BI - MONTHLY RESEARCH NOTES

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BI-MONTHLY RESEARCH NOTES

A selection of notes on current research conducted by the Department of Forestry of Canada

NOTICE TO READERS

This is the maiden issue of Bi-Monthly Research Notes which replaces the Bi-Monthly Progress Report and extends the field of coverage to all facets of research carried out by the Department of Forestry.

Long-time readers may recollect that the scope of the Bi-Monthly Progress Report, which first appeared in January-February of 1945 as a publication of the Canada Department of Agriculture for presentation of accounts of forest insect problems and activities, was in January-February of 1951 (Volume 7, Number 1) enlarged to include material on forest disease problems. This coincided with the merging of forest entomology and forest pathology research units of the Department of Agriculture into the Forest Biology Division. Beginning with Volume 17, in January-February of 1961, the Report has been published by the newly created Department of Forestry, to which the Forest Biology Division had been transferred.

The change in coverage beginning with the present issue is an outgrowth of the extensive re-organization of the Department of Forestry in 1965, and the merging of its several research branches into the Forestry Branch, with the objective of greater co-ordination and integration of all programs. It was decided that one publication, similar to the Bi-Monthly Progress Report, should serve for departmental research notes in all fields. The title, Bi-Monthly Research Notes, establishes linkage with its predecessor and emphasizes the research content of notes appearing in this publication. Longer research papers will be published as hitherto in scientific, technical and trade journals.

The attention of readers is also drawn to the departmental publication Research News, containing popular and semi-technical articles but formerly restricted to the forest products field. The scope of this publication has been enlarged to include newsworthy items in all fields in which the Forestry Branch is engaged.

BOTANY

Root Sucker Origin on Bitternut Hickory.—According to Boisen and Newlin (U.S.D.A. Forest Serv. Bull. 80, 1910) the larger the stump of bitternut hickory (*Carya cordiformis* (Wang.) K. Koch), the greater is the distance from it that root suckers occur. They found the maximum distance was about 8 ft., with the average about 2 ft. Not specifically mentioned, however, is the feature that suckers may arise on two 'types' of roots. First, there are suckers on roots which originate on a lateral root located deeper in the soil, and may be found at various distances from the parent tree (Fig. 1). Secondly, there are those on surface laterals originating from the stem at the groundline (Fig. 2).

Sucker-producing roots of the first type may originate from another root at least 6 inches below the soil surface. They grow upwards at a steep angle, level off at or just below the surface and either dip down or continue horizontally beyond. Once the sucker has developed the proximal portion of the root grows less in diameter than the distal portion and may eventually die. No taproot, typical of hickory seedlings is formed at the base of the sucker.

FIG. 1. Suckers on root of subterranean origin at a distance from parent stem.

FIG. 2. Sucker on surface lateral root from stem base.

The examples shown here were among several observed in a mixed hardwood woodlot in northwestern Metropolitan Toronto. Suckers were found primarily on exposed portions of roots, although not all exposed roots possessed suckers. Some originated from roots 1 to 3 inches below the surface.

The soil in the woodlot is a deep silty clay loam with a 6-inch mull surface horizon. Exposure of roots near the surface of this soil is brought about by the physical movement of soil and rapid incorporation of leaf litter by earthworms, by rain and temperature actions, and by diameter growth of the roots themselves.—D. C. F. Fayle, Forest Research Laboratory, Maple, Ontario.

ENTOMOLOGY

Studies on the Fat Content of the Douglas-Fir Beetle.—Insects that occupy temporary or widely and unevenly spaced habitats must have a great capacity to disperse if they are to locate new breeding sites. Many scolytids are in this category, and any factor that reduces their capacity to disperse would, therefore, restrict the population. A recent investigation showed that fat accumulated within the insect provides much of the energy used by the Douglas-fir beetle during flight. Young adults that were flown on a flight mill for an average of 210 min had significantly less fat than similar unflown individuals. Therefore, the amount of stored fat in newly emerged beetles available as fuel for flight must be considered as a factor affecting population movements and fluctuations.

Atkins (unpublished data) showed that the behaviour of the Douglas-fir beetle is related to their fat content. Beetles with more than 20% of their dry weight composed of fat usually rejected suitable host material and displayed a strong inclination to fly (disperse). Those with less than 10% fat usually failed to fly continuously for more than a few minutes. Beetles with between 10% and 20% fat, although capable of sustained flight, usually responded readily to suitable host material.

After the relationship between fat content and behaviour was established, factors that influence the accumulation of fats were investigated. For example, young adults that developed slowly under cool conditions contained significantly more fat than those that developed rapidly in logs from the same tree under warm conditions. Ninety-six per cent of the progeny reared at the low temperature contained more than 20% fat, while only 22% of the progeny that developed under warm conditions had more than 20% fat, and 38% had less than 10% fat. The adult brood from logs containing two galleries per square foot of bark surface had a mean fat content of 30.3% compared to 21.3% for the adult brood from logs containing 10 to 12 galleries per square foot. Eighty-five per cent of the adults reared at the low level of competition contained more than 20% fat and only 1.4% had less than 10% fat. At the high level of competition, 51% of the young adults had more than 20% fat, whereas 22% had less than 10% fat.

Thus temperature and intraspecific competition affect a population both directly and indirectly; they cause direct mortality, and also influence the effectiveness of the survivors to reproduce by affecting their physiological processes. As the prediction of population trends and movements, and attempts to manipulate populations must be based on the behaviour and physiology of survivors, the indirect action of environmental factors must be considered.—M. D. Atkins, Forest Research Laboratory, Victoria, B.C.

The Effect of Wild Carrot on a Common Parasite of the European Pine Shoot Moth.—Since 1955, studies have been conducted on the European pine shoot moth, *Rhyacionia buoliana* (Schiff.) in southern Ontario. In the course of these studies, the role of parasites and predators in the population dynamics of the shoot moth have been investigated, and it has been found that *Orgilus obscurator* (Nees), is one of its most effective parasites. Recent studies have been orientated towards an understanding of the ecological factors influencing the effectiveness of this parasite.

Van Emden (Entomol. Mon. Mag. 98. 1963) found that the presence of flowers along the edges of fields greatly increased trap catches of parasites. Leius (Can. Entomol. 92. 1960) showed that *O. obscurator* fed on flowers of only the Umbelliferae in laboratory experiments. In 1964, examinations of all shoot moth study plots in southern Ontario were begun with a view to discovering relationships between the presence of flowering Umbelliferae and parasitism of the shoot moth by *O. obscurator*. These surveys established that wild carrot, *Daucus carota L.*, a common biennial species, was the only abundant species of Umbelliferae blooming in shoot moth plots during the flight period of *O. obscurator*.

O. obscurator emerges during the latter half of the emergence period of shoot moth adults and, for the most part, attacks the needle mining stages (Juillett, J. A., Can. Entomol. 92. 1960), although laboratory studies (Arthur, A. P. *et al.*, Can. Entomol. 96. 1964) indicate that it will attack larvae in the buds. Studies at Elmira, Ontario, have shown that the parasite is present when the first host larvae become available but that it ceases flying several weeks before the last larvae leave the needles and enter the buds. Ohnesorge (unpublished report, 1962) showed that parasitism by this species in the field was increased from 28 to 50% by releasing laboratory reared *O. obscurator* adults from 1 to 2 weeks after the natural population of this parasite ceased flying. It seems, therefore, that the effectiveness of *O. obscurator* could be increased if its flight and oviposition period could be extended.

In experiments at Elmira, ten *O. obscurator* females were introduced into each of two cages, one containing flowering wild carrot and one containing non-flowering plants. The longevity of parasites confined with the flowering wild carrot was 20.0 ± 5.3 days while that of parasites confined with non-flowering plants was only 4.2 ± 2.1 days. Although the numbers involved in the foregoing experiment are small, the results are striking and it seems likely that if wild carrot flowers were available and were utilized by adults of *O. obscurator* in the field, the latter's longevity (and oviposition period) would be increased significantly. This, in turn, should increase its effectiveness against the European pine shoot moth.

Surveys in 1964 and 1965 showed that although wild carrot was common in the general area, it was not present in permanent shoot moth sampling plots at Elmira, Waterloo County; Mansfield, Dufferin County; and Port Elgin, Bruce County. Presumably, it was not present in these plots in 1962 and 1963. During the period 1962-1965, parasitism by *O. obscurator*, as determined from fall samples, varied from about 25 to 50% in these areas. At a fourth plot, near Dorcas Bay, Bruce County, a very high population of the shoot moth began an abrupt decline in 1961 and reached such a low level in 1965 that sampling it for *O. obscurator* became impossible. *O. obscurator* was absent from this plot prior to 1960, but was released there in that year. Although the decline in the host population subsequent to the release was too rapid to be attributed entirely to *O. obscurator*, parasitism by this species rose from 20% in 1961 to 90% in 1964. In this plot, wild carrot was blooming abundantly during the flight period of *O. obscurator* in 1964 and 1965 and, therefore, presumably in earlier years. It is possible that wild carrot contributed to the success of *O. obscurator* at Dorcas Bay.

Since wild carrot in Ontario is a noxious weed under the Weed Control Act (Revised Statutes of Ontario, 1960, Chapter 427 *as amended by* Statutes of Ontario, 1965, Chapter 141), it cannot legally be encouraged, or indeed, allowed to flower. However, because wild carrot is a plant of open spaces, it will persist in a pine plantation only until closure occurs, at a time when damage by the shoot moth also becomes less severe. If future studies confirm the foregoing data, the status of wild carrot as a purely noxious weed may bear reviewing.—Paul D. Syme, Forest Research Laboratory, Sault Ste. Marie.

First Record of the Larch Casebearer in Manitoba.—The larch casebearer, *Coleophora laricella* (Hbn.), is considered to be a European species. It was first recorded in North America at Northampton, Massachusetts in 1886, and since then it has spread throughout most of eastern Canada and the neighbouring United States as far west as Minnesota on tamarack, *Larix laricina* (Du Roi) K. Koch, and to parts of Idaho, Montana, and Washington on western larch, *Larix occidentalis* Nutt. Since 1961, when it was found in western Ontario about 20 miles southeast of Lake of the Woods, (Ann. Rep. Forest Insect and Disease Survey, 1961. Can. Dept. Forestry, Ottawa), a particularly close watch for it has been maintained in the Manitoba-Saskatchewan Region.

In March 1965, several cases containing overwintering larvae of the casebearer (identified by F. E. Webb and H. R. Wong) were found on tamarack for the first time in Manitoba at three points within 30 miles of the extreme southeastern corner of the Province. The casebearers were detected as a result of ocular examination of the crowns of 10 or 15 trees selected at random in each stand; branches bearing cases, or residual needles that could possibly be cases, were returned to the laboratory for detailed examination. Surveys during the summer indicated that the insect was restricted to the extreme southeastern corner of Manitoba. Tamarack stands in this area have been under close surveillance since 1948 without any evidence of the casebearer and the present record suggests a recent extension of populations from adjacent areas of Ontario or Minnesota. Mass collections will be made in the future to determine if the introduced parasites, *Agathis pumila* (Ratz.) and *Epilampsis laricinellae* (Ratz.), have also become established in Manitoba.—K. R. Elliott and V. Hildahl.

FOREST MANAGEMENT

Stand Structure and Diameter Growth of Individual Trees in a Young Red Pine Stand.—The relationship between 5-year growth in diameter at breast height (5-yr.Dg.) and diameter at breast height measured outside bark (d.b.h.o.b.), age and the amount of competition to which the tree is subjected, was studied in a natural stand of red pine (*Pinus resinosa* Ait.) at Chalk River, Ontario, in which the trees were between 14 and 24 years in age. The competitive status of the trees ranged from open-grown to suppressed. There were 785 red pine trees per acre and 32 trees of other species. The average total height of the red pine trees was 24.2 ft, the average d.b.h.o.b. was 4.03 inches and the basal area per acre 88.61 sq ft; the other species had a basal area of 1.26 sq ft.

The d.b.h.i.b. at the beginning of the previous 5-year period was estimated from increment cores and converted to outside bark measurement using the regression:

$$\text{d.b.h.o.b.} = 0.1180 + 1.0486 \ \text{d.b.h.i.b.}$$

(No. of observations, $N = 413$; standard error of the estimate, $s_e = \pm 0.069$ in.) The 5-yr.Dg. of each tree was then estimated by subtracting the estimated d.b.h.o.b. 5 years ago from the current d.b.h.o.b.

Total age (A) of each tree was estimated by adding the number of branch whorls below breast height to the number of annual growth rings at breast height. (In coding the data, A was actually the total age less 5 years but, as this is a constant difference, the overall relationships are not affected).

Two measures of juvenile, or micro-, site index were estimated for each tree. The first of these (S_1) was the length of the first three internodes above breast height and the second (S_2) the number of branch whorls below breast height. Both these indices are not true site indices in that they are responses, not only to micro-site quality, but also to the inherited growth characters of the tree and early competition in the life of the stand. This latter factor does not appear to have been important in the present case so that S_1 and S_2 can be taken as estimates of the growth-potential of the tree before the onset of competition.

In order to construct a three-dimensional model of the stand. the relationship between total height (H), height to the base of the live crown (Hlc) and crown width (Cw) and d.b.h.o.b. was studied.

Eighteen competition indices were tested and the two indices which were found to be most useful in this study were C_{21}, for predicting H and Hlc, and C_{22}, for predicting 5-yr.Dg. and Cw. The methods of calculating these two indices are shown in Fig. 1. It can be seen that C_{21} is a measure of the amount of linear overlap of competition

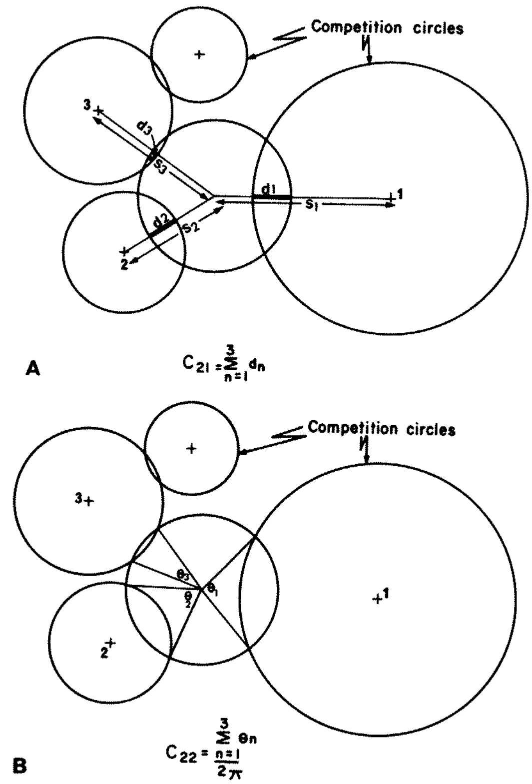

FIG. 1.A. Competition index C_{21}—a measure of the linear overlap of competition circles.

B. Competition index C_{22}—a measure of the proportion of the circumference of the competition circle occupied by the circles of competitors.

circles and C_{22} is the proportion of the circumference of the competition circle occupied by the circles of the tree's competitors. The other competition factors tested, and found to be of less importance in this study, did not measure the amount of overlap but were based on the size of the tree being studied, the number of competitors and the size of and distance to each competitor. The radius in feet of the competition circle of each tree was calculated by multiplying the d.b.h.o.b. in inches of the tree by 1.375. Two other conversion factors were tested. One involved the use of crown width, the other the multiplication of d.b.h.o.b. by 0.9722.

Competition was found to be most important in determining diameter growth. The competition index C_{22} accounted for 41.5% of the variation in 5-yr.Dg. Inclusion of the d.b.h.o.b. (D) at the beginning of the 5-year period accounted for another 25.5% of the variation. A further 5.5% was accounted for by A^2. The inclusion of further variables did not greatly improve the estimates of 5-yr.Dg. The regression equation was:

$$\text{5-yr.Dg.} = 1.597 - 0.3928\, C_{22} + 0.5273\, D - 0.009475\, A^2$$
$$(N = 121;\ s_e = \pm 25.1\%)$$

The total height (H) of the individual tree was found to be correlated with diameter, age, competition index (C_{21}) and juvenile site index (S_1). D, D^2 and A^2 accounted for 89.6% of the variation in H. C_{21} and S_1 accounted for another 1.7 and 1.0% respectively, these two contributions, although small, were significant at the 0.1% level of probability. The regression equation was:

$$H = -4.627 + 6.379\,D - 0.5132\,D^2 + 0.02924\,A^2 + 0.7032\,C_{21} + 1.143\,S_1$$
$$(N = 121;\ s_e = \pm 8.26\%)$$

The amount of competition was very important in determining the height to the base of the live crown (Hlc). Competition index C_{21} accounted for 65.0% of the variation in Hlc. Inclusion of A, S_1, D^2 and S_2 accounted for a further 14.2% of the variation. The regression equation was:

$$Hlc = -3.265 + 1.163\,C_{21} + 0.9420\,A + 1.163\,S_1 - 0.08643\,D^2 - 1.051\,S_2$$
$$(N = 121;\ s_e = \pm 18.6\%)$$

The crown width (Cw) of the tree was largely dependent on D which accounted for 81.8% of the variation in Cw. Inclusion of C_{22} accounted for a further 3.6% of the variation. The regression equation was:

$$Cw = 3.417 + 1.609\,D - 0.5952\,C_{22}$$
$$(N = 121;\ s_e = \pm 16.8\%)$$

The investigation is being extended to other red pine stands on the Petawawa Forest Experiment Station at Chalk River. These will cover a range of sites, ages and densities and will include plantations as well as natural stands, both thinned and unthinned. By developing relationships such as those given above, it will be possible to simulate the growth of stands in a computer and thus study the effects of spacing, thinning and mortality on the development of red pine stands.—R. M. Newnham, Forest Management Research and Services Institute, Ottawa.

FOREST PRODUCTS

Microbiological Deterioration of Piled Wood Chips Stored Outside.—There has been a trend in recent years toward the outside storage of wood chips to be used in the manufacture of pulp and paper products in eastern Canada. It is anticipated that chip storage in piles will continue to increase because of greater demand for paper products and because it is reported to be more economical to store pulpwood as chips than as roundwood.

A study was made on the deterioration of chip samples taken from various levels in a large, 90-ft high, balsam fir and spruce chip pile in New Brunswick. The majority of chips in these samples were found to be in good condition after storage periods of 3 to 8 months with respect to the small amount and light discoloration resulting from the blue-staining fungi. However, deterioration was greater in those chips which had been obtained from the bottom third of the pile after storage periods exceeding 7 months, while chips stored for just over 9 months in the lower central region of the pile were in very poor condition. This deterioration was characterized by a dark brown discoloration, an increase in brashness and greater acidity in the chips. The relationship of this discoloration and the basic specific gravity of the chips kept near the bottom of the pile is indicated in Fig. 1 for the different storage periods. The percentage of wood chips with the brown discoloration increased while the basic specific gravity decreased with longer storage. Over 80%

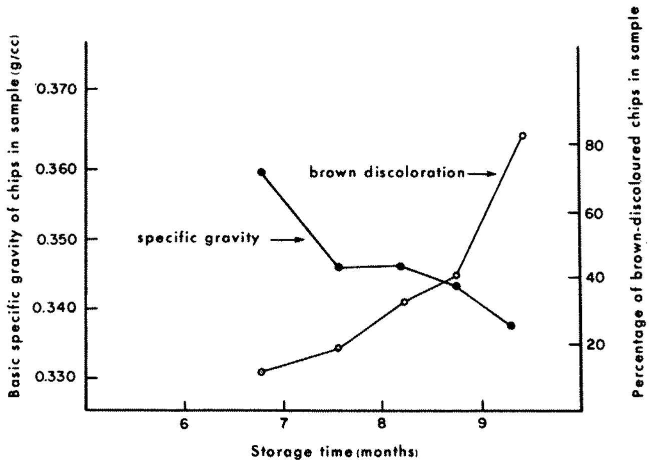

FIG. 1. The effect of increased storage time of balsam fir-spruce wood chips on the basic specific gravity and percentage of brown-discoloured chips situated near the bottom of a large pile at Atholville, New Brunswick.

TABLE 1

Micro-organisms isolated from balsam fir and spruce chips stored in an outside pile at Atholville, N.B.

Micro-organisms	Percentage of chips infected with each micro-organism(1)			
	Non-stored chips	Top of pile	Middle of pile	Bottom of pile
Bacteria	75	57	52	34
Chytrid		4	9	6
Moulds				
Aspergillus fumigatus Fres.		24	2	
Chrysosporium species			8	12
Paecilomyces variota Bainier		2	1	
Paecilomyces species		13	10	1
Penicillium species			9	5
Sporotrichum thermophile Apinis		4	1	
Trichoderma viride Pers.	36	15	32	45
Stain Fungi				
Ceratocystis species (*Graphium* state)	7	1		14
Cladosporium species				3
Phialophora americana (Nannf.) Hughes				3
Phialophora fastigiata (Lagerb. & Melin) Conant	6			4
Phialophora melinii (Nannf.) Conant		1	4	1
Phialophora species	1		8	6
Scytalidium lignicola Pesante			5	4
Unidentified species No. 3		4	11	12
Decay Fungi				
Corticium evolvens (Fr. ex Fr.) Fr.	1			1
Odontia species				7
Peniophora gigantea (Fr.) Massee			1	
Ptychogaster species		3	2	
Unidentified species No. 4		2		2
Unidentified species No. 5			7	
Unidentified species No. 7	2			

(1) Percentages are based on averages of chip samples from each of the three general areas. In many cases more than one micro-organism developed from each isolation.

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

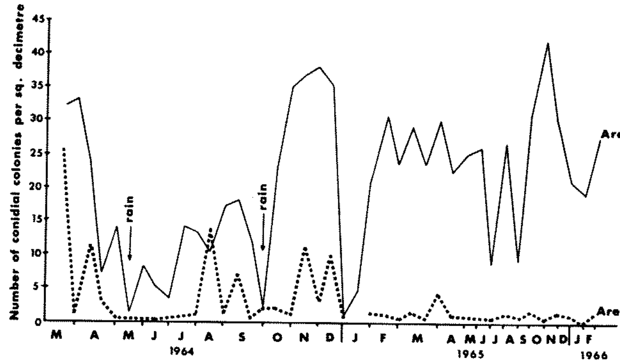

FIG. 1. Seasonal fluctuation in deposition of *Fomes annosus* basidiospores expressed by the number of conidial colonies developing on white pine wood discs. No sample was taken from Area II in mid-January, 1965, the area being inaccessible because of snow.

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.

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 ¼-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

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