observed throughout the main outbreak areas in Manitoba. In 1964, it appeared in large enough numbers to reduce beetle populations to levels that restricted skeletonizing to scattered patches. This reduction is best illustrated by the results of observations and studies carried out in 1964 in an aspen stand near Winnipeg that had suffered severe defoliation and skeletonizing during the previous 2 years. The adults of the aspen leaf beetle started to appear early in June and were numerous enough by the end of the month to cause light defoliation in many parts of the stand. Mating commenced during the last week of June and the first egg masses were observed on July 5. On July 12 when 300 egg masses were collected; 51.7% of the egg masses contained syrphid eggs or newly hatched larvae, and an additional 13% showed evidence of predation. The beetle egg masses averaged 37.8 eggs (range 11 to 52), and contained an average of 2.1 predators (range 1 to 6). On July 22 when oviposition by the beetle was almost complete, a count of the remnants of 1,000 egg masses revealed that 963 had been partially or wholly destroyed. By the end of August when feeding activity of both insects had ceased, only very small patches of light skeletonizing were evident. Similar reductions were observed throughout both provinces wherever predator activity was noted.

This syrphid was not recorded in northwestern Ontario by Smereka (Can. Entomologist 97. 1965) who carried out a study of the life history and habits of the aspen leaf beetle before populations had increased to outbreak numbers. He noted that the main natural control factors were the mortality of overwintering adults, predation of eggs and larvae by ants, spiders, wasps and pentotomid nymphs, and parasitism of larvae by two dipterous species. Although similar factors were observed in Manitoba and Saskatchewan, they were not as effective in reducing aspen leaf beetle populations as the syrphid predator. —Ken. R. Elliott and Horne R. Wong, Forest Research Laboratory, Winnipeg, Manitoba.

Observations on the Crawlers of the Balsam Woolly Aphid, *Adelges piceae* (Ratz.).—Physiological and behavioural studies are being conducted on the crawlers (neosytentes) of the balsam woolly aphid, which is threatening large volumes of *Abies* spp. in southwestern British Columbia. Aspects relating to dispersal are being emphasized. Observations on 1966 spring and summer populations of crawlers are reported here.

The light reactions of crawlers were observed≤24 hours from hatching by releasing them on vertical or horizontal sheets of white paper with a light source. On vertical surfaces, the light source was a 300-watt tungsten bulb located at the top of the paper; for horizontal surfaces, the source was either a window or a bulb behind a water filter to eliminate heat radiation. The paths of the crawlers, released at light intensities from 20 ft-c to 800 ft-c and in the dark, were traced with a pen and 5-min intervals were marked for estimates of velocities.

The most obvious reaction to light was photokinesis (Fraenkel and Gunn, "The Orientation of Animals", Dover, 1961), a light-stimulated increase in walking velocity. The threshold for photic stimulation was below 20 ft-c. The crawlers generally avoided going directly toward the light source. The average rate of movement of nine crawlers was 8.8 mm/min in the light, and 1.7 mm/min in the dark, on either horizontal or vertical surfaces. Movements in the dark were confined to an area not more than about 50 cm^2, as a result of unoriented activity. Balch (Canada Dept. of Agric. Pub. No. 867, 1952) reported a negative geotaxis and positive photoaxis in crawlers collected in New Brunswick. The difference in our observations may be due to physiological differences between eastern and western forms, or the possibility that the test samples of crawlers were taken at different times within generations.

Although wind is considered a major factor in the dispersal of the crawlers, the mechanisms by which they are launched into the atmosphere are mainly speculative. Experiments were conducted to determine whether they drop from bark in still air, and if dropping is related to the time in the diel. Pieces of infested bark were fixed above 24-hour turntables bearing a sticky "Tanglefoot" surface marked in hourly segments. The number of crawlers trapped in each time segment was counted at 2 to 3 day intervals.

In a regime with diurnally cycling temperatures (25° C or more during the day, and 18° C at night; lighted from 0500 hours to 2100 hours) crawlers dropped in greatest numbers during the time of most rapid warming. i.e., 0700 to 1000 hours. Some dropping occurred at other times in the diel, with a minor peak in late afternoon; dropping was minimal at night. However, at a constant 25° C the build-up of the diurnal dropping period was more protracted. Other nymphal stages and adults were also found alive, beneath portions of bark attached to trunk sections, in high humidities (80%-90% RH) and as low as 30% RH, even after the wood had been waxed to prevent drying. It is not yet known whether the later developmental stages can re-establish on bark after dropping.

Dropping in the field is probably stimulated by the temperature increases following sunrise, particularly on clear days. Such a temperature change also results in maximum convection currents, which would facilitate dispersal of the flightless crawlers. Probably most dispersal by air currents occurs between sunrise and midday on clear days.

To assess the effect on survival of different evaporation rates at different temperatures groups of 10 vigorous crawlers were placed (24 hours after hatching) in small silk containers. The containers were placed in humidity jars, over glycerol solutions, at 27° and 17° C. The air in the humidity jars was circulated slowly over the solutions. Evaporation rates were determined with the capillary evaporimeter described by Ramsay, *et al.*(J. Exp. Biol. 15: 255-265, 1938); our instrument had an evaporating surface area of 31.16 mm^2, and a capillary tension of 3.74 mgm. The solutions were adjusted to give the same range of evaporation rates at the different temperatures. The mean number of crawlers per group which survived after 48 hours in the jars was as follows:

Temperature	Evaporation rate (mm^3/mm^2 per min)	Mean no. survivors per group of 10	N groups
27° C	3.6×10^{-3}	0.41	22
	5.7×10^{-3}	0.21	14
	8.9×10^{-3}	0.25	24
17° C	3.6×10^{-3}	3.64	14
	5.4×10^{-3}	6.60	10
	8.5×10^{-3}	5.43	14

Survival was greater after 2 days at 17° C than at 27° C. However, a relationship was not evident between survival and evaporation rate.

Observations of crawlers kept at 25° C and 60% RH for 24 hours after hatching showed, in samples collected at different times in the season, that there were variations in the ratio of the number of vigorous to the number of moribund crawlers. Crawlers were classified by picking them up with a camel-hair brush and putting them on a piece of paper inside a circle 1 cm in diameter; vigorous insects soon left the circle, while moribund crawlers made only feeble movements inside the circle. A "vigour index" for crawlers was calculated with the formula:

$$\text{V.I.} = \frac{V}{V + M}$$

where V= the number of vigorous crawlers in a sample, and M= the number of moribund crawlers.

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.