of the chips in the sample stored for just over 9 months were affected by this brown discoloration and had a reduction of approximately 7% in basic specific gravity when compared to non-stored chips. Chip quality was therefore greatly reduced for storage periods exceeding 8 months in the lower central areas of the pile.

The more common micro-organisms isolated in the chip pile are listed in Table 1. More wood-rotting and staining fungi were found in the middle and lower regions than the upper third of the pile. This is attributed to the higher temperatures (30 to 43°C) which prevailed near the top of the pile and which would have an inhibitory effect on the mesophilic fungi commonly found in the saprophytic colonization of wood. Isolations from chips obtained from the "hot" areas of the pile yielded heat tolerant fungi such as the mould *Aspergillus fumigatus,* and the decay fungus *Ptychogaster* species, as well as the thermophilic fungus *Sporotrichum thermophile,* which could contribute to degradation of the chips in those areas. Since the pile was built upon a foundation of old chips, it is likely that this could be an important cause of the greater deterioration experienced at the bottom of the chip pile, and indicates that more care should be taken with the preparation of the base to minimize deterioration. In addition, this study indicates that chip storage time should be kept to reasonable limits and the chips utilized within 8 months.—J. K. Shields, Forest Products Laboratory, Ottawa.

The Presence of Guaiacyl Glycerol in Western Hemlock (*Tsuga heterophylla* **(Raf.) Sarg.) Sapwood.**—At least 10% of an isolated phenolic glucoside fraction of western hemlock (Goldschmid and Hergert, Tappi 44: 858-870, 1961) has been found to consist of guaiacyl glycerol. This previously unreported constituent of western hemlock exhibits identical chromatographic properties to the phenolic glucoside and cannot be separated from it by the standard paper or thin-layer procedures. However, this difficulty was overcome by developing a thin-layer separation of their respective acetates on silica gel, using diethyl ether as the solvent. (R_F of phenolic glucoside acetate, 0.29; R_F of guaiacyl glycerol tetraacetate, 0.67.) Chromatographic, ultra-violet and infrared comparisons of the separated hemlock guaiacyl glycerol acetate with authentic reference samples of threo and erythro guaiacyl glycerol tetraacetates (Professor E. Adler) confirmed that the hemlock sample was a mixture of the erythro and threo isomers. The amount present in the original wood is estimated in the order of 0.001 to 0.006%—G. M. Barton, Forest Products Laboratory, Vancouver, B.C.

PATHOLOGY

Seasonal Variation in Spore Deposition of *Fomes annosus* **in Coastal Forests of British Columbia.**—Fomes root rot, caused by the fungus *Fomes annosus* (Fr.) Cke., is one of the most important diseases of immature forests in the temperate region. Wind-dispersed spores are capable of infecting the wood of freshly cut stumps thus enabling the fungus to spread rapidly in stands that have been thinned. In British Columbia, *F. annosus* causes a common butt rot of mature western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) and fir (*Abies* spp.) but it is not yet a problem in immature forests. This may be related to the limited amount of thinning that has taken place.

It was considered that *F. annosus* might pose a threat to plantations and forests if extensive thinning operations were undertaken. Accordingly, studies were commenced to determine the abundance of *F. annosus* and the susceptibility to infection of Douglas-fir—western hemlock stands. Preliminary observations on the seasonal occurrence and quantity of airborne spores in this important forest type are presented.

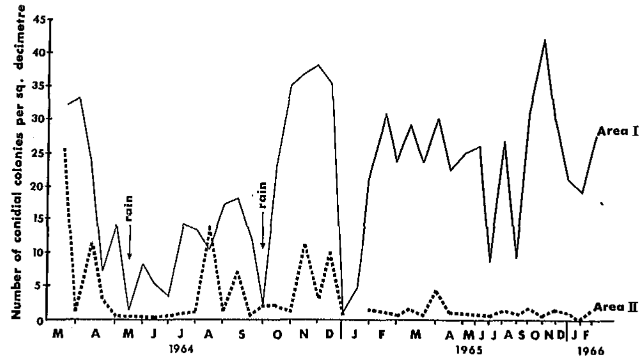

FIG. 1. Seasonal fluctuation in deposition of *Fomes annosus* basidiospores expressed by the number of conidial colonies developing on white pine wood discs. No sample was taken from Area II in mid-January, 1965, the area being inaccessible because of snow.

Spore samples were taken in two areas near Cowichan Lake: Area 1 was in a 65-year-old stand of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and western hemlock in which sporophores of *F. annosus* were known to be nearby; Area II was in a 25-year-old stand of Douglas-fir in which sporophores were not present. Discs of western white pine (*Pinus monticola* Dougl.) wood served as spore traps as outlined by Rishbeth (Ann. Botany 14. 1950). A sample comprised 15 discs exposed for 2 hr. Five discs which had not been exposed to the atmosphere served as controls. Conidial colonies were counted using a stereo microscope at 20× magnification. The wood discs were exposed at 2-week intervals from March 1964 until April 1965 and at monthly intervals until February 1966.

Viable spores were present in the atmosphere in each sampling period but the quantity showed marked seasonal fluctuations. The highest population was in October-November and this dropped sharply in December at the onset of freezing temperatures. The spore population increased in February-March, declined in April and remained at a low level throughout the dry summer (Fig. 1). Spores were recovered from the atmosphere in January 1965 and 1966 even though there was 30 inches of snow in exposed areas of the forest. Some sporophores released spores in all trapping periods except during the short periods of freezing temperatures. Initiation of new sporophores occurred most frequently in the fall.

A correlation was not evident between spore deposition and temperature or precipitation, either prior to or at the time of trapping. When the temperature was below 45°F. but above freezing for extended periods, airborne spore populations increased. However, precipitation was usually high during these cool months. Fewer spores were deposited on the discs when they were exposed during periods of heavy rain fall than at other times. The seasonal variation in spore deposition was considerable in Area I (near sporophores); in Area II the number of spores trapped on the discs was too low to indicate a trend.

It is obvious that the first requisite for a rapid spread of *F. annosus* in thinned stands, namely an abundance of innoculum, is present in coastal British Columbia during most of the year. Studies on the invasion of stumps by the fungus, and its spread to living trees are in progress.—G. Reynolds and G. W. Wallis, Forest Research Laboratory, Victoria, B.C.

Grey Mould of Douglas-Fir Seedlings.—Grey mould of Douglas-fir seedlings caused by *Botrytis cinerea* Pers. appears to occur sporadically in forest nurseries of coastal British Columbia. Etiological factors are believed to include the prevalence of humid weather, abundance of inoculum, and susceptibility of the host species (T. R. Peace, Pathology of Trees and Shrubs, Oxford University Press 1962). In the coastal nurseries of B.C. the fungus attacks newly flushed needles; the climatic events most likely to promote the disease are a warm period in early spring causing the needles to flush, followed by a cool, humid period which delays their maturation. The sporadicity of the disease is attributed to the infrequency of this combination. Tests under controlled conditions have demonstrated the importance of temperature on disease incidence; 16 shoots were attacked on five seedlings grown at 55° compared to five shoots on the same number of seedlings at 65° F.

Abundance of inoculum is probably a factor of secondary importance. The fungus is always present on dead or moribund plants; however, a build-up of inoculum on cull seedling and weed piles can intensify infection in nurseries. In densely stocked beds the lowermost needles are often colonized and constitute a source of infection of the new foliage. Losses from grey mould may be greater in beds where frost or winter-killed seedlings are abundant, or where killing by other diseases has been extensive. A random sample of 150 seedlings killed by *Fusarium oxysporum* Schlecht showed that 47% were invaded by *Botrytis*.

Douglas-fir is more susceptible to the disease than spruce, hemlock, or balsam fir.

The sporadic occurrences of the disease makes the application of routine control practices difficult. Assessment of late winter inoculum levels, observation of seedlings which flush early, and the removal of small intact plots to a controlled environment are useful in forecasting the potential severity of the disease. When a severe disease potential combined with suitable weather conditions indicates an outbreak of grey mould, preventive sprays should be applied. Tests of various chemicals for their effectiveness against grey mould, using the small intact plot technique (Table 1), showed Ferham and Thiram to be highly effective, Zineb to be partially effective, and that Bordeaux mixture stimulated the disease. Although effectiveness of Captan cannot be evaluated from this test, additional testing showed that it did not give complete protection. Paradoxically, stunted seedlings were more resistant than thrifty ones. Relative succulence of foliage of the two types of seedlings may be a factor in their differential susceptibility.—W. J. Bloomberg, Forest Research Laboratory, Victoria, B.C.

TABLE 1

Infection of Douglas-fir seedlings by *Botrytis cinerea* in intact plots sprayed with various chemicals.

Spray	Seedling condition	Percentage infection
Ferbam	Thrifty	0
Thiram	"	0
Zineb	"	56
Control (water)	"	73
Captan	Stunted	0
Bordeaux	"	100
Control (water)	"	0

SILVICULTURE

Stand Conversion in the Maritime Provinces.—Much of the tolerant hardwood forest in the northern and northeastern part of its commercial range is decadent and difficult to rehabilitate. Field trials suggest that converting such stands to softwoods may be better land use. These trials consisted of planting and seeding of white spruce to evaluate the difficulties of such stand conversion and of maintaining the desired species. In northern New Brunswick 1-acre blocks of cut-over tolerant hardwood land were planted in three successive years after scarifying with a bulldozer. In a pole-sized tolerant hardwood stand in northern Nova Scotia twelve ⅛-acre plots were planted and seeded, six without site preparation and six after clear cutting and partial burning.

In 1962 the average growth on each of the New Brunswick plantations, including some trees severely suppressed by raspberry, was about 1 ft. This was the fourth, fifth, and sixth growing season since planting and the five tallest trees in each of the plantations averaged 6.0, 7.0, and 9.5 ft in height respectively. In 1963 a growth of 3 ft in 2 years was common.

In Nova Scotia, also in 1962 and 12 growing seasons since planting, the growth rate of the trees planted on the cut-over plots was 1.2 ft, the overall average height was 9.0 ft, and the four tallest trees averaged 15.8 ft. Broadcast and spot seeding on the cut-over plots gave poor results in spite of protection of the seeds against rodents by covers of hardware cloth. The growth rates in 1962 of these seedlings was 0.8 ft and total height averaged 3.5 ft. Seedling and planting on the uncut plots failed.

The results (Tables 1 and 2) indicate that:

1) Bulldozing and clear cutting can be effective in preparing tolerant hardwood sites for white spruce transplants.
2) Attempts to establish white spruce under dense hardwood cover were fruitless. Eleven years after white spruce was sown and planted on six uncut plots, only a few suppressed trees remained.
3) Planting is superior to seeding. The number of seedlings was small compared with the amount of seed used and survival and initial growth of seedlings were inferior to those of transplants; further mortality of seedlings is likely owing to competition from hardwoods.
4) Hardwood and most shrub regrowth after clear cutting and bulldozing did not inhibit the vigorous growth of white spruce transplants. In 1962 the height growth of transplants at both locations was keeping pace with the sometimes dense hardwood growth. Few softwoods, however, have outgrown the hardwoods.
5) Dense raspberry can be a serious threat to the survival of spruce transplants where snow and raspberry canes combine to flatten the spruce.—L. J. Post, Forest Research Laboratory, Fredericton, N.B.

TABLE 1.

Survival and Growth of Planted Spruce in Northern Nova Scotia

Treatment	1951		1954		1962	
	Number planted	Average height (ft)	Survival (%)	Average height (ft)	Survival (%)	Average height (ft)
Cut-over plots	300	0.5	81	1.8	73	9.0
Uncut plots	300	—	—	—	2	1.3

TABLE 2.

Survival and Growth of Planted Spruce in Northern New Brunswick

Establishment	Number planted	Average height at planting (ft)	1960		1962	
			Survival (%)	Average height (ft)	Survival (%)	Average height (ft)
1956	400	0.8	94	3.2	88	4.8
1957	400	1.2	94	2.8	91	4.7
1958	400	1.2	99	1.9	96	3.7