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Breeding and Genetic Resources of Five-Needle Pines:

Growth, Adaptability, and Pest Resistance

IUFRO Working Party 2.02.15
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Abstract

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This volume presents 29 overview and research papers on the breeding, genetic variation, genecology, gene conservation, and pest resistance of five-needle pines (*Pinus* L. subgenus *Strobus* Lemm.) from throughout the world. Overview papers provide information on past and present research as well as future needs for research on white pines from North America, Europe, and Asia. Research papers, more narrowly focused, cover various aspects of genetics. Throughout the distribution of five-needle pines, but particularly in many of the nine North American species, the pathogen *Cronartium ribicola* J.C. Fisch. continues to cause high levels of mortality and threatens ecosystems and plantations. Studies on genetic resistance to *C. ribicola* are described in papers from different regions of the world. Use of *P. strobus* as an exotic species in Europe and Russia and corresponding problems with white pine blister rust are discussed in several papers. Other papers focus on examining and exploiting patterns of genetic variation of different species.

Key words: five-needle pines, white pines, Cronartium ribicola, genetic variation, conservation, restoration

Pinus L. Subgenus *Strobus* Lemm. Species

Classification of the species as used in these proceedings follows: Price, R.A., A. Liston, and S.H. Strauss. 1998. Phylogeny and systematics of *Pinus*. In Richardson, D.M. (ed.), *Ecology and Biogeography of Pinus*. Cambridge University Press. p. 49-68.

Section *Strobus*, Subsection *Strobi* Loud.

P. armandii Franchet. Armand pine
P. ayacahuite Ehrenberg ex. Schlechtendahl. Mexican white pine
P. bhutanica Grierson, Long & Page. (no English common name)
P. chiapensis (Martinez) Andresen. (formerly *P. strobus* var. *chiapensis*) Mexican white pine
P. dabeshanensis (formerly syn. for *P. armandii*, now separate species)
P. dalatensis de Ferré (Vietnamese common names only)
P. fenzeliana Handel-Mazzetti (Vietnam; no English common name)
P. flexilis James. Limber pine
P. lambertiana Douglas. Sugar pine
P. monticola Douglas ex. D.Don. Western white pine
P. morrisonicola Hayata. Taiwan white pine
P. parviflora Siebold & Zuccarini. Japanese white pine
P. peuce Grisebach. Macedonian pine; Balkan pine
P. strobiformis Engelmann. Southwestern white pine
P. strobus Linnaeus. Eastern white pine
P. wallichiana A.B. Jackson (syn. *P. griffithii* McClelland). Blue pine; Himalayan white pine
P. wangii Hu & Cheng. (no English common name)

Section *Strobus*, Subsection *Cembrae* Loud.

P. albicaulis Engelmann. Whitebark pine
P. cembra Linnaeus. Swiss stone pine; Arolla pine
P. koraiensis Siebold & Zuccarini. Korean pine
P. pumila von Regel. Japanese stone pine
P. sibirica du Tour. Siberian stone pine

Section *Parrya* Mayr, Subsection *Balfourianae* Engelm.

P. aristata Engelmann. Rocky Mountain bristlecone pine
P. balfouriana Greville & Balfour. Foxtail pine
P. longaeva D.K. Bailey. Great Basin bristlecone pine

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Proceedings of the
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Sponsors

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Preface

An international conference on breeding and genetic resources of the five-needle pines took place in southwestern Oregon, USA, July 23-27, 2001. The scope was worldwide, including 25 species of subgenus *Strobus* found in North and Central America, Europe, and Asia. The conference was held under the auspices of Working Unit 2.02.15 of the International Union of Forest Research Organizations (IRFRO), with the support of the USDA Forest Service and several other forestry organizations. The goals of the conference were to review available knowledge from research on the genetics and genetic resources of this diverse group of pines, and to report current research on genetic diversity and natural hybridization and on the genetics of growth, adaptability, pest resistance, and other traits of interest in applied tree genetics and gene resource conservation.

The five-needle pines are nearly all in three sections of Subgenus *Strobus*. Although there is no universal agreement on the systematics of the subgenus, we have chosen to adhere to the recent classification by Price and others (Richardson 1998), although new phylogenetic research results based on isozyme and molecular analysis do not fully concur with this arrangement. We include two sections, Section *Strobus* and Section *Parrya*, the latter including the foxtail and bristlecone pines, two groups quite different from the rest of the species, of interest for *in situ* conservation of species with an ecological role important in their habitat. Most genetic research to date has been conducted within Subsections *Strobi* and *Cembrae* of Section *Strobus*. Until recently, the greatest attention was given to the approximately 17 species of Subsection *Strobi*, which includes several species of great importance as timber trees, many of which are capable of interspecific hybridization. More recently, research in Subsection *Cembrae*, especially in Siberia, has been focused on genetic diversity and natural hybridization. In addition to two important timber species, this subsection has some species that, although slow-growing, have great importance in horticulture and watershed protection.

The conference had 53 participants from nine countries, including the USA, Canada, Germany, Romania, Bulgaria, Russia, Pakistan, China, and South Korea. Papers were also contributed by nonattending scientists in Japan, Austria, New Zealand, and Russia. Because of the worldwide natural distribution of the five-needle pines, overview papers were invited covering the regions where five-needle pines are of major importance from a forestry standpoint. The exception was the Mexico/Central America region, from which we were unable to secure scientist participation. Research papers addresssed genetics and genecology, blister rust resistance, breeding and propagation, genetic diversity, and gene conservation. In addition to paper sessions, the conference, held in Medford, Oregon, included excursions to seed orchards, research plantations, native stands, Crater Lake National Park, and the Dorena Genetic Resource Center of the USDA Forest Service. Indigenous species of five-needle pines included in the field trips were *P. monticola, P. lambertiana* and *P. albicaulis*.

In Subsection *Strobi*, the white pine blister rust (*Cronartium ribicola*) is the major target of applied research, with the goal of removing this obstacle to survival and growth of natural and artificial stands, especially of sugar pine, western white pine, and eastern white pine. Resistance screening and breeding are proving to be effective strategies for restoring susceptible western North American species of five-needle pines. In eastern North America, rust resistance breeding has been more difficult in eastern white pine, although screening and breeding continues in the USA and Canada. In Europe, *P. strobus* would be a premier species for forestry were it not for the blister rust, which is a serious problem throughout the region, including Russia. For this reason other species are employed in forest planting.

The Balkan or Macedonian white pine has a dual role in the Balkans, critical for watershed protection and to a lesser degree as a timber species. Provenance research has shown that geographic variation in *P. peuce* can be exploited to some extent for optimum productivity, and population research has facilitated gene conservation. The blue or Himalayan pine, *P. wallichiana*, is an important timber tree, especially in India and Pakistan; its wide geographic and altitudinal range requires much more research on population variation and gene diversity for effective conservation of genetic resources. This will only be possible through regional cooperation with support from international organizations.

Subsection *Cembrae* includes several cold-climate and high-elevation five-needle pines of Eurasia and western North America. Research on the phylogenetics of the Siberian stone pines (*P. sibirica* and *P. pumila*) and *P. parviflora* indicates that the current partitioning of Subsections *Strobi* and *Cembrae* needs revision. Research on within-species genetic diversity in Siberia shows that there are relatively low interpopulation differences within the stone pines, and that natural hybridization occurs between the species. Korean pine also has small genetic distances between populations, even over a wide area; the main diversity occurs within populations. All of these species are nut pines, related to the North

American *P. albicaulis*. The interconnection between subsections is shown by the similarity of ecological role between the high elevation species limber pine, the pines of Subsection *Cembrae*, and the Rocky Mountain bristlecone pine (*P. aristata*), all of which occupy and stabilize habitats not likely to be occupied by other, less tolerant tree species. They are for the most part, less susceptible to blister rust, some much less, than is *P. albicaulis*.

These are but a few of the many findings of recent research brought out in the conference. The extensive worldwide distribution of the five-needle pines, their varied and critical ecological roles in the plant and animal diversity of the world's forest ecosystems, and their aesthetic and economic importance to human society are all indicators of the need for continued worldwide research on these important forest trees. We look forward to continued cooperation and information exchange in the future.

Howard Kriebel
Medford, New Jersey, USA
June 13, 2003

Acknowledgments

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The sponsors of the conference and this volume include IUFRO, USDA Forest Service, USDI BLM, Crater Lake National Park, Oregon Department of Forestry, Washington Department of Natural Resources, The University of Tennessee, Inland Empire Tree Improvement Cooperative (IETIC), White Pine Working Group (IETIC), Sierra Pacific Industries, and Forest Renewal BC (British Columbia); this array of sponsors allowed us to invite speakers from throughout the world. The hospitality shown by both the conference hotel (Rogue Regency Inn in Medford), and the town of Jacksonville was truly outstanding. The conference banquet hosted by Dennis and Mary Ann Ramsden in the gardens of the McCully House Inn in Jacksonville on a beautiful southern Oregon evening was truly superb.

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P. balfouriana (foxtail pine), *Pinus aristata* (Rocky Mountain bristlecone pine) and *P. flexilis* (limber pine)

P. aristata and *P. flexilis* photos courtesy of A. Schoettle

P. balfouriana photo courtesy of D. Burton