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FOREST-TREE BREEDING WORK OF THE CABOT FOUNDATION

FOREST-TREE breeding was first formally recognized at Harvard University with the establishment of the Maria Moors Cabot Foundation in 1937 by Dr. Godfrey L. Cabot of Boston. Since that time a number of basic studies have been started. These include investigations of natural variability in forest-tree species, hybridization of species of timber trees, vegetative propagation and the study of insect and disease resistance in forest trees. These projects involve work not only in genetics, but also in plant physiology, plant pathology, entomology, ecology, and wood anatomy. It is evident that considerable foresight was demonstrated by the founder in establishing the Cabot Foundation in an institution where workers in these special fields are available for collaborative study.

The tree breeding work of the Cabot Foundation was started at the Arnold Arboretum—an institution which may be truly called a tree breeder's paradise. Among the extensive collections are species of timber trees from all parts of the north temperate zone. It has been possible, for instance, to make hybrids between the Himalayan white pine and our native *Pinus strobus*, between *Populus Maximowiczii* from Manchuria and our native cottonwoods, and between other Old and New World species which have been established in the Arnold Arboretum for many years.

Earlier work in forest-tree breeding has shown that species hybrids are often possessed of remarkable growth vigor. One of the best examples is the London Plane tree, a hybrid of *Platanus occidentalis* from eastern United States and *P. orientalis* from southern Europe. This hybrid originated in England before 1700, and is now widely grown in Europe and North America where it will thrive under conditions too adverse for the parental species. Recent work with hybrid pines indicates that we can expect certain hybrids to grow nearly twice as fast as the parental species and similar growth acceleration has been reported in hybrid poplars and aspens. (Plate I)

The tree breeding program was started with pines and poplars. The pines, especially the white pines, are among our most valuable timber trees. Although poplars are not highly regarded by American foresters they grow rapidly and provide good wood for pulp and plastics.

The hybrid seedlings are grown at the Bussey Institution and propagated for field testing. Fortunately, the Case Estate at Weston became available at the time when extensive field tests of the hybrid poplars were needed. There are now more than 100 hybrid clones of poplars in the field test covering about three acres. In addition a collection of hybrids and parental species are maintained for a source of propagating wood. Test plots have also been planted near the Harvard Forest through the cooperation of the Metropolitan District Commission of Boston which has made available several plots of land in the Quabbin Reservoir District.

One of the most interesting aspects of the tree breeding program is the study of ecotypes of diverse geographic origin. Poplar clones native of the far north when grown at Weston start their growth early in the spring and stop growing early in the fall, while clones from more southern areas continue growth in the fall until killed by autumn frosts. These southern ecotypes make much greater growth than do their northern relatives, with differences in some cases of as much as 600 percent.

Crosses between northern and southern ecotypes of balsam poplar result in hybrids which grow as fast as the southern strain, but stop growing in the fall as early as does the northern strain. Such hybrids should be of great value for areas where cold hardiness is a critical factor. (Plate II) Similar work is being done with pines. With the cooperation of V. C. Dunlap of the United Fruit Company, pollen of Central American pines has been sent to the Arnold Arboretum by air mail and used to pollinate our hardy northern species. Even if such hybrids may not thrive in New England, they might be of great value in the southern states.

Hybrids between Asiatic and North American white pines were made in 1938 and these are now growing in the Arnold Arboretum. Several of these F_1 hybrids flowered in 1948 and 1949 and have been used in other cross combinations. The hybridization of pines was resumed on a larger scale when another tree breeder was added to the staff in 1948.

Some of the breeding work done at the Arnold Arboretum primarily for the production of ornamentals has proved to be of some interest in forestry and, conversely, it is to be expected that by-products of ornamental value will derive from the forest-tree breeding work. A cross between red and silver maple made in 1944 has shown unusually rapid growth. A few second generation segregates of this hybrid have already been obtained.

Tree breeding has been greatly facilitated by new techniques and modern transportation. One of the most important is the "greenhouse method" of crossing poplars, willows and elms. Dormant flowering branches are brought into the

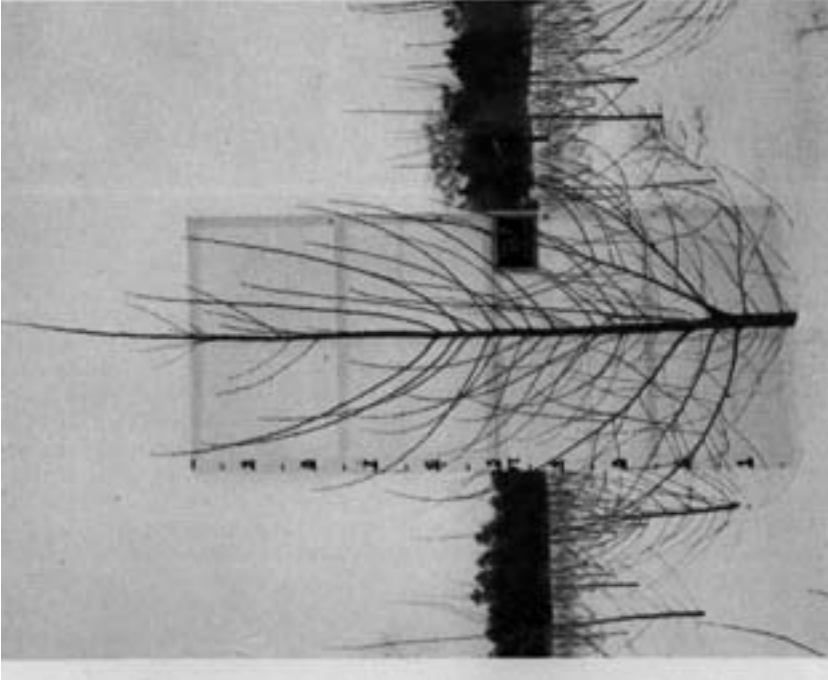
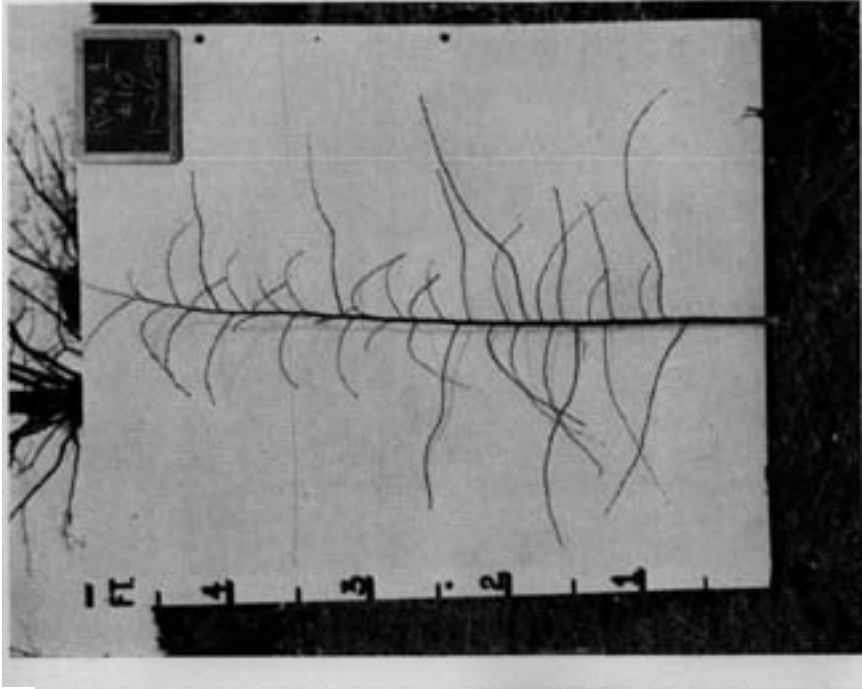


PLATE I. *Left:* Hybrid poplar, over 13 feet in height, after two growing seasons from an unrooted cutting at the Arnold Arboretum's Case Estate, Weston, Massachusetts. *Right:* Hybrid aspen seedling after two growing seasons. This plant was transplanted at the end of the first season to a test plot near Petersham, Massachusetts. There has been less than a foot of height growth during the second season due to the shock of transplanting.



PLATE II. *Above:* Female Alaskan (A), male Montanan (M) balsam poplar and hybrid (F₁) between them photographed at the Cabot Foundation propagation area on the Case Estate, Weston, Massachusetts, September 10, 1949. The vigorous height growth of the hybrid compares favorably with the paternal parent (both of which represent a *single* season's growth from unrooted cuttings) but is in sharp contrast to the maternal parent which is *two* years old from an unrooted cutting. The young man in the picture is a student from Denmark. *Below:* Terminal portions of stems of the above, photographed on the same day, showing early cessation of growth in the female parent from Alaska and incorporation of this character in the hybrid. The male parent from Montana continued in active growth until the middle of October.

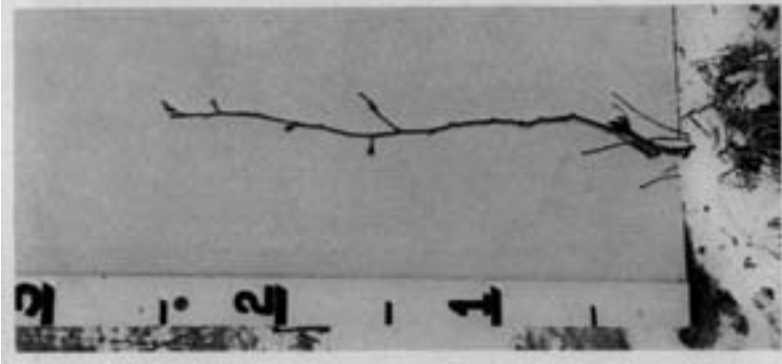
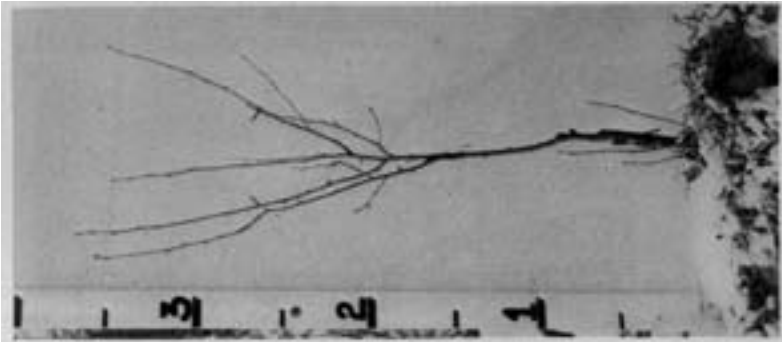
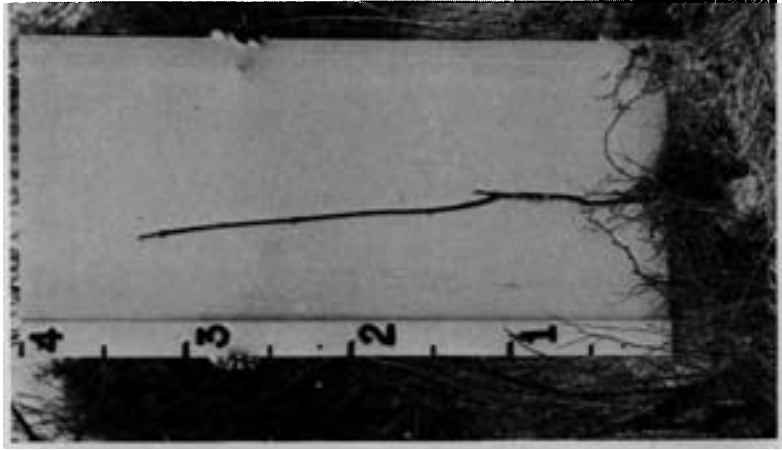


PLATE III. All photographs taken January, 1950. *Left:* Bottle-graft of largetooth aspen on trembling aspen made in spring, 1949. Note numerous flower buds. *Middle:* Bottle-graft of paper birch on grey birch made in spring, 1948. These "dwarf trees" will be repotted this spring, moved into the greenhouse and forced into flower for crossing. In the fall they will be returned to the nursery bed. *Right:* Superior red ash on native wild white ash seedling in woodlot near the Harvard Forest; grafted spring, 1949.



PLATE IV. *Above:* Scaffold permitting access to crown of phenotypically élite Scotch pine, near Swedish Forest Tree Breeding Institute branch station, Brunsberg, Sweden. *Below:* Worker on scaffold platform as shown above inspecting recently pollinated cones. Photographs by the author while in Sweden en route to the Third World Forestry Congress held in Finland in the summer of 1949.

greenhouse and forced into flower. The crosses are made in the greenhouse and the seed will mature on the cut branches kept in a jar of water. Thus it is possible to ship cuttings of poplars from wide areas and make the crosses even when it may be impossible to grow one of the parental trees in this area. Pollen can also be shipped for long distances by air mail. During the current season we have sent pollen to cooperators in Sweden, Norway, Denmark and Holland. The ancient art of "bottle-grafting" has also been used with birches, where the fruiting branches do not live long enough as cut branches to mature their seed. By keeping such grafted plants pot bound it is possible to stimulate annual flowering. Such "dwarf trees" may thus be preserved and used for hybridization year after year. (Plate III)

Methods of vegetative propagation are of special interest to the tree breeder because hybrid vigor can be maintained only by such methods. The balsam poplars root easily from cuttings, but the aspens are usually difficult. The pines also root from cuttings with difficulty even when auxin treatment is used. A great deal of work on the rooting of cuttings has been done by Prof. Kenneth V. Thimann of Harvard, who has recently published a survey of the use of plant hormones in vegetative reproduction under the auspices of the Cabot Foundation. (Thimann, K. V. and Jane Behnke-Rogers. *The use of Auxins in the rooting of woody cuttings*. Maria Moors Cabot Foundation Pub. No. 1. 344 pp. 1950.)

The use of grafts as a means of introducing genetically superior individuals directly into the forest or woodlot is under investigation by the Cabot Foundation (*Jour. For.* 46: 524-525. 1948). This appears to be a feasible technique with such easily budded or grafted (but difficult to root) species as aspens, ashes and maples. (Plate III)

Rapid growth of forest trees is of little value if these vigorous hybrids or ecotypes are unduly subject to disease or insect injury. After all, death by disease or insect attack is just as final and disastrous in a stand of streamlined thoroughbreds as in a stand of mongrel relatives. Studies of disease resistance in hybrid trees has been started in cooperation with the U.S. Department of Agriculture, Bureau of Plant Industry. Our disease test plot of poplars is located in a relatively isolated area of the Arnold Arboretum. It is planned to extend these studies to include geographic races within various forest-tree species in a search for resistant or immune types for future breeding work.

Great progress has been made in the improvement of our domestic plants and animals by selection and hybridization. The utilization of hybrid vigor has made amazing progress in corn production and is being applied to other crops and to domestic animals. But foresters have only in recent years realized the potential possibilities in forest-tree breeding. In the United States the reluctance of foresters to adopt genetic methods is understandable since most of them are confronted at present with the problem of managing large areas of forests with budgets so limited that the care of the forests must be restricted to routine silvicultural treat-

ment. European foresters, although still properly concerned with problems of cultural practice, are increasingly aware of the need for forest genetics. In Sweden alone about twice as much money is expended for forest-tree improvement as is spent for such purposes by all of the government, college and private agencies in the entire United States.

With the increasing need for substituting wood and wood products for our non-renewable resources of gas, coal and metals, a more intensive management of our forests appears to be imminent. Under such conditions a logical approach to more efficient wood production will most certainly involve genetic analyses of wild forest stock, based on progeny tests, and the inauguration of carefully planned tree breeding programs to fulfill specific local needs.

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Note

Regular Field Class again this year

A Field Class for the study of the flowering trees and shrubs as they are growing in the Arnold Arboretum, will again be held this year. The first meeting will be on Saturday, April 29, at 10:00 A.M., meeting at the Forest Hills Gate. Weekly meetings will be held every Saturday morning during May, unless prevented by inclement weather, when the class will meet the next clear weekday morning. The period is two hours long, and discussions will be held about the plants as they come into bloom during this spring season. Members of the "Friends of the Arnold Arboretum" are welcome to attend all classes without charge. Others must register in advance by mail and pay a registration fee.