TABLE 1. Relationship of cone storage period, cone characteristics, mycelial growth and seed condition in Douglas fir.

	Cone Characteristics				Mycelial Growth			Seed Condition	
					Mycelial Density[2]				
Lot	Cone storage period (days)	Moisture content % oven dry wt	Scale Closure[1] index	Cone surface covered %	On inner scale index	Around empty seeds index	Around filled seeds index	Germinable[3] %	Diseased[3] %
A	0	50	1.2	14				87	
	7	—	—	40				—	
	30	41	1.0	65				89	
	60	25	1.0	—				87	
	90	26	1.0	—				87	
B	0	140	4.9	0	0	0.2	0	66	27
	7	—	—	12	1.0	0.5	0	—	—
	30	126	2.2	99	2.7	2.6	2.6	74	19
	60	92	1.5	100	5.5	4.2	3.2	80	17
	90	62	1.3	100	6.3	5.5	4.1	80	13
C	0	134	3.7	2	0.7	0.6	0	82	12
	7	—	—	45	2.9	2.5	2.0	—	—
	30	118	2.5	90	3.3	2.9	2.7	72	21
	60	78	1.4	98	4.3	4.4	3.9	87	11
	90	46	1.1	100	6.2	4.9	3.3	86	11

Note: Within the same lot, means followed by a bar are not significantly different ($p < .05$) by Duncan's multiple range test.
[1] Rated from 1 = fully open to 5 = tightly closed.
[2] Rated from 0 = nil to 10 = very heavy.
[3] Per cent of filled seeds: Other categories of seed condition (not shown) account for the balance of 100%.

the first 30 days in storage, then decreased. Fungus genera associated with disease included: *Penicillium*, *Gliocladium*, *Papulospora* and *Cephalosporium*.

Germinability (per cent filled seeds germinating) in all lots exceeded 80% after 90 days in storage. In lots A and C, germinability after 90 days in storage was the same as at the time of picking, whereas germinability of lot B increased.

The above results support indications from the previous study that, under local operational conditions, cone storage for at least 90 days does not reduce the germinability of Douglas-fir seeds, but may increase it; also that fungi are non-injurious to seeds while in the cones but are associated with disease during germination. As in the previous investigation, and in partial disagreement with other reports (Rediske and Shea, Forest Sci. 11: 463-472, 1965; Shea, Weyerhaeuser Co. Forest Res. Note 31, 1960), no other factors examined had any relationship to disease or germinability. Nor did insect damage, negligible in the previous investigation but severe in the present one, bear any relationship to disease or germinability — W. J. Bloomberg, Forest Research Laboratory, Victoria, B.C.

Infection of Western Larch by Hemlock Dwarf Mistletoe.—Since it was first described (Rosendahl, Minn. Bot. Studies 3: 271-273, 1903), hemlock dwarf mistletoe [*Arceuthobium campylopodum* Engelm. forma *tsugensis* (Rosend.) Gill] has been considered distinct from larch dwarf mistletoe [*A. campylopodum* forma *laricis* (Piper) Gill] (Piper, Contr. U.S. Nat. Herb. 11: 222-223, 1906). In a monograph of the genus (Gill, Trans. Conn. Acad. Arts and Sci. 32:111-245, 1935), the two were differentiated as forms mainly on the basis of principal hosts, western hemlock [*Tsuga heterophylla* (Raf.) Sarg.] for hemlock mistletoe and western larch [*Larix occidentalis* Nutt.] for larch mistletoe. The lack of evidence of cross-infection was considered justification for taxonomic separation even in the absence of demonstrated morphological differences. However, a report of natural infection of plantation-grown European larch [*Larix decidua* Mill.] by hemlock dwarf mistletoe on Vancouver Island (Kuijt, Madrono 17:254-256, 1964) suggested that physiological differences in the two forms were less pronounced than hitherto believed. The latter combination produced distinct swellings but no aerial shoots. Wicker (Ph.D thesis, Wash. State Univ., 1965) obtained a single infection of hemlock mistletoe on western larch by using an inoculation technique involving an artificial incision on the host branch.

To further the knowledge of host ranges, a series of inoculations employing several dwarf mistletoe and conifer species were conducted in a plantation near Victoria, B.C. Results pertinent to the taxonomy of larch and hemlock dwarf mistletoes are reported here.

Hemlock mistletoe seeds were collected in early October on Vancouver Island from western hemlock, the primary host, and from shore pine [*Pinus contorta* Dougl.], an occasional host. Larch mistletoe seeds were collected in September from western larch growing in southeastern British Columbia. All seeds were stored at 5C before inoculation in late October and early November. To effect adhesion to the branch surface, the seeds were briefly wetted and then placed mainly on 1- and 2-year-old branches at the axils of needles or at the bases of buds. Inoculations were repeated for 4 years from 1963 to 1966.

Twenty-nine of the 160 hemlock mistletoe seeds collected from shore pine and placed on western larch produced swellings, normally the first indication of infection; however, by 27 Aug. 1969, none bore aerial shoots even though swellings reached to 100 mm in length. Ten of the 160 seeds collected from western hemlock caused swellings on larch and one of these produced aerial shoots. The production of aerial shoots by this host-parasite combination is apparently rare. The inoculation was made in early November 1965, and a swelling with aerial shoots was first observed in October 1966. By 1968, five shoots were present. The largest (48 mm in length) bore staminate flowers in 1968. Anthesis occurred normally. Pollen recovered from the flowers was examined by F. G. Hawksworth (U.S.F.S., Ft. Collins, Colorado) who classified it with the hemlock dwarf mistletoe type. By early 1969, all aerial shoots had died and no new shoots have appeared since.

It is instructive to compare the response of western larch to hemlock mistletoe with that of western larch to larch mistletoe. Of 144 larch mistletoe seeds planted on larch, 39 caused swellings. All swellings bore aerial shoots and new shoots are continually appearing. A comparison of the size of swellings caused by the two dwarf mistletoes indicates that the endophytic system of larch mistletoe is more vigorous than hemlock mistletoe when both are parasitizing western larch (Fig. 1).

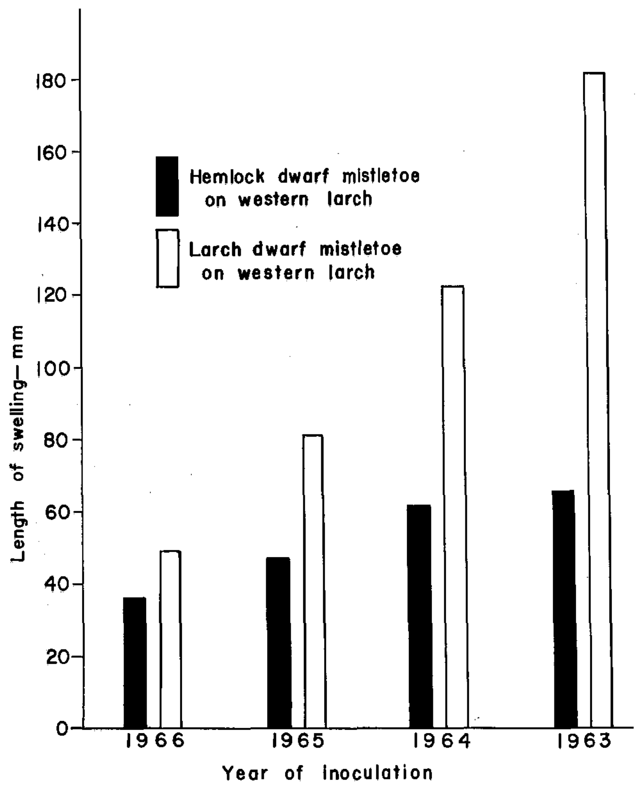

FIGURE 1. A comparison of the length of swellings on western larch caused by larch and hemlock dwarf mistletoes. Measurements were made 27 August 1969. Basis: 39 infections for each type.

No larch mistletoe infections were obtained on western hemlock.

Evidently, hemlock dwarf mistletoe can establish fairly readily on western larch. However, the slow growth it exhibits and the rarity of aerial shoot production shows that larch is a relatively incompatible host. Results also suggest that western hemlock is immune to larch mistletoe under artificial conditions, substantiating observations made in nature (Kuijt, Nat. Mus. Can. Bull. 186:134-148, 1963). These differences in the responses of western larch and western hemlock to larch and hemlock dwarf mistletoes, indicate that taxonomic separation of the two mistletoes, at least on a physiological basis, is justified.—R. B. Smith, Forest Research Laboratory, Victoria, B.C.

Butt Decay in Balsam Fir Defoliated by the Spruce Budworm.—The 1949-1959 outbreak of the spruce budworm [*Choristoneura fumiferana* (Clem.)] caused varying degrees of defoliation, top-killing, and tree mortality in dense stands of balsam fir [*Abies balsamea* (L.) Mill.] in northern New Brunswick (Baskerville, Forest. Chron. 36: 342-345, 1960). The surviving trees constitute the pulpwood forest of the future and the possibility of a high incidence of butt decay associated with the budworm stress is of vital interest. Rankin (Phytopathology 10: 314-315, 1920) and McCallum (Can. Dep. Agr. Bull. 104, 1928) reported no correlation between the amount of cull and previous budworm injury; however, Stillwell (Forest Sci. 2: 174-180, 1956) found a higher incidence of stem decay was commonly associated with buried leaders which had been killed by severe budworm defoliation. Similar information on the incidence of butt decay is lacking, although Redmond (Forest Sci. 4: 15-21, 1957) reported that the presence of butt decay could not be exclusively related to rootlet mortality resulting from budworm defoliation. However, existing infections may spread more quickly because of the reduction in tree growth and vigor.

In 1967, 368 trees greater than 4.5 inches dbh. were felled in two stands which had not been sprayed with insecticide during the 1949-1959 outbreak of spruce budworm: 191 trees were from the Kedgwick watershed in northwestern New Brunswick and 117 were from the Charlo watershed in north central New Brunswick. Both stands were released by the 1912-1920 outbreak and are predominantly balsam fir. The Kedgwick and Charlo stands were subjected to 9 and 7 years respectively of moderate to severe defoliation.

The volume of butt decay was determined for each tree. If no decay was visible in the stump, all main roots were cut about 1 foot from the root collar and examined. Decay fungi were cultured on 2% malt agar slants. A disk, marked on the north side, was taken from each tree about 2 feet from ground level and the dates and number of suppression rings were determined.

Of the isolation attempts on the two study areas, 54% yielded basidiomycetes. Six basidiomycetes were commonly isolated from both areas with nearly the same relative frequency (Table 1). Of the 122 basidiomycete isolates, 38% were *Scytinostroma galactina* which did not appear to be associated with any particular suppression group. *Armillaria mellea*, previously isolated with low frequency from balsam fir, constituted 30% of the isolates and was associated with trees of the higher suppression classes, conforming with the established pattern of *A. mellea* progressing rapidly in weakened trees (Boyce, Forest Pathology, McGraw Hill, 1961). *Coniophora puteana* comprised 22% of the isolates and was isolated with about equal frequency from all suppression classes.

TABLE 1

Frequency of isolation of basidiomycetes from butt decay in the Kedgwick and Charlo stands

Fungus	Kedgwick	Charlo
	Number of times isolated	
Scytinostroma galactina (Fr.) Donk	25	22
Armillaria mellea (Vahl ex Fr.) Kummer	21	15
Coniophora puteana (Schum. ex Fr.) Karst.	17	10
Odontia bicolor (Alb. & Schw. ex Fr.) Quel.	1	2
Polyporus balsameus Peck	2	2
Xeromphalina campanella (Batsch ex Fr.) Kuehn. & Maire	4	1
	70	52
TOTAL	122	

Radial growth of balsam fir is reduced 1 to 3 years after the first severe defoliation (Mott, Nairn, and Cook, Forest Sci. 3: 286-304, 1957). In the present study, all suppression rings initiated during the known period of the budworm infestation were assumed to be the result of defoliation. The few stems with more than seven suppression rings appeared to be suppressed by factors in addition to defoliation and were discarded.

The percentage of trees with butt decay in each suppression class is shown in Figure 1. Repression analysis of the data resulted in r^2 values of 0.67 and 0.79 for the Kedgwick and Charlo stands respectively, and the slopes of both regression lines were significant at the 5% level. Trees in the Charlo stand that suffered little or no suppression had an appreciably higher incidence of decay than trees of the same group in the Kedgwick stand. This suggests that factors in addition to budworm defoliation, such as site and stand history, are responsible for the overall higher incidence of decay in the Charlo stand.