

Spruces in the Arnold Arboretum

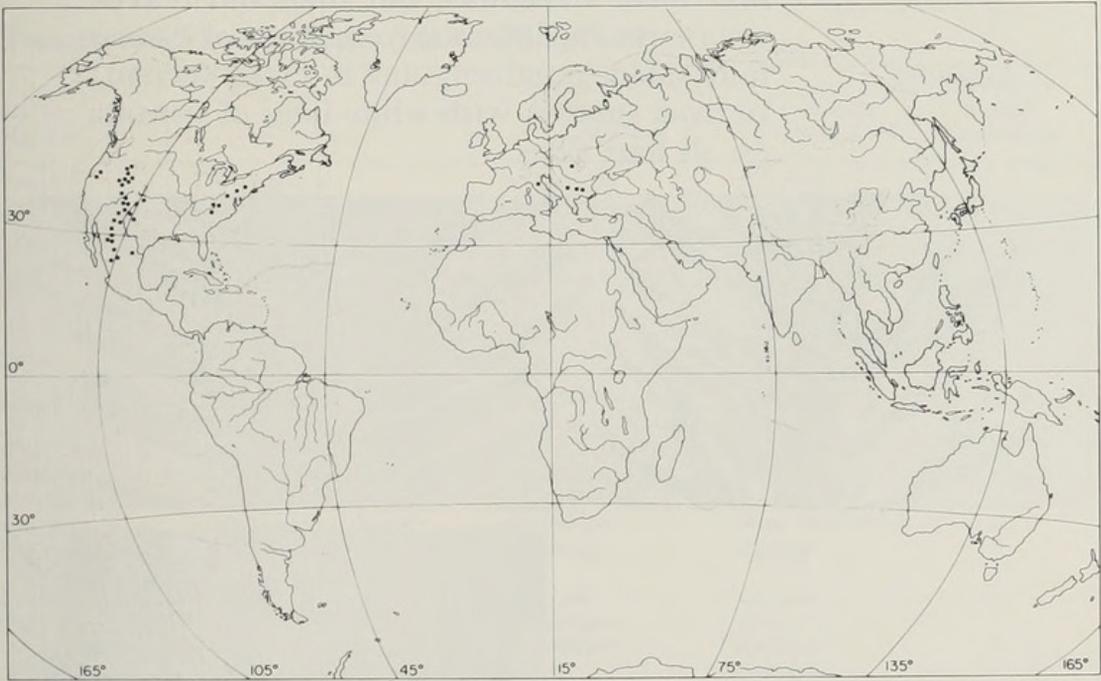
by RICHARD WARREN

The members of the genus *Picea* (the spruces) grow exclusively in the North Temperate Zone and stretch around the world in the higher latitudes. In North America they grow above the Arctic Circle to latitude 70° north and extend south into Mexico. In favorable climates they reach heights of 70 meters. Among conifers this range is matched in extent only by the genera *Pinus* (pines) and *Juniperus* (junipers). Although relatively sensitive to air pollution and drought, spruces tolerate shade better than most other conifers. Some members of the genus have no peers in their ability to stand extreme cold.

The Arboretum's mission to grow all woody plants hardy in our climate has been well fulfilled in the case of the spruces. The representatives of the 21 species now growing on the grounds demonstrate many interesting features.

DESCRIPTION OF THE GENUS

Picea belongs, under the gymnosperms, to the family Pinaceae, in which the plants are monoecious, with spirally arranged linear or needlelike leaves, two microsporangia on each microsporophyll, two ovules on each ovuliferous scale (to which the bract scale is not, or is only loosely, attached), and pollen grains with "wings." The other members of the family are *Abies* (the firs), *Cathaya* (a recently de-



Above: Arnold Arboretum pinetum in winter. The two tallest trees are Norway spruces. Photograph by R. Warren. Below: Range of spruces in the world. Shading indicates contiguous distribution, and dots show scattered occurrences. Map drawn by L. Meszoly after Schmidt-Vogt (1977).

scribed Chinese genus), *Cedrus* (the true cedars), *Keteleeria* (a Chinese genus resembling *Abies*), *Larix* (the larches), *Pinus* (the pines), *Pseudolarix* (the golden larch), *Pseudotsuga* (the Douglas firs), and *Tsuga* (the hemlocks).

The family Pinaceae is divided into two groups according to the arrangement of the leaves on the branchlets. In one the leaves grow in clusters or pseudowhorls from short side-shoots. This group includes *Larix*, *Pseudolarix*, *Cedrus*, and *Pinus*. In the other, which contains *Abies*, *Cathaya*, *Keteleeria*, *Picea*, *Pseudotsuga*, and *Tsuga*, the leaves grow individually from the long shoots. The spruces can be distinguished from other members of the second group by several characteristics:

- Bark: platelike, often flaking; frequently fissured on the lower stems of old trees.
- Winter buds: conical or ovoid (not round), with or without resin.
- Shoots: fissured and ridged, with the ridges being interrupted by woody projections (sterigmas or pulvini) that bear the leaves. These pegs are the most distinct diagnostic feature that separates *Picea* from the other genera. The branchlets of the genus *Tsuga* also have sterigmas, but their flat leaves are markedly different from those of *Picea*.
- Leaves: four sided (quadrangular in cross section) in most species, with white lines of stomata on all four sides.



Above: Sterigmas support the leaves on spruces (*Picea abies*, left) but are absent on firs (*Abies alba*, right). Photograph by A. Coleman. Right: typical spruce bark, shown on *Picea montigena*. Photograph by R. Warren.

The leaves of *Picea* ordinarily stay on the shoots for seven to ten years, but when branches are removed from the tree the leaves fall off within a few weeks, a feature that hampers the preparation of herbarium specimens and that is familiar to all who have used spruces as Christmas trees. The members of the genus *Tsuga* also lose their leaves, since they, too, bear their leaves on woody pegs.

The bright yellow or reddish color of the microsporangiate cones of many of the spruces makes a fine showing in the spring. The immature ovuliferous cones are often a handsome blue or purple. They stand erect at the end of the branches at the time of pollination, but turn downward on fertilization shortly thereafter and grow to maturity in the fall of the first year — unlike cones of *Pinus*, in which fertilization is delayed for a year after pollination in most species. The cones open and shed seeds while on the trees, then fall to the ground from weeks to years thereafter.

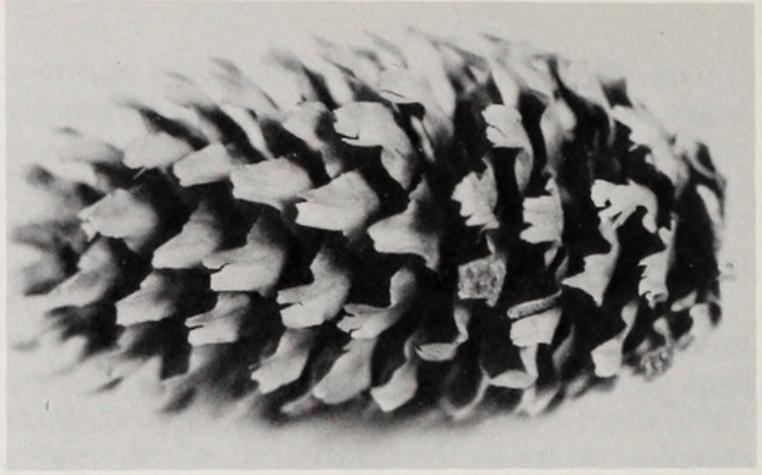
Spruce cones are cylindrical and taper, depending on the species, to a more or less rounded or pointed tip. The cone scales are thin, like those of haploxylon (soft) pines, and are imbricated or appressed, and regularly arranged.

The recognized number of species in the genus varies between 26 and 40, depending upon interpretation of specific and varietal limits. The Table lists 28 of the better-known species. It shows an interesting,

Twenty-eight common species of spruce.

Native Habitat	Area	Scientific Name of Species	Common Name	Present in Arnold Arboretum
North America	NW. U.S.A.	<i>brewerana</i>	Brewer's	+
	Mexico	<i>chihuahuana</i>	Chihuahua	0
	Rocky Mountains	<i>engelmannii</i>	Engelmann	+
	Transcontinental	<i>glauca</i>	White	+
	Transcontinental	<i>mariana</i>	Black	+
	Rocky Mountains	<i>pungens</i>	Colorado	+
	NE. North America	<i>rubens</i>	Red	+
	NW. North America	<i>sitchensis</i>	Sitka	0
Europe	Transcontinental	<i>abies</i>	Norway	+
	E. Europe	<i>omorika</i>	Serbian	+
Western, central, and southern Asia	Caucasus	<i>orientalis</i>	Oriental	+
	Central Asia	<i>schrenkiana</i>	Schrenk's	+
	Afghanistan, Nepal	<i>smithiana</i>	West Himalayan	0
	E. Himalayas	<i>spinulosa</i>	Sikkim	0
Eastern Asia	China	<i>asperata</i>	Chinese	+
	Japan	<i>alcoquiana</i>	Alcock's	+
	China	<i>brachytyla</i>	Sargent	0
	Sakhalin Is., Japan	<i>glehnii</i>	Sakhalin	+
	Japan, NE. Asia	<i>jezoensis</i>	Yezo	+
	Japan, Korea	<i>koyamai</i>	Koyama's	+
	China	<i>likiangensis</i>	Likiang	+
	Japan	<i>maximowiczii</i>	Maximowicz's	0
	China	<i>montigena</i>	Candelabra	+
	Formosa	<i>morrisonicola</i>	Mt. Morrison	0
	N. Europe, Asia	<i>obovata</i>	Siberian	+
	China	<i>purpurea</i>	Purple-cone	+
	Japan	<i>torano</i>	Tiger-tail	+
	China	<i>wilsonii</i>	Wilson's	+

A cone of *Picea pungens*, showing papery and wrinkled cone scales with erose edges. This distinguishing feature is also shown by *P. engelmannii*, *P. jezoensis*, and *P. sitchensis*. Photograph by R. Warren.



uneven geographic distribution, with half of the species growing in eastern Asia. In 1916 Charles Sargent, alluding to the recent exciting accomplishments of Ernest Wilson, stated that the Arnold Arboretum had received more spruce trees from western China during the preceding few years than had been known in the entire world 20 years earlier.

Using the above criteria, one can easily recognize and separate *Picea* from other genera of the Pinaceae. Distinguishing some of the species from each other, however, presents a problem. Helmut Schmidt-Vogt (1977, p. 12; author's translation) states: "The high variability of the morphological characteristics [of the spruces] makes the distinction between species difficult. This is especially true in the East Asian area, which has a propensity to produce manifold forms. . . . It is not possible to make an exact identification from the characteristics of single specimens in arboreta." Despite this statement, the following key is presented. It includes all of the species listed in the Table. Amplification of the descriptive material follows.

KEY TO THE COMMONLY RECOGNIZED SPECIES OF SPRUCES

1. Leaves more flat than quadrangular in cross section, with stomata on lower surfaces only. —
 2. Branchlets remarkably pendulous.
 3. Leaf-tips blunt. *Picea brewerana*.
 3. Leaf-tips pointed. *Picea spinulosa*.
 2. Branchlets not remarkably pendulous.
 4. Cone scales papery and wrinkled, the edges erose.
 5. Leaves often keeled. *Picea jezoensis*.
 5. Leaves entirely flat. *Picea sitchensis*.
 4. Cone scales not papery and wrinkled, the edges rounded.
 6. Leaf-tips mucronulate. *Picea omorika*.
 6. Leaf-tips acute. *Picea brachytyla*.

1. Leaves more quadrangular than flat in cross section, with stomata on all four sides.
 7. Branchlets remarkably pendulous. *Picea smithiana*.
 7. Branchlets not remarkably pendulous.
 8. Cone scales papery and wrinkled, the edges erose.
 9. Cones less than 6 cm long; branchlets slightly hairy.
 *Picea engelmannii*.
 9. Cones more than 6 cm long; branchlets glabrous.
 *Picea pungens*.
 8. Cone scales not papery and wrinkled, the edges rounded.
 10. Most leaves less than 1.5 cm long.
 11. Young shoots glabrous or only slightly hairy.
 12. Young shoots pale yellow or yellow-brown.
 *Picea glauca*.
 12. Young shoots reddish brown.
 *Picea maximowiczii*.
 11. Young shoots consistently hairy.
 13. Leaves of uniform length, shiny green, with rounded tips. *Picea orientalis*.
 13. Leaves of varying lengths on the same shoot, dull green, with truncate or acute tips.
 14. Decurrent ridges on first- and second-year shoots rounded; cones falling after seeds have been shed. *Picea rubens*.
 14. Decurrent ridges on first- and second-year shoots flat; cones remaining on branches long after seeds have been shed.
 *Picea mariana*.
10. Most leaves more than 1.5 cm long.
 15. Most cones more than 10 cm long, the scales rhombic with truncate, emarginate tips. . . *Picea abies*.
 15. Cones 8 cm or less long, the scales not rhombic, with rounded tips.
 16. Foliage bluish to gray-green.
 17. Leaves rigid; young shoots red-brown or yellow.
 18. Leaves curved.
 19. Leaves very sharp.
 *Picea asperata*.
 19. Leaves blunt.
 *Picea montigena*.
 18. Leaves straight.
 20. Edges of cone scales erose.
 *Picea pungens*.
 20. Edges of cone scales rounded.
 *Picea chihuahuana*.

- 17. Leaves not rigid; young shoots ashy-gray.
..... *Picea wilsonii*.
- 16. Foliage green.
 - 21. Leaves at right angles to shoots, extremely rigid and sharp. *Picea torano*.
 - 21. Leaves at less than right angles to shoots, not extremely rigid and sharp.
 - 22. Outer bud scales elongated and acicular. *Picea glehnii*.
 - 22. Outer bud scales not elongated or acicular.
 - 23. Stomatic lines on leaves conspicuously whiter on one side than the other. ... *Picea alcoquiana*.
 - 23. Stomatic lines on leaves not conspicuously whiter on one side than the other.
 - 24. Young shoots hairy.
 - 25. Young shoots pale gray.
..... *Picea purpurea*.
 - 25. Young shoots red-brown.
..... *Picea obovata*.
 - 24. Young shoots glabrous.
 - 26. Young shoots orange-brown.
..... *Picea koyamai*.
 - 26. Young shoots pale yellow-brown.
.... *Picea schrenkiana*.

THE NAME

Anyone perusing the writings of the early botanists or inspecting early herbarium specimens expects to find that there have been major nomenclatural changes in almost any genus. Nowhere is this more evident than in the spruces. In addition to *Picea*, the genus has been known at various times as *Pinus*, *Peuce*, and, most frequently, *Abies*. Before the 1890's, when standardization of botanical nomenclature on the basis of priority and accurate description began to be emphasized, the matter was hotly debated. In these debates the thread of consistency was most frequently maintained by the common vernacular names. In English the spruces (present genus *Picea*) were referred to as spruce firs, and the firs (present genus *Abies*) as silver firs.

Linnaeus (1753) named the spruce fir *Pinus abies* and the silver fir *Pinus picea* despite the reverse use of the names by earlier writers. After Linnaeus confusion reigned. Some eminent botanists followed his names, and others the older ones. The protagonists in the debate often quoted the classics to support themselves. The faction support-

ing *Abies* as the correct name for the spruce fir cited Pliny, who said that in his "Abies" the fruit hung downward. Therefore, they said, it could not be the silver fir. The *Picea* faction quoted Virgil, who wrote in the *Aeneid* that the ribs of the Trojan horse were made of *Abies*. This, they claimed, must refer to the silver fir, since that is the only single-needled conifer native to Troy, and no spruces grow there. Sargent (1899, p. 26) summed up the modern opinion: ". . . in the United States and in Continental Europe the Spruces are almost habitually called *Picea* and the Firs *Abies*. According to the rules of botanical nomenclature this use is certainly correct without reference to the classical meaning of the two words, or to Linnaeus's use of *Picea* and *Abies* as specific names for his genus *Pinus*, because *Picea* is the oldest name under which the Spruce trees have been generically distinguished."

According to the *Oxford English Dictionary*, the English word "spruce" comes from the word "Prussia." *Picea abies* is as prevalent there and in neighboring areas of northern Europe as it is in Norway, and was thus perhaps more accessible to English-speaking travelers of the early days. The other meaning of "spruce" — neat in personal appearance — has no relation to the tree, but apparently arises from the one-time elegant fashion of wearing jerkins of Spruce (Prussian) leather.

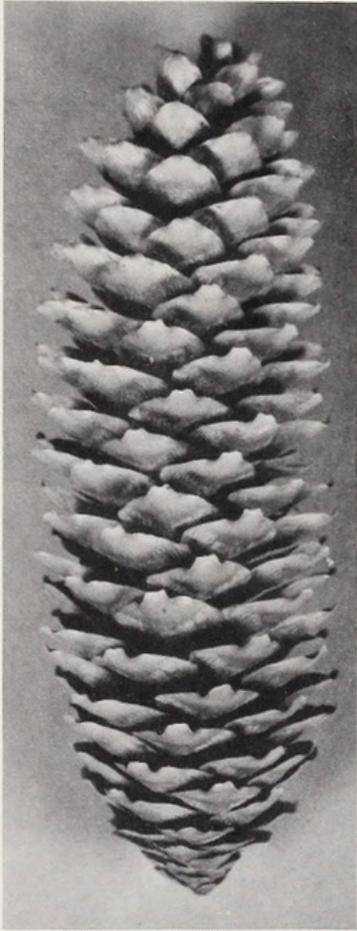
THE ARNOLD ARBORETUM'S PLANTS

***Picea abies* (L.) Karsten**

Norway spruce

Introduced into North America from Europe late in the 18th century, this tree grows faster in the New England climate than our native spruces. It can reach a height of 40 meters. If it is in a free-standing situation, it keeps its lower branches well. Those of older trees often layer, put down their own roots, and form a palisade of new young plants that continue to grow around the parent tree after it has died. John Loudon (1838, p. 2295) called it "the loftiest of European trees." He praised it as excellent for sheltering other plants and for protecting wildlife against the weather; a "good nurse," the expression then was.

Charles Sargent (1897, p. 482), however, showed little enthusiasm for the tree. He stated that, although it grows rapidly for 30 or 40 years, it then begins to fail at the top: "vigorous Norway spruces more than 50 years old are uncommon in this country." He termed its popularity "a misfortune," and this point of view has prevailed in the literature since. Admittedly, planting of Norway spruce may have been overdone, but many trees over 100 years of age are flourishing today. Its pyramidal, straight-growing habit and its swooping branches, adorned in most forms of the tree with pendulous branchlets (which have given rise to the German term "Kammfichte," or comb spruce), are a pleasant sight in most northeastern towns. Its profuse elongated cones with distinctive rhomboid and slightly emar-



Picea Abies. Left: Typical cone, showing scales with truncate-emarginate tips. Photograph by R. Warren. Above right: A mature plant in the Hunnewell Pinetum, Wellesley, Massachusetts, with layered branches around it. Arnold Arboretum photograph. Below right: The same tree thirty years later after the main stem has declined and been removed. The layered branches are represented by a rosette of independent plants. Photograph by R. Warren.

ginate cone scales often take on a handsome purple color in the spring and later in the year form a carpet under the mature trees. Its minimum seed-bearing age is 30 to 50 years.

Tradition and availability have led Britons and Europeans to favor this spruce for Christmas trees. In North America other needle evergreens have provided competition. To many people, the spruce's habit of dropping its needles after the tree has been cut is a disadvantage.

Long ago, people used to crush the leaves and twigs of spruces to produce an essence for making spruce beer. This was combined with sugar, molasses, treacle or honey, and yeast, allowed to ferment, and then bottled. The resulting potation was consumed for pleasure and was also used as an antiscorbutic for long sea voyages. The taste was both aromatic and medicinal. American spruces can be used in the same way as Norway spruces for this purpose, for those so inclined.

Because the wood of *Picea abies* is light, strong, and straight grained and takes a good finish, it is excellent for carpentry and construction. Its planks, as well as those of pine and fir, are referred to as "deal" (those of *P. abies* are known as "white deal").

At least 140 horticultural varieties of *Picea abies* have been identified. They are distinguished by varying habits of growth and, to some extent, by the shape, angle, and rigidity of the leaves. Most can still be recognized as *P. abies*, however, by the typical red-brown shoots, the dark green foliage, and the familiar slightly resinous buds.

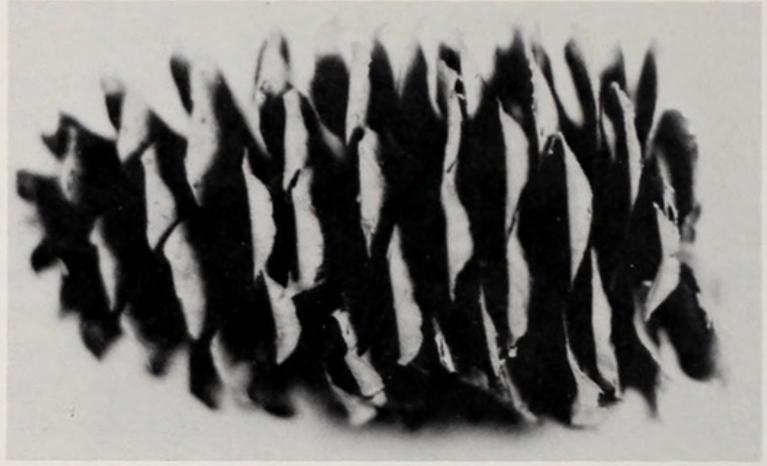
The Arboretum has 25 plants of typical *Picea abies*. Two are just 100 years old, and 28.2 and 29.7 meters tall; they form the showpieces of the pinetum as viewed from the southwest. They, together with the 29-meter *Acer saccharinum* on Meadow Road, are the tallest trees in the Arboretum. Eleven other *P. abies* of accession number 2306 are of unknown origin or age but are well-grown trees between 19.5 and 28.2 meters in height. Two forms, f. *conica* and f. *cupressina*, are represented by plants of 100 and 66 years, respectively, and measure 19.5 and 22.5 meters. Together with many other cultivars, these plants are important and distinguished constituents of the pinetum.

Picea alcoquiana (J. G. Veitch ex Lindley) Carrière Alcock's spruce

This tree was discovered in 1861 by John Veitch while he was climbing Mt. Fuji in company with Rutherford Alcock, British Minister to Tokyo. In its native habitat it grows sparsely and at high elevations. It is a tree with delicate leaves that point strongly forward on the upper aspect of the shoots and are spreading and less forward pointing below. The stomatic lines are more prominent than in most other quadrangular-leaved spruces and are brighter on the lower surface of the leaves than on the upper, thus giving rise to the name *Picea bicolor* (Maxim.) Mayr, under which the species has recently been known.

The cones are medium sized (5–10 cm), with the tips of the scales slightly wavy or serrulate. In the Arboretum trees the scale tips have a

A cone from a *Picea alcoquiana* tree in the Arnold Arboretum. The tips of the cone scales roll outward. Photograph by R. Warren.



tendency to roll outward. This character reaches full expression in the variety *reflexa*, which is not included in the Arboretum's collection.

Picea alcoquiana is not a rapid grower, and its main ornamental feature is its interesting two-toned leaves. It is rare in cultivation.

Six plants grow in the pinetum, all of them over 60 years of age. Two were received from Veitch's Nursery in England and three from the Hunnewell Pinetum in Wellesley, Massachusetts. They are between 10.8 and 16.8 meters tall.

***Picea asperata* Masters**

Chinese spruce

Ernest Wilson brought the seed of *Picea asperata* back from China in 1911. Its role in that country has been compared with that of *Picea abies* in Europe: it covers a wide area, and its foliage varies in character — to some extent depending on the climate. It is a stronger grower there than most other native Chinese spruces.

Its glaucous, light gray-green foliage is striking when seen from a distance and has given rise to a Chinese vernacular name that means "cloud spruce." The leaves are stiffer than those of Norway spruce; they spread all around the reddish shoot and sweep upward on the branchlets. Their tips are sharp. This feature, combined with the stiffness, makes the foliage very prickly and probably occasioned the tree's common name, dragon spruce. The winter bud is large and conical with a swollen base.

Wilson recognized three varieties: var. *heterolepis* Rehder & Wilson) Cheng, with split cone scales; var. *notabilis* Rehder & Wilson, with narrow cone scales; and var. *ponderosa* Rehder & Wilson, with large cones. *Picea aurantiaca* Masters, introduced from western China in 1908, *P. meyeri* Rehder & Wilson, introduced from northern China in 1910, and *P. retroflexa* Masters, introduced from western China in 1911, are closely related species, showing slight differences in the color or hairiness of the branchlets and in the shape of the leaves or the cone scales.

Picea asperata grows slowly here. This quality, its gray-green foliage, and its informal habit of growth have a charm or, at least, an



Left: *Picea asperata* var. *ponderosa* growing on the north side of Bussey Hill in the Arnold Arboretum. Photograph by R. Warren. Right: *P. brewerana* growing in Dublin, Ireland, in 1952. Arnold Arboretum photograph.

interest that should lead to its wider use as an ornamental. It is commonly found in botanic gardens and arboreta but is seldom offered commercially.

Forty plants, including representatives of the above-mentioned varieties and related species except for *Picea retroflexa*, are growing at the Arnold Arboretum. The tallest is 13.5 meters. They are located in four areas: the pinetum, the south side of Bussey Hill near South Street, Peters' Hill, and the knoll west of the Hunnewell Building.

***Picea brewerana* Watson**

Brewer's spruce

The home of this spruce is the Siskiyou Mountains of southern Oregon and northern California. Probably discovered by Prof. William H. Brewer in 1863, it was first brought into cultivation on the West Coast, whence Sargent procured it for the Arnold Arboretum in the 1880's. Kew Gardens received a plant from him in 1897 that is still growing there; in December, 1981, it was 12.8 meters tall.

It is the slowest growing of the spruces. In the 80 years of their cultivation, none is known to have reached 13 meters in height. Even in their native habitat, trees over 22 meters are rare.

Picea brewerana is one of the three spruces (not including *P. abies*, in which the characteristic is not so extreme) that show outstanding pendulous branchlets. The other two are *P. smithiana* and *P. spinulosa*, from the Himalayan region, neither of which is hardy in our area.

Normally the crown is pointed. The branches sweep upward at the top but point downward in the lower areas. The dangling, hairy branchlets can be more than a meter long. The leaves arise all around the shoot, point forward, and curve away from it. They are up to 3.5 cm in length, flattened, and blunt tipped.

Charles Sargent (1897, p. 482) said, "a few small grafted plants in the Arnold Arboretum are probably the only representatives of this interesting tree in the eastern states." We have no record of the fate of these plants. Today, however, one plant — obviously a tree of some age but only 2.5 meters tall — is growing in the Peters' Hill area. Its record is lost, and it was only recently that Dr. Richard Weaver recognized it as an example of *Picea brewerana*. The branchlets are pendulous, but the stunted habit prevents their proper display. The flattened leaves are, however, diagnostic.

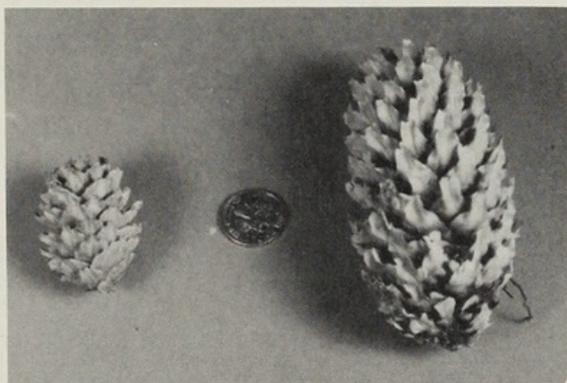
<i>Picea engelmannii</i> (Parry) Engelmann and	Engelmann spruce
<i>Picea pungens</i> Engelmann	Colorado spruce

The similar appearance of these two handsome spruces, their overlapping habitats in the Rocky Mountains, and their almost simultaneous discovery make it appropriate to discuss them together. Charles Parry found them near Pike's Peak in 1862. Engelmann spruce covers a wider area than Colorado spruce, extending into Canada and to the Mexican border. It grows at a higher altitude. Both have blue foliage. In the case of Engelmann spruce, bluish foliage is relatively constant, whereas in Colorado spruce the leaves of different specimens vary from vivid blue to drab gray-green.

The cones of both are light yellow, and the papery scales have erose tips. Differences do exist, however. Engelmann spruce, when compared to Colorado spruce, has a broader crown (viewed from a distance), smaller cones, and usually hairy (rather than glabrous) shoots. Its leaves are more flexible and less pointed, and the branches are less stiffly horizontal. Often, in fact, Engelmann spruce has been considered allied to *Picea glauca*.

The Colorado spruce is a favorite in landscaping. (It is the State tree of Colorado). Its many cultivated varieties providing different shades of blue are seen throughout North America and Europe on large and small estates. Many agree that their planting has been overdone, and the trees have often been placed too close to houses. Their symmetrical horizontal branching and showy blue color make them vulnerable to vandalism during the Christmas season. Engelmann spruce is considered by many to be an equally handsome tree. It deserves more consideration in decorative planting than it now receives.

Cultivars of *Picea engelmannii* are not common, whereas those of *P. pungens* are many and familiar.



Above: Plants in the Arnold Arboretum pinetum. The trees with narrow crowns are *Picea pungens*, and those with broad crowns are *P. engelmannii*. Photograph by R. Warren. Below left: Shoots of *P. pungens* (left) are smooth, while those of *P. engelmannii* (right) are hairy. Photograph by A. Coleman. Below right: Cones of *P. engelmannii* (left) and *P. pungens* (right). Photograph by R. Warren.



Left: *Picea glauca* in the Arnold Arboretum. Right: Sixty-year-old plants of *P. glauca* f. *conica* growing in the old dwarf conifer area of the Arboretum. Photographs by R. Warren.

The Arboretum's collection contains nine plants of *Picea engelmannii*, all over 50 years of age. Four of these — among the finest trees in the pinetum — are over 100 years old and reach a height of 19 meters. Of the many specimens of *P. pungens* in the Arboretum, 14 are over 50 years old, and 5 over 100. The tallest is 22 meters.

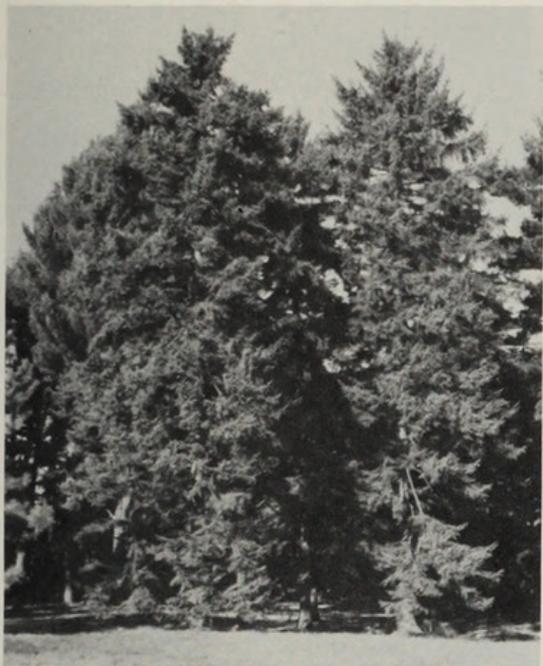
***Picea glauca* (Moench) Voss**

white spruce

Picea glauca, together with *P. rubens*, the red spruce, and *P. mariana*, the black spruce, are the most abundant conifers of the northern part of North America. The southern boundary of the range of the white spruce extends from western Massachusetts to western Montana, the northern from latitude 60° N in Labrador to 70° N in the Mackenzie District of northwestern Canada. Its profile in the wild is broader than that of the spirelike black spruce, and the foliage is denser. The color, true to the common name, is lighter than that of the black spruce, and it can show either a bluish or a greenish cast. Its yellow-brown, glabrous branchlets distinguish *P. glauca* from the other two spruces, which are customarily reddish and hairy.

The crushed foliage of *Picea glauca* exudes a musky odor that has caused woodsmen to name it the cat or skunk spruce. Its yellow cones are of a distinctive teardrop shape and are up to 7–8 cm in length; they do not appear until the plants are 25 years of age, and they fall at maturity. The black spruce's smaller cones appear at a younger age and remain on the tree for some years after shedding their seeds.

From the lumberman's viewpoint, *Picea glauca* is the most important constituent of our great northern forests. Its long-fibered wood is excellent for paper pulp as well as for construction, but the species



Picea glehnii growing on Peters' Hill.
Photograph by R. Warren.

cannot compete in speed of growth with the West Coast spruces.

Its unremarkable appearance, its odor, and perhaps its familiarity make it less popular ornamentally than the Norway spruce. The Arboretum grows four *Picea glauca* trees at the present time. The oldest of known age is 85 years; its height 14.4 meters. Another, of unknown age, is 15 meters tall.

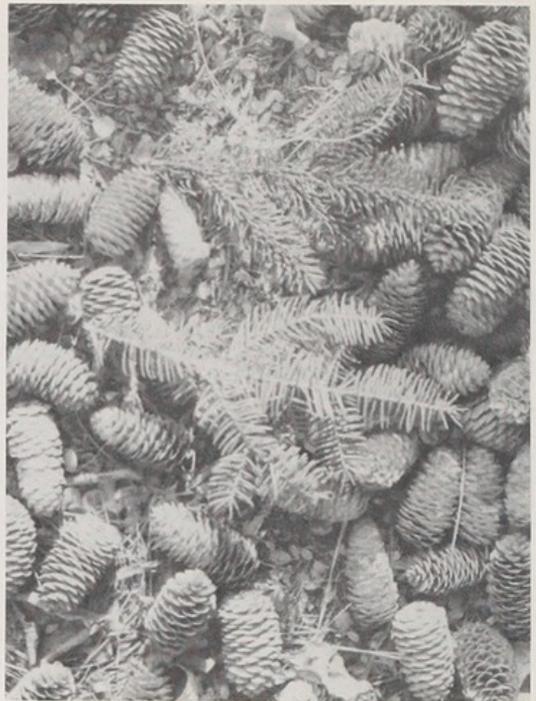
Picea glauca has given rise to a few cultivated varieties. A familiar one, forma *conica* Rehder, must be mentioned. In 1904 Alfred Rehder and John Jack, while awaiting a train that was behind schedule near Lake Laggan, Alberta, took a stroll and found some dwarf spruces resembling witches' brooms, which they sent back to the Arnold Arboretum. This was the origin in cultivation of the familiar slow-growing, conical plant that has been a conspicuous addition to ornamental planting, particularly in rock gardens. It is sold in nurseries as dwarf Alberta spruce. As an ornamental it has few disadvantages, although if it suffers winter burn or some other disfiguring accident, a long-standing blemish afflicts its otherwise tidy appearance. In the old dwarf conifer area at the Arboretum, there are several plants that are 60 years of age. Although these are obviously now oversize for a rock garden, they are interesting and decorative items.

About two dozen other varieties and cultivars of *Picea glauca* are recorded in the literature.

***Picea glehnii* (Fr. Schmidt) Masters**

Sakhalin spruce

This tree is native to Sakhalin Island in Russia and to the nearby Japanese island of Hokkaido. It was introduced to Britain in 1877 by Maries for the Veitch Nurseries in England. Its size in its native habitat is moderate, reaching to 30 meters. It is similar to the red spruce (*Picea rubens*). The scales of the bark are somewhat reddish, and the branchlets, buds, and cones are reddish brown. The branch-



Picea koyamai. Left: One of the group growing on the slope near the Hunnewell Building, Arnold Arboretum. Right: Cones. Photographs by R. Warren.

lets are hairy, particularly in the furrows. The outer scales of the buds have curious needlelike projections extending the length of the bud, a feature seen in three other spruces, *P. mariana*, *P. omorika*, and *P. rubens*. The leaves are slender, short, straight, and stiff; they are arranged in a pectinate fashion beneath the branchlets, pointing forward to cover the branchlets above.

Although *Picea glehnii* is not well known by the general public, it is handsome and has an exotic attraction that has given it a place in many collections.

The Arnold Arboretum has 12 specimens of *Picea glehnii*, all grown from seeds received in 1894 from the Government Forestry School at Tokyo. The trees stand in two groups: one of seven trees located in the pinetum, the other of five on Peters' Hill. The tallest have now reached 19 meters in height.

***Picea koyamai* Shirasawa**

Koyama's spruce

Picea koyamai has a restricted distribution in central Japan. Mitsuo Koyama discovered it on Mt. Yatsuga-dake in 1909 and guided Ernest Wilson to the area in 1914.¹ Wilson sent the seeds to the Arnold Arboretum, which passed them on to other botanic gardens. It is a handsome spruce with dark foliage, bark with large rectangular plates, and sturdy, spreading branches that turn conspicuously up-

¹ I am grateful to Dr. Tatemi Shimizu, of Shinsu University, Matsumoto, Japan (located near the area on Mt. Yatsuga-dake where *Picea koyamai* grows), who visited the Arnold Arboretum in 1980. He informed us that two separate stands grow there, one of which Wilson apparently did not know. In 1958 a typhoon flattened the stand from which our specimens come, leaving the other intact. New growth is taking place well, however, in the grove that Wilson visited.

ward at the ends. The shoots are pale orange, glabrous on the leading branches, and often hairy on the side branches. The buds are large, conical, and resinous. The leaves are stiff, pectinate below, lying forward and curved upward above. The cones are brown when mature, moderately tapered, and on some plants distinctly barrel shaped, with smooth, rounded scale edges.

Similar trees, but with more delicate and straighter needles, have subsequently been found in Korea. There is considerable disagreement as to whether they are variants of *Picea koyamai* or belong to a separate species, *P. koraiensis* Nakai.²

Picea koyamai, and occasionally some of its allies, are seen in most pineta, but not in small collections. Its unique dark, sturdy appearance should recommend it for wider use. No cultivars are reported.

The Arnold Arboretum's collection now contains 15 specimens of *Picea koyamai*, 11 dating from the introductions by Wilson in 1915, and four others from the early 1920's. The tallest is 17.4 meters. There are also three younger plants grown from seed received in 1960 from Minnesota. Because their leaves are narrower and straighter than those of other specimens, and because the plants came from near the Yalu River in North Korea, they are probably referable to *P. koraiensis*, if indeed this is a distinct species.

Picea likiangensis (Franchet) Pritzel
and

Likiang spruce

Picea purpurea Masters

purple-cone spruce

These two spruces go together here because many botanists consider the latter to be a variety of the former. *Picea likiangensis* grows in western China and Tibet. Discovered by Delavay in 1884, it was introduced to Veitch's Nursery by Wilson in 1904. *Picea purpurea* is from an area of western China somewhat north of the locality for the type he introduced in 1910.

More than any other species of the genus, *Picea likiangensis* typifies the identity problems of the Chinese spruces. From cross-breeding trials Jonathan Wright (1955) considered it to be a group rather than a single species. To quote William Bean (1976, p. 188): "even from a single seed collection *P. likiangensis* varies considerably in the colour and degree of hairiness of the shoots, colour of leaves, etc." Any description, therefore, must be couched in general terms. Its leaves are bicolored as in *P. alcoquiana*, and its shoots are usually light yellow or whitish gold, and hairy. The sterigmas lean forward, curving upward and back at the tips. The young cones are bright red. The scales of the mature cones are rhomboid, narrowed, and usually erose at the tips.

² Reports have appeared on three varieties of *Picea koraiensis*: *intercedens*, *pungsanensis*, and *tonaiensis*. Some observers contend that all of these are transitional forms between *P. koyamai* and *P. obovata*, a relative of the Norway spruce that extends into northeastern Asia.

Picea purpurea, often termed *P. likiangensis* var. *purpurea* (Masters) Dall. & A. B. Jackson, differs from *P. likiangensis* only in having shorter leaves and brighter, more purple cones.

In its living collections the Arboretum has only one specimen of *Picea likiangensis*, dating from 1965. It has lost its upper half and is presently an ungainly, stunted plant 2 meters tall. Of the five specimens of *P. purpurea*, four are from seeds that Wilson brought here in 1911. The tallest is 13.5 meters. They are all growing in congested situations and have not achieved their potential as specimen trees. The fifth tree, received from H. H. Hunnewell in 1922, is growing in a less crowded section and is 11 meters tall.

Picea mariana (Miller) Britton, Sterns, & Poggenburg black spruce
and

Picea rubens Sargent red spruce

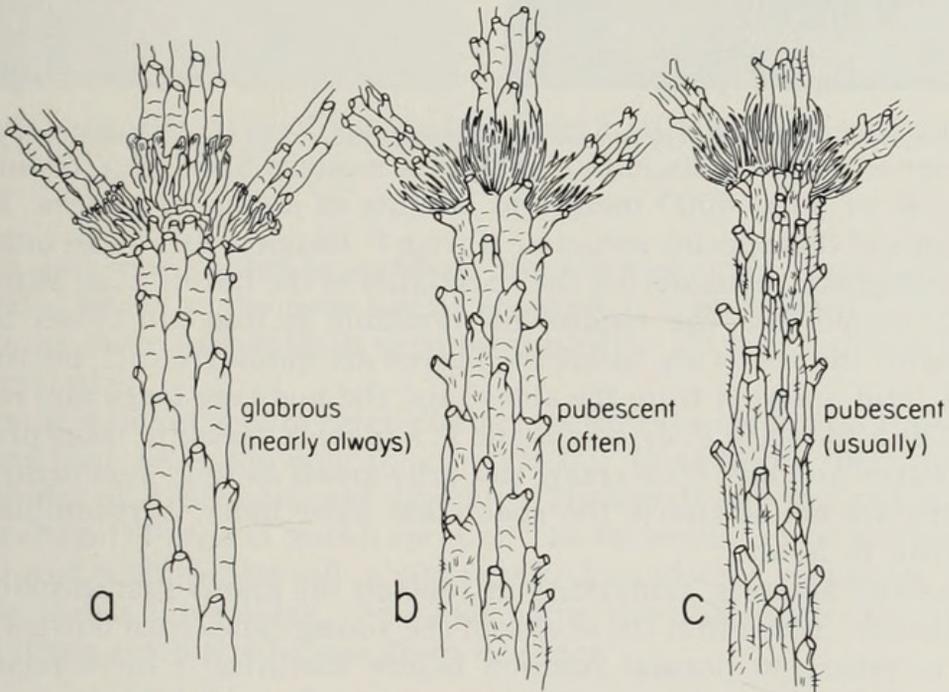
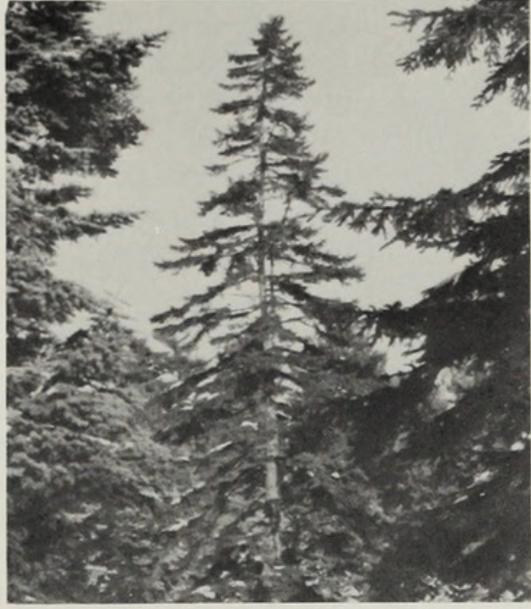
These two plants are similar in appearance. The habitat of the black spruce approximates that of the white: Canada, from the Atlantic coast in the east but stopping short of the Pacific coast in the west, extending southward into the northern United States. The red spruce is limited to northern New York and New England, Nova Scotia, New Brunswick, and the St. Lawrence Valley, extending down the Alleghenies to North Carolina. Both species have reddish scaly bark and reach a maximum height of 24 meters. The black spruce ranges farther north than does the red and often grows in boggy places. When seen from a distance, its foliage is dark green, while that of the red spruce is faintly auburn. The leaves of both are short — hardly more than 1.4 cm. On the black spruce they are straight and show blue-white below, whereas on the red spruce they are lighter green, with the lateral ones incurved.

The branchlets of both spruces are reddish brown and hairy. The ridges on them that lead to the sterigmas have flattened crests in the black spruce, and rounded crests in both the white and red spruces. On black spruce branchlets, particularly those on which newest growth has just been completed, these crests look like a long row of coffins. In the older shoots later growth in diameter tends to flatten out the rounded crests of the ridges.

The outer scales of the buds in both these plants have needlelike tips similar to those of *Picea glehnii* and *P. omorika*. The cones of the two species are similar, but those of the black spruce are shorter, appear when the plants are younger, and conspicuously cling to the branches after they have shed their seeds.

The profile of the black spruce is more spirelike and neatly symmetrical than that of the red, except in the far north, where climatic conditions reduce the black spruce to a shrubby habit and the red spruce does not grow.

The wood of both *Picea mariana* and *P. rubens*, as well as that of *P. glauca*, is used for making paper pulp. In *P. mariana* the wood is



glabrous
(nearly always)

pubescent
(often)

pubescent
(usually)

a

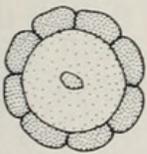
b

c

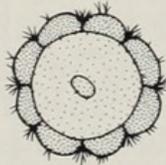
WHITE SPRUCE

RED SPRUCE

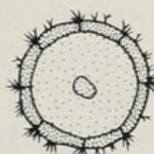
BLACK SPRUCE



decurrent ridge
externally rounded



decurrent ridge
externally rounded



decurrent ridge
externally flattened

Above: *Picea mariana* (left) and *P. rubens* (right) in the Arnold Arboretum. Photographs by R. Warren. Below: Branchlets of *P. glauca*, *P. rubens*, and *P. mariana* (after Gordon, 1952, with permission).

strong and useful for building. The slow growth of these trees, however, renders them no longer economical for this use.

A few cultivars are known from each species. Those of *Picea mariana* — 'Beissneri', 'Doumetii', and 'Ericoides' — are more familiar, having a compactness and a light, bicolored flecking to the leaves that are especially attractive. They are more desirable for ornamentals than the species itself.

One 50-year-old plant of *Picea mariana* is growing as a free-standing specimen slightly separated from, and to the northeast of, the pinetum's spruce collection, not far from Bussey Brook. It was acquired in 1922 from Jasper Park, Alberta, Canada, via J. G. Jack. It is a fine, sturdy specimen 11.4 meters tall, but it does not show the shapely conical top characteristic of these trees in the wild. Three other young (1969) plants are growing at the Case Estates in Weston. The Arboretum's specimens of *P. rubens* consist of eight plants received in 1895 from Bar Harbor, Maine. They are healthy trees 11 to 18 meters tall.

***Picea montigena* Masters**

candelabra spruce

Introduced in 1904 by Ernest Wilson for Veitch's Nursery, *Picea montigena* grows in its native habitat of western Szechuan, China, at altitudes of 3000–4000 meters to heights of about 30 meters. Most accounts of this species associate it with *P. likiangensis* — an unhelpful comparison, considering the variability of the latter. Alan Mitchell (1972) stated that the specimens available to him are closer to *P. asperata*: the cones are alike; the leaves are similarly stiff, pectinate below, and upswept from the sides; and the buds are large and resinous. The bark, as in *P. asperata* and *P. koyamai*, flakes in large plates. The leaves are dark blue-green, not gray-green as in *P. asperata*, and the tips are not so sharp; the shoots are more hairy. It resembles *P. asperata* in habit.

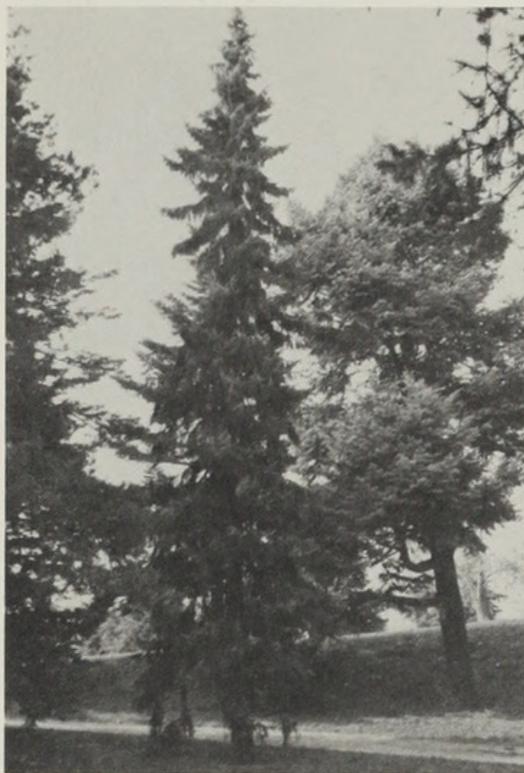
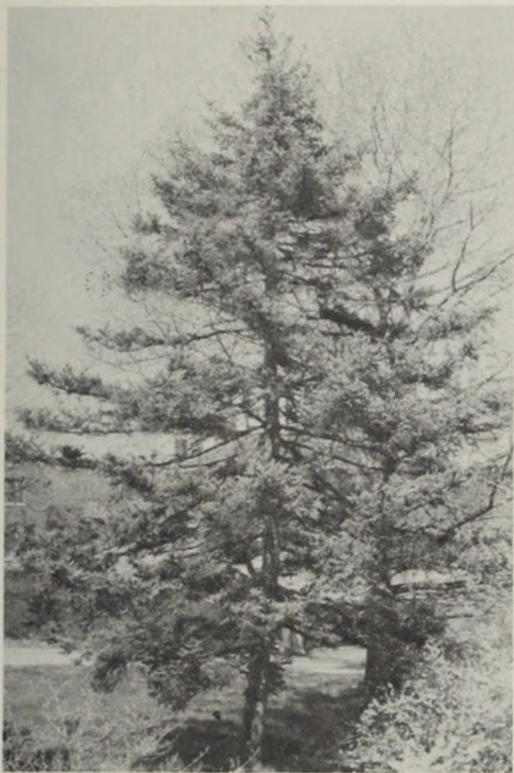
Maxwell Masters, remarking in 1906 on the plants just introduced into Britain, noted that the scales of the young cones turn downward, only to return to normal position before maturity. I have recently observed this phenomenon on plants in the Arnold Arboretum: it is striking at the time of pollination — an exaggeration of the downward curving seen in the cone-scale tips of all spruces during this period.

Eight specimens are growing in the Arboretum, all from seed brought by Wilson in 1911. The tallest has reached 12.3 meters after 70 years. They closely resemble *Picea asperata*, but they do not have the grayish cast to the foliage and the leaves are less prickly.

***Picea obovata* Ledebour**

Siberian spruce

Picea obovata is commonly considered to be a close relative of *P. abies* that extends into Asia; many think that it is a variety of that species. Helmut Schmidt-Vogt, a recent authority, even denies it varietal status. The slower growth, the shorter, more slender leaves, the



Picea montigena (left) and *P. omorika* (right) in the Arnold Arboretum. Photographs by R. Warren.

paler and more hairy branchlets, the shorter cones, and the more rounded edges to the cone scales separate it from typical *P. abies*.

Picea obovata is seldom seen in nurseries. No horticultural forms are recorded.

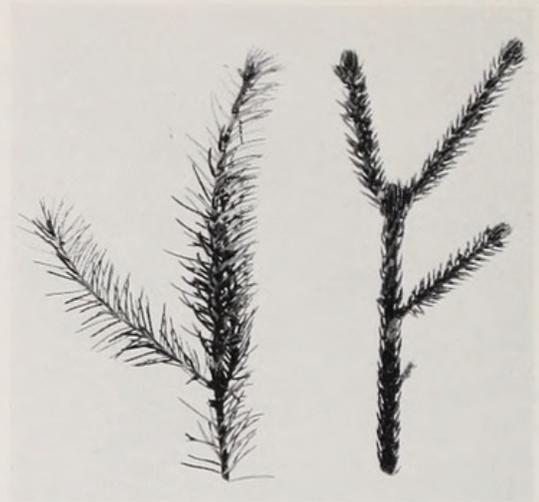
In the Arboretum are three plants labeled *Picea obovata*, the oldest dating from 1904 and now 16.5 meters tall. In addition, there are two examples of *P. obovata* var. *coerulea* Tigerstedt and one of var. *fennica* (Regel) Henry (Finnish spruce). The latter plant was acquired in 1901 and is 20 meters tall, a vigorous and handsome specimen. In all these plants the foliage and cones show the differences mentioned that distinguish *P. obovata* from *P. abies*.

Picea omorika (Pančić) Purkyně

Serbian spruce

This tree, from a restricted area in southwestern Yugoslavia, was not introduced into cultivation in western Europe until 1881. With its characteristic narrowly columnar habit, the pendulous branches turning upward at the tips, it is easily recognized at a distance. In its native habitat it reaches 30 meters in height, a dimension that the oldest specimens in cultivation in Britain have now attained after 90 years.

The upper leaves of *Picea omorika* may lie forward along the shoot in a broadly imbricated arrangement, curving gently upward at the ends, the lower ones spreading laterally. The leaves are flat, with the upper surface shiny, slightly convex transversely, and without stomata, and the lower surface with two white stomatic bands. The



Left: *Picea orientalis* in the Arnold Arboretum. Photograph by R. Warren. Right: The short, regularly arranged leaves of equal length of *P. orientalis* (right) compared with the long, flat leaves of *P. omorika* (left). Photograph by A. Coleman.

leaf tip appears blunt, somewhat like that of *Picea brewerana*, but close inspection often reveals a tiny sharp mucro prickly to the touch.

Picea omorika is hardy here and is tolerant of a variety of soils. Its buds break late in the season, thus rendering it less vulnerable than others to damage from late frosts. It has been recommended as a competitor to *P. abies* for forest plantings in Britain. It has become justifiably popular in our area as an ornamental and is available in nurseries.

Cultivars of *Picea omorika* are few but interesting. The compact, globular growth of *P. omorika* 'Nana' is very different from the slender habit of the type plant, and its bicolored green and white leaves make it a popular ornamental.

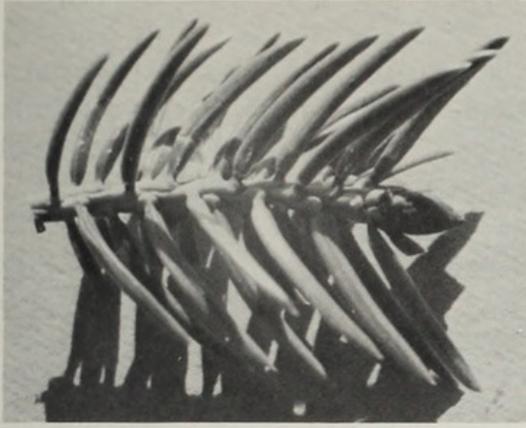
The Arnold Arboretum first received *Picea omorika* in 1881 as seed from Germany. The trees grown from these seeds no longer survive, but in 1887 they provided scions from which our present mature plants grew. There are now 16 trees, including five dating from that time. The tallest are 18 meters. Although not as tall as our *P. abies* of the same age, they compete well with them as specimen trees.

***Picea orientalis* (L.) Link**

oriental spruce

Scattered descriptions of this tree, whose native habitat is the Caucasus, date from as far back as 1717. It was probably introduced into cultivation in western Europe around 1840 and presumably came to America not long thereafter. In its native habitat it can reach heights of 60 meters, and in cultivation in Britain it has grown to over 30 meters.

Alan Mitchell (1972, p. 25) has pointed out that "crowns of older trees become very dense indeed, but around the apex remain open. Slender straight young shoots project, slightly ascending, from the



Left: Rigid, sicklelike leaves of *Picea torano*. Photograph by R. Warren. Right: buds of *P. torano* (lower left; large and smooth), *P. abies* (above), and *P. mariana* (lower right; note needlelike tips to the bud scales). Photograph by A. Coleman.

general line of the crown in a distinctly spiky way” — a useful thing to remember when viewing the tree from a distance. The leaves are among the shortest in any spruce, and the length varies little throughout the tree. They point forward in regular rows, giving an attractive, tidy appearance. They are glossy green and blunt tipped. The shoots are pale yellow and hairy, and the cones are 6–10 cm long, tapered, slightly curved, and gray-brown. The tips of the cone scales are rounded and entire.

Picea orientalis is present in most botanical gardens and some nurseries. Its dense habit and textured foliage make it the favorite spruce of many conifer enthusiasts. Although it is not the hardiest spruce in our area, it should increase in popularity.

Several cultivated forms of *Picea orientalis* exist. The dwarf ones, particularly ‘Aurea’, are beautiful additions to a rock garden.

The Arboretum’s eight specimens include five grown from seed acquired in 1873 from the St. Petersburg Botanical Garden, and one other collected in the wild in 1903 by Charles Sargent. These are magnificent trees reaching 21 meters in height.

***Picea torano* E. Koehne**

tigertail spruce

This Japanese native was introduced to the West (England) by J. G. Veitch in 1891. In Japan it grows to 90 meters or more. It is a pyramidal tree, dark green in color, and of dense habit. Its most outstanding characteristic is its curved, very rigid, sharp-pointed leaves, which make it stand out from all other spruces. This feature gives rise to the name tigertail, although presumably this refers not to the sharpness of the bristles on the tail but to the scratching one would get from grabbing it. The leaves and the surface of the branchlets are glossy smooth, a feature perhaps responsible for the other name by which it is known, *Picea polita* (Sieb. & Zucc.) Carr. (“polita” is Latin for “polished”). The sterigmas are extraordinarily thick and sturdy to match the leaves they bear.

Picea torano is not readily available in nurseries, a situation that I feel should be remedied. It is hardy. Its distinctive foliage and vigorous habit make it a source of curiosity and admiration wherever it is grown.

Despite its large size in its native habitat, it is a slow grower in cultivation. Although some of the trees planted in England are 90 years old, the tallest ones are under 22 meters. This deliberate growth can be an advantage on a limited estate.

The Arboretum's collection contains two specimens received in 1895 from Veitch's Nurseries. They have reached heights of 18 meters.

***Picea schrenkiana* Fischer & Meyer**

Schrenk's spruce

This spruce comes from Central Asia, crossing the border between the southern USSR and Sinkiang Province, China, where it grows at altitudes of 1400–3000 meters. It was discovered by A. G. Schrenk in 1840 and was introduced into cultivation in western Europe in 1878. Although it was first confused with *Picea smithiana* (Wallich) Boiss., West Himalayan spruce, and apparently still is in some herbaria, it is quite distinct from it. *Picea smithiana*, coming from considerably farther south, has longer leaves and cones and more pendulous branchlets. *Picea schrenkiana* has also been associated with *P. obovata*, a Siberian species that extends into the northern part of its range. As with other spruces, there are variations in the habit and foliage of Schrenk's spruce that have stimulated attempts to recognize more than one species. The only one that seems possibly valid at the present time is *P. tianschanica* Rupr. From a southerly range contiguous with that of *P. schrenkiana*, it is a smaller tree with hairy, terra cotta-colored branchlets. The buds are barrel shaped and of a cinnamon color, and the cones are almost twice as long as those of *P. schrenkiana*.

Picea schrenkiana grows to 50–60 meters in its native habitat, but (at least in England) it has reached only one-third that height in cultivation. The bark is dark gray, and the buds are golden brown, 4.0 to 6.8 mm long, and nonresinous. The shoots, which may or may not be hairy, are cream colored. The green leaves point forward, covering the shoot above and scarcely parted below. They are quadrangular in cross section, 15–35 mm long, and with two to four lines of stomata on all four sides. The cones are 6–11 cm long, with the scales coffee brown, their edges rounded and wavy.

This species is not known to be available in nurseries. Because of its resemblance to the Himalayan spruces (*Picea smithiana* and *P. spinulosa*), it might be considered for cultivation. No cultivated varieties of *Picea schrenkiana* are known.

The Arboretum's only living specimen at present is a plant received from St. Petersburg, Russia, in 1903. Eleven meters tall, it is growing in a shaded situation in the pinetum and has lost the lower half of its foliage. No cones are available, but the vegetative characteristics of



Picea wilsonii growing on Peters' Hill, Arnold Arboretum. Photograph by R. Warren.

the tree conform to its classic description and to our herbarium specimens.

***Picea wilsonii* Masters**

Wilson's spruce

Another East Asian spruce, this tree was collected first by Henry in 1888 and was introduced by Wilson to Veitch's Nursery in England in 1901. It is widespread in the mountains of northwestern Szechuan and Hupeh, extending into Kansu and Shansi. It grows there to a height of 25 meters.

It is a handsome, pyramidal tree with branches that tend to grow out to the same length at all levels of the tree, resulting in a broad crown. The most distinctive feature of the tree is the ashen-yellow color of the glabrous branchlets, not only on the new growth, but lasting for the next three or four years. The sterigmata are noticeably small to support the slender, dark green leaves, which point forward above the branchlets, laterally below, and show faint lines of stomata on all sides. The buds of *Picea wilsonii* are dark and shiny chestnut in color, producing a marked contrast with the pale branchlets. The nondistinctive cones are 4–6 cm long; the scales have rounded edges.

Because of the gray color of its shoots, *Picea wilsonii* is relatively easy to distinguish from other East Asian spruces. For that reason, in addition to its pleasing habit of growth, it should be more widely known and seen. It is as yet rare in cultivation.

The Arboretum's collection contains 17 trees, all accessioned between 1908 and 1912. The tallest is 15.3 meters.

COMMENT

Of the 28 species of *Picea* listed in the Table, there are seven that the Arboretum does not grow as established trees. Most have been tried unsuccessfully and are continuing to be tested as material comes in from different areas of the world. Named hybrids to be found on the grounds are: *Picea* × *hurstii* De Hurst (*P. engelmannii* × *P. pungens*), *Picea* × *mariorika* Boom (*P. mariana* × *omorika*), and *Picea* × *notha* Rehder (*P. glehnii* × *P. jezoensis* var. *hodoensis*), as well as several formula hybrids.

With rare exceptions this account has not dealt with the horticultural forms of the various species. Of the 283 of these listed in Den Ouden and Boom's *Manual of Cultivated Conifers*, our inventory includes 120, many of which are represented by several specimens. Forty-five (or more than one-third) of these are cultivars, varieties, or forms of *Picea abies*. The next most highly represented species is *P. pungens* with 23 subspecific taxa. Each is worth close attention and separate study.

Acknowledgments

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