

THE FERTILE SPECIES HYBRID, PINUS MURRAYBANKSIANA

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The species hybrid between the lodgepole pine, *Pinus contorta* var. *latifolia* Englem. (long known as *P. Murrayana* Grev. & Balf.) and the jack pine, *P. Banksiana* Lamb., has proved to be of considerable interest. In the first place, production of this hybrid throws light on the relationship of two economically important North American pines. Secondly, its good form and rapid growth may indicate hybrid vigor, or heterosis.

The history of this hybrid, produced at the Eddy Arboretum, Institute of Forest Genetics, Placerville, California, began in April, 1939, when pollen-bearing strobili of the jack pine were collected from a tree grown in the Eddy Arboretum from seed obtained from Michigan. The pollen was used on June 9 and 12 to pollinate previously bagged ovulate conelets of a lodgepole pine growing at an elevation of 5700 feet in El Dorado County, California, on the west slope of the Sierra Nevada. The breeding techniques used have been described by Cumming and Righter (1948). In May, 1940, both wind-pollinated and hand-pollinated conelets on the El Dorado County lodgepole pine were bagged for protection from insects and squirrels during the period of seed maturation. The following October, 43 wind-pollinated and 34 hand-pollinated cones were harvested from this tree. The wind-pollinated cones yielded a total of 905 seeds with a viability of approximately 30 per cent, and the hand-pollinated cones yielded 700 seeds, approximately 6 per cent of which were viable. Hybrid seeds from the hand-pollinated cones germinated 3 days sooner on the average than seed of equal weight from the open- or wind-pollinated cones, and the hybrid seedlings displayed, from the outset, a faster growth rate than the wind-pollinated seedlings (Righter, 1945). At 3 years of age the average height of the hybrids was 23.8 inches, while the wind-pollinated lodgepole pine averaged 13.3 inches in height. Typical plots of 3-year-old progenies are shown in Figure 1.

At the age of 3 years, 15 hybrid seedlings were paired with 15 wind-pollinated seedlings in a plantation "t" test (Fisher, 1941) consisting of 5 pairs of plots of 3 seedlings each. The average height of the seedlings from the hand pollinations at the age of 7 years was 4.9 feet, while the wind-pollinated seedlings averaged 2.6 feet in height, a highly significant difference.

Some of the hybrid seedlings obtained from the controlled crossing produced strobili of one sex, or of both, when 2 years old (at the beginning of the third growing season). Reproductive activity increased until at 6 years it was possible to place 50 pollination bags, enclosing more than 200 conelets on 12 of the hybrid

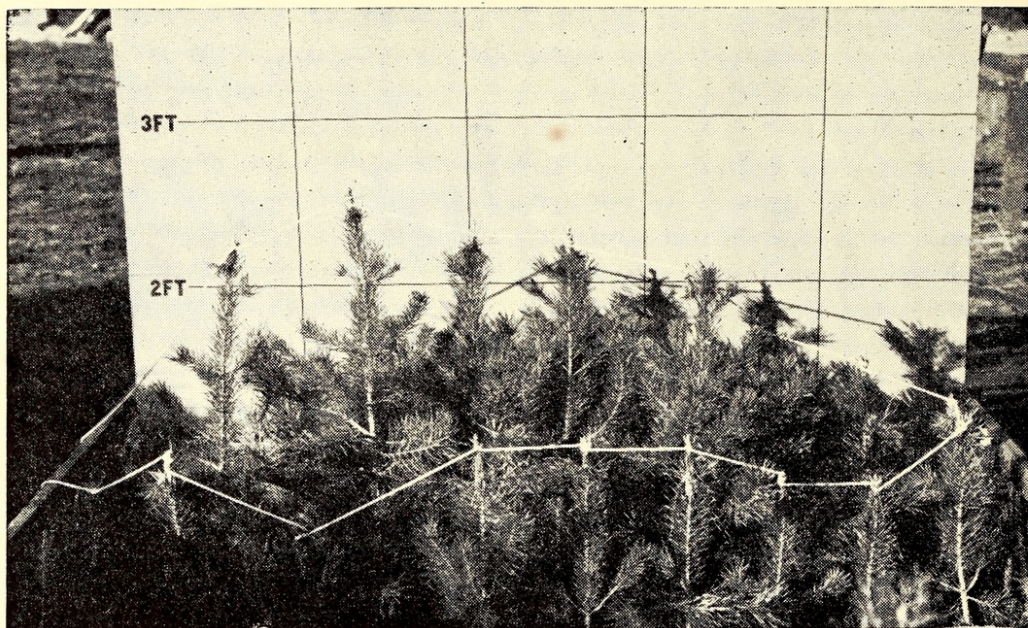


FIG. 1. In the front row with twine tied from top to top are lodgepole pines. In the back row, and similarly marked are the hybrids between lodgepole and jack pine. All are three years old.

seedlings. None of the seedlings from wind pollination produced catkins or conelets until the age of 6 years, when a few strobili of one sex or of both were borne by some of the trees in the plantation test. However, flower production (both sexes) has been reported previously on jack pine at the age of 3 years, and on lodgepole pine at the age of 4 years (Richter, 1939). In another instance ovulate strobili were observed on 2 year old jack pine.

Pollen of the hybrid (fig. 2) was found to be 40 to 50 per cent abortive while that of the parent species is normally only 5 to 10 per cent abortive. Seed-production data, however, indicate that the hybrid is similar to the parents in its output. Thus, an average of 13 sound seeds per cone was obtained from wind-pollinated cones of 2 lodgepole pine trees and an average of 13.1 sound seeds per cone was obtained from wind pollinations and from backcrossing jack pine onto several of the hybrids. This disparity between the production of sound seed and pollen sterility may be explained by two facts. First, from several to many pollen grains usually enter each pollen chamber and are available for fertilizing the egg cell. Second, from 3 to 5 archegonia are normally initiated, but usually only one of these matures and forms a functional egg cell. Thus one viable pollen grain from the several that enter the pollen chamber and one functional egg cell from the 3 to 5 archegonia that are initiated would insure complete fertility (Stockwell, 1939).

The vegetative vigor and reproductive precocity of the hybrid led to an investigation by Buchholz (1945) into the embryological

aspects of hybrid vigor in this cross. The same El Dorado lodgepole pine seed tree was used, but the pollen used in making the cross for Professor Buchholz was a mixture obtained from several trees of jack pine growing in the Eddy Arboretum. Buchholz

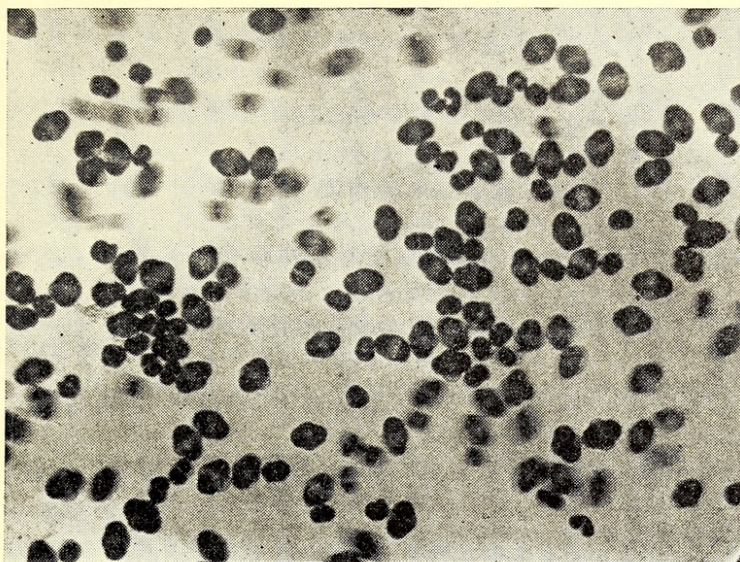


FIG. 2. Pollen of the hybrid between lodgepole pine and jack pine showing approximately 50 per cent abortion.

determined that the rate of development of the embryo in the resulting hybrid seeds exceeded that in the natural seeds of the parental species.

Additional seeds obtained from the above cross were germinated and the seedlings were compared in nursery tests with the natural progeny of, first, the same lodgepole pine seed-tree and, second, jack pine. Conclusive results with respect to vegetative vigor were not obtained from these tests. Exceptional variation in vigor among individuals in the hybrid plots in both tests indicated that the seed might have been mixed in weighing or that pollination had not been controlled completely. In both tests the hybrids were slightly taller on the average than their competitors, but the differences were not statistically significant.

Both jack pine and the hybrid grow faster than lodgepole pine. Any seed mixture or lack of pollination control, where lodgepole pine was the seed parent, would have resulted in seed of lodgepole pine and the hybrid being mixed and sown together with a consequent reduction in average growth rate. Because of the variability of the hybrids and the fact that their average growth equalled or slightly exceeded that of jack pine it may be assumed that the hybrids at least equal, or probably surpass jack pine in growth rate.

In 1944 the cross was repeated on the same El Dorado County lodgepole pine seed tree with a mixture of pollen from several jack pine trees. Seeds obtained from this cross were tested

TABLE 1. DISTINGUISHING CHARACTERS OF *P. CONTORTA* VAR. *LATIFOLIA*, *P. BANKSIANA* AND \times *P. MURRAYBANKSIANA*.

Distinguishing characters	<i>P. contorta</i> var. <i>latifolia</i>	<i>P. Banksiana</i>	\times <i>P. Murray-</i> <i>banksiana</i>
Branches	stiff, ascending, straight	flexible, often drooping, sinuate	stiff, ascending, straight
Spring shoots	glaucous	glabrous	\pm glabrous
Strobili	15-20 mm. long	6-8 mm. long	8-12 mm. long
Open cones	50-70 mm. long; 35-40 mm. diam. recurved	4-5 mm. long; 3-4 mm. diam. incurved	3-4 mm. long; 2.5-3.5 mm. diam. recurved
Cone scales	opening regularly at maturity	opening irregularly and incompletely at maturity	opening regularly and completely at maturity
Apophyses	moderately carinate	usually depressed or plane	usually plane
Prickles	slender, recurved, to 5 mm. long	minute or absent	absent to 1 mm. long

against the natural progeny of the seed parent in a "t" test, consisting of 10 pairs of plots of 10 seeds per plot at a spacing of 12 inches between rows. Germination records were taken every 4 days; there was no statistically significant difference in time of germination between the hybrid and the parental form. At the age of 2 years, the average heights of the hybrids and the natural progeny were 8.9 inches and 6.6 inches, respectively, a highly significant difference.

In 1945, conelets on hybrid seedlings were pollinated with a mixture of jack pine pollen from several trees. Seeds from this backcross were tested in the 1947 nursery against jack pine seeds obtained from the Chippewa National Forest, Minnesota. This test, started on May 7, consisted of 10 pairs of plots, after one pair had been discarded because no seedlings survived in the jack pine plot. There was no difference in time required for germination. Sixty per cent of the hybrid seeds germinated and 27 per cent of the jack pine seeds germinated. At the age of 1 year the average heights of the hybrids and the jack pine seedlings were 3.8 inches and 2.5 inches, respectively, a significant difference. The averages are based on 69 hybrids and 34 jack pine seedlings, or approximately 7 hybrid seedlings and about 4 jack pine seedlings per plot. A number of very weak jack pine seedlings were excluded in computing plot means.

Although the results of these experiments do not constitute conclusive evidence that the backcross is superior to jack pine in height at the age of 1 year, they do indicate that it is distinctly superior on the average to lodgepole pine in vegetative vigor and that it is equal to or possibly superior to jack pine.

Segregation of characters in the progenies of this hybrid will be studied when the seedlings have matured sufficiently to permit analysis.

The two parental species of this hybrid are very similar in all except cone characters. The close relationship indicated by their morphology (table 1) is borne out by the crossing tests. The hybrid is similar vegetatively to the parents; its cone is intermediate.

In order to preserve its identity in the literature as a hybrid and to indicate its derivation, it is proposed that this hybrid be known as \times *Pinus Murraybanksiana*. This name was chosen because the lodgepole pine has long been known to western botanists, as *P. Murrayana* and because it would be difficult to coin a satisfactory name from the accepted tri-nomial *P. contorta* var. *latifolia*.

\times *Pinus Murraybanksiana* hybr. nov. Arbor hybrida fertilis (*Pinus contorta* var. *latifolia* Engelm. \times *P. Banksiana* Lamb.), forma *P. contorta* var. *latifolia* similis; recta, pyramidata-angustata; trunco excurso, ramis verticillatis, adscencis; ramulis multinodis, plerumque glabris, levibus; foliis binis, 4–5 cm. longis, rigidis, obscuro-viridibus; canaliculis resiniferis medianis; hypodermis biformi; vaginis 5–7 mm. longis, pallida-fuscis, membranaceis, erosis, recurvis ultimum, iulis staminiferis 8–12 mm. longis, ochro-fuscis; conis sessilibus, inaequalibus, anguste-ovatis, 5–7 cm. longis, fuscis; apophysis planis vel pauciens carinatis, umbonibus planis vel pauciens convexis; spinis brevibus, tenuibus, fragilibus, recurvis; seminibus fertilibus, ca. 3 mm. longis, obscure triangularibus, fuscis; alis angustis, membranaceis, ca. 1.5 cm. longis.

Type. Institute of Forest Genetics, Placerville, California, April 24, 1947, *Stockwell and Cumming 2015* (Herbarium University of California, Berkeley, 773157; isotypes distributed). Specimens of parental species: *P. contorta* var. *latifolia*, *Stockwell and Cumming 2013*; *P. Banksiana*, *Stockwell and Cumming 2014*.

Institute of Forest Genetics, a branch of the California Forest and Range Experiment Station maintained by the Forest Service, USDA, in cooperation with the University of California, Berkeley.

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