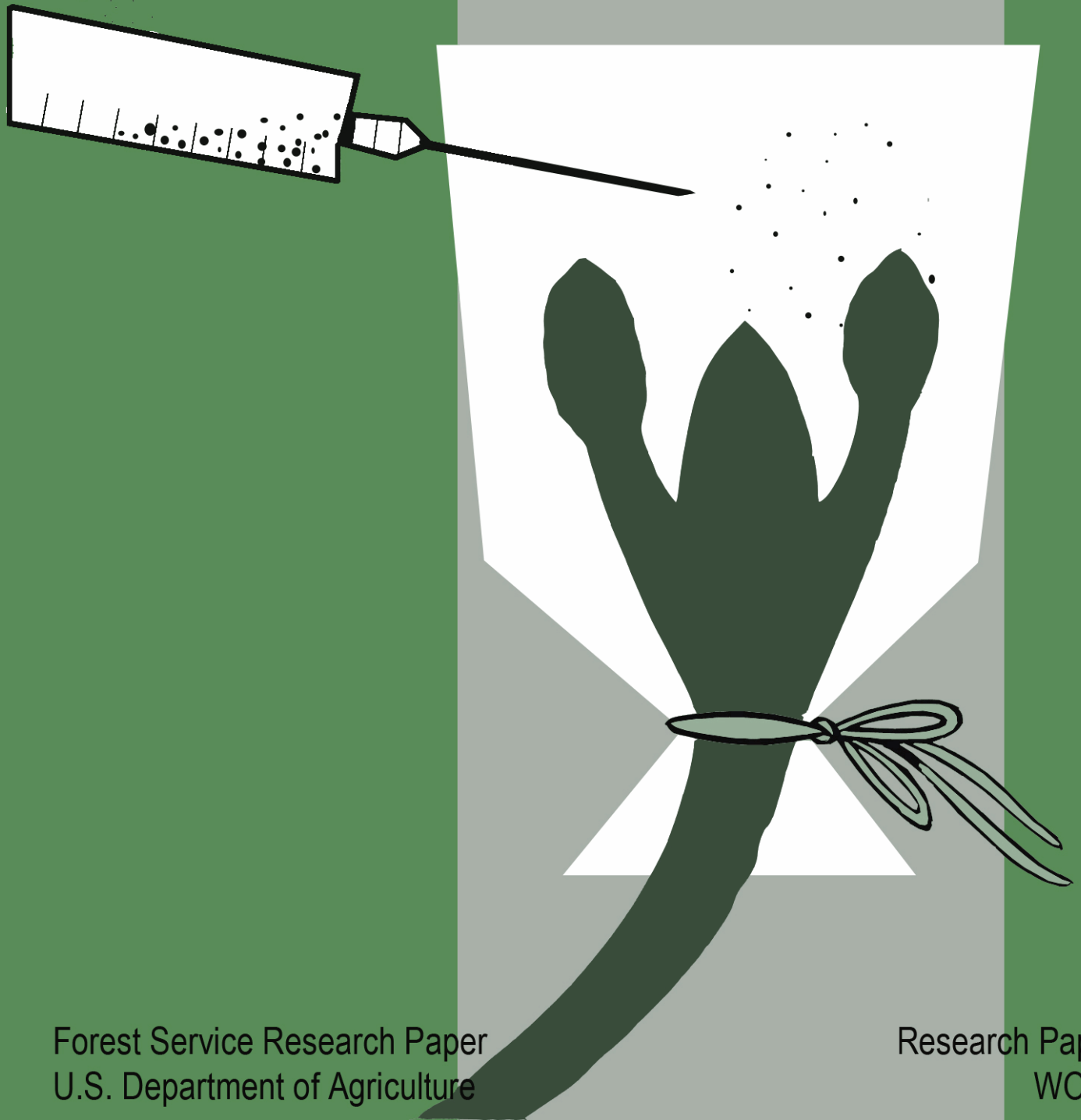


GENETICS

of PONDEROSA PINE



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RESEARCH SUMMARY

The ponderosa pine seed source test of Pikes Peak 1910 is the first forest tree provenance test in the New World. Later replicated experiments confirmed distinct genetic differentiation of geographic and altitudinal variations. The variations appear in a well-defined ecotypic pattern. They distinguish the three taxonomic varieties of ponderosa pine, var. *ponderosa*, var. *scopulorum*, and var. *arizonica*.

Genetic differences have been reported in morphological and physiological traits, including frost resistance, growth initiation, growth cessation, height growth of seedlings to 50-year trees, needle number and color, bud characteristics, stem form, and wood properties.

Natural regeneration is by seed. Seed production is sporadic and good seed years are few and far apart, but seed remains viable after long years of cold storage. Natural vegetation propagation, except root graft, is not reported. Artificial rooting of juvenile materials and grafting of succulent scion on seedling stock are successful.

Techniques of controlled pollination are well

developed. Artificial hybridizations have been made in interspecies crosses, interecotypic crosses, back crosses, and trispecies crosses with a number of species and varieties in the subsection *Ponderosae*, and indirectly through *P. jeffreyi* with pines of the subsection *Sabiniana*, the big-cone pine group. The crossability pattern suggests the potentials of hybridization involving numerous species of American and Mexican pines in the long-range breeding program.

Provenance selection is stressed in artificial reforestation and in prairie planting. Tree improvement programs include seedling seed orchard and family selection and stand selection by progeny tests. For early production of genetically superior seeds in commercial quantities, the superior trees and the superior stands as recognized by their superior progeny performance are maintained as natural seed orchards. Selected through this process, the 12-year height of the half-sib progeny families of the best parents are 36 to 50 percent taller than the nonselected local provenance.

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Chi-Wu Wang¹

INTRODUCTION

Pinus ponderosa Laws. is the most widely distributed indigenous pine of the Western Hemisphere. The natural range extends from southern British Columbia to northern Mexico over a distance of approximately 2,200 mi (3,540 km) (Callahan 1960, Critchfield and Little 1966). Economically, it is the most important of North American pines. It has greater timber volume in both growing stock and live sawtimber than any pine species on this continent (Crafts 1958).

Ponderosa pine is polymorphic and genetically variable. The 3-seed source (Arizona, Colorado, and Idaho) provenance test established in 1910 at Pikes Peak (Hayes 1913) and the rangewide 20-seed source experiment (Test Plot

No. 162) initiated in 1911 at Priest River in northern Idaho (Kempff 1928) are the earliest provenance test plantations of forest trees in North America. Later, replicated experiments confirmed strong geographic and altitudinal differentiation in ponderosa pine.

Ponderosa pine hybridizes with several pine species and varieties of the subsection *Ponderosae*. On the basis of morphological differences, several variants have been recognized. It is obvious, however, that ponderosa pine belongs to a species complex which includes several distinct and incipient species and varieties with limited genetic restriction of gene exchange.

EVOLUTION AND SUCCESSION

This complex of ponderosa pine and ponderosa pinelike forms was evolved during a long period of the Cenozoic era. Ponderosa pine was represented by fossil species *P. harneyana* in the Eocene circa 40 million years ago in Nevada (Axelrod 1966). This pine, together with the fossil forms of *Abies*, *Picea*, and *Pseudotsuga*, was an element of the Eocene flora found near Jerbidge Mountains (Cooper Basin flora) in Elko County, Nev., south of Twin Falls, Idaho. Wodehouse (1933) observed pollen of *Pinus scopulipites* together with those of two other species of pines from a Middle Eocene strata in northwestern Colorado (Green River flora).

In the western North American continent, ponderosalike pine was widely distributed in the early Tertiary. *P. florissanti* Lesq., a fossil pine, which bore close resemblance to the living ponderosa pine, was first described from the Oligocene bed near Colorado Springs, Colo., and was later reported in the Oligocene in Death Valley (Titsu Canyon), Calif., and in the Miocene near Fallon, Nev. (Lesquereux 1883), MacGinite 1953, Axelrod 1939, 1956 Gausson 1960). A pine similar to modern ponderosa pine was represented in both the Lower and Upper Seldovian Floras (Miocene-Pliocene) near Anchorage, Alaska (Wolfe *et al* 1966). Fossil *Pinus*

ponderosa seed, needles, and cones indistinguishable from the extant species were reported from the Stewart Spring and Fingerrock floras (Miocene) in southwestern Nevada (Wolfe 1964).

The ancestral form of ponderosa pine probably existed in climatic conditions that were milder than those of its living descendant (Chaney *et al* 1944). The range of the ancestral form during the early Tertiary possibly far exceeded the modern range of ponderosa pine in the interior of the continent. The present colonies of ponderosa pine in the Black Hills of South Dakota, in north-central Nebraska, and in western Oklahoma and Texas along the fringe of the woodland-grassland transitional zone possibly represent a once continuous population extending beyond the Rockies.

In the ensuing epochs of the late Miocene and early Pliocene, the Cascade and Sierra Nevada range were formed. This massive uplift brought drastic changes in climate and biota in the Great Basin between the coastal ranges and the Rocky Mountains. The differentiation and speciation within the modern *Pinus ponderosa* complex are possibly related to the increasing continentality, isolation of the inland populations, and its relatively recent migrations (Haller 1965b).

It was suggested that the general trend of

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