Pacific Silver Fir

A BIBLIOGRAPHY WITH ABSTRACTS

compiled by CARROLL B. WILLIAMS, JR.,

and JERRY F. FRANKLIN

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

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FOREST AND RANGE EXPERIMENT STATION
Philip A. Briegleb, Director Portland, Oregon

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

FOREWORD

This bibliography lists references containing information on Pacific silver fir, *Abies amabilis* (Dougl.) Forbes, in North American and European literature. We have attempted to include all references which might conceivably provide useful information on this species and we would appreciate notification of additional references. Articles are listed alphabetically by author; abstracts are provided for those considered more significant. A subject matter index is given on pages 81 through 83, and a list of common and scientific names of tree species mentioned in the bibliography is found on page 84.

Appreciation is expressed to Miss Marie Gould, librarian at the U.S. Forest Service Library, Portland, Oregon, for obtaining many of the references for examination.

BIBLIOGRAPHY

1. Anonymous.
1855. Ascertained effects of the winter of 1853-4 upon exotics cultivated in the gardens of Great Britain. Jour. Hort. Soc. London 9: 207-248.

The severe winter of 1853-4 did not harm Pacific silver fir trees anywhere in Britain.

2. Anonymous.
1892. Conifers suitable for various purposes. Jour. Roy. Hort. Soc. London 14: 572-574.

Pacific silver fir was ranked 26 (out of 40) as a coniferous species suitable for large gardens and pleasure grounds.

3. Anonymous.
1954. Serious silver fir beetle damage reported in Washington. Jour. Forestry 52: 961.

4. Anonymous.
1958. Here's how the aphid changed everything. Timberman 59(5): 48-50, illus.

A general description of the logging plans and operations of Weyerhaeuser Timber Co. in Chermes-infested Pacific silver fir stands on their Mount St. Helens tree farm.

5. Abrams, LeRoy.
1923. An illustrated flora of the Pacific States, Washington, Oregon, and California. v. 1, Ophioglossaceae to Aristolochiaceae. 557 pp., illus. Stanford University: Stanford University Press.

6. Adams, Thomas C., and Syverson, Martin L.
1958. Production and marketing of Christmas trees in the Pacific Northwest in 1957.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta., 20 pp., illus.

Pacific silver fir accounted for 0.5 percent of the Christmas trees produced in Washington and about 0.1 percent of those produced in Oregon.

7. Aho, Paul E.
1960. Heart-rot hazard is low in Abies amabilis reproduction injured by logging.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Note 196, 5 pp., illus.

An investigation of the extent of heart rot in scarred, silver fir advance regeneration 8 to 9 years after release by logging. Examination of 74 scars on 47 trees revealed no decay behind the scars and only 1 small scar infected with wood-rotting fungi. Rapid growth recovery of the formerly suppressed trees was noted; trees up to 100 years of age responded well to release.

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* Address requests for copies to the originating office.

8. Allen, G. F.
1916. Forests of Mount Rainier National Park. U.S. Dept. Int., 32 pp., illus.

Pacific silver fir is abundant from 2,500- to 5,000-foot elevation on level benches and gentle north slopes. Common associates are western hemlock, Douglas-fir, and noble fir. Above 4,000 feet, Pacific silver fir often occurs in clusters and open groves. The largest trees vary between 150 to 180 feet in height and 3 to 5 feet in diameter. Foliage is deep green and cones are dark purple in color. Seeds ripen in early October.

9. Aller, Alvin R.
1956. A taxonomic and ecologic study of the flora of Monument Peak, Oregon. Amer. Midland Nat. 56: 454-472, illus.

Pacific silver fir is found in two of the coniferous forest communities described as occurring above 3,700-foot elevation on this peak located in the western portion of the central Oregon Cascades. An *Abies amabilis-Tsuga heterophylla* community is best developed on a south slope between 4,000 and 4,400 feet. Hemlock outnumbers silver fir nearly three to one and averages somewhat larger in diameter. Reproduction of both species is present in localities within the stand where the canopy is rather open. Above 4,300 feet, noble fir replaces hemlock and an *Abies procera–A. amabilis* community results. Soils throughout both communities are of medium-to-shallow depth with occasional rock exposures and contain a considerable amount of humus in the A horizon. Floristic descriptions of both communities are included.

10. Andersen, H. E.
1955. Climate in southeast Alaska in relation to tree growth.* U.S. Forest Serv. Alaska Forest Res. Center Sta. Paper 3, 5 pp., illus.

The northern coastal limits of Pacific silver fir are reached at or near the British Columbia-Alaska boundary. The limits of this species lie within an area where the mean temperature during the growing season is probably greater than 55° F.

11. Anderson, J. P.
1959. Flora of Alaska and adjacent parts of Canada. 543 pp., illus. Ames: Iowa State University Press.

12. Anderson, James R.
1925. Trees and shrubs; food, medicinal, and poisonous plants of British Columbia. 165 pp., illus. Victoria, B. C.: Charles F. Banfield.

13. Andrews; H. J., and Cowlin, R. W.
1940. Forest resources of the Douglas-fir region. U.S. Dept. Agr. Misc. Pub. 389, 169 pp., illus.

14. Applegate, Elmer I.
1939. Plants of Crater Lake National Park. Amer. Midland Nat. 22: 225-314, illus.

Applegate believes that Pacific silver fir does not occur in the park.

15. Ayres, H. B.
1899. Washington Forest Reserve. In U.S. Geol. Survey 19th Ann. Rpt. 1897-98, Pt. V, Forest Reserves. pp. 283-313, illus.

In the Mount Baker area of northern Washington, Pacific silver fir occurs on moist sites on alluvial bottoms and on the mountain slopes up to the lower limits of the alpine zone. It predominates above 4,000 feet.

16. Babb, M. F.
1959. Propagation of woody plants by seed. Alaska Agr. Expt. Sta. Bul. 26, 12 pp., illus.

17. Baerg, Harry J.
1955. How to know the western trees. 170 pp., illus. Dubuque: Wm. C. Brown Co.

18. Bailey, Harold E., and Bailey, Virginia Long.
1941. Forests and trees of the western national parks. U.S. Dept. Int. Natl. Park Serv. Conserv. Bul. 6, 129 pp., illus.

19. Bailey, L. H.
1923. The cultivated evergreens. 434 pp., illus. New York: The Macmillan Co.

20. _____
1933. The cultivated conifers in North America. 404 pp., illus. New York: The Macmillan Co.

21. Bailey, Vernon.
1936. The mammals and life zones of Oregon. U.S. Bur. Biol. Survey North Amer. Fauna 55, 416 pp., illus.

22. Bailey, Virginia L., and Bailey, Harold E.
1949. Woody plants of the western national parks. Amer. Midland Nat. Monog. 4, 274 pp.

23. Baker, Frederick S.
1949. A revised tolerance table. Jour. Forestry 47: 179-181.

Pacific silver fir is rated tolerant in this five-class tolerance table: very tolerant, tolerant, intermediate, intolerant, and very intolerant.

24. Baker, William H.
1951. Plants of Fairview Mountain, Calapooya Range, Oregon. Amer. Midland Nat. 46: 132-173, illus.

Pacific silver fir is a common tree in the Canadian Zone on this 5,933-foot peak located in southeastern Lane County, Oreg.

25. Balfour, F. R. S.
1915. The trees and shrubs of the Pacific Coast. Jour. Hort. Soc. London 41: 21-27.

26. Ballard, Pat.
1954. A Christmas tree with a future. Univ. Wash. Arbor. Bul. 17: 82, 83, 94.

27. Barnes, Irston R.
1955. Glacier Peak--wilderness wonderland. Mazama 37(13): 40-43, illus.

28. Barton, G. M., and Gardner, J. A. F.
1962. The occurrence of matairesinol in mountain hemlock *(Tsuga mertensiana)*, western hemlock *(T. heterophylla)* and balsam *(Abies amabilis)*. Jour. Organ. Chem. 27: 322-323.

29. Becking, R. W.
1956. Die natürlichen Douglasien-Waldgesellschaften Washingtons und Oregons. Allg. Forst-u. Jagdztg. 127: 42-56, illus.

A classification of the Douglas-fir forests of the west side of the Cascade Range according to the Braun-Blanquet system. The Montane sword fern-Douglas-fir and Montane salal-Douglas-fir associations are both characterized by the presence of Pacific silver fir.

30. Benson, Gilbert Thereon.
1930. The trees and shrubs of western Oregon. Contrib. Dudley Herb. Stanford Univ. v. 2, 170 pp., illus. Stanford University: Stanford University Press.

Synonymy, type locality, range, and list of cited specimens (mostly from the Dudley Herbarium). Pacific silver fir is found generally in the Canadian Zone in the Cascade Range at 2,000- to 6,000-foot elevation as far south as the divide between the Rogue and Umpqua Rivers just north of Crater Lake. It is most abundant on the Western slopes, but is found on the east side of the Cascade crest at higher elevations.

31. Berger, John M.
1962. Forest statistics for Okanogan County, Washington. U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 139, 29 pp., illus.

In 1959, there were an estimated 12 million board feet of live Pacific silver fir sawtimber and 5 million cubic feet of growing stock (up to 4 inches minimum top) on commercial forest land in Okanogan County.

32. Besley, Lowell.
1959. Relationships between wood fibre properties and paper quality. Pulp & Paper Res. Inst. Canada Tech. Rpt. 156 (Woodlands Res. Index 114), 19 pp.

Wood properties data for Canadian species, including Pacific silver fir, compiled from several references.

33. Betts, H. S.
1929. The strength of North American woods. U.S. Dept. Agr. Misc. Pub. 46, 18 pp.

34. _____
1945. White fir. Forest Serv., U.S. Dept. Agr. American Woods. 12 pp., illus.

35. Betts, Harold S.
1917. The seasoning of wood. U.S. Dept. Agr. Bul. 552, 28 pp., illus.

36. Bickford, C. A., Clarke, S. C., and Jahn, E. C.
1934. A study of the nature of certain fir *(Abies)* oleoresins. Fifth Pac. Sci. Cong. Proc. (1933) 5: 3941-3948.

37. Bier, J. E., and Buckland, D. C.
1947. Relation of research in forest pathology to the management of second growth forests. I. *Poria weirii* root rot, an important disease affecting immature stands of Douglas fir. Brit. Columbia Lumberman 31(2): 49-51, 64, 66, illus.

38. _____ Salisbury, P. J., and Waldie, R. A.
1948. Studies in forest pathology. V. Decay in fir, *Abies lasiocarpa* and *A. amabilis*, in the Upper Fraser region of British Columbia. Canada Dept. Agr. Pub. 804 (Tech. Bul. 66), 28 pp., illus.

Scaling and decay loss studies showed that an average of 25 saw-log-size firs per acre contained an average gross merchantable volume (B.C. log rule) of 4,474 board feet, of which 29 percent was cull. An average of 70 pulpwood-size trees per acre yielded an average gross merchantable volume of 1,271 cubic feet, of which 18 percent of actual volume or 43 percent of gross merchantable volume was cull.

Decay was most pronounced in trees past 80 years of age, and maximum net periodic increment indicated a pathological rotation of 121 to 140 years of age. Local volume tables showing deductions in board and cubic feet by diameter classes are included. No consistent difference in decay percent was evident between fast- and slow-growing trees in the same age classes.

Lists 21 wood-destroying fungi found associated with decay in living trees. Of these the trunk rots *Stereum sanguinolentum*, red heart rot, and *Echinodontium tinctorium*, brown stringy rot, caused 87 percent of the decay. Root and butt rots accounted for 10.8 percent of the total loss-- *Poria subacida* and *Polyporus* [*Polystictus*] *abietinus* were the most prevalent of this group.

39. Blair, Sir James Hunter.
1946. Frost damage to woodlands on Blairquhan Estate in April, 1945. Scot. Forestry Jour. 60: 38-43.

40. Boulger, G. S.
1908. Wood; a manual of the natural history and industrial applications of the timbers of commerce. Ed. 2, 348 pp., illus. London: Edward Arnold.

41. Bowers, Nathan A.
1942. Cone-bearing trees of the Pacific Coast. 169 pp., illus. New York, London: Whittlesey House, McGraw-Hill Book Co.

42. Boyce, J. S.
1926. Diseases of commercially important conifers in the Pacific Northwest. U.S. Dept. Agr. Bur. Plant Indus., 37 pp.

The following fungi commonly attack the *Abies* (Pacific silver fir included) in the Pacific Northwest: *Echinodontium tinctorium*, *Polyporus sulphureus*, *Hypodermella abietis-concoloris* and *Hypoderma robustum*, *Melampsorella elatina* and various species of needle rust fungi.

43. _____
1927. Losses in windthrown timber. Timberman 28(10): 178, 180, 182, 184, 186, illus.

Examinations were made periodically on the deterioration rate of timber windthrown in 1921. By 1926 western hemlock and Pacific silver fir were completely unmerchantable, Sitka spruce losses were heavy, and losses in Douglas-fir and western redcedar were comparatively small.

44. Boyce, J. S.
1929. Deterioration of wind thrown timber on the Olympic Peninsula, Washington. U.S. Dept. Agr. Tech. Bul. 104, 28 pp., illus.

Measurements of wood deterioration were made during the summer of 1926 on windthrown (January 29, 1921) western hemlock, Douglas-fir, western redcedar, Pacific silver fir, and Sitka spruce. Pacific silver fir's deterioration rate was exceeded only by that of western hemlock, and timber of both species was nonsalvageable. The sapwood of all species was destroyed, and considerable heartwood of Sitka spruce, Pacific silver fir, and hemlock had rotted. Eleven species of wood-destroying fungi were found attacking the silver fir trees. Those found on more than 10 percent of Pacific silver fir trees were: *Fomes pinicola*, 70 percent of the trees; *Fomes applanatus*, 49.0 percent; *Polystictus abietinus*, 48 percent; *Ganoderma oregonense*, 29 percent, *Fomes annosus*, 16.0 percent; *Fomes roseus* and *Polystictus versicolor*, 16.0 percent.

45. _____
1930. Decay in Pacific Northwest conifers. Yale Univ. Osborn Bot. Lab. Bul. 1, 51 pp., illus.

Notes on decays of various northwestern species. Pacific silver fir is attacked by brown stringy rot *(Echinodontium tinctorium)*, red ring rot, red-brown butt rot, and brown crumbly rot and possibly brown cubical rot caused by sulphur fungus as well.

46. _____
1943. Host relationships and distribution of conifer rusts in the United States and Canada. Conn. Acad. Arts Sci. Trans. 35: 329-482.

Various stages of the following rust fungi have been recorded on Pacific silver fir: *Calyptospora goeppertiana* Kühn, *Hyalopsora aspidiotus* (Peck) Magnus, *Melampsorella cerastii* (Pers.) Schroet., *Milesia fructuosa* Faull, *Peridermium rugosum* Jacks., *Pucciniastrum abieti-chamaenerii* Kleb., *Pucciniastrum myrtilli* (Schum.) Arth., and *Uredinopsis macrosperma* (Cooke) Magn.

47. _____
1961. Forest pathology. Ed. 3. 572 pp., illus. New York and London: McGraw-Hill Book Co.

48. Bray, Mark W., Martin, J. S., and Schwartz, S. L.
1939. Sulphate pulping of silver fir. Effect of chemical concentration and of wood selection on yield and pulp quality. Paper Trade Jour. 109(18): 29-36, illus. (TAPPI Sec.: 233-240)

Pacific silver fir is suitable for the production of both strong kraft and easy-bleaching sulphate pulps. Upper logs and slabwood gave higher yields of pulp and stronger fibers than butt log and heartwood material for kraft and bleachable sulphate pulps.

49. Bray, Mark W., and Martin, J. Stanley.
1947. Sulphate pulping of Douglas-fir, western hemlock, Pacific silver fir, and western redcedar logging and sawmill waste. U.S. Forest Prod. Lab. Rpt. R1641, 10 pp.

Logging and sawmill wastes of these species are suitable for the production of good quality kraft and bleachable sulphate pulps.

Higher yields of kraft pulps, based on moisture-free weights, were obtained from western hemlock and Pacific silver fir than from Douglas-fir; however, Douglas-fir excelled in yield per unit volume of wood.

50. Brayshaw, T. C.
1960. Key to the native trees of Canada. Canada Dept. Forestry Bul. 125, 43 pp., illus.

51. Brink, V. C.
1959. A directional change in the subalpine forest-heath ecotone in Garibaldi Park, British Columbia. Ecology 40: 10-16, illus.

52. _____ and Biller, K.
1963. An unusual leaf inversion in amabilis fir. Canad. Field Nat. 77(1): 61-62.

53. British Columbia Department of Lands.
1929. Report of the Forest Branch for the year ended December 31st, 1928. 54 pp., illus.

54. _____
1931. Report of the Forest Branch for the year ended December 31st, 1930. 55 pp., illus.

55. _____
1932. Report of the Forest Branch for the year ended December 31st, 1931. 52 pp., illus.

56. _____
1933. Report of the Forest Branch for the year ended December 31st, 1932. 38 pp., illus.

57. _____
1934. Report of the Forest Branch for the year ended December 31st, 1933. 39 pp., illus.

58. _____
1935. Report of the Forest Branch for the year ended December 31st, 1934. 39 pp., illus.

59. _____
1936. Report of the Forest Branch for the year ended December 31st, 1935. 37 pp.

60. _____
1937. Report of the Forest Branch for the year ended December 31st, 1936. 44 pp., illus.

61. British Columbia Department of Lands.
1938. Report of the Forest Branch for the year ended December 31st, 1937. 45 pp., illus.

62. _____
1939. Report of the Forest Branch for the year ended December 31st, 1938. 58 pp., illus.

63. _____
1940. Report of the Forest Branch for the year ended December 31st, 1939. 57 pp., illus.

64. _____
1942. Report of the Forest Branch for the year ended December 31st, 1941. 55 pp., illus.

65. British Columbia Department of Lands and Forests.
1948. Report of the Forest Service. Year ended December 31st, 1947. 111 pp., illus.

Contains a volume table for mature coast balsam which probably is mainly Pacific silver fir.

66. _____
1950. Report of the Forest Service. Year ended December 31st, 1949. 141 pp., illus.

Preliminary investigations into decay of western hemlock and Pacific silver fir in the Prince Rupert Forest District showed stand losses of 60 and 49 percent in hemlock and Pacific silver fir, respectively. Decay losses averaged 51 and 44 percent in western hemlock and Pacific silver fir trees, respectively.

67. _____
1951. Report of the Forest Service. Year ended December 31st, 1950. 133 pp., illus.

68. _____
1952. Report of the Forest Service. Year ended December 31st, 1951. 153 pp., illus.

The forest associations on the west coast of Vancouver Island were divided into two categories: group A, associations maintained by denuding factors (principally fire) recurring every 300 to 500 years, and group B, associations capable of being maintained in the long-continued absence of denuding factors.

Pacific silver fir is a characteristic species of the latter category and occurs in the dominant canopy of the (1) Deerfern-Three-leaved Collwort-Beech fern Association and (2) the Vaccinium-Moss-Deerfern Association, is capable of attaining dominance in the (3) Vaccinium-Bunchberry Association; and occurs in the lower strata of the (4) Salal-Bunchberry-Sphagnum Association.

69. _____
1953. Report of the Forest Service. Year ended December 31st, 1952. 171 pp., illus.

70. British Columbia Department of Lands and Forests.
1955. Report of the Forest Service. Year ended December 31st, 1954. 147 pp., illus.

71. _____
1957. Report of the Forest Service. Year ended December 31st, 1956. 149 pp., illus.

Contains tables of diameter class net volume factors for coniferous trees with or without visible signs of decay. Coast balsam is presumably mainly Pacific silver fir.

72. _____
1959. Report of the Forest Service. Year ended December 31st, 1958. 125 pp., illus.

73. _____
1960. Report of the Forest Service. Year ended December 31st, 1959. 127 pp., illus.

74. Britton, Nathaniel Lord, and Shafer, John Adolph.
1908. North American trees; being descriptions and illustrations of the trees growing independently of cultivation in North America, north of Mexico and the West Indies. 894 pp., illus. New York: Henry Holt & Co.

75. Brockman, C. Frank.
1933. The forests of Mt. Rainier. Nat. Hist. 33: 523-532, illus.

76. _____
1947. Flora of Mount Rainier National Park. U.S. Dept. Int., 170 pp., illus.

Pacific silver fir is one of the most widely distributed tree species in the park. It is typical of the Canadian Zone and occurs up to the lower limits of the Hudsonian Zone.

77. _____
1949. Conifers of the Cascades. Univ. Wash. Arbor. Bul. 12: 11-13, 31, illus.

A general listing of species and their habitats along the Cascade Range from Mount Baker in Washington to Mount Lassen in California. Pacific silver fir is the dominant true fir in the Cascades near the middle elevations.

78. _____
1949. Trees of Mount Rainier National Park. 49 pp., illus. Seattle: University Washington Press.

"Most widely distributed...and...abundant true fir in the state of Washington...the most common of the true firs in Mount Rainier National Park."

Needles clothe branches thickly, growing from both sides of the twig and along the top as well. Cones are barrel shaped, deep purple in color, 3 to 6 inches long, and about 2-1/2 inches wide. Bark is smooth, ash gray, and distinctly marked with conspicuous chalky areas; it is rarely furrowed and ridged, and, if so, only near the base.

79. Brockman, C. Frank.
1955. Pacific silver fir, *Abies amabilis* (Dougl.) Forbes. Univ. Wash. Arbor. Bul. 18(4): 97, illus.

A general description of the gross botanical characteristics of Pacific silver fir and a comparison of these with the botanical characteristics of common true fir associates that may be confused with it. The role of the beetle, *Pseudohylesinus* sp., in logging Pacific silver fir is mentioned.

Foliage of Pacific silver fir grows from the top as well as the sides of the branches--sometimes hiding the twig--a feature distinguishing it from grand fir whose foliage grows only from the sides of the branch. Pacific silver fir is stomatiferous only on the lower surface of its foliage, whereas noble and alpine fir foliage has stomates on all surfaces. In addition, the individual leaves of noble fir are usually plump or angular in cross section while the leaves of silver fir are flat.

The cones of Pacific silver fir are deep purple in color, cylindrical, and 3-1/2 to 6 inches long. Subalpine fir cones, though purple, are smaller and different in shape; grand fir cones are green and smaller; noble fir cones are larger, columnar in form, and their overlapping green bracts extend from between the cone scales, covering the cones.

80. Browne, J. E.
1962. Standard cubic-foot volume tables for the commercial tree species of British Columbia, 1962. Brit. Columbia Forest Serv., 107 pp.

81. Brush, Warren D.
1945. Silver fir, *Abies amabilis* (Dougl.) Forb. Amer. Forests 51: 498-499, illus.

A general description of the species and its silvical characteristics.

82. Brydon, James E., Dore, William G., and Clark, John S.
1963. Silicified plant asterosclereids preserved in soil. Soil Sci. Soc. Amer. Proc. 27: 476-477, illus.

Tests with plant material of several species including Pacific silver fir indicated that only Douglas-fir yielded opal particles resembling those found in a soil on Vancouver Island.

83. Buchanan, T. S.
1940. Fungi causing decay in wind-thrown Northwest conifers. Jour. Forestry 38: 276-281.

An evaluation of the fungi causing decay in timber windthrown in 1921 and examined in 1926, 1929, and 1936. Pacific silver fir was examined only in 1926. At that time, it had the greatest variety of sporophores on a higher percentage of trees (99 percent) than any of the other species, and 54 percent of Pacific silver fir cubic-foot volume was lost. Of the three most important fungi, *Fomes pinicola* was present on 70 percent of the trees, decaying 28 percent of the volume; *F. applanatus* on 49 percent of the trees, decaying 33 percent of the volume; *Polyporus abietinus* on 48 percent of the trees, decaying 14 percent of the volume.

84. Buchanan, T. S.
1948. *Poria weirii:* Its occurrence and behavior on species other than cedars. Northwest Sci. 22: 7-12.

85. _____ and Englerth, G. H.
1940. Decay and other volume losses in wind-thrown timber on the Olympic Peninsula, Wash. U.S. Dept. Agr. Tech. Bul. 733, 30 pp., illus.

A continuation of Boyce's study (cf. ref. 41). The results are practically the same.

86. _____ and Englerth, G. H.
1943. Deterioration of Olympic wind thrown timber. Timberman 44(8): 24, 26, 28, 30, illus.

Popularized version of the information presented in the U.S. Dept. Agr. Tech. Bul. 733.

87. Buckhorn, W. J., and Lauterbach, Paul G.
1957. Timing of aerial surveys for the balsam woolly aphid.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Note 142, 2 pp.

88. _____ and Orr, P. W.
1959. Forest insect conditions in the Pacific Northwest during 1958.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta., 41 pp., illus.

89. _____ and Orr, P. W.
1959. Forest insect conditions in the Pacific Northwest during 1959.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta., 37 pp., illus.

90. _____ and Orr, P. W.
1961. Forest insect conditions in the Pacific Northwest during 1960.* U.S. Forest Serv. Pacific NW. Forest & Range Expt. Sta., 40 pp., illus.

91. _____ and Orr, P. W.
1962. Forest insect conditions in the Pacific Northwest during 1961.* U.S. Forest Serv. Region 6, 41 pp., illus.

92. Buckland, D. C., Foster, R. E., and Nordin, V. J.
1949. Studies in forest pathology. VII. Decay in western hemlock and fir in the Franklin River area, British Columbia. Canad. Jour. Res. C, 27: 312-331, illus.

An investigation of decay in true firs (primarily Pacific silver fir) and western hemlock in the Juan de Fuca forest region on southern Vancouver Island, B. C. *Poria subacida* accounted for 17.7 percent, *Armillaria mellea* 6.6 percent, and *Fomes annosus* 3.0 percent of the infections occurring in the fir, all three as root or butt rots. *Poria weirii* caused 2.2 percent of the infections in western hemlock but none in the fir. *Fomes pinicola* was the most important trunk rot, accounting for 19.7 percent of all infections. Other organisms occurring in the trunk and their percent of all infections were: *Stereum abietinum*, 15.1 percent, and *Hydnum abietis*, 5.6 percent. In fir, trunk infections were 53.0 percent of the total, root and butt infections 41.9 percent, and sap rots 5.1 percent. Almost two-thirds of the infections entered through scars.

In terms of loss through decay, *Fomes pinicola* was most important, causing 40.5 percent of the total decay volume in fir. *Hydnum abietis* was next in importance, causing 12.1 percent, and *Poria subacida* was third with 11.5 percent. *Fomes pini*, of importance in western hemlock stands, was a minor cause of loss in fir.

Studies of decay in relation to age showed fir to be a shorter lived tree than western hemlock. Below 300 years of age, fir was more resistant than hemlock, but beyond that age incidence of decay was greater in fir, all trees over 400 years old being infected. Tables showing the relation between age and volume of decay are also included. Decay volume goes from 0 percent at 75 years to 11.3 percent at 275 and 39.6 percent at 375 years. The relation of decay to diameter is also tabulated and plotted. Attempts to relate decay to rate of growth were not successful.

Actual volumes of fir utilized by a logging company in the area were 84 percent of the average gross board-foot volumes to a 10-inch top, or 89 percent of the net volume. Losses other than through decay were mostly top breakage in fir.

93. Buell, Edward D.
1938. Forest statistics for Clatsop County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta., 11 pp., illus.

94. _____
1941. Forest statistics for Polk County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 83, 14 pp., illus.

95. Buffam, P. E.
1962. Observations on the effectiveness and biology of the European predator *Laricobius erichsonii* Rosen. (Coleoptera: Derodontidae) in Oregon and Washington. Canad. Ent. 94: 461-472, illus.

96. Burden, F. P., Naden, G. R., and Caverhill, P. Z.
1928. Forests and forestry in British Columbia. Brit. Columbia Dept. Lands Forest Branch, 33 pp., illus.

97. Burns, Findley.
1911. The Olympic National Forest: Its resources and their management. U.S. Dept. Agr. Forest Serv. Bul. 89, 20 pp., illus.

Pacific silver fir is generally confined to the western and southern portions of the forest, where it grows in two silvicultural types: the foothill or lower type and the upper-slope or subalpine type. Pacific silver fir and grand fir are estimated to comprise 15 percent of the total merchantable timber in the forest.

98. Canada Department of Agriculture.
1942. Twenty-first annual report of the Canadian plant disease survey, 1941. 102 pp.

Poria weirii is reported killing Pacific silver fir at elevations of 3,000 to 4,000 feet near Youbou, B. C.

99. Canada Department of Interior.
1917. Canadian woods for structural timbers. Forestry Branch Bul. 59, 44 pp., illus.

100. Canada Department of Mines and Resources.
1941. Report of the lands, parks and forest branch for the fiscal year ended March 31, 1940. Ann. Rpt., pp. 60-135.

101. Canada Department of Northern Affairs and National Resources.
1956. Strength and related properties of woods grown in Canada. Forestry Branch Forest Prod. Lab. Tech. Note 3, 7 pp.

102. Canada Department of Resources and Development Forestry Branch.
1951. Canadian woods--their properties and uses. Ed. 2, 367 pp., illus. Ottawa: Edmond Cloutier, King's Printer and Controller of Stationery.

103. Canada Dominion Forest Service.
1961. Native trees of Canada. Canada Dept. Mines and Resources, Dominion Forest Serv. Bul. 61, ed. 6, 291 pp., illus.

104. Carl, G. Clifford, Guiguet, C. J., and Hardy, George A.
1952. A natural history survey of the Manning Park area, British Columbia. Brit. Columbia Provisnl. Mus. Occas. Papers 9, 130 pp., illus.

105. Carlberg, G. L., and Kurth, E. F.
1960. Extractives from the western true firs. TAPPI 43: 982-988, illus.

Extractives from Pacific silver fir, noble fir, white fir, and grand fir were comparatively examined for their composition in an attempt to find differences on which to base a distinquishing chemical test. No distinguishing differences were found in the extractives from the wood of these species. Paper chromatography indicated that only Pacific silver fir may have a component that is different from the other species.

106. Carpenter, Stanley Barton.
1961. A description of the Pacific silver fir-hemlock forest on the western slopes of the Cascade Mountains in the vicinity of Mount Rainier, Washington. 55 pp., illus. Unpublished M. S. thesis on file at Univ. Wash.

An analysis of five forest community types occurring in the Mount Rainier area. Types are segregated on the basis of elevation, species composition, and stand structure.

Pacific silver fir is present mainly as an understory species in the Canadian-Humid Transition Zones between 3,000 and 3,500 feet. The dominant tree species in this area are western hemlock, western redcedar, and sometimes Douglas-fir. Soils are deep and of good quality. Litter accumulates to depths of 3 to 4 inches. At 3,500 to 4,000 feet, Pacific silver fir and western hemlock dominate the stand canopy; silver fir also dominates the understory, although hemlock is present. Alaska-cedar, noble fir, and Douglas-fir are present as minor components. Soil characteristics and litter depths are approximately the same. From 4,000 to 4,600 feet, the forest stands are composed almost entirely of Pacific silver fir. Occasional specimens of subalpine fir, mountain hemlock, and Alaska-cedar are scattered through the stand, and western hemlock occurs sparsely in the understory. The soils are shallow podsols and the litter layer is 4 to 5 inches deep. From 4,600 to 5,000 feet, the forests gradually become more open, resembling those found in the Hudsonian Zone. Pacific silver fir is present but does not

dominate. Western white pine, Alaska-cedar, Douglas-fir, mountain hemlock, and subalpine fir are present. The soils are extremely shallow; no organic layer is present. Meadow vegetation is found between and under the scattered trees.

107. Ceballos y Fernández de Córdoba, Luis.
1958. Los abetos del mundo. Montes (Madrid) 14(80): 91-102, illus.

Contains generalized distribution maps of some of the world's more commercially important species of true firs, Pacific silver fir included.

108. Chamberlin, Willard Joseph.
1918. Bark beetles infesting the Douglas-fir. Oreg. Agr. Col. Expt. Sta. Bul. 147, 40 pp., illus.

109. Chamberlin, W. J.
1958. The Scolytoidea of the Northwest; Oregon, Washington, Idaho and British Columbia. 208 pp., illus. Corvallis: Oregon State College.

110. Chang, Ying-Pe.
1954. Bark structure of North American conifers. U.S. Dept. Agr. Tech. Bul. 1095, 86 pp., illus.

111. Childs, T. W., and Clark, J. W.
1953. Decay of wind-thrown timber in western Washington and northwestern Oregon. U.S. Bur. Plant Indus. Forest Path. Spec. Release 40, 20 pp., illus.

Graphs and tabulated data provide information on rates of decay in wind-thrown Douglas-fir, Sitka spruce, western hemlock, and Pacific silver fir. Pacific silver fir decays rapidly compared with associated species.

112. Chittenden, F. J., ed.
1931. Conifers in cultivation: the report of the conifer conference held by the Royal Horticultural Society. 634 pp., illus. London: Royal Horticultural Society.

Contains listings of the largest trees of each species planted in Britain and the important books on the subject published between 1553 and 1931.

Contains many pieces of information concerning the relative success of Pacific silver fir in many parts of Great Britain, the history of its identification by early botanists, and its economic value.

113. Clark, Donald H.
1946. Methods for processing secondary species for wood shingles. Jour. Forestry 44: 878-880.

Pacific silver fir shingles treated with a combination of urea, dimethylolurea, and a plasticising agent, may compete successfully with other roofing materials.

114. Clifford, N.
1957. Timber identification for the builder and architect. 141 pp., illus. London: Leonard Hill Ltd.

115. Coleman, W.
1889. On conifers. Jour. Roy. Hort. Soc. London 11: 320-339.

Remarks on the selection of coniferous species, sites and planting procedures, and general horticultural information for establishing pinetums. Pacific silver fir is mentioned as a suitable species.

116. Collingwood, G. H., and Brush, Warren D.
1955. Knowing your trees. New and rev. ed., 328 pp., illus. Washington, D. C.: American Forestry Association.

117. Coltman-Rogers, Charles.
1920. Conifers and their characteristics. 333 pp., illus. New York: The Macmillan Co.

118. Condon, Thomas.
[n.d.] The forest trees of Oregon. II, III. West. Amer. Sci. 7: 115-117; 142-143.

119. Cooke, M. C.
1905. Fungoid pests of forest trees. Jour. Roy. Hort. Soc. London 29: 361-391.

Silver fir cluster-cups are discussed on p. 386. *Aecidium pseudo-columnare* (Kuhn), known in Great Britain as *Peridermium columnare*, occurs on Pacific silver fir in Britain and Germany.

120. Cooke, Wm. Bridge.
1962. On the flora of the Cascade Mountains. Wasmann Jour. Biol. 20: 1-67.

A comparison of the floras of Mount Baker, Mount Rainier, Mount Mazama (Crater Lake), Mount Shasta, and Mount Lassen. Pacific silver fir is found on the first two mountains listed.

121. _____ and Shaw, Charles Gardner.
1952-53. The Suksdorf fungus collections. Wash. State Col. Res. Studies 20: 135-145; 21: 3-57.

The following fungal species were collected on Pacific silver fir: *Hypoderma robustum* v. Tub., *Lophodermium consociatum* Darker, *Corticium radiosum* Fr.

122. Cooper, W. S.
1957. Vegetation of the Northwest-American province. Pac. Sci. Cong. Proc. 8(4): 133-138.

123. Coulter, W. K.
1954. Silver fir beetles *(Pseudohylesinus)*. NW. Forest Pest Leaflet 1, 4 pp. [unnumbered]. Portland, Oreg.: Industrial Forestry Association.

124. _____ and Hunt, John.
1953. Progress report; *Pseudohylesinus* bark beetles in silver fir in the State of Washington, 1949-1952. U.S. Bur. Ent. Plant Quar. Forest Insect Lab. unpublished office rpt., 24 pp., illus. Portland, Oreg.

A discussion of the severe damage to mature and overmature Pacific silver fir trees in mixed stands caused by an association of bark beetles, *Pseudohylesinus granulatus* Lec. and *P. grandis* Sw., and parasitic fungi, principally *Armillaria mellea*. It appears that the fungus assists the beetles in overcoming the host resistance and providing favorable food for developing larvae; the insects provide the fungus with avenues of entry into the tree and are a partial means of dispersal. The success of this association appears related to host vigor. Effectiveness of control by salvage logging is limited, and increased utilization of the timber resource is stressed.

Other fungi found associated with the bark beetles are: *Fomes annosus*, *Poria weirii*, and *Poria subacida*.

125. Cowlin, R. W., Moravets, F. L., and Forest Survey Staff.
1937. Timber volume and type acreage on the national forests of the North Pacific Region, from the inventory phase of the forest survey. U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Res. Notes 22, 6 pp. plus 10 tables, illus.

126. Cox, William T.
1911. Reforestation on the national forests. Pt. 1--Collection of seed. Pt. 2--Direct seeding. U.S. Dept. Agr. Forest Serv. Bul. 98, 57 pp., illus.

127. Currier, Raymond A.
1963. Compressibility and bond quality of western softwood veneers. Forest Prod. Jour. 13(2): 71-80.

Compressibility and panel thickness during hot pressing and after reconditioning were determined for Pacific silver fir veneer bonded with interior blood glue and exterior phenolic glue. Bond quality was ascertained by standard test methods.

128. Curtis, Carlton C., and Bausor, S. C.
1943. The complete guide to North American trees. 337 pp., illus. New York: New Home Library.

129. Dallimore, W., and Jackson, A. Bruce.
1948. A handbook of Coniferae including Ginkgoaceae. Ed. 3, 682 pp., illus. London: Edward Arnold & Co.

130. Darker, Grant Dooks.
1932. The Hypodermataceae of conifers. Arnold Arboretum Contrib. 1, 131 pp., illus.

The following rusts have been found on Pacific silver fir: *Hypoderma robustum* v. *Tubeuf*, *Hypodermella punctata*, sp. nov., *Hypodermella abietis-concoloris* (Mayr) Dearn., *Lophodermium uncinatum*, sp. nov., *Lophodermium autumnale*, sp. nov., *Lophodermium consociatum*, sp. nov.

131. Davidson, J.
1931. The flora of British Columbia. Jour. Roy. Hort. Soc., London 56: 201-206.

132. Davidson, John, and Abercrombie, Ivy.
1927. Conifers, junipers and yew: gymnosperms of British Columbia. 72 pp., illus. London: T. Fisher Unwin Ltd.

133. Davidson, John G. N.
1961. A nutritional study of grand fir and amabilis fir in the greenhouse. Unpublished M. S. thesis on file Univ. Brit. Columbia, 177 pp., illus.

The effects of deficiencies of nitrogen, phosphorus, potassium, calcium, magnesium, and sulphur on the growth and development of Pacific silver fir and grand fir seedlings were studied. These deficiencies caused a significant reduction of growth of both species, except in the low sulphur treatment which was probably contaminated. Deficiencies of these elements affected the root/shoot and foliage/stem ratios and produced a reduction in the total moisture content.

Foliage analyses revealed that in each case the total concentration of the deficient element was much reduced. The grand fir foliage concentrations were consistently higher than for amabilis fir and were influenced more greatly by the treatments.

Each deficiency produced a different visual effect. These were documented photographically, chiefly in color. The actual colors of symptoms were not specific, but the patterns generally were. Diagnostic keys to the deficiency symptoms were prepared. Magnesium and phosphorus symptoms were very distinctive, potassium and calcium were usually so, and nitrogen was the least. An unreported type of calcium deficiency symptom was observed and described.

No single criterion expressed the net result of any treatment. Deficiency symptoms changed with time. In general, it was observed that grand fir is more sensitive to deficiencies than amabilis fir.

134. Day, W. R.
1957. Sitka spruce in British Columbia; a study in forest relationships. Gt. Brit. Forestry Comn. Bul. 28, 110 pp., illus.

135. Dick, James.
1960. A direct seeding of Pacific silver fir.* Weyerhaeuser Co. Forestry Res. Center Forestry Res. Note 33, 4 pp.

An experimental seeding of endrin-treated Pacific silver fir and Douglas-fir seeds and untreated Pacific silver fir seeds resulted in significantly greater stocking of Douglas-firs. There were no significant differences between treated and untreated Pacific silver fir seed in stocking of plots.

In order to obtain equivalent quantities of viable seed per acre, Pacific silver fir seed was sown at the rate of 7 pounds per acre whereas Douglas-fir was sown at the rate of 0.57 pound per acre. Although Pacific silver fir seed costs less, the greater quantity of seed made direct seeding of Pacific silver fir six times more expensive than seeding of Douglas-fir.

136. Dickson, F.
1927. A study of heart-rot in the amabilis fir *(Abies amabilis)* in the Upper Fraser region of British Columbia. Unpublished report of the Dept. Bot., Univ. Brit. Columbia, 44 pp.

A severely suppressed stand of Pacific silver fir, growing beneath Engelmann spruce in the Aleza Lake district of British Columbia, was heavily infected with *Echinodontium tinctorium*. Out of the 502 trees examined, 57.7 percent (17.4 percent of the total volume) were defective. Branch stubs were the most

frequent infection courts; other injuries usually served to increase the rate of the longitudinal spread of the rot. The number of defective trees and the volume of rot increased with age. No trees below 120 years of age showed infection.

Suggested control measures: heavy cutting of Pacific silver fir in timber sales, burning of infectious debris, and fire-girdling of all standing defective trees to prevent further production of sporophores.

137. Dimock, Edward J., II.
1958. Silvical characteristics of Pacific silver fir.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Silvical Series 4, 12 pp., illus.

Summarizes the habitat conditions and life history of Pacific silver fir.

138. Dimpflmeier, R. von.
1957. Winterfrostshäden 1955/56 im forstlichen Exotenversuchsgelände Grafrath. Forstwiss. Centbl. 76: 174-187, illus.

Pacific silver fir suffered light needle damage from severe frosts. Many other species, including other true firs, were more heavily damaged.

139. Dixon, Dorothy.
1961. These are the champs. Amer. Forests 67(1): 40-46, 48-50, illus.

The largest Pacific silver fir known is 245 feet tall, is 26 feet 3 inches in circumference, has a crown spread of 54 feet, and is located in the Olympic National Park, Washington.

140. Dodwell, Arthur, and Rixon, Theodore F.
1900. Olympic Forest Reserve, Washington. U.S. Geol. Survey 21st Ann. Rpt. 1899-1900, Pt. 5, Forest Reserves: 145-208, illus.

Contains brief general descriptions of the location and boundaries of the reserve and its natural and cultural features. Data on forest conditions and timber volumes, which make up the greater portion of the article, are presented by townships. Maps indicating tree species distributions on the reserve are included.

The reserve was heavily forested up to 3,000-foot elevation. The total volume of timber in the reserve was 37,100 million board feet. Distribution of the volume by species was estimated as follows: western hemlock, 42 percent; Douglas-fir, 26 percent; Pacific silver fir, 15 percent; western redcedar, 10 percent; and Sitka spruce, 7 percent. Pacific silver fir was found at considerable elevations in the reserve but rarely below 1,500 feet.

141. _____ and Rixon, Theodore F.
1902. Forest conditions in the Olympic Forest Reserve, Washington. U.S. Geol. Survey Prof. Paper 7, 110 pp., illus.

Pacific silver fir comprised 18 percent of the total volume of timber on the reserve and was second only to western hemlock in abundance. It was found everywhere except on the immediate coast of the Pacific Ocean and on the highest mountains. It was not found in commercial amounts below 1,500 feet. Average height was 164 feet and average diameter was 35 inches.

142. Douglas-fir Second-Growth Management Committee.
1947. Management of second-growth forests of the Douglas-fir region. U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta., 151 pp., illus.

143. Douglass, Bernard S.
1960. Collecting forest seed cones in the Pacific Northwest.* U.S. Forest Serv. Region 6, 21 pp., illus.

A popular guide to cone collecting in the Northwest which includes information on identification of cones, collection period and cone testing, selection of parent trees, methods of collection, and care of cones after collecting. Cutting tests of Pacific silver fir cones should be made by slicing the cone lengthwise about one-fourth to one-half inch to one side of the core. Seed quality is measured by the percent of exposed seeds that are sound, 50 percent or more constituting a good average.

144. Dowden, Philip B., and Crosby, David.
1958. The present status of the balsam woolly aphid in the United States. Tenth Internatl. Cong. Ent. Proc. (1956) 4: 823-825.

145. Duffield, John W., and Eide, Rex P.
1959. Polyethylene bag packaging of conifer planting stock in the Pacific Northwest. Jour. Forestry 57: 578-579.

146. Dümmer, R. A.
1913. The conifers of the Lindley Herbarium; Botany School, Cambridge. Jour. Roy. Hort. Soc. London 39: 63-91.

147. Dunn, Malcolm.
1892. Statistics of conifers in the British Islands. Jour. Roy. Hort. Soc. London 14: 481-571.

Lists the largest specimens of introduced conifers by counties with their dimensions, health, and the soil condition in which they are growing. Pacific silver fir is listed in many counties.

148. _____
1892. The value in the British Islands of introduced conifers. Jour. Roy. Hort. Soc. London 14: 73-102.

California red fir was widely distributed in Britain from 1850 onwards as the *"Abies amabilis* of Douglas" and is known in many places by that erroneous name.

149. Dyer, E. D. A.
1963. Attack and brood production of ambrosia beetles in logging debris. Canad. Ent. 95: 624-631, illus.

150. Eades, H. W.
1932. British Columbia softwoods, their decays and natural defects. Canada Dept. Int. Forest Serv. Bul. 80, 126 pp., illus.

151. _____
1958. Differentiation of sapwood and heartwood in western hemlock by color tests. Forest Prod. Jour. 8(3): 104-106.

Application of the colorimetric agents, perchloric acid, iron, salts, and the pH indicators bromcresol green and bromphenol blue, showed that true firs (Pacific silver and grand firs) possess a high proportion of sapwood as does western hemlock.

152. Ebell, L. F., and Schmidt, R. L.
1961. The influence of meteorological factors upon dispersal of coniferous pollen on Vancouver Island, British Columbia. Canada Dept. Forestry Pub. 1036, 28 pp., illus.

A three-season record is presented of pollen dispersal characteristics of Douglas-fir and associated species and of meterorological data collected along an elevational transect. The study centered upon the relationship between temperature and the production and maturation of male cones. The temperature records indicated a possible relationship between high July temperatures and the dispersion of pollen in abundance the following year by Douglas-fir, mountain hemlock, and the three species of true firs (grand fir, Pacific silver fir, and subalpine fir).

The most favorable weather for pollen dispersal occurs when a high pressure system prevails over the area; and the most unfavorable conditions are associated with low pressure systems and frontal activity. The duration of pollen release is greatly influenced by current weather conditions.

153. Ebell, Lorne F., and Schmidt, Ralph L.
1960. Effect of elevation and climatic factors on production and dispersal of coniferous tree pollen. (Abs.) Soc. Amer. Foresters Proc. 1959: 39.

154. Edlin, H. L.
1944. British woodland trees. 182 pp., illus. London: B. T. Batsford Ltd.

Pacific silver fir has been grown as a part tree in Britain since 1830 but has little potential there as a forest tree.

155. Eis, Slavoj.
1962. Statistical analysis of several methods for estimation of forest habitats and tree growth near Vancouver, B. C. Univ. Brit. Columbia Faculty Forestry Bul. 4, 76 pp., illus.

156. Eliot, Willard Ayres, and McLean, G. B.
1938. Forest trees of the Pacific coast. New ed., 565 pp., illus. New York: G. P. Putnam's Sons.

A dendrological reference which provides a description of the range of the species as well as information on the silvics.

157. Elliott, Simon B.
1912. The important timber trees of the United States. A manual of practical forestry. 382 pp., illus. Boston and New York: Houghton Mifflin Co.

158. Elwes, Henry John, and Henry, Augustine.
1909. The trees of Great Britain & Ireland. v. 4, pp. 713-1000, illus. Edinburgh: Privately printed.

159. Empire Forestry Association.
1962. The Commonwealth Forestry handbook, 1962. Ed. 8, rev., 142 pp. London: Empire Forestry Association.

160. Engelhardt, N. T.
1957. Pathological deterioration of looper-killed western hemlock on southern Vancouver Island. Forest Sci. 3: 125-136, illus.

After the second year, decay fungi rapidly penetrated western hemlock trees and reduced the saw log volume below the point of economic recovery by the fifth year. The most important decay-causing fungus was *Fomes pinicola* (Sw.) Cooke, which accounted for 56 percent of the infections and 81 percent of the decay. An examination of a few looper-killed Pacific silver firs revealed a deterioration rate equal to that of western hemlock.

161. Engelmann, George.
1878. A synopsis of the American firs. Acad. Sci. Trans. St. Louis 3: 593-602.

The article attempts to subdivide the genus *Abies* using leaf structure and length of bracts.

Engelmann, after examining foliage specimens from various botanical collections, believed that trees cultivated from some of Douglas' Oregon seeds under the name *A. amabilis* are variety *densiflora* of *A. grandis*. (See next reference).

162. _____
1882. Notes on western conifers. Bot. Gaz. 7: 45.

"*Abies amabilis* (Douglas) Forbes, is not a variety of *A. grandis* as I had assumed, but a very distinct species peculiar to the higher mountains of the Cascade Range from Oregon to British Columbia. It is easily recognized by its dense, dark-green, glossy leaves, very white underneath, usually emarginate, but on the fertile branchlets acute; by its large very thick purple cones and oblanceolate acuminate bracts."

163. English, Edith Hardin.
1951. The flowering season on Mount Baker. Univ. Wash. Arboretum Bul. 14(3): 8-12.

164. _____
1958. Plant life of the area surrounding Glacier Peak. Mountaineer 51(4): 28-39.

165. Engstrom, W. H.
1953. Oregon cone crop, 1953.* Oreg. State Bd. Forestry Res. Note 13, 6 pp., illus.

166. _____
1954. Oregon cone crop, 1954.* Oreg. State Bd. Forestry Res. Note 16, 7 pp.

167. Faull, J. H.
1934. The biology of Milesian rusts. Jour. Arnold Arboretum 15: 50-85.

An account of the biology of the fern rusts belonging to the genus *Milesia* including a list of hosts. True firs serve as alternate hosts for these fern rusts, although the various rust species do not appear very host specific. Successful inoculations of *Milesia fructuosa* have been made on many firs including Pacific silver fir, white fir, and California red fir. Some of these rusts are a potential

hazard to natural regeneration of true firs and kill or reduce the growth of seedlings and saplings associated with rust-infected ferns.

168. Ferguson, J. W.
1939. How to identify Oregon trees. Oreg. State Bd. Forestry, 15 pp.

169. Ferré, Y. de.
1952. Les formes de jeunesse des Abiétacées. Ontogénie-phylogénie. Toulouse Univ. Lab. Forest. Trav., tome 2, v. 3, art. 1, 284 pp., illus.

170. Flett, J. B.
1922. Features of the flora of Mount Rainier National Park. U.S. Dept. Int. Natl. Park Serv., 50 pp., illus.

Pacific silver fir is sometimes called larch by lumbermen. It is generally present in the park between elevations of 2,000 and 4,000 feet.

171. Forbes, James.
1839. Pinetum Woburnense: or a catalogue of coniferous plants in the collection of the Duke of Bedford at Woburn Abbey. 226 pp., illus. London.

A compilation of brief botanical descriptions and notes of various conifers accompanied by detailed colored drawings of cone, cone scale, leaf, seed, and branchlet specimens. Contains one of the earliest botanical descriptions of Pacific silver fir. The accompanying drawings of cone, branchlet, leaves, etc., are not botanically accurate. The cone, though of correct genus and size, is incorrectly colored brown instead of purple. The leaves and branchlet resemble those of *Picea* not *Abies*. It appears that the drawing was made from mixed specimens of *Abies* and *Picea*.

172. Forest Soils Committee of the Douglas-fir Region.
1957. An introduction to forest soils of the Douglas-fir region of the Pacific Northwest. Various paging, illus. Seattle: University Washington.

173. Foster, R. E., Browne, J. E., and Foster, A. T.
1958. Studies in forest pathology. XIX. Decay of western hemlock and amabilis fir in the Kitimat region of British Columbia. Canada Dept. Agr. Pub. 1029, 37 pp., illus.

Measurements of decay incidence and degree are collated with gross volumes of western hemlock and Pacific silver fir logs in two sample areas described by their vegetative associations: (1) the "fern" association, western hemlock–Pacific silver fir–beech fern–oak fern, and (2) the "moss" association, western hemlock–Pacific silver fir–tall blue bilberry–moss. There was no significant difference between the associations in the amount of decay. However, western hemlock reached its best regional development in the fern association, and Pacific silver fir attained its best regional development in the moss association. In both associations, hemlock and fir had a history of early suppression and temporary releases during the first 100 years of their growth.

A tree decadence classification was applicable to both hemlock and Pacific silver fir and indicated average volumetric losses of approximately 6, 36, and 82 percent for residual, suspect, and dead trees, respectively. Generally, decay

increased and net volume decreased with increasing age and diameter. However, subsamples indicated that older surviving trees per se do not necessarily contain less sound wood than younger trees. Approximately 16 percent of the Pacific silver fir was scarred, 70 percent of the scar occurring in the bottom 16 feet of the boles.

Echinodontium tinctorium E. & E. was the most important fungus found attacking living Pacific silver fir, accounting for 41 percent of the infections and 65 percent of the decay. *Fomes pini* (Thore ex Fr.) Karst. was found in 8 percent of the infections and caused 13 percent of the decay. Other white rots found, in order of relative importance, are: *Hericium* sp., *Stereum sanguinolentum* A. & S. ex Fr., *Fomes annosus* Fr., *Poria subacida* (Pk.) Sacc., *Polyporus tomentosus* Fr., and *Armillaria mellea* (Vahl. ex Fr.) Quil. Brown cubical rots found on fir and listed in order of their relative importance are: *Stereum abietinum* Pers., *Fomes pinicola* (Sw.) Cke., and *Polyporus sulphureus* Bull. ex Fr.

174. Foster, R. E., Thomas, G. P., and Browne, J. E.
1953. A tree decadence classification for mature coniferous stands. Forestry Chron. 29: 359-366, illus.

Individual trees in varying stages of susceptibility to and deterioration by wood-destroying fungi can be classified by the presence or absence of visible abnormalities indicative of decay. The classification was composed of: suspect trees, living trees with one or more abnormalities indicative of decay; residual trees, living trees with no abnormality indicative of decay; and dead trees.

Of 102 Pacific silver firs from the Kitimat region, 28 percent of the residual, 63 percent of the suspect, and 100 percent of the dead trees contained defects. These were associated with 13.1 percent decay in the residual class, 37.7 percent decay in the suspect, and 100 percent decay in the dead trees.

175. Foster, R. E., and Ziller, W. G.
1952. Forest disease survey, British Columbia. Canada Dept. Agr. Forest Insect and Disease Survey. Ann. Rpt. 1951: 147-154, illus.

Decay losses in Pacific silver fir are not excessively high--they approach an average cull factor of 30 percent. However, only the younger age and small diameter classes are entirely free from defect. The Indian paint fungus, *Echinodontium tinctorium* Ellis and Everh. and *Fomes pini* (Thore) Lloyd caused 55 and 17 percent of the total decay.

176. Franco, João do Amaral.
1949. Notas nomenclaturais. Soc. Broteriana (Coimbra) B., (ser. 2) 23: 159-176. [In Portugese.]

Took up the name *Abies grandis* for the species universally known as *A. amabilis* and published the new name *A. excelsior* for the species known as *A. grandis*.

177. _____
1950. Abetos. Anais Inst. Superior Agron. vol. 17, 260 pp., illus.

178. Franklin, Jerry F.
1961. A guide to seedling identification for 25 conifers of the Pacific Northwest.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta., 65 pp., illus.

Contains information on the seedling characteristics of Pacific silver fir up to the age of 1 year.

179. Franklin, Jerry F.
1963. A proposed physiographic subdivision of the true fir–hemlock forests of the Pacific Northwest. (Abs.) Northwest Sci. 37: 159.

180. _____
1964. Color of immature cones of several Pacific Northwest conifers. Forest Sci. 10: 103-104.

Pacific silver fir growing in the Cascade Range of Oregon and Washington has been observed to produce immature cones of two colors, green and red. The red form is more abundant. Color variation occurs in the cone bracts; thus, it can only be observed when the cones are very young.

181. _____
1964. Douglas' squirrels cut Pacific silver fir cones in the Washington Cascades. U.S. Forest Serv. Res. Note PNW-15, 3 pp., illus.

Observations in the Washington Cascade Range during 1962 indicate the Douglas' squirrel directly affects both present and future seed crops of Pacific silver fir. Squirrels harvest cones by cutting the entire cone-bearing twig rather than by cutting the cone pedicel. As a result, some of the next year's cone buds are removed with the present year's cones.

182. _____ and Trappe, James M.
1963. Plant communities of the northern Cascade Range: a reconnaissance. (Abs.) Northwest Sci. 37: 163-164.

Pacific silver fir is a major climax species in both the *Abies amabilis-Tsuga mertensiana* and *Abies amabilis-Tsuga heterophylla* zones along much of the crest and through the western North Cascades. Pacific silver fir is a timberline species along the westernmost parts of the North Cascades.

183. Frye, Theodore C., and Rigg, George B.
[n.d.] Northwest Flora. 453 pp. Seattle: University Washington.

184. Fulling, Edmund H.
1934. Identification, by leaf structure, of the species of *Abies* cultivated in the United States. Torrey Bot. Club Bul. 61: 497-524, illus.

Fulling prepared a key to species of *Abies* using leaves from sterile branches and a series of photomicrographs of leaf cross sections. He extensively reviewed the literature concerning the anatomical specificity of leaf structure and examined structural variation of particular species. Fulling concluded, at least in regard to those characters necessary for identification, that structural variation is negligible. The "procedure section" of the article fully describes sources and selection of material and methods and techniques of material preparation.

Abies amabilis: "Stomata abundant only on lower surface...hypodermal layer more or less continuous, only an occasional cell or two lacking along upper surface,...leaves not stomatiferous on upper surface."

185. Gannett, Henry.
1902. The forests of Oregon. U.S. Geol. Survey Prof. Paper 4, 36 pp., illus.

186. _____
1902. The forests of Washington; a revision of estimates. U.S. Geol. Survey Prof. Paper 5, 38 pp., illus.

187. Garman, E. H.
1963. Pocket guide to the trees and shrubs of British Columbia. Brit. Columbia Forest Serv. Pub. B 28 (ed. 3, rev.), 137 pp., illus.

188. Gedney, Donald R., and Mayer, Carl E.
1956. Forest statistics for Hood River County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 125, 28 pp., illus.

In 1954, the net volume of live Pacific silver fir sawtimber and growing stock inventoried on commercial forest land in Hood River County, Oregon, was 399 million board feet (Scribner) and 113 million cubic feet, respectively.

189. _____ and Spada, Benjamin.
1958. Forest statistics for Wasco County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 127, 33 pp., illus.

In 1954, the net volume of live sawtimber and growing stock of Pacific silver fir in Wasco County was estimated as 54 million board feet (Scribner) and 32 million cubic feet, respectively.

190. _____ and Twerdal, Melvin P.
1956. Forest statistics for Klickitat County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 124, 27 pp., illus.

191. Gibson, Henry H.
1913. American forest trees. 708 pp., illus. Chicago: Hardwood Record.

192. Gildemeister, E.
1916. The volatile oils. Ed. 2, v. 2, 686 pp., illus. Miltitz near Leipzig: Schimmel and Co.

193. Gilkey, Helen M., and Powell, Garland M.
1961. Handbook of Northwest flowering plants. Ed. 2, rev., 414 pp., illus. Portland, Oreg.: Binfords & Mort.

194. Gill, L. S.
1935. Arceuthobium in the United States. Conn. Acad. Arts Sci. Trans. 32: 111-245, illus.

The dwarfmistletoe, *Arceuthobium campylopodum*, was reported on Pacific silver fir.

195. Gordon, George.
1875. The Pinetum: Being a synopsis of all the coniferous plants at present known, with descriptions, history and synonyms and a comprehensive systematic index. Ed. 2, 484 pp. London: Henry G. Bohn.

196. Gorman, M. W.
1907. Vegetation of the northeast slope of Mount Baker. Mazama 3: 31-48.

Pacific silver fir is present as a minor species below 1,000-foot elevation, is common between 1,000 and 4,000 feet, and, with mountain hemlock, is the most abundant species at 4,000 to 5,000 feet. It is not found above 5,500 feet. Forest line is at 5,000 feet, tree line at 6,700 feet, and timberline at 6,600 feet.

197. _____
1920. The flora of Mount Hood. Oreg. Out-of-Doors 1: 64-96.

198. Graham, Kenneth.
1945. The current outbreak of defoliating insects in coast hemlock forests of British Columbia. Part III. Considerations of chemical control. Brit. Columbia Lumberman 29(4): 38-39, 60, 62, 64, 118, 120, 122, 124, 126, illus.

199. Gratkowski, H. J.
1956. Windthrow around staggered settings in old-growth Douglas-fir. Forest Sci. 2: 60-74, illus.

A detailed study of wind behavior in eight staggered settings on the H. J. Andrews Experimental Forest and of factors affecting wind damage to reserve stands and individual trees.

Windfirmness of species is one of the factors affecting reserve stands. In this study, western redcedar was found to be the most windfirm species followed by Douglas-fir, western hemlock, and Pacific silver fir. Hemlock and silver fir were mainly in the protected understory and, therefore, their root systems were not adapted to withstand the wind stresses which occur on the clear cut perimeters.

200. Great Britain Department of Scientific and Industrial Research.
1957. A handbook of softwoods. Gt. Brit. Dept. Sci. Indus. Res. Forest Prod. Res. Bd., 73 pp. London: Her Majesty's Stationery Office.

A general description of the woods, their mechanical and working properties, uses, durability, resistance to insect attack, botanical ranges, and synonyms. Pacific silver fir is included.

201. Green, George Rex.
1933. Trees of North America (exclusive of Mexico). v. 1, The conifers. 186 pp. Ann Arbor: Edward Bros., Inc.

General dendrological and silvical characteristics of forest trees. A good reference for synonyms and common names of tree species.

202. Griffith, B. G.
1934. A pocket guide to the trees and shrubs of British Columbia. Brit. Columbia Forest Branch, 108 pp.

203. Gruenfeld, J. J., Wright, Ernest, and Coulter, W. K.
1956. Operation counterattack. Timberman 57(12): 92-93, illus.

A general account of the silver fir beetle infestation that began in 1947 in Skagit County, Washington, and the salvage operations that followed it.

The beetles, assisted by shoestring root rot fungus, killed 528 million board feet of timber between 1950 and 1953. In 1954, the infestation covered 652,000 acres but it subsided to 115,000 by 1955. Subsequent deterioration studies indicated that killed trees must be salvaged within 4 years to yield a 50-percent lumber recovery and a 70-percent pulp recovery.

204. Haddock, Philip G.
1961. Coniferous shade trees in suburban development. 37th Natl. Shade Tree Conf. Proc.: 147-159.

205. _____
1961. New data on distribution of some true firs of the Pacific Coast. Forest Sci. 7: 349-351.

Describes the discovery and verification of the occurrence of Pacific silver fir growing in the Marble Mountains of Siskiyou County, California.

206. Hale, J. D.
1932. The identification of woods commonly used in Canada. Canada Dept. Int. Forest Serv. Bul. 81, 48 pp., illus.

207. Halliday, W. E. D.
1937. A forest classification for Canada. Canada Dept. Mines & Resources Forest Serv. Bul. 89, 50 pp.

Pacific silver fir is an important component of the southern, central, and northern sections of the coast forest.

208. _____ and Brown, A. W. A.
1943. The distribution of some important forest trees in Canada. Ecology 24: 353-373, illus.

In Canada, Pacific silver fir is a Pacific coast species. "Amabilis fir is a western American coast radiant that for the most part evidently survived south of the ice during the Wisconsin glaciation and re-invaded northwards." Originally, it spread from southern Beringia in the D-interglacial period.

209. Hansbrough, J. R.
1934. Occurrence and parasitism of Aleurodiscus amorphus in North America. Jour. Forestry 32: 452-458, illus.

Pacific silver fir is a host of this weakly parasitic fungus.

210. Hansen, Carl.
1892. Pinetum Danicum. Jour. Hort. Soc. London 14: 257-480.

Lists the scientific names of various coniferous species and the early botanists who described them, contains accounts of their discoveries by botanists, and describes species habitat and wood characteristics.

Abies amabilis had been described in various publications by Forbes, Engelmann, Sargent; called *Pinus amabilis* by Douglas, *Picea amabilis* by Loudon, *Pinus grandis* by Lambert, and *Abies grandis* var. *densiflora* by Engelmann.

The species was discovered along with noble fir by David Douglas on September 7, 1825, in the Cascades, south of the Grand Rapids of the Columbia River. Douglas called the first species *Pinus amabilis* because of its lovely appearance, and the other species *Pinus nobilis*, a noble tree. Although most of Douglas' specimens were lost in various mishaps during his long explorations, he was able to preserve a few which were taken to England.

In 1833, Dr. Lindley transferred *P. nobilis* and *P. grandis* to *Abies* in the "Penny Cyclopaedia." In 1839, Forbes cited all three species under the generic name of *Abies* in "Pinetum Woburnense" and published the name *Abies amabilis*.

Many botanists, visiting the Northwest, did not see the amabilis fir, although Jeffrey in 1856 reported seeing it in the Fraser River region. Subsequently, botanists, who catalogued the species, tired of relying upon the statements of Douglas and Jeffrey and began to ignore the species. Engelmann believed that the specimens of Douglas and Jeffrey were mixed and that amabilis fir was a fictitious species. In 1880, Engelmann, Sargent, and Parry, on an extended exploration of the Pacific Northwest, rediscovered the species on Silver Mountain, near Fort Hope, Fraser River, between 4,000- and 5,000-foot elevation. Several weeks later, Sargent again found amabilis fir just south of the Columbia River Cascades near the area where Douglas first saw the species. Subsequently, in 1885 and 1889, Mr. and Mrs. Lemmon explored the region and reported that it contained more species of fir than any other known region--*Abies grandis*, *A. amabilis*, *A. nobilis*, and *A. lasiocarpa* (arranged by increasing elevation).

211. Hansen, Henry P.
1940. Paleoecology of two peat bogs in southwestern British Columbia. Amer. Jour. Bot. 27: 144-149, illus.

212. _____
1941. Further pollen studies of post Pleistocene bogs in the Puget lowland of Washington. Torrey Bot. Club Bul. 68: 133-148, illus.

213. _____
1941. Paleoecology of a bog in the spruce-hemlock climax of the Olympic Peninsula. Amer. Midland Nat. 25: 290-297, illus.

214. _____
1942. A pollen study of lake sediments in the lower Willamette Valley of western Oregon. Torrey Bot.Club Bul. 69: 262-280, illus.

215. _____
1943. A pollen study of two bogs on Orcas Island, of the San Juan Islands, Washington. Torrey Bot. Club Bul. 70: 236-243, illus.

216. _____
1944. Further pollen studies of peat bogs on the Pacific Coast of Oregon and Washington. Torrey Bot. Club Bul. 71: 627-636, illus.

217. _____
1947. Postglacial forest succession, climate, and chronology in the Pacific Northwest. Amer. Phil. Soc. Trans. v. 37, pt. 1, 130 pp., illus.

A monographic presentation of the results of a series of pollen analyses of sediments obtained from lakes and bogs throughout the Pacific Northwest. Summarizes most of the preceding references by Hansen.

Due to the similarity of the *Abies* pollen-grain size-frequency distributions, Hansen was not able to accurately distinguish between species so referred to them collectively as the balsam firs. Generally, they were poorly represented in the sedimentary columns, and their "pollen profiles present little that suggests trends of succession or that can be correlated with the interpreted succession of other species."

218. Hansen, Henry P.
1950. Pollen analysis of three bogs on Vancouver Island, Canada. Jour. Ecol. 38: 270-276, illus.

219. _____
1955. Postglacial forests in southcentral and central British Columbia. Amer. Jour. Sci. 253: 640-658, illus.

220. _____ and Mackin, J. Hoover.
1949. A pre-Wisconsin forest succession in the Puget Lowland, Washington. Amer. Jour. Sci. 247: 833-855, illus.

221. Hanzlik, E. J.
1914. The distinguishing features of the true firs *(Abies)* of western Washington and Oregon. Soc. Amer. Foresters Proc. 9: 272-277, illus.

Describes the differences between the bark, leaves, cones, and cone bracts of noble fir, Pacific silver fir, grand fir, and alpine fir.

222. _____
1925. A preliminary study of the growth of noble fir. Jour. Agr. Res. 31: 929-934, illus.

223. _____
1925. A site classification scheme for the western Cascades forest region. Univ. Wash. Forest Club Quart. 4(1): 5-8.

Hanzlik suggests that the various tree species segregate according to site quality. Only Douglas-fir, western hemlock, Sitka spruce, Port-Orford-cedar, and western redcedar are found on site 1, for example. Pacific silver fir occurs on sites 2, 3, 4, and 5. Hanzlik contends that since all species yield about the same in pure stands on the same site, the Douglas-fir site tables can be used for sites 1, 2, and 3 and western hemlock and Pacific silver fir curves used for site 4 and site 5, respectively. According to this scheme, there is no site 1 for Pacific silver fir, noble fir, mountain hemlock, etc., since these are species not found in the best sites in the region.

224. _____
1932. Type successions in the Olympic Mountains. Jour. Forestry 30: 91-93.

Hanzlik describes forest succession in terms of stages in those areas on the western and southern slopes of the Olympic Mountains where fire or windthrow has not occurred for 500 or more years. Stage 1 begins with the establishment of an even-aged, dense Douglas-fir forest following some natural catastrophe. As the

Douglas-fir stand grows older, its dense crown canopy opens slightly and western hemlock becomes established as an understory type. When the Douglas-fir overstory is 300 to 350 years old, the individual trees begin to accrue high-quality growth, although the forest itself is beyond optimum development. The understory hemlocks are of all sizes and ages up to 200 to 250 years old. Stage 2 begins at this time with the appearance of Pacific silver fir as understory type to both hemlock and Douglas-fir. Mortality begins to noticeably reduce the dominant Douglas-fir crown density. Hemlock gradually fills in the crown space formerly occupied by the Douglas-fir and becomes a codominant as well as a suppressed species. Stage 3 commences when the Douglas-firs, now about 500 to 600 years of age, are widely scattered and comprise only a small number of trees compared with the aggregate. However, they probably contain upwards to 50 percent of the merchantable volume. The hemlock, advanced in age and being much shorter lived, also declines. Pacific silver fir responds very well to release and fills in the openings created by the mortality of its two predecessors. In the final stage, Douglas-fir and hemlock occupy a very small portion of the crown canopy or are entirely lacking, and an uneven-aged stand of Pacific silver fir dominates the area. Unless some form of catastrophe substantially opens up the stand, Pacific silver fir will occupy any small openings and continually reestablish itself, thereby excluding the other species.

225. Hanzlik, E. J.
1936. Amount, growth and yield of pulp species on the Olympic Peninsula. Pac. Pulp & Paper Indus. 10(5): 27.

226. Hanzlik, Edward J.
1928. Trees and forests of western United States. 128 pp., illus. Portland, Oreg.: Dunham Printing Co.

Brief descriptions of forest tree species and their growth and of western forest regions and National Forests, keys, and forest statistics. The botanical range of Pacific silver fir extends from southern Alaska southward on both sides of the Cascades to the vicinity of Crater Lake. The species is found at sea level only in Alaska and British Columbia--elsewhere, its altitudinal range is between 1,000 and 5,000 feet, and occasionally 6,000 feet.

In the northern Cascades, Pacific silver fir volume averages 40,000 to 50,000 board feet per acre. Pacific silver fir regenerates entirely by seed; and seedlings endure heavy shade, but thrive in the open wherever soil and atmospheric moisture conditions are sufficient. The wood is soft, easily workable, light in weight, and is used primarily for pulp; it is also suitable for boxes, interior finish, and sash and door stock. The Indian paint fungus, *Echinodontium tinctorium*, is the principal rot--primarily of trees over 200 years of age.

227. Hardin, James W.
1960. Workbook for woody plants. 131 pp., illus. Minneapolis: Burgess Publishing Co.

228. Harding, A.
1892. Conifers at Orton Longueville. Jour. Hort. Soc. London 14: 67-71.

229. Harkness, Bernard.
1949. Conifers at Rochester, New York. Univ. Wash. Arboretum Bul. 12(4): 26, 27, 34.

230. Harlow, W. M.
1934. The dendrology of the more important trees of the United States. Pt. 2, Softwoods. Ed. 3, 69 pp., illus. Ann Arbor: Edward Bros.

231. Harlow, William M., and Harrar, Ellwood, S.
1958. Text book of dendrology. Ed. 4, 561 pp., illus. New York: McGraw-Hill Book Co., Inc.

A general dendrological reference covering the commercial species of North America, written primarily for a beginning student in forestry. A general description of the botanical and silvical features and range of Pacific silver fir is included.

232. Harris, J. W. E.
1960. The balsam woolly aphid, *Adelges piceae* (Ratz), in British Columbia, 1959. Canada Dept. Agr. Div. Forest Biol. Bimo. Prog. Rpt. 16(2): 3-4.

233. Harshberger, J. W.
1911. Phytogeographic survey of North America. Die Vegetation der Erde, Bd. 13, 790 pp., Leipzig.

234. Hartmann, F. K., Querengässer, F., and Jahn, G.
1953. Unterlagen für den anbau westamerikanischer nadelholzarten in Deutschland. Allg. Forst-u. Jagdztg. 125: 25-48.

Lists the various Pacific Northwest tree species and provides notes on their geographic distribution, climatic, soil, and light tolerances, growth rates, common forest tree associates, wood characteristics, and suitability for planting in Germany. Pacific silver fir appears suitable for planting in the best mountain drainage sites.

235. Harvey, Athelstan George.
1947. Douglas of the fir. 290 pp., illus. Cambridge: Harvard University Press.

Discloses (pp. 58-60) how Douglas named *Abies amabilis* and *Abies nobilis* during an expedition in the Cascades south of the Columbia River. Subsequently, the existence of *Abies amabilis* was doubted by botanists until an expedition by Dr. Engelmann, Parry, and Sargent traced Douglas' old route and rediscovered the species.

236. Hayes, G. L.
1959. Forest and forest-land problems of southwestern Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta., 54 pp., illus.

Pacific silver fir occurs in southwestern Oregon but is considered commercially unimportant.

237. Hedgcock, George Grant.
1912. Notes on some diseases of trees in our national forests. II. Phytopathology 2: 73-80.

Pacific silver fir is attacked by *Polyporus schweinitzii* Fr. and *Echinodontium tinctorium* E. & E.

238. Hedgcock, George Grant.
1914. Notes on some diseases of trees in our national forests. IV. Phytopathology 4: 181-188.

Fomes pinicola Fr. has been reported or collected on Pacific silver fir.

239. Heinig, Melburn, and Simmonds, F. A.
1948. Length and width of unbleached sulphate pulp fibers from certain western woods. Paper Indus. & Paper World 30: 738-741, illus.

Pacific silver fir fibers averaged longer and wider than those of Douglas-fir, western hemlock, and western redcedar.

240. Henderson, Louis F.
1936. The early flowering of plants in Lane County, Oregon, in 1934. Univ. Oreg. Monog. Stud. Bot. 1, 16 pp.

241. Henry, Joseph Kaye.
1915. Flora of southern British Columbia and Vancouver Island, with many references to Alaska and northern species. 363 pp. Toronto: W. S. Gage.

242. Hergert, H. L., and Goldschmid, Otto.
1958. Biogenesis of heartwood and bark constituents. I. A new taxifolin glucoside. Jour. Organic Chem. 23: 700-704.

Extracts were taken from wood, bark, and/or needle samples of Sitka spruce, western hemlock, western redcedar, western larch, grand fir, Pacific silver fir, Atlas cedar, and baldcypress. A trace of taxifolin-3'-glucoside was found in the needles of Pacific silver fir, but no taxifolin was present in the needles, bark, sapwood, or heartwood. Additional flavonol glucosides were also present in Pacific silver fir needles.

243. Herrin, Charles.
1892. Conifers at Dropmore. Jour. Hort. Soc. London 14: 61-66.

244. Hetherington, J. C.
1960. E. P. 538--seed dissemination and the influence of weather conditions on this process on the west coast of Vancouver Island. In Forest Research Review, year ended March, 1960. Brit. Columbia Forest Serv., pp. 21-23, illus.

Seed traps were placed in a 70-acre clearing surrounded by timber composed of western hemlock, 45 percent; Pacific silver fir, 40 percent; western redcedar, 14 percent; and Sitka spruce, 1 percent. Approximately 80,000 western hemlock, 15,000 western redcedar, and 900 Pacific silver fir seeds were collected, most of the Pacific silver fir and western redcedar seed falling within the timber.

Seedfall commenced September 16 for Pacific silver fir, September 21 for western redcedar, and September 23 for western hemlock; the peak seedfall period occurred at the end of September for Pacific silver fir, in November for western redcedar, and from November to March for western hemlock. The disintegration of Pacific silver fir cones is hastened by conditions of low humidity.

245. Hetherington, J. C.
1961. E. P. 538--seed dissemination and the influence of weather conditions on this process on the west coast of Vancouver Island. In Forest Research Review, year ended March, 1961. Brit. Columbia Forest Serv., pp. 13-15, illus.

Most Pacific silver fir seed fell less than 90 feet beyond the margins of the forest stand and its germinative capacity averaged 18 percent.

246. Heusser, C. J.
1954. Alpine fir at Taku Glacier, Alaska, with notes on its postglacial migration to the Territory. Torrey Bot. Club Bul. 81: 83-86, illus.

247. Heusser, Calvin J.
1952. Pollen profiles from southeastern Alaska. Ecol. Monog. 22: 331-352, illus.

248. _____
1960. Late-Pleistocene environments of North Pacific North America. Amer. Geog. Soc. Spec. Pub. 35, 308 pp., illus.

Presents and discusses late-Pleistocene plant geography and the associated climatic and physiographic changes in the Pacific Coast regions from Kodiak Island, Alaska, south to Fort Bragg, California. Palynological methods and the establishment of a chronology based on radiocarbon dating and stratigraphic correleations are used. With the possible exception of the large pollen grains of subalpine fir, the true firs could not be positively distinguished from one another by palynological methods. Heusser, however, with a knowledge of their respective ranges and forest associates, was able to draw some tentative conclusions about their respective roles in forest succession. For example, grand fir is associated with Douglas-fir and Pacific silver fir is associated with mountain hemlock. So, when true fir fossil pollen grains increase and decrease with Douglas-fir pollen grains in the sediment, grand fir is probably the true fir represented in the profile.

Pollen profiles at Menzies Bay suggest that Pacific silver fir migrated into the dry eastern sector of Vancouver Island during the humid Late Postglacial. In northern British Columbia Pacific silver fir has recently increased in numbers. "True fir [probably *amabilis*] developed contemporaneously with mountain hemlock during the Late-glacial at Humptulips...[near] the Olympic Mountains.... Amabilis fir also appears to be the species that was associated with mountain hemlock during the Early Postglacial at Malahat, Menzies Bay, Harbledown Island, and as far north as Upper Hope Island in British Columbia."

Pollen profiles from Masset support the observations that true firs have not occurred on the Queen Charlotte Islands during the Postglacial.

249. Higinbotham, N., and Higinbotham, Betty Wilson.
1954. Quantitative relationships of terrestrial mosses with some coniferous forests at Mt. Rainier National Park. Butler Univ. Bot. Studies 11: 149-168.

Frequency and coverage estimates of terrestrial mosses, made in 13 forest stands representing 5 climax forest communities, indicated correlations of moss species with tree species in terms of the former's abundance. The

predominant moss species in the Douglas-fir community was *Eurhynchium oreganum;* in the western hemlock-western redcedar community and the Pacific silver fir—western hemlock community, *Rhytidiopsis robusta* was the predominant moss; *Dicranum fuscesens* was the predominant moss in the Pacific silver fir—mountain hemlock community. Mosses observed beneath alpine fir community were forms generally characteristic of mineral soils.

250. Hofmann, J. V.
1917. Natural reproduction from seed stored in the forest floor. Jour. Agr. Res. 11: 1-26, illus.

251. _____
1925. Laboratory tests on effect of heat on seeds of noble and silver fir, western white pine, and Douglas fir. Jour. Agr. Res. 31: 197-199.

Seed samples of noble fir, Pacific silver fir, western white pine, and Douglas-fir were subjected for 10 hours to dry heat varying from 100° to 300° F. and moist heat varying from 100° to 240° F. Microscopic examinations of the seed and germination tests were made after the treatments. Pacific silver fir had the lowest number of seeds germinating after all temperature treatments. (However, it was not stated whether this was due to heat treatments or low-quality seeds.) There was no apparent change in the general physical appearance of Pacific silver fir seed subjected to dry heat until 140° F. when a slight drying was noticed, the endosperm was whiter and pitch began to ooze from the seed coats by 160° F., at 200° F. the seeds began to stick together, and by 300° F. the seeds had browned and were stuck to their container. There was no apparent change under moist heat until 240° F. when the seeds stuck to one another.

252. Hogan, J. B.
1950. Forest Service reports damage to Pacific silver fir. Jour. Forestry 48(6): 429.

Several species of *Pseudohylesinus* are primarily responsible for the killing of Pacific silver fir in the Mount Baker National Forest.

253. Hooker, J. D.
1864. Account of the botanical collections made by David Lyall, surgeon and naturalist to the North American Boundary Commission. Jour. Linnean Soc. London 7: 124-144.

254. Hoopes, Josiah.
1868. The book of evergreens; a practical treatise on the coniferae or cone-bearing plants. 435 pp., illus. New York: Orange Judd & Co.

255. Hopping, George.
1925. A key to the true firs of North America. Oreg. Agr. Col. Forestry Club Ann. Cruise[6]: 43-46, illus.

256. Hornibrook, Murray.
1923. Dwarf and slow-growing conifers. 195 pp., illus. New York: Charles Scribner's Sons.

257. Howard, Alexander L.
1948. A manual of the timbers of the world. Their characteristics and uses. Ed. 3, 751 pp., illus. London: MacMillan & Co. Ltd.

258. Howell, Thomas.
1903. A flora of Northwest America. v. 1, Phanerogamae. 792 pp., Portland, Oreg. (No publisher recorded.)

259. Hultén, Eric.
1941. Flora of Alaska and Yukon. I. Pteridophyta, Gymnospermae, and Monocotyledonae (Pandanales and Helobiae). Lunds Univ. Aarsskr. N.F. Avd. 2, Bd. 37, Nr. 1, pp. 1-127, illus.

Hultén reported that he has not seen any specimen of Pacific silver fir in Alaska. However, he cites its Alaskan distribution as reported by others: Pacific silver fir occurs from sea level to elevations of 1,000 feet in the Boca de Quadra and Portland Canal regions in Alaska.

260. _____
1960. Flora of the Aleutian Islands, and westernmost Alaska peninsula with notes on the flora of Commander Islands. Ed. 2 (rev.), 376 pp., illus. Weinheim/Bergstr: J. Kramer.

261. Hunnewell, Walter.
1949. The pinetum at Wellesley, Massachusetts. Univ. Wash. Arboretum Bul. 12(4): 22, 23, 33.

262. Hunter, Lillian M.
1927. Comparative study of spermogonia of rusts of *Abies*. Bot. Gaz. 83: 1-23.

263. Hutchison, A. H.
1924. Embryogeny of *Abies*. Bot. Gaz. 77: 280-289.

264. Hylander, Clarence J.
1939. The world of plant life. 722 pp., illus. New York: Macmillan Co.

265. Isaac, Leo A.
1956. Where do we stand with Douglas-fir natural regeneration research? Soc. Amer. Foresters Proc. 1955: 70-72.

266. _____
1956. Place of partial cutting in old-growth stands of the Douglas-fir region.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Paper 16, 48 pp., illus.

Pacific silver fir, as a member of the understory species component, usually showed accelerated growth after the partial cutting of old-growth Douglas-firs.

267. _____
1960. Leo A. Isaac on silviculture. 32 pp., illus. Corvallis: Oregon State College Press.

268. Jay, B. Alwyn.
1952. Conifers in Britain. An illustrated guide to identification. 47 pp., illus. London: Adam & Charles Black.

Provides a key for each genus and good photographs of the foliage and buds of the species included. Pacific silver fir "succeeds best in highlands of Wales and Scotland."

269. Jeffrey, Edward C.
1904. The comparative anatomy and phylogeny of the coniferales. Pt. 2.-- The Abietineae. Mem. Boston Nat. Hist. 6: 1-37, illus.

270. Jenkins, J. H.
1926. The kiln-drying of British Columbia softwoods. Canada Dept. Int. Forest Serv. Cir. 18, 13 pp.

271. _____ and Guernsey, F. W.
1954. The kiln-drying of British Columbia lumber. Canada Dept. North. Aff. & Natl. Resources Forestry Branch Bul. 111, 80 pp., illus.

272. Johnson, F. A.
1955. Volume tables for Pacific Northwest trees. U.S. Dept. Agr. Handb. 92, 122 tables.

A compilation of mostly regional volume tables giving volumes of the tree species up to various d.i.b.'s in both cubic-foot and board-foot units of measure. Log rules used were International 1/8- and 1/4-inch rule, and Scribner rule. Accuracy, methods, source, and other pertinent information head each table. Board-foot variables are d.b.h. and either total height or number of 16- or 32-foot logs.

Pacific silver fir is represented by eight tables.

273. Johnson, Norman E.
1959. *Pineus* infestation on true firs in western Washington. Jour. Econ. Ent. 52: 828-829, illus.

A chermid of the genus *Pineus* is reported feeding on the bole and branches of Pacific silver and grand firs. The insect apparently does not cause the gouting and serious damage of the balsam woolly aphid *(Chermes piceae)* but is very similar to the latter in general appearance.

274. _____ and Heikkenen, H. J.
1958. A method for field studies of the balsam woolly aphid. Jour. Econ. Ent. 51: 540-542, illus.

275. _____ Mitchell, Russell G., and Wright, Kenneth H.
1963. Mortality and damage to Pacific silver fir by the balsam woolly aphid in southwestern Washington. Jour. Forestry 61: 854-860, illus.

276. _____ and Wright, Kenneth H.
1957. The balsam woolly aphid problem in Oregon and Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Paper 18, 34 pp., illus.

A complete presentation of the balsam woolly aphid problem in the Northwest, including a discussion of the insect *(Adelges piceae* Ratz.) and its habits and a report of control actions being undertaken and actions which should be undertaken in the future.

The most serious epidemic was on Pacific silver fir in the Cascade Range of southern Washington, particularly in large sawtimber stands near Mount St. Helens. Other infestations had been noted on silver fir as far north as Mount Rainier, in the

Cascade Range of northern Oregon from Mount Hood southward to Crater Lake National Park, and in a nearly pure stand of large sawtimber in the Oregon Coast Ranges in Polk and Lincoln Counties. The large quantities of dead and dying timber resulting from these attacks have had a very disturbing effect on forest management plans in the affected areas, necessitating large salvage programs by public and private owners; these programs will probably have a disturbing effect on lumber manufacture and marketing programs. Neither sawmills nor pulpmills are geared to handle the large volume of true fir salvage timber anticipated.

Details of the insect's history in North America, description, seasonal history, method of spread, and effect on the host are included in the paper. Detailed biological studies of balsam woolly aphid have been made only in Pacific silver fir stands near Mount St. Helens. The life cycle in the Northwest differs from those in the Northeast and Europe primarily in an overlapping of summer and winter generations and a longer period of seasonal activity. Wind has been the principal means of dispersion in the Pacific Northwest, although the possibility of spread through the distribution of infected nursery stock should be checked by frequent nursery inspections. Insect attack on twigs causes contorted swellings (gout), inhibiting the growth of new foliage to the extent that death may result. Death may result even more quickly from infestations on the main stems of trees. Pacific silver fir usually dies from the top down. The aphid has shown a preference for mature or overmature silver fir, the only young trees affected being in the understory of infested stands or immediately adjacent to them. No significant infestations have been found on silver fir regeneration in clear cuts.

Several control methods--natural, chemical, and silvicultural--are suggested. Silvicultural means particularly relevant to silver fir include: replacement of Pacific silver fir by noble fir at higher elevations and Douglas-fir and hemlock at low elevations; tests of undamaged silver fir trees found in heavily infected stands to determine if they are chemically or physically resistant and, if so, why; management of Pacific silver fir on a short rotation based on the observation that only mature and overmature stands have been significantly attacked and the largest trees appear to be the hardest hit; and removal of all mature silver fir from mixed stands as far back from the timber cutting edge as possible.

277. Jones, George Neville.
1936. A botanical survey of the Olympic Peninsula, Washington. Univ. Wash. Pub. Biol., v. 5, 286 pp., illus.

278. _____
1938. The flowering plants and ferns of Mount Rainier. Univ. Wash. Pub. Biol., v. 7, 192 pp., illus.

279. Jones, W. S.
1924. Timbers, their structure and identification. 148 pp., illus. Oxford: Clarendon Press.

Ray tracheids have been observed in Pacific silver fir after injury.

280. Keen, F. P.
1952. Insect enemies of western forests. U.S. Dept. Agr. Misc. Pub. 273 (rev.), 280 pp., illus.

Contains listings and descriptions of insect pests that attack Pacific silver fir. Type of damage and control measures are also discussed.

281. Keen, F. P.
1958. Cone and seed insects of western forest trees. U.S. Dept. Agr. Tech. Bul. 1169, 168 pp., illus.

Lists and discusses insect species reared from cone collections of western forest trees. Descriptions of the insects, their seasonal history, distribution, hosts, parasites, and predators and control measures are presented. No cone collections were made from Pacific silver fir, but Keen believes that the same insect species damages all species of true fir. These insects are mainly in the cone maggots, cone moths, and seed chalcid groups.

282. Kelsey, Harlan P., and Dayton, William A.
1942. Standardized plant names. Ed. 2, 675 pp. Harrisburg: J. Horace McFarland Co.

283. Ker, J. W., and Smith, J. H. G.
1957. Sampling for height-diameter relationships. Jour. Forestry 55: 205-207.

284. King, James P.
1961. Growth and mortality in the Wind River Natural Area. Jour. Forestry 59: 768-770, illus.

Growth and mortality observations in a 350-year-old stand of Douglas-fir show that the still considerable annual stand growth is being offset by mortality. In some places in the stand, decadent Douglas-fir is being replaced by western hemlock and Pacific silver fir; in other parts of the stand, the latter species are just beginning to form part of the overstory.

The annual growth and mortality data show the gross growth for Douglas-fir, western hemlock, and Pacific silver fir to be 179, 397, and 72 board feet (Scribner rule), respectively; the mortality, 350, 149, and 31 board feet. This leaves a net growth for the three species of -171, 248, and 41 board feet, respectively.

285. Kinghorn, J. M.
1954. The influence of stand composition on the mortality of various conifers, caused by defoliation by the western hemlock looper on Vancouver Island, British Columbia. Forestry Chron. 30: 380-400, illus.

Forest stands of Douglas-fir, Pacific silver fir, western hemlock, and Sitka spruce were subjected to 4 years of defoliation by the hemlock looper. In general, tree mortality increased directly with degree of defoliation. Multiple regression equations were presented to show the relation of basal area mortality to stand composition and percent defoliation; they showed that the mortality of larger trees (excluding Douglas-fir) was higher in all defoliation classes.

286. Klaehn, F. U., and Winieski, J. A.
1962. Interspecific hybridization in the genus Abies. Silvae Genetica 11: 130-142, illus.

Reports natural crossing of subalpine fir and Pacific silver fir and the artificial crossing of white fir and Pacific silver fir.

287. Klein, William H., and Wright, Kenneth H.
1960. Final report, accomplishments of the Silver Fir Beetles Committee, 1954 to 1959. U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. unpublished office report, 17 pp.

An outbreak of silver fir beetles in northern Washington precipitated the appointment of the Silver Fir Beetles Committee by the Northwest Forest Pest Action Council in 1953. This report summarizes developments and the work done by the committee until it was disbanded in 1959. Cooperative surveys showed 528 million board feet of Pacific silver fir sawtimber were killed up to 1954. Trend data obtained from cooperative plots in the Mount Baker area of Washington indicated a sharp decline in Pacific silver fir mortality after 1954. Similar data from the Olympic Mountains of Washington showed neglibible mortality of silver fir over the entire period of the study. In 1959, vigor of silver fir on both areas was good.

288. Knauss, A. C.
1955. Seasoning defects of western softwoods. Seventh Ann. Meeting West. Dry Kiln Clubs Proc., pp. 10-18.

289. Krajina, V. J.
1961. 1960 progress report on N.R.C. Grant No. T-92 entitled ecology of the forests of the Pacific Northwest. Univ. Brit. Columbia Dept. Biol. Bot., 62 pp., illus.

See abstract of next reference.

290. _____
1962. 1961 progress report on N.R.C. Grant No. T-92 entitled ecology of the forests of the Pacific Northwest. Univ. Brit. Columbia Dept. Biol. Bot., 37 pp., illus.

Reviews some research presently in progress in British Columbia. Pacific silver fir is included in the studies of: nutrition of grand fir and amabilis fir in the greenhouse; ecological study of forest types and soils in the Coastal Western Hemlock Zone; plant communities and ecotypes of plant communities in the ecosystem classification of the Coastal Subalpine Zone in British Columbia; and ecological studies in the subalpine-alpine ecotone of Garibaldi Park.

291. Krajina, Vladimir J.
1959. Bioclimatic zones in British Columbia. Univ. Brit. Columbia Bot. Ser. 1, 47 pp., illus.

The vegetation climate and zonal soil groups of bioclimatic zones in British Columbia. Pacific silver fir is characteristic of the climatic and edaphic climaxes of the "Coastal Western Hemlock Zone" and the "Subalpine Mountain Hemlock Zone."

292. Krüssmann, Gerd.
1960. Die Nadelgehölze. Ed. 2 (rev.), 335 pp., illus. Berlin and Hamburg: Paul Parey.

293. Krueger, Kenneth W.
1960. Behavior of ground vegetation under a partially cut stand of Douglas-fir.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Note 198, 3 pp.

294. Lamb, Frank H.
1938. Sagas of the evergreens; the story and the economic, social and cultural contribution of the evergreen trees and forests of the world. 364 pp., illus. New York: W. W. Norton & Co., Inc.

295. Lamb, William H.
1914. A conspectus of North American firs (exclusive of Mexico). Soc. Amer. Foresters Proc. 9: 528-538, illus.

A taxonomic description of American true firs which places considerable emphasis on the form of the cone bract.

296. Lang, Walter.
1962. Growth studies of Pacific silver fir, *Abies amabilis* (Dougl.) Forb. M.F. thesis on file Univ. Wash. 101 pp., illus.

A study of growth and yield of Pacific silver fir in the Mount Baker area. Growth of Pacific silver fir in this area was found to approximate yields of site I European silver fir stands in Europe.

297. Langille, H. D., Plummer, Fred G., Dodwell, Arthur, and others.
1903. Forest conditions in the Cascade Range Forest Reserve, Oregon. U.S. Geol. Survey Prof. Paper 9, 298 pp., illus.

298. Lanner, Ronald M.
1962. Controlling the moisture content of conifer pollen. Silvae Genetica 11: 114-117, illus.

Pollen of nine species of pine, true fir (including Pacific silver fir), Douglas-fir, and true cedar was placed in a series of constant humidity chambers until it reached equilibrium moisture content. The time to reach equilibrium depended upon the differences between the initial moisture content and the equilibrium moisture content of the atmosphere. Species of pine and true fir reached similar equilibria.

299. Laslett, Thomas.
1894. Timber and timber trees. Ed. 2, 442 pp., illus. London: MacMillan and Co.

300. Lawrence, Donald B.
1939. Some features of the vegetation of the Columbia River Gorge with special reference to asymmetry in forest trees. Ecol. Monog. 9: 218-257, illus.

301. Leiberg, John B.
1900. Cascade Range Forest Reserve, Oregon, from Township 28 south to Township 37 south, inclusive; together with the Ashland Forest Reserve and adjacent forest regions from Township 28 south to Township 41 south, inclusive, and from Range 2 west to Range 14 east, Willamette meridian, inclusive. U.S. Geol. Survey 21st Ann. Rpt. 1899-1900, Pt. 5, Forest Reserves: 209-498, illus.

302. Lewis, R. G.
[n.d.] Commercial forest trees of Canada. Canada Dept. of Int. Forestry Branch Cir. 14, 8 pp.

303. Little, Elbert L., Jr.
1944. Notes on nomenclature in Pinaceae. Amer. Jour. Bot. 31: 587-596.

The names *Abies grandis* and *A. amabilis* perhaps were not used for the plants with which they had been associated originally. The incomplete evidence was summarized, including new evidence that the name *Pinus grandis* Dougl. was published in 1832.

304. _____
1953. Check list of native and naturalized trees of the United States (including Alaska). U.S. Dept. Agr. Handb. 41, 472 pp.

The accepted scientific name of Pacific silver fir is *Abies amabilis* (Dougl.) Forbes. Some common names are: Cascades fir, amabilis fir, lovely fir, red fir, and white fir.

305. _____
1949. Important forest trees of the United States. U.S. Dept. Agr. Yearbook 1949: 763-814, illus. (Reprinted in 1950 as U.S. Dept. Agr. Yearbook Separate 2156.)

306. Lodewick, J. Elton, and Harrar, Ellwood S.
1937. What wood is that? Timberman 38(8): 33, 34, 36, 38, 40, illus.

307. Lyons, C. P.
1952. Trees, shrubs and flowers to know in British Columbia. 168 pp., illus. Toronto, Vancouver: J. M. Dent & Sons (Canada) Ltd.

308. _____
1956. Trees, shrubs and flowers to know in Washington. 211 pp., illus. Toronto, Vancouver: J. M. Dent & Sons (Canada) Ltd.

309. McAvoy, Blanche.
1931. Ecological survey of the Bella Coola region. Bot. Gaz. 92: 141-171, illus.

Pacific silver fir occurs in nearly pure stands on Canoe Crossing Mountain from 1,098 meters to 1,310 meters in altitude.

310. MacBean, A. P.
1941. A study of the factors affecting the reproduction of western hemlock and its associates in the Quatsino region, Vancouver Island. Brit. Columbia Dept. Lands Forest Branch, 36 pp., illus.

Contains tables comparing seedling growth of western hemlock, Pacific silver fir, Sitka spruce, and western redcedar.

311. McBride, C. F.
1957. Sawmill residue in the Prince George Area of British Columbia. Canada Dept. North. Aff. & Natl. Resources Forestry Branch Forest Prod. Lab. Div. V-1013, 28 pp., illus.

312. MacDonald, J. Alan B.
1950. Conifers on the west coast of Scotland. Univ. Wash. Arboretum Bul. 13(2): 14, 15, 30.

A general discussion of the success of exotic coniferous plantings in Scotland. Pacific silver fir is among the western American species making promising growth on moorlands.

313. Macdonald, James, Wood, R. F., Edwards, M. V., and Aldhous, J. R., eds.
1957. Exotic forest trees in Great Britain. Gt. Brit. Forestry Comn. Bul. 30, 167 pp., illus.

Pacific silver fir was first introduced by Douglas in 1830. Few survived, however, so it was reintroduced in 1882. The species was never widely planted and is considered by some as a failure in cultivation. One tree has a height of 99 feet and is presumed to be the largest in the country.

An extremely successful plantation exists at Crarae, Argyllshire. In 23 years the trees have grown 38 feet in height and have an average d.b.h. of 15 inches. The present volume is 2,000 Hoppus feet per acre--396 Hoppus feet have been removed in thinnings.

The most promising environments are the better mountain soils in western Britain. Because it is highly shade tolerant, Pacific silver fir is considered for underplanting or the conversion of poor broadleaved shrub to high forest.

314. McElhanney, T. A., and Perry, R. S.
1927. Some commercial softwoods of British Columbia; their mechanical and physical properties. Canada Dept. Int. Forest Serv. Bul. 78, 45 pp., illus.

315. McGugan, B. M.
1958. Forest lepidoptera of Canada recorded by the Forest Insect Survey, v. 1 - Papilionidae to Arctiidae. Canada Dept. Agr. Forest Biol. Div. Pub. 1034, 76 pp., illus.

Halisidota argentata Pack., an Artiidae defoliator was recorded feeding on Pacific silver fir.

316. Mackay, Margaret Rae.
1962. Larvae of the North American Tortricinae (Lepidoptera: Tortricidae). Canad. Ent. Sup. 28, 182 pp., illus.

Pacific silver fir is one of the hosts of *Choristoneura fumiferana* Clemens and *Choristoneura ex Pseudotsuga menziesii*.

317. MacLean, Colin D., and Hightree, Paul E.
1959. Forest statistics for Skagit and Whatcom Counties, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 133, 47 pp., illus.

In 1957, there was 5,289 million board feet (Scribner rule, trees 11.0 inches d.b.h. and larger) of Pacific silver fir live sawtimber in Skagit County. This amounted to 35 percent of the total sawtimber volume. Pacific silver fir growing-stock volume amounted to 1,178 million cubic feet (sound trees 5.0 inches d.b.h. and larger to a 4-inch top inside bark), which is 34 percent of the total growing-stock volume.

In Whatcom County, Pacific silver fir comprised 29 percent of the live sawtimber volume (3,214 million board feet, Scribner) and 26 percent of the growing-stock volume (703 million cubic feet).

318. McMahon, R. O.
1961. The economic significance of mortality in old-growth Douglas-fir management.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Paper 37, 21 pp., illus.

319. McMinn. Howard E., and Maino, Evelyn.
1956. An illustrated manual of Pacific Coast trees. Ed. 2, 409 pp., illus. Berkeley: University California Press.

320. M'Nab, William Ramsay.
1877. A revision of the species of *Abies*. Royal Irish Acad. Proc., ser. 2, 2: 673-704, illus.

321. Makins, F. K.
1936. The identification of trees and shrubs. 326 pp., illus. London: Dent & Sons Ltd.

322. Marckworth, Gordon D.
1951. Fundamental research in the growth of trees and stands at the College of Forestry. Univ. Wash. Forest Club Quart. 24(1): 3-7.

323. Markwardt, L. J.
1930. Comparative strength properties of woods grown in the United States. U.S. Dept. Agr. Tech. Bul. 158, 39 pp., illus.

324. _____
1941. Aircraft woods: their properties, selection and characteristics. U.S. Forest Serv. Forest Prod. Lab. Rpt. 1079, 51 pp., illus.

325. _____ and Wilson, T. R. C.
1935. Strength and related properties of woods grown in the United States. U.S. Dept. Agr. Tech. Bul. 479, 99 pp., illus.

Includes tabulated data on strength and other properties of Pacific silver fir wood. The wood tested was from six trees grown in Snohomish County, Wash. Information is provided on rings per inch, summerwood percent, moisture content, specific gravity, weight, shrinkage, maximum tensile strength, and results of static bending, impact bending, compression, hardness, shear, and cleavage tests.

326. Massee, G.
1905. *Abies amabilis*, diseased. Jour. Roy. Hort. Soc. London 31: LXXXIV.

Pacific silver fir was badly affected by *Chermes abietis*.

327. M[asters], M. T.
1880. *Abies amabilis*. Gard. Chron., n.s., 14: 720-721, 725, illus.

A report of the rediscovery of *Abies amabilis* at the type locality in 1880 by G. Engelmann, C. S. Sargent, and C. C. Parry.

328. Masters, M. T.
1900. *Abies amabilis* attacked by Chermes. Jour. Roy. Hort. Soc. London 25: XXVIII.

"Dr. Masters showed specimens of this tree, also called *A. lowiana*, with gouty branches. The bark was badly infested by an aphis much resembling that which attacks beeches...."

329. Masters, Maxwell T.
1886. Contributions to the history of certain species of conifers. Jour. Linn. Soc. [London] Bot. 22: 169-212, illus.

330. _____
1892. List of conifers and taxads in cultivation in the open air in Great Britain and Ireland. Jour. Roy. Hort. Soc. London 14: 179-256.

Lists the accepted scientific names and synonyms for the various species and the botanists that named and described the species.

331. _____
1892. Some features of interest in the order of conifers. Jour. Roy. Hort. Soc. London 14: 1-18.

A general presentation superficially covering the antiquity, genealogy, stages of growth, physiology, appearance, utility nomenclature, economic value, and introduced species of conifers in England.

Mentions that it is difficult to obtain a leader in Pacific silver fir without insect or fungal injury. Masters believes this is because the lateral buds, circling the terminal bud, commence growth in the spring before the terminal bud, thereby appropriating much of the nourishment. A leader is easily secured by suppression of the lateral buds.

332. _____
1901. Hybrid conifers. Jour. Roy. Hort. Soc. London 26: 97-110, illus.

The compilation of reported hybrids included *Abies lasiocarpa* X *A. amabilis* Sargent.

333. Matson, E. E.
1957. White fir lumber recovery at a western Washington sawmill.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Note 141, 8 pp., illus.

Presents in tabular and graphical form volume and lumber grade recovery data from 166 Pacific silver fir and grand fir logs. The lumber industry groups these species together and sells them as white fir.

334. Meagher, G. S.
1946. Forest statistics for Clackamas County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 97, 20 pp., illus.

335. Melville, R.
1957. *Abies amabilis;* coniferae. Curtis's Bot. Mag., n.s., 171: tab. 306. 4 pp., illus.

336. Melville, R.
1959. Notes on gymnosperm nomenclature. Kew Bul. 3 [1958]: 531-535.

Discusses the early confusion between the identities of grand fir and Pacific silver fir which apparently arose from the earliest description of David Douglas' specimens being made from a mixture, possibly because the two species did not appear sufficiently distinct enough to be separated. This mistake caused some confusion among botanists until Forbes correctly identified both species and Pacific silver fir was subsequently rediscovered in 1880 by Engelmann, Parry, and Sargent.

337. Miller, Vera Mentzer, and Bonar, Lee.
1941. A study of the Perisporiaceae, Capnodiaceae, and some other sooty molds from California. Univ. Calif. Pub. Bot. 19: 405-417.

Phaeosaccardinula dematia sp. nov. was found on Pacific silver fir near Adelaide Lake, Mount Rainier National Park, Washington, in September 1935 by H. E. Bailey.

338. Milliron, H. E.
1949. Taxonomic and biological investigations in the genus *Megastigmus*, with particular reference to the taxonomy of the Nearctic species (Hymenoptera: Chalcidoidea; Callimomidae). Amer. Midland Nat. 41: 257-420, illus.

A very thorough presentation of all information known up to 1949 on the taxonomy and biology of the genus *Megastigmus*. Pacific silver fir is a host for *Megastigmus lasiocarpae* Cy. and *Megastigmus pinus* Parf.

339. Mitchell, A. F.
1963. The Dropmore Pinetum. Gt. Brit. Forestry Comn. Forest Rec. 48, 39 pp., illus.

This publication contains a list of species and best trees in the Pinetum; Pacific silver fir is included.

340. Mitchell, Russel G.
1962. Balsam woolly aphid predators native to Oregon and Washington. Oreg. Agr. Expt. Sta. Tech. Bul. 62, 63 pp., illus.

341. _____ Johnson, Norman E., and Rudinsky, Julius A.
1961. Seasonal history of the balsam woolly aphid in the Pacific Northwest. Canad. Ent. 93: 794-798, illus.

342. Molnar, A. C.
1954. Forest disease survey. British Columbia. Canada Dept. Agr. Forest Insect & Disease Survey Ann. Rpt. 1953: 150-158.

343. _____
1955. Forest disease survey. British Columbia. Canada Dept. Agr. Forest Insect & Disease Survey Ann. Rpt. 1954: 128-135.

Lachnella agassizii (Berk. and Curt.) Seaver was recorded for the first time on Pacific silver fir at Kitimat, British Columbia.

344. Molnar, A. C.
1956. Forest disease survey. British Columbia. Canada Dept. Agr. Forest Insect & Disease Survey Ann. Rpt. 1955: 102-106.

A sooty mold fungus, *Limacinia alaskensis* Sacc. and Scalia, was found causing damage to Pacific silver fir foliage at Kitimat, Cowichan Lake, and Forbidden Pateau, V. I.

345. _____
1959. Forest disease survey. British Columbia. Canada Dept. Agr. Forest Insect & Disease Survey Ann. Rpt. 1958: 97-103.

Flammula alnicola (Fr.) Quél. and *Merulius himantioides* Fr. were cultivated for the first time on Pacific silver fir at Duncan, V. I. Pacific silver fir was inoculated with *Uredinopsis pteridis* Diet. & Holw. at Cordova Bay, V. I.

346. Moravets, F. L.
1943. Forest statistics for Lane County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 92, 23 pp., illus.

347. _____
1943. Part I. The forest resource. In Forest Resources of Oregon. Oreg. State Bd. Forestry and Oreg. State Col. School Forestry, pp. 7-28, illus.

348. _____
1947. Forest statistics for Multnomah County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 98, 15 pp., illus

349. _____
1952. Forest statistics for Cowlitz County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 105, 24 pp., illus.

In 1949, the net volume of live Pacific silver fir sawtimber on commercial forest land in Cowlitz County was estimated to be 1,672 million board feet (Scribner). Growing stock was estimated as 339 million cubic feet.

350. _____
1953. Forest statistics for Grays Harbor County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 111, 24 pp., illus.

The net volume of live Pacific silver fir timber in Grays Harbor County was 2,721 million board feet (Scribner) in 1951. Growing-stock volume was 509 million cubic feet.

351. _____
1953. Forest statistics for Lewis County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 112, 24 pp., illus.

The net volume of live Pacific silver fir sawtimber in Lewis County was 2,231 million board feet (Scribner) in 1952. Growing-stock volume was 517 million cubic feet.

352. _____ 1953. Forest statistics for Mason County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 110, 24 pp., illus.

In 1951, the net volume of Pacific silver fir sawtimber on commercial forest lands in Mason County was 194 million board feet (Scribner). Growing stock was 47 million cubic feet.

353. _____ 1953. Forest statistics for Skamania County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 107, 23 pp., illus.

The net volume of Pacific silver fir live sawtimber in Skamania County in 1950 amounted to 3,580 million board feet (Scribner). Growing stock was approximately 867 million cubic feet.

354. _____ 1954. Forest statistics for Clatsop County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 113, 24 pp., illus.

The net volume of Pacific silver fir live sawtimber on commercial forest land in Clatsop County was 92 million board feet (Scribner) in 1952. Growing-stock volume was 27 million cubic feet.

355. _____ 1954. Forest statistics for Deschutes County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 116, 24 pp., illus.

In 1953, the net volume of Pacific silver fir sawtimber on commercial forest land in Deschutes County was computed as 7 million board feet (Scribner). Growing-stock volume was 2 million cubic feet.

356. _____ 1954. Forest statistics for Jefferson County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 115, 23 pp., illus.

The net volume of Pacific silver fir live sawtimber on Commercial forest lands in Jefferson County was estimated as 51 million board feet (Scribner) in 1953. Growing-stock volume was estimated as 18 million cubic feet.

357. _____ 1954. Forest statistics for Kittitas County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 117, 24 pp., illus.

In 1953, the net volume of Pacific silver fir sawtimber on commercial forest lands in Kittitas County was estimated as 1,341 million board feet (Scribner). Growing stock was 308 million cubic feet.

358. Morrill, George E.
1946. Forest statistics for Marion County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 96, 21 pp., illus.

359. Morton, B. R.
1921. Native trees of Canada. Canada Dept. Int. Forestry Branch Bul. 61, 233 pp., illus.

360. Mosher, Milton M., and Lunnum, Knut.
1959. Trees of Washington. Wash. State Col. Inst. Agr. Sci. Ext. Bul. 440 (reprint), 40 pp., illus.

361. Mueller, Dombois Deiter.
1959. The Douglas-fir forest associations on Vancouver Island in their initial stages of secondary succession. Unpublished Ph. D. thesis on file Univ. Brit. Columbia, 570 pp., illus.

Western hemlock and Pacific silver fir are the prominent tree species in submountainous forest associations which occur in the upper and western fringe zones of the study areas.

362. Muenscher, W. C.
1941. The flora of Whatcom County, State of Washington. 134 pp., illus. Ithaca, N.Y.

363. Mulholland, F. D.
1937. The forest resources of British Columbia. Brit. Columbia Forest Serv., 153 pp., illus.

Grand fir, Pacific silver fir, and alpine fir are grouped under silver fir. They include 17,580 million board feet of timber in coastal forests (11 percent of the total) and 13,904 million board feet of timber in the interior stands (14 percent of the total). On good sites, Pacific silver fir grows from 3 to 5 feet in diameter and 150 to 200 feet in height.

364. Mulligan, B. O., and Michaud, L. J.
1950. Raising conifers from seeds at Arboretum. Univ. Wash. Arboretum Bul. 13(2): 35-36.

A listing by species of germination information from coniferous seeds sown at the University of Washington Arboretum.

365. Munger, Thornton T.
1927. Timber growing and logging practice in the Douglas fir region. U.S. Dept. Agr. Dept. Bul. 1493, 42 pp., illus.

366. _____
1940. The cycle from Douglas fir to hemlock. Ecology 21: 451-459, illus.

367. Munns, E. N.
1938. The distribution of important forest trees of the United States. U.S. Dept. Agr. Misc. Pub. 287, 176 pp., illus.

Contains maps of the botanical ranges of the important tree species, including Pacific silver fir.

368. Munroe, Eugene.
1959. Canadian species of *Dioryctria* Zeller (Lepidoptera: Pyralidae) Canad. Ent. 91: 65-72, illus.

Pacific silver fir is one of the hosts of *Dioryctria reniculella* Grote.

369. Newberry, [J. S.]
1884. On the forest trees of the country bordering the line of the Northern Pacific Railroad. Torrey Bot. Club Bul. 11(2): 21-24.

370. Newlin, J. A., and Wilson, T. R. C.
1919. The relation of the shrinkage and strength properties of wood to its specific gravity. U.S. Dept. Agr. Bul. 676, 35 pp., illus.

371. _____ and Wilson, Thomas R. C.
1917. Mechanical properties of woods grown in the United States. U.S. Dept. Agr. Bul. 556, 47 pp., illus.

372. Northcott, P. L., Colbeck, H. G. M., Hancock, W. V., and Shen, K. C.
1959. Undercure...casehardening in plywood. Forest Prod. Jour. 9: 442-451, illus.

373. Northwest Forest Tree Seed Committee.
1959. Rules for service testing forest tree seed of the Pacific Northwest.* Oreg. Agr. Expt. Sta. Misc. Paper 83, 27 pp.

Five ounces is the minimum weight of Pacific silver fir seed needed for standard tests (purity, germination, 1,000 seed count, and cutting tests); 6 ounces is the minimum for hydrogen peroxide and staining tests. At least 100 grams of Pacific silver fir seed are needed in working samples for purity analysis. There are three pretreatment methods for germination tests of Pacific silver fir seed: no pretreatment, 4 weeks' stratification at 5° C., wash 16 hours or soak 30 hours, then 1 week's stratification at 5° C. The duration of the germination tests is approximately 21 days at temperatures (with light) of 20° to 30° C.

The minimum recommended standards for Pacific silver fir seed processing are: seeds should be 50 percent filled in the cutting test, be 55 percent pure by weight, be 20 percent viable in the peroxide test, and have a moisture content of 9 to 12 percent.

374. Orr, P. W.
1963. Important insect outbreaks in Oregon and Washington in 1963.* U.S. Forest Serv. Region 6, 11 pp., illus.

Epidemic outbreaks of silver fir beetles (*Pseudohylesinus* spp.) occurred in Pacific silver fir on extensive areas of the Mount Baker and Snoqualmie National Forests with lighter damage on the Gifford Pinchot National Forest and in Mount

Rainier National Park. Many of the infested trees are also severely infected with *Armillaria mellea* root rot.

375. Ouden, P. den.
1949. Coniferen, ephedra en ginkgo. 444 pp., illus. Wageningen: H. Veeman & Zonen.

376. Pady, S. M.
1941. Further notes on the witches' brooms and the substomatal pycnia of *Melampsorella*. Kansas Acad. Sci. Trans. 44: 190-201, illus.

Contains a photograph of a cross section of subcuticular pycnia of *Melampsorella* on Pacific silver fir.

377. _____
1942. Distribution patterns in Melampsorella in the national forests and parks of the western states. Mycologia 34: 606-627, illus.

378. Paul, Benson H.
1959. The effect of environmental factors on wood quality.* U.S. Forest Serv. Forest Prod. Lab. Rpt. 2170, 48 pp.

Pacific silver fir wood has an average specific gravity of 0.37, with a variation from 0.35 for wood with 6 to 15 rings per inch to 0.41 for wood with 21 rings or more per inch. Ring widths of less than five rings per inch were not encountered among samples of Pacific silver fir, probably due to close initial stocking of young trees in natural stands. Wood samples from a high-rainfall area in the Olympic National Forest (Washington) averaged 0.38 in specific gravity, those from a lower rainfall and higher elevation area--the Gifford Pinchot and Snoqualmie National Forests (Washington)--averaged 0.35. Specific gravity varied considerably both among and within trees on all three sites. In samples from the Olympic and Gifford Pinchot Forests, younger trees averaging about 15 rings per inch were found to contain wood of much lower average specific gravity than trees about 100 years older. The heaviest wood was found in an intermediate radial position between the pith and the bark.

For production of a more uniform wood quality, close initial stocking followed by thinnings to maintain an even growth rate is recommended. True firs are often subject to heavy snowloads and consequent bending when young. Compression wood is formed on the underside of bent trees, and trees which are unable to straighten themselves form this wood indefinitely. Removal of bent and leaning trees is therefore an important phase of thinning and stand improvement work.

379. _____
1961. Properties and uses of some minor western softwoods. Hitchcock's Wood Working Digest 63(10): 26-27.

380. _____
1963. The application of silviculture in controlling the specific gravity of wood. U.S. Dept. Agr. Tech. Bul. 1288, 97 pp., illus.

See reference 378 in this bibliography.

381. Pardé, Léon Gabriel Charles.
1955. Les coniferes: ouvrage honoré d'une souscription de la Direction Générale des Eaux et Foréts. 294 pp., illus. Paris: La Maison Rustique.

382. Peattie, Donald Culross.
1953. A natural history of western trees. 751 pp., illus. Boston: Houghton Mifflin Co.

383. Peavy, George W.
1922. Oregon's commercial forests; their importance to the State. Oreg. State Bd. Forestry Bul. 2, 80 pp., illus.

384. Pechanec, Anna Alice.
1961. Some aspects of the ecology of the bryophytes in the Three Sisters Primitive Area. Unpublished Ph. D. thesis on file Oreg. State Univ., 187 pp., illus.

A survey of combinations of tree and bryophyte species indicated some correlations between the two plant groups. Forest stands were tentatively assembled in 10 groups on the basis of these correlations.

Pacific silver fir was one of the dominant (high basal area) tree species in the following groups: (group e) *Picea engelmanni* ± *Abies amabilis* and other tree species with *Brachythecium hylotapetum -B. curtum forma;* (group g) *Tsuga mertensiana* and *Abies amabilis* with *Dicranum fuscescens.*

Pacific silver fir was present but was not one of the dominant tree species in the following groups: (group f) *Abies* sp. with *Bryum sandbergii;* (group h) *Pinus contorta* and *Tsuga mertensiana* with *Polytrichum piliferum* and *P. juniperinum.*

385. Peck, Morton Eaton.
1961. A manual of the higher plants of Oregon. Ed. 2, 936 pp., illus. Portland, Oreg.: Binfords & Mort.

386. Peck, Oswald.
1963. A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). Canad. Ent. Sup. 30, 1092 pp.

Megastigmus hoffmeyeri, M. lasiocarpae, M. pinus pinus, M. rafni, M. spermotrophus var. *spermotrophus,* and *M. tsugae* var. *tsugae* reported on Pacific silver fir seed.

387. Penhallow, D. P.
1896. The generic characters of the North American Taxaceae and Coniferae. Proc. and Trans. Roy. Soc. Canada, ser. 2, v. 2, sect. 5, pp. 33-57, illus.

388. Penhallow, David Pearce.
1904. The anatomy of North American coniferales together with certain exotic species from Japan and Australasia. Amer. Nat. 38: 243-273, 331-359, 523-554, 691-723, illus.

389. _____
1907. A manual of the North American gymnosperms. 374 pp., illus. Boston: Ginn & Co.

Lists, describes, and illustrates various anatomical features of certain coniferous woods. Discusses their relationships in the development of the conifers and general phylogeny of the higher gymnosperms. A key differentiates the

anatomical characteristics of 92 North American species, 21 Japanese species, and 4 Australian species. Quantitative values for various strength properties are also presented.

Pacific silver fir--Transverse section: "Resin cells few and widely scattering on the outer face of the summer wood...distinguished by (1) the sieve-plate structure of the terminal wall and (2) their often advanced position. Medullary rays rather prominent, not resinous, 1 cell wide...." Radial section: "Rays non-resinous, wholly devoid of tracheids. Ray cells chiefly straight except in the summer wood...upper and lower walls thick, unequal, and coarsely but very unequally pitted...the lateral walls with small, round, or oval pits...1-2, rarely 3, or in the marginal cells sometimes 5...." Tangential section: "Rays medium to high, the cells uniform, chiefly oval, more rarely round or narrowly oval, sometimes in pairs."

390. Pernot, J. F.
1916. Forests of Crater Lake National Park. U.S. Dept. Int., 39 pp., illus.

Pernot reported that the Crater Lake region is the extreme southern limit of the botanical range of Pacific silver fir.

391. Piper, Charles V.
1906. Flora of the State of Washington. Contrib. U.S. Natl. Herb., v. 11, 637 pp., illus.

392. _____ and Beattie, R. Kent.
1915. Flora of the northwest coast, including the area west of the summit of the Cascade Mountains, from the forty-ninth parallel south to the Calapooya Mountains on the south border of Lane County, Oregon. 418 pp. Lancaster, Pa.: Press of the New Era Printing Co.

393. Plummer, Fred G.
1900. Mount Rainier Forest Reserve, Washington. U.S. Geol. Survey 21st Ann. Rpt. 1899-1900, Pt. 5, Forest Reserves: 81-143, illus.

394. _____
1902. Forest conditions in the Cascade Range between the Washington and Mount Rainier Forest Reserves. U.S. Geol. Survey Prof. Paper 6, 42 pp., illus.

This report covers those areas comprising Tps. 19 to 28 N. and from R. 9 E. eastward to the Columbia River. The proportion and amounts of timber species on these areas are treated in detail in descriptions of the several watersheds.

Pacific silver fir is found in the subalpine fir zone which ranges in elevation from 5,000 to 6,000 feet at latitude 45°30'. Its associates are subalpine fir, noble fir, mountain hemlock, Alaska-cedar, and western hemlock. At latitude 47°30' Pacific silver fir occurs within the lodgepole pine zone. Its associates here are lodgepole pine, western white pine, Engelmann spruce, noble fir, western larch, Alaska-cedar, and western yew. "Wind shake" is one of the greatest defects of Pacific silver fir in these zones. Trees exhibit wide seams from their bases almost to their tops.

395. _____
1912. Lightning in relation to forest fires. U.S. Dept. Agr. Forest Serv. Bul. 111, 39 pp., illus.

396. Pope, Robert B.
1957. The role of aerial photography in the current balsam woolly aphid outbreak. Forestry Chron. 33: 263-264.

397. _____
1958. Final report, cooperative evaluation survey of Chermes damage, Mount St. Helens, Washington, 1957. 25 pp., illus. Unpublished report on file U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta.

Major landowners in the Mount St. Helens area of Washington cooperated in a survey designed to obtain a reliable estimate of the total amount of dead and heavily damaged true firs and establish a base from which to measure future trends. Damage from the balsam woolly aphid has been severe in this vicinity. Estimates were obtained by combining interpretation of large-scale aerial photographs with field checks using standard statistical techniques. Within the 413,000-acre area surveyed were 6 billion board feet of true fir timber of which 1,765 million board feet were trees classed as dead or heavily damaged. True fir volumes averaged 30,000 board feet per acre made up of two-thirds silver fir and one-third noble fir. Approximately 9,000 board feet per acre were within trees classed as dead or heavily damaged. Silver fir constituted 100 percent of the true fir volume killed or heavily damaged by Chermes, 90 percent of the volume with light-to-moderate damage, and 50 percent of the undamaged volume. Thirty percent of the total volume of all species in the stands sampled was Pacific silver fir.

398. Prebble, M. L., and Graham, K.
1945. The current outbreak of defoliating insects in coast hemlock forests of British Columbia. Part I. Description of outbreak and damage. Part II. Factors of natural control. Brit. Columbia Lumberman 29(2): 25-27, 42, 44, 46, 48; 29(3): 37-39, 88, 90, 92, illus.

The black-headed budworm, *Peronea variana*, was the principal cause of defoliation damage to the western hemlock, mountain hemlock, and Pacific silver fir forests of northern Vancouver Island and the Queen Charlotte Islands from 1940-44. Virus diseases were primarily responsible for reducing the budworm populations in 1944; however, the populations of three other insect species increased markedly in 1944. Generally reduced increment, top-kill, and bud and twig mortality resulted from periods of defoliation; Pacific silver fir suffered less defoliation damage than either of the hemlocks.

The insect outbreaks, resulting defoliation damage, and life histories of the participating insect species are presented in Part I. The principal factors of natural control and their influences on the 1940-44 insect outbreak are described in Part II.

399. _____ and Graham, K.
1957. Studies of attack by ambrosia beetles in softwood logs on Vancouver Island, British Columbia. Forest Sci. 3: 90-112, illus.

Density of attack and damage by several species of ambrosia beetles on blocks sectioned from 630 Douglas-firs, western hemlocks, and Pacific silver firs between 1942 and 1945 were found to vary with time of felling, period of exposure, tree species, beetle species, and between logs from different and the same trees. Pacific silver fir logs felled in April to June had few attacks during the first season of exposure. However, these logs and those felled during July through January were moderately to heavily attacked when left in the woods until the following May or June.

The ambrosia beetles causing the damage in these studies are *Platypus wilsoni* Swaine, *Trypodendrom lineatum* (Oliver), *Gnathotrichus sulcatus* Lec., *Gnathotrichus retusus* Lec., and *Xyleborinus tsugae* Swaine. Each species of beetles exhibited distinctive and consistent patterns of attack in relation to season and felling date.

400. Prentice, R. M.
1962. Forest Lepidoptera of Canada. Recorded by the Forest Insect Survey, v. 2 - Nycteolidae, Noctuidae, Notodontidae, Liparidae. Canada Dept. Forestry Forest Ent. & Path. Branch Bul. 128, 281 pp., illus.

Lists 12 species that attack Pacific silver fir.

401. _____
1963. Forest Lepidoptera of Canada. Recorded by the Forest Insect Survey, v. 3 - Lasiocampidae, Thyatiridae, Drepanidae, Geometridae. Canada Dept. Forestry Forest Ent. & Path. Branch Pub. 1013, pp. 283-543, illus.

Lists 28 species that attack Pacific silver fir.

402. Preston, Richard J., Jr.
1961. North American trees (exclusive of Mexico and tropical United States). Ed. 2, 395 pp., illus. Ames: Iowa State College Press.

403. Querengässer, von F.
1953. Beiderseits der Kaskaden-kammlinie. Forstarchiv 24: 48-58.

404. Raabe, Robert D.
1962. Host list of the root rot fungus, *Armillaria mellea*. Hilgardia 33(2): 25-88.

Armillaria mellea has been reported on Pacific silver fir in the United States and in Canada.

405. Randall, Warren R.
1958. Manual of Oregon trees and shrubs. 234 pp., illus. Corvallis: Oregon State College Cooperative Association.

406. Record, Samuel J.
1914. Identification of the economic woods of the United States; including a discussion of the structural and physical properties of wood. 117 pp., illus. New York: John Wiley & Sons, Inc.

407. _____
1934. Identification of the timbers of temperate North America; including anatomy and certain physical properties of wood. 196 pp., illus. New York: John Wiley & Sons, Inc.

408. _____ and Hess, Robert W.
1943. Timbers of the new world. 640 pp., illus. New Haven: Yale University Press.

409. Rehder, Alfred.
1940. Manual of cultivated trees and shrubs hardy in North America. Ed. 2, 996 pp., illus. New York: The Macmillan Co.

410. Rhoads, Arthur S., Hedgcock, George G., Bethel, Ellsworth, and Hartley, Carl.
1918. Host relationships of the North American rusts, other than Gymnosporangiums, which attack conifers. Phytopathology 8: 309-352.

Peridermium balsameum Peck occurs as a leaf rust on Pacific silver fir.

411. Roach, Archibald W.
1952. Phytosociology of the Nash Crater lava flows, Linn County, Oregon. Ecol. Monog. 22: 169-193, illus.

A report on a phytosociologic study made of several communities developing on a series of different, young, volcanic substrates. The study area is at an elevation of 3,200 to 4,200 feet at the head of the McKenzie River in the central Oregon Cascades. Pacific silver fir is found in the *Pseudotsugeto-abietum grandis* association This association occupies the most mesic substrate of the five associations described as growing on the young substrates: grayer, rounded block basalts with a high proportion of volcanic sand and ash mixed in and on scoria cones. It is represented in the reproduction and 3- to 12-inch size classes.

Pacific silver fir is an important constituent of the Douglas-fir–western hemlock forest bordering the volcanic deposits on the west and north. It was found in all size classes, except 24+ inches in diameter, and attained a frequency of 83 percent and a basal area of 7 percent of the total. Pacific silver fir and western hemlock are considered to be the climax species in this association.

412. Rochester, G. H.
1933. The mechanical properties of Canadian woods, together with their related physical properties. Canada Dept. Int. Forest Serv. Bul. 82, 88 pp., illus.

413. Roff, J. W., and Eades, H. W.
1959. Deterioration of logging residue on the British Columbia coast (western hemlock, amabilis fir, and Sitka spruce). Canada Dept. North. Aff. & Natl. Resources Forestry Branch F.P.L. Tech. Note 11, 38 pp., illus.

Annual observations of logging residues (no pieces shorter than 8 feet or less than 6 inches in top diameter included) revealed that Pacific silver fir was less decay resistant than either western hemlock or Sitka spruce, particularly 1 to 2 years following logging. At the end of 4 years, 72.9 percent of the original volume of Pacific silver fir residue exhibited a partial or complete disintegration of wood structure, and 98.2 percent of the original volume exhibited all manifestations of decay including discolorations and disintegration of structure. Generally, the relative importance of brown and white rots in the annual deterioration of Pacific silver fir residue varied by year since logging: brown rots accounted for 65, 11, and 60 percent of all decay in the second, third, and fourth years following logging; white rots accounted for the remainder. Specifically, the most important fungal organisms on Pacific silver fir residues were *Stereum sanguinolentum* and *Fomes annosus*, both white rots, which caused 41 and 47 percent, respectively, of all the decay.

In general, severity of residue deterioration was directly associated with high moisture content within the wood, lower elevations, damage by ambrosia beetles *(Trypodendron cavifrons)*, and amount of decay prior to logging. The amounts of sapwood in the three study species showed no relationships to the amounts or rates of decay, and the rate of sapwood decay was similar to that of heartwood.

On the basis of this study, salvage of western hemlock and Pacific silver fir residue should be done within 2 years of logging.

414. Rohmeder, E.
1961. Praktische Anwendungsmöglichkeiten forstgenetischer Forschungsergebnisse. Schweiz. Ztschr. für Forstw. (Jour. Forestry Suisse) 112: 43-71, illus.

415. Ross, Charles R.
1957. Trees to know in Oregon. Oreg. Ext. Serv. Bul. 697 (rev.), 88 pp., illus. Corvallis: Oregon State College Press.

416. Rowe, J. S.
1959. Forest regions of Canada. Canada Dept. North. Aff. & Natl. Resources Forestry Branch Bul. 123, 71 pp., illus. (Revision of "A forest classification for Canada," by W. E. D. Halliday, Canada Dept. North. Aff. & Natl. Resources Bul. 89, 1937.)

Pacific silver fir is represented in the "Interior Subalpine Section" (SA. 2) and "Coastal Subalpine Section" (SA. 3) of the "Subalpine Forest Region" and in the "Southern Pacific Coast Section" (C. 2) and "Northern Pacific Coast Section" (C.3) of the "Coast Forest Region."

417. Rübel, E.
1915. Die auf der "Internationalen pflanzengeographischen Exkursion" durch Nordamerika 1913 kennengelernten Pflanzengesellschaften. Bot. Jahrb. 53, Bleib. 116: 3-36, illus.

418. Rudinsky, J. A.
1957. Notes on the balsam woolly aphid. Weyerhaeuser Timber Co., 12 pp., illus.

A limited review of the information available on the balsam woolly aphid, including preventive practices and control measures likely to be of some merit in the Northwest and some recent European studies of interest.

Adelges piceae had not been reported on Pacific silver fir previous to the heavy infestation discovered in 1954. Swelling or "gouting" was much more pronounced in Pacific silver fir than in the European firs, but the effects of the aphid were similar to those described for balsam fir. Trees of any age can be attacked and any part of the tree infested. Crowns of dominant and codominant Pacific silver firs and those on the edge of the stand or in the open seem to be particularly preferred, possibly because of a positive phototropic behavior of the insect. On mature and overmature silver fir, crown infestation may be most important; on young trees, a stem infestation.

Preventive measures suggested include avoiding planting of infested seedlings, winter cutting and removal of timber, short rotation ages, and replacement of silver

fir with other species. Control by natural predators offers the most promise, much more so than control by silvicultural or chemical means.

419. _____ and Vité, J. P.
1959. Certain ecological and phylogenetic aspects of the pattern of water conduction in conifers. Forest Sci. 5: 259-266, illus.

Presents five water-conducting systems and discusses their ecological and phylogenetic significance. These systems are: spiral ascent, turning right; spiral ascent, turning left; interlocked ascent; sectorial, winding ascent; and sectorial, straight ascent.

All investigated species of true fir (including Pacific silver fir), larch, and spruce and the hard pines possess the spiral-ascent, turning-right system, which of all the systems exhibits the greatest water distribution to the crown. The inherent advantage of this system is that it decreases the danger that loss of individual roots will decrease the water supply of entire tree sectors. The authors suggest that tree species with this system may respond quickly to environmental changes and thus become better competitors than other tree species.

420. Ruth, Robert H.
[1963]. Site preparation in the high elevation types of the west Cascades and coastal forests; the conditions under which site preparation is required and the methods now available. In Western Reforestation 1962. West. Forestry & Conserv. Assoc. West. Reforestation Coordinating Comm. Proc. 1962: 14-16.

421. St. John, Harold, and Hardin, Edith.
1929. Flora of Mt. Baker. Mazama 11: 52-102, illus.

422. _____ and Warren, F. A.
1937. The plants of Mount Rainier National Park, Washington. Amer. Midland Nat. 18: 952-985.

423. Sargent, C. S.
1885. The woods of the United States. With an account of their structure, qualities, and uses. With geographical and other notes upon the trees which produce them. 203 pp., illus. New York: D. Appleton & Co.

This valuable book describes the physical appearances and properties of 412 species of American tree woods and rates them by their specific gravity, percentage of ash, relative approximate fuel value, coefficient of elasticity, modulus of rupture, resistance to pressure, and weight per cubic foot. The wood samples used in this study were obtained from the American Museum of Natural History collection.

Pacific silver fir: "Wood light, hard, not strong, close grained, compact; bands of small summer cells broad, resinous, dark-colored, conspicuous, medullary rays numerous thin; color light brown. The sap-wood nearly white."

424. Sargent, Charles Sprague.
1898. The silva of North America. v. 12, 144 pp., illus. Boston, New York: Houghton Mifflin Co.

A description of the botanical characteristics, range, and synonymy of North American conifers with plates illustrating the botanical features of cones, flowers, and foliage.

Pacific silver fir often reaches 250 feet in height, bark of the trunk is usually thin, smooth, and pale or silvery white. Winter buds are nearly globose with closely imbricated purple scales thickly coated with resin. Leaves are flat, deeply grooved, dark green, and lustrous on the upper surface and silvery white on the lower. The cones are oblong, deep purple, from 3 to 6 inches in length and 2 to 2-1/2 inches in diameter, and cone scales are nearly as long as they are broad.

Sargent reports on a supposed natural hybrid between Pacific silver fir and subalpine fir found by him in a stand of the two species growing on a ridge of the Olympic Mountains which separates the Solduc [sic] and Quillyhute [sic] rivers. The hybrid had the slender, spirelike head and foliage of subalpine fir and the cones of Pacific silver fir.

425. Sargent, Charles Sprague.
1933. Manual of the trees of North America (exclusive of Mexico). Ed. 2, 910 pp., illus. Boston, New York: Houghton Mifflin Co. (Reprinted 1961, 2 v. New York: Dover Publications, Inc.)

A classical dendrological reference containing botanical and gross wood anatomy descriptions along with botanical ranges and uses of native North American trees.

426. Schmitz, Henry.
1916. Preliminary note on the occurrence of *Peridermium balsameum* in Washington. Phytopathology 6: 369-371.

Peridermium balsameum Peck. was found in abundance on grand fir seedlings, and *Peridermium pseudo-balsameum* (D. & H.) Arth. was provisionally identified on Pacific silver fir needles.

427. Schmidt, R. L.
1955. Some aspects of western red cedar regeneration in the coastal forests of British Columbia. Brit. Columbia Forest Serv. Res. Notes 29, 10 pp., illus.

428. _____
1957. The silvics and plant geography of the genus *Abies* in the coastal forests of British Columbia. Brit. Columbia Forest Serv. Tech. Pub. T. 46, 31 pp., illus.

The maximum abundance and development of Pacific silver fir occurs in British Columbia in areas with high annual precipitation. The species is rare or absent in coastal areas with warm dry summers--probably because of the high fire frequency of those areas. The species is able to occupy a wide range of site conditions although its best growth occurs on deep, well-drained soils supplied with abundant but not excessive moisture. Its poorest growth occurs on poorly drained sites with excessive moisture. The species is able to grow even when the root systems are confined to organic soil layers.

Pacific silver fir, if not the most shade-tolerant species of the coastal conifers, is at least as tolerant as western hemlock or western redcedar. The

average maximum age the species attains is between 400 and 500 years on the best sites, 250 and 350 years on the poorer sites.

Pacific silver fir seed is large and has a high rate of fall so the seed is not adapted to long-distance wind dispersion. Since the seeds are not effectively distributed by birds and mammals, the species is a slow migrator and takes 700 to 800 years to invade new areas if fire is excluded. There is considerable evidence suggesting that Pacific silver fir has not fully inhabited its potential range because it is poorly equipped for rapid migration and enough postglacial time has not elapsed to offset this shortcoming.

429. Schmidt, R. L.
1957. E. P. 368--The adaptability of tree species to forest sites. In Forest Research Review 1956. Brit. Columbia Forest Serv. Pub., p. 13.

Douglas-fir, western hemlock, western redcedar, Pacific silver fir, grand fir, and Sitka spruce were seeded in a sword fern association and in a salmonberry-fern association on the west coast of Vancouver Island. After three growing seasons grand fir and Douglas-fir survived best. The poor performance of the other four species was attributed to low germinative capacity and unfavorable seedbed conditions

430. _____
1958. E. P. 368--The adaptability of tree species to forest sites. In Forest Research Review, Year Ended March 1958. Brit. Columbia Forest Serv. Pub., p. 13.

Planted Pacific silver fir seedlings had 90-percent survival after one growing season on a slash-burned area at Ucluelet.

431. _____
1958. E. P. 482--Climate and the altitudinal distribution of conifers. In Forest Research Review, Year Ended March 1958. Brit. Columbia Forest Serv. Pub., pp. 18-19.

An abrupt decrease in the length of frost-free periods, which occurred 500 feet above the altitudinal limits of Douglas-fir, western hemlock, and western redcedar, is considered a climatic boundary. However, this climatic boundary does not control the altitudinal ranges of the upland species in the Ek Valley on Vancouver Island. Subalpine fir and mountain hemlock occur from 2,300-foot elevation to tree line, and Pacific silver fir and Alaska-cedar grow from the valley bottom to over 5,000-foot elevation.

432. _____
1959. E. P. 368--The adaptability of tree species to forest sites. In Forest Research Review, Year Ended March 1959. Brit. Columbia Forest Serv. Pub., p. 23.

Measurements of several coniferous species planted on two slash-burned areas at Ucluelet revealed Douglas-fir performed better than the other species with respect to survival, initial growth, and health. Pacific silver fir had the poorest height growth of all the conifers and only fair survival.

433. _____
1960. E. P. 368--The adaptability of tree species to forest sites. In Forest Research Review, Year Ended March 1960. Brit. Columbia Forest Serv. Pub., pp. 10-11, illus.

Several species of conifers were planted in areas that originally supported an uneven-aged mixture of western hemlock and Pacific silver fir. These species were subsequently compared in terms of survival, growth, and health. Douglas-fir, Sitka spruce, Port-Orford-cedar, and western hemlock were rated good, western redcedar and grand fir were rated fair, and Pacific silver fir was rated poorest--despite the fact it was a primary species in the former stand.

434. Schmidt, R. L.
1960. E. P. 482--Climate and the altitudinal distribution of conifers. In Forest Research Review, Year Ended March 1960. Brit. Columbia Forest Serv. Pub., pp. 15-18, illus.

Western redcedar pollen dispersal began around the middle of April, followed by Douglas-fir on May 2, western hemlock on May 7, grand fir on May 15, and Pacific silver fir on May 19. There is little or no difference between the species in the time of beginning of radial growth. Radial growth began before pollen dispersion in the two true firs, indicating either faulty techniques or a generic behavioral difference.

435. _____
1961. E. P. 368--The adaptability of tree species to forest sites. In Forest Research Review, Year Ended March 1961. Brit. Columbia Forest Serv. Pub., pp. 10-11.

The average heights of the conifers planted at Ucluelet Area No. 1 after five growing seasons were: Port-Orford-cedar, 55 inches; Douglas-fir, 53 inches; western hemlock, 11 inches; and Pacific silver fir, 11 inches. Heights at 3 years at Area No. 2 were: Douglas-fir, 55 inches; western hemlock, 51 inches; Sitka spruce, 50 inches; Port-Orford-cedar, 42 inches; grand fir, 30 inches; western redcedar, 26 inches; and Pacific silver fir, 12 inches.

436. _____
1962. E. P. 368--The adaptability of tree species to forest sites. In Forest Research Review, Year Ended March 1962. Brit. Columbia Forest Serv. Pub., pp. 11-12.

437. Scott, David R. M.
1962. The Pacific Northwest region. In Regional Silviculture of the United States, ed. by John W. Barrett. Pp. 503-570, illus. New York: The Ronald Press Co.

Discusses the physical environment and major forest type groups with the primary emphasis on description of typical sites of these groups, their place in ecological succession, growth rates, rotation ages, silvicultural practices, and damaging agents. The Pacific silver fir-hemlock cover type group (climax) succeeds the subclimax Douglas-fir–noble fir–white pine type group in the Canadian Zone on the western slopes of the Cascades. Pacific silver fir is also a frequent component of stands in the Humid Transition Zone.

438. _____
1962. Plant associations of western Washington. Univ. Wash. Arboretum Bul. 25(1): 11-14, 26.

In the Humid Transition Zone of western Washington, Pacific silver fir is a prominent species on higher elevation sites within the western hemlock–western

redcedar association and hemlock-cedar-spruce associations. The climax association of the Canadian Zone is distinguished by the dominance of Pacific silver fir.

439. Serenius, R. S.
1956. Sulphite pulping of western hemlock, balsam and spruce. Pulp & Paper Mag. Canada 57(9): 133-137, illus.

Author's abstract: "The sulphite pulping properties of western hemlock, Sitka spruce and balsam (grand and Pacific silver fir) have been studied using a small experimental digester. These species are compared at constant permanganate number, cooking schedule and screenings content. For each species there is shown to exist a 'critical' permanganate value at which important changes in strength and yield occur. The obtained data are capable of many practical applications as indicated by examples."

440. Shantz, H. L, and Zon, Raphael.
1924. Natural vegetation, sect. E. Pt. 1. The physical basis of agriculture. Atlas of American Agriculture. U.S. Dept. Agr., 29 pp., illus.

441. Shaw, Charles Gardner.
1958. Host fungus index for the Pacific Northwest. I. Hosts. Wash. Agr. Expt. Sta. Cir. 335, 127 pp.

Lists 61 species of fungi known to occur on Pacific silver fir.

442. _____
1958. Host fungus index for the Pacific Northwest fungi. Wash. Agr. Expt. Sta. Cir. 336, 237 pp.

443. Shea, Keith R.
1960. Deterioration--a pathological aspect of second-growth management in the Pacific Northwest.* Weyerhaeuser Timber Co. Forestry Res. Center Forestry Res. Note 28, 16 pp.

Brings together pertinent information on the deterioration of injured coniferous forest trees in the Pacific Northwest. Discusses decay associated with mechanical injury, windthrow, fire, and insects. Pacific silver fir is included.

444. _____
1960. Yellow laminated root rot of Douglas-fir: A literature review. Weyerhaeuser Timber Co. Forestry Res. Center, 18 pp.

Poria weirii has been isolated from Pacific silver fir host.

445. _____ and Johnson, Norman E.
1957. Analysis of deterioration of Chermes-killed Pacific silver fir. Weyerhaeuser Timber Co. Forestry Res. Center, 12 pp.

Reviews the findings of other studies on the agents and factors causing and correlated with deterioration losses in Chermes-killed Pacific silver fir. Objectives and general methods for proposed research are presented.

446. _____ Johnson, Norman E., and McKee, Samuel.
1962. Deterioration of Pacific silver fir killed by the balsam woolly aphid. Jour. Forestry 60: 104-108, illus.

The study's purpose was to determine "(1) insects and fungi found in dead and deteriorating silver fir killed by the aphid; (2) rate and extent of deterioration; (3) yield and quality of representative pulps; and (4) characteristics of silver fir dead for varied periods up to five years."

Ambrosia beetles were the most numerous of the wood-boring insects in trees dead 1 year or less. Their activity was concentrated mainly in the butt logs of the trees. The species involved included *Gnathotrichus sulcatus*, *Trypodendron lineatum*, and *Platypus wilsoni*. The horntails (Siricidae) and round-headed borers (*Monochamus oregonensis* and *Stenocorus lineatus*) attacked the middle and top of the sample trees. Bark beetle (*Pseudohylesinus grandis*) attacks were found in all portions of the trees but concentrated on the upper and middle portions. *Pseudohylesinus granulatus* attacks were located in the butt and lower bole.

Brown rot (*Fomes piniçola*) was the most common wood-destroying fungus, followed in importance by a white rot (*Polyporus abietinus*) and patchy rot (*Stereum chailletii*). Mycelial fans of shoestring root rot (*Armillaria mellea*) occurred at the base of half of the trees dead less than 1 year and was evident in all dead trees after 2 years. It caused negligible loss of merchantable volume, however.

The average depth of penetration of incipient and advanced decay increased with height above the ground for each mortality class (living, dead 1 year or less, dead 2 or 3 years, dead 3 to 5 years). The butt log was least affected by decay. Deterioration of study trees averaged 13 percent of the merchantable cubic volume per year and reached an average of 53 percent of the cubic volume and 64 percent of the board-foot volume in 3 to 5 years.

Unbleached sulfite pulps from trees dead 3 to 5 years were characterized by low alpha cellulose, low viscosity, high potassium hydroxide solubility, and low physical strength. The pulp yields varied from tree to tree with no correlation with elapsed time after tree death. Unbleached kraft pulp yields decreased rapidly with time after death. Pulp quality decreased rapidly with time regardless of pulping process.

Several characteristics of the tree crown and lower bole may be useful indices for salvage. A table is included showing the relationship of percentage of foliage persisting, percentage of branchlets broken off, phloem color and decay, bark tightness, sapwood color and decay, and percent of trees attacked by three species of insects and by shoestring root rot to number of years the tree has been dead.

447. Sigafoos, R. S., and Hendricks, E. L.
1961. Botanical evidence of the modern history of Nisqually Glacier, Washington; a description of botanical methods used to determine dates of recession of three glaciers at Mount Rainier, Washington. U.S. Geol. Survey Prof. Paper 387-A, 20 pp., illus.

448. Siggins, Howard W.
1933. Distribution and rate of fall of conifer seeds. Jour. Agr. Res. 47: 119-128, illus.

The average rate of fall of Pacific silver fir seed is 4.95 feet per second. The average weight of good seed is 0.75 gram.

449. Silen, Roy R., and Woike, Leonard R.
1959. The Wind River Arboretum, 1912-1956.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Paper 33, 50 pp., illus.

Two lots of Pacific silver fir are represented among the 24 true firs surviving in this southwestern Washington arboretum. A growth index of 0.41 (based on 1.00 for indigenous Douglas-fir) illustrates silver fir's slow growth in the area. No significant insect or climatic damage to the species has occurred.

450. Silver, G. T.
1959. The balsam woolly aphid, *Adelges piceae* (Ratz). Brit. Columbia Canada Dept. Agr. Div. Forest Biol. Bimo. Prog. Rpt. 15(1): 3.

451. Society of American Foresters.
1954. Forest cover types of North America (exclusive of Mexico). 67 pp., illus. Washington, D. C.

Pacific silver fir is a major component of type 226, Pacific silver fir-hemlock, although it may not predominate. This widespread but discontinuous type extends from southern Alaska to southern Oregon. In Alaska and British Columbia, it ranges from near sea level to 4,000 feet; in Washington and Oregon, the type ranges from 1,500 to 5,000 feet in elevation. It is bounded by the Douglas-fir and western redcedar-hemlock types at lower elevations and by the alpine types at higher elevations.

Pacific silver fir is also found in types 229 (Pacific Douglas-fir), 230 (Douglas-fir-western hemlock), 225 (Sitka spruce-western hemlock), 224 (western hemlock), 223 (Sitka spruce), and 205 (mountain hemlock-subalpine fir).

452. Sowder, A. M.
1961. 1960 Christmas tree data. Jour. Forestry 59: 829-830.

453. Spada, Benjamin.
1962. Forest statistics for Clallam County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 145, 26 pp., illus.

In 1960, estimated volumes were 1,552 million board feet (Scribner rule) of Pacific silver fir sawtimber and 307 million cubic feet of growing stock on commercial forest land in Clallam County.

454. _____
1962. Forest statistics for Jefferson County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 144, 26 pp. illus.

In 1960, estimated volumes were 4,201 million board feet (Scribner rule) of Pacific silver fir sawtimber and 781 million cubic feet of growing stock on commercial forest land in Jefferson County.

455. _____
1962. Forest statistics for King County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 143, 27 pp., illus.

In 1960, estimated volumes were 3,422 million board feet (Scribner rule) of Pacific silver fir sawtimber and 759 million cubic feet of growing stock on commercial forest land in King County.

456. Spada, Benjamin.
1962. Forest statistics for Pierce County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 141, 26 pp., illus.

In 1959, estimated volumes were 1,113 million board feet (Scribner rule) of Pacific silver fir sawtimber and 270 million cubic feet of growing stock on commercial forest land in Pierce County.

457. _____ and Bones, James T.
1957. Forest statistics for Snohomish County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 128, 30 pp., illus.

In 1955, estimated volumes were 4,488 million board feet (Scribner rule) of Pacific silver fir sawtimber and 927 million cubic feet of growing stock on commercial forest land in Snohomish County.

458. _____ and Usher, Jack H.
1955. Forest statistics for Yakima County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 121, 29 pp., illus.

In 1954, estimated volumes were 797 million board feet (Scribner rule) of Pacific silver fir sawtimber and 258 million cubic feet of growing stock on commercial forest land in Yakima County.

459. Spaulding, Perley.
1956. Diseases of North American forest trees planted abroad; an annotated list. U.S. Dept. Agr. Agr. Handb. 100, 144 pp.

460. Sprague, F. LeRoy, and Hansen, Henry P.
1946. Forest succession in the McDonald Forest, Willamette Valley, Oregon. Northwest Sci. 20: 89-98, illus.

461. Staebler, George R.
1958. Silvical characteristics of noble fir.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Silvical Ser. 5, 12 pp., illus.

462. Steele, Robert W., and Worthington, Norman P.
1955. Increment and mortality in a virgin Douglas-fir forest.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Note 110, 6 pp., illus.

463. Stein, William I.
1951. Germination of noble fir and silver fir seed on snow. Jour. Forestry 49: 448-449, illus.

Germination of noble and silver fir seeds was observed to take place on the snow. Very few of the resulting seedlings managed to establish their root tips in the soil. Those that did were shallow rooted and possessed crooked and elongated

stems. It was considered extremely doubtful they could survive a normal summer. These findings suggest that broadcast sowing of true fir seed on snow will be unsuccessful.

464. Stokes, W. B.
1925. Canadian softwoods. Canada Dept. Int. Forestry Branch Cir. 19, 13 pp.

465. Stone, Herbert.
1904. The timbers of commerce and their identification. 311 pp., illus. London: W. Rider & Son Ltd.

466. Streets, R. J.
1962. Exotic forest trees in the British Commonwealth. 765 pp., illus. Oxford: Clarendon Press.

467. Sudworth, Geo. B.
1893. On legitimate authorship of certain binomials with other notes on nomenclature. Torrey Bot. Club Bul. 20: 40-46.

468. Sudworth, George B.
1897. Nomenclature of the arborescent flora of the United States. U.S. Dept. Agr. Div. Forestry Bul. 14, 417 pp.

469. _____
1908. Forest trees of the Pacific slope. U.S. Dept. Agr. Forest Serv., 441 pp. illus.

Pacific silver fir, *Abies amabilis* (Loud.) Forbes, "white" or "silver" fir, is a "straight tree, clear of branches for from 50 to 100 feet in close, dense stands. Its height in favorable situations is from 150 to 180 feet, sometimes 200 feet, and its diameter from 3 to 5 feet, or rarely 6 feet. In less favorable sites the height is from 75 to 100 feet and from 18 to 30 inches in diameter.... The spherical resin-covered buds of this fir are characteristic.... The dark purple cones...about 4 to 5-1/2 inches in length by 2-1/4 to 2-1/2 inches in thickness.... Wood...light but considerably heavier than that of the white or grand firs...fine-grained...one of the best of the soft firs."

"A most striking characteristic is its smooth, ashy-gray, unbroken bark, conspicuously marked with large chalky-white areas."

"Grows in well-drained, shallow, gravelly sand to moist, sandy loam, or in porous rocky soils; best on sandy loam; good drainage necessary, as is also abundant...soil moisture.... In pure, limited stands and small groups (Vancouver Island, Olympics, high levels in Cascades), but more commonly in mixture .... Prolific seeder. Some seed borne locally nearly every year...heavy seeding occurs at rather irregular intervals of 2 to 3 years. Seed...low rate of germination...vitality...transient."

470. _____
1927. Check list of the forest trees of the United States, their names and ranges. U.S. Dept. Agr. Misc. Cir. 92, 295 pp.

471. Suksdorf, William N., and Howell, Thomas.
1896. Flora of Mount Adams. Mazama 1: 68-97.

472. Sweeten, James Ross.
1961. A study of ray tracheids in hemlock and balsam from southwestern British Columbia. 35 pp., illus. Unpublished B.S.F. thesis on file Univ. Brit. Columbia.

Because of their different strength properties, a method was sought for distinguishing "hemlock" (western and mountain hemlocks) from "balsam fir" (Pacific silver, grand, and subalpine firs) which are presently sold indiscriminately as "hemlock" in the Vancouver area. Ray tracheids proved a reliable means of distinguishing the woods. Ray tracheids were found in all hemlock samples but in only one of the 200 balsam fir samples (subalpine fir). No reliable macroscopic method of identification was found, however. The theory that ray tracheids in some true firs are caused by injury was not confirmed in this study; none of the wood samples from injured true firs exhibited them.

473. Tarrant, Robert F., Isaac, Leo A., and Chandler, Robert F., Jr.
1951. Observations on litter fall and foliage nutrient content of some Pacific Northwest tree species. Jour. Forestry 49: 914-915.

The annual litter fall of Pacific silver fir is 1,582 pounds per acre (ovendry weight basis). A nutrient analysis of Pacific silver fir litter indicates the following quantities of nutrients, in pounds per acre, are deposited annually: nitrogen, 14.8; phosphorus, 1.9; potassium, 3.8; calcium, 14.5; magnesium, 0.9. The acidity (pH) of soil horizons developed under Pacific silver fir stands were Ao horizon, 3.77; 0- to 2-inch depth, 4.35; and 8- to 10-inch depth, 5.02.

474. Taylor, Raymond F.
1956. Alaska. In A World Geography of Forest Resources. Ed. by Stephen Haden-Guest, John K. Wright, and Eileen M. Teclaff for Amer. Geog. Soc. pp. 115-125, illus. New York: The Ronald Press Co.

475. _____ and Little, Elbert L., Jr.
1950. Pocket guide to Alaska trees. U.S. Dept. Agr. Agr. Handb. 5, 63 pp., illus.

Pacific silver fir is found near southeast tip of Alaska. It occurs on well-drained lower slopes of canyons, benches, and flats from sea level to an elevation of 1,000 feet. It attains a height of 75 feet.

476. Taylor, Walter P.
1922. A distributional and ecological study of Mount Rainier, Washington. Ecology 3: 214-236, illus.

477. Thickens, J. H., and McNaughton, G. C.
1916. Ground-wood pulp. Pt. 1. The grinding of cooked and uncooked spruce. Pt. 2. Substitutes for spruce in the manufacture of ground-wood pulp. U.S. Dept. Agr. Bul. 343, 151 pp., illus.

478. Thomas, Gerard M.
1957. Climate and growth rate as related to an outbreak of silver fir beetles.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Note 150, 5 pp., illus.

Abnormally warm and dry weather conditions existed immediately before and during the beetle outbreak. However, there was no positive correlation between climate (temperature and precipitation) and radial growth.

479. Thomas, Gerard M., and Wright, K. H.
1961. Silver fir beetles. U.S. Dept. Agr. Forest Pest Leaflet 60, 7 pp., illus.

The fir root bark beetles *Pseudohylesinus granulatus* (Lec.) and the silver fir beetle *P. grandis* Sw. are highly destructive to Pacific silver fir. This leaflet describes the beetles' appearance, their life cycles and habits, and evidences of their attack. Felling infested trees and either burning or spraying them with chemicals are ineffective control measures. Logging infested stands during the fall, winter, and spring reduces the beetle population and provides some control. *Armillaria mellea*, *Fomes annosus*, *Poria weirii*, and *Poria subacida* are root-rotting fungi, commonly associated with the bark beetle attacks.

480. Thomas, G. P.
1958. Studies in forest pathology XVIII. The occurrence of the Indian paint fungus, *Echinodontium tinctorium* E. and E., in British Columbia. Canada Dept. Agr. Forest Biol. Lab. Pub. 1041, 30 pp., illus.

A survey of the known hosts on 50 habitat types revealed Indian paint fungus is absent from 16 of these forest types despite the occurrence in them of one or more of its known hosts. The survey indicated the distribution and abundance of the fungus are directly influenced by summer climate and the inherent susceptibilities of its different hosts to infection. Indian paint fungus is indirectly influenced by altitude, topography, and the silvical characteristics of trees. High average summer temperatures in combination with high humidities and the proportion of the stem length of trees over which these atmospheric conditions prevail are also important.

True firs appear more susceptible to infection than hemlocks, spruces, or Douglas-firs. Pacific silver fir is infected by the fungus on 16 of the 24 habitat types in which it occurs. The infections were heaviest at heights above the midpoint of dominant trees. Trees intermediate or less in height often escaped infection. The author believes that the low degree of infection in understory Pacific silver fir is due to the cool atmospheric conditions that normally prevail near the ground. Conditions in the upper canopies high above the ground are more conducive to infections.

481. Thompson, Allen E.
1924. The forest resources of Washington. Univ. Wash. Forest Club Quart. 3(1): 19-32, illus.

482. Thompson, W. P.
1910. The origin of ray tracheids in the coniferae. Bot. Gaz. 50: 101-116.

Reports the occurrence of ray tracheids in a wounded root of Pacific silver fir.

483. _____
1912. Ray tracheids in Abies. Bot. Gaz. 53: 331-338.

Thompson describes ray tracheids found associated with wounds in Pacific silver fir and white fir and in uninjured wood of *Abies homolepis* and *A. veitchii*. Ray tracheids were also associated with degenerating cells or "ghosts" and with marginal parenchyma cells at the ends of some annual rings. Thompson concludes, "...ray tracheids were present in the ancestors of *Abies*, and have persisted sporadically in a few species, but in the majority have either degenerated or been transformed to parenchyma."

484. Timell, T. E.
1961. Isolation of galactoglucomannans from the wood of gymnosperms. TAPPI 44(2): 88-96.

485. Timell, Tore E.
1961. Characterization of four celluloses from the bark of gymnosperms. Svensk PappTidn. 64: 685-688.

Celluloses were isolated from barks of Pacific silver fir, Engelmann spruce, lodgepole pine, and ginkgo in yields of 38.1, 30.9, 30.4, and 37.6 percent, respectively.

486. _____
1961. Constitution of a glucomannan from the bark of amabilis fir *(Abies amabilis)*. Svensk PappTidn. 64: 744-747.

The glucomannan was isolated in a yield of 3 percent from the bark of Pacific silver fir. Its structure was discussed and found to be very similar to the corresponding polysaccharides found in wood of this and other species of gymnosperms.

487. _____
1961. Isolation of polysaccharides from the bark of gymnosperms. Svensk PappTidn. 64: 651-661.

The general chemical composition was determined for the whole bark of Pacific silver fir and Engelmann spruce.

488. _____
1961. The structure of an arabino-4-0-methylglucuronoxylan from the bark of amabilis fir *(Abies amabilis)*. Svensk PappTidn. 64: 748-750.

This water-soluble chemical was isolated in a yield of 2.1 percent from bark of Pacific silver fir. The structure of this bark xylan was described.

489. Trelease, William, and Gray, Asa, ed.
1887. The botanical works of the late George Engelmann, collected for Henry Shaw. 548 pp., illus. Cambridge, Mass.: John Wilson & Son.

A complete collection of Engelmann's botanical publications assembled as a memorial. In an 1880 number of the Gardener's Chronicle, Engelmann related the discovery of *Abies amabilis* by him, Sargent, and Parry on Silver Mountain, near Fort Hope, Frazer River, at an altitude of 4,000 to 5,500 feet.

490. Trappe, James M.
1960. Some probable mycorrhizal associations in the Pacific Northwest. II. Northwest Sci. 34: 113-117.

An association, probably mycorrhizal, was noted between *Boletus edulis* Bull. ex Fries and Pacific silver fir and western hemlock on the east slope of the Cascade Range in Washington at an elevation of 3,000 feet.

491. _____
1961. Some probable mycorrhizal associations in the Pacific Northwest. III. Northwest Sci. 35: 91-94.

A probable mycorrhizal association was noted between Pacific silver fir and *Lactarius sanguifluus* (Paulet ex) Fries on the west slope of the Cascade Range in southern Oregon at 3,000-foot elevation. Also noted was an association with *Russula delica* which occurs throughout the coniferous forests from sea level to at least 4,500-foot elevation.

492. _____
1962. Fungus associates of ectotrophic mycorrhizae. Bot. Rev. 28: 538-606.

Fungal species reported in the literature to form mycorrhizal associations with Pacific silver fir are *Boletus edulis*, *Cenococcum graniforme*, *Lactarius deliciosus*, *L. sanguifluus*, *Russula delica*, *R. emetica*, and *Xerocomus pulverulentus*.

493. Troll, C.
1955. Der Mount Rainier und das mittlere Cascaden-Gebirge. Erdkunde 9(4): 264-274, illus.

494. Tunstell, George.
1956. Canada. In A World Geography of Forest Resources. Ed. by Stephen Haden-Guest, John K. Wright, and Eileen M. Teclaff for Amer. Geog. Soc. pp. 127-147, illus. New York: The Ronald Press Co.

495. Twerdal, Melvin P., and Minore, Don.
1955. Forest statistics for Thurston County, Washington.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 123, 27 pp., illus.

496. Twerdal, M. P., and MacLean, C. D.
1957. Forest statistics for Tillamook County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 130, 34 pp., illus.

It was estimated in 1955 there were less than 0.5 million board feet (Scribner) and 0.5 million cubic feet of Pacific silver fir sawtimber and growing stock, respectively, in Tillamook County.

497. Underwood, G. R., and Balch, R. E.
1964. A new species of *Pineus* (Homoptera: Adelgidae) on *Abies*. Canad. Ent. 96: 522-528, illus.

A new anholocyclic species, *Pineus abietinus*, found on Pacific silver fir and grand fir, is described.

498. U.S. Agricultural Research Service.
1960. Index of plant diseases in the United States. U.S. Dept. Agr. Agr. Handb. 165, 531 pp., illus.

499. U.S. Forest Service.
1908. Amabilis fir. *Abies amabilis* (Loud.) Forb. U.S. Dept. Agr. Forest Serv. Silvical Leaflet 22, 3 pp.

500. _____
1932. Key to native conifers and yew of Oregon. Unpublished leaflet on file, U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta., 4 pp.

501. U.S. Forest Service.
1936. Forest type map, State of Oregon (NW. quarter), 1 inch = 4 miles. Prepared by the Forest Survey staff, U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta.

502. _____
1936. Forest type map, State of Oregon (SW. quarter), 1 inch = 4 miles. Prepared by the Forest Survey staff, U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta.

503. _____
1936. Forest type map, State of Washington (NW. quarter), 1 inch = 4 miles Prepared by the Forest Survey staff, U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta.

504. _____
1936. Forest type map, State of Washington (SW. quarter), 1 inch = 4 miles. Prepared by the Forest Survey staff, U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta.

505. _____
1948. Woody-plant seed manual. U.S. Dept. Agr. Misc. Pub. 654, 416 pp., illus.

Pacific silver fir flowers in the spring, cones ripen in September, and seed dispersal occurs in October. Good seed crops occur every 2 to 3 years. A bushel of cones may yield 48 ounces of seed and there are 8,200 to 14,900 cleaned seed per pound. Eight samples of commercial seed averaged 45 percent sound and 91 percent pure.

506. _____
1950. Annual report, 1949.* Pac. NW. Forest & Range Expt. Sta., 62 pp.

A forest insect survey revealed 127,000 acres of Pacific silver fir in Washington and Oregon were infested by the fir engraver beetles *(Pseudohylesinus* sp.). Studies were initiated to evaluate the problem and to determine the habits of the insects, characteristics of their attack, and factors responsible for the outbreak.

507. _____
1952. Annual report, 1951.* Pac. NW. Forest & Range Expt. Sta., 51 pp.

The fir engraver beetle *(Pseudohylesinus* sp.) infestation in Pacific silver fir expanded primarily on the west side of the Olympic Peninsula. Current investigations suggested that stand age, vigor and species composition, and soil composition and structure are important factors in an outbreak. Root-rotting fungi were closely associated with the bark beetles in the killing of Pacific silver fir. Salvage of infested trees was used to control the outbreak.

508. _____
1952. Forest type classification for Pacific Northwest Region.* Pac. NW. Forest & Range Expt. Sta., 33 pp.

509. _____
1953. Density, fiber length, and yields of pulp for various species of wood.* Forest Prod. Lab. Tech. Note 191 (rev.), 9 pp.

The average length of fibers from Pacific silver fir is 3.55 mm. The density of the wood is 24 pounds per cubic foot. Yields of chemical pulps for various processes are: sulfite, 49 percent; sulfate, 49 percent; and soda, 42 percent.

510. _____ 1953. Volume tables for permanent sample plots as recommended by the Puget Sound Research Center Advisory Committee for use in western Washington.* Pac. NW. Forest & Range Expt. Sta., 28 tables.

A compilation of the best existing volume tables applicable to the important commercial trees in the Puget Sound region. Pacific silver fir is included.

511. _____ 1954. Annual report, 1953.* Pac. NW. Forest & Range Expt. Sta., 68 pp.

The silver fir beetle *(Pseudohylesinus* sp.) infestation increased to 603,000 acres, primarily in Washington. Merchantable Pacific silver fir is particularly susceptible. Causes of the outbreak were unknown and control measures were not satisfactory. Salvage of dead and dying timber was in process.

512. _____ 1955. Annual report, 1954.* Pac. NW. Forest & Range Expt. Sta., 68 pp.

In 1954, the silver fir beetle *(Pseudohylesinus* sp.) infestation increased to 652,230 acres in Washington and Oregon. A special survey in the infested area indicated a total Pacific silver fir volume of 6,949 million board feet, of which 528 million board feet was recently killed and 1,332 million was considered high risk. Deterioration studies of the beetle-killed trees indicated Pacific silver fir should be salvaged within 4 years of death. Approximately 147 million board feet of Pacific silver fir was salvaged in 1954.

In 1954, Pacific silver fir was also severely attacked by the balsam woolly aphid *(Chermes piceae)* which infested 146,240 acres along with silver fir beetles and 129,920 acres alone. Most of the Pacific silver fir was dead or dying on heavily infested areas.

513. _____ 1955. Wood handbook. U.S. Dept. Agr. Handb. 72, 528 pp., illus.

514. _____ 1956. Annual report, 1955.* Pac. NW. Forest & Range Expt. Sta., 84 pp., illus.

The silver fir beetle *(Pseudohylesinus* sp.) infestation declined to 114,000 acres in 1955. Biological studies were directed at the life cycle and feeding habits of the insects. These studies showed that the moisture content and degree of deterioration of the tree cambium are important factors in broad development.

Exploratory studies were being continued on the balsam woolly aphid *(Chermes* sp.) which were still killing Pacific silver fir extensively.

515. _____ 1957. Annual report, 1956.* Pac. NW. Forest & Range Expt. Sta., 107 pp., illus.

The *Chermes* infestation was still spreading and killing trees. Crown infestations kill terminal and lateral buds causing trees to die slowly whereas bole infestations cause a more rapid death of the trees.

The silver fir beetle infestation declined to a very low point in 1956. Trap tree and rearing studies provided considerable information about the insects, hymenopterous parasites, insect-attacking fungi, and bacteria which have been collected and identified. *Armillaria mellea* seems to be associated with the beetles.

516. U.S. Forest Service.
1957. Forest resources and forest industries of Lane County, Oregon.* Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 131, 117 pp., illus.

Four true firs (Pacific silver, noble, white, and subalpine firs) and Engelmann spruce had a combined sawtimber volume of nearly 14 billion board feet in the higher elevations of Lane County.

517. _____
1958. Annual report, 1957.* Pac. NW. Forest & Range Expt. Sta., 82 pp., illus.

"The balsam woolly aphid...continued to spread and kill true firs in Oregon and Washington...." Life history studies show the insect may have four generations per year in mild localities although it has only two generations per year in Europe. Almost 2,000 predaceous flies *(Aphidoletes thompsoni)*, imported from Europe, were released at selected localities. Several native predators have been found.

Color photographs at a scale of 1:4,000 can be used successfully to identify the true firs and distinguish those that are dead and those that are heavily damaged.

518. _____
1958. Timber resources for America's future. Separate 13. Appendix--Criteria for rating productivity. Forest Resource Rpt. 14, pp. 670-704.

519. _____
1959. Annual report, 1958.* Pac. NW. Forest & Range Expt. Sta., 94 pp., illus.

Six species of foreign insect predators of the balsam woolly aphid were imported and were being colonized. The life cycles of some native predators are poorly synchronized with that of the aphid and they are effective only with high aphid populations.

A list of 14 species of true fir was included, indicating the degree of damage each species suffers when attacked by balsam woolly aphid.

520. _____
1959. 1959 seed and plant stock dealers. 19 pp.

A directory of American seed suppliers of common forest and shelterbelt plants.

521. U.S. Forest Service.
1960. Annual report, 1959.* Pac. NW. Forest & Range Expt. Sta., 90 pp., illus.

"Findings to date indicate that, among true firs of the Northwest, subalpine fir is by far the most susceptible to attack and damage by the aphid. Pacific silver fir and grand fir are next in susceptibility."

522. _____
1960. Production and marketing of Christmas trees in the Pacific Northwest.* Region 6, 21 pp., illus.

Pacific silver fir, together with noble fir, accounted for 0.6 percent of the Christmas trees produced in Oregon. Pacific silver fir brought about the same prices as Shasta red fir and noble fir, averaging $1 per lineal foot in retail yards. High-elevation true firs, including silver fir, were in greater demand and greater supply. The increase in production of true firs was due to more Christmas tree sales by timber companies, a gradual increase in high-elevation cutover areas, and to an open winter that permitted access to cutting areas well into December.

523. _____
1961. Annual report, 1960.* Pac. NW. Forest & Range Expt. Sta., 97 pp., illus.

Aphid host-tree susceptibility studies indicated that susceptibility increases with tree age for grand fir, and at a given age the fastest growing trees are the most susceptible. It was suggested that this relationship is also true for subalpine fir and Pacific silver fir.

524. _____
1961. Forest insect conditions in the United States, 1960. 38 pp., illus.

525. _____
1962. Annual report, 1961.* Pac. NW. Forest & Range Expt. Sta., 105 pp., illus.

Of the 18 species of insect predators of balsam woolly aphid colonized before 1961, a small beetle, *Laricobius erichsonii*, is probably the most effective. Three species of flies have also become established.

Cooperative studies were being made with Weyerhaeuser Co. to determine the effect of aphid infestation on the growth rate of Pacific silver fir, subalpine fir, and grand fir. In general, stem-infested Pacific silver fir and subalpine fir die within 2 to 4 years after initial attack. However, grand fir can withstand heavy infestations for 12 years or longer although showing serious growth losses, particularly in height.

526. _____
1963. Internationally dangerous forest tree diseases. U.S. Dept. Agr. Misc. Pub. 939, 122 pp.

527. _____
1963. 1963 seed and planting stock dealers. Tree Planters' Notes 60, 25 pp.

A directory of commercial dealers in seeds and planting stock for common trees and shrubs.

528. University of British Columbia.
[n.d.] The first decade of management research--U.B.C. Forest, 1949-1958. Univ. Brit. Columbia, 82 pp., illus.

529. _____
1961. University of British Columbia Research Forest, Haney, British Columbia, annual report for period April 1, 1960 to March 31, 1961. Faculty of Forestry, 26 pp., illus.

A western hemlock-Pacific silver fir spacing test was established at 3- and 6-foot spacings; lammas shoots were observed on Pacific silver fir (p. 10); data on growth and survival of planted Pacific silver fir are provided on pages 11-13.

530. University of British Columbia Forest Club.
1959. Forestry handbook for British Columbia. Ed. 2, 800 pp., illus. Vancouver, British Columbia: University British Columbia Forest Club.

A compilation of general forestry information in sufficient detail to be very useful. Much information on Pacific silver fir is included.

531. Uphof, J. C. Th.
1920. Die Waldflora im Staate Washington. Vegetationsbilder, 13 Reihe, Heft 7, illus.

A generalized presentation of Washington flora by life zones with six photographs.

532. Usher, Jack H., and Hall, Hoyt H.
1957. Forest statistics for Lincoln County, Oregon.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Forest Survey Rpt. 129, 30 pp., illus.

In 1955, 197 million board feet (Scribner) of Pacific silver fir sawtimber and 35 million cubic feet of growing stock were estimated on commercial forest land in Lincoln County.

533. Van Dersal, William R.
1938. Native woody plants of the United States; their erosion-control and wildlife values. U.S. Dept. Agr. Misc. Pub. 303, 362 pp., illus.

Pacific silver fir: "A very large, long-lived evergreen tree; slow growing; susceptible to fire damage because of its thin bark; somewhat attacked by rot; wood of importance commercially, especially as pulp; grows poorly in cultivation; seeds borne heavily every 2 or 3 years, vitality transient, germination low, 11,000 seeds per pound."

534. Veitch, Harry J.
1892. The Coniferae of Japan. Jour. Roy. Hort. Soc. London 14: 18-33.

"*Abies veitchii*...foliage...may be compared with that of *A. amabilis* and *A. Nordmanniana*, between which it is intermediate in colour, but the leaves are far more silvery beneath than either" (p. 25).

535. Veitch, James.
1900. Veitch's manual of the Coniferae. Revised by Adolphus H. Kent (new ed.), 562 pp., illus. Chelsea, S. W.: James Veitch & Sons, Ltd.

Contains a botanical description and range references of Pacific silver fir and recounts the discovery of the species by David Douglas in September 1825.

536. Viguié, Marié-Thérèse, and Gaussen, Henri.
1928-1929. Révision du genre *Abies*. I. Historique. II. Description du genre. III. Monographie et iconographie des espèces. Toulouse Soc. d'Hist. Nat. Bul. 57: 369-434, illus.; 58: 245-564, illus. (Reprinted as Toulouse Univ. Lab. Forest. Trav., tome 2, v. 2, art. 1, 386 pp., illus. 1928-29.)

The discussion of Pacific silver fir contains a long listing of names and synonyms for the species, a list of arboretums in France where Pacific silver fir is growing (mentions the seed sources), a detailed botanical description, and illustrations.

537. Vité, J. P., and Rudinsky, J. A.
1959. The water-conducting systems in conifers and their importance to the distribution of trunk injected chemicals. Boyce Thompson Inst. Contrib. 20(1): 27-38, illus.

All of the true firs studied, including Pacific silver fir, exhibited a clockwise, spiral, conducting system. The genus was further characterized by a precise arrangement of the tracheidal conduits, an excellent intake of dye, and an ability to transport dye long distances.

538. Wakefield, W. E.
1957. Determination of the strength properties and physical characteristics of Canadian woods. Canada Dept. North. Aff. & Natl. Resources Forestry Branch Bul. 119, 64 pp., illus.

539. Walters, J., and Soos, J.
1962. The vertical and horizontal organization of growth in some conifers of British Columbia. Univ. Brit. Columbia Faculty of Forestry Res. Paper 51, 11 pp., illus.

Includes a stem analysis of a suppressed Pacific silver fir.

540. Warren, H. V., and Delavault, R. E.
1949. Further studies in biogeochemistry. Geol. Soc. Amer. Bul. 60: 531-560, illus.

Includes copper and zinc analyses of Pacific silver fir.

541. _____ Delavault, R. E., and Irish, Ruth I.
1952. Biogeochemical investigations in the Pacific Northwest. Geol. Soc. Amer. Bul. 63: 435-484, illus.

Normal and abnormal amounts of copper and zinc were found in various parts of plants including Pacific silver fir and subalpine fir. The biogeochemical behavior of these species is similar.

542. Warren, H. V., Delavault, R. E., and Fortescue, J. A. C.
1955. Sampling in biogeochemistry. Geol. Soc. Amer. Bul. 66: 229-238, illus.

Includes copper and zinc analyses of Pacific silver fir. Pacific silver fir is useful in prospecting for copper deposits.

543. _____ and Howatson, C. H.
1947. Biogeochemical prospecting for copper and zinc. Geol. Soc. Amer. Bul. 58: 803-820, illus.

Includes copper and zinc analyses of Pacific silver fir twigs and leaves in areas of ore concentrations.

544. Weaver, Harold.
1961. Ecological changes in the ponderosa pine forest of Cedar Valley in southern Washington. Ecology 42: 416-420, illus.

545. Wells, Sidney D., and Rue, John D.
1927. The suitability of American woods for paper pulp. U.S. Dept. Agr. Bul. 1485, 102 pp., illus.

546. West, W. I.
1949. A collection of Oregon woods. Oreg. State Col. School Forestry Cir. 1, 31 pp.

547. Western Forestry and Conservation Association.
1950. Reports of the West Coast Forestry Procedures Committee on various recommended forest practices and techniques. 67 pp. Portland, Oreg.

548. Western Pine Association.
[n.d.] Facts about white fir. 4 pp. Portland, Oreg.

This brochure describes the various properties, uses, and grading of white fir lumber which is manufactured from the following true firs: Pacific silver, white, grand, and California red firs.

549. Weyerhaeuser Company.
[n.d.] 1960 Forestry Research Report. Forestry Res. Center, 20 pp. [unnumbered].

550. Weyerhaeuser Timber Company.
1957. Annual report for 1956. Forestry Res. Center, 39 pp.

Cutting tests of Pacific silver fir seeds revealed a range of filled seed per cone of 6.7 to 35.0 percent. All cones from a given tree contained approximately the same percentage of filled seed.

Trend plots were established in mature Pacific silver fir stands infested by the balsam woolly aphid in 1954 and 1956 to "(1)...determine the rate of tree mortality, stand decline, and timber deterioration resulting from Chermes infestation, and (2) to develop a marking guide based on mortality risk for use in planning salvage." Results to date showed annual basal area losses up to 28 percent and 11,000 board feet per acre. Some trees survived heavy stem infestation by growing a layer of secondary peridem.

The aphid affects trees ranging in size from seedlings to specimens 6 feet in d.b.h. An attempt was made to study the tumor effect of the aphid on transplante Pacific silver fir seedlings artificially inoculated with the aphid homogenate. No tumors were produced, however.

551. _____
1958. Annual report for 1957. Forestry Res. Center, 51 pp.

Twenty-one thousand endrin-coated or nontreated seed per acre were broadcast uniformly on a high-elevation burn in 1955. In July 1957, 300 and 900 seedlings per acre remained from the broadcasting of untreated and treated seed, respectively.

A test was begun of the response of planted Douglas-fir, noble fir, Pacific silver fir, and grand fir seedlings to fertilization with four levels each of nitrogen, phosphorus, and potassium. All species, except for Pacific silver fir, varied in their response to different fertilizer levels.

Cones collected at 2-week intervals from Pacific silver fir trees growing at an altitude of 4,500 feet contained no viable seed until September 21. In five cases out of seven, seed from cones which overwintered on the tree in plastic net bags had a higher germination percentage than seed collected on September 27 and stored during the winter at 0° F. and 12-percent seed moisture content.

A small-scale deterioration study of Chermes-killed Pacific silver fir indicated that the quantity of wood loss is correlated with the time since death. For trees dead 1 year, 2 to 3 years, and over 3 years, decay averages 16, 41, and 52 percent of the merchantable cubic volume, respectively. Pulping tests showed a 7-percent volume loss in cleaning and chipping pulp logs produced from trees dead 3 years.

Observations of Chermes infestations on the St. Helens Tree Farm reveale the duration of insect generations on the boles of Pacific silver fir is longer than on grand fir and shorter than on subalpine fir.

Greenhouse-grown 1-year-old Pacific silver and noble firs were inoculatec with Chermes to provide information on insect development and gall formation and to provide a means of testing insecticides. "The infestation of trees prior to bud-bursting completely halted growth on the terminal and lateral branches, even though infested by as few as one or two aphids. Abnormal swellings or galls are produced around the buds and at branch nodes and along the main tree stem. Trees infested subsequent to bud bursting were gouted at the nodes and on the stem. After buds were formed on the new growth aphids attacked and also galled them."

Reexamination of trend plots established in a Chermes-infested old-growth Pacific silver fir stand showed a maximum loss of 7,000 board feet per acre (18.7 percent of the total Pacific silver fir volume). The 1956 and 1957 mortality trends on all seven study plots are tabulated. Severe gouting of the branch tips, heavy branch killing, and sparse foliage characterize trees dying over an extended period These characteristics may not be evident on trees which die in a comparatively short time.

552. _____
1959. 1958 Forestry Research Report. Forestry Res. Center, 39 pp.

553. Whiteside, J. M.
1957. Forest insect conditions in the Pacific Northwest--1956.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta., 40 pp., illus.

554. _____
1958. Forest insect conditions in the Pacific Northwest during 1957.* U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta., 49 pp., illus.

555. Whitford, H. N., and Craig, Roland D.
1918. Forests of British Columbia. Comn. Conserv. Canada, 409 pp., illus. Ottawa.

Describes the geographic, physiographic, and climatic relations and species composition of British Columbia forests. Estimates of the available supply of timber in the province are included and conditions affecting the administration and utilization of the forests are discussed.

556. Wiesehuegel, E. G.
1932. Diagnostic characteristics of the xylem of the North American Abies. Bot. Gaz. 93: 55-70, illus.

Wiesehuegel examined numerous specimens of wood, taken from trees characteristic of the species in many areas within its habitat, to construct an identification key.

Pacific silver fir: "Heartwood and sapwood light brown to buff or light ivory yellow in color but without reddish tinge in springwood; sometimes a reddish tinge in summerwood, transition spring to summerwood gradual.... Resin passages absent in normal wood, or if present are of traumatic character in frost rings or scars...crystals absent in ray parenchyma cells. Resin cells prominent, many partly biseriate rays present, mostly one pit per crossfield, rays up to 62 cells high."

557. Williston, E. M.
1960. Proposed: New stress values for the coast white woods. Forest Prod. Jour. 10: 621-625, illus.

Williston discusses the volume and distribution of the "coast white woods" (western hemlock, Pacific silver fir, grand fir, and noble fir) and by means of tables compares published data on their respective strength properties with new data obtained by Weyerhaeuser Timber Co. The comparison reveals the published stress values are low and are based on an inadequate sample. Until more information is available, Williston suggests that existing western hemlock values be a minimum acceptable level for a grouping of these species to improve their economic utilization.

Pacific silver fir is second only to western hemlock in terms of volume of "coast white woods" with 33.3 billion feet in Washington and 3.7 billion feet in Oregon. Its specific gravity values, based on weight when ovendry and volume when green (presented in table 3), ranged from 0.35 to 0.37.

558. Wilson, Sinclair A.
1929. Key to native trees of Oregon. Pt. 1. Conifers and yews (gymnosperms). 3 pp. [unnumbered]. Compiled in cooperation with Pac. NW. Forest Expt. Sta.

559. Winkenwerder, Hugo, and Wangaard, Frederick F.
1939. Short keys to the native trees of Oregon and Washington. 19 pp. Seattle Imperial Publishing Co.

560. Wood, R. F.
1955. Studies of north-west American forests in relation to silviculture in Great Britain. Gt. Brit. Forestry Comn. Bul. 25, 42 pp., illus.

Judged by its natural distribution, Pacific silver fir should be more adapte to Britain than grand fir. Introduction trials should be made on the better mountain soils of western Britain.

561. Wright, Ernest, Coulter, W. K., and Gruenfeld, J. J.
1956. Deterioration of beetle-killed Pacific silver fir. Jour. Forestry 54: 322-325.

Presents the results of a study on changes in the physical properties of wood caused by decay fungi that enter beetle-killed Pacific silver fir trees 2 to 4 years after death. Using a technical scale (graphic forms--Forest Service Form 558 A), pathologists estimate that Pacific silver fir trees annually deteriorate 5 percent or more of the total volume up to 4 years after trees are killed.

Three methods were used for log scale cull deductions: a bureau lumber scale (Scribner Decimal C) gave the highest deductions for cull due to rot; a pulp-mill recovery scale (Scribner Decimal C net truck scale) gave the lowest deductions and the technical scale was intermediate.

The principal rot-causing fungi in decreasing order of importance are: *Fomes pinicola*, brown-cubical rots; *Armillaria mellea*, shoestring rot; *Stereum chaillettii*, patchy rot; and *Polyporus abietinus*, white rot.

562. _____ and Isaac, Leo A.
1956. Decay following logging injury to western hemlock, Sitka spruce, and true firs. U.S. Dept. Agr. Tech. Bul. 1148, 34 pp., illus.

563. Wright, K. H., and Johnson, N. E.
1957. Chermes threaten Northwest white fir forest. Timberman 58(7): 82, 84 illus.

A general account of the balsam woolly aphid outbreak on Pacific silver and subalpine firs in the Washington and Oregon Cascades. The insect's life histor and symptoms of its attacks are described.

There is no feasible chemical control but biological control is being attempted by importation of predatory and parasitic insects. Salvage operations are handicapped by inaccessibility of the stricken timber, limited utilization of true firs in the mills, and the checkerboard ownership pattern in the affected areas.

564. Wyman, Donald.
1943. A simple foliage key to the firs. Arnoldia 3: 65-71, illus.

565. Zehetmayr, J. W. L.
1960. Afforestation of upland heaths. Gt. Brit. Forestry Comn. Bul. 32, 145 pp., illus.

Trials of Pacific silver fir are planned to determine its possible use in exposed areas.

566. Zeller, S. M., and Goodding, L. N.
1930. Some species of Atropellis and Scleroderris on conifers in the Pacific Northwest. Phytopathology 20: 555-567, illus.

Scleroderris abieticola Zeller & Goodding, sp. nov., is the name proposed by the authors for a canker-causing fungus found attacking Pacific silver and grand firs. The development of the canker is much slower on Pacific silver fir. The canker and fungus are described and the distribution of the examined specimens is presented.

567. Ziller, W. G.
1959. Studies of western tree rusts. IV. *Uredinopsis hashiokai* and *U. pteridis* causing perennial needle rust of fir. Canad. Jour. Bot. 37: 93-107.

Field observations and inoculation experiments show that the perennial needle rust of firs (including Pacific silver fir) known as *Peridermium pseudo-balsameum* is caused by the pycnial and aecial stages of *Uredinopsis hashiokai* and *U. pteridis*. The taxonomy of the various stages of these two organisms and their life histories are described. Inoculations of Pacific silver fir with *U. hashiokai* were unsuccessful whereas those with *U. pteridis* were successful.

568. _____
1959. Studies of western tree rusts. V. The rusts of hemlock and fir caused by *Melampsora epitea*. Canad. Jour. Bot. 37: 109-119, illus.

569. _____ and Molnar, A. C.
1953. Forest disease survey, British Columbia. Canad. Dept. Agr. Forest Insect & Disease Survey Ann. Rpt. 1952: 142-154.

The distribution of Indian paint fungus *(Echinodontium tinctorium)* on western hemlock and Pacific silver fir in some localities studied is compared in a table.

570. Ziller, Wolf G., and Stirling, David.
1961. Sapsucker damage in coastal British Columbia. Forestry Chron. 37: 331-335, illus.

Pacific silver fir may be damaged by the sapsucker.

571. Zim, Herbert S., and Martin, Alexander C.
1952. Trees; a guide to familiar American trees. 157 pp., illus. New York: Simon & Schuster.

COMMON AND SCIENTIFIC NAMES OF TREE SPECIES NAMED IN CITED LITERATURE

Abies alba	European silver fir
Abies amabilis (Dougl.) Forbes	Pacific silver fir
Abies concolor (Gord. & Glend.) Lindl.	white fir
Abies grandis (Dougl.) Lindl.	grand fir
Abies lasiocarpa (Hook.) Nutt.	subalpine fir
Abies magnifica A. Murr.	California red fir
Abies procera Rehd.	noble fir
Cedrus atlantica	atlas cedar
Chamaecyparis lawsoniana (A. Murr.) Parl.	Port-Orford-cedar
Chamaecyparis nootkatensis (D. Don) Spach	Alaska-cedar
Ginkgo biloba	Ginkgo
Larix occidentalis Nutt.	western larch
Picea engelmannii Parry	Engelmann spruce
Picea sitchensis (Bong.) Carr.	Sitka spruce
Pinus contorta Cougl.	lodgepole pine
Pinus monticola Dougl.	western white pine
Pseudotsuga menziesii (Mirb.) Franco	Douglas-fir
Taxus brevifolia Nutt.	Pacific yew
Thuja plicata Donn	western redcedar
Tsuga heterophylla (Raf.) Sarg.	western hemlock
Tsuga mertensiana (Bong.) Carr.	mountain hemlock

Williams, Carroll B., Jr., and
Franklin, Jerry F. (comp.)
1965. Pacific silver fir--a bibliography with abstracts. U.S. Forest Serv. Res. Paper PNW-21, 84 pp. Pacific Northwest Forest & Range Experiment Station, Portland, Oreg.

This bibliography lists references containing information on Pacific silver fir, *Abies amabilis* (Dougl.) Forbes, in North American and European literature. Abstracts are provided for those considered more significant.

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