Volume 48  Number 1  Winter 1988

Arnoldia (ISSN 0004-2633; USPS 866-100) is published quarterly, in winter, spring, summer, and fall, by the Arnold Arboretum of Harvard University.

Subscriptions are $12.00 per calendar year domestic, $15.00 per calendar year foreign, payable in advance. Single copies are $3.50. All remittances must be in U. S. dollars, by check drawn on a U. S. bank or by international money order. Address subscription orders, remittances, change-of-address notices, and all other subscription-related communications to: Helen G. Shea, Circulation Manager, Arnoldia, The Arnold Arboretum, Jamaica Plain, MA 02130–2795. Telephone (617) 524-1718.

Postmaster: Send address changes to: Arnoldia The Arnold Arboretum Jamaica Plain, MA 02130–2795.


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Arnoldia is printed by the Office of the University Publisher, Harvard University.

Page 2  A Guide to the Firs (Abies spp.) of the Arnold Arboretum
Richard Warren
Ethan W. Johnson

Front cover:—Abies concolor [Gordon] Engelmann, the white fir, photographed in the Arnold Arboretum by Herbert Wendell Gleason on August 12, 1930. Taken from a hand-colored glass lantern slide prepared by the J. Horace McFarland Company of Harrisburg, Pennsylvania. (See page 21.) Inside front cover:—Abies pinsapo Boissier, the Spanish fir, photographed by an unidentified person in the Serrania de Ronda, Spain. (See page 39.) This page:—Foliage [top] and habit of Abies veitchii Lindley, Veitch’s fir, the latter taken by Heman A. Howard. (See page 46.) Inside back cover:—Abies holophylla Maximowicz, the needle fir, photographed by Ernest H. Wilson in the forests near Choa-nji, Kongo-san, Kogen Province, Korea, on October 16, 1917. This tree was ninety feet (27.5 m) tall; its trunk had a girth of ten feet (3 m). (See page 30.) Back cover:—Abies lasiocarpa [Hooker] Nuttall, the subalpine fir, photographed in the Amethyst Lakes region of Jasper National Park, Canada, by Ethan W. Johnson. (See page 43.) All photographs except the last one are from the Archives of the Arnold Arboretum.
A Guide to the Firs (Abies spp.) of the Arnold Arboretum

Richard Warren
Ethan W. Johnson

Twenty-five of the thirty- to forty-odd species (and hybrid species) of the wide-ranging Northern Hemisphere genus Abies currently grow in the Arnold Arboretum

Abies is the scientific name of the firs, or, as is more common in Britain, of the silver firs. Botanists took many years to agree upon it (Warren, 1982). Virgil (70–19 B.C.) applied the word "abies" to the wood employed for the ribs of the Trojan horse (Virgil, circa 19 B.C.). This may have led to the modern naming of the genus; certainly it influenced the naming, in 1883, of a species from northwestern Anatolia—Abies equi-trojani Aschers & Sint.

The English word "fir" is of Scandinavian (Old Norse) origin and referred originally to pine, which in that part of the world is Scotch pine (Pinus sylvestris L.). Many English still refer to their pines as "firs." Their use of "silver fir" as the common name for members of the genus Abies is due to the whiteness of the undersides of the leaves in most species.

The aims of this guide are, first, to highlight the morphologic characters of the genus Abies so that it may readily be distinguished from related genera and, second, to accentuate the characters that clearly separate the species of Abies from each other.

The Genus Abies

The genus Abies, as do the genera Pinus, Picea, and Larix, grows widely in the North Temperate Zone around the world, reaching from the Arctic Circle (Abies sibirica) to the Tropical Zone, at 15 degrees North latitude (Abies guatemalensis) in Central America. In general, it is not as hardy in Arctic climates as are members of the genus Picea, but Picea does less well than Abies in southern climates like that of the Mediterranean area.

There are some thirty to forty species in the genus Abies, depending on the author. Liu (1971), for example, lists forty-one species, sixteen varieties, and six hybrids. Abies competes for third place with Picea as the genus of conifers in the Northern Hemisphere containing the greatest number of species [Pinus contains about one hundred species and Juniperus about sixty]. This guide is based on the species of Abies in the Arnold Arboretum—twenty-three species and two named hybrids, twenty-five in all (see the list on page 13).

Opposite: Drawings made by Charles Edward Faxon of various macroscopic and microscopic structures of the grand fir (Abies grandis Lindley). From Charles Sprague Sargent's The Silva of North America. (See page 29.)
Habit
Erect. Narrow. Pyramidal. With the notable exception of Abies nordmanniana, the branches do not droop. The leader is seen upright and rigid against the sky as in Picea (not nodding as in Tsuga).

Bark
Smooth at first but stippled with horizontal rows of resin blisters appearing like lenticels. With age the lower bark in most species becomes rough. Departures from these generalizations form the basis for the identification of certain species.

Buds
Ovate or round (less pointed than in Picea). Resinous or not resinous. It is to be noted that the resinosity or nonresinosity of the buds is useful in distinguishing species but is of no use after they have broken open in the growing season (May through July) until the new ones have formed. The resin may present to the eye either as semicrystallized white granules or as glairy, clear material. Both are sticky to the touch.

Branchlets
Surface generally even in contour but often fissured or undulate. Not roughened nor scaled. Hairy or not hairy according to species. When the leaves fall off the branchlet symmetrical, round leaf scars are left. These scars are different from those on the branches of Picea, which are at the tips of woody pegs, or projections from the branchlet surface called sterigmas. The leaf scars in Pseudotsuga (Douglas fir) are also rounded but are slightly raised from the branchlet surface.

Foliage
Leaves are in two ranks, each rank consisting of two or more rows in which the shorter leaves are above. They tend to be arranged in a pectinate fashion, with a "V" between the rows above and less of a V below. Prominent exceptions are Abies koreana, and Abies pinsapo, whose leaves, although more dense below, are arranged all around the branchlet. Also, the nearer the situation of the branchlet to the crown, the greater the tendency to suppression of the V.

Leaves
Flattened, linear. Above: few or no stomata [exceptions showing stomata above, such as Abies concolor, Abies lasiocarpa, Abies magnifica, Abies pinsapo, and Abies procera give a first clue to identity], a groove usually being present. Below there are two longitudinal bands made up of several rows each of stomata varying in color from white to gray-green. The bands are framed by three longitudinal, slightly raised, green ribs, the midrib, and the sideribs. The tip of the leaf is rounded or pointed or notched. The attachment of the leaves to the branchlet is by a rounded end of the pedicel, which looks like a suction cup.

Resin Canals
Resin canals are tubular channels in the leaf tissue lined with resin-secreting cells. Their position in the leaf relative to other structures seen in cross section is of use in distinguishing between species, as is true to some extent in all conifers. This is particularly so in the genus Abies, where the position is more constant and reliable than in other conifers.

Firs have two resin canals. They are seen with a lens as two holes in the cut surface of a transected leaf from which drops of resin emerge (see the figure, page 10). The two categories of position are marginal, wherein the canal edge touches the hypoderm, and median, when it does not.

Since the relative position of the canal within the leaf may vary between its base and its tip, make the section of the leaf near its middle. Use a very sharp instrument, such as a razor blade, and wipe away the emerging resin droplet, which may be so large as to obscure the position of the canal. A hand lens and a good light are needed. A dissecting microscope is a useful "luxury."
Cones
The barrel-shaped, upright megasporangiate cones of Abies occur, as they do in most conifers, in the uppermost branches of the tree. The young cones of most species are purple, but the color changes to brown later in the year. A few conspicuous exceptions have cones that are green when young—Abies nephrolepis forma chlorocarpa, Abies homolepis var. umbellata [Abies Xumbellata], and Abies veitchii var. olivacea, for example. Ovuliferous (seed-bearing) scales of Abies cones are woody, each bearing two winged seeds on its adaxial surface. They mature in one growing season and disintegrate on the tree. The scales detach in the fall, and the seeds are dispersed by the wind. The central spikelike element of the cone denuded of scales remains erect on the branchlet for up to a year or more.

The bracts of Abies cones are in certain species longer than the cone scales. The tips are then visible, and they are described as "exserted." This is a helpful lead toward identity. All species of the genus Abies are monoecious. Pollination is by wind.

Similar Genera and Distinguishing Characters
Genera of evergreen trees that might be confused with are Picea spp. (the spruces), Tsuga spp. (the hemlocks), Pseudotsuga spp. (the Douglas firs), and Taxus spp. (the yews). The salient differences among them are tabulated on page 12.

The first important step is examination of the branchlet for the character of the leaf scars. The next is the leaves themselves. The bud and the cone, when available, are extremely, if not definitively, important, but they are not as dependably available as the leaves. Study of the bark and habit should come next. Having accomplished examination of these, then reexamination of the specimen in more detail (hairiness and color of branchlet, resin canals in leaves) is advisable. This order of examination can obviously be changed if one is in the presence of the tree itself from the outset. The habit and the bark will then naturally be examined first.

The following seventeen species, in addition to those listed on page 13, which grow in the Arnold Arboretum, are recorded as belonging to the genus Abies. Some have in the past been tried in the Arnold Arboretum and failed and therefore have not been included in this report. We make note of them here for completeness in overviewing the genus but have appended no descriptions. We will refer to them occasionally.

- Abies bracteata [D. Don] D. Don ex Poiteau
- Abies chensiensis Van Tieghem
- Abies ernestii [Rehder] Liu
- Abies delavayi Franchet
- Abies durangensis Martinez
- Abies guatemalensis Rehder
- Abies hickeli Flous & Gaussen
- Abies kawakamii [Hayata] Ito
- Abies mariesii M. T. Masters
- Abies mexicana Martinez
- Abies nebrodensis [Lojacono-Pojero] Mattei
- Abies numidica De Lannoy ex Carrière
- Abies pardei Gaussen*
- Abies pindrow [Lambert] Royle
- Abies religiosa [von Humboldt, Bonpland & Kunth] Schlechtendal & Chamisso
- Abies squamata M. T. Masters
- Abies vejari Martinez

Having determined that an unknown is a member of the genus Abies one must establish which, if any, of the above species best fits the characters observed. Since keys are often difficult to follow, we have chosen to present the material in tabular form (pages 6 and 11). Smoothness of bark, resinosity of buds, ridges or grooves on the branchlet surface, hairiness of branchlet, stomata situated on the upper surface of the leaves in addition to the underside, whiteness of stomata, position of resin canals, and degree of exsertion of scale bracts of the cones are considered the most significant characters.

*A plant designated "A. pardei" does grow in the Arnold Arboretum, but an irregular taxonomic feature (glabrous branchlets) casts doubt on its identity and prompts us to omit it from the list.
Tabulations According to Important Characters

**Bark**
Young bark is relatively smooth (i.e., is not scaly or ridged). "Smoothness" does not rule out a "pikskin," pebbly character, and the old bark roughened with flat or elevated plates or ridges. The following are exceptions:

<table>
<thead>
<tr>
<th>Old bark smooth</th>
<th>New bark rough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies sachalinensis</td>
<td>Abies holophylla</td>
</tr>
<tr>
<td>Abies veitchii</td>
<td>Abies homolepis</td>
</tr>
</tbody>
</table>

**Bud**
Most buds in firs, as in spruces and pines, are resinous. The following five exceptions are useful only when the buds are unbroken:

<table>
<thead>
<tr>
<th>Abies alba</th>
<th>Abies cephalonica (occasionally resinous)</th>
<th>Abies cilicica (occasionally resinous)</th>
<th>Abies holophylla (occasionally resinous)</th>
<th>Abies nordmanniana</th>
</tr>
</thead>
</table>

**Ridges or grooves on surface of branchlet**
Branchlets conspicuously ridged and grooved (gentle undulations and shallow fissures not included):

<table>
<thead>
<tr>
<th>Abies firma</th>
<th>Abies holophylla</th>
<th>Abies nephrolepis</th>
<th>Abies pinsapo</th>
<th>Abies sachalinensis</th>
</tr>
</thead>
</table>

**Hairiness of branchlet**
Hairiness of branchlets is best looked for on the previous year's growth. A hand lens is helpful. A thorough examination is necessary to derive a concept of the trend. Scattered hairs are occasionally found in the grooves of those listed as not hairy.

<table>
<thead>
<tr>
<th>Conspicuously hairy</th>
<th>Slightly hairy</th>
<th>Not hairy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies alba</td>
<td>Abies amabilis</td>
<td>Abies borisii-regis/regular</td>
</tr>
<tr>
<td>Abies balsamea</td>
<td>Abies firma</td>
<td>Abies cephalonica</td>
</tr>
<tr>
<td>Abies xborisii-regis</td>
<td>Abies nephrolepis</td>
<td>Abies concolor</td>
</tr>
<tr>
<td>Abies concolor</td>
<td>Abies koreana</td>
<td>Abies procera</td>
</tr>
<tr>
<td>Abies fraseri</td>
<td>Abies xbornmuelleriana</td>
<td>Abies concolor</td>
</tr>
<tr>
<td>Abies grandis</td>
<td>Abies cephalonica</td>
<td>Abies procera</td>
</tr>
<tr>
<td>Abies lasiocarpa</td>
<td>Abies holophylla</td>
<td>Abies procera</td>
</tr>
<tr>
<td>Abies magnifica</td>
<td>Abies homolepis</td>
<td>Abies procera</td>
</tr>
<tr>
<td>Abies nordmanniana</td>
<td>Abies pinsapo</td>
<td>Abies procera</td>
</tr>
<tr>
<td>Abies sachalinensis</td>
<td>Abies recurvata</td>
<td>Abies procera</td>
</tr>
<tr>
<td>Abies sibirica</td>
<td>Abies veitchii</td>
<td>Abies procera</td>
</tr>
</tbody>
</table>

**General**

<table>
<thead>
<tr>
<th>Abies concolor</th>
<th>Abies magnifica</th>
<th>Abies pinsapo</th>
<th>Abies procera</th>
</tr>
</thead>
</table>

**Partial**

<table>
<thead>
<tr>
<th>Abies amabilis</th>
<th>Abies xborisii-regis (occasionally)</th>
<th>Abies xbornmuelleriana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies cephalonica</td>
<td>Abies concolor</td>
<td>Abies sibirica</td>
</tr>
<tr>
<td>Abies fraseri</td>
<td>Abies lasiocarpa</td>
<td>Abies veitchii</td>
</tr>
</tbody>
</table>

The fourteen other species show no stomata on the upper surface.

**Stomata on underside of leaves gray or green (not white)**

<table>
<thead>
<tr>
<th>Abies xborisii-regis</th>
<th>Abies cilicica</th>
<th>Abies concolor</th>
</tr>
</thead>
<tbody>
<tr>
<td>gray-green</td>
<td>gray-green</td>
<td>glaucous</td>
</tr>
<tr>
<td>Abies firma</td>
<td>Abies holophylla</td>
<td>Abies pinsapo</td>
</tr>
<tr>
<td>gray-green</td>
<td>Abies lasiocarpa</td>
<td>Abies recurvata</td>
</tr>
<tr>
<td>gray</td>
<td>gray</td>
<td>green</td>
</tr>
</tbody>
</table>

The seventeen other species show white stomata on the lower surface.

*(continued on page 11)*
View toward the south in the Arnold Arboretum's Pinetum (left). Abies concolor is in the foreground, Abies homolepis in the background. The small plant is Abies concolor 'Candicans', which was damaged by vandals. A fine, 25-meter-tall, 60-year-old specimen of Abies concolor (right). All photographs on pages 7 through 10 were taken by Ethan W. Johnson.

Leaf attachments of coniferae. Abies concolor: leaf bases resembling suction cups (a); Abies veitchii: leaf scars circular (b); Picea koyamae: pegs, or sterigmata (c); Pseudotsuga menziesii: leaf scars slightly raised, oval (d); Taxus cuspidata: oblique, easily peeling attachments (e); Tsuga caroliniana: petioles tiny, leaf scars raised (f).
Bark. Abies balsamea: resin blisters numerous on otherwise smooth bark (left); Abies holophylla: bark flaking off in papery strips (right).

Grooving of branchlets. Abies homolepis: Branchlets grooved (left); Abies concolor: branchlets not grooved (right).
Hairiness of branchlets. Abies alba: hairs on branchlets visible to the naked eye (left); Abies concolor: hair on branchlets short, best observed with the aid of a magnifying glass (right).

Leaf attitudes and contours. Abies firma: leaves on lower (immature) branches with bifid tips (a); Abies procera: leaf bases curved in hockey-stick fashion (b); Abies recurvata: leaves pointing back, away from terminal (c); Abies pinsapo 'Clauca': leaves short, stiff, and stout (d); Abies lasiocarpa: leaves long, slender, and supple (e); Abies grandis: leaves spreading nearly at right angles to the branchlet (f); and Abies koreana: leaves that reach out on all sides of branchlet, no "V" (g).
Leaf markings and resin canals. Abies cephalonica: dorsal stomata often present in groove at tip of leaves (a); Abies lasiocarpa: dorsal stomata usually above middle of leaves (b); Abies concolor: resin canals marginal (c); Abies holophylla: resin canals median (d).

Cones. Abies koreana: bract scales exserted (left); Abies concolor: bract cones hidden in cones (right). A silvery resin is dripping from the cone.
(continued from page 6)

**Position of resin canals**
Species accompanied by an asterisk (*) appear in both columns.

**Marginal**
- Abies alba
- Abies amabilis
- *Abies ×borisii-regis
- Abies ×bornmuelleriana
- Abies cephalonica
  - (occasionally submarginal)
- *Abies cilicica
- Abies concolor
- Abies grandis
- Abies nordmanniana
- Abies procera
- Abies recurvata

**Median**
- Abies balsamea
- *Abies ×borisii-regis
  - (occasionally on fruiting branches)
- *Abies cilicica
  - (occasionally on fruiting branches)
- Abies fargesii
- Abies firma
  - (occasionally more than two resin canals)
- Abies fraseri
- Abies holophylla
- Abies homolepis
- Abies koreana
  - (occasionally submarginal)
- Abies lasiocarpa
- Abies magnifica
- Abies nephrolepis
- Abies pinsapo
- Abies sachalinensis
- Abies sibirica
- Abies veitchii
  - (occasionally submarginal)

**Cones**
In *Abies*, cones are harder to obtain than are those of other conifers. The most conspicuous characteristic in differentiation of species is the exsertion of the bract scales, or their lack of exsertion. Other features, such as cone-scale shape, color, and size, and shape of cone, are less important.

**Cone bracts**

**Markedly exserted**
- Abies alba
- Abies ×borisii-regis
- Abies ×bornmuelleriana
- Abies cephalonica
- Abies fargesii
- Abies firma
- Abies fraseri
- Abies procera
- Abies veitchii
  - (occasionally slightly)

**Slightly exserted**
- Abies nephrolepis
- Abies nordmanniana
- Abies sachalinensis
  - (often hidden)
- Abies koreana

**Hidden**
- Abies amabilis
- Abies balsamea
- Abies cilicica
- Abies concolor
- Abies grandis
- Abies holophylla
- Abies homolepis
- Abies lasiocarpa
- Abies magnifica
- Abies pinsapo
- Abies recurvata
- Abies sibirica
### Genera of Coniferae with Pectinate, Linear Leaves

<table>
<thead>
<tr>
<th>Character</th>
<th>Abies</th>
<th>Picea</th>
<th>Pseudotsuga</th>
<th>Taxus</th>
<th>Tsuga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branchlet</td>
<td>Circular, flush leaf scars</td>
<td>Leaf scars on woody sterrigmæ</td>
<td>Leaf scars circular, very slightly raised, like Tsuga</td>
<td>Leaf scars on small, prickle-like pegs</td>
<td></td>
</tr>
<tr>
<td>Bud</td>
<td>Round or ovoid, usually resinous</td>
<td>More pointed than Abies, resinous in all species</td>
<td>Conspicuously long and pointed, as in Fagus</td>
<td>Very small</td>
<td>Very small</td>
</tr>
<tr>
<td>Bark</td>
<td>In youth gray, smooth but for resin blisters, in age, rough</td>
<td>Dark gray, rough, in large or small thin plates</td>
<td>Brown–gray, often like Picea with thicker plates; older trees have ridges with deep fissures</td>
<td>Pink–brown, shredding in thin, flat plates of varying length</td>
<td>Brown to dark green, long, 2–5 cm wide, broken plates, appressed, longitudinal, not shredding</td>
</tr>
<tr>
<td>Leaves (cross section)</td>
<td>More flattened (two-sided) than rhomboid (four-sided)</td>
<td>More rhomboid than flattened</td>
<td>Flattened</td>
<td>Flattened</td>
<td>Flattened</td>
</tr>
<tr>
<td>Leaves (stomata)</td>
<td>Stomata on lower surface only in most species</td>
<td>Stomata on four sides in most species</td>
<td>Stomata on lower surface only</td>
<td>Stomata (green) on lower surface only</td>
<td>Stomata on lower surface only</td>
</tr>
<tr>
<td>Cone</td>
<td>Upright; scales deciduous; bracts exserted in some species; monœcious</td>
<td>Pendent, deciduous, monœcious</td>
<td>Pendent, deciduous, trident bracts exserted; monœcious</td>
<td>Single seed almost covered by an aril; dioecious</td>
<td>Pendent, deciduous, monœcious</td>
</tr>
</tbody>
</table>
# The Firs of the Arnold Arboretum

<table>
<thead>
<tr>
<th>Abies alba Miller</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies amabilis (Douglas) J. Forbes</td>
<td>17</td>
</tr>
<tr>
<td>Abies balsamea (Linnæus) Miller</td>
<td>18</td>
</tr>
<tr>
<td>Abies ×borisii-regis Mattfeld</td>
<td>19</td>
</tr>
<tr>
<td>Abies ×bornmuelleriana Mattfeld</td>
<td>20</td>
</tr>
<tr>
<td>Abies cephalonica Loudon</td>
<td>21</td>
</tr>
<tr>
<td>Abies cilicica (Antoine &amp; Kotschy) Carrière</td>
<td>22</td>
</tr>
<tr>
<td>Abies concolor (Gordon) Engelmann</td>
<td>23</td>
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<td>Abies fargesii Franchet</td>
<td>25</td>
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<tr>
<td>Abies firma Siebold &amp; Zuccarini</td>
<td>26</td>
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<tr>
<td>Abies fraseri (Pursh) Poiré</td>
<td>28</td>
</tr>
<tr>
<td>Abies grandis Lindley</td>
<td>29</td>
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<tr>
<td>Abies holophylla Maximowicz</td>
<td>30</td>
</tr>
<tr>
<td>Abies homolepis Siebold &amp; Zuccarini</td>
<td>31</td>
</tr>
<tr>
<td>Abies koreana E. H. Wilson</td>
<td>33</td>
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<td>Abies lasiocarpa (Hooker) Nuttall</td>
<td>34</td>
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<td>Abies magnifica A. Murray</td>
<td>36</td>
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<td>Abies nephrolepis Maximowicz</td>
<td>37</td>
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<td>Abies nordmanniana (Steven) Spach</td>
<td>38</td>
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<td>Abies pinsapo Boissier</td>
<td>39</td>
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<tr>
<td>Abies procera Rehder</td>
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<td>Abies recurvata M. T. Masters</td>
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<td>Abies sachalinensis M. T. Masters</td>
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<td>48</td>
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</tbody>
</table>
In describing the genus Abies and those of its species that grow in the Arnold Arboretum, we list characters in the same sequence. Though we do not provide a key, we do provide summary tabulations that group by character the species that possess it (see pages 6, 11, and 12).

Examine an unidentified specimen in the sequence suggested—that is, its habit first, then its bark, branchlet including bud, foliage, leaf, and, finally, cone. There may be some disagreement on definitions of the above terms because they overlap. Some categories, such as “branchlet,” “foliage,” and “leaf,” have been arbitrarily defined. “Branchlet” as used here includes both the new shoot and the adjacent growth of recent years. Except in late summer and fall, the previous year’s growth usually is the most useful for determining color, hairiness, and texture of the surface. We deal with leaf scars under “Branchlet” rather than under “Leaves,” while the arrangement of leaves on the branchlets we treat under “Foliage.” Leaf color we usually discuss under “Leaves,” unless there was some particular advantage in describing the color imparted to the whole leaf, as in the blue Spanish fir, Abies pinsapo forma glauca, in which case we refer to it under “Foliage.”

The descriptions are based on our personal inspection of living material, most of it from the Arnold Arboretum. References from the literature reinforce our observation. When we refer to trees growing in the Arnold Arboretum they are older, established plants. We include infraspecific taxa and cultivars if they grow at normal rates; slow-growing taxa and dwarfs we refer to only if they are the sole representatives of the species in the Arnold Arboretum or if they possess some special feature that is worthy of note.

Dimensions
The dimensions of the species are based on cultivated trees unless we specifically state that we are dealing with a native habitat. Conifers in cultivation in the United States today usually are no more than one hundred fifty years old and thus do not indicate the size they eventually will achieve in their natural habitats.

Foliage
The foliage available for examination usually is taken from the tree at a level between 1.5 and 3 meters from the ground. Foliage on the upper, better-lit, “fruiting” branches differs from that lower down on the tree. At the high levels the branchlets and leaves are thicker and stiffer, and the leaves, in addition, are shorter, more upswept, pointed, and curved with resin canals that become, in plants where they are typically marginal, more median.

Cone
Be prepared to do without a cone for examination. With few exceptions the cones of Abies are borne in the crown of the tree and disintegrate there when mature. So climbing or using some other method of reaching the upper part of the tree is necessary unless one is fortunate enough to find a cone-bearing top branch knocked off by a strong wind or a heavy load of snow. The only other conifer genus whose cones behave in the same way is Cedrus, but in Cedrus some cones grow lower down the tree and therefore are more accessible from the ground.
Variations within Taxa

In pursuing the identification of plants by morphologic characters one is dealing with unstable factors and must not expect a single individual in a taxonomic category to be exactly like another. George Russell Shaw, in his monograph *The Genus Pinus* (1914), quoted Schimper:

> There are species... and this is equally important for the systematist and the physiologist,... which so completely react to the changing requirements of moisture that extreme forms can appear to belong to dissimilar species.

In the following treatment it has been necessary to seem positive about the presence or absence of certain characters, knowing that a small proportion of the specimens do not conform. The character of hairiness versus hairlessness of the branchlet, for instance, may depend on whether a high magnification is used. The branchlets of *Abies concolor* generally appear glabrous to the naked eye or through a hand lens, but the dissecting microscope will show short hairs. The foliage of *Abies ×bornmuelleriana* is listed as pectinate on the upper surfaces of the branchlets, but one of our trees does not show this. The undersides of the leaves of *Abies nephrolepis* are recorded as having no midrib, but one of our plants does show a thin one.

The great importance of looking at all the characters in a given plant and being prepared to choose which ones are determining cannot be overemphasized. A certain amount of familiarity with the species is necessary in achieving an authoritative opinion. The tabulations are guides only, not infallible descriptions. But this is true also of keys.

A Note on the Symbols and Terms Used

The most important characteristics for distinguishing a species from similar ones are signalled by the device "~" and are set in *boldface italic type*. In many cases the degree to which a character expresses itself is rated as "0," "+," "1+," "2+," "3+," or "4+.

The hardiness zones used to indicate the cold hardiness of species are those of the Arnold Arboretum, not those of the United States Department of Agriculture.
Abies alba grows widely in Europe, mostly in mountain areas, from 38° North latitude to 52° North latitude between 30° and 27° East longitude. In Britain, where, it is cultivated very widely and has been for centuries, it is almost regarded as native. It is the most common on the continent of Europe.

Abies alba is hardy in Zones IV–VII in the eastern United States and in the Arnold Arboretum, which grows 9 specimens. All but 3 are less than 20 years old. One of the 3 oldest plants is a magnificent tree of approximately 25 m in height; its trunk is 66 cm in diameter. The record is not available, but it is known to have been growing there for at least 60 years. The next oldest is 50 years old and 16 m tall.

No infraspecific relatives of Abies alba grow in the Arnold Arboretum.

**Habit**
Reaching 50 m in height
Pyramidal when young

**Bark**
Gray, smooth, except in old trees, on which it is rough and fissured

**Bud**
Very small
Round to conical
*Not resinous*

**Branchlet**
Light tan to dark brown
2+ hairy, scattered
Surface regular to slightly undulating
Flexibility 2+

**Foliage**

<table>
<thead>
<tr>
<th>Above</th>
<th>Below</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves pointing forward</td>
<td>Pectinate, with a wide V</td>
</tr>
<tr>
<td>90°–60° from branchlet</td>
<td>Pectinate, pointing 80° from branchlet</td>
</tr>
</tbody>
</table>

**Leaves**
2 cm x 2 mm
Flattened, linear
Sides parallel
Tips round or slightly notched
Not curved
Margins entire
Flexibility 2+

**Above**
Shiny green
No stomata (occasional exceptions)
Shallow groove
No midrib

**Below**
Stomata white
Margins not revolute
Not keeled
Resin canals marginal

**Cones**
11 x 4 cm
Cylindrical
1+ tapered both ends
Green–purple, turning brown
Bracts exserted

**Similar Species**
- *Abies nordmanniana*: leaves above point forward, eliminating the V and concealing the branchlet surface
- *Abies balsamea*: upper surfaces of leaves less glossy; resin canals median; buds resinous; resin blisters on bark
- *Abies amabilis*: leaves arranged like those of *Abies nordmanniana* but more curved and often with scattered stomata on their upper surfaces
- *Abies veitchii*: leaves 4+ flexible with strikingly blue–white, chalky bands beneath
**Abies amabilis** (Douglas) J. Forbes: RED FIR

*Abies amabilis* grows from southern Alaska to the Oregon–California border at medium elevations. It is very common on the Olympic Peninsula in Washington. One of its common names is “lovely fir,” a translation of the Latin *amabilis*. It lives up to the epithet, its spirelike crown distinguishing it from the slightly rounded tops of other firs of the same stature, such as *Abies procera*. *Abies amabilis* is hardy in Zones V–VII.

The Arnold Arboretum contains only one mature specimen of *Abies amabilis*, the slow-growing cultivar ‘Spreading Star’, an attractive dwarf accessioned in 1971 and now 40 cm tall.

### Habit
- Pyramidal, graceful, spirelike
- Growing to 80 m in its native habitat

### Bark
- White-gray
- Smooth, except at base, which on old trees is very rough

### Bud
- Small
- 4+ resinous

### Branchlet
- Gray-brown
- Dense, with short hairs
- Surface undulating

### Foliage
- **Above**
  - Leaves pointing forward
  - 40°–60° from branchlet

- **A rank of appressed, forward-growing leaves occupying center and covering branchlet**

- **V wide**
  - **Below**
  - Pectinate, leaves pointing forward 70°–80° from branchlet

- **Leaves**
  - Up to 3 cm x 2 mm
  - Flattened, linear
  - Sides parallel
  - Tip truncated, occasionally notched
  - Curved slightly (1+) in flat and lateral dimensions
  - Margins entire
  - Flexibility 3+

- **Above**
  - Shiny green
  - Occasional patches of stomata at tip or rarely scattered sparsely in lines
  - Crooked shallowly
  - **Below**
  - Stomata 3+–4+, white
  - Margins not revolute
  - Not keeled
  - Resin canals marginal

### Cones
- 10–15 x 5–6 cm
- Barrel-shaped
- Purple, becoming brown
- Bracts (with rare exceptions) hidden

### Distinguishing Characters
- Crushed foliage reputed to smell of tangerines
- A specimen of *Abies* with leaves like those of *Abies veitchii* but longer and more curved, and arranged like those of *Abies nordmanniana*, but appressed in the center of the V, and having few stomata above and marginal resin canals likely to be *Abies amabilis*

### Similar Species
- **Abies nordmanniana**: leaves flexible, point forward covering the branchlet, but with median resin canals and no white patches of stomata near tips on upper surface; cones with exserted bracts
- **Abies veitchii**: leaves with similar very white lines of stomata below, flexible, and pointing forward above the branchlet, but with median resin canals
Abies balsamea is native to the northern United States and Canada, from Newfoundland to Alberta. It is fragrant with a balsam odor and is used for pulp and Christmas trees in the northeastern United States. The name "balsam fir" is applied to other firs in various localities: to Abies fraseri in the Appalachians, Abies lasiocarpa in the Southwest, and Abies concolor in the Sierra Nevada of California. All members of the genus Abies, in fact, possess varying amounts of resin (or balsam).

A cold-climate tree, Abies balsamea does not do well in the Boston area. It is hardy to Zone II, but Zone V is often too mild; some trees native to the warmer coastal parts of New England do well in Zone V, however. One of the best specimens in southern New England, a tree transplanted from southern Maine as a seedling, is approximately 12 m tall; it grows next to a small pond in northeastern Connecticut (Storrs).

The Arboretum grows two specimens of Abies balsamea; accessioned about thirty years ago, they are 11 m and 12 m tall, respectively.

Its only infraspecific taxa in the Arnold Arboretum's collections are slow-growing forms.

**Habit**
- Growing slowly, reaching no more than 20 m in 50 years
- Symmetrical, conical; crown spirelike, lasting into mature years
- In maturity, not distinguished as an ornamental

**Bark**
- Gray-green
- Smooth except for prominent resin blisters
- Rougher in old age

**Buds**
- Small, less than 6 mm
- 4+ resinous

**Branchlet**
- 2+ undulating ridges covered with fine hairs

**Foliage**
- Above
  - Leaves pointing forward
  - 80°-45° from branchlet
- Pectinate, with a wide V
- Below
  - Pectinate, leaves pointing 45°-90° forward

**Leaves**
- 1.5-2 cm x 1.5-2 mm
- Flattened in cross section
- Sides parallel
- Tip entire, occasionally with a tiny notch
- Not curved
- Margins entire
- Flexibility 2+

**Above**
- Dark green, not conspicuously shiny
- No stomata
- Grooved
- No midrib

**Below**
- 2 white bands of stomata, 8 or fewer rows to each band
- Margins not revolute
- Midrib 1+ prominent
- Not keeled
- Resin canals median

**Cones**
- 5-8 cm long
- Cylindrical
- Green-purple, turning brown
- Bract tips usually hidden

**Similar Species**
- *Abies alba*: buds non resinous; leaves shiny; resin canals marginal
- *Abies amabilis*: leaves shiny above, 3 cm long, flexible
- *Abies fraseri*: shoots densely hairy; 8-12 rows of stomata in each band on undersurfaces of leaves; tips of cone bracts exserted
- *Abies nordmanniana*: leaves project forward, covering the shoot; buds non resinous; resin canals marginal
- *Abies veitchii*: leaves 4+ flexible; conspicuously chalky white stomata on undersurface of leaves
Abies × borisii-regis Mattfeld: BULGARIAN FIR

A hybrid of Abies cephalonica and Abies alba, Abies × borisii-regis, the Bulgarian (or King Boris) fir, grows in Bulgaria and Greece. It was described in the early 1920s and named for King Boris of Bulgaria, who was monarch at the time the plant was identified as a separate species. A previous name was Abies alba var. acutifolia, a useful point to remember because one of its outstanding characteristics is its pointed leaves. The hybridization may have taken place when Abies alba migrated southward in Europe as the cooling for the Ice Age began.

Abies × borisii-regis is hardy in Zones V–VII. In the Arnold Arboretum 3 magnificent 60-year-old specimens grow. Acquired as seeds from trees growing wild in Greece, they are 16 to 20 m tall and 60 cm in diameter.

No infraspecific relatives of Abies × borisii-regis grow in the Arnold Arboretum.

Habit
A handsome, densely branched, dark tree with glossy foliage and a broadly conic crown

Bark
Very dark gray
Smooth, high on old trees

Bud
Pink-brown, ovoid-conical
4 mm
Resinous

Branchlet
Light brown
3+ hairy
Surface 1+ grooved
Flexibility 2+

Foliage
Above
Pectinate
V very wide
Leaves pointing forward 60° from branchlet
Below
Pectinate
Leaves pointing 80°-90° from branchlet

Leaves
3–3.5 cm x 2.5 mm
Flattened, linear, tapering at tip
Sides parallel
Tip long, pointed
Curved 2+ in flat dimension
Margins entire
Flexibility 3+

Above
Very shiny deep green, no stomata except occasionally scarce at tip
Grooved prominently
No midrib

Below
Stomata gray–green
Margins subrevolute
Not keeled
Resin canals marginal but reported to be median on fruiting branchlets

Cones
8–12 x 3–4.5 cm
Cylindrical, gradually tapering from base to broad rounded tip
Bracts markedly exserted

Similar Species
• The long, pointed leaves suggest Abies holophylla, but in that plant the branchlets are not hairy, the resin canals in the leaves are in the median position, and the bud is only slightly resinous. The cone of Abies holophylla, furthermore, does not expose its bracts. The leaves of Abies holophylla are lighter green.

A striking feature of the specimens in the Arnold Arboretum is the glossiness of the upper surface of their leaves. This is often matched by one of its parents, Abies alba, which plant differs, however, in having nonresinous buds and shorter, less pointed leaves.
Abies ×bornmuelleriana Mattfeld: TURKISH FIR

Named for Joseph Bornmüller (1862–1948), a German botanical explorer in Asia Minor, Abies ×bornmuelleriana is native to the north shore of Asia Minor, on the Black Sea. A hybrid between Abies cephalonica and Abies nordmanniana, it was described in 1925. Abies ×bornmuelleriana is hardy in Zone V. The Arnold Arboretum has 2 specimens, the older of which is 27 years old and 6 m tall.

**Habit**
- Broad
- Rounded conical

**Bark**
- Gray, smooth, but pebbled like pigskin
- Old bark rough

**Bud**
- Resinous 2+

**Branchlet**
- Glabrous
- Undulating
- Greenish tan

**Foliage**
- *Above*
  - Not pectinate (occasional exceptions)
  - Incomplete V
  - Leaves pointing forward 30° from branchlet
- *Below*
  - Pectinate

**Leaves**
- 2.5–3 cm x 2 mm
- Linear
- Sides bitapered
- Tip a rounded, entire point, occasionally emarginate
- Curved 2+ in the flat plane
- Margins entire
- Flexibility 1+

**Above**
- Shiny green
- Stomata scarce in groove at tip
- Shallow groove
- No midrib

**Below**
- Stomata whitish gray
- Margins not revolute
- Keeled by midrib
- Resin canals marginal

**Cones**
- 12–15 x 4 cm
- Cylindric turret-shaped
- Bracts exserted

**Distinguishing Characters**
- *Abies ×bornmuelleriana*: evenly placed between its two parents, sharing some qualities of each [both have marginal resin canals and exserted cone bracts, although in Abies nordmanniana they are less conspicuous than in Abies cephalonica], but Abies ×bornmuelleriana has the glabrous branchlets and resinous buds of Abies cephalonica (not seen in Abies nordmanniana)

**Similar Species**
- *Abies nordmanniana*: leaves point forward above the branchlet but buds nonresinous
- *Abies cephalonica*: stomata on the upper surface but leaves more pointed and never emarginate
Abies cephalonica is native to Greece and other parts of the southern Balkans, where it grows in mountainous areas. Widely planted elsewhere in Europe, it is hardy from Zone V to the milder parts of Zone VII. Three mature specimens grow in the Arnold Arboretum. They are 103, 88, and 33 years old and measure 23 m, 22 m, and 13 m in height and 70-75 cm in diameter.

Abies cephalonica var. græca differs from the type in having shorter, stiffer leaves crowded on the upper surface of the shoot. Its previous name was Abies cephalonica var. apollinis. The Arnold Arboretum grows 2 specimens, 1 accessioned in 1900 and 13 m tall, the other accessioned in 1943 and 9 m tall.

Habit
Conical with a dome-shaped crown
Transverse branches, long and strong
Bark green

Bark
Gray-brown, occasionally with a touch of pink
Younger parts of the tree with beech-gray bark, smooth but for pigskin stippling
Older parts fissured into 2 x 3-cm plates

Bud
Round, with domed tip
Resinous 1+-2+
Bud-scale tips slightly reflexed

Branchlet
Light brown
Shallow fluted grooves
Glabrous
Flexibility 1+

Foliage
Above
Leaves pointing 70°–90° from branchlet
Leaves going around shoot to some extent, leaving the upper side without a V
Below
Incompletely pectinate, but leaves less dense below than above, pointing 60° from the branchlet

Leaves
2-3 cm x 2 mm
Flattened, linear with 2+ keel
Sides parallel but tapered at both ends
Tips pointed, entire on most specimens but occasionally rounded and notched
Curved 2+ in flat plane
Margins entire
Flexibility 1+-2+

Above
Shiny dark green, with a patch of stomata at the tip
Groove present
No midrib
Below
Stomata in two white rows
Margins not revolute
Midrib prominent, making a keel
Resin canals marginal or submarginal, very small

Cones
10-23 x 5 cm
Cylindrical
Tip sharply tapered, but with a point
Bracts exserted

Distinguishing Characters
• Leaves dark green, stiff-pointed, often with small patches of white stomata at the tip of upper surface; bud scarcely resinous

Similar Species
• Abies pinsapo: leaves stiff, pointed, but unlike those of Abies cephalonica dramatically stiff, distributed all around the shoot with no semblance of a V above or below, and with rows of stomata beside the midrib and below
• Abies × borisii-regis: branchlets hairy; leaves shinier and shorter
• Abies × bornmuelleriana: shingled arrangement of leaves on the upper surface like Abies nordmanniana
Abies cilicica (Antoine & Kotschy) Carrière: CILICIAN FIR

Abies cilicica grows in Turkey, Syria, and Lebanon. (Cilicia is on the southern coast of Asia Minor directly west of Syria.) It has to some extent the same distribution as Cedrus libani. Hardy in Zone V, it is not common in cultivation, but the Hunnewell Pinetum in Wellesley, Massachusetts, has three specimens. One of them (of unknown age) is a patriarch 18 m in height and with a trunk 100 cm in diameter. Two 50-year-old specimens grow in the Arnold Arboretum’s Pinetum area; they are 9.5 m and 14 m tall.

Abies cilicica and Abies nordmanniana are closely allied. Their geographic ranges touch southern Turkey (Abies cilicica) and northern Turkey (Abies nordmanniana). Abies cilicica has been termed “a weak nordmanniana.”

No infraspecific relatives of Abies cilicica grow in the Arnold Arboretum.

Habit
Narrow columnar, with spirelike crown

Bark
Beech gray, with stippling arranged circumferentially
Fissured on old trees and scaly low down

Bud
Ovoid, with conical tip
Chestnut brown
Scale tips free
Nonresinous

Branchlets
Light brown to yellow
Grooved longitudinally in very shallow, wide grooves
Hairy 2+
Flexibility 2+

Foliage
Above
Incomplete V
Leaves curved forward at 30°-60°, loosely covering shoot
Below
Incompletely pectinate, pointing 45° forward

On all sides leaves standing apart from each other, “trying” to point all around the branchlet

Leaves
3.0+ cm x 2 mm
Flattened, linear
Sides parallel all the way except at base and tip
Tip rounded, with a tiny notch
Curved 2+ in flat plane
Margins entire

Flexibility 3+

Above
Pea-green to dark green, shiny
Scattered stomata in dorsal groove at the very tip in most plants
Grooved
No midrib
Below
Stomata gray-green
Margins not revolute
Midrib prominent 2+
Keeled 3+
Resin canals marginal (on cone-bearing branchlets the resin canals are reported to be median)

Cones
14 x 4 cm
Cylindrical, with noticeable taper toward tip, which is rounded
Peduncle very short
Bracts hidden

Similar Species
• Abies nordmanniana: buds nonresinous, resin canals marginal, leaves on upper side of shoot cover it without a V, but much more densely arranged, cone bracts exserted (not hidden as in Abies cilicica); stomata on the lower surface of leaves far whiter than those of Abies cilicica
Abies concolor's native range is a scattered one. On the Pacific coast it is principally in California, in the Sierra Nevada and the coastal range extending into Mexico. It also is found in the southern Rocky Mountain states: Utah, Colorado, Arizona, and New Mexico. The epithet "concolor" refers to the fact that both surfaces of the leaf show the same blue-gray color.

Abies concolor is hardy in Zone IV–VII, and it flourishes in the Arnold Arboretum. Along with Abies homolepis, it was one of the favorite conifers of Charles Sprague Sargent when he was Director. Of the total of 19 normally fast-growing specimens of Abies concolor (13 Abies concolor, 3 Abies concolor 'Violacea' [bright-blue foliage], 2 Abies concolor 'Conica', and 1 Abies concolor 'Candicans' [very light pale-blue foliage]), the Arboretum grows 10 that date from the nineteenth Century, most of them over 20 m tall, with sturdy trunks of 50–70 cm in diameter at breast height.

In the Arnold Arboretum Abies concolor seem to have been particularly vulnerable to hurricanes. The records show that of 64 specimens introduced since 1874, 41 are no longer with us; of those, 21 were uprooted in the hurricanes of 1938, 1954, and 1985.

Habit
Conico-columnar, rounded, different trees favoring one or the other of these contours, not entirely depending on whether they grow crowded or in the open
Crown rounded
Old trees massive, growing to 60 m in their native habitat
Handsome; one of the best for cultivation

Bark
Smooth whitish gray, with resin blisters, in young trees or on new branches of old trees
Rough and fissured into 5 x 12-cm plates on the lower boles of old trees
Can be of corky texture, somewhat resembling Pseudolarix amabilis

Bud
Broad
Conico-globular
7 mm long
Resinous 2+
Scale tips appressed

Branchlet
Yellow-green or olive-green
Glabrous or scarcely hairy
Surface regular, no grooves

Foliage
Above
Leaves pointing forward
30°–40° from branchlet
Gray-green
No V

Below
Wide V
Pointing 80° from branchlet
Spreading, curving upward
\[ \text{Leaves above and below widely spaced} \]

Leaves
\[ 5–6 \, \text{cm} \times 2 \, \text{mm} \]
Linear, flattened in cross-section
Sides parallel
Tips rounded, no notch
Curving 3+ towards upper side
Margins entire
Flexibility 3+

Above
Light glaucous green
\[ \text{Stomata so numerous, though small, as to give a homogeneous glaucous color} \]
\[ \text{No midrib, but a suggestion of a shallow groove} \]

Below
Stomata as above but with a 1+ midrib
Felt as a keel
Resin canals marginal

Cones
5 x 12 cm, but many sizes
Purple when young, brown later
Columnar, but with gradually curving sides and a taper
Ends rounded
Bracts concealed
Distinguishing Characters
• The widely spaced, glaucous leaves with their characteristic curve are distinctive

Similar Species
• *Abies grandis*: leaves as long as those of *Abies concolor*, resin canals also marginal, and buds also resinous, but with no stomata on the upper surfaces of its leaves and the leaves not curved (*Abies concolor* var. *iowiana* tends to resemble *Abies grandis* in these features)
This slow-growing fir comes from China, where it grows at elevations of between 2,000 m and 3,900 m in the provinces of Hupeh, Szechuan, Sikiang, Shensi, and Kansu. It was discovered by the French missionary Père Paul Guillaume Farges, probably about 1892, and introduced by Wilson and planted in 1911. It is hardy in the Arnold Arboretum (Zone V), where there are 2 specimens. The taller is 10 m in height. Abies fargesii is rare in collections in the United States, but there is 1 specimen of it in the Hunnewell Pinetum in Wellesley, Massachusetts.

No infraspecific relatives of Abies fargesii are recorded.

**Habit**
Subconical
Branches upturning, short; reaching 35 m in its native habitat
Thick
Crowns of old trees flattened

**Bark**
Rough and scaly, even in youth

**Buds**
Columnar
Resinous
6 mm
Reddish

**Branchlet**
*Homogeneous reddish brown*
Glabrous
Undulat grooves and ridges

**Foliage**
*Above*
Dark, shiny green
V present
Leaves pointing at right angles (80°–90°) from branchlet, those on the upper side becoming dramatically shorter (to 1 cm) towards the end of branchlet
*Below*
Pointing 60°–90° from branchlet

**Leaves**
1.5–2.5 cm x 2.5 mm
Flattened, linear
Sides bitapered (taper greater at base, almost club-shaped)
Tip short, rounded with notch
Not curved
Margins entire
Flexibility 2+

*Above*
Dark, shiny green
No stomata
Shallow groove
No midrib
*Below*
Stomata gray-white
Margins nearly revolute
Not keeled
Resin canals median

**Cones**
Peduncle short
5–8 cm x 3–4 cm
Bracts markedly exserted and reflexed

**Similar Species**
- In mid-southern China, Abies fargesii has several neighbors with overlapping habitats: Abies chensiensis (plus its varieties smithii, fabri, and georgii), and Abies fargesii's own varieties faxoniana and sutchuensis. These all have bright red-brown branchlets, except for Abies chensiensis and Abies recurvata, on which they are yellow. Because of the rarity of these in cultivation in New England, they are merely listed, not discussed, here. Other than these, Abies fargesii has no competitors for identification.
**Abies firma** Siebold & Zuccarini: MOMI FIR

The range of *Abies firma* is the southern half of the Japanese archipelago. It is widespread there, growing at elevations of 50–1,600 m, between 30° and 39° North latitude. It thus also contains the habitat of *Abies homolepis*, which is discontinuous within it but at a higher elevation, and which it resembles somewhat.

*Abies firma* reaches 50 m in height in its native range and has been called the most beautiful of the Japanese firs, but, as Charles Sprague Sargent pointed out, although it is very hardy in Massachusetts, environmental stress prevents it from assuming the beautiful proportions it demonstrates in Japan. The epithet "firma" means stout. Sargent wrote of trees in Japan with trunk diameters of 4–6 feet (1.2–1.8 m). It is hardy in Zone VI in cultivation in the United States. The Arnold Arboretum has 1 mature specimen that is 50 years old and 18 m tall.

No infraspecific relatives of *Abies firma* have been reported.

**Habit**
- Reaching 20 m in cultivation when mature
- Wide, with horizontal branches
- Pyramidal crown becomes broad and often irregular in old age
- Has been called the most beautiful of the Japanese firs (Bean, 1976; Liu, 1971)

**Branchlet**
- Brown–green to yellow–green
- Surface with shallow fissures as in *Abies homolepis*, but far less conspicuous
- Hairs in the fissures, not on the ridges
- Flexibility 1+

**Foliage**
- **Above**
  - Pectinate, with a wide V
  - Leaves pointing forward to a 75° angle with the branchlet
- **Below**
  - Pectinate, angle with branchlet 60°–80°

**Leaves**
- 2–3 cm x 2–3 mm
- Flattened, linear
- Sides bitapered
- **Tip on young trees bifid, forming a notch with two sharp points on either side of it**
- Curved 1+–2+ toward lower side and 1+ laterally
- Margins entire
- Flexibility 1+

**Bark**
- As in other species of the genus, young trees and recent growth on old trees having gray bark that is smooth but of a pebbly, pigskinlike texture
- Old bark on old trees rough, with peeling scales rather than thick plates

**Bud**
- Round, with a slightly conical tip
- 5 x 4 mm
- Milk-chocolate brown, scarcely resinous
- Bud scales appressed

**Above**
- Shiny green
- No stomata
- Shallow groove

**Below**
- Stomata gray–green

**Margins revolute**
- Not keeled

**Cones**
- 10–12 x 4.5 cm
- Cylindrical but tapered from base to outer end, which is rounded
- Peduncle short
- Green, turning brown
- Bracts markedly exserted
Distinguishing Characters

• The characteristic notch at the outer end of the leaf set between two spiny tips is diagnostic, even if the tree is an older one and may show this on a very limited number of leaves. If an example does not come forward and no leaf tip is notched, one must look for the very flattened, broad, bitapered leaves with revolute margins, nonwhite stomata below, and scarcely resinous buds.

Similar Species

• *Abies homolepis*: fissures in the branchlets more distinct; leaf stomata whiter below
• *Abies recurvata*: leaves mostly recurved and leaf stomata green below; buds very resinous; resin canals marginal
• *Abies chensiensis* [not discussed here]: can have sharp-pointed, notched leaves, but resin canals marginal and cone bracts hidden
**Abies fraseri** (Pursh) Poir: FRASER FIR

*Abies fraseri* has been called the more southerly version of *Abies balsamea*. Its range is the southern Appalachian Mountains, the mountainous areas of Virginia, North Carolina, and Tennessee. Although listed as hardy to Zone IV and being a mountain tree, it has not done well in the Arnold Arboretum. At present our 2 specimens, which were acquired as seedlings from the National Arboretum, are 13 years old.

No infraspecific relatives of *Abies fraseri* grow in the Arnold Arboretum.

<table>
<thead>
<tr>
<th>Habit</th>
<th>Branchlet</th>
<th>Above</th>
</tr>
</thead>
<tbody>
<tr>
<td>A small tree, reaching no higher than 25 m</td>
<td>Yellow–gray to red–brown</td>
<td>Green, more matte than shiny</td>
</tr>
<tr>
<td>Conical in shape when young</td>
<td>Hairs short, stiff, red, in confluent patches</td>
<td>Stomata often in a patch in the tip of the groove</td>
</tr>
<tr>
<td>Like <em>Abies balsamea</em>, favored for Christmas trees</td>
<td>Surface undulating</td>
<td>Groove shallow</td>
</tr>
<tr>
<td>Branches tending to ascend from the trunk at an angle of 45°</td>
<td>Flexibility 2+</td>
<td>No midrib</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bark</th>
<th>Foliage</th>
<th><strong>Stomata in two ranks of 8–12 rows each, whiter than in Abies balsamea</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark gray, with resin blisters</td>
<td>Above Medium-wide V, often violated by aberrant leaves</td>
<td>Resin canals median</td>
</tr>
<tr>
<td>Becoming rough and fissured on old trees</td>
<td>Leaves pointing forward 60°–80° from branchlet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Below Pectinate</td>
<td>Bracts markedly exserted</td>
</tr>
<tr>
<td></td>
<td>Leaves pointing forward 45° from branchlet</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bud</td>
<td>Leaves</td>
<td>Cones</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>Small [2 x 3 mm]</td>
<td>2 cm x 1 mm</td>
<td>4–6 x 2.5–3.5 cm</td>
</tr>
<tr>
<td>Reddish brown</td>
<td>Flattened, linear</td>
<td>Cylindrical, but tapered on both ends</td>
</tr>
<tr>
<td>Scales seen as prominent through the invariable coat of resin</td>
<td>Sides parallel</td>
<td>Green, turning brown</td>
</tr>
<tr>
<td></td>
<td>Tip rounded, with tiny notch</td>
<td>Sessile</td>
</tr>
<tr>
<td></td>
<td>Not curved</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Margins entire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flexibility 2+</td>
<td></td>
</tr>
</tbody>
</table>

**Similar Species**
- *Abies balsamea*: also has resin blisters on bark of young trees

**Distinguishing Characters**
- Has more rows of stomata on the under surface of the leaves and thus shows a whiter underside than does *Abies balsamea*
- Cones, if present, with bracts exserted
Abies grandis is hardy in Zone IV and very commonly cultivated in Britain but rare in New England. The Arnold Arboretum has two specimens, one 86, the other 97 years of age, that were planted on Hemlock Hill, where there was good protection by the mature hemlocks at that time. They have grown successfully to heights of 21 m and 22 m and to diameters of 90 cm and 92 cm, but now are hidden away from their neighbors. They are well worth a visit because of their unique pectinate foliage.

No infraspecific relatives of Abies grandis grow in the Arnold Arboretum.

Habit
True to its name, the tallest of the true firs, growing to 100 m in its native habitat
Popular in cultivation in climates where it is truly hardy, growing rapidly (up to 1 m a year)
Branches pendulous at their bases, turning up at the end so that the tree in its prime is narrow columnar and the crown spirelike

Bark
Young bark (less than 50 years old) gray with a pebbled surface
Old bark thickened, in broad, deep grooves with prominent plates in between

Bud
Round, resinous
Very small (<5 mm)
Scale tips divergent

Branchlet
Olive green to bright red–brown
Faint hairs
Shallow longitudinal grooves
Flexibility 3+

Foliage
Above
Leaves widely pectinate at 70°–80° angle from branchlet
Below
As in “Above”

Leaves
2–5 cm x 2 mm
Flattened, linear; proximal ends sharply twisted
Sides parallel
Tip rounded and notched
Margins entire
Flexibility 3+

Above
Shiny, dark green
No stomata
Prominent groove
No midrib
Below
Stomata gray–white
Margins subrevolute
Not keeled
Resin canals marginal

Cones
7–10 × 3–3.5 cm
Submarine shaped
 Rounded at both ends
Green, turning brown
Bracts concealed

Similar Species
• Abies concolor var. lowiana: stomata on upper surface of leaves

Distinguishing Characters
• The long, parallel-sided, pectinately arranged, separately spaced leaves making the branchlets flattened sprays, to an extent not seen in any other fir (except Abies concolor var. lowiana)
Abies holophylla Maximowicz: NEEDLE FIR

Introduced by Ernest H. Wilson in 1905, Abies holophylla comes from northeastern China and Korea, where it has a limited distribution along the border. It is hardy in Zones V and VI and may prove successful in colder and warmer areas as well.

The Arnold Arboretum grows 6 plants, but none of the original Wilson introductions survive. The oldest are 2 specimens received as plants from the Ames private collection in North Easton, Massachusetts, in 1923. They are, respectively, 20 m and 18 m tall and have boles 67 cm and 30 cm thick. The bark consists of slightly raised, thin, 2.0–2.5-cm-square plates.

No infraspecific relatives of Abies holophylla are recorded.

Habit
Reaches 40–50 m in its native habitat
Branches short and ascending, crown broad and pyramidal
A graceful, tall tree

Branchlet
Prominently ridged and sharply fissured longitudinally; both ridges and fissures shallow and broad, unlike those of Abies homolepis, which are narrow
Glabrous
Milk-chocolate brown

Leaves
Length: 2.5–3.5 cm
Width: 2 mm
Flattened, linear
Sides parallel
Tip long drawn-out point, no notch
0–1+ curved in flat plane
Margins entire
Flexibility 2+
Above
Matte green
No stomata
Groove very shallow
No midrib
Below
Margins not revolute
No keeled
Resin canals median

Cone
8 x 10 cm
Cylindrical, with rounded ends
Peduncle short
Bracts concealed

Distinguishing Character
• Youngest bark scaly on trees of any age
Similar Species
• Abies borisii-regis: leaves often pointed, but darker green; branchlets hairier
• Firs with conspicuously pointed leaves (excluding Abies bracteata, which is extremely rare and has the widest [3 mm] and longest [up to 6 cm] leaves of the firs): leaves orderly, glossy green above and white below
• Firs with leaves that stand apart from each other (e.g., Abies concolor, Abies grandis, and Abies ciliata): tips of leaves not pointed
Abies homolepis grows in the southern half of Japan, between 33° and 37° North latitude at elevations of between 700 m and 2,200 m. Its range, which is discontinuous, overlaps that of Abies firma, which is more densely distributed. "Homolepis" means "similar scales." It formerly was called Abies brachyphylla ("short leaves"), in contrast to many other firs. It is hardy to Zone V. Charles Sprague Sargent, writing 70 years ago, remarked on how well Abies homolepis and Abies concolor flourished here in their early years. They have continued to do so.

The Arnold Arboretum's holdings of Abies homolepis and its infraspecific relatives are 18 trees, several about 100 years old. (The total number of plants of this group of Abies homolepis growing in the Arnold Arboretum is: Abies homolepis, 9; Abies ×umbellata, 8; Abies homolepis forma tomomi, 1; or, 18 in all. Seven were acquired before 1900 and others soon thereafter [2 in 1902 and 4 in 1908].) As with Abies concolor, the tallest are 20–25 m tall, and their boles are up to 100 cm in diameter. They are important features of the Arboretum’s Pinetum, having fulfilled Sargent's predictions. It is of interest, however, that of all 34 specimens of Abies homolepis and its relatives planted starting in 1880 none of the 16 that are no longer with us were uprooted in hurricanes. For contrast with Abies concolor in this respect, see page 23.

Abies ×umbellata
Abies ×umbellata is a relative of Abies homolepis, recognized by Ernest Wilson under the name Abies homolepis var. umbellata. It differs in that its cone tips are umbilicated to more than those of the species. Most recent opinion considers it to be a hybrid between Abies homolepis and Abies firma, and its name has been changed to Abies ×umbellata.

Abies homolepis forma tomomi
Abies homolepis forma tomomi has slightly shorter leaves and is less densely branched than the species.

**Habit**
A broad-growing tree with long branches and a dome-shaped crown, conspicuously broad in old age

**Bark**
Rough and scaly over the resin blisters, unlike most other firs, even on young trees
Scales small and thin at first, in old trees coarse, with 3 x 10-cm scales

**Buds**
Rounded, with a conical point 6 mm
Resinous 2+
Scales appressed but prominent

**Branchlet**
Yellow—brown
Glabrous

**Leaves**
2.5 cm x 2 mm
Flattened, linear
Sides parallel to 1+ bitapered
Tip rounded, sometimes entire
but usually a small notch
Curved 0–1+
Above
Dark green, not conspicuously shiny
No stomata
Groove medium
No midrib
Below
Stomata gray—white
Margins not revolute
Midrib 1+
Not keeled
Resin canals median
Cones
8 x 3 cm
Purple when young, brown when mature
Evenly bitapered (submarine-shaped)
Sessile
Bracts hidden

**Distinguishing Characters**
- The sturdy, yellow, glabrous branchlets with the tight, deep fissures are nearly unique
**Similar Species**
- *Abies holophylla*: branchlets prominently ridged but not with narrow fissures; leaves long and pointed
- *Abies firma*: tips of young leaves bifid; Even without that, leaves broad, very flat, bitapered; furrows of branchlets not narrow and deep
The range of *Abies koreana* is southern Korea and the volcanic island of Cheju Do (Quelpart) up to elevations of 2,000 m. The type specimen is in the herbarium of the Arnold Arboretum in Cambridge, Massachusetts. It is hardy from Zone V to Zone VII.

The Arnold Arboretum grows six specimens of *Abies koreana*, one of them an original specimen from the group introduced to the West by Ernest Wilson in 1917. It is 18 m tall and has a trunk 70 cm in diameter.

The prostrate forms, usually called *Abies koreana* ‘Prostrate Beauty’, follow the tendency of the types to set cones when young. They are popular in dwarf-conifer collections. Six specimens are growing in the Arnold Arboretum’s collections of dwarf conifers, where there are also two plants of *Abies koreana* ‘Aurea’.

### Similar Species
- *Abies sachalinensis* and *Abies veitchii*: leaves longer but conspicuously more flexible than those of *Abies koreana*
- *Abies sachalinensis*: stomata on undersides of leaves dull white; bark smooth until an advanced age
- *Abies veitchii*: undersides of leaves very white but bark smooth and bract scales of the cones hidden or their tips barely visible
- *Abies nephrolepis*: leaves also longer than those of *Abies koreana*, linear (not bitapered), with dull-white stomata below; bark smooth; more hairs on branchlet; cone scales kidney-shaped
Abies lasiocarpa (Hooker) Nuttall: SUBALPINE FIR

With the exception of Abies balsamea, Abies lasiocarpa is the most widely distributed species of Abies in the United States. Hardy in Zones V–VI, it grows from southern Alaska to the Mexican border in the Rocky Mountains (35°–63° North latitude), often in association with Picea engelmannii. In addition, it occurs in the mountains of Washington and Oregon.

"Lasiocarpa" (meaning "hairy fruit") refers to the hirsuteness of the cones. "Subalpine," an adjective commonly applied to this species, is appropriate, since Abies lasiocarpa is a mountain tree.

Alfred Rehder stated that Abies lasiocarpa "does not do well in the eastern states." It is hardy in the Arnold Arboretum, which contains three mature trees in addition to the variety arizonica. The growth of the three has been slow to average. Acquired in 1942, 1958, and 1966, they are 11, 3, and 2.5 m tall, respectively.

Abies lasiocarpa var. arizonica
Abies lasiocarpa var. arizonica (Merriam) Lemmon is a common variety, more popular as an ornamental than the species. It is distinguished from the species by its more intensely whitish blue leaves, which have emarginate tips, and by its corky bark (hence its common English name, cork-bark fir). There is one handsome specimen in the Arnold Arboretum. Dating from 1932, it is now 20 m tall; its trunk is 40 cm in diameter.

In the Arboretum's dwarf-conifer collection there are three specimens of Abies lasiocarpa 'Compacta'.

Habit
Narrow, spirelike, with short, upcurved, dense branches
Can grow to 40 m but winds at timberline in its native habitat discourage such statures

Bark
Smooth, gray, slightly roughened when young, with resin blisters
Bark of older trees rougher, fissured
Bark on some plants with rusty tinge

Bud
5–6 mm
Ovate
Resinous
Scales obscured by the resin

Branchlet
Silvery tan, almost fawn-colored on some plants
Grooved shallowly
No fissures
Hairy 1+–scattered, in grooves

Foliage
Above
Gray
Incomplete V or no V
Leaves pointing forward at 45° from branchlet
Below
Incompletely pectinate, leaves pointing forward 30°–40° from branchlet

Leaves
2.5 cm x <2 mm
Flattened, linear
Sides parallel
Tip round, with tiny notch
Curved 1+ toward upper surface
Margins entire
Flexibility 2+

Above
ursal green–gray
Distal half with two bands of several rows of tiny stomata
Shallow groove
No midrib
Below
Two bands of light-gray stomata
Margins not revolute
Midrib prominent
Resin canals median

Cones
8–10 x 3.5 cm
Cylindrical to submarine-shaped
Bracts hidden
Purple when young
Distinguishing Characters
• One of the few members of the genus with full lines of stomata on the upper surface of leaves, the others being Abies concolor, Abies magnifica, Abies pinsapo, and Abies procera

Similar Species
• Abies concolor: leaves much longer and more widely spaced spaced, resin canals marginal
• Abies magnifica: leaves quadrangular in cross section and running parallel to the shoot before spreading from it
• Abies pinsapo: leaves 4+ stiff, at right angles to the branchlet, very pointed
• Abies procera: leaves like those of Abies magnifica but not quadrangular in cross section
Abies magnifica A. Murray: RED FIR

*Abies magnifica* grows in northern California and southern Oregon, its range being more southerly and at slightly higher elevations (35° 40'–45° 3' North latitude and 1,400–2,700 m) than that of *Abies procera* (41°–48° 30' North latitude and 900–2,000 m), which in some ways it resembles, particularly in the presence of stomata on the upper surface of its leaves and the arrangement of the leaves at their origins from the branchlets. It is reputed to be hardy in the warmer parts of Zone V but less frost hardy than *Abies procera*. The name “red fir” derives from the color of the bark. The translation of the Latin name to “magnificent fir” is more appropriate and is sometimes used.

The Arnold Arboretum grows only 1 specimen—*Abies magnifica* ‘Nana’—which is 50 cm tall and not thriving, but no specimens of the species. We list it here chiefly for comparison with *Abies procera*, which also appears in the Arboretum only in its dwarf form. The Hunnewell Pinetum in Wellesley, Massachusetts, does possess a specimen 17 years old and 1.5 m tall. It is healthy but not fast-growing.

*Abies magnifica var. shastensis*

Even though the Arnold Arboretum does not possess a specimen of it, we list *Abies magnifica var. shastensis* Lemmon here because it is well known as a natural variety. It is distinguished from the type because the bract scales on its cones are exserted. This suggests that it is a hybrid between *Abies magnifica* and *Abies procera*.

---

**Habit**

A columnar tree with a spirelike head, one of the most elegant known

Can grow to 70 m in the wild (trees cultivated in Britain for over 100 years have reached about half that height)

Trunks of mature trees often branchless for half their heights

**Bark**

Smooth (but for resin blisters in youth) and very light gray

Becoming deeply furrowed in age, revealing reddish inner bark

**Buds**

Ovoid, acute at tip

Brown

Small, 4 mm

Hard to see because terminal leaves crowd about them

Resinous on the upper aspect

**Branchlets**

Red-brown

Shallowly grooved longitudinally

Hairy

**Foliage**

*Above*

Gray–green

*Stomata present in two full bands*

*No groove*

Small midrib

*Below*

Stomata in two gray–white ranks

Keel present

Resin canals marginal

**Cones**

15–25 x 10–12 cm

Sessile or nearly so

Purple at first, brown when mature

Nearly cylindrical, thick

Bract scales hidden

**Leaves**

2–3 cm x 2 mm

Flattened, linear

Sides parallel

Tips rounded, without notch

Not curved but angled as described

Margins entire

Flexibility 1+
**Abies nephrolepis Maximowicz: KHINGHAN FIR**

The native range of *Abies nephrolepis* is North Korea. Some have called it the eastern-Asiatic form of *Abies sibirica*. The specific epithet "nephrolepis" refers to its cone scales, which, when looked at individually, are kidney-shaped; this characteristic is not different enough to distinguish it from other members of the genus. Alfred Rehder and Ernest Wilson considered that its name should be *Abies sibirica* var. *nephrolepis*.

The Arnold Arboretum has 3 specimens, all of them over 60 years of age. One, *forma chlorocarpa* Wilson (cones green when young), was introduced by Wilson in 1917 and is now a beautiful tree 20 m in height. No other infraspecific forms are known.

<table>
<thead>
<tr>
<th>Habit</th>
<th>Foliage</th>
<th>Above</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columnar, broad,</td>
<td>Above</td>
<td>Dull green</td>
</tr>
<tr>
<td>conical, short</td>
<td>V, pointing forward 60° from branchlet</td>
<td>No stomata</td>
</tr>
<tr>
<td>branches</td>
<td><em>Below</em></td>
<td>Groove present</td>
</tr>
<tr>
<td>Crown conical,</td>
<td>Pectinate, pointing forward 60° from</td>
<td>No midrib</td>
</tr>
<tr>
<td>becoming</td>
<td>branchlet</td>
<td>Below</td>
</tr>
<tr>
<td>irregular</td>
<td></td>
<td>Stomata dull</td>
</tr>
<tr>
<td></td>
<td></td>
<td>white</td>
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<tr>
<td></td>
<td></td>
<td>Margins not</td>
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<td></td>
<td></td>
<td>revolute</td>
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<tr>
<td></td>
<td></td>
<td>Not keeled,</td>
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<tr>
<td></td>
<td></td>
<td>midrib thin</td>
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<tr>
<td></td>
<td></td>
<td>Resin canals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>median</td>
</tr>
<tr>
<td>Bark</td>
<td></td>
<td></td>
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<tr>
<td>Beech gray, pebbly</td>
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<tr>
<td>Becomes shalllowly</td>
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<td></td>
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<tr>
<td>fissured on old</td>
<td></td>
<td></td>
</tr>
<tr>
<td>trees</td>
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<td></td>
</tr>
<tr>
<td>Foliage Above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branchlet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conical, blunt</td>
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<td></td>
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<tr>
<td>Light reddish</td>
<td></td>
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<tr>
<td>brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resinous</td>
<td></td>
<td></td>
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<tr>
<td>Scales prominent</td>
<td></td>
<td></td>
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<tr>
<td>in relief</td>
<td></td>
<td></td>
</tr>
<tr>
<td>under the resin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branchlet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow-gray</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shallowly ribbed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>or grooved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hairy 2+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 cm x 2 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flattened, linear</td>
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<td></td>
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<tr>
<td>Sides parallel</td>
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<tr>
<td>Tip rounded, with</td>
<td></td>
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<tr>
<td>notch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not curved</td>
<td></td>
<td></td>
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<tr>
<td>Margins entire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexibility 3+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Similar Species**

- *Abies sachalinensis* and *Abies sibirica* [see the table on page 45]
The range of *Abies nordmanniana* lies just east of the eastern shore of the Black Sea. Introduced to the West (Britain) in 1836, it is a strong, beautiful addition to collections in the British Isles. Named after Alexander Nordmann (1803–66), a Finnish botanist and one of its discoverers, *Abies nordmanniana* is hardy in Zones V–VII.

The Arnold Arboretum acquired two mature, narrow and tall specimens from a nursery in Holland in 1903. Twenty-six meters tall and with boles 55 and 64 cm in diameter, they are among the most impressive specimens in the Arboretum’s Pinetum.

The only infraspecific relative in the Arnold Arboretum is *Abies nordmanniana* ‘Pendula’, which grows at the same rate as the species but differs from it by the exaggerated pendulosity of its branches. Although 30 years old, it has lost its crown and is only 2 m tall.

**Habit**
Growing to 60 m in the Caucasus Mountains
Conical, with a narrow, spirelike crown
Main branches horizontal, lower branches sweeping downwards
Living up to its reputation of having an impressive, lordly aspect
Starting to grow late in spring (a characteristic useful in cultivation), which makes it insensitive to late frosts

**Bark**
Smooth above to rough below
Grayish when smooth; brownish when rough

**Bud**
Red-brown, conical-ovate, not resinous

**Branchlet**
Olive, with a brownish tinge
Surface shallowly grooved (fissured) longitudinally
No undulations or ridges
Covered with moderately dense, short, stiff hairs

**Foliage**
Above
Leaves on most shoots shingled, i.e., no V, but all pointing forward at an angle of 35°–45° from the shoot and covering it
Below
Leaves pointing forward at a 60° angle
Imperfectly pectinate, making a wide, irregular V

**Leaves**
2–3 cm x 2.5 mm
Linear, curving 2+ in the flat plane
Midrib 2+, thickened in a keel, as are the side ribs
Sides parallel
Tip rounded, notched
Curving 2+ in the flat plane
Margins entire
Flexibility 1+
Above
Glossy 1+
No stomata
Groove prominent
Midrib prominent
Below
Stomata white-gray
Margins not revolute
Keel on midrib
Resin canals marginal

**Cones**
5 x 14 cm
Cylindrical, tip pointed
Bracts just exserted

**Similar Species**
- *Abies alba*: leaves also shiny, with notched tips, nonresinous buds, and hairy branchlets, but arranged in a pectinate V above the branchlet
- *Abies amabilis*: leaves above likewise cover the branchlet but are flexible 3+ and occasionally have some stomata on the tip of the upper surface
**Abies pinsapo** Boissier: SPANISH FIR

The native range of *Abies pinsapo* is a localized one near Ronda in southern Spain, where it was discovered and described and whence it was introduced to cultivation early in the Eighteenth Century by Pierre Boissier (1810-85). Because its short, stiff, sharp leaves emerge at right angles, it has been called by some the “hedgehog fir.” It is not uncommon in cultivation and is hardy from Zone VI into parts of Zone VIII.

**Infraspecific Relatives**
The most common horticultural variety is ‘Glauca’, one specimen of which is in the holdings of the Arnold Arboretum. It was accessioned 44 years ago and is a sturdy plant 7.5 m tall.

**Habit**
Relatively short branches set in pseudowhorls, making for a columnar, or narrow, pyramidal tree
Growing up to 30 m

**Bark**
Remaining remarkably smooth on the lower trunks of certain trees, but rough in most

**Bud**
Small (3 mm)
Resinous
Scale tips visible in relief under the resin

**Branchlet**
Glabrous
Surface rusty red
Conspicuously grooved and fissured

**Foliage**
* Short leaves radiating around branchlet
  Above
  Leaves at right angle (90°) to branchlet
  Below
  Leaves at right angle (90°) to branchlet
  No V on either side but leaves less dense on underside
  Some leaves occasionally recurved

  Leaves
  1-1.5 cm x 2 mm
  Flattened, linear
  Sides parallel, bordering on bitapered
  Tip an obtuse horny point; not notched
  Curving 1+ toward underside
 Margins entire
  Flexibility 0

**Above**
Matte green
Covered with tiny white stomata in two bands on either side of slightly elevated midrib

**Below**
Two bands of gray stomata
Midrib definite but not conspicuous
Not keeled
Resin canals median

**Cones**
10–12 x 3–4 cm
Subcylindrical, submarine-shaped
Sessile
Bracts hidden

**Distinguishing Characters**
- Leaves short, stiff, at right angles to branchlet

**Similar Species**
- Looks superficially like a spruce, particularly the tiger-tail spruce (*Picea polita*), which has similarly stiff leaves
- The roughness of the branchlet surfaces at the points where the leaves are attached resembles that seen in *Picea polita*
- If no stigmas at the leaf attachments and if specimen belongs to the genus *Abies*, the only confusion would be with a hybrid of *Abies pinsapo* and *Abies nordmanniana*
(Abies ×insignis), Abies cephalonica (Abies ×vilmorinii), or Abies numidica (Abies ×marocana); though uncommon, these hybrids of Abies pinsapo must be suspected in specimens with stiff, short, prickly leaves that are not entirely characteristic of the species, Abies pinsapo, itself.
Abies procera Rehder: NOBLE FIR

One of the tallest trees of the West Coast ("procera" means tall, or slender), the noble fir grows on the western slope of the Cascade Mountains, from Washington to upper northern California. Its range is continuous with that of Abies magnifica, which, although it overlaps with that of Abies procera, is primarily south of the California–Oregon border. As noted under Abies magnifica, these two species can be regarded as "nonidentical twins." They share many characteristics.

Abies procera was described by David Douglas in 1825 and introduced into Great Britain, where it has always flourished. Although none of the original introductions are still living, some survived until 1968. Specimens planted as long ago as 1840 were registered as still living in the early 1970s (Bean, 1976, Volume 1, page 65). The only examples of the species in the Arnold Arboretum are dwarfs, the well known beautiful cultivars 'Glauca' and 'Glauca Prostrata', on which the characteristics of the typical foliage can be studied.

In the United States Abies procera is just hardy to Zone V but not common. The Hunnewell Pinetum in Wellesley, Massachusetts, grows one specimen (under its earlier name, Abies nobilis). It is 4.5 m high, and the bole is 5 cm in diameter at breast height.

Habit
Reaching 80 m in its native habitat
Bole straight; can remain unbranched for over 40 m
Branches relatively short, making for a narrow crown that is, however, rounded at its top

Bark
Smooth, reddish gray for many years, eventually becoming rough with soft plates

Bud
Very small, about 3 mm (hard to see among the terminal forward-growing leaves)
Resinous
Scale tips divergent

Branchlet
Reddish brown
Hairy 1+
Surface regular
Suggestion of longitudinal grooves

Foliage
Above
Incomplete V; most leaves in a wide V, but many singles arising in center of it, all pointing 70°–90° from the branchlet
Below
Pectinate with occasional strays; pointing forward 60°–80° from the branchlet

Leaves both above and below characteristically running forward parallel to the branchlet for 2 mm before departing at the angle mentioned (seen more easily from the lower aspect of the branchlet), similar in this feature to Abies magnifica

Leaves
2–3 cm x 2 mm
Linear, flattened
Tip rounded, notched or not notched
Curved 1–2+ toward lower surface
Margins entire
Flexibility 1–2+

Above
Matte green

Stomata in bands on both sides of shallow groove (in some cases a lens is needed to observe this)

No midrib, but upper surface can be slightly convex and surmounted by the groove, which can change to a midrib near the tip

Below
Stomata small, numerous, white
Margins not revolute
Midrib prominent
Resin canals marginal

Cones
10–15 x 6–7 cm
Subcylindrical (submarine- or blimplike)
Green when young, turning brown
Bracts strongly exserted and reflexed
Similar Species

- *Abies concolor*: stomata in full bands on the upper surfaces of leaves but leaves long, flexible, widely spaced

- *Abies lasiocarpa*: stomata in full bands on the upper surfaces of leaves but leaves extend from the branchlet directly, with no appressing of the initial few millimeters; resin canals median; cone bract scales hidden

- *Abies magnifica*: stomata in full bands on the upper surfaces of leaves (resembles *Abies procera* more than any other species), but leaves have no groove on their upper surface and cones have hidden bracts [Note: Cone bracts of *Abies magnifica* var. *shastensis* exserted; if none available, one must rely on leaf characteristics]

- *Abies pinsapo*: stomata in full bands on the upper surfaces of leaves but leaves rigid 4+, with no groove on upper side; tips horny; at right angles to branchlets

- See also *Abies lasiocarpa*
**Abies recurvata M. T. Masters: MIN FIR**

The English name of *Abies recurvata* derives from the Min River in central China (Szechuan), where the tree grows between 25° and 45° North latitude. Hardy in Zone V, it is uncommon in cultivation.

Three plants grow in the Arnold Arboretum, all from the original introduction by Wilson in 1911. It has been a slow grower; the tallest of the Arboretum’s trees is 9 m tall. The Hunnewell Pinetum in Wellesley, Massachusetts, grows one plant.

*Abies recurvata* is not recorded as having cultivars or infraspecific forms.

### Habit
Reaches 40 m in its native habitat
Pyramidal, the crown becoming flattened with age

### Bark
Gray or red-brown
Smooth in youth, later becoming rough with 2- to 3-cm-long flaking plates

### Bud
5–7 mm or larger
Light grayish brown with a rosetate tinge
Covered with gray resin through which the outlines of the prominent bud scales can be seen in relief

### Branchlet
Silvery yellow–gray
Glabrous
Flexibility 1+
Surface undulate with shallow, wide grooves and ridges

### Foliage
**Above**
Stiff, sturdy leaves point backwards, often to 60° from branchlet

**Many leaves nearly at a right angle, occasionally slightly forward**

**Below**
Same as "Above"

### Leaves
2–3 cm x 3 mm
Flattened, linear
Sides bitapered
Tip pointed
Flexibility 1–2+

### Distinguishing Characters
- Leaves recurved and green beneath, making it difficult to confuse *Abies recurvata* with any other species of *Abies*
Abies sachalinensis (formerly called Abies veitchii var. sachalinensis) is restricted to the Kurile and Sachalin Islands and to Hokkaido, the northern island of Japan. Its relationship to certain neighboring firs—Abies sibirica and Abies nephrolepis—has been noted. It is hardy from Zones II–VI. The Arnold Arboretum grows seven specimens, two of them at the Case Estates in Weston, Massachusetts. Two of those growing at the Arnold Arboretum itself (in Jamaica Plain) are 105 and 93 years old and 17 and 18 m tall, respectively. One of our specimens is the variety mayriana, which came as seed in 1932 from Hokkaido. It is now 12 m tall.

In addition to Abies sachalinensis var. mayriana Miyabe & Kudo, the only other recorded infraspecific relative is Abies sachalinensis var. nemorensis Mayr, which has smaller cones than the species and hidden bracts; it does not grow in the Arnold Arboretum.

**Habit**
Growing to 40 m
Columnar
Dense foliage in the crown

**Bark**
Gray
Pebbly, otherwise smooth, even in older trees, but in them finally becoming scaly

**Bud**
Conical, with a domed tip
Resinous 4+
Scales prominently bulging, but tips not spreading
Conspicuously white

**Branchlet**
Gray-brown
Furrowed gently longitudinally
Hairy 3+

**Foliage**

Above
Incomplete V, leaves pointing forward 30°

Below
Pectinate with occasional strays; leaves pointing forward 30°; rather closely set

**Leaves**
3–3.5 cm x 1.25–1.5 mm
Flattened, linear
Sides parallel the whole length of the leaf
Tip blunt, with tiny notch
Curved 1+
Margins entire
Flexibility 3+

Above
Shiny green
No stomata (occasionally a few in the groove at the tip)
Groove well defined
No midrib
Below
Dull white
Stomata very small and numerous in narrow bands
Margins not revolute
Not keeled
Resin canals median and conspicuously large

**Cones**
7 x 2 cm
Between ellipsoid and cylindrical
Coffee-colored
Bracts exserted

**Similar Species**
*Abies nephrolepis* and *Abies sibirica* (which have thin, flexible, regularly arranged leaves) are the species that most resemble *Abies sachalinensis* (see *Abies sibirica* for discussion)
Abies sibirica Ledebour: SIBERIAN FIR

The range of Abies sibirica lies between 40° and 140° East longitude, from Moscow almost to the Sea of Okhotsk, the most extensive in the genus Abies. Because of its great resemblance to its neighboring species, Abies sachalinensis, a systematic description of Abies sibirica will not be made below, but only its differences from Abies sachalinensis mentioned. It is hardy to Zone II.

The Arnold Arboretum grows one specimen, now 40 years old, that is 12 m tall and 30 cm in diameter.

Similar Species

- *Abies sachalinensis*: branchlets ribbed (not ribbed in Abies sibirica), stomata below dull white (white in Abies sibirica), cone bracts exserted (hidden or only slightly exserted in Abies sibirica). See the table, below.

Notes on Three Similar Species of Abies

Three members of the genus Abies, neighbors in eastern Asia, Abies nephrolepis, Abies sachalinensis, and Abies sibirica, are strikingly similar. All three have resinous buds; hairy branchlets; narrow, flexible, linear leaves with parallel sides; and large, median resin canals. The following table lists some features—unfortunately not always constant—that help to distinguish them.

<table>
<thead>
<tr>
<th>Character</th>
<th>Abies nephrolepis</th>
<th>Abies sachalinensis</th>
<th>Abies sibirica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bark on mature trees</td>
<td>Rough</td>
<td>Rough</td>
<td>Smooth</td>
</tr>
<tr>
<td>Branchlet ribbed</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Stomata on upper side of leaf</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Color of leaf stomata</td>
<td>Dull white</td>
<td>Dull white</td>
<td>White</td>
</tr>
</tbody>
</table>
A rather small fir whose native range extends from central Japan southwards in detached populations, *Abies veitchii* was introduced to cultivation in the West by John Gould Veitch (1839–70), the illustrious English botanist and nurseryman. Veitch made two extensive collecting trips to the Far East, one in 1860 and one in 1864–66. He died in 1870 at the age of 31, leaving his name attached to hundreds of plants, and a legacy of plant collecting that has been carried on in his name for 100 years. It was under the Veitch firm that Ernest Wilson got his start.

*Abies veitchii* is subalpine and seldom seen below 1,500 m. It is hardy in Zones III–VI.

### Habit
- Slender, with short, level branches when young
- Cylindrical, with a spirelike crown; in maturity, branches more wide-spreading, forming a broadly pyramidal tree

### Bark
- Gray, becoming only slightly roughened in old age
- Smooth, with resin blisters

### Bud
- 4 mm
- Spherico-conical
- Red-brown
- Resinous

### Branchlet
- Gray-yellow
- Covered with short hairs
- Surface regular
- Unribbed

### Foliage

#### Above
- V occasionally incomplete
- Leaves pointing forward 45° from branchlet

#### Below
- Pectinate
- Leaves pointing forward 45° from branchlet

### Leaves
- 2–3 cm x 2 mm
- Flattened, linear
- Sides parallel
- Tip truncated, notched
- Not curved
- Margins entire
- Flexibility 3–4+

### Stomata chalaky blue-white
- Margins revolute 1+
- Midrib and marginal green bands thin
- Resin canals median to submarginal

### Cones
- 6 x 2 cm
- Cylindrical
- Sessile
- Purple, turning dark brown
- Bracts slightly exserted

### Similar Species
- *Abies nephrolepis*, *Abies sachalinensis*, and *Abies sibirica*: leaves also parallel-sided, flexible; resin canals median; branchlets hairy; and buds resinous, but the whiteness of the undersides of their leaves far less bright
- *Abies delavayi* group: undersides of leaves also white, but branchlets conspicuously red-brown and midrib and marginal green bands of leaves very prominent; leaves stiffer

Six specimens grow in the Arnold Arboretum. Two of them are historic. One dates from 1895, having been provided by the Veitch Nursery; it is 17 m tall and has a bole that is 47 cm thick. The other historic specimen is *Abies veitchii* var. *olivacea* (the epithet *olivacea* derives from the olive-green color of the cone when it is young). Introduced by Ernest H. Wilson in 1915, it is 12.3 m tall and has a trunk 40 cm in diameter. A scion of Wilson's tree was grafted onto an understock of *Abies balsamea* in 1959. Planted out in the Pinetum in 1969, it is thriving. These are the only infraspecific relatives of *Abies veitchii*.
and resin canals marginal; undersides of leaves tending to be revolute

• *Abies koreana*: undersides of leaves bright white, but leaves radially arranged and conspicuously shorter than those of *Abies veitchii*; cone bracts prominently exserted and reflexed

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**Glossary of Terms**

**Adaxial.** Facing toward the axis.

**Dioecious.** Having staminate and pistillate elements on separate plants.

**Emarginate.** With a shallow notch at the apex (as of a leaf).

**Entire.** Margin continuous, not broken by divisions, teeth, or serrations.

**Exserted.** Projecting beyond an encircling organ or part.

**Glabrous.** Smooth; free of roughness or hairs.

**Hypoderm.** In a leaf, the layer of thick-walled cells between the epiderm and the mesophyll.

**Glaairy.** Having the appearance of white-of-egg. (Said of resin.)

**Infraspecific.** Of taxonomic rank lower than a species. For convenience, the rank of cultivar is included here, although strictly it is inaccurate to do so.

**Keeled.** Having an under surface longitudinally ridged like the bottom of a boat.

**Lenticel.** Roughened area on a plant’s surface that allows exchange of gasses between the atmosphere and the internal structure of the plant.

**Linear.** Long and narrow. In the case of a conifer leaf, the term infers that the leaf’s sides are parallel.

**Midrib, siderib.** Narrow, green, longitudinal bands on the under surface of a leaf, framing the bands of stomata. If the midrib is raised, the leaf is “keeled.”

**Monocious.** Having staminate and pistillate elements on the same plant.

**Pectinate.** An arrangement, usually of leaves, in which parts relate to each other in a comblike fashion. Most *Abies* leaves spread in two lateral ranks, creating a “V” between them that can vary from wide to incomplete or nearly absent.

**Resin canal or resin duct.** An intercellular space lined with resin-secreting cells.

**Revolute.** Rolled backward or downward, as the edge of a leaf.

**Sessile.** Attached immediately at the base, with no intervening stalk or pedicel.

**Sterigama.** A peg-shaped projection from the surface of a stem or of a branchlet to which a leaf is attached.

**Stoma** (*plural, stomata*). The pore in a leaf, usually on its lower surface, appearing as a whitish or grayish dot, and arranged in rows.

**Umbilicate.** Depressed or indented like a navel.
References


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