

## **Historic, Archive Document**

Do not assume content reflects current scientific knowledge, policies, or practices.



A455  
.8  
.F85

A GUIDE TO



Seedling  
Identification  
for 25 Conifers  
OF THE PACIFIC NORTHWEST

BY JERRY F. FRANKLIN



PACIFIC NORTHWEST  
FOREST AND RANGE EXPERIMENT STATION  
U. S. DEPT. OF AGRICULTURE · FOREST SERVICE  
SEPTEMBER 1961

United States  
Department of  
Agriculture



**National Agricultural Library**

2 select specimens which are  
healthy and sound, and

3 if possible, have known  
specimens for comparison.

A455  
8  
F85

A GUIDE TO  
SEEDLING IDENTIFICATION  
FOR 25 CONIFERS  
OF THE PACIFIC NORTHWEST

by Jerry F. Franklin

September 1961

U.S. DEPARTMENT OF AGRICULTURE  
NATIONAL AGRICULTURAL LIBRARY  
MAR 24 1997

CATALOGING PREP.

USDA National Agricultural Library  
NAL Building  
10301 Baltimore Blvd.  
Beltsville, MD 20705-2351

PACIFIC NORTHWEST FOREST and RANGE  
EXPERIMENT STATION  
Portland, Oregon  
R. W. Cowlin, Director

U. S. DEPARTMENT OF AGRICULTURE  
FOREST SERVICE

# CONTENTS

	<u>Page</u>
INTRODUCTION . . . . .	1
METHODS . . . . .	2
TERMS . . . . .	3
REFERENCES . . . . .	6
KEY TO NORTHWESTERN CONIFEROUS SEEDLINGS . . . . .	7
INDEX TO SEEDLING DESCRIPTIONS . . . . .	14
SEEDLING DESCRIPTIONS . . . . .	16

## INTRODUCTION

Positive field identification of very young seedlings of Pacific Northwest conifers has been difficult because they often occur in mixture and available descriptions of seedling characteristics have been scattered, incomplete, and in some cases, inaccurate.

This is a guide for the identification of young seedlings. It consists of a key to the seedling characteristics of 25 important conifers of the Pacific Northwest. Supplemental descriptions and photos are also provided for each. The key and descriptions are based on the characteristics of very young seedlings--that is, from the time seedcoats are initially shed until either (1) cotyledons are shed, or (2) the second season of growth starts.

## METHODS

The key and seedling descriptions were developed in two steps. First, 25 to 50 seedlings of each species were grown in the greenhouse for one season. <sup>1/</sup>

Second, field checks of at least 25 seedlings of each species were made in various locations in Oregon and southwest Washington.

Information on seedling size is based on measurements of both greenhouse- and field-grown seedlings. These size data apply only to normal healthy seedlings and may not fit abnormal seedlings or those growing under adverse conditions. Maximum seedling sizes presented are generally based on greenhouse-grown seedlings. Seedling growth is, of course, highly variable and influenced by size and quality of seed, seed source, depth of planting, and amount of light and moisture.

<sup>1/</sup> Acknowledgment is made to Manning Seed Co., Oregon State University School of Forestry, and Woodseed, Inc., for supplying some of the seed for this study. Acknowledgment is also made to Harold J. Jensen of the Gifford Pinchot National Forest for supplying supplementary data on seedling characteristics.



## TERMS

Seedlings, as described in this guide, are the young plants during the first growing season. The seed leaves, or first leaves formed by the seedling, are called cotyledons. Conifers have two to several cotyledons, all attached at the same point. The growing tip, including the young stem and leaves above the cotyledons, is the epicotyl. The first true leaves, called juvenile leaves, generally are unlike adult leaves formed later on mature twigs. In shape, cotyledons and juvenile leaves may be needlelike, i. e., very slender and gradually tapering to a point; or linear, i. e., long and narrow with margins mainly parallel. The tip or end of cotyledons and juvenile needles may be acuminate, if gradually tapering to a point, or acute, if forming a broad sharp point. The tip may also be blunt, rounded, or notched. Cotyledons or juvenile needles may be glaucous--partially covered with a white, waxy bloom. Juvenile needles and cotyledons in some species are serrulate, that is, the margins of the leaves have fine teeth or barbs pointing toward the apex. Cotyledon cross sections may be of four types (fig. 1), including three triangular shapes and flat.

Bud characteristics are indispensable in positive identification of Abies seedlings. Three types of buds occur in western Abies (fig. 2). The importance of buds is apparent in the key on page 7.

## Cotyledons



Isosceles triangle (example, Pinus)



Equilateral triangle (example, Picea)



Obtuse triangle (example, Abies)



Flat (example, Chamaecyparis)

Figure 1.--Shapes of cotyledons in cross section.

## Bud Characteristics



498724

Figure 2. --Bud characteristics of Abies.

Left: bud of Abies procera, typical of those in which the outer scales are nonresinous, elongated, and free.

Middle: bud of Abies grandis, typical of those in which buds are resinous and bud scales distinct.

Right: bud of Abies amabilis, typical of those in which the bud is enclosed by resin and bud scales are not visible.

## REFERENCES

1. Bates, Carlos G.  
1925. A key to the identification of some coniferous seedlings. *Jour. Forestry* 23: 278-281, illus.
2. Harlow, William M., and Harrar, Ellwood S.  
1950. *Textbook of dendrology*. Ed. 2, 55 pp., illus. New York: McGraw-Hill Book Co., Inc.
3. Little, Elbert L., Jr.  
1953. Check list of native and naturalized trees of the United States (including Alaska). U. S. Dept. Agr. Handb. 41, 472 pp.
4. Olson, D. S.  
1959. Identification of coniferous seedlings in the northern Rocky Mountains. Univ. Idaho Forest, Wildlife and Range Expt. Sta. Res. Note 15, 4 pp. (Processed.)
5. Sudworth, George B.  
1908. *Forest trees of the Pacific slope*. 441 pp., illus. Washington, D. C.: Government Printing Office.

# KEY TO NORTHWESTERN CONIFEROUS SEEDLINGS <sup>2/</sup>

- A. Cotyledons, two (rarely three), flat in cross section.
- B. Length of cotyledons less than 12 mm.
  - C. Juvenile needles not glaucous..... Chamaecyparis nootkatensis (p. 32)
  - C. Juvenile needles glaucous
    - D. Glaucous on both surfaces of juvenile needles..... Chamaecyparis lawsoniana (p. 30)
    - D. Glaucous only on lower surface of juvenile needles..... Thuja plicata (p. 60)
- B. Length of cotyledons more than 12 mm.
  - C. Cotyledons and juvenile needles not glaucous. Cotyledons 12 to 22 mm. long, 1.5 to 2.0 mm. wide; found generally throughout the region..... Taxus brevifolia (p. 58)
  - C. Cotyledons glaucous on upper surface, juvenile needles glaucous on both surfaces. Cotyledons

<sup>2/</sup> Individuals using this key should note that it may not always be possible to key out an individual seedling due to overlapping characteristics as, for example, with some of the pines and true firs. In such cases it may be possible to identify the unknown by comparing the general descriptions and pictures of the possible species or by obtaining additional seedling specimens. The author would like to acknowledge the helpful advice given by Miss LaRea Dennis of the Oregon State University Herbarium during the preparation of this key.

18 to 30 mm. long, 2.5 to 3.5 mm. wide; found in Cascade Range from central Oregon southward, also in Siskiyou Mountains..... Libocedrus decurrens (p. 36)

A. Cotyledons, three or more, not flat in cross section (except in Tsuga)

B. Shape of cotyledons needlelike with acute or acuminate tips, tending to form an isosceles (Pinus) or equilateral (Picea) triangle in cross section. Cotyledons 3 to 17 in number, densely glaucous on upper surface (except in Pinus lambertiana)

C. Cotyledons consistently more than 16 mm. in length, forming an isosceles triangle in cross section, acuminate tips; margins of juvenile needles serrulate. Epicotyl development usually extensive during the first growing season; cotyledons 3 to 17 in number.

D. Glaucous on upper (lateral) surfaces. Cotyledons 3 to 13 in number.

E. Cotyledons, 3 or 4 (occasionally 5, 6, or 7). 16 to 30 mm. in length..... Pinus contorta (p. 46)

E. Cotyledons, 5 to 13. 16 to 70 mm. in length:

The following species are very difficult to separate on the basis of one or two seedling characteristics. Identification should be based on the following descriptions:

1. Cotyledons, 5 to 8; 20 to 35 mm. long; found from southwestern Oregon southward..... Pinus attenuata (p. 44)

- 2. Cotyledons, 6 to 10 (usually 7 or 8); 16 to 30 mm. long, may be serrulate along margins and midribs..... Pinus monticola (p. 52)
  - 3. Cotyledons, 6 to 12; 25 to 60 mm. long; may be slightly serrulate near base of midrib; bloom not as dense as on cotyledons of Pinus monticola..... Pinus ponderosa (p. 54)
  - 4. Cotyledons, 7 to 13; 40 to 80 mm. long; may be slightly serrulate near base of midrib; seedlings larger and more vigorous than those of Pinus ponderosa; found from southwestern Oregon southward..... Pinus jeffreyii (p. 48)
- D. Bloom not usually visible on upper (lateral) surfaces of cotyledons. Cotyledons, 11 to 17 in number, 30 to 65 mm. long; may be serrulate along margins and midribs; found from mountains of western Oregon southward..... Pinus lambertiana (p. 50)
- C. Cotyledons less than 15 mm. in length (except up to 21 mm. in Picea breweriana), forming an equilateral triangle in cross section, acute to acuminate tips; margins of juvenile needles not serrulate or only slightly so. Epicotyl development usually limited during the first season; cotyledons, 4 to 8 in number.

- D. Found only in Siskiyou Mountains and northern Sierras; rare.  
Cotyledons, 4 to 7; 11 to 21 mm. long..... Picea breweriana (p. 38)
- D. Found elsewhere in Pacific Northwest, rarely if at all in  
Siskiyou Mountains and northern Sierras. Cotyledons,  
4 to 8; 6 to 13 mm. long.  
E. Found in coastal regions. Cotyledons, 4 to 6; 6 to  
11 mm. in length..... Picea sitchensis (p. 42)
- E. Found above 2,500-foot elevation in inland and  
Cascade Mountains. Cotyledons, 4 to 8; 6 to  
13 mm. in length..... Picea engelmannii (p. 40)
- B. Shape of cotyledons linear with acute, round, blunt, or  
notched tips, tending to form an obtuse or equilateral  
triangle in cross section (except flat in Tsuga).  
Cotyledons, 3 to 13 in number; may or may not be  
glaucous.
- C. Cotyledons less than 10 mm. in length, flat or slightly  
triangular in cross section. Usually 3 or 4, rarely 2,  
5, or 6, in number.
- D. Usually less than 3 mm. of epicotyl growth during the  
first season; found at higher elevations, stem usually  
greater than 0.8 mm. in diameter, stomata white  
and rounded. Cotyledons, 3 to 5, rarely 6..... Tsuga mertensiana (p. 64)



- D. Usually 4 to 10 mm. of epicotyl growth during the first season; found generally throughout region; stem usually less than 0.8 mm. in diameter; stomata white and linear, resembling short white hairs. Cotyledons, 3, occasionally 4, or rarely 2..... Tsuga heterophylla (p. 62)
- C. Cotyledons more than 10 mm. in length, tend to form obtuse or equilateral triangle in cross section.  
Cotyledons, 4 to 13 in number.
- D. Seedlings with tips of juvenile needles acute and ending in a tiny bristle; not glaucous on upper surface of juvenile needles.
- E. Juvenile needles with midrib which appears dark when held to light while the rest of the needle is translucent; buds are not pointed and do not have reddish scales; found on east side of Cascades south to central Oregon and eastward. Cotyledons, 4 to 7; 11 to 21 mm. long..... Larix occidentalis (p. 34)
- E. Juvenile needles not as above; buds are pointed with reddish scales; found throughout region. Cotyledons, 5 to 8, occasionally 9 or 10; 12 to 25 mm. long..... Pseudotsuga menziesii (p. 56)
- D. Seedlings not as above in all points.
- E. Juvenile needles generally not glaucous on upper surface.

- F. Bud scales visible, buds resinous..... Abies grandis (p. 20)  
 F. Bud scales not visible, buds enclosed  
 by resin..... Abies amabilis (p. 16)

E. Juvenile needles glaucous on upper surface.

F. Outer scales of bud elongated and free, not resinous, light red brown in color.

The following species are very difficult to separate on the basis of seedling characteristics. Tentative identification should be based on the following descriptions:

1. Cotyledons, 4 to 6 (rarely 7); 15 to 30 mm. long; juvenile needles grooved on the upper surface except on needles located near the bud. Found in mountains of western Oregon and

Washington..... Abies procera (p. 28)

2. Cotyledons, 5 to 8; 20 to 44 mm. long; juvenile needles usually grooved on the upper surface except on needles located near the bud. Found in mountains from central Oregon

southward..... Abies magnifica var. shastensis (p. 26)

3. Cotyledons, 6 to 13; 30 to 45 mm. long;

juvenile needles indistinctly grooved on upper surface and commonly only on needles located near the cotyledons. Found in

- mountains from southern Oregon  
southward..... Abies magnifica (p. 24)
- F. Outer scales of bud not elongated and free,  
resinous; bud dark in color.
- G. Cotyledons, 3 to 6; 10 to 25 mm. long; usually  
less than 5 mm. of epicotyl growth during  
the first season; bud scales either distinct  
or indistinct. Found above 3,000 feet in  
inland and Cascade Mountains..... Abies lasiocarpa (p. 22)
- G. Cotyledons, 5 to 8; 20 to 30 mm. long; usually  
5 to 10 mm. of epicotyl growth during the  
first season; bud scales distinct. Found  
in Oregon Cascades southward..... Abies concolor (p. 18)

## INDEX TO SEEDLING DESCRIPTIONS

	<u>Page</u>
<i>Abies amabilis</i> (Pacific silver fir) . . . . .	16
" <i>concolor</i> (white fir) . . . . .	18
" <i>grandis</i> (grand fir) . . . . .	20
" <i>lasiocarpa</i> (subalpine fir) . . . . .	22
" <i>magnifica</i> (California red fir) . . . . .	24
" <i>magnifica</i> var. <i>shastensis</i> (Shasta red fir) . . . . .	26
" <i>procera</i> (noble fir) . . . . .	28
<i>Chamaecyparis lawsoniana</i> (Port- Orford-cedar) . . . . .	30
" <i>nootkatensis</i> (Alaska-cedar) . . . . .	32
<i>Larix occidentalis</i> (western larch) . . . . .	34
<i>Libocedrus decurrens</i> (incense-cedar) . . . . .	36
<i>Picea breweriana</i> (Brewer spruce) . . . . .	38
" <i>engelmannii</i> (Engelmann spruce) . . . . .	40
" <i>sitchensis</i> (Sitka spruce) . . . . .	42
<i>Pinus attenuata</i> (knobcone pine) . . . . .	44
" <i>contorta</i> (lodgepole pine) . . . . .	46
" <i>jeffreyi</i> (Jeffrey pine) . . . . .	48
" <i>lambertiana</i> (sugar pine) . . . . .	50
" <i>monticola</i> (western white pine) . . . . .	52
" <i>ponderosa</i> ( <i>ponderosa</i> pine) . . . . .	54

	<u>Page</u>
<i>Pseudotsuga menziesii</i> (Douglas-fir) . . . .	56
<i>Taxus brevifolia</i> (Pacific yew) . . . . .	58
<i>Thuja plicata</i> (western redcedar) . . . . .	60
<i>Tsuga heterophylla</i> (western hemlock) . . .	62
" <i>mertensiana</i> (mountain hemlock) . . .	64

PACIFIC SILVER FIR  
Abies amabilis (Dougl.) Forbes <sup>3/</sup>

Cotyledons: Four to seven, 20 to 30 mm. long, 1.5 to 2.5 mm. wide; linear; tend to form an obtuse triangle in cross section; tips blunt, notched, or rounded. Spreading and horizontal. Abundantly glaucous on upper surface. Persist and remain green for several seasons.

Stem: Length from soil to cotyledons, 20 to 35 mm.

Growth: Epicotyl usually grows from 3 to 8 mm. in length during the first season (maximum observed, 15 mm.). Juvenile needles linear and usually grooved on the upper surface; abundantly glaucous on the under surface, not above (occasional exception). Buds globular, resin enclosed, and bud scales not visible; purple in color.

<sup>3/</sup> All common and scientific names in this publication are in accordance with Little (1953).



498694

Figure 3. --Seedlings of Pacific silver fir at the end of the first growing season. (All seedling pictures in this publication are full-size reproductions of greenhouse-grown seedlings. The grid is 1/2 inch square.)

WHITE FIR  
Abies concolor (Gord. & Glend.) Lindl.

Cotyledons: Five to eight, occasionally four, 20 to 30 mm. in length, 1.0 to 2.0 mm. in width; linear; tend to form an obtuse triangle in cross section; tips pointed, rounded, or rarely notched. Spreading and horizontal or curving slightly upward. Glauous on upper surface. Persist and remain green for several seasons.

Stem: Length from soil to cotyledons, 15 to 45 mm.

Growth: Epicotyl usually grows from 5 to 10 mm. in length during the first season (maximum observed, 15 mm.). Juvenile needles linear and grooved on the upper surface; abundantly glauous on the under surface, less above, usually along the grooves. Buds resinous and bud scales distinct; dark in color.





498695

Figure 4. --Seedlings of white fir at the end of the first growing season.

GRAND FIR  
Abies grandis (Dougl.) Lindl.

Cotyledons: Four to seven, usually five or six, 15 to 35 mm. long, 1.0 to 2.2 mm. wide; linear; tend to form an obtuse triangle in cross section; tips blunt, rounded, acute, or notched. Spreading and horizontal or curving upward. Glaucous on upper surface. Persist and remain green for several seasons.

Stem: Length from soil to cotyledons, 20 to 50 mm.

Growth: Epicotyl usually grows from 3 to 10 mm. in length during the first season (maximum observed 22 mm.). Juvenile needles linear and slightly grooved on the upper surface; abundantly glaucous on the under surface, usually not above. Buds resinous and bud scales distinct; dark in color.



498696

Figure 5. --Seedlings of grand fir at the end of the first growing season.

SUBALPINE FIR  
Abies lasiocarpa (Hook.) Nutt.

Cotyledons: Three to six, usually four or five, 10 to 25 mm. in length, 1.0 to 2.0 mm. in width; linear; tend to form an obtuse triangle in cross section; tips rounded, blunt, or notched. Spreading and horizontal or curved upward near the tips. Glauous on upper surface. Persist and remain green for several seasons.

Stem: Length from soil to cotyledons, 10 to 25 mm.

Growth: Epicotyl usually grows less than 4 mm. in length during the first season (maximum observed, 8 mm.). Juvenile needles linear and usually grooved on the upper surface; abundantly glaucous on the under surface, less above, usually along the grooves. Buds resinous, bud scales either distinct or indistinct; dark in color.



498697

Figure 6. --Seedlings of subalpine fir at the end of the first growing season.

CALIFORNIA RED FIR  
Abies magnifica A. Murr.

Cotyledons: Six to thirteen, usually seven to ten, 30 to 45 mm. in length, 1.0 to 2.0 mm. in width; tend to form an equilateral or obtuse triangle in cross section; tips acute or rounded. Spreading and usually curved upward. Glauous on upper surface. Persist and remain green for several seasons.

Stem: Length from soil to cotyledon, 20 to 45 mm.

Growth: Epicotyl usually grows from 10 to 30 mm. in length during the first season (maximum observed, 45 mm.). Juvenile needles linear with rounded or acute tips, rather indistinctly grooved on upper surface and commonly only on needles located near the cotyledons; abundantly glauous on both surfaces. Outer scales of bud elongated and free; light red brown in color. California red fir seedlings were the most vigorous of the Abies spp. examined, some even branching the first season.



498698

Figure 7. --Seedlings of California red fir at the end of the first growing season.

SHASTA RED FIR

Abies magnifica var. shastensis Lemm.

Cotyledons: Five to eight, 20 to 40 mm. in length, 1.0 to 2.0 mm. in width; tend to form an equilateral or obtuse triangle in cross section; tips rounded or acute. Spreading and horizontal or curved upward. Glauous on upper surface. Persist and remain green for several seasons.

Stem: Length from soil to cotyledons, 20 to 40 mm.

Growth: Epicotyl usually grows from 5 to 20 mm. in length during the first season (maximum observed, 35 mm.). Juvenile needles linear with rounded or acute tips, usually grooved on upper surface except on needles located near the bud; abundantly glauous on both surfaces. Outer scales of bud elongated and free; light red brown in color.





498699

Figure 8. --Seedlings of Shasta red fir at the end of the first growing season.

NOBLE FIR  
Abies procera Rehd.

Cotyledons: Four to six, rarely seven, 15 to 30 mm. long, 1.0 to 2.0 mm. wide; linear; tend to form an obtuse triangle in cross section; tips rounded or acute. Spreading and horizontal or curving upward. Glauous on upper surface. Persist and remain green for several seasons.

Stem: Length from soil to cotyledons, 15 to 40 mm.

Growth: Epicotyl usually grows from 5 to 20 mm. in length during the first season (maximum observed, 30 mm.). Juvenile needles linear with rounded, blunt, or notched tips and grooved on the upper surface, except on needles located near the bud; abundantly glaucous on the under surface and less above, especially along the groove. Outer scales of bud elongated and free; light red brown in color.



498700

Figure 9. --Seedlings of noble fir at the end of the first growing season.

PORT-ORFORD-CEDAR  
Chamaecyparis lawsoniana (A. Murr.) Parl.

Cotyledons: Two, 5 to 10 mm. long, 1.0 to 2.0 mm. wide; linear; flat in cross section; tips blunt or rounded. Horizontal or curved upwards near the tips. Not glaucous on either surface. Persist but usually turn brown before the end of the first season.

Stem: Length from soil to cotyledons, 9 to 22 mm.

Growth: Epicotyl usually grows from 25 to 100 mm. in length during the first season (maximum observed 350 mm.). Juvenile needles linear, two glaucous lines on both surfaces. The initial whorl consists of two needles at right angles to the cotyledons. Subsequent needles are produced in whorls of four, each whorl alternating its position so, when viewed from above, it appears to bisect the right angles formed between the needles of the previous whorl. Seedlings usually branch and produce mature (scalelike) foliage before the end of the first growing season.



498701

Figure 10.--Seedlings of Port-Orford-cedar at the end of the first growing season.

ALASKA-CEDAR  
Chamaecyparis nootkatensis (D. Don) Spach

Cotyledons: Two, 7 to 11 mm. long, 1.5 to 2.2 mm. wide; linear; flat in cross section; tips rounded. Spreading and horizontal or curved upward near the tips. Not glaucous on either surface. Persist and usually remain green through the first season.

Stem: Length from soil to cotyledons, 5 to 15 mm.

Growth: The epicotyl usually grows from 10 to 18 mm. in length during the first season (maximum observed, 25 mm.). Juvenile needles are linear, not glaucous on either surface. The initial whorl consists of two needles at right angles to the cotyledons. Subsequent whorls consist of four needles, each whorl alternating its position so, when viewed from above, it appears to bisect the right angles formed between the needles of the previous whorl. Seedlings usually do not branch or produce mature (scalelike) foliage until the second or third growing season.



498702

Figure 11. --Seedlings of Alaska-cedar at the end of the first growing season.

WESTERN LARCH  
Larix occidentalis Nutt.

- Cotyledons: Four to seven, usually five or six, 11 to 21 mm. long, 0.4 to 1.0 mm. wide; linear; tend to form an equilateral triangle in cross section; acute tip. Glaucous areas scattered over upper surface. Usually persist but dead by the end of the first growing season.
- Stem: Length from soil to cotyledons, 5 to 18 mm.
- Growth: Epicotyl usually grows from 25 to 55 mm. in length during the first season (maximum observed, 85 mm.). Juvenile needles linear, tips acute with a tiny bristle; scattering of glaucous areas on the under surface; midvein appears dark when held to the light while the remainder of the needle is translucent. Epicotyl on larger seedlings presents a unique appearance, being light in color with dark strips extending from the base of needles vertically downward along portions of its length.





498703

Figure 12. --Seedlings of western larch at the end of the first growing season.

INCENSE-CEDAR  
Libocedrus decurrens Torr.

Cotyledons: Two, <sup>4/</sup> 18 to 30 mm. long, 2.5 to 3.5 mm. wide; linear; flat in cross section; tips rounded. Horizontal and spreading. Glaucous on upper surface. Persist but usually turn brown or purple by the end of the first growing season.

Stem: Length from soil to cotyledons, 15 to 40 mm.

Growth: Epicotyl usually grows from 25 to 60 mm. in length during the first growing season (maximum observed, 80 mm.). Juvenile needles linear; usually glaucous on both surfaces. The first whorl consists of two needles which are at right angles to the cotyledons, and succeeding whorls contain four needles. Seedlings usually branch and produce mature (scalelike) foliage before the end of the first growing season.

<sup>4/</sup> Harlow and Harrar (1950) report that incense-cedar may occasionally have three cotyledons.



498704

Figure 13. --Seedling of incense-cedar at the end of the first growing season.

BREWER SPRUCE  
Picea breweriana S. Wats.

Cotyledons: Four to seven, 11 to 21 mm. long, 0.5 to 1.0 mm. wide; needlelike; tend to form an equilateral triangle in cross section; tips acute to acuminate. Usually curved upward to almost a vertical position. Abundantly glaucous on upper surface. Persist and remain green during the first season.

Stem: Length from soil to cotyledon, 6 to 18 mm.

Growth: Epicotyl usually grows less than 6 mm. in length during the first season (maximum observed, 15 mm.). Juvenile needles needlelike with acute or acuminate tips; two glaucous lines present on upper surface.



498705

Figure 14. --Seedlings of Brewer spruce at the end of the first growing season.

ENGELMANN SPRUCE  
Picea engelmannii Parry

Cotyledons: Four to eight; 6 to 13 mm. long, 0.3 to 0.6 mm. wide; needlelike; tend to form an equilateral triangle in cross section; acuminate tip. Glauous on upper surfaces, may be glauous on lower surfaces. Persist and remain green during the first season. Frequently twisted and drawn toward top of seedling.

Stem: Length from soil to cotyledons, 8 to 18 mm.

Growth: Epicotyl usually grows from 2 to 5 mm. in length (maximum observed, 18 mm.) during the first season. Juvenile needles needlelike with acuminate tips; glauous on both surfaces.

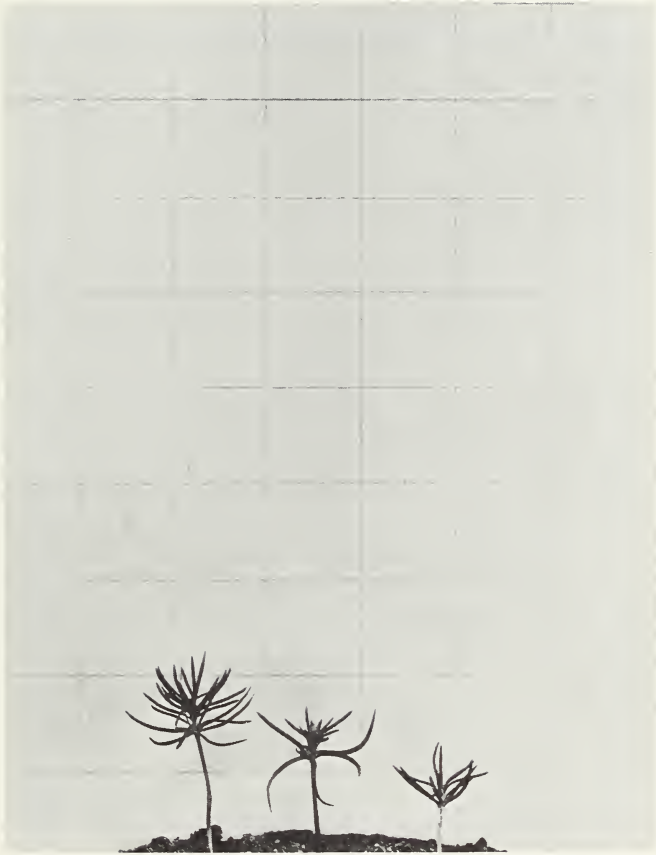


Figure 15.--Seedlings of Engelmann spruce at the end of the first growing season.

SITKA SPRUCE  
Picea sitchensis (Bong.) Carr.

Cotyledons: Four to six, 6 to 11 mm. long, 0.3 to 0.6 mm. wide; needlelike; tend to form an equilateral triangle in cross section; tips acute. Glauous on upper surfaces. Usually persist and remain green during the first season. May be either twisted and drawn toward the top of the seedling or horizontal and spreading.

Stem: Length from soil to cotyledons, 7 to 15 mm.

Growth: Epicotyl usually grows from 3 to 9 mm. in length during the first season (maximum observed, 18 mm.). Juvenile needles are needlelike with acute or acuminate tips; glauous on the under surface.



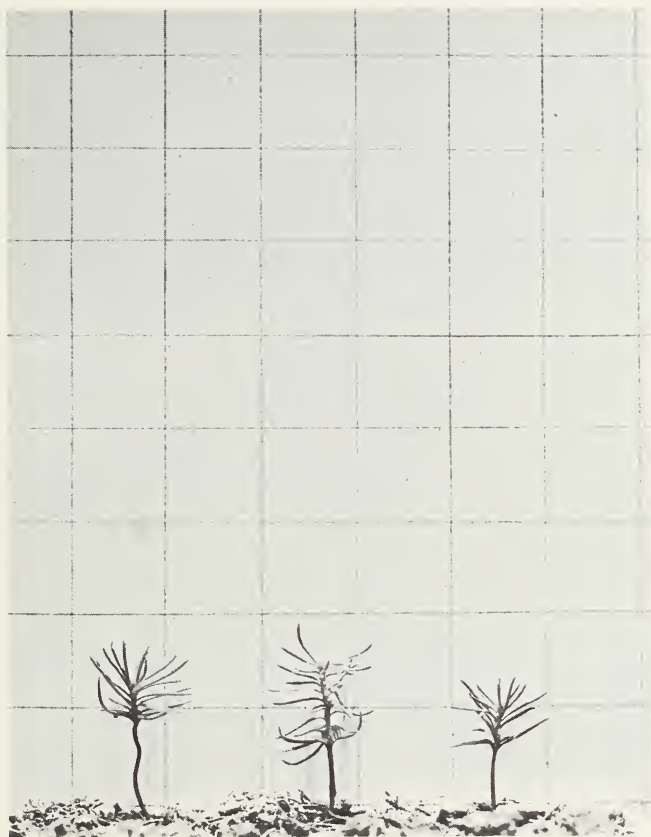


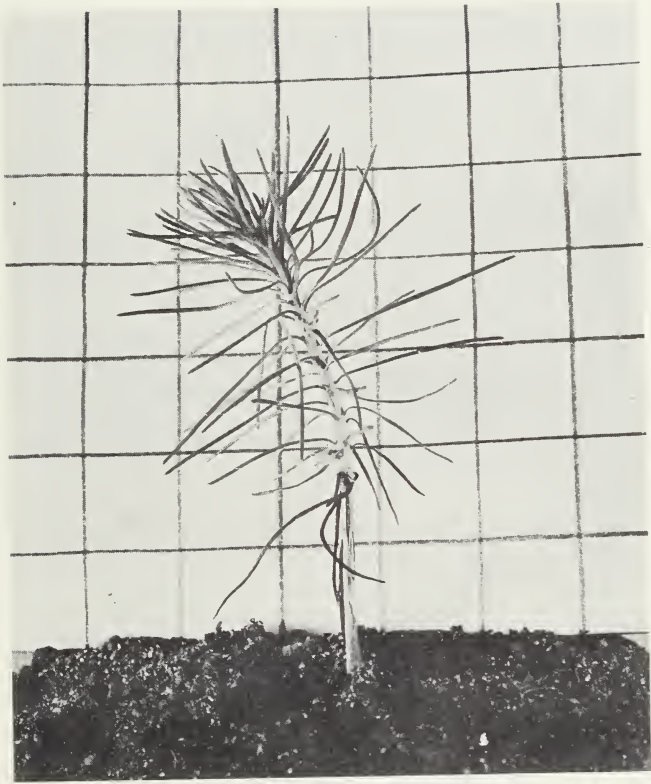
Figure 16. --Seedlings of Sitka spruce at the end of the first growing season.

KNOBCONE PINE  
Pinus attenuata Lemm.

Cotyledons: Five to eight, 20 to 35 mm. long; tend to form an isosceles triangle in cross section, the base 0.4 to 0.6 mm. and the sides 0.7 to 0.9 mm.; needlelike; acuminate tip. Horizontal and spreading, occasionally twisted. Glaucous on all surfaces. Persist but dead by the end of the first season.

Stem: Length from soil to cotyledons, 20 to 35 mm.

Growth: Epicotyl usually grows from 20 to 35 mm. in length during the first season (maximum observed, 40 mm.). Juvenile needles flat and taper to an acute or acuminate tip; glaucous on both surfaces; serrulate margins. Seedlings do not produce mature (fascicled) foliage during the first growing season.



498708

Figure 17. --Seedling of knobcone pine at the end of the first growing season.

LODGEPOLE PINE  
Pinus contorta Dougl.

Cotyledons: Three to seven, usually four, 16 to 30 mm. long; tend to form an isosceles triangle in cross section, the base 0.4 to 0.5 mm. and the sides 0.4 to 0.6 mm.; needlelike; acuminate tip. Horizontal and spreading. Glauous on upper (lateral) surfaces.<sup>5/</sup> May persist, but dead by the end of the first growing season. May be of unequal lengths.

Stem: Length from soil to cotyledons, 10 to 25 mm.

Growth: Epicotyl usually grows from 20 to 40 mm. in length during the first season (maximum observed, 60 mm.) on seedlings grown from coastal seed sources (greenhouse only) or from 5 to 10 mm. in length (maximum observed, 17 mm.) on seedlings grown from mountain seed sources. Juvenile needles flat and generally linear with an acute tip; glaucous on both surfaces; serrulate margins. A few vigorous seedlings (coastal seed source) produced mature (fascicled) foliage the first season.

<sup>5/</sup> Olson (1959) reports cotyledons as glabrous, i. e., not glaucous.



498709

Figure 18. --Seedlings of lodgepole pine at the end of the first growing season.

JEFFREY PINE  
Pinus jeffreyi Grev. & Balf.

Cotyledons: Seven to thirteen, 40 to 80 mm. in length; form an isosceles triangle in cross section, the base 0.4 to 0.9 mm. and the sides 0.9 to 1.5 mm.; needlelike; acuminate tip. Twisted over one or several times. Glauous on upper (lateral) surfaces. Persist but dead by the end of the first growing season. Few serrations may be visible along midrib near base.

Stem: Length from soil to cotyledons, 25 to 40 mm.

Growth: Epicotyl usually grows from 30 to 60 mm. in length during the first season (maximum observed, 150 mm.). Juvenile needles flat and taper to an acute or acuminate tip; glauous on both surfaces; serrulate margins. Seedlings do not produce mature (fascicled) foliage until the second season.



498712

Figure 19. --Seedling of Jeffrey pine at the end of  
the first growing season.

SUGAR PINE  
Pinus lambertiana Dougl.

Cotyledons: Eleven to seventeen, 30 to 65 mm. long; form an isosceles triangle in cross section, the base 0.4 to 0.8 mm. and the sides 1.2 to 2.0 mm.; needle-like; acuminate tip. Curved upward and/or twisted over one or several times, exposing one or both sides and the base of the cotyledon. Stomata present on the upper (lateral) surfaces, but glaucous areas not usually apparent. Persist and usually remain alive during the first season; however, often do not retain a healthy appearance. May have serrations along margins and midribs near base.

Stem: Length from soil to cotyledons, 20 to 50 mm.

Growth: Epicotyl usually grows from 10 to 50 mm. in length during the first season (maximum observed, 125 mm.). Juvenile needles flat with an acuminate tip; scattering of glaucous areas present on upper surface; margins serrulate, very lightly so on vigorous seedlings. Seedlings usually do not produce mature (fascicled) foliage until the second season.





498713

Figure 20. --Seedling of sugar pine at the end of the first growing season.

WESTERN WHITE PINE  
Pinus monticola Dougl.

Cotyledons: Six to ten, usually seven or eight, 16 to 30 mm. long; form an isosceles triangle in cross section, the base 0.4 to 0.7 mm. and the sides 0.5 to 1.0 mm.; needlelike; acuminate tip. Curved upward or twisted sideward producing pinwheel effect. Glauous on upper (lateral) surfaces. Persist and usually remain green through first season. May have serrations along midribs and margins near base.

Stem: Length from soil to cotyledons, 16 to 30 mm.

Growth: Epicotyl usually grows from 10 to 25 mm. in length during the first season (maximum observed, 35 mm.). Juvenile needles flat and taper to an acute tip; glauous condition usually visible on both surfaces; serrulate margins. Vigorous seedlings may produce mature (fascicled) foliage the first season.



498715

Figure 21. --Seedlings of western white pine at the end of the first growing season. (This photo is slightly less than full scale.)

PONDEROSA PINE  
Pinus ponderosa Laws.

Cotyledons: Six to twelve,<sup>6/</sup> 25 to 60 mm. long; form an isosceles triangle in cross section, the base 0.2 to 0.5 mm. and the sides 0.4 to 1.0 mm.; needlelike; acuminate tip. Usually twisted one or more times. Glaucons upper (lateral) surfaces.<sup>7/</sup> Usually persist but dead by the end of the first season. May be few serrations on midrib near the base.

Stem: Length from soil to cotyledons, 15 to 40 mm.

Growth: Epicotyl usually grows from 10 to 40 mm. in length during the first season (maximum observed, 60 mm.). Juvenile needles flat and taper to an acute or acuminate tip; glaucons on both surfaces; serrulate margins. Seedlings usually do not produce mature (fascicled) foliage until the second season.

<sup>6/</sup> Sudworth (1908) reports cotyledons numbering five to nine, and Bates (1925) reports five to eight.

<sup>7/</sup> Olson (1959) reports cotyledons as being glabrous, i. e., not glaucons.



498717

Figure 22. --Seedling of ponderosa pine at the end of the first growing season.

DOUGLAS-FIR  
Pseudotsuga menziesii (Mirb.) Franco

Cotyledons: Five to eight, occasionally four, nine, or ten, 10 to 25 mm. long, 0.7 to 1.2 mm. wide; linear; tend to form an obtuse or equilateral triangle in cross section; tip acute. Spreading and horizontal or curving either slightly downward or upward. Some glaucous areas on upper surface. Persist and usually remain green through first year.

Stem: Length from soil to cotyledons, 15 to 35 mm.

Growth: Epicotyl usually grows from 5 to 25 mm. in length during the first season (maximum observed, 85 mm.). Juvenile needles linear with acute tips and a tiny bristle; two glaucous bands on the underside. Buds sharply pointed, red in color.



498718

Figure 23. --Seedlings of Douglas-fir at the end of the first growing season.

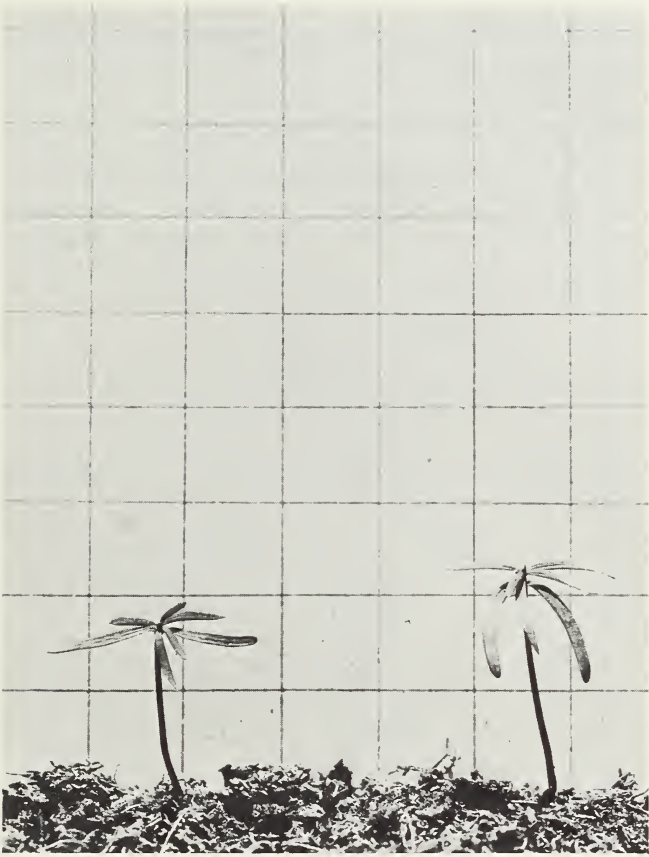
PACIFIC YEW  
Taxus brevifolia Nutt.

Cotyledons: Two, 12 to 22 mm. in length, 1.5 to 2.0 mm. in width; linear; flat in cross section; taper near the ends to a rounded tip. Spreading and horizontal or curved downward; commonly curved laterally toward each other (see fig. 24). Not glaucous on either surface. Usually persist and may remain green for several seasons.

Stem: Length from soil to cotyledons, 15 to 25 mm.

Growth: Epicotyl usually grows from 2 to 10 mm. in length during the first season (maximum observed, 15 mm.). Juvenile needles generally linear, tapering to an acute tip with a tiny bristle; not glaucous on either surface.





498719

Figure 24. --Seedlings of Pacific yew at the end of the first growing season.

WESTERN REDCEDAR  
Thuja plicata Donn

Cotyledons: Two, rarely three, 5 to 10 mm. long, 1.0 to 2.0 mm. wide; linear; flat in cross section; blunt or rounded tips. Horizontal and spreading, sometimes curving upwards on ends. Not glaucous on either surface. Persist but may be dead by the end of the first season.

Stem: Length from soil to cotyledons, 6 to 16 mm.

Growth: Epicotyl usually grows from 10 to 40 mm. in length during the first growing season (maximum observed, 90 mm.). Juvenile needles linear with two glaucous bands on the under surface. The initial whorl consists of two needles at right angles to the cotyledons. Subsequent needles are produced in whorls of four, each whorl alternating its position so, when viewed from above, it appears to bisect the right angles formed between the needles of the previous whorl. Vigorous seedlings may branch and produce mature (scalelike) foliage during the first season.



498720

Figure 25. --Seedlings of western redcedar at the end of the first growing season.

WESTERN HEMLOCK  
Tsuga heterophylla (Raf.) Sarg.

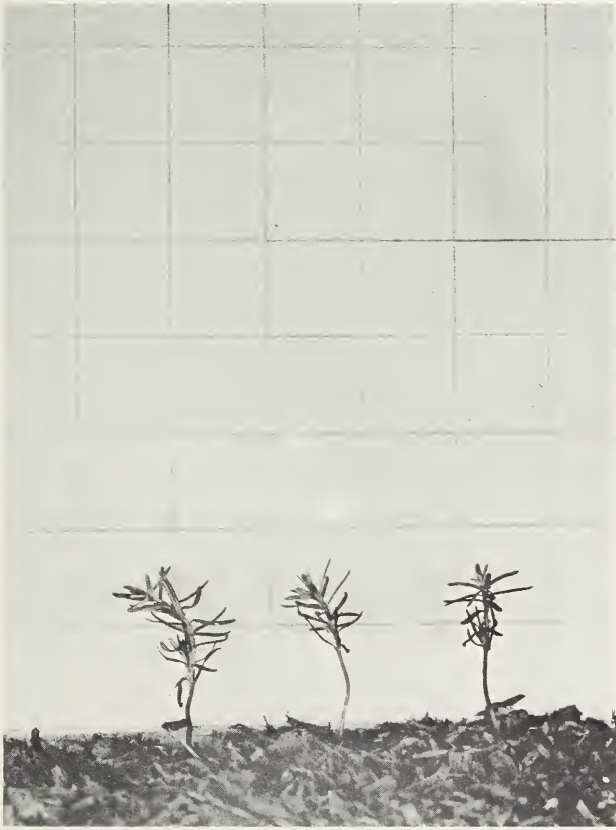
Cotyledons: Three, occasionally four, or rarely two,<sup>8/</sup> 4 to 8 mm. long, 0.7 to 1.3 mm. wide; linear; flattened or slightly triangular in cross section; tips blunt or rounded. Horizontal and spreading. Glaucous areas may be visible on the upper surface.<sup>9/</sup> May persist and remain green during first growing season. Stomata tend to be white and linear, resembling short white hairs.

Stem: Length from soil to cotyledons, 6 to 15 mm., usually less than 0.8 mm. in diameter.

Growth: Epicotyl usually grows from 4 to 10 mm. in length during the first growing season (maximum observed, 15 mm.). Juvenile needles linear with glaucous under surface; very lightly serrulate. Needles are usually produced in whorls of three, alternating in such a manner that, when viewed from above, each whorl appears to bisect the angles formed by the previous whorl, producing a symmetrical appearance.

<sup>8/</sup> Sudworth (1908) reports five cotyledons.

<sup>9/</sup> Olson (1959) reports the upper surface as glossy, i. e., not glaucous.



498721

Figure 26. --Seedlings of western hemlock at the end of the first growing season.

MOUNTAIN HEMLOCK  
Tsuga mertensiana (Bong.) Carr.

Cotyledons: Three to five, rarely six, 4 to 8 mm. long, 0.7 to 1.1 mm. wide; linear; flattened or slightly triangular in cross section; tips rounded or blunt. Horizontal and spreading. Scattered glaucous areas may be visible on upper surface. Stomata tend to be white and rounded. May persist and remain green during the first season.

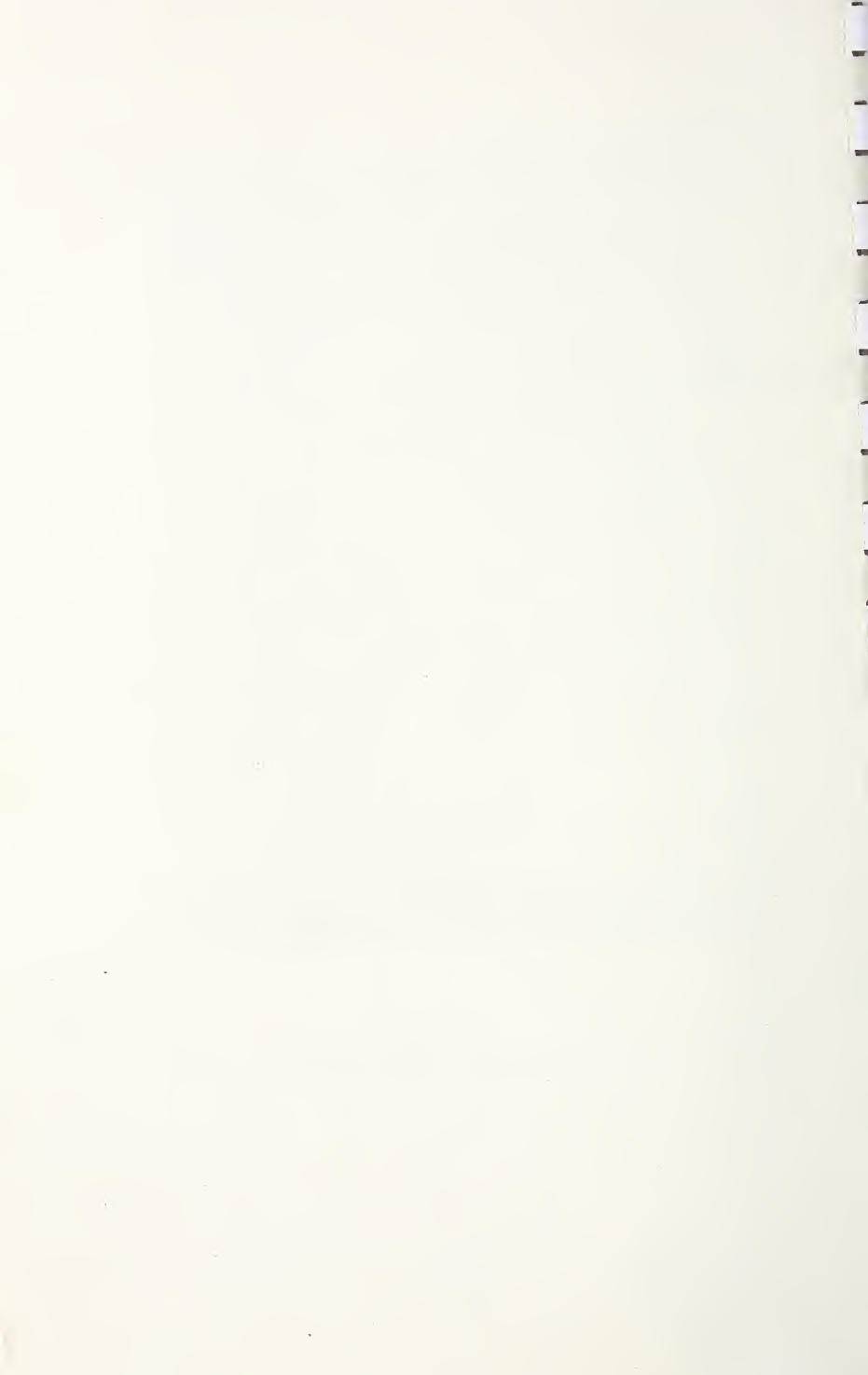
Stem: Length from soil to cotyledons, 6 to 12 mm., usually greater than 0.8 mm. in diameter.

Growth: Epicotyl usually grows less than 3 mm. in length during the first growing season (maximum observed, 12 mm.). Juvenile needles linear, with glaucous under surface; very lightly serrulate.



498722

Figure 27. --Seedlings of mountain hemlock at the end of the first growing season.





\* NATIONAL AGRICULTURAL LIBRARY



1022403788

/ Inches

0

3

4

5

z

i

NATIONAL AGRICULTURAL LIBRARY



1022403788

