Acer nigrum Michx. f. Black Maple

Aceraceae Maple family

William J. Gabriel

Black maple *(Acer nigrum),* also called black sugar maple, hard maple, or rock maple, is closely related to sugar maple *(A. saccharum)* in habit, range, and quality and use of wood. Black maple grows on a variety of soils, but most commonly on moist soils of river bottoms in mixed hardwood forests. It grows rapidly in early life, then slowly and may live 200 years. Black maple is cut and sold with sugar maple as hard maple lumber. The trees can be tapped for sap for making maple syrup. Young trees are often browsed by deer, and buds and seeds are eaten by birds. Occasionally this tree is used as an ornamental.

Habitat

Native Range

Black maple (fig. 1) extends from New England, New York, and southern Quebec west through southern Ontario to central Michigan, northern Wisconsin, and southeastern Minnesota; south to northeastern Kansas and Missouri; and east in Tennessee to western North Carolina, Virginia, West Virginia, Maryland, Pennsylvania, and New Jersey. It was once found in Delaware but is now extinct there *(20).*

Black maple increases in frequency from east to west. It is the only form in the sugar maple complex found in central and western Iowa, where it appears to be better adapted to the warmer and drier prairie climate. At the onset of these conditions, sugar maple begins to drop out, but black maple continues westward some 193 km (120 mi) beyond the western limits of sugar maple *(1).*

Black maple is found with sugar maple over a large part of its range (fig. 2). In the cooler, more moist eastern section, sugar maple is better adapted to the climate and introgression into black maple occurs. Black maple, considered a relict of an earlier exerothermic climatic era, is only sparsely represented in the area (8).

Climate

The important climatic factors within the range of black maple are as follows: normal annual total precipitation, 610 to 1420 mm (24 to 56 in); growing season precipitation, 300 to 510 mm (12 to 20 in); average annual snowfall, 15 to 150 cm (6 to 60 in) (28); average annual minimum temperature -12" to –34° C (10° to -30" F); average length of frost-free period, 120 to 210 days; precipitation effectiveness index (effectiveness of precipitation at the temperature at which it fell), 48 to 127 *(19,29).*

The factors limiting the distribution of black maple are a combination of temperature and moisture. A comparison of its range with that of closely related sugar maple shows that sugar maple extends about 4 degrees in latitude farther into the cooler north and ranges northeast into the mainland provinces of Canada, well into lower Quebec. But to the west, black maple extends into the warmer, drier, subhumid grasslands 193 km (120 mi) farther than sugar maple, whose distribution ends at the western boundary of the humid forest zone. The importance of temperature and precipitation effectiveness is further reflected in only scattered appearances of black maple in predominantly sugar maple stands in Quebec, where they are considered relicts of a past warm, dry period (8).

Soils and Topography

Several general soil types lie within the range of black maple. In the cooler, more moist areas they are podzolic (order Spodosolsl, subject to mineral and organic losses through leaching and eluviation. In the warmer and more temperate sections are melanized, cryptorganic, and vadose soils of sialic substrata. In the drier, subhumid western areas of its range, the invasion of the prairies by forests has resulted in degraded chernozems or embryonic groods *(30).* These soils are included in the orders Mollisols, Inceptisols, Entisols, and Spodosols.

In the part of the black maple range included in northwestern Ohio, northern Indiana, and southwestern Michigan, the soils are light in color and low in organic matter; there are dark-colored, poorly drained areas dispersed among them. These soils were developed from various types of glacial deposit and are variable in texture (23).

In western Ohio, black maple increases in abundance as the soil type changes from a silty clay loam to a silt loam, indicating that poorer aeration and internal drainage react unfavorably with the taxon *(26).*

In central Iowa, black maple is found on well-drained, moderate slopes with dark topsoils 20 to 25

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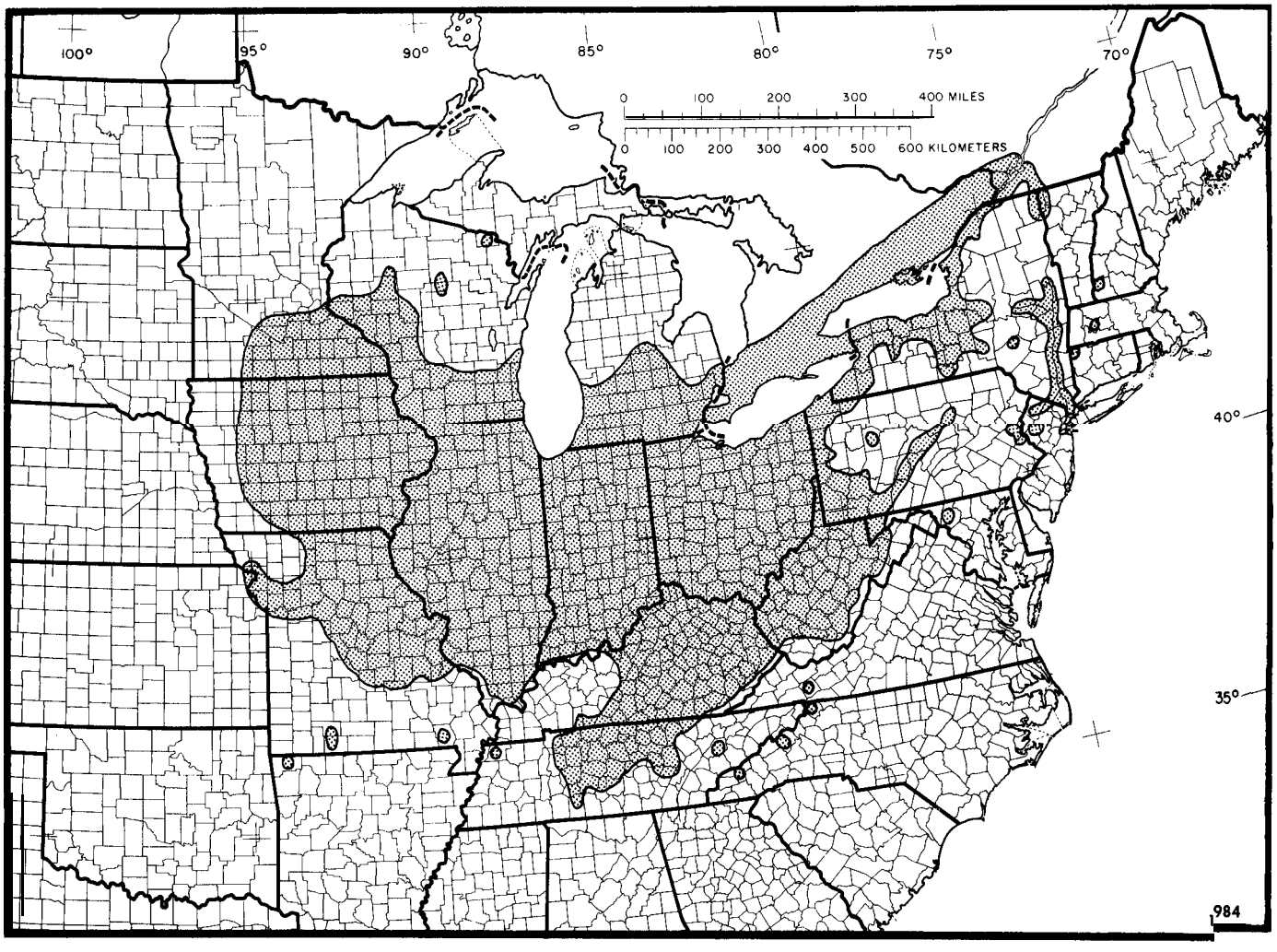

Figure *l-The native range of black maple.*

cm (8 to 10 in) deep, grading into a subsoil that is yellow-brown clay, changing to calcareous clay till at *75* cm (30 in) *(18).*

In Quebec and New York, black maples are restricted to rich, low grounds with a limestone substratum *(11).* In central and northern Missouri, black maple in association with other species is found in rich woods, on slopes, in ravines and valleys, and near streams (27).

In a study of black maple originating in glaciated and unglaciated areas of Ohio, it was concluded that the present-day population is a postglacial hybrid swarm between black and sugar maple, and that black maple had not been subjected to strong selection forces as the result of glaciation (22).

Associated Forest Cover

Black maple has been treated taxonomically as a species or as a subspecies in the sugar maple complex *(20,25).* In most practical forest treatments, because of its similarities in wood properties, black maple has been included with sugar maple and treated as a subspecies. Although their ranges overlap and black maple appears with sugar maple in a number of forest types, black maple is not usually listed as a component of these types. In some areas, black maple is found in large numbers; in others, sugar maple is found in nearly pure stands.

Oak-hickory and maple-beech-birch are major forest types in which black maple is an associate *(19).*

Figure *2-A* mature *black maple growing in a Vermont sugarbush.*

In the Mixed Mesophytic climax forests in the Eastern United States, black maple appears as a dominant member in the forest canopy in association with American beech *(Fagus grandifolia),* yellow-poplar *(Liriodendron tulipifera),* American basswood *(Tilia americana),* sugar maple, yellow buckeye *(Aesculus octandra),* northern red oak *(Quercus rubra),* white oak *(Q. alba),* and eastern hemlock *(Tsuga canadensis) (5).*

The black maple-basswood association on north slopes in central Iowa represents a transition from a beech-maple climax centered in Ohio (18). On flood plains, the principal species in a transitional community are American basswood, slippery elm *(Ulmus rubra),* American elm *(U. americana),* and black maple (5). In five forest stands that were predominantly black maple, the proportion of commercially important species was as follows: black maple, 30.8 percent; American basswood, 14.9 percent; northern red oak, 8.5 percent; American elm, 7 percent; black walnut *(Juglans nigra),* 5 percent; white ash *(Fraxinus americana),* 3.5 percent; slippery elm, 3.5 percent; white oak, 3 percent; bitternut hickory *(Carya cordiformis),* 2.5 percent; eastern redcedar *(Juniperus virginiana),* 1.5 percent; bur oak *(Quercus macrocarpa),* 0.5 percent; shagbark hickory *(Carya ovata),* 0 to 5 percent (unpublished data, North Central Forest Experiment Station, St. Paul, MN).

In central Kentucky, on the lower slopes of ravines, black maple is well represented in mixture with American beech, white ash, blue ash *(Fraxinus quadrangulata),* yellow-poplar, white oak, northern red oak, and chinkapin oak *(Quercus muehlenbergii) (5).*

The understory vegetation associated with black maple is quite variable because of the variation in habitat over its range. On melanized loam soils in the Lake States area, the shrub understory consists mainly of Atlantic leatherwood *(Dirca palustris)* and species of *Viburnum,* blackberries and raspberries *(Rubus),* and elder *(Sambucus).* Ground cover commonly found in the area includes maidenhair fern *(Adiantum pedatum),* sweet jarvil *(Osmorhiza claytonii),* red baneberry *(Actaea rubra),* early meadowrue *(Thalictrum dioicum),* Dutchmans-breeches *(Dicentra cucullaria),* rue anemone *(Anemonella thalictroides),* wild sarsaparilla *(Aralia nudicaulis),* and bristly greenbrier *(Smilax hispidia) (30).*

In the unglaciated highland area of southern Indiana, where black maple is well represented, as many as 40 species have been listed in the herbaceous layer of the forest (5). Some of the most prominent plants in the understory are the common pawpaw *(Asimina triloba),* spicebush *(Lindera benzoin),* poison-ivy *(Toxicodendron radicans),* and horsebrier *(Smilax rotundifolia) (24).*

Life History

Reproduction and Early Growth

Flowering and Fruiting-The yellowish-green flowers of black maple are borne on pendulous, hairy pedicels that are 3 to 7 cm (1.2 to 2.8 in) long, in subsessile corymblike inflorescences. Female flowers are found mainly in terminal buds; lateral buds

usually contain male flowers with few or no female flowers.

Like sugar maple, black maple is monoecious. Flowers are pseudohermaphroditic (flowers may be morphologically perfect but functionally they are unisexual) and occur in mixed buds. The rachis of the inflorescence results from the differentiation of the vegetative shoot. The latter is laid down first in the bud and consists of two pairs of leaves and a short stem. The leaves are arranged in an upright, protective manner about the lower part of the inflorescence. There is little difference in external morphology between vegetative and flower-containing buds when in deep dormancy.

The first expression of a break in dormancy is the swelling of the mixed buds, which take on a four-sided appearance. After budburst, the inflorescence develops more rapidly than the leaves. The time for full development of flowers depends on the air temperature but normally occurs in 3 to 4 days. Duration of stigma receptivity may range from 3 days during warm, dry periods to 8 days during cool, moist periods.

The same dichogamous condition found in sugar maple is found in black maple. Protandry, or a male-female sequence in flower blooming, occurs in some trees while protogyny, or a female-male sequence, occurs in others *(13).* Pollination of female flowers is by wind and bees.

In Vermont, the average flowering period is the first week in May. May is the average month for flowering in Indiana and Michigan *(10)*, but over its entire range, April is considered the average month for flower blooming (25).

Fruits that contain seeds are treated for germination as for sugar maple (7). After a 24-hour initial soaking in water, the seeds are stratified in a moist media. Germination is epigeal and starts with the appearance of a radicle about 6 weeks after stratification. Within a week to 10 days, a pair of cotyledons appears, followed by a pair of primary leaves. Two pairs of secondary leaves replace the primary leaves and a terminal bud is set, provided soil moisture is adequate. Second, and occasionally third, flushes of growth may occur during the growing season.

Seed Production and Dissemination-Black maple fruits are paired samaras, fused at the pericarps and each with a papery wing ranging in length from 15 to 30 mm (0.6 to 1.2 in) and in width from 5 to 15 mm (0.2 to 0.6 in). Wings may be divergent or parallel in varying degrees. At seedfall, the fruits split apart and the peduncles remain on the tree. Fruit and seed size vary from tree to tree. Smaller fruits and seeds appear to be related to more divergent wings. Within trees, fruits and seeds are relatively uniform.

In ripening fruits, the pericarp changes from green to brownish or reddish green. The outer integument of the seed changes from silver to brown. The seeds are exalbuminous, having no endosperm. Fruits of black maple ripen on schedule in the fall with sugar maple fruits. In New England, seedfall occurs in late September and early October, depending on latitude and altitude. Heavy seed crops usually occur in 4-year cycles in Vermont and surrounding States, with lighter seed production during intervening years. Although the fruits and seeds are moderately heavy, during high winds the papery wing of the fruits can carry the seed considerable distances from the seed tree. Size and weight of black maple fruits and seeds follow closely those of sugar maple, which averages 15,500 seeds per kilogram (7,030/lb) (28).

Seedling Development-Black maple produces a sufficient quantity of seeds and subsequent seedlings to reproduce itself over its entire range but finds more optimum conditions for reproduction in the midwestern and western parts of its range. In a maple-basswood community located on a north slope in central Iowa, one seedling count was 40,150/ha (16,250/acre). On a western slope dominated by oaks and hickories, the count dropped to 8,400/ha (3,400/acre), and under floodplain conditions, 740/ha (300/acre) *(1)*. Germination of black maple seeds is epigeal (26). In central Kentucky, black and sugar maple together with beech are successfully reproduced on limestone soils on lower slopes. On the upper slopes, a great increase in the abundance of black maple in the understory indicates a movement of black maple and other species from the lower to the upper slopes at the expense of oaks and hickories *(5)*.

The scattered growth of black maple in cooler, more moist southern Quebec and northern New England indicates it cannot compete successfully with sugar maple in these areas *(9,11)*. The few stands in southern Quebec where black maple still can be found are considered remnants of an earlier warmer and drier period (9).

Survival and growth of outplanted black maple seedlings in experimental plantings are similar to that of sugar maple (fig. 3). Seedlings of both taxa during the initial developmental stages in the plantation require protection from competing vegetation and gnawing rodents. Where deer are prevalent, protection must be provided or seedlings should be planted that are tall enough to extend beyond their reach.

Figure *3-A young mixed plantation of control-pollinated black and sugar maples and hybridsgrowing in Vermont.*

Vegetative Reproduction-No information available.

Sapling and Pole Stages to Maturity

Growth and Yield-The average height and diameter of black maple after six growing seasons in a transplant bed were 1.9 m (6.3 ft) and 21 mm (0.84 in), respectively. Among plantation-grown black maple (fig. 3), the average height and d.b.h. after nine growing seasons were 4.9 m (16.1 ft) and 6.4 cm (2.5 in), respectively. Mature trees reach heights of 21 to 34 m (70 to 110 ft) and more than 100 cm (40 in) in d.b.h. (4).

In central Iowa, the average height of maple trees ranged from 14 to 23 m (43 to 75 ft). The median diameter class was 20 cm (8 in) in d.b.h. Black maples in maple-basswood communities were adversely affected when subjected to a severe drought *(1)*. Total volume of all commercially important species in five stands dominated by black maple was 191 m^3 (6,756 ft^3), of which 73 m^3 (2,564 ft^3) or 39 percent was black maple (unpublished data, North Central Forest Experiment Station, St. Paul, MN).

Rooting Habit—No information available.

Reaction to Competition-Black maple is classed as very tolerant of shade. Seedlings prosper under heavy forest cover and trees respond to release even after extreme and prolonged suppression.

Damaging Agents-The damaging agents of black maple are considered to be the same as those for sugar maple.

Special Uses

The wood properties of black and sugar maple overlap in a narrow range and for all practical purposes are considered the same. A sampling of black maple trees showed that the average vessel segment length was 340 μ; the average fiber length was 845 μ. Sugar maple had 15 percent more uniseriate rays than black maple *(21)*.

Black maples are tapped for sap in the process of making maple syrup. Tests on unreplicated plots of black and sugar maple showed little differences between the two taxa in the sugar content of sap *(16)*.

In Marshall County, IN, individual volume tables were developed for both black and sugar maple. These were combined when statistical analysis indicated no significant differences *(15)*.

Genetics

There appear to be two broad populations of black maple with respect to its hybridizing with sugar maple. One is in the western part of its range, where it maintains its identity and shows little tendency to cross with sugar maple *(2,3,12,27)*. The second population is in the eastern section, where it hybridizes readily with sugar maple *(9,11)*. Evidence of this has, in most cases, been based on studies of leaf characters, which are considered more useful in systematic studies than other characters such as flowers, fruits, and winter buds *(12)*.

In speculating on the hybrid origin of black maple, one of the parents advanced is sugar maple. On the basis of an "average" leaf constructed from numerous leaves of maple that were collected over its range, it has been hypothesized that the second parent is Rugel maple *(Acer saccharum* var. *rugelii* (Pax) Rehder) *(6,25)*. The foliar stipules at the base of leaf petioles of black maples (fig. 4) are not found on either proposed parents and may represent a reversion resulting from gene interaction in the hybrid.

In the Northeast, black and sugar maple are separate populations with distinct characters that are united by a large intermediate population which includes a variety of recombinations from the two taxa. Introgression by sugar maple occurs because of differences in ecological requirements. The cooler, more moist climate favors the survival of those hybrids and back-cross progenies that tend to be more like sugar maple than black maple (9).

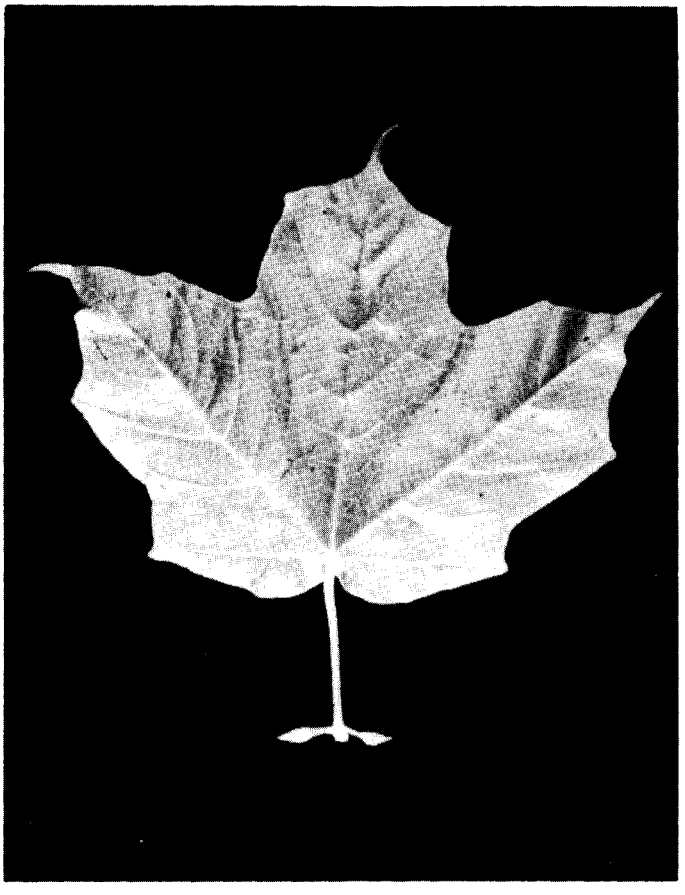

Figure 4—*Foliar stipules at the base of a black maple leaf stem.*

Systematic studies have been based mainly on observations of herbarium specimens of leaves collected over the range of black and sugar maple. Hybridization has been verified through intermediacy of leaf characters, but controlled pollinations have been successful between the two taxa using parents of Vermont origin *(14)*. Crosses using sugar maple as a female parent were more successful than those using black maple as a female. Hybrid leaf shapes favored sugar maple in outline, but pubescence was intermediate. With a little practice, workers could easily distinguish hybrids between the two taxa among mixed 5-year-old stock-representing both straight sugar maple and black maple progenies and hybrids-by the intermediate pubescence and by differences in leaf lobules.

In a provenance study of sugar maples, which included some black maples, height growth of the latter ceased earlier, fall foliage color developed sooner, and leaf fall occurred earlier than that of sugar maple *(17)*. Exceptions were black maples from Iowa, which showed no differences from sugar maple. Young black maple trees showed less forking, or a higher degree of apical dominance, than sugar maples of the same age.

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