo-hermaphroditic, quite hairy; stipules present.

2. In spite of prominent differences observed between typical specimens of the two maple, numerous intermediate forms were found, especially in bark characters, indicating that natural hybridization takes place between the two maples. This, combined with the ease with which the taxa were artificially hybridized, indicated that they would be treated as varieties in a sugar maple complex that perhaps should include floridanum and schneckii, but not leucoderme and grandidentatum.

3. Introgression of saccharum and nigrum was not apparent with respect to bark characters in northern Vermont.

4. Leaves of the hybrid progeny favors the saccharum female parent in outline and the nigrum male parent in pubescence.

LITERATURE CITED

Anderson, E., and Hubricht. 1938. The American sugar maples. I. Phylogenetic relationships deduced from a study of leaf variation. Bot. Gaz. 100:312-324.

Bailey, L. H. 1888. The black maple. Bot. Gaz. 13:213-214.

Carvell, K. L., and W. Maxey. 1970. A practical method of evaluating forest tree vigor. W. Va. Agr. and Forest. 3(1):4-5. Morgantown.

Dansereau, P., and Y. Desmarais. 1947. Introgression in sugar maple--II. Amer. Midland Natur. 37:146-161.

Desmarais, Y. 1952. Dynamics of leaf variation in the sugar maples. Brittonia 7:347-387.

Kriebel, H. B. 1955. Comparative "sweetness" of black and sugar maple. Ohio Agr. Exp. Sta. Forest. Mim. 22, 3p.

Kriebel. H. B., and W. J. Gabriel. 1969. Genetics of sugar maple. USDA Forest Serv. Res. Pap. WO-7, 17 p.

Little, Elbert L. 1950. Checklist of native and naturalized trees of the United States. U.S. Dep. Agr. Handbk. 41, 472 p.
Rehder, A. 1940. Manual of cultivated trees and shrubs hardy in North America. MacMillan Co. 2nd ed. 996 p.
U.S. Forest Service. 1955. Wood Handbook. U.S. Dep. Agr. Handbk. 72, 528 p.

Table 1.--Crossing results between saccharum and nigrum, 1961

Female parent	Blooming[2] habit	Male parent	Flowers pollinated	Filled seed
			No.	Percent
M-4	♀	M-7	216	67.6
		M-14	262	57.6
		M-15	228	71.9
		M-19	114	38.6
M-7	♂	M-4	108	5.6
		M-14	32	25.0
		M-15	60	50.0
		M-19	96	33.3
M-14	♂	M-7	12	0
		M-14	38	0
		M-19	10	30.0
M-15	♂	M-7	132	0.8
		M-4	80	1.3
		M-14	218	19.7
M-19	♂	M-7	38	0
		M-14	102	17.6
		M-15	102	22.5

[1] Saccharum parents are M-4 and M-7. Nigrum parents are M-14, M-15, and M-19.

[2] ♀ = Protogynous. ♂ = Protandrous.

Figure 1.--Typical bark of saccharum.

Figure 2.--Typical bark of nigrum.

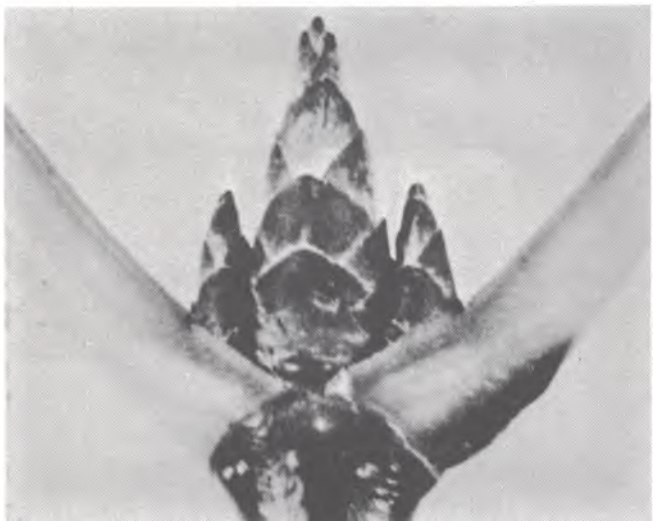

Figure 3.--Terminal bud of saccharum is exposed and is sparsely covered with hair.

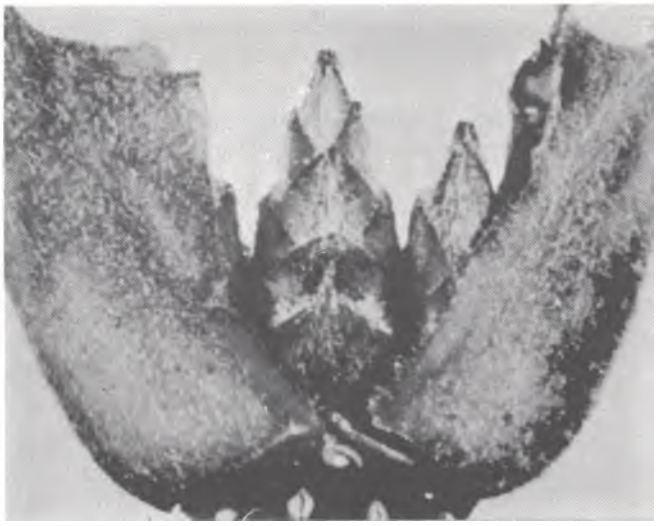

Figure 4.--Terminal bud of nigrum is densely covered with hair and is protected by broadened petiole bases.

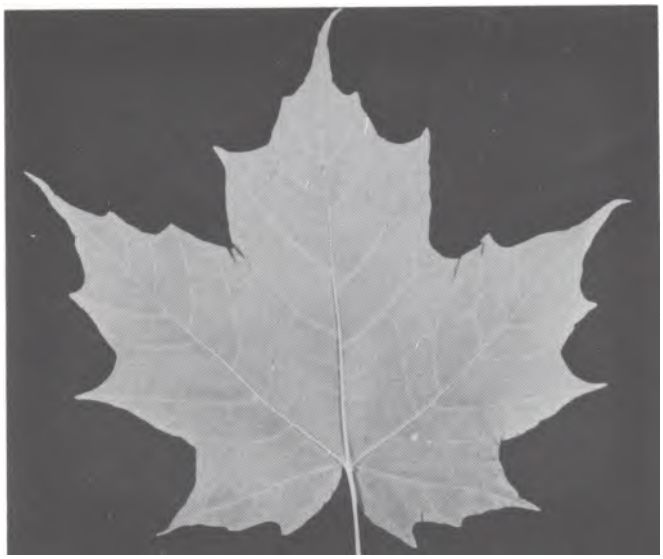

Figure 5.--Leaf of saccharum parent (M-4) used in saccharum x nigrum cross, showing deep sinuses, five pronounced lobes, and several smaller lobes.

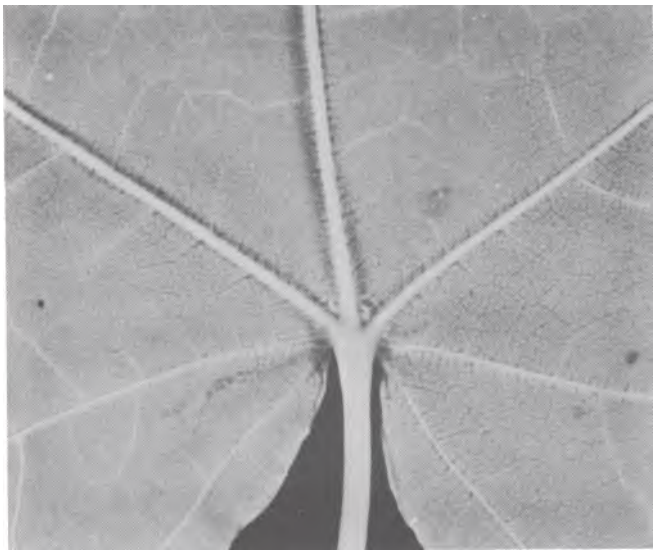

Figure 6.--The underside of saccharum leaf is glabrous.

Figure 7.--Leaf of nigrum parent (M-14) used in saccharum x nigrum cross, showing three prominent lobes and extremely shallow sinuses.

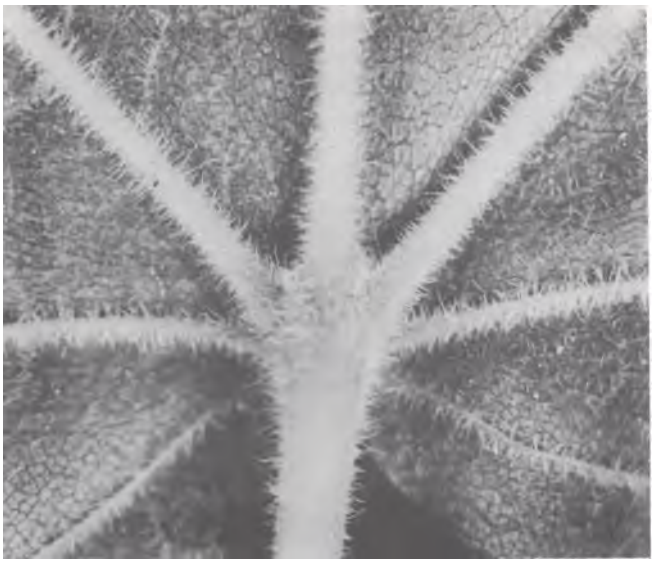

Figure 8.--A dense mat of pubescence can be seen on the underside of the nigrum leaf.

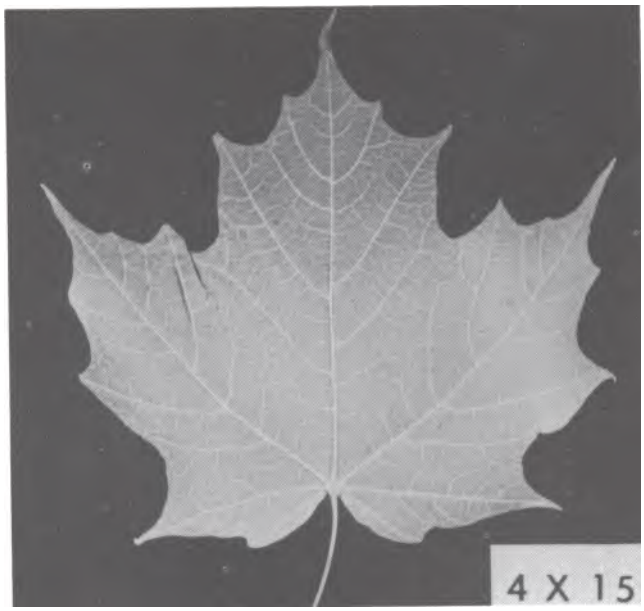

Figure 9.--The leaves of the hybrid resemble those of the female parent in the saccharum (4) x nigrum (15) cross.

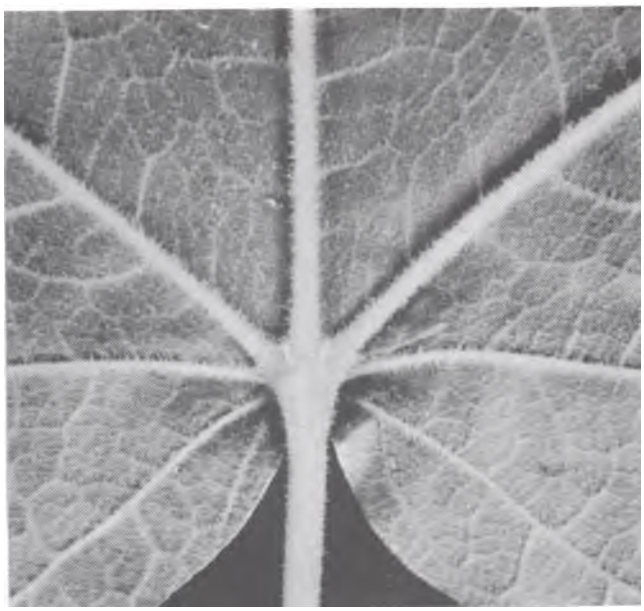

Figure 10.--The underside of the hybrid leaf shows the pubescence of the nigrum male parent rather than the glabrous condition of the saccharum female parent.

Figure 11.--The leaves of the progeny in this nigrum (15) x nigrum (14) cross are considered typical of the taxa.

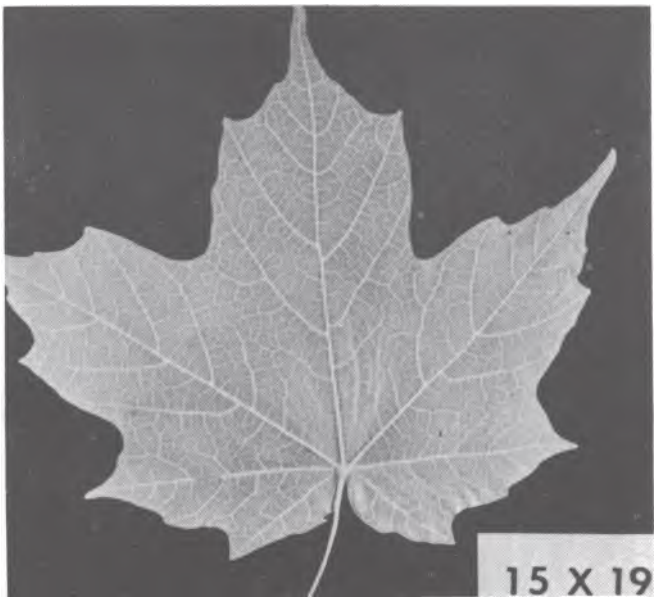

Figure 12.--The stronger tendency toward lobing and more pronounced sinuses in the leaves of the progeny in this nigrum (15) x nigrum (19) cross indicates possible saccharum influence in the male parent (19).