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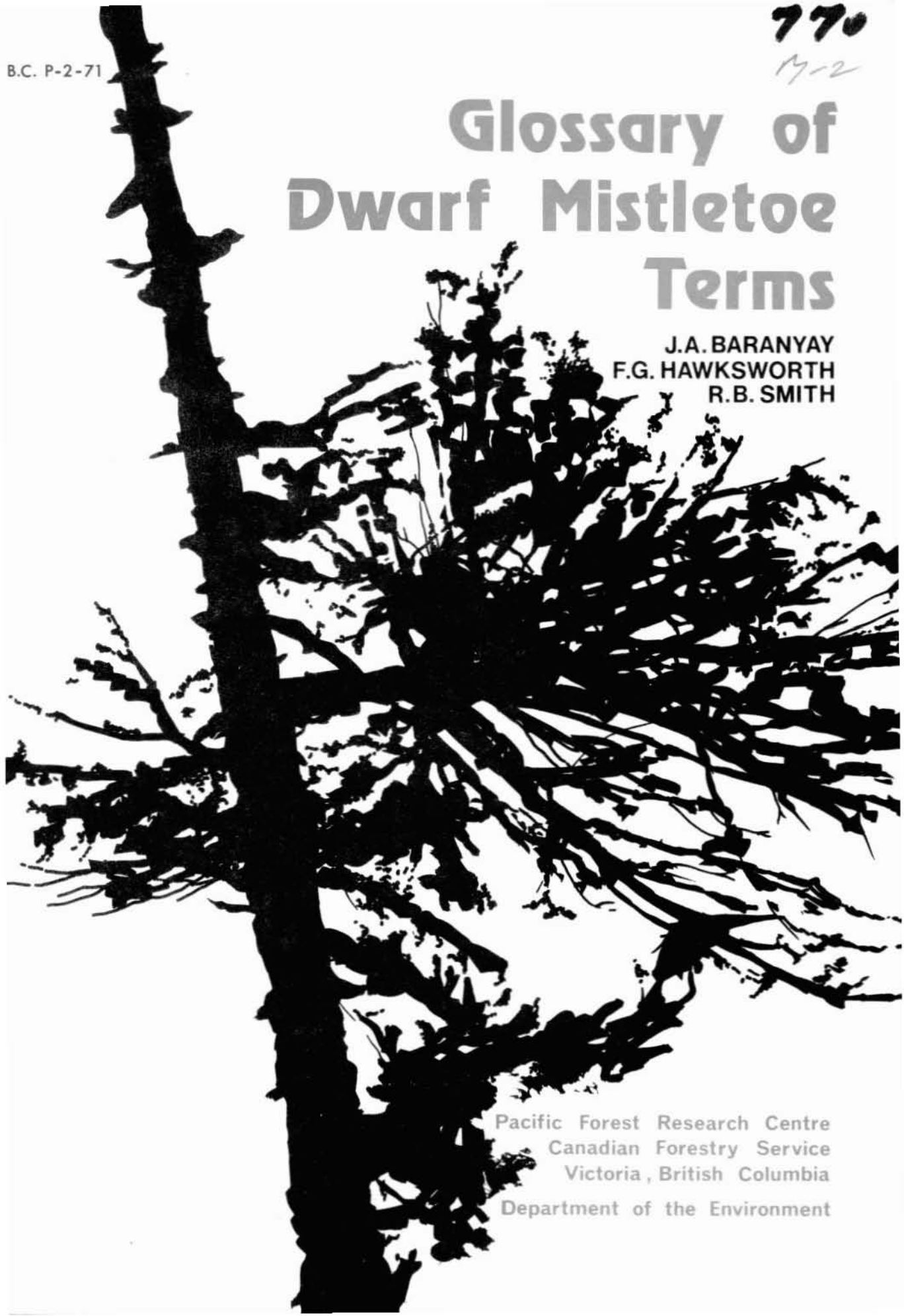
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Glossary of Dwarf Mistletoe Terms

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DEPARTMENT OF THE ENVIRONMENT
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GLOSSARY OF DWARF MISTLETOE TERMS

by

J. A. Baranyay¹, F. G. Hawksworth² and R. B. Smith¹

PREFACE

Since Engelmann first published observations on the North American species of *Arceuthobium* between 1850 and 1860 (Gill, 1935), interest in the pathological significance of the dwarf mistletoes has continued as shown by the several hundreds of papers subsequently published. During this 120 years of dwarf mistletoe research, a sizeable terminology has developed, including terms that have special meaning in relation to the various fields of dwarf mistletoe research. Owing to present intensive forest management, many hosts of dwarf mistletoes, which were so-called weed species a few decades ago, are now important in our forest economy. Losses caused by dwarf mistletoes are no longer tolerable. Foresters are more and more involved in prevention and control of the disease, and they are exposed to the technical terminology broadly used in the literature. In addition, some older terms have become obsolete; the meaning of others has undergone amplification and various synonyms have been introduced by researchers and used in the literature. Due to these factors, communication at scientific and practical levels has become difficult.

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The Dwarf Mistletoe Committee of the Western International Forest Disease Work Conference recognized the need for a glossary that would lead to a more accurate and uniform application of terms used in dwarf mistletoe research, teaching, data retrieval and applied work. During the 1970 meeting, J. A. Baranyay was appointed to chair and organize a special Dwarf Mistletoe Glossary Committee. F. G. Hawksworth and R. B. Smith accepted membership in the special committee and the work commenced during the fall of 1970. The objective of the Glossary Committee was not to make a comprehensive reference list but to:

- a. include terms used in a special sense in dwarf mistletoe literature,
- b. include terms from other sciences that have a special dwarf mistletoe connotation and which may not be defined in other glossaries or texts in this sense,
- c. select the most preferred term where a number of synonyms are in use.

Seventy-one major publications, representing various fields of dwarf mistletoe research, were selected and read. Terms were extracted and listed. A list of terms considered suitable for inclusion in the Glossary, but without definitions, was circulated among active dwarf mistletoe workers for amendments and additions. After the terms were selected, the members of the Glossary Committee defined the terms and again circulated the draft. Illustrative material was prepared to exemplify certain difficult terms. The result of this process is the Glossary presented here. The compilers are grateful to the following

individuals for assistance and encouragement during the work: Dr. R. C. Dobbs (Silviculturist), Dr. Dave French (Professor of Plant Pathology), Dr. D. M. Knutson (Forest Pathologist), Dr. Job Kuijt (Professor of Botany), Mr. J. Laut (Forest Pathologist), Dr. Paul C. Lightle (Forest Pathologist), Dr. John R. Parmeter Jr. (Professor of Plant Pathology), Dr. Lewis Roth (Professor of Plant Pathology), Dr. R. F. Scharpf (Forest Pathologist), Dr. Keith R. Shea (Forest Pathologist), and Mr. Melvin Weiss (Forest Pathologist). Mr. John Wiens, Pacific Forest Research Centre, Victoria, prepared the diagrams.

Arrangement of the Glossary

Terms are numbered and presented in alphabetical order. Preferred terms are listed in boldface type with synonyms after in parentheses. These synonyms are also included in the alphabetical list, but are printed in regular type. The number in parentheses following each synonym refers to its preferred term. Definitions for closely related terms are grouped under a major heading, but are also listed alphabetically with a reference to the major heading. When a preferred term is mentioned within the definition of another term, it is underlined, indicating that this term is included and defined in the Glossary.

Abbreviations used are as follows:

Ariz., B.C., etc.	= conventional abbreviations for countries, states and provinces.
cf.	= cross-reference, compare.
centr.	= central
N,E,S and W	= cardinal directions
p.	= page
pl.	= plural
Syn.	= synonym

GLOSSARY

1. Abnormal ring (97)
2. Absorptive system (55)
3. Active infection (187)
4. Aerial shoot (Syn.: shoot)
Stem-like portion of dwarf mistletoe plant outside the host bark. Its primary function is reproduction. Frequently referred to collectively as an aerial plant.
5. Anisophasic infection (154)
6. Anisophasic witches' broom (155)
7. Autumnal anthesis (63)
8. Average plot rating (105)
9. Bark strand (33)
10. Basal cup (Syn.: basal shoot scar, shoot scar)
The cup-like remnant on the bark of an infection which remains visible long after the disintegration of an aerial shoot (Fig. 1, p.6).
11. Basal shoot scar (10)
12. Basipetal growth (180)
13. Biological control
Significant reduction of dwarf mistletoe populations by other organisms such as parasitic fungi, insects or rodents.
14. Biological girdle
Accumulation of photosynthates above a dwarf mistletoe infection.
15. Bole canker (229)
16. Bole infection (229)
17. Bole scar
A large, elongated, diamond-shaped scar on the stems of severely infected trees (Fig. 2, p.6).

18. Bole swelling (231)

19. Branching of dwarf mistletoe shoots

Primary branching

The basic, decussate type of branching exhibited by all species of *Arceuthobium* (Fig. 6, p.8).

Secondary branching

Branching that develops in addition to the primary branching; it may be either flabellate or verticillate (Fig. 3, p.6).

20. Broom (259)

21. Buffer zone (138)

22. Burl (231)

23. Callus mass

Undifferentiated mass of cells which occasionally develops at the base of the radicle and on the dwarf mistletoe seed during in vitro culture (Bonga & Chakraborty, 1967).

24. Canker

Malformation of a host stem or branch caused by a disruption of the cambium as a result of dwarf mistletoe infection (Fig. 17, p.34).

25. Canker fungi

Fungi occurring in the host bark, cortex, wood or associated endophytic system in the vicinity of dwarf mistletoe infections (cf. shoot fungi).

26. Capsule

The pericarp, or outer layer of the dwarf mistletoe fruit which drops off during seed discharge (Fig. 15, p.30).

27. Central cushion

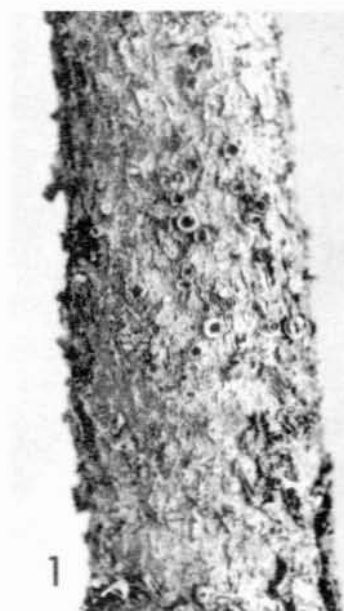
The small raised structure in the center of the staminate flower. It apparently serves as a nectary to attract pollinating insects (Fig. 4, p.8).

P L A T E I

Fig. 1. Basal cups of *Arceuthobium americanum* on lodgepole pine.

Fig. 2. Bole scar on ponderosa pine, caused by *A. campylopodum*.

Fig. 3. Branching pattern of dwarf mistletoes: a. verticillate branching b. flabellate branching.



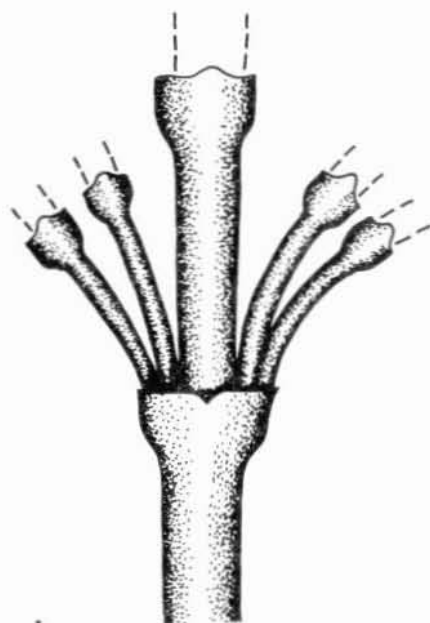
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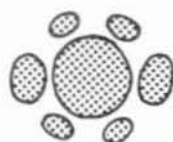
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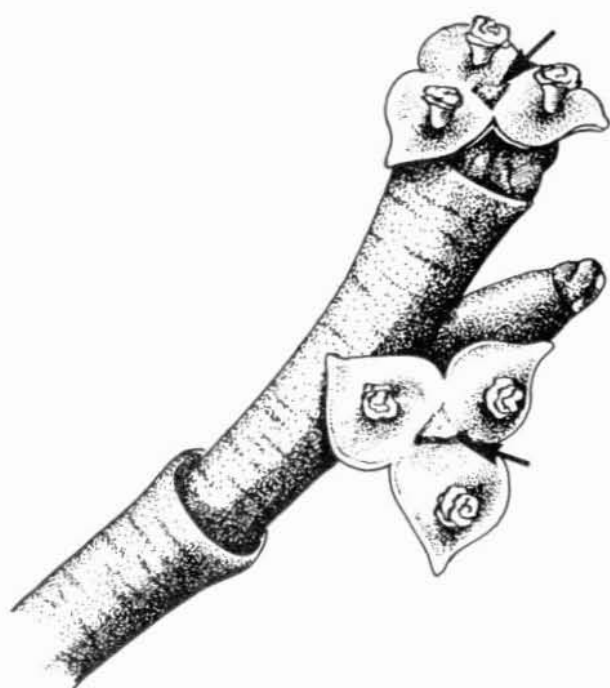
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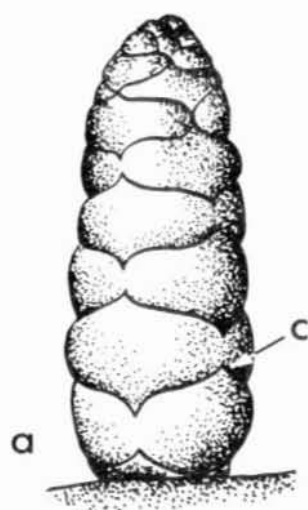
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P L A T E I I

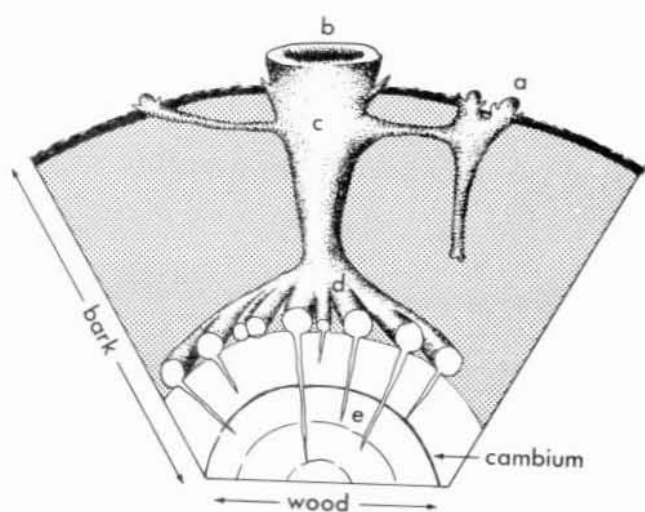
- Fig. 4. Staminate flower of dwarf mistletoe with central cushion (arrow).
- Fig. 5. Diagrammatic cross section of an infected branch showing the major structures of dwarf mistletoe:
a. buds b. basal cup c. plexus d. cortical strands e. sinkers.
- Fig. 6. Diagrams showing typical decussate branching:
a. young aerial shoot b. older aerial shoot
c. scale leaves.



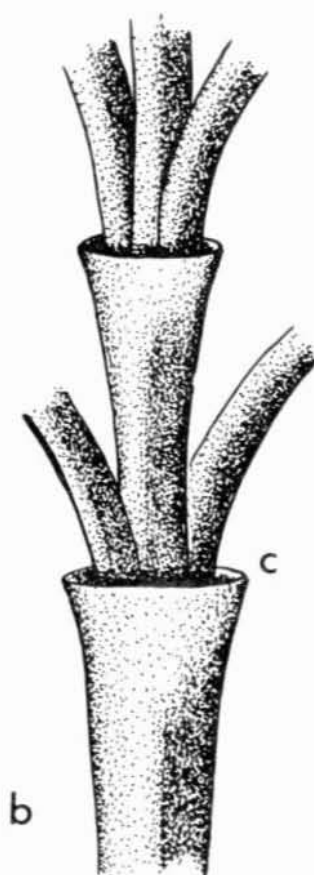
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b

28. Chemical control

Significant reduction of dwarf mistletoe populations by chemical means.

29. Cleaning

An operation which may consist of silvicultural, chemical or biological control methods designed to eradicate individual diseased trees in dwarf mistletoe infected stands (cf. re-cleaning).

30. Collateral branching (251)

31. Complete control; see silvicultural control

32. Control

Control of dwarf mistletoes, as for other types of forest diseases, can be accomplished by the following four basic methods:

Exclusion

The use of quarantines and inspection measures to prevent the spread of the disease. In the case of dwarf mistletoes, this would involve removing infected trees from the immediate vicinity of nurseries or establishing nurseries in mistletoe-free areas, to prevent infection and subsequent development of the parasite in new areas.

Eradication

The removal or destruction of diseased trees or parts by using silvicultural, chemical and/or biological control methods. This is the most commonly used method available for control of dwarf mistletoes. This involves removing infected trees, sanitation thinnings, destruction of infected residual trees in cutover or burned stands, and pruning out infected branches.

Protection

This involves measures for protecting stands such as chemical sprays, manipulation of biological control agents, etc., or of protecting regenerated stands by removal of residual infected trees.

Immunization

This entails developing resistance to disease by tree breeding, selection or other means.

33. Cortical strand (Syn.: bark strand, endophytic strand)

A structure that ramifies throughout the inner bark of the host from which the aerial shoots and sinkers are derived (Fig. 5, p.8).

34. Cortical system

That part of the dwarf mistletoe endophytic system contained in the inner bark of the host and consisting of cortical strands (Fig. 5, p.8).

35. Cross-infection (Syn.: cross-over, transfer)

Parasitism by a specific dwarf mistletoe on a tree species other than its principal host (see 82).

36. Cross-over (35)

37. Decussate

An arrangement on shoots in which the scale leaves alternate in pairs at right angles (Fig. 6, p.8).

38. Delayed throughfall; see throughfall

39. Diembryony

The condition in which a seed contains two embryos (Fig. 7). Seeds with a single embryo are most common in *Arceuthobium*.

40. Diffuse infection (237)

41. Diffuse pattern (237)

42. Dioecious

The situation in which each individual possesses only a single sex. A generic character of *Arceuthobium*.

43. Direct flowering

Uninterrupted development of the floral buds from initiation to flowering, e.g., *Arceuthobium campylopodum*, *A. vaginatum* (cf. indirect flowering).

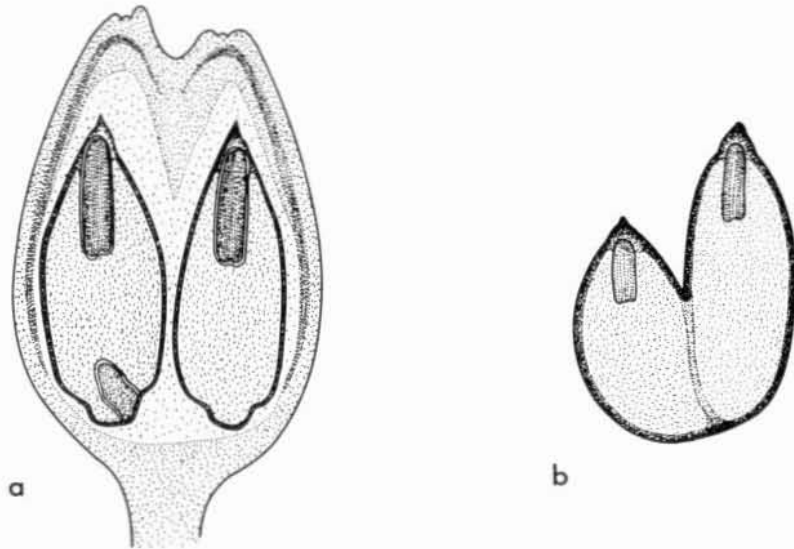


Fig. 7. Abnormal dwarf mistletoe fruit and seed: a. abnormal fruit, seed on the left showing diembryony b. fused seed.

44. Direct throughfall; see throughfall

45. Disc (80)

46. Distal growth

Growth of the endophytic system of a dwarf mistletoe infection toward the apex of the branch or bole.

47. Distal pole

The pointed end of the dwarf mistletoe seed farthest from the pedicel of the fruit (Fig. 14, p. 30).

48. Divaricate

A branching habit in which the parts spread widely away from each other, e.g., in the male shoots of *Arceuthobium divaricatum* and *A. gillii*.

49. Dual parasitism

Parasitism of an individual tree by two species of dwarf mistletoe.

50. Duration of infection (Syn.: infection period)

The length of time a stand has been infested by dwarf mistletoe. This can be approximated by determining the age of the oldest apparent infections.

51. Dwarf mistletoes

Any members of the genus *Arceuthobium* (Razoumofskya), family Viscaceae. This genus was formerly included in the family Loranthaceae. Other common names for dwarf mistletoe include: dwarfmistletoe, false mistletoe, lesser mistletoe, scaly mistletoe, leafless mistletoe, small mistletoe, snappers, faux gui (French), Zwergmistel, Wacholdermistle (German), and muerdago enano (Spanish).

Some common names suggested for the North American dwarf mistletoes are listed in Table 1 (Hawksworth & Wiens, 1970).

52. Endophyte (55)

53. Endophytic filament

Early stage in the development of a cortical strand consisting of a series of single cells in a linear file.

54. Endophytic strand (33)

55. Endophytic system (Syn. absorptive system, inner system, endophyte)

The root-like parts of dwarf mistletoe within the host tissues. The endophytic system consists of cortical strands within the bark and sinkers which are embedded in successive layers of xylem (Fig. 5, p. 8). Formerly referred to as haustorial root system or haustorial system.

Growth of the endophytic system may be either circumferential (Syn.: tangential, lateral) around the branch or stem, longitudinal along the long axis or radial toward the center.

56. Endophytic wreath

Concentration of endophytic filaments at the girdles of systemically infected host branches. This could be responsible for the dominance and precociousness of girdle shoots (Kuijt, 1960).

57. Entry point

Original point of penetration by the infection peg.

58. Epicormic branch (host)

Branch arising from a dormant bud (see witches' broom).

59. Eradication; see control

60. Exclusion; see control

61. Explosive fruit

A type of fruit in which the seed at maturity is forcibly ejected. Characteristic of the genus *Arceuthobium* (Fig. 15, p.30).

62. Extra-limital host

Infection of a tree that does not occur within the natural range of a particular dwarf mistletoe. Susceptibility of such trees may be established either by inoculations or by introducing trees into areas where the dwarf mistletoe occurs.

63. Fall flowering (Syn.: autumnal anthesis)

Plants that flower in the fall. This type of flowering is characterized by dwarf mistletoes in the *Arceuthobium campylopodum* group.

64. Fan-like branching (66)

65. Female infection (Syn.: pistillate infection)

A dwarf mistletoe infection that produces female flowers (cf. male infection, dioecious).

66. Flabellate branching (Syn.: fan-like branching)

Fan-shaped; a branching pattern produced by the continued development of axillary buds (Fig. 3, p.6).

67. Focus (107)

68. Follow-up cleaning (186)

69. Foot (80)

70. Form

A taxon, used by Gill (1935), below the subspecies or variety level but which is still distinguishable on morphological grounds (cf. host form, forma specialis).

71. Forma specialis (pl. formae speciales)

A taxon, below the species level, which is not distinguishable morphologically yet has distinct hosts. Similar to physiological races but the latter are not given taxonomic names (cf. form, host form).

72. Fused seed

Abnormal seed in which two endosperms and embryos are included within a common endocarp (Fig. 7, p.12).

73. Fusiform swelling

A spindle-shaped swelling on a host branch or stem caused by hypertrophy or hyperplasia of host bark and wood tissue. It is widest near the middle and tapers toward each end and is typical of non-systemic dwarf mistletoe infections. Dimensions are described in terms of diameter (width) at its widest point and length measured along the long axis of the host segment.

74. Gelatinous layer (252)

75. Girdle (host) (Syn.: whorl)

The point on a vegetative branch or main stem of a conifer between two annual growth segments. This is incorrectly referred to as a "node".

76. Haustorial disc (80)

77. Haustorial root system (55)

78. Haustorial system (55)

79. Haustorial wedge (103)

TABLE 1

Scientific Name	Common Name	Principal Hosts	Distribution
<i>A. abietinum</i> Engelm. ex Munz			
f. sp. <i>concoloris</i> Hawksw. & Wiens	White fir dwarf mistletoe	<i>Abies concolor</i> , <i>A. grandis</i>	W. U.S.
f. sp. <i>magnifica</i> Hawksw. & Wiens	Red fir dwarf mistletoe	<i>Abies magnifica</i>	Calif. & Oreg.
<i>A. abietis-religiosae</i> Heil	(None)	<i>Abies</i> spp.	Mex.
<i>A. americanum</i> Nutt. ex Engelm.	Lodgepole pine dwarf mistletoe	<i>Pinus contorta</i> , <i>P. banksiana</i>	W. Canada & W. U.S.
<i>A. apacheum</i> Hawksw. & Wiens	Apache dwarf mistletoe	<i>Pinus strobiformis</i>	New Mex., Ariz., N. Mex.
<i>A. bicarinatum</i> Urban	Hispaniolan dwarf mistletoe	<i>Pinus occidentalis</i>	Haiti, Dominican Rep.
<i>A. blumeri</i> A. Nels.	(None)	<i>Pinus strobiformis</i>	Mex. & Ariz.
<i>A. californicum</i> Hawksw. & Wiens	Sugar pine dwarf mistletoe	<i>Pinus lambertiana</i>	Calif. & Oreg.
<i>A. campylopodium</i> Engelm.	Western dwarf mistletoe	<i>Pinus ponderosa</i> , <i>P. jeffreyi</i> , <i>P. attenuata</i> , <i>P. coulteri</i>	Wash. & Idaho to Baja Calif., Mex.
<i>A. cyanocarpum</i> A. Nels.	Limber pine dwarf mistletoe	<i>Pinus flexilis</i> , <i>P. longaeva</i>	W. U.S.
<i>A. divaricatum</i> Engelm.	Pinyon dwarf mistletoe	<i>Pinus edulis</i> , <i>P. monophylla</i>	S.W. U.S., Baja Calif., Mex.
<i>A. douglasii</i> Engelm.	Douglas-fir dwarf mistletoe	<i>Pseudotsuga menziesii</i>	S. B.C. to Centr. Mex.
<i>A. gillii</i> Hawksw. & Wiens	Chihuahuan pine dwarf mistletoe	<i>Pinus chihuahuana</i>	N. Mex. & Ariz.
ssp. <i>gillii</i>	(None)	<i>Pinus</i> spp.	Mex.
ssp. <i>nigrum</i> Hawksw. & Wiens			

<i>A. globosum</i> Hawksw. & Wiens	(None)	<i>Pinus</i> spp.	Mex., Guatemala & Br. Honduras
<i>A. guatemalense</i> Hawksw. & Wiens	Guatemalan dwarf mistletoe	<i>Pinus ayacahuite</i>	Guatemala
<i>A. hondurensis</i> Hawksw. & Wiens	Honduran dwarf mistletoe	<i>Pinus occarpa</i>	Honduras
<i>A. laricina</i> (Piper) St. John	Larch dwarf mistletoe	<i>Larix occidentalis</i>	S.E. B.C. & N.W. U.S.
<i>A. microcarpum</i> (Engelm.) Hawksw. & Wiens	Southwestern spruce dwarf mistletoe	<i>Picea engelmannii</i> , <i>P. pungens</i>	Ariz. & New Mex.
<i>A. occidentale</i> Engelm.	Digger pine dwarf mistletoe	<i>Pinus sabiniana</i>	Calif.
<i>A. pusillum</i> Peck	Eastern dwarf mistletoe	<i>Picea mariana</i> , <i>P. glauca</i>	E. Canada, N.E. U.S.
<i>A. rubrum</i> Hawksw. & Wiens	(None)	<i>Pinus</i> spp.	Centr. Mex.
<i>A. strictum</i> Hawksw. & Wiens	(None)	<i>Pinus</i> spp.	Centr. Mex.
<i>A. tsugense</i> (Rosendahl) G.N. Jones	Hemlock dwarf mistletoe	<i>Tsuga heterophylla</i> , <i>T. mertensiana</i>	Alaska to Centr. Calif.
<i>A. vaginatum</i> (Willd.) Presl.	(None)	<i>Pinus</i> spp.	Mex.
ssp. <i>vaginatum</i>	(None)	<i>Pinus</i> spp.	Centr. Mex.
ssp. <i>durangensis</i> Hawksw. & Wiens	(None)	<i>Pinus ponderosa</i>	Utah & Colo. to N. Mex.
ssp. <i>cryptopodum</i> (Engelm.) Hawksw. & Wiens	Southwestern dwarf mistletoe	<i>Pinus</i> spp.	Centr. Mex.
<i>A. verticilliflorum</i> Engelm.	(None)		

80. Holdfast (Syn.: disc, foot)

A disc-like swelling at the distal end of the radicle through which infection of the host takes place. Formerly referred to as haustorial disc (Fig. 9, p.24).

81. Host-form

A taxon of dwarf mistletoe based exclusively on host relationships. Used by Gill (1935) as a provisional treatment in the *Arceuthobium campylopodium* and *A. vaginatum* complexes.

82. Host susceptibility rating

Many undefined, subjective terms (such as "common", "principal", "main", "uncommon" or "rare" hosts) have been used to describe relative susceptibility of trees to dwarf mistletoes. Hawksworth and Wiens (1970) attempted to develop a less subjective classification system based on determination of an infection factor. The infection factor is the percentage of trees of the species in question that are infected within 20 feet of heavily-infected principal or main hosts. Trees are then placed in five host-susceptibility classes based on these "infection factor" percentages.

Principal host

The main host of a particular taxon. Infection factor is at least 90% and usually nearly 100%. Although some trees may show little infection within the 20-foot zone, uninfected trees are seldom found unless they are very suppressed. A dwarf mistletoe may have several principal hosts.

Secondary host

Infection factor ranges from 50 to 90%.

Occasional host (Syn.: tertiary host)

Infection factor ranges from 5 to 50%.

Rare host

Infection factor more than zero but less than 5%.

Immune (Syn.: non-host)

Trees not infected, even in stands where the dwarf mistletoe in question is common. Infection factor zero.

83. Hyperparasitism

The parasitism of a parasite by another parasite. Hyperparasites of dwarf mistletoes are usually fungi.

84. Hyperplasia

Abnormal growth of host tissues due to increased number of cells (cf. fusiform swelling).

85. Hypersensitive reaction

A reaction of the host that prevents the establishment of dwarf mistletoe, e.g., death of cells (necrotic fleck), mortality of needles in contact with holdfast or production of wound periderm.

86. Hypertrophy

Abnormal growth of host tissues due to increase in size of cells (cf. fusiform swelling).

87. Hypocotyl (183)

88. Immune; see host susceptibility rating

89. Immunization; see control

90. Inactive infection (248)

91. Incidence

Number of trees infected in a stand (cf. intensity).

92. Incipient infection

An infection in an early developmental stage in which external symptoms are not yet visible (cf. lag period).

93. Incompatible host (Syn.: non-compatible host)

A tree that is infected by a dwarf mistletoe but the development of the parasitic relationship is abnormal. For example, marked swellings are frequently formed and there may be very few, or even no shoots produced. Incompatible hosts are usually but not always rare hosts (see 82).

94. Incubation period; see lag period

95. Indirect flowering

The occurrence of a rest period (usually about six months) between the initiation of floral buds and flowering, e.g., *Arceuthobium americanum*, *A. douglasii*, *A. pusillum*.

96. Infected residual

Dwarf mistletoe infected tree remaining after a natural catastrophe (e.g., fire, windstorm) or after human activity (e.g., selective logging).

97. Infected ring (Syn.: abnormal ring, invaded ring, swollen ring)

Annual rings in which mistletoe sinkers are embedded. The first ring affected often exhibits localized xylem stimulation (Fig. 8, p.24).

98. Infection

- a. That process in which dwarf mistletoes successfully penetrate host tissues and initiate establishment of the endophytic system.
- b. The whole mistletoe plant (aerial shoots and endophytic system) developing from a single seed, plus associated host symptoms. Frequently but incorrectly referred to as a plant.

99. Infection age

Number of years since penetration of host tissue by the mistletoe radicle. Usually determined by counting the number of infected rings and adding one or two years to account for the period before xylem stimulation (Fig. 8, p.24).

100. Infection class; see infection rating systems

101. Infection factor; see host susceptibility rating

102. Infection intensity level (105)

103. Infection peg (Syn.: penetrating structure, wedge)

Structure that develops from the holdfast and initiates the infection process. Formerly referred to as haustorial wedge or primary haustorium.

104. Infection period (50)

105. Infection rating systems

Rating systems, based on symptoms and signs, designed to evaluate intensity of dwarf mistletoe in trees or stands.

Infection class

A measure of dwarf mistletoe intensity for individual trees (cf. six-class system).

Stand infection index (Syn.: average plot rating, infection intensity level)

The average of individual tree ratings for a stand.

106. Infestation

A condition in a stand in which one or more trees are infected.

107. Infestation center (Syn.: focus)

Origin of stand infestation indicated by the earliest infected trees.

108. Initial infection

First infection on a tree or in a stand.

109. Inner system (55)

110. Intensification

Increase in the number of dwarf mistletoe infections in a tree (cf. spread).

Vertical intensification

Upward intensification within a tree.

111. Intensity

Amount of dwarf mistletoe within a tree (cf. infection rating systems).

112. Interior seed source; see seed source

113. Internode (host) (209)

114. Internode (dwarf mistletoe) (Syn.: segment)

That portion of a dwarf mistletoe aerial shoot between two successive nodes.

115. Interwhorl (209)

116. Intrafascicular bud (148)

117. Intrafoliar bud (148)

118. Invaded ring (97)

119. Isophasic infection (237)

120. Isophasic witches' broom (238)

121. Klendusity

The ability of a potential suspect to escape attack by a given pathogen when inoculum and environmental conditions are favorable for infection.

122. Lag period (Syn.: latent period, pre-emergence period)

That period in the development of an infection from seed deposition to appearance of the first shoots. Incubation period is frequently used as a synonym but the proper meaning of this term is different, i.e., time to production of first symptoms (Fig. 11, p.24). Latency period has been used to describe that period from infection to reproduction for pathogens other than dwarf mistletoes.

123. Latent infection

A dwarf mistletoe infection that is established but has not yet produced shoots (cf. lag period).

124. Latent period (122)

125. Lateral seed source; see seed source

126. Lateral spread; see spread

127. Leader broom (259)

128. Life table

A method of studying populations employing a device that records in systematic fashion those facts basic to the age distribution of mortality.

129. Limited control; see silvicultural control

130. Local hypertrophy (154)

131. Local pattern (154)

132. Local sanitation (214)

133. Local swelling (154)

134. Localized infection (154)

135. Long-distance spread; see spread

136. Male infection (Syn.: staminate infection)

A dwarf mistletoe infection that produces male flowers (cf. female infection, dioecious).

137. Mamelon (158)

138. Man-made barrier (Syn.: buffer zone)

An artificial obstacle to the local spread of dwarf mistletoe, such as a road, railroad or powerline right-of-way or plantation of immune tree species.

139. Mortality center

A descriptive term applied to an infestation center where the duration of infection has resulted in high mortality.

140. Mucilage (252)

141. Mucilaginous cells (253)

142. Mucopectin (252)

143. Natural barrier

A natural obstacle to the local spread of dwarf mistletoe, such as a river, lake, barren area or stand of immune tree species.

144. Natural exclusion

The absence of a dwarf mistletoe within parts of the range of its principal host due to natural factors.

145. Necrotic fleck; see hypersensitive reaction

146. Nectar (Syn.: receptive fluid, stigmatic exudation, stigmatic secretion)

Sugary liquid secreted by dwarf mistletoe flowers that attracts insects and promotes pollination.

147. Needle angle

The angle defining the alignment of a needle in relation to the vertical plane.

Negative needle angle

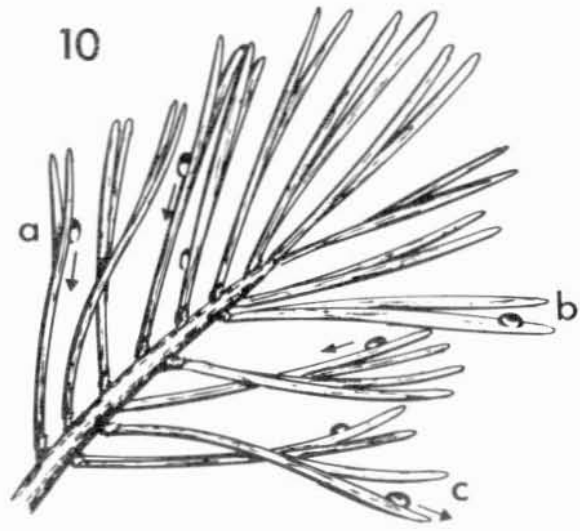
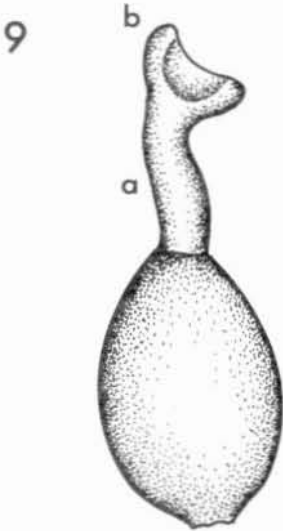
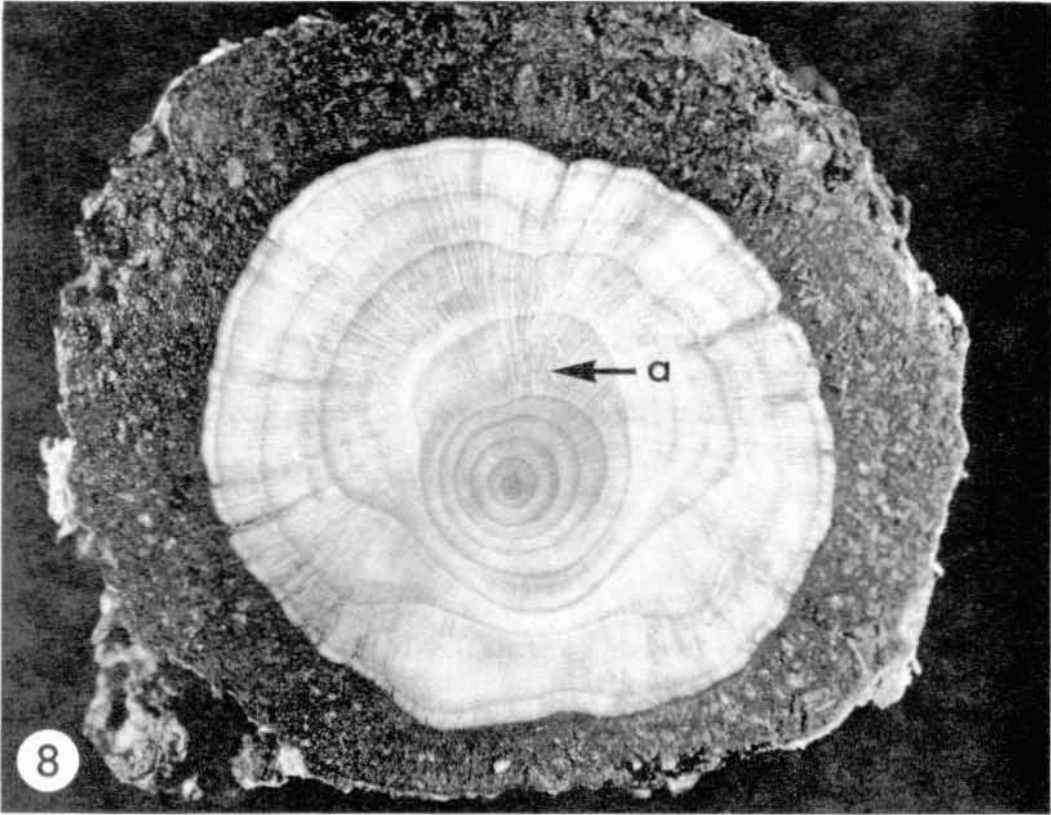
The tip of a needle is lower than its base. In this case, dwarf mistletoe seeds tend to move away from the twig (Fig. 10, p.24).

Positive needle angle

The tip of a needle is higher than its base. In this case, dwarf mistletoe seeds tend to move toward the twig (Fig. 10, p.24).

P L A T E I V

- Fig. 8. Cross section of a dwarf mistletoe infected western hemlock branch showing: a. the first infected ring with xylem stimulation.
- Fig. 9. A fully developed dwarf mistletoe seedling with:
a. radicle b. holdfast.
- Fig.10. Needle angles as they affect dwarf mistletoe seed movement: a. positive b. level c. negative.
- Fig.11. Diagram showing the difference between incubation period and lag period.



148. Needle fascicle bud (Syn.: intrafascicular bud, intrafoliar bud)

A bud occurring within the needle fascicle of pines which may be stimulated by dwarf mistletoe endophytic system to form a branchlet (Fig. 12, p.30).

149. Negative needle angle; see needle angle

150. Node (dwarf mistletoe)

The place on a dwarf mistletoe aerial shoot where the scale leaves arise (cf. girdle).

151. Node (host) (75)

152. Non-compatible host (93)

153. Non-host (82)

154. Non-systemic infection (Syn.: anisophasic infection, local hypertrophy, local pattern, local swelling, localized infection, tufted type shoot distribution)

An infection in which the endophytic system is generally restricted to the swollen portion of the host (cf. systemic infection).

155. Non-systemic witches' broom (Syn.: anisophasic witches' broom)

A witches' broom associated with a non-systemic infection.

156. Nub

A tiny knob-like dwarf mistletoe shoot, frequently indicative of an incompatible host.

157. Occasional host; see host susceptibility rating

158. Ovarian papilla (Syn.: mamelon)

An undifferentiated structure in which the two embryo sacs of the female flower are embedded (Kuijt, 1960).

159. Overhead seed source (206)

160. Overstory seed source; see spread

161. Overstory spread; see spread

162. Papilla (pl. papillae)

A structure at the margin of the holdfast that aids in securing it to the host bark.

163. Passive infection (248)

164. Pedicel

The stalk attaching the dwarf mistletoe flower or fruit to the aerial shoot (Fig. 15, p.30).

165. Pendulous broom (259)

166. Penetrating structure (103)

167. Pistillate infection (65)

168. Plant (98)

169. Plexus

A large conical mass of dwarf mistletoe tissue in the host bark from which aerial shoots arise (Fig. 5, p.8).

170. Positive needle angle; see needle angle

171. Pre-emergence period (122)

172. Primary branching; see branching of dwarf mistletoe shoots

173. Primary haustorium (103)

174. Primary infection

Infection by dwarf mistletoe of previously uninfected host tissue (cf. secondary infection).

175. Primary root (183)

176. Primary spread (223)

177. Principal host; see host susceptibility rating

178. Protection; see control

179. Proximal cap

A dome-like formation consisting of thick-walled cells situated at the proximal pole of the dwarf mistletoe seed (Fig. 14, p.30).

180. Proximal growth (Syn.: basipetal growth)

Growth of the endophytic system of a dwarf mistletoe infection from an apical or distal point towards the base of the tree.

181. Proximal pole

The blunt end of the dwarf mistletoe seed closest to the pedicel of the fruit (Fig. 14, p.30).

182. Pruneable infection

A branch infection in which the endophytic system of dwarf mistletoe has not invaded the stem, so the infection can be eliminated by pruning.

183. Radicle (Syn.: primary root)

The germinating root-like structure of a dwarf mistletoe seed. Frequently but incorrectly referred to as a hypocotyl.

184. Rare host; see host susceptibility rating

185. Receptive fluid (146)

186. Re-cleaning (Syn.: follow-up cleaning)

A control treatment following an initial treatment. This is usually done from three to five years after the initial cleaning. In some situations, a second and even subsequent re-cleaning may be needed.

187. Reproductive infection (Syn.: active infection)

A dwarf mistletoe infection that produces aerial shoots (cf. vegetative infection).

188. Resin canker

A canker associated with a dwarf mistletoe infection in which the sapwood is heavily infiltrated with resin.

189. Salvage; see silvicultural control

190. Sanitation; see silvicultural control

191. Scale leaf

A reduced leaf occurring in pairs at the nodes of dwarf mistletoe aerial shoots (Fig. 6, p.8).

192. Screening (Syn.: umbrella effect)

Reduction in target area by interposition of adjacent trees.

193. Seam

Abnormality associated with dwarf mistletoe infections on hemlock, characterized by included bark (Fig. 13, p.30).

194. Secondary branching; see branching of dwarf mistletoe shoots

195. Secondary host; see host susceptibility rating

196. Secondary infection

Infection by dwarf mistletoe of previously infected tissue, e.g., a non-systemic infection on a systemic witches' broom (cf. primary infection).

197. Secondary spread (223)

198. Seed

A propagating structure of dwarf mistletoe made up of endosperm and embryo, lacking a true seed coat but encased in the endocarp of the fruit (Fig. 14, p.30).

199. Seed coating

A protective tissue surrounding dwarf mistletoe seeds composed of the endocarp of the fruit and viscin cells. Owing to the lack of integuments, this is not a true seed coat.

200. Seed discharge (Syn.: seed dissemination, seed expulsion)

Forceful ejection of dwarf mistletoe seeds from the fruit as a result of internal pressure (Fig. 15, p.30).

201. Seed dispersal

Spread of seeds by seed discharge and other factors such as wind.

202. Seed dissemination (200)

203. Seed expulsion (200)

204. Seed interception

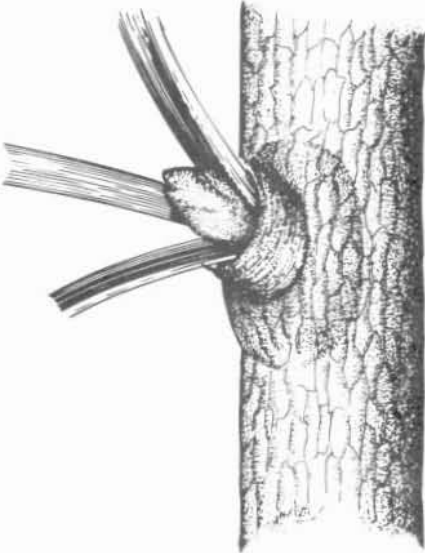
The interception of discharged dwarf mistletoe seeds before they hit the ground.

205. Seed removal

Dislodgement of dwarf mistletoe seeds from a potential host by natural factors such as rain, snow, wind and insects.

P L A T E V

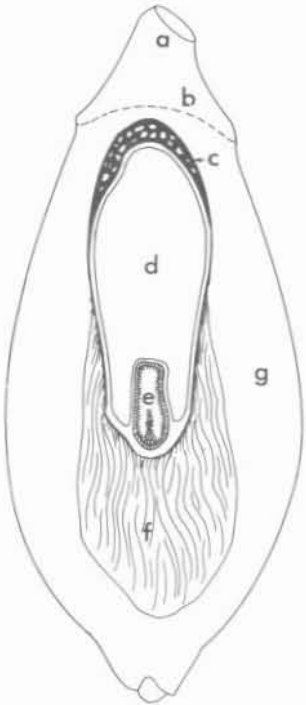
- Fig. 12. Early stage of dwarf mistletoe infection showing a stimulated needle fascicle bud.
- Fig. 13. Seam resulting from dwarf mistletoe infection on western hemlock.
- Fig. 14. Cross section of a dwarf mistletoe fruit: a. pedicel b. abscission zone c. proximal cap d. endosperm e. embryo f. viscin cells g. pericarp (after Kuijt, 1960).
- Fig. 15. Dwarf mistletoe seed discharge: a. pedicel b. seed c. capsule or pericarp.



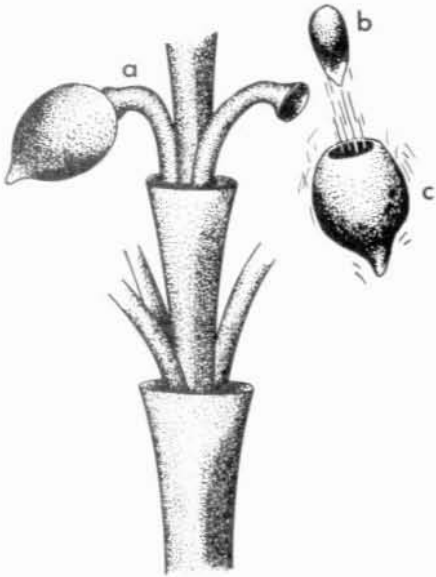
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14



15

206. Seed source

Interior seed source

Dwarf mistletoe seed source within the tree in which seed interception occurs.

Lateral seed source (Syn.: side seed source)

Dwarf mistletoe seed source in an infected stand from which the seed is intercepted laterally by trees of similar height.

Overstory seed source (Syn.: overhead seed source)

Dwarf mistletoe seed source in overstory trees from which the seed is intercepted by trees in inferior crown classes (cf. overstory spread, 223).

207. Seed transfer

Seed movement, usually aided by water, from needles to potential infection sites on branches (Fig. 10, p. 24).

208. Segment (dwarf mistletoe) (114)

209. Segment (host) (Syn.: interwhorl)

The single year's growth in length of a vegetative branch or main stem of a conifer. This is often but incorrectly referred to as an internode (Kuijt, 1960).

210. Shoot (4)

211. Shoot fungi

Fungi infecting the aerial shoots of dwarf mistletoe (cf. canker fungi).

212. Shoot scar (10)

213. Side seed source (206)

214. Silvicultural control

Reduction of dwarf mistletoe by silvicultural means.

Salvage

Harvesting severely dwarf mistletoe infested stands, before the normal rotation age, to avoid further losses.

Sanitation (Syn.: local sanitation)

A silvicultural treatment that reduces the level of dwarf mistletoe in an infected stand.

214. (continued)

Complete control

Reduction of dwarf mistletoe populations to as near zero as possible (Heidmann, 1968).

Limited control

Reduction of dwarf mistletoe populations to levels that do not seriously affect timber production (Heidmann, 1968).

Species manipulation

Favoring immune or rare hosts in mixed stands during stand treatment.

215. Sinker

Structures, composed of tracheary and parenchyma elements (Srivastava and Esau, 1969), that originate from dwarf mistletoe cortical strands and grow centripetally to the cambium where they are embedded by successive layers of xylem (cf. endophytic system) (Fig. 5, p. 8).

216. Sinker system

That part of the dwarf mistletoe endophytic system embedded in xylem and consisting of sinkers.

217. Six-class system

A system for rating dwarf mistletoe intensity on individual trees. Degrees of infection, up to a maximum of six, are determined by classifying each third of the crown as either 0 (healthy), 1 (light) or 2 (severe) and adding the three figures (cf. infection rating system) (Fig. 16, p. 34).

218. Sleeper (248)

219. Slime threads (253)

220. Species manipulation; see silvicultural control

221. Spike-tip

Terminal portion of male aerial shoots that is shed after flowering (Kuijt, 1970).

222. Spike-top

Dead top in living trees, often associated with severe dwarf mistletoe infection.

P L A T E VI

Fig. 16. The six-class system for rating dwarf mistletoe intensity on individual trees.

Fig. 17. Stem canker on white fir resulting from dwarf mistletoe infection.

INSTRUCTIONS

STEP 1: DIVIDE CROWN INTO THIRDS

STEP 2: RATE EACH THIRD 0, 1, or 2

- (0) No visible infections
- (1) Light infection ($\frac{1}{2}$ or less of total number of branches in the third infected)
- (2) Heavy infection (more than $\frac{1}{2}$ of total number of branches in the third infected)

STEP 3: ADD RATINGS OF THIRDS TO OBTAIN RATING FOR TOTAL TREE

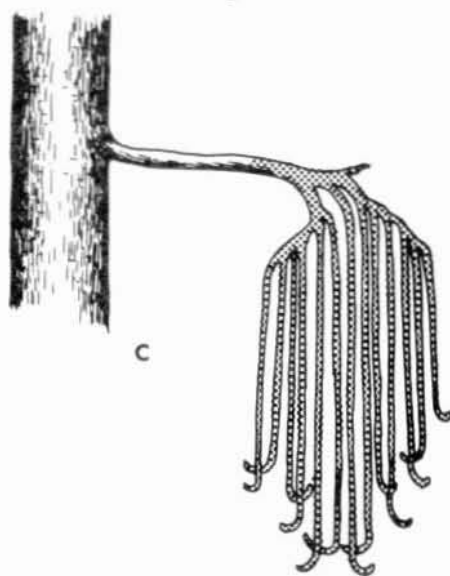
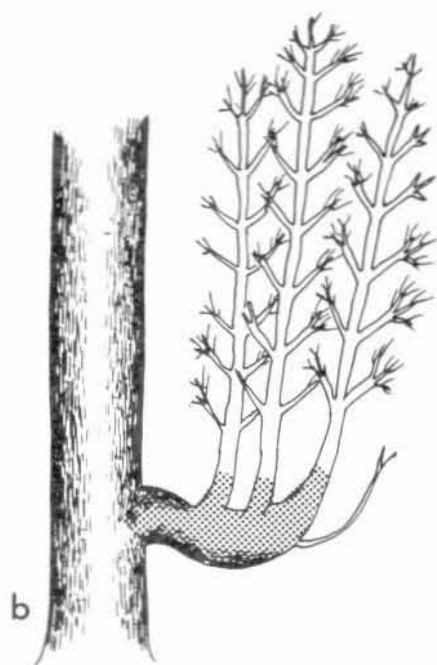
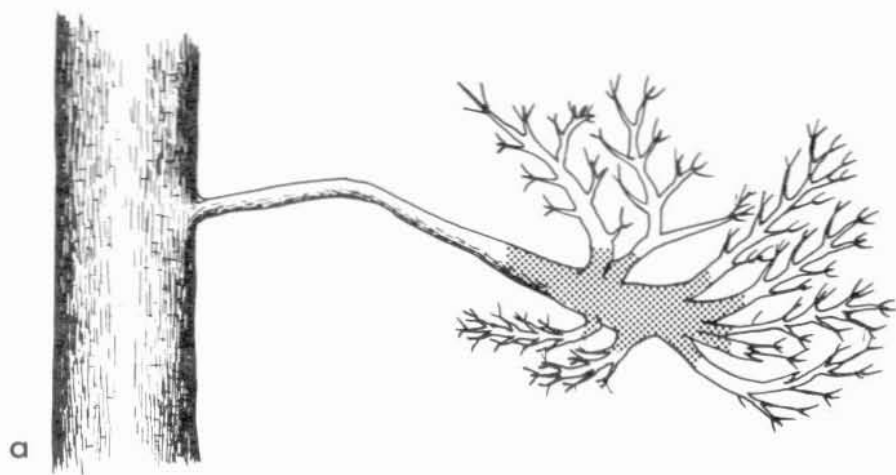


P L A T E V I I

Fig. 18. Witches' brooms caused by dwarf mistletoe on ponderosa pine:

- a. typical broom
- b. volunteer (leader) broom
- c. weeping (pendulous) broom.

Shading indicates the extent of the endophytic system.



223. Spread

The increase in number of dwarf mistletoe infected trees in a stand (cf. intensification).

Long-distance spread

Spread of dwarf mistletoe beyond the range of explosive seed discharge.

Lateral spread

Spread of dwarf mistletoe through single-storied stands.

Overstory spread (Syn.: primary spread)

Spread of dwarf mistletoe from overstory to understory due to seeds dispersed from the overstory.

Subsequent spread (Syn.: secondary spread)

Spread in a stand beyond the limits of seed dispersal directly from an overstory.

224. Spring flowering (Syn.: vernal anthesis)

A phenological characteristic of some dwarf mistletoes in which flowering occurs in the spring (cf. fall flowering).

225. Staminate infection (136)

226. Stand infection index; see infection rating systems

227. Stand invasion

Spread of dwarf mistletoe into a previously uninfested stand.

228. Stem canker; see canker

229. Stem infection (Syn.: bole infection, trunk infection)

An infection of the main stem of the host, established directly from a dwarf mistletoe seed. Frequently but incorrectly referred to as a bole canker.

230. Stem invasion

Growth of the endophytic system of a branch infection into the main stem of the host (cf. stem infection).

231. Stem swelling (Syn.: bole swelling, trunk swelling)

Hypertrophy, or hyperplasia of the host stem induced by dwarf mistletoe. Frequently referred to as a burl.

232. Stigmatic exudation (146)

233. Stigmatic secretion (146)

234. Subsequent spread; see spread

235. Swollen ring (97)

236. Sympatry

A condition when, in terms of temporal and spatial characteristics, gene exchange is possible unless there is genetic isolation; that is, two species of dwarf mistletoes growing in close proximity (Hawksworth & Wiens, 1970).

237. Systemic infection (Syn.: diffuse infection, diffuse pattern, isophasic infection)

An infection in which the endophytic system is in the terminal bud and keeps pace with the apices of the host (cf. non-systemic infection). There is generally little hypertrophy or hyperplasia.

238. Systemic witches' broom (Syn.: isophasic witches' broom)

Witches' broom resulting from a systemic infection. Dwarf mistletoe aerial shoots are scattered along the branch (cf. non-systemic infection).

239. Target area

Surface area of potential hosts exposed to dwarf mistletoe seeds.

240. Taxon (pl. taxa)

A taxonomic unit of any rank (species, subspecies, variety, form, etc.).

241. Throughfall

Dwarf mistletoe seeds that fall to the ground.

Delayed throughfall

Seeds that are intercepted by trees but later fall to the ground, usually because of rains (Hawksworth, 1965) (cf. seed removal).

Direct throughfall

Seeds that miss the trees and fall directly to the ground (Hawksworth, 1965).

242. Transfer (35)

243. Trunk infection (229)

- 244. Trunk swelling (231)
- 245. Tufted type shoot distribution (154)
- 246. Typical broom; see witches' broom
- 247. Umbrella effect (192)
- 248. Vegetative infection (Syn.: inactive infection, passive infection, sleeper)

A dwarf mistletoe infection that does not produce aerial shoots; most often occurs on heavily shaded branches or on incompatible hosts (cf. reproductive infection).

- 249. Vernal anthesis (224)
- 250. Vertical intensification; see intensification
- 251. Verticillate branching (Syn.: collateral branching, whorled branching)

The occurrence of more than two branches or flowers at a single node, arranged in a whorl (Fig. 3, p.6).

- 252. Viscin((Syn.: mucilage, mucopectin, gelatinous layer)

Mucilaginous material contained in the viscin cells of dwarf mistletoe fruit, which acts as the means of attachment of the seed to the host.

- 253. Viscin cells (Syn.: mucilaginous cells, slime threads)

Elongated mucilaginous cells that cover most of the dwarf mistletoe seed (Fig. 14, p.30).

- 254. Volunteer broom; see witches' broom
- 255. Wedge (103)
- 256. Weeping broom; see witches' broom
- 257. Whorl (75)
- 258. Whorled branching (251)

259. Witches' broom (Syn.: broom)

An abnormally profuse, dense mass of host branches (Fig. 18, p.36). This is a common symptom induced by dwarf mistletoes, as well as other parasites and abiotic agents. Witches' brooms caused by the dwarf mistletoes are of two basic types: systemic or non-systemic.

Various kinds of brooms have been described for different host parasite-combinations (Anderson & Kaufert, 1959; Kuijt, 1960; Hawksworth, 1961). For example, Hawksworth has described three types of witches' brooms caused by *Arceuthobium vaginatum* ssp. *cryptopodium* on ponderosa pine.

Typical broom

A broom roughly spherical in outline, with a marked taper in the infected branches (Fig. 18a, p.36).

Volunteer broom (Syn.: leader broom)

A broom in which one or several branches assume a vertical habit (Fig. 18b, p.36). This is basically similar to the typical broom but occurs near the bole or near ground level.

Weeping broom (Syn.: pendulous broom)

A broom in which branches show a definite drooping tendency (Fig. 18c, p. 36).

The first two types are non-systemic but weeping brooms are always systemic.

260. Xylem stimulation

Hypertrophy or hyperplasia of xylem cells of the host due to dwarf mistletoe infection (Fig. 8, p.24).

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