Acer pensylvanicum L. Striped Maple

Aceraceae Maple family

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Striped maple *(Acer pensylvanicum) (8),* also called moosewood, is a small tree or large shrub identified by its conspicuous vertical white stripes on greenish-brown bark. It grows best on shaded, cool northern

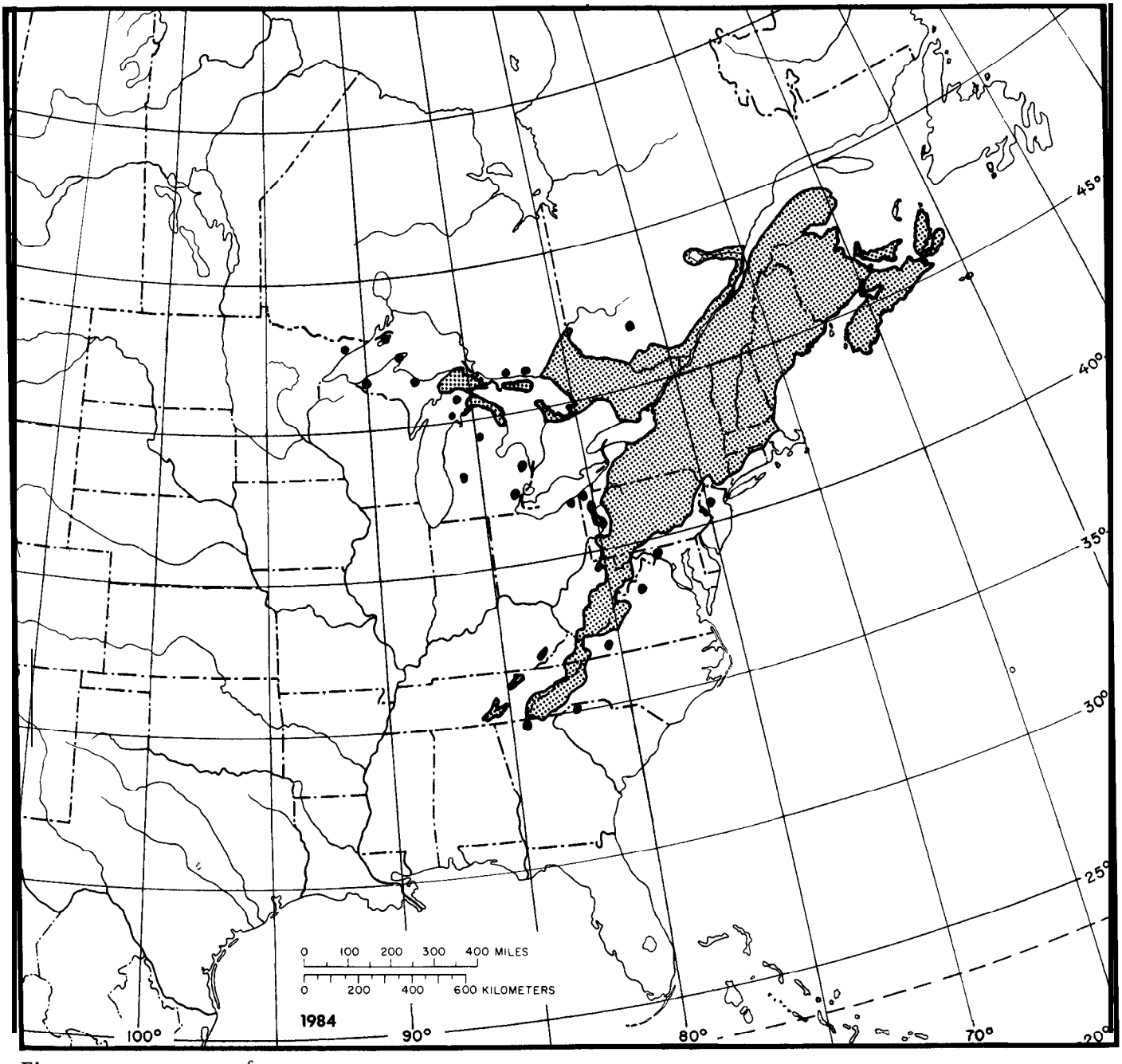

Figure *l-The native range of striped maple.*

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slopes of upland valleys where it is common on well-drained sandy loams in small forest openings or as an understory tree in mixed hardwoods. This very slow growing maple may live to be 100 and is probably most important as a browse plant for wildlife, although the tree is sometimes planted as an ornamental in heavily shaded areas (33,371.

Habitat

Native Range

Striped maple (figs. 1, 2) is widely distributed over the northeastern quarter of the United States and southeastern Canada. Its natural range extends from Nova Scotia and the Gaspé Peninsula of Quebec, west to southern Ontario, Michigan, and eastern Minnesota; south to northeastern Ohio, Pennsylvania, and New Jersey, and in the mountains to northern Georgia (28). The species is distinct from other maples, and there is no evidence of intergrading with other species.

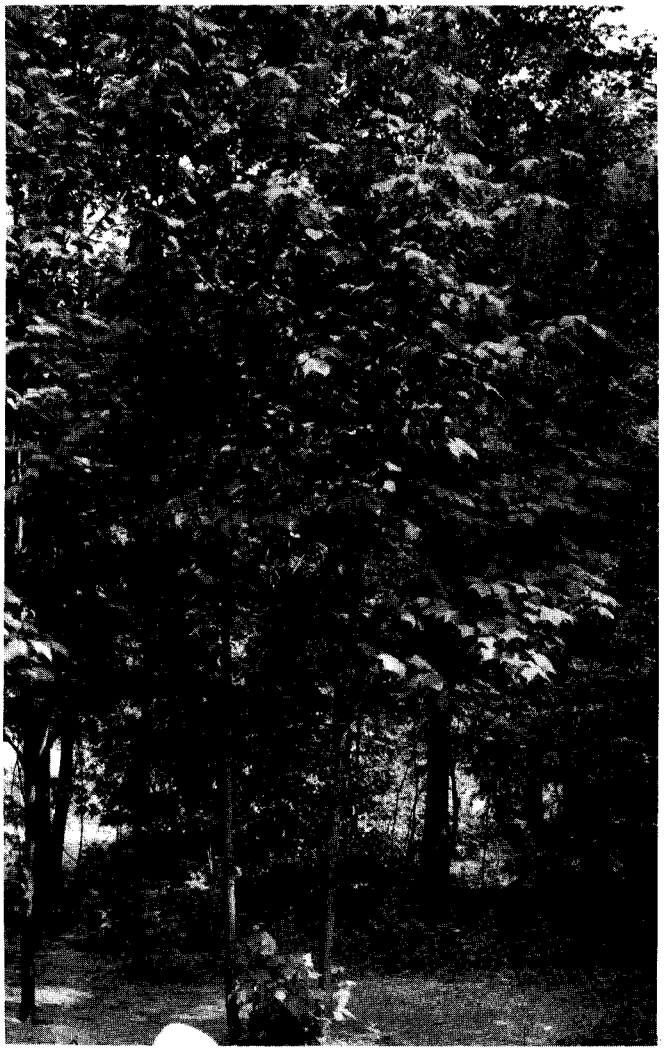

Figure 2—*Striped maple.*

Climate

The important climatic factors within the range of striped maple are as follows: total annual precipitation, 710 to 1630 mm (28 to 64 in); normal monthly growing season precipitation (May, June, July, and August), 50 to 100 mm (2 to 4 in) in the northern and eastern part of the range and from 100 to 200 mm (4 to 8 in) in the central and southern sections; mean annual total snowfall, 5 to 250 cm (2 to 100 in) with pockets up to 500 cm (200 in); mean length of frost-free period between the last 0" C (32" F) temperature in the spring and the first 0° C (32" F) in the autumn, 90 to 210 days; and average January temperature, -12" C (10° F) to 4" C (40° F) (43).

Soils and Topography

Striped maple is found on brown and gray-brown podzolic soils (orders Inceptisols, Alfisols, and Spodosols) that characterize the areas of mixed coniferous and hardwood forests. It also grows on the strongly weathered and leached podzols (order Spodosols) as well as on darker melanized soils (order Mollisols) *(3,47)*. Compared to other species in the genus *Acer*, which are relatively indifferent to soil reaction, striped maple prefers acid soils *(42,45)*. Neither the range in soil pH nor the optimum acidity level is known for the species.

Soil moisture and texture influence the local distribution of striped maple. It is common on sandy loams that are moist and well drained *(23,42)*. A study of local distribution in western Massachusetts showed that on study plots where striped maple was present there was a positive correlation between species density and windthrow mounds that resulted in small openings in the stand. No significant correlations were found with depths of organic and A horizons, rock outcrops, or stoniness of soils *(13,16)*.

In areas of granitic drift in the White Mountains of New Hampshire, striped maple of sapling size was most abundant (15 percent of total basal area) on soils with a matrix of sharp-angled or rounded boulders or on nearly pure weathered granite found not more than 65 cm (26 in) below the top of mineral soil (24). On wet compact till and on washed till, the species made up 6.8 percent and 7.3 percent of the stand basal area, respectively, It is one of five species that seems to be permanent and abundant in local

distribution on a well-drained, fine, sandy loam podzol in the White Mountains (23).

Striped maple and its associates are found on glaciated knoll tops and slopes in Quebec (26). In the mountainous areas of New England, it develops best at elevations between 550 and 800 m (1,800 and 2,600 ft) (2,421. It apparently does not do well at higher elevations in the northeast. In two transects beginning at 610 and 630 m (2,000 and 2,070 ft) at different locations in the White Mountains of New Hampshire, striped maple was only 2 to 4 percent of the basal area of the forest stand (25). It dropped out completely between elevations of 830 and 860 m (2,720 and 2,820 ft).

Density of striped maple in western Massachusetts increased with a slope up to 45" and with an elevation up to 700 m (2,300 ft) *(13,16).* Growth increased on northerly facing, local aspects and on steeper slopes and towards the top of slopes. In the southern Appalachian Mountains, the species is common on mesic sites with an elevation between 760 and 1370 m (2,500 and 4,500 ft); above this elevation it disappears very rapidly (46).

Striped maple attains its best growth on shaded, cool northern slopes in deep valleys *(18).* It can exist under a number of different combinations of environmental factors, but as a mesophyte it favors habitats where moisture conditions are moderate.

Associated Forest Cover

Striped maple is a common but minor forest component, appearing as an understory species in the boreal hardwoods and in the spruce-fir and northern hardwood types of the northern forest region. It is a part of the undergrowth vegetation in 12 of the following eastern forest cover types (Society of American Foresters) *(7).*

17 Pin Cherry
20 White Pine-Northern Red Oak-Red Maple
22 White Pine-Hemlock
23 Eastern Hemlock
24 Hemlock-Yellow Birch
25 Sugar Maple-Beech-Yellow Birch
28 Black Cherry-Maple
30 Red Spruce-Yellow Birch
31 Red Spruce-Sugar Maple-Beech
32 Red Spruce
35 Paper Birch-Red Spruce-Balsam Fir
60 Beech-Sugar Maple

In the boreal hardwoods, striped maple is found in association with the following overstory species: pin cherry *(Prunus pensylvanica),* quaking aspen *(Populus tremuloides),* bigtooth aspen *(P. grandidentata),* paper birch *(Betula papyrifera),* yellow birch *(B. alleghaniensis),* red maple *(Acer rubrum),* sugar maple *(A. saccharum),* American beech *(Fagus grandifolia),* northern red oak *(Quercus rubra),* balsam fir *(Abies balsamea),* and red spruce *(Picea rubens).*

In the spruce-fir cover types in the northern forest region, the dominant species in association with striped maple are red spruce, gray birch *(Betula populifolia),* American mountain ash *(Sorbus americana),* American beech, and sugar maple. In the northern hardwoods, the most common overstory species are sugar maple, American beech, yellow birch, black cherry *(Prunus serotina),* and eastern hemlock *(Tsuga canadensis) (2,13,16,42).* Striped maple in the southern Appalachian Mountains appears with eastern hemlock, Carolina silverbell *(Halesia Carolina),* yellow buckeye *(Aesculus octundra),* sugar maple, white basswood *(Tilia heterophylla),* yellowwood *(Cladrastis kentukea),* black birch *(Betula lenta),* and witch-hazel *(Hamamelis virginiana) (46).*

The most common understory species associated with striped maple in addition to reproduction of the overstory species are hobblebush *(Viburnum alnifolium),* Canada yew *(Taxus canadensis),* mountain maple *(Acer spicatum),* woodsorrell *(Oxalis* spp.), eastern hophornbeam *(Ostrya virginiana),* American hornbeam *(Carpinus caroliniana),* serviceberry *(Amelanchier* spp.), hawthorn *(Crataegus* spp.), and pawpaw *(Asimina triloba).*

Life History

Reproduction and Early Growth

Flowering and Fruiting-Sex expression in striped maple is variable. It can be monoecious, with male and female flowers on the same tree, or dioecious, with some trees male and others female *(11,18,33,35,38);* the same tree may differ in expression from year to year *(13,21).*

Sex expression varied in a sample of 312 trees taken under natural habitat conditions in western Massachusetts. Four percent of the trees sampled were monoecious and 96 percent were dioecious. The ratio of female to male flowering trees under the latter condition was 8 to 1 *(15).*

Sex expression changed for six of eight specimens of striped maple growing under arboretum conditions in Europe. In annual observations made over a period of 2 to 6 years, dioecy appeared 15 times and monoecy 10 times *(21).* The ratio of male to female trees under the dioecious conditions was 1 to 14.

There is a strong possibility that sex expression is influenced by environmental effects. In one year, 27

trees of 243 changed sex. Most changes were from male to female *(13,151.* Trees bearing female flowers tended to be less vigorous than those bearing male flowers. Flowering trees, including both sexes, averaged 52/ha (21/acre). As an understory tree, striped maple has a high mortality rate. During the year, nearly 65 percent of the female trees under observation died.

Striped maple produces a crop of flowers each year, under either arboretum *(21)* or natural *(13,15)* conditions. Blooming occurs in May and June *(40)* and begins after the leaves are nearly mature *(1,35,38).* Flowers are usually pseudohermaphroditic, yellow, and about 6 mm (0.25 in) in diameter, occurring in pendulous racemes that range from 10 to 15 cm (4 to 6 in) in length.

Functional male flowers have a rudimentary pistil that may occasionally be absent; functional female flowers develop stamens but the pollen sacs do not dehisce. A few flowers have been found that appear to be functionally perfect. Flowering may occur among trees as young as 11 years old and as small as 1 m (3.3 ft) in height *(13,15).*

Fruits of striped maple are samaras borne on pedicels ranging from 10 to 15 mm (0.4 to 0.6 in) in length. Their color is somewhat reddish in early development, changing later to tan. Wings are widely divergent with nutlets about 20 mm (0.8 in) long.

Seed Production and Dissemination-Most fruits and seeds of striped maple ripen in September and October and are dispersed in October and November *(40).* Seed production varies from tree to tree; some trees produce as few as 10 seeds, whereas others produce several thousand. The density of seed dispersal from a tree drops quickly as the distance from the tree increases. At 10 m (33 ft) from a seed tree the average number of seeds was 13.75 per square meter (1.28/ft^2). At 60 m (200 ft) the number dropped to 1.25 seeds per square meter (0.1/ft^2). Seeds that fall on crusted snow cover may be blown as far as 4 km (2.48 mi) from the seed tree *(14).* The number of cleaned seeds varies from 21,400 to 34,400/kg (9,700 to 15,600/lb) averaging 24,500/kg (11,100/lb) *(40).*

Seedling Development-Newly collected striped maple seeds are dormant and must receive moist stratification at 5" C (41" F) for 90 to 120 days to germinate *(40).* Mature seeds covered only by the current year's leaf litter do not germinate until the second year but, if buried under soil or humus, germinate the first year. There also seems to be a testa-imposed dormancy in the species which causes mechanical restriction of radicle elongation. Seeds would not germinate after stratification of 30 to 90 days with the testae intact, but when testae were removed from over the radicles, germination was rapid and complete. Unstratified seeds with the testae removed from over the radicles and treated with benzyladenine germinated 100 percent at 23" C (74" F) *(49).*

Delay in germination of striped maple seed was reduced when two-thirds of the basal area of the stand was removed and was completely eliminated when the stand was clearcut (29). In the clearcut, however, total germination dropped sharply with the complete removal of the overstory.

Seed germination is epigeal, with the radicle first to emerge. Soon after the emergence and elongation of the radicle, the shoot begins its upward growth. The cotyledons unfold and are followed by the formation of the first pair of leaves. The leaf margins are serrate and lobes are usually absent. The leaf area is small, ranging from about 25 to 65 mm (1 to 2.5 in) *(5).*

Suppressed new seedlings generally grow less than 30 mm (1.2 in) per year and mortality is nearly 90 percent after the first growing season. In the following 15 years, the mortality rate drops to less than 1 percent per year. Between 15 and 40 years of age, mortality rises to 3.8 percent per year but drops to 1.6 percent after 40 years *(13,14).*

Vegetative Reproduction-Vegetative reproduction does not seem to play an important part in the reproduction of the species. Although striped maple reproduces by layering and basal sprouting, sampling of a striped maple population showed that only 3 percent of the trees originated from layering and 8 percent by sprouting *(15).* In general, natural vegetative propagation of the species seems to be a mechanism by which it survives suppression rather than increasing its numbers. The first leaves of sprouts are small, with coarse serrations, and are unlobed. Sprouting begins relatively soon after a tree dies. Sprouts appeared around the main stem of understory trees within 2 months after main stems were killed in a prescribed burn.

In vitro culture of striped maple has been successful. Callus tissue was formed in a medium consisting of a mixture of coconut milk, naphthalene acetic acid, sucrose, and salt (31).

Sapling and Pole Stages to Maturity

Growth and Yield-Striped maple develops best under moderate light intensity. Rapid shoot growth under low light intensity can occur but the growth resembles etiolation (48). Under direct sunlight

striped maple may be succeeded by mountain maple *(19)*.

The species is well adapted to survival under heavy shade. As a suppressed understory tree, its growth and development are extremely slow. Height growth over a lo-year period may be as little as 30 cm (12 in), but trees that have been heavily suppressed for 35 to 40 years respond well to release *(13,14)*.

Growth rate of trees following the removal of the overstory is correlated with growth rate before overstory removal, whether or not they were previously growing in a suppressed or released state. The maximum rate of growth observed among released striped maple under optimum light was 1 m (3.3 ft) per year. The species grows well in small forest openings and under a thinned overstory that results in moderate understory lighting. Because its maximum height growth is about 15 m (49 ft), it will never become a major member in the upper canopy of the northern hardwood forest cover type, though the species has been known to occupy forest openings for more than 100 years *(13,14)*.

Rooting Habit-The root system of striped maple is shallow and wide-spreading *(18)*, illustrating its adaptation to an understory position in the forest. Because it is protected from wind damage by the dominant trees in the overstory, it does not need a deep root system designed for strong support, and its shallow, spreading features make it strongly competitive for soil moisture and nutrients.

Reaction to Competition-The species is ideally suited to expanding and developing its understory position in the forest should the situation arise. Large numbers of small trees that are capable of surviving from year to year under heavy shade await a disturbance in the upper canopy. They show an instant response to increased light even though overtopped for as long as 35 to 40 years. The species does not require full sunlight to realize its maximum growth potential but grows best under moderate lighting found in partial or small forest openings. Striped maple is classed as very tolerant of shade. Sexual reproduction in striped maple is closely associated with changes in the upper canopy, resulting in regeneration of the trees that will be stored in the understory *(13,15)*. Asexual propagation is capable of regenerating individual trees within a few months.

Striped maple is often considered a serious silvicultural problem. When large numbers of this species occupy an understory before cutting, they frequently become the dominant vegetation after cutting, excluding more desirable species ***(17).*** In Allegheny hardwood stands in northwestern Pennsylvania, Marquis and others (30) found that when more than 30 percent of the 1.83-m (6-ft) radius regeneration plots had more than eight striped maple seedlings before clearcutting, these species became dominant after cutting. If the number of striped maple stems exceeds these recommendations, it is essential to reduce their number before harvest cutting to permit establishment of regeneration of desirable hardwood species. Striped maple can be controlled with glyphosate applied with a mistblower at the rate of 1.12 kg/ha (1 lb/acre) a.i. Best kill was achieved when applied from July 1 through September 1 *(17)*.

Damaging Agents-Probably the most serious enemy of striped maple is Verticillium wilt *(Verticillium albo-atrum)*, a soil-borne stem disease that kills the trees it attacks ***(12).*** Less destructive to the species is ***Cristulariella depraedens,*** one of the common leaf spot diseases found on a number of other maple species (36). Although Pezicula trunk and branch cankers are found on several maple species, ***Pezicula subcarnea*** attacks striped maple only (9). *P. acericola* occasionally appears on striped maple but is most common on mountain maple.

The species is relatively free of insect attack. However, it is subject to infestation by one of the flatheaded borers, *Agrilus* ***politus,*** which forms stem galls (4).

Special Uses

Probably the most important use of striped maple is for wildlife food. It is one of the preferred species for rabbits and is frequently eaten by porcupines *(6,34)*. It provides browse for deer and moose, though the net energy derived from winter browse is relatively low *(27,32,44)*. The samaras are eaten, to a limited extent, by ruffed grouse (22). When ***Populus*** species are lacking, striped maple is eaten by beavers and it is browsed by woodland caribou during summer months *(41,44)*.

Striped maple is occasionally planted as an ornamental tree. Because it does poorly in full sunlight, it must be planted with other species. It was introduced into England about 1760, and into continental Europe shortly thereafter where reportedly it reached heights of 9 to 12 m (30 to 40 ft) with trunk diameters up to 45 cm (18 in).

The wood of the species is diffuse-porous, white, and fine grained, and on occasions has been used by cabinet makers for inlay material. Botanists who visited North America in the early 18th century found that farmers in the American colonies and in Canada fed both dried and green leaves of the species

to their cattle during the winter. When the buds began to swell in the spring, they turned their horses and cows into the woods to browse on the young shoots.

An active antitumor substance has been isolated from striped maple, and tests are underway to determine its practical application *(10)*.

Genetics

No organized genetics research has been conducted in striped maple, probably because of its lack of commercial value. The species hybridizes in nature with Tatarian maple *(Acer tatarium)* as the female parent, resulting in the hybrid *A. boscii (20)*. Striped maple has a chromosome complement of n=13, determined from specimens collected from several northern localities. No marked meiotic irregularities were observed. The species appears to be diploid over the northern part of its range *(38)*.

Sex expression was studied in two different samples of 69 and 243 trees each in western Massachusetts. Results of both samples were nearly identical, implying that no genetic differences existed in sex expression between the two areas sampled and that samples came from the same population with respect to the character sampled.

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