Pinus nigra Arnold European Black Pine

Pinaceae Pine family

David F. Van Haverbeke

European black pine *(Pinus nigra)*, also called Austrian pine, was one of the early tree introductions into the United States, first reported in cultivation in 1759 (52). Black pine was one of the first conifers tested for adaptability in the Sandhills of Nebraska in the 1891 Bruner plantation, Holt County, and in 1909 on the Nebraska National Forest. It was also planted by homesteaders on the Great Plains in the early 1900's to provide beauty and protection from wind and snow on the treeless prairies (fig. 1).

The most common seed sources of European black pine introduced into the United States have been from Austria and the Balkans (69). Sources from other parts of the natural range are relatively scarce in this country, except in a few arboreta. The best of these, however, grow as much as 50 percent faster than the typical Austrian sources. Today, European black pine is one of the most common introduced ornamentals in the United States.

Figure ***l-European black pine, an 18th century introduction into the northeastern United States.***

Habitat

Range

European black pine is native to Europe. Its range extends from longitude 5" W. in Spain and Morocco to about 40" E. in eastern Turkey; and from latitude 35" N. in Morocco and Cyprus to 48" N. in northeastern Austria and to 45" N. latitude in the Crimea, U.S.S.R. (II). Black pine grows widely throughout southern Europe from the eastern half of Spain, southern France, and Italy to Austria; south throughout Yugoslavia, western Romania, Bulgaria, and Greece on the Balkan Peninsula; east to southern Russia in the Crimea and south to Turkey; and on the islands of Cyprus, Sicily, and Corsica, with outliers in Algeria and Morocco (40).

Black pine is hardy in southern Ontario and New England, the North Central United States, and in parts of the West; and, along with Scotch pine *(Pinus sylvestris)*, Japanese black pine *(P. thunbergii)*, and Japanese red pine *(P. densiflora)*, it is reported to have become naturalized in parts of New England and the Lake States (72). Its escape from cultivation locally in the northeast, and west to Missouri, is acknowledged, but it is not generally recognized as having become naturalized (36).

The ecotypic variation in wide-ranging species such as *F! nigru* normally includes sufficient morphological variation that taxonomists have recognized many nomenclaturally distinct species, subspecies, or varieties to describe this variation. In this paper, for simplicity, the species are referred to by geographic origin, for example, European black pine or black pine from Austria, the Balkans, or Corsica, rather than by subspecies or varietal names. For synonymy see the Genetics section.

Climate

In parts of its native European habitat, black pine grows in a cool to cold temperate climate (23). The northern varieties are very frost-hardy, withstanding temperatures of -30" C (-22" F), and the southern varieties tolerate -7" C (19" F) temperatures. Annual precipitation varies from 610 to 1020 mm (24 to 40 in>. The species has been shown to carry on

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The author is Research Forester (retired), Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

photosynthesis at -5" C (23" F), with respiration still detectable at -19" C (-2" F) *(21).* Black pine withstands the weight of ice well and is considered hardy except in the coldest, hottest, and driest regions.

In the United States, black pine is mainly suited to Climatic Zone IV, which includes most of Nova Scotia, southern Maine, New Hampshire, Vermont, New York, southern Ontario, Michigan, northern Indiana, northern Illinois, Wisconsin, Iowa, northern Missouri, Nebraska, Kansas, Colorado, Utah, Idaho, Montana, southwestern Alberta, and central British Columbia (52). It has either failed or has performed poorly in the southern states of Oklahoma, Texas, North Carolina, Georgia, northern Florida, and Arkansas.

Soils and Topography

European black pine is adapted to many soil types and topographic habitats. In its native range the species commonly is separated into three geographic groupings: western, central, and eastern. Sources from southern France and Spain, the western group, often are indifferent to soil type; sources from Corsica, Italy, and Sicily, the central group, grow poorly on limestone soils; while sources from the Balkans and the Crimea, U.S.S.R., the eastern group, appear to do well on the poorer limestone soils *(31).* Black pine also grows well on podzolic soils (8).

In England, Austrian material does well as a shelterbelt tree in exposed situations near the sea on light, dry, shallow soils, sands, chalks, and limestone. It is less well-suited than Corsican strains in infertile, "stiff," or wet soils (6).

Although European black pine often is found on poor, calcareous, sandy, and even pure limestone soils, it requires a deep soil. On good sites, Italian, Sicilian, and Corsican strains are fast growing (up to 40 m or 131 ft tall) and straight *(23,40).*

In Europe, black pine is found at elevations ranging from 250 to 1800 m (820 to 5,910 ft). In Austria, it is found on poor dolomite and limestone sites from 260 to 500 m (850 to 1,640 ft) and on good soils from 300 to 700 m (980 to 2,300 ft); at about 610 m (2,000 ft) in the Dinaric Alps of the Balkans; at 1200 m (3,940 ft) in the Sierra de Segura of southeastern Spain; and from 900 to 1800 m (2,950 to 5,910 ft) on Corsica (40).

In the United States the major experience with European black pine has been with Austrian sources. Most planting stock is provided by private nurseries, and several million trees are produced annually in the Northeastern States. The species has been especially successful in the Northeast on soils of high pH in the southern part of the area formerly planted to red pine *(Pinus resinosa)* (69). There is evidence, however, that black pine is not a good choice to replace red pine on many northeastern sites (42). After 21 growing seasons, black pine averaged about 2.1 m (7 ft) shorter and 3.2 cm (1.25 in) less in d.b.h. on several New York soil types.

In the Great Plains region, European black pine is not a demanding species and is being planted on soils of the orders Aridisols, Entisols, Mollisols, and Vertisols. More specifically it grows well throughout a broad range of soils including sandy loams, silty clays, and calcareous soils. It is about as adaptable to most Great Plains windbreak and shelterbelt sites as ponderosa pine *(Pinus ponderosa),* although on the very poor sites it suffers considerable mortality. Once established, however, the rate of height growth is good, and density and form of the crown are superior to ponderosa pine *(50).* Survival, height, vigor, and crown development throughout the Great Plains region are best in deep, permeable, well-drained, and mostly sandy loams along river lowlands and stream valleys where the water table is 6.1 m (20 ft) or less below the surface; they are poorest on shallow, sandy, or silty soils underlain by claypan or gravel.

After early success in the turn of the century plantings in the Nebraska Sandhills, black pine was not considered as desirable for extensive plantings as eastern redcedar *(Juniperus virginiana),* jack pine *(Pinus banksiana),* or ponderosa pine. In Iowa, black pine was reported to be tolerant of high-lime soils, where survival and growth were best on western and northern exposures *(19).*

Associated Forest Cover

European black pine in its many forms grows naturally throughout the Mediterranean region in association with Scotch pine, Swiss mountain pine *(Pinus mugo)*, Aleppo pine *(P. halepensis),* Italian stone pine *(P. pinea)*, and Heldreich pine *(P. heldreichii)(11,40,69).* Other pine species that share the same geographic range or portions of it with European black pine include Swiss stone pine *(P. cembra),* Balkan pine (I? *peuce)*, maritime pine *(P. pinaster),* and *P. brutia* and its variant *P. pithyusa* *(11).* In England some naturally regenerating European black pines, from principally Corsican sources, are associated with birch *(Betula pendula),* willows *(Salix caprea* and *S. cinerea),* and oak *(Quercus robur)* on the sand dunes, saltmarshes, and intertidal sand and mudflats of the north Norfolk coast *(27).*

In the United States, European black pine is associated with numerous species consequent to its use in landscape and environmental plantings. Its apparent tendency to escape, possibly to naturalize, and to hybridize with certain other pines may, in time, result in some natural species associations in this country.

Life History

Reproduction and Early Growth

Flowering and Fruiting-European black pine is monoecious, with staminate (microsporangiate) and ovulate (megasporangiate) strobili borne separately on the same tree (67). Staminate strobili, clustered at the base of new shoots, mostly on older lateral branches in the lower crown, are cylindrical, short-stalked, bright yellow, about 2 cm (0.8 in) long with numerous scales, and contain pollen in great quantity *(12,49,52).*

One or two ovulate strobili (conelets) emerge near the end of the new growth of terminal and lateral branches; they are cylindrical, small, bright red, and short-stalked or sessile *(12,49,67).* Pollen dispersal and conelet receptivity occur from May to June. Individual ovulate conelets are receptive for the pollen for only about 3 days, however (67). After pollen dispersal, the staminate strobili dry and fall within several weeks. The scales of the ovulate strobili close within a few days of pollination, and the conelets begin a slow developmental process. At the beginning of the second growing season, the ovulate strobili are only about 2 cm (0.8 in) long (47). Fertilization takes place in the spring or early summer about 13 months after pollination, and the cones, now turned green in color begin to grow rapidly from about May until maturity in the fall (67).

The fruit, a tough, coarse, woody, yellow-green cone during the preripening second summer, changes to shiny yellow-brown to light brown at maturity from September to November of the second growing season *(12,49,52).* Cones are descending, sessile, ovoid, and 5 to 8 cm (2 to 3 in) long. Cone scales are shiny, thickened at the apex, and end in a short spine on the dorsal umbo.

Minimum seed bearing age is 15 to 40 years *(40,52,67).* In England, black pine from Corsican sources produce their first heavy cone crops at ages 25 to 30 years and reach maximum production between 60 and 90 years of age (27). The interval between large cone crops is 2 to 5 years.

Seed Production and Dissemination-Seeds are dispersed from October through November of the second growing season. Seeds are reddish brown, often mottled, 6.4 mm (0.25 in) long at one end of a membranous wing 19 mm (0.75 in) long *(49).* Two winged seeds are produced on the upper surface of each scale of the cone except for those at the tip and base.

Seeds are extracted from harvested cones by air-drying for 3 to 10 days or kiln-drying at 46” C (115” F) for 24 hours. Sound seeds are separated from empty seeds by flotation in 95 percent ethanol *(31).* The number of sound seeds per cone in Austrian black pine ranges from 30 to 40, of which 15 to 20 are germinable (67).

Cleaned seeds average 57,300 per kilogram (26,000/lb) with a range from 30,900 to 86,000/kg (14,000 to 39,000/lb). Seeds from the Crimea, Turkey, and Cyprus tend to be the largest, ranging from 38,600 to 45,900/kg (17,500 to 20,800/lb), and those from Corsica the smallest, ranging from 61,700 to 79,400/kg (28,000 to 36,000/lb) *(31,67).*

Seedling Development-European black pine is easily grown from seed and transplants well. Fresh seeds require no pre-sowing stratification; but stored seeds can be cold-stratified up to 60 days to hasten germination. Ninety-nine percent germination was obtained from seeds stored 10 years in closed containers at 6.6 percent moisture content (ovendry-weight basis) at 0” to 2” C (32” to 36” F). No loss of viability occurred in seeds stored in sealed containers at room temperature after 2 years. Storage at moisture contents as low as 2 percent or as high as 12 percent, however, was detrimental to seeds stored for long periods *(25).* A light period of 8 hours at 30” C (86° F) and a dark period of 20” C (68° F) for 16 hours is recommended for germination (24). Germination is epigeal *(31).* Seeds from Corsican sources tend to germinate more slowly than those from Austria and Calabria (55).

In nurseries, nonstratified seeds are sown in the fall or spring, at a density to obtain 540 to 650 seedlings per square meter (50 to $60/ft^2$). Seeds should be sown at a depth of 13 to 19 mm (0.5 to 0.75 in).

Black pine seedlings can be produced in peat-perlite containers using low rates of fertilizers (e.g. Osmocote 18 N–2.6P–10K) *(1).* Experiments with 3-year-old nursery seedlings from 27 different European provenance locations demonstrated that nitrogen and manganese ion uptake was significantly enhanced, but that uptake of potassium, phosphorus, magnesium, boron, zinc, and aluminum ions was suppressed by 45 percent urea (33). Application of a pre-emergence herbicide was found to enhance mycorrhizal formation in nursery-grown seedlings *(61).*

In Germany, seedlings of all provenances of black pine from Corsica, Spain, and southern France suffered severe frost damage in the nursery, and those from southern Italy suffered some damage; but seedlings from eastern provenances (Austria, Yugoslavia, Greece, and Cyprus) were undamaged (54). Experience in the United States strongly suggests that black pine seed be obtained from the Balkan Peninsula or from the Crimea, for improved winter hardiness (32).

Nursery-grown seedlings are commonly field-planted as 2-0, 2-1, or 2-2 seedlings. Field-plantable seedlings can be greenhouse grown in containers in 9 months following a predetermined schedule of temperature, moisture, relative humidity, and nutrient application *(62)*.

In England, germination success of direct-sown Corsican black pine seed was found to be strongly dependent on aspect; satisfactory germination was achieved on north-facing slopes on young sand dunes nearest the sea (27). Newly germinated seedlings suffered very heavy losses from voles and rabbits but became unpalatable to them within 2 months.

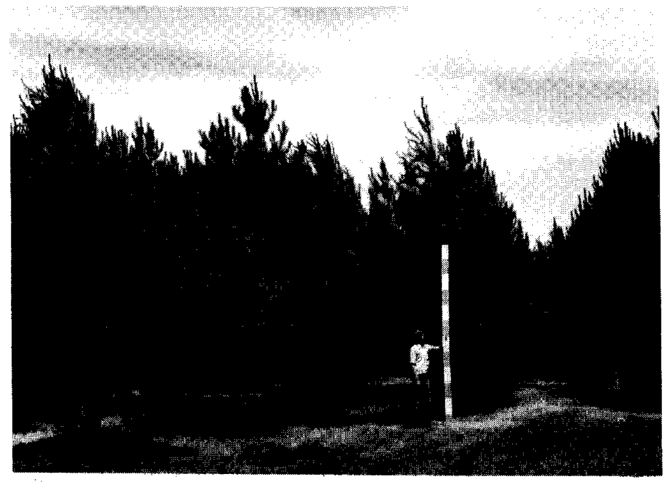

Figure 2—*Provenance tests, like this one in Nebraska, identify seed sources of European black pine best adapted to particular environments.*

Vegetative Reproduction-At present, grafting is the most common method for vegetatively propagating European black pine. Needle fascicles have been rooted, but only fascicles from l-year-old short shoots on young (5-year-old) plants were able to form callus or to root. Propagation by cuttings and air-layering has not been reported.

The side graft method is the usual practice, but cleft and veneer grafts can also be used. Grafting is done on actively growing stock, and removal of the stock by pruning must be gradual after scion growth begins.

Stock-scion incompatibility in black pine is not a serious problem, especially if the stock and the scion are of the same race. Black pine can be grafted onto ***Pinus sylvestris, P. resinosa, P. khasya, P. montana, P. mugo,*** and ***F! contorta;*** but semi-incompatibility has been found with ***P. ponderosa, P. radiata,*** and ***P. armandii (67)***.

Research in Yugoslavia indicates that a wide range of auxin concentrations, can promote the development of rootable plantlets from shoot tip explants *(30)*.

Sapling and Pole Stages to Maturity

Growth and Yield-European black pine transplants well when small, or when larger if transplanted in the dormant season *(49)*. It is a fast and vigorously growing tree of pyramidal form with full, dark foliage. In England, its habit has been described as bushy in youth, presenting a coarse appearance and having poor stem form; this severely limits its timber value, although it grows rapidly, is hardy, and provides an excellent windbreak *(6)*.

In the Great Plains region black pine grows relatively rapidly during the first 20 years after planting-approximately 0.3 m (1 ft) per year on the average site (57). Similar rates of growth have been reported in Iowa, where 12-year-old trees average 3.9 m (12.9 ft) in height *(19)*. The fastest growing source in a Nebraska provenance study, a disease resistant source from Yugoslavia, was 5.9 m (19.4 ft) tall at age 12 *(51) (fig. 2)* and 9.7 m (31.8 ft) tall at age 20 (64). Average heights of 4.4 m (14.5 ft) and diameters of 13.5 cm (5.3 in) were recorded in a l&year-old Michigan provenance plantation (68).

The average growth rate of European black pine in Great Plains shelterbelts decreases 7.6 cm (3.0 in) per year from about age 20, so that annual height increase is only 6.1 to 9.1 cm (2.4 to 3.6 in) 50 years after planting. Height growth in the Loess Plains of Nebraska compares favorably with height growth in Europe up to age 50. Height growth in Europe, however, is slower during the early years and faster after 40 to 50 years (57).

A 25-year-old stand of planted black pine in Michigan State University's Kellogg Forest is similar in growth to red pine stands on the same forest and, like them, is being thinned for pulpwood and pruned for timber production (69). Use of faster growing black pine sources does not cause the production of lower wood quality (34).

Forest plantings established in the North Central and Northeastern United States during recent decades are generally thrifty. Data on growth of older stands, however, is limited to a few relatively small plantings, such as the group of 50-year-old trees in the University of Michigan's Nichols Arboretum at Ann Arbor. These trees are similar in growth rate to nearby red pine, Scotch pine, and eastern white pine (*P. strobus*) (69). European black pine, in the Secrest Arboretum at Ohio State University's Agricultural Research and Development Center in Wooster, OH, has performed as follows (3):

Age	Average d.b.b.		Average height	
yr	*cm*	*in*	*m*	*ft*
10	9.7	3.8	5.3	17.4
13	10.7	4.2	6.3	20.6
19	14.2	5.6	9.6	31.5
24	16.0	6.3	11.7	38.5
25	18.0	7.1	11.8	38.8
31	17.8	7.0	14.5	47.7
40	22.4	8.8	17.1	56.0
45	24.1	9.5	17.6	57.7

At age 45, the above trees would produce about 0.4 m^3 (14 ft^3) of wood per tree.

Height growth of Corsican material in England was proportional to the preceding winter's rainfall from October to March if soil moisture was below field capacity, and volume increment was proportional to the preceding year's height growth. Diameter growth began when the mean 5-day temperature rose to 10" C (50° F) and ended when the mean temperature fell below 10° C (50° F) (56). Wood density of Corsican black pine grown in England was higher than that of other commercially grown exotics, and resin contents as high as 20 percent were found in the heartwood of individual trees *(10)*.

European black pine matures at about 80 years of age, commonly developing a flat, round, or spreading crown. The species attains heights of 20.1 to 50.3 m (66 to 165 ft) *(52,69)*. Minimum rotation periods of 160 to 180 years have been reported for black pine in Corsica, 240 to 360 years being the normal to produce trees 1 m (3.3 ft) in diameter ***(12)***.

Rooting Habit-All varieties of European black pine are considered to be deep laterally rooted and, therefore, to perform best in deep soils *(22,49)*.

Reaction to Competition-European black pine is classed as intolerant of shade, and, therefore, must be planted in situations where it will receive full sunlight. Those from Austria and the Balkans have received increasing attention during recent decades from foresters and Christmas tree growers in the Northeastern United States as an alternative to red pine, which has been heavily damaged by the European pine shoot moth ***(Rhyacionia** buoliana)*. It has proven especially successful on soils of high pH in the southern part of the area formerly planted to red pine (69).

At Ithaca, NY, a series of four-paired, quarter-acre plots of red pine and black pine were established on a series of somewhat poorly drained to excessively well-drained acidic, silty loam, and other associated soils typical of New York's southern tier, to compare their performances. After 21 growing seasons, black pine averaged about 1.8 m (6 ft) in height and 3.2 cm (1.25 in) in diameter less than red pine over all sites. Branches were usually thicker and closer together, suggesting slower early height growth; stems suffered sapsucker damage, and the trees had many double forks and malformed shoots. These tests suggested that European black pine, from this source at least, was a poor choice to replace red pine on many northeastern sites (42).

In the Great Plains shelterbelt planting, European black pine was frequently intermixed with ponderosa pine within the same row. Survival was about 5 percent better and height growth was about 0.7 m (2.3 ft) more for black pine over a 12- to 19-year period on the deep to medium, permeable, well-drained silty and sandy loams of loess origin *(50)*. Heights of trees also were more uniform within black pine rows because of freedom from damage by tip moths ***(Rhyacionia*** spp.). Density and form of crowns also were superior to ponderosa pine.

In West Virginia, 10 sources of European black pine, ponderosa pine, black locust ***(Robinia pseudo-acacia),*** autumn olive ***(Elaeagnus umbellata),*** and European alder *(Alnus **glutinosa)*** were tested on strip mine spoils. Although all hardwood species grew faster than the pines, Yugoslavian sources grew faster and survived best of all other black pine sources (29).

Damaging Agents-European black pine is susceptible to infection by many pathogens that damage seedlings, foliage, stems, and roots (26). Damping-off and seedling root rots, caused by ***Rhizoctonia solani, Phytophthora cactorum,*** and ***Pythium debaryanum,*** and loss of seedling vigor caused by the dagger nematode *(Xiphinema americanum)* (45) are among the most common causes of seedling damage in nurseries.

Dothistroma needle blight, caused by the fungus ***Dothistroma pini***, is one of the most damaging of the foliage diseases of black pine. The fungus has been found in 23 States in the United States and in three Provinces in Canada. Dothistroma needle blight is widespread and causes extensive damage to Austrian pine in Christmas tree plantings in Minnesota *(43)*, and in shelterbelt, ornamental, and Christmas tree plantings in the central and southern Great Plains (48). Infection of current-year needles first occurs in mid-July, while infection of second-year needles begins in late May in the Great Plains and in British Columbia. Symptoms develop in early September to early November and consist of yellow and tan spots and bands that appear water-soaked on the needles. The bands and spots may turn brown to reddish brown, and the distal end of the needle becomes chlorotic, then necrotic, while the base of the needle remains green. Infected needles are cast prematurely *(46).*

Genetic resistance to Dothistroma needle blight has been detected in European black pine. In a Nebraska test of 21 geographic sources *(51)*, some individual trees within 16 sources were highly resistant, while those from one Yugoslavian source showed universally high resistance (48).

Lophodermium needle cast of pines, caused by *Lophodermium pinastri,* is a serious disease of European black pine in the Lake States, causing browning and premature dropping of needles and terminal bud dieback (60). A needle disease caused by the fungus *Nemacyclus minor* has been reported from Pennsylvania (38).

Diplodia tip blight, caused by the fungus *Diplodia pinea*, is a very damaging twig and stem disease of European black pine, especially to trees more than 30 years old. Entire new shoots are killed rapidly by the fungus. Trees repeatedly infected have some branches killed back to the main stem (47).

Black pine seedlings in nurseries are susceptible to the fungi *Cylindrocladium scoparium* and *C. floridanum*. These fungi cause root rot, damping-off, and needle blight *(9).*

Damage to black pine by insects and other pests is apparently of lesser consequence than that from fungal pathogens. The species has been reported to be injured by pine aphids, pine beetles, and pine weevils, but growing trees, on the whole, are relatively free from insect pests *(12).* Damage by rabbits and sapsuckers has been noted *(19,42).*

Some incidence of attack in northeastern United States from the Zimmerman pine moth *(Dioryctria zimmermani),* the European pine sawfly *(Neodiprion sertifer)*, and the European pine shoot moth has been observed (68).

Special Uses

European black pine is a widespread and important timber-producing tree of central and southern Europe, especially Corsica. The wood resembles Scotch pine but is rougher, softer in texture, and possesses less strength. Although the wood has a relatively larger proportion of sapwood to heartwood and thus requires a long rotation, it is used extensively throughout the Mediterranean region for general construction, fuelwood, and other purposes for which pine timber is needed *(12).*

Elsewhere, black pine has been grown more for estate and landscape uses than as a timber crop, although in England during World War II it proved serviceable for box boards and pit props.

The species has been planted extensively in cold, semi-arid, exposed coastal regions for protection and sand dune fixation because of its capacity to withstand drought, to grow on light, dry sandy soils of low productivity, and to tolerate fill (6). This frost-hardy, windfirm, and light-demanding species has been widely used for nearly 100 years in windbreaks and roadside plantings throughout the eastern Great Plains of the United States, where its dense foliage and stiff branches withstand wind, ice, and heavy snow.

The species has not been widely grown in the United States for timber production, although estate, school, and experimental plantings have been thinned for pulpwood and timber products (69). It is occasionally tapped for resin, but its pitch is not as high in quality as that of slash pine *(Pinus elliottii).*

European black pine is grown for Christmas trees in the North Central and Northeastern States (34) where it is not subject to heavy damage from the European shoot moth and tip moth, but where it is severely damaged by Dothistroma, Lophodermium, and Diplodia needle and tip blights.

It is being increasingly used in urban and industrial environmental improvement plantings because of its rapid growth and protoplasmic insensitivity to salt spray *(4)* and to industrial dust, dry soil, and smoke containing sulfur dioxide *(7).* Excised shoots of black pine and other conifer species are capable of absorbing more SO_2, NO_2, and O_3 than shoots of a number of deciduous species *(18).* It also provides wildlife habitat and might be used as a wood source *(39).*

Genetics

Within the climatically and topographically diverse and disjunct distribution of European black pine, recognizable differences in the population have evolved through natural selection. As early as the third century B.C., Theophrastis (370–285 B.C.) recognized several striking variations within what is here called *Pinus nigra.*

Races and Varieties

The taxonomic record indicates that *Pinus nigra* is an extremely variable taxon, including more than 100 Latin specific, varietal, and formal names. Common names associated with the species include black pine, Austrian pine, "tsrnog bor," and "crnog bora." There is no general agreement on its nomenclature.

Among the several major treatments of the taxon, each based on solid work, there are differences in certain aspects *(5,12,13,14,15,22,52)*. Two commonly accepted authorities *(12,52)* are in general agreement, however, each partitioning the species into four varieties, the first of which describes the type:

- *Pinus nigra* var. ***austriaca*** (Hoess) Aschers. & Graebn. (Austria to Balkan Peninsula) (52)
- *P. n.* var. ***nigra*** Arnold (Austria, Yugoslavia, Hungary) *(12)*
- *P. n.* var. ***caramanica*** (Loud.) Rehd. (Asia Minor) *(52)*
- *P. n.* var. ***caramanica*** (Loud.) Rehd. (Crimea) *(12)*
- *P. n.* var. ***poiretiana*** (Ant.) Aschers. & Graebn. (So. Europe) *(52)*
- *P. n.* var. ***maritima*** (Aiton) Melville (Spain, Corsica, So. Italy, Greece) *(12)*
- *P. n.* var. ***cebennensis*** (Gren. & Gord.) Rehd. (Pyrenees & So. France) **(52)**
- ***P. n.*** var. ***cebennensis*** (Gren. & Gord.) Rehd. (Cévennes & Pyrenees) ***(12)***

Blecić *(5)* treated European black pine as a series of subspecies as follows:

- *Pinus nigra* ssp. ***nigra*** (Austria, Italy, Greece, Yugoslavia)
- *P. n.* ssp. *salzmannii* (France, Northern Pyrenees, Central and Eastern Spain)
- *P. n.* ssp. ***Zaricio*** (Corsica, Calabria, Sicily)
- *F! n.* ssp. *dalmatica* (central region of the Yugolslav seaboard and neighboring islands)
- *P. n.* ssp. *pallasiana* (Balkan Penninsula, Southern Carpathians, the Crimea)

Other treatments of the taxon have resulted in assignment of subspecies rank to segments of the population: *Pinus nigra* ssp. *occidentalis* with 6 named varieties, and *P. n.* ssp. *orientalis* with as many as 10 named varieties ***(13).*** Recent genetic analyses of the European black pine population have added further refinements either confirming, expanding, or cornpositing the already established nomenclature *(2,32,33,54,55,67,68,69)*. Recent isoenzyme *(20,44)* and karyotic *(28)* analyses have further differentiated European black pine into identifiable groups.

Hybrids

Reports of natural hybridization between European black pine and other pine species in Europe include: *Pinus nigra* and *P. montana (58), P. nigra* and *P. sylvestris (65),* and *P. nigra* and *P. heldreichii* var. ***Zeucodermis*** *(22)*, although l? ***heldreichii*** is considered synonymous with *P. nigra* by many.

In the United States, natural hybridization has been reported between *Pinus nigra* and Japanese red pine *(P. densiflora)* in planted stands within close

Figure ***3-An outstanding specimen*** *of* ***European black pine. suitable*** *for* ***breeding.***

proximity of one another *(71)*; although research based on enzyme analyses, suggests that red pine cannot be the pollen donor in this naturally occuring putative hybrid ***(41).*** Ninety-two percent of the seedlings derived from open-pollinated cones collected from the black pine stand were hybrids, and heterosis was evident in these seedlings. Cones yielded 22 filled seeds per cone. These are considered among the easiest of all tree hybrids to produce, providing the concentration of ***P. densiflora*** pollen in the pollen mix is very high (63).

Early attempts at artificial crossing of European black pine with other pine species were mostly unsuccessful. Species included ***Pinus resinosa, F! sylvestris, P. thunbergii, P. caribeae,*** and ***P. rigida (13,37,53).***

Later, ***Pinus nigru*** was successfully fertilized by ***P. resinosa*** to produce progenies superior to either parent (17). ***P. nigra*** has been reciprocally crossed successfully with ***P. densiflora (35,66,70,71), P. sylvestris (65,70),*** and ***I? thunbergii;*** and with ***P. tabulaeformis, I? taiwanensus (70)***, and ***P. mugo (67).***

In addition to the crosses shown above, the following combinations have been achieved using ***P. nigra*** and ***P. sylvestris*** as the mother tree:

P. nigra x (P. thunbergii x densiflora)
P. nigra x (I? densiflora x nigra)
I? nigra x (P. nigra x densiflora)
P. sylvestris x (P. densiflora x nigra)

The application of genetic principles, including testing and selecting adapted seed sources (provenances), followed by intraspecific and interspecific breeding of individuals selected from within adapted seed sources, promises further improvement in the form, disease resistance, vigor, and other economically important characteristics of ***I? nigra (fig. 3).***

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