Vigour indices for crawlers (number in parentheses) from samples collected from different standing trees on different dates were:

Collection date	Vigour index
May 31	0.12 (1088)*
June 6	0.58 (658)
" 13	0.60 (308)
" 21	0.86 (185)
" 28	0.42 (310)
July 4	0.76 (561)
" 11	0.83 (502)
" 18	0.89 (1154)
" 26	0.83 (607)

* felled 3 weeks prior to taking sample.

The vigour index for the standing tree population was low at the beginning of June but later reached a plateau greater than 0.80, except for a brief decline around the end of June. The changes in the indices may reflect differences in population quality through changes in the amount of nutritional reserve in the eggs. Studies to clarify these points are in progress.—D. K. Edwards, Forest Research Laboratory, Victoria, B.C.

FOREST PRODUCTS

Application of Gas Chromatography to Study the Photodegradation of Cellulosic Materials.—A literature survey reveals that the study of volatile products from photodegradation of cellulosic materials has received very little attention. Previous investigations using conventional gas analysis (Stillings, R. A. and R. J. Van Nostrand, J. Am. Chem. Soc. 66, 753, 1944; Sharvin, W. and A. Pakschwar, Z. Angew. Chem. 40, 1008, 1927) and mass spectometry (Flynn, J. H. and W. L. Morrow, J. Polymer Sci. 2A, 81, 1964) indicated the presence of H_2, CO, CO_2 and water vapour among the volatile products of photolysis of cellulosic materials. So far, no attempt has been made to study the photochemical degradation of cellulosic materials by gas chromatography, although this technique has been extensively used for pyrolytic studies. The present note describes the preliminary results of the examination of these volatile products by gas chromatography.

Whatman No. 1 filter paper and cotton cellulose were used for the photolysis experiments. Samples in quartz tubes, closed at both ends with rubber septums, were irradiated with unfiltered light from an ultraviolet lamp. At suitable time intervals, 10 ml of the volatile products were withdrawn from the tubes and analysed on an F & M gas chromatograph Model 700, equipped with hydrogen flame detector. Chromatograms were also obtained under identical experimental conditions for mixtures of vapours of known reference compounds.

Table 1

Relative retention times

Component	Retention time (Min)*	
	Mixture of known Reference Substance	Photolysis Products
Fixed gases	1.00	1.00
Acetaldehyde	2.48	2.47
Propionaldehyde	3.91	3.93
Acetone	4.47	4.46
Methanol	6.20	6.15

*Expressed relative to the first peak attributed to the fixed gases.

The primary method of component identification was by comparison of the retention times of unknown peaks of the volatile photolysis products with those for the reference compounds. The retention times, calculated relative to the first peak of fixed gases, for the various peaks in the chromatograms of the photolysis products as well as of the mixture of reference substances are given in Table 1. The components identified are: acetaldehyde, propionaldehyde, acetone and methanol. The identification was further achieved by introducing a small amount of vapour of the reference compound into the experimental volatile products of photolysis and observing the increase in the peak area corresponding to that particular compound in the chromatograms.

Further studies are in progress to examine the effect of wavelength of light on the photochemical decomposition of cellulosic materials in vacuum as well as under controlled conditions of temperature and relative humidity.—R. L. Desai, Forest Products Laboratory, Ottawa.

Biosynthesis of 1-hydroxyl-3-methyl anthraquinone.—During studies of the cause of black heartwood stain in yellow cedar (*Chamaecyparis nootkatensis* (D. Don) Spach) two fungi were isolated which produced abundant yellow crystals in agar media. Because one of these fungi (HS4) inhibited the growth of other fungi when grown together on the same agar plate, this yellow crystalline material was isolated and identified.

The yellow crystalline material was identified as 1-hydroxyl-3-methyl anthraquinone on the basis of its infra-red and nuclear magnetic resonance spectra.

The fungus HS4 was cultured on both liquid malt and liquid 0.5% malic acid/malt solutions of various concentrations to determine the optimum conditions for crystal production. Results from these experiments showed that a solution of 5% malt gave the best cultural condition, such cultures yielding abundant amounts of the anthraquinone.—Roger S. Smith and A. J. Cserjesi, Forest Products Laboratory, Vancouver.

PATHOLOGY

Time of Germination of Hemlock Dwarf Mistletoe Seeds.—Dwarf mistletoe seeds (*Arceuthobium* spp.) may germinate a few weeks after dispersal, e.g., *A. vaginatum* (Willd.) Presl. f. *cryptopodum* (Engelm.) Gill in southwestern United States (Gill. R.M.F.R.E.S. Sta. Paper 14. 1954; Hawksworth. For. Sci. 11.1965), or more commonly the following spring, e.g., *A. campylopodum* f. *campylopodum* (Engelm.) Gill in northwestern United States (Kimmey and Mielke. U.S.D.A.

Table 1

Percentage germination of hemlock dwarf mistletoe seed at various intervals after dispersal, southern Vancouver Island

Date	Number of seeds examined	Seeds germinated %
	1963 crop[1]	
Feb. 26, 1964	65	49
Mar. 17, 1964	126	68
Apr. 22, 1964	120	94
May 14, 1964	152	85
May 26, 1964	150	98
	1964 crop[1]	
Feb. 9, 1965	651	9
Mar. 5, 1965	261	25
Apr. 21, 1965	361	88
May 20, 1965	422	97
	1965 crop[1]	
Mar. 9, 1966	248	81

[1]Dispersal period mainly September–November.

For. Pest Leaf. 40. 1959), *A. campylopodum* f. *abietinum* (Engelm.) Gill in California (Scharpf. U.S.D.A. For. Pest Leaf. 89. 1964), *A. douglasii* Engelm. in western United States (Graham. U.S.D.A. For. Pest Leaf. 54. 1961), and *A. americanum* Nutt. ex Engelm. in Colorado (Hawksworth. For. Sci. 11. 1965). Few reports state the month germination begins in the spring, but *A. campylopodum* seeds from plants parasitizing digger pine (*Pinus sabiniana* Dougl.) and Coulter pine (*P. coulteri* D. Don.) in California may germinate as early as January (Kuijt. Leaf. West. Botany IX. 1961).

To determine the time of germination of hemlock dwarf mistletoe seed (*A. campylopodum* f. *tsugensis* (Rosend.) Gill), samples from western hemlock trees (*Tsuga heterophylla* (Raf.) Sarg.) were obtained near Cowichan Lake, Vancouver Island, during late winter and spring of 1964-1966. The seeds, disseminated mainly from September to November each year, were collected while adhering to twigs and needles. After wetting, they were removed and examined with a dissecting microscope. Seed germination was considered to have occurred when the radicle punctured the seed coat.

Germination of seeds began in early February and by late May less than 5% had not germinated (Table 1). A small number may have germinated earlier but data are not available. In a few instances, radicles had burrowed into the epidermal and outer corky layers of the host in February. The formation of holdfasts at leaf axils, probably the usual mode of penetration, was rarely observed until late April.

Further development of hemlock dwarf mistletoe seeds and infections is being followed.—R. B. Smith, Forest Research Laboratory, Victoria, B.C.

Germination of *Pythium* Sporangia in Nursery Soils in Ontario.—Studies to be published elsewhere showed that in the Midhurst nursery (Lake Simcoe District) seedbeds contained about 30 viable *Pythium* "propagules" per cubic centimetre of surface soil. At the Orono nursery (Lindsay District, Ontario) the number of *Pythium* propagules was only about one per cubic centimetre. Despite the heavy infestation in Midhurst soils, seedling mortality due to damping-off varied from none to low in most of the areas sampled.

A study was undertaken to explore the factors which contribute to the reduced capability of *Pythium* propagules to cause disease in soil. These were studied by comparing the behaviour of the propagules in these two soils and in the same soils after autoclaving or amending with nutrients. Several *Pythium* isolates from Midhurst were tested for potential pathogenicity against seedlings of red pine (*Pinus resinosa* Ait.) in potted sterilized soil. All isolates were pathogenic under greenhouse conditions. The most virulent isolates, provisionally identified as *P. ultimum* Trow, had a tendency to produce abundant large, mostly spherical, sometimes ellipsoidal, sporangia but few or no oogonia.

Sporangia 8 to 12 days old were excised from cornmeal agar cultures of such an isolate and placed in distilled water. A suspension was prepared by brief maceration in a Waring blender, and free water was removed with a Millipore filter (2μ). The sporangia were then resuspended in a small amount of distilled water. There were several hundred sporangia per drop of the suspension. Three drops of fresh suspension were mixed with 0.5 g of soil in glass vessels. After 16 hours incubation at 15° C, smears of the soil were placed on a slide and stained with acid fuchsin (0.1% in 80% lactic acid). Germination of about 50 sporangia was recorded for each of ten treatments of soil from Midhurst and from Orono. The treatments consisted of autoclaving and amending the soils with glucose, asparagin, or proline (100 ppm); in the control treatment the soils were neither autoclaved nor amended. These five soil treatments were repeated at two moisture levels (12.8 and 20.4% of dry weight). The experiment was replicated three times. For a period of 4 months prior to the experiment, the soils were exposed to repeated watering and aeration (but not drying) at temperatures ranging from 15° to 20°C in open polyethylene sacks. This was done to stimulate intensive but natural microbial activity that might result in the accumulation of inhibitory substances.

Only negligible differences were noted between the two soils and the two moisture levels. Therefore, the following results are presented as averages for these four series of data. Germination percentages varied as follows: natural condition 6, autoclaved 92, glucose 92, asparagin 93, proline 93. Statistical analysis showed that germination in untreated soil was significantly lower than in any other treatment (at the 0.1% level). Because the sporangia usually germinated well in distilled water, the marked inhibition in soil was not due to a lack of available nutrients, but rather to the presence of inhibitory substances. The results thus suggest that biologically produced inhibitors should be considered as one factor which may limit pathogenesis in soils containing pathogenic propagules of *Pythium*. The exact role of this factor, however, may be difficult to evaluate as various nutrients, such as sugars and amino acids, probably exuding from roots, seem to overcome the inhibition.—O. Vaartaja and V. P. Agnihotri, Forest Research Laboratory, Maple, Ontario.

SILVICULTURE

Potential Genetic Improvement in White Spruce in Ontario.—An analysis of the genetic variation in some of the white spruce populations of Ontario has been made to estimate the potential rate of improvement in growth rate by selection and to indicate the most efficient techniques for achieving genetic gain. Estimates of additive genetic variance and phenotypic variance were used in heritability calculations to test the effectiveness of selection. Heritability was also calculated by regression of progeny on parents.

Nine pairs of dominant trees were selected in a relatively uniform area in the triangle: Carnarvon-Algonquin Park-Sundridge. Each pair consisted of one tree with a slender crown (plus tree) and one with a broad crown in each of nine stands. Their progenies by open pollination were planted at the Petawawa Forest Experiment Station in replicated trials. Data on height at 11 years of age, crown form and the percentage of trees with more than one leader were collected and analysed.

Significant differences, at the 5% level of probability, occurred in height and leader number both among progenies from different stands and among progenies from individual trees with the same stands. Within stands, the slender crowned plus-tree types produced progenies which were 4% taller than progenies from broad-crowned trees. These results suggest that propagation of slender plus-trees from superior, tested stands could be used to provide faster growing white spruce in this area of Ontario.

Narrow-sense heritabilities (fractions of the observed variation transmissible to the next generation) were: number of leaders, 85%; height, 75%; branch length relative to leader length, 57%; and branch length, 0%.

In a second experiment, progenies from 26 open-pollinated plus-trees selected at random at the Petawawa Forest Experiment Station were grown in a replicated experiment. Heritabilities for height and leader number at 8 years of age were 87% and 68% respectively. These high heritabilities support the use of progeny testing as an effective technique for yield improvement.

Heritability can be used to predict the genetic gain. For example, if one tree in twenty was selected from the population studied in the first experiment, the expected genetic gain would be 4.5% for plus-tree selection and 7.2% for progeny tests. These estimates are probably conservative owing to the small samples extracted from the population.—M. J. Holst and A. H. Teich, Petawawa Forest Experiment Station, Chalk River, Ontario.