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QUEBEC

Results of Three Years of Spraying Operations Against the Spruce Budworm in the Lower St. Lawrence Region.—In 1962, aerial application of DDT against the spruce budworm in the Rimouski River and Matapedia Watersheds in Quebec was practised for the third consecutive year, in a continued effort to control the recrudescent outbreak in this area.

The egg survey conducted in 1961 showed that populations of the insect, although much reduced, could be expected to maintain epidemic conditions over an area of approximately 100 square miles in 1962. Since it was deemed necessary to treat all infested areas to achieve control, and since discrepancies frequently occur between distribution of eggs in the summer and distribution of larvae the following spring, the area to be sprayed was based on a population survey conducted during the early larval stage in the spring of 1962. A total of 70 locations, in and immediately outside the outbreak area, were sampled in mid-June 1962. All insects were counted on one 18-inch branch tip from each of five trees for each location. The pre-spray survey showed that populations were generally very low, and were concentrated in and around the area where eggs had been found the previous summer. An area of 108 square miles was delimited for treatment. Insects were found in all but two of the 27 locations sampled within the area proposed for treatment, and the average population within this area was 2.4 larvae per 18-inch branch tip. Of the 43 locations sampled outside the spray area, two-thirds gave a negative larval count and the average population was only 0.1 larva per 18-inch branch tip. The highest number of larvae per 18-inch branch tip for any one location within, and outside the area to be treated was 10, and 1 respectively. These results indicate that the area proposed for spraying encompassed nearly all infested stands. Outside this area, only extremely low populations occurred in isolated pockets.

In 1962, the same formulation and operational methods were used as in past years (Côté, A., Report 38th Annual Meeting Corporation of Forest Engineers for Province of Quebec: 47-55, 1958). Application of the insecticide began on June 23 when the larvae were mostly fully grown. Weather conditions favoured the operations and it was possible to spray each day until completion of operations on June 29. During this period, 34,664 gallons of insecticide were applied.

Following the application of the insecticide, population counts were made in both sprayed and unsprayed areas. In unsprayed areas, an attempt was made to collect sixth-instar larvae and pupae for parasite studies. In early July it was possible to obtain 200 larvae in a period of 8 man-hours, from a number of places where the insects were present at the time of the pre-spray survey. Toward the end of July the same places were visited for pupae, but not one pupa could be found after 10 man-hours of diligent searching. In the sprayed area, all 27 locations sampled at the time of the pre-spray survey were re-sampled at the end of July at the time of the pupal stage. Again not one spruce budworm was found.

An egg survey was conducted in late August throughout the areas formerly under attack and the surrounding areas. A total of 64 locations were sampled according to the sequential sampling system adopted in former years. All locations sampled gave a negative egg count. These results confirmed the complete collapse of the spruce budworm outbreak in the Lower St. Lawrence region.

The spraying operations seem to have been the principal cause of the disappearance of this outbreak. Control of the infestation was not solely due to the 1962 operations, but rather to the combined action of the three consecutive years of spraying and of natural control factors. In 1960 and 1961, although the insect remained in an epidemic state in parts of the area, the operations succeeded in greatly reducing populations in the treated sectors (Table I). Since the sprayed areas represented a large portion of the infested area, the outbreak was kept within restricted boundaries and populations within these boundaries were kept relatively low.

The purpose of the whole program was to keep populations sufficiently depressed so as to permit the ascendancy of natural control factors. Without the help of such factors, suppression of the infestation could certainly not be achieved, since the insecticide alone could never bring about a 100 per cent kill. Results in Table I show how populations in both sprayed and unsprayed areas diminished from year to year, and how natural control increased. The reduction in population between the first (early larval stage) and the second (pupal stage) survey in unsprayed areas was due solely to natural control factors, while in sprayed areas the reduction was the result of the combined effects of natural control and the sprays. Because the second survey was not conducted for all localities in unsprayed areas in 1962, the reduction in population between the two surveys cannot be calculated. However, observations made at the time of the pupal stage in unsprayed areas and reported above indicate that this reduction was certainly very close to 100 per cent, and results of the egg survey confirm this.

Parasites and predators appear to have been the two most important factors that brought about the final collapse of the outbreak. Larval mortality through parasitism amounted to 26 per cent in 1960, 45 per cent in 1961, and 55 per cent in 1962. Aggregate parasitism for all stages of the insect amounted to 30 and 58 per cent for 1960 and 1961 respectively, but could not be calculated for 1962 because no pupae were found. The action of predators, mostly birds, is almost impossible to measure directly, but the indications are that they were extremely important, especially during the last weeks of the outbreak, as was the case when the widespread outbreak in the Lower St. Lawrence-Gaspé region collapsed in 1958 (Blais, J. R., and R. Martineau, For. Chron. 36: 209-224, 1960). In 1962, when sixth-instar larvae were collected in early July, 50 per cent of the feeding sites of late-instar larvae were vacated; three weeks later, pupae should normally have been present in the webbing left by the larvae but none were found. The disappearance of some individuals could be attributed to the action of parasites, but when insects are parasitized some evidence usually remains. It is probable that most of the pupae and late-instar larvae that formed the low residual population were destroyed by birds.

Studies carried out in a number of spruce budworm outbreaks in eastern Canada indicated that parasites or predators are unable to initiate a decline in population. The initial decline can be caused by lack of food or unfavourable weather; when this happens, parasites and predators can bring about the final collapse. In the present infestation, it was hoped that the initial decline could be brought about through chemical treatment, and that final collapse would result through the action of natural control factors and this apparently occurred.

This is the first time that chemical control can be credited with having almost certainly been the primary cause of the suppression of a spruce budworm outbreak. The relatively small size of the outbreak area undoubtedly contributed to this success but it is conjectural whether the same results could be obtained in very extensive infestations. It may eventually be possible to restrict, or perhaps even prevent, widespread outbreaks by intensively treating incipient infestations.—J. R. Blais.

TABLE I

Average population per 18-inch branch tip for sprayed and unsprayed localities during the early larval stage (pre-spray) and the pupal stage (post-spray) and per cent reduction in population between the two surveys for 1960, 1961, and 1962

Year	Treatment	No. of locations	Av. no. of insects per 18-inch branch: Early larval stage (pre-spray)	Pupal stage (post-spray)	Per cent reduction in population
1960	Unsprayed	40	8.9	3.3	62.9
	Sprayed	27	18.2	0.6	96.7
1961	Unsprayed	30	1.4	0.13	90.7
	Sprayed	15	12.3	0.07	99.4
1962	Unsprayed	43	0.1	—	—
	Sprayed	27	2.4	0	100

A Record of Fomes annosus (Fr.) Cke. in Quebec.— Owing to the increasing importance of the *Fomes* root rot, particularly in plantations in Europe and in the United States, a published record of this tree pathogen in Quebec should be brought to the attention of forest pathologists. During the mycological foray of the Mycological Society of America, which took place at Duchesnay, Que., from August 23 to 24, 1938, fruit bodies of *F. annosus* were collected on August 24, 1938, by L. O. Overholts and the author, on a large dead stump of white pine (*Pinus strobus* L.), located in a natural mixed stand (FBQ. 1,323). On the same stump another collection was made on July 9, 1940 (FBQ. 10, 114). Part of the first collection is kept in the Overholts herbarium at State College, Pennsylvania. This finding is recorded in the list of fungi collected at the Mycological Foray (Mycologia 31: 728-736, 1939). On the basis of the same collection, Quebec was also mentioned in the distribution of *F. annosus* in Overholts: The Polyporaceae of the United States, Alaska, and Canada, 1953, p. 41.—René Pomerleau.

ONTARIO

The Cottonwood Leaf Miner, Leucoptera albella Cham.—Adult moths of the lyonetiid, *Leucoptera albella* Cham., were obtained for the first time by the Ontario Forest Insect Survey during 1962. Identification was made by Dr. T. N. Freeman, Entomology Research Institute, Ottawa. No previous mention of this species occurs in Canadian literature, although Freeman indicates that it also occurs in British Columbia. The most recent published report on *albella*, is P. A. Glick's account of the life stages in the 14th Ann. Rept. Ariz. Comm. Agric. and Hort.: 68-73, 1923. In the same year W. T. M. Forbes, in his Lepidoptera of New York and Neighbouring States, Cornell Univ., Agric. Exp. Stn., Memoir 68, shows the known distribution as Kentucky, Colorado, and points west.

In Ontario, *L. albella* was collected mainly in the southeast part of the Province but a single collection was also received from near Arnprior. What appears to be the same species, although no adults were obtained, was recorded near Cedar Lake, north of Vermilion Bay, Ontario. Recorded host trees in the Province were *Populus balsamifera* L., *P. canadensis* Moench. *P. deltoides* Bartr., *P. grandidentata* Michx., *P. nigra* L., and *P. tremuloides* Michx.

The larvae are gregarious in blotch mines on the upper surface of the leaf. The mine is grey-green in colour near current feeding sites, turning dark brown with age. The hatched eggs persist on the surface of the mine in compact clusters of 3 to 10, silvery whitish in colour, ovate, with sculptured upper surfaces. The larvae are pale cream to yellow in colour, with prolegs on abdominal segments 3 to 6 and 10. Crotchets are arranged in a circle, uniserial except in the caudal portion of the circle where they are biserial. Larvae vacate the mine to pupate on the leaf in a spindle-shaped silken cocoon under a characteristic bridge-like, white, silken mat, which spans a curl in the leaf surface. Two generations per year are indicated in southern Ontario, where larvae collected in late July yielded adults in early August. Larvae were again present in late summer and as late as October 1.

The mines resemble those made by coleopterous miners in the genus *Zeugophora*, although those of the latter are darker and more opaque. The larvae of *L. albella*, however, can be separated from all other species of leaf miners on *Populus* in Ontario by the presence of four pairs of well developed abdominal prolegs and the arrangement of the proleg crotchets.—O. H. Lindquist.

The Status of the Spruce Budworm in the Black Sturgeon Lake Region of Ontario.—A major outbreak of the spruce budworm, *Choristoneura fumiferana* (Clem.), was detected west of Lake Nipigon about 1942. This outbreak, often referred to as the Nipigon outbreak, had spread into the Black Sturgeon Lake vicinity by 1943, and in 1944 the Sault Ste. Marie Forest Insect Laboratory initiated ecological studies in the area. The studies were continued until 1958 by which time spruce budworm populations had been reduced to endemic levels and most of the merchantable susceptible trees had been destroyed. In 1961, studies of the spruce budworm were resumed to assess budworm populations in regenerating stands and relict trees, and to ascertain the effectiveness of various mortality factors.

Samples of spruce and fir foliage were collected in two stands during June, 1961, and in five stands during June, 1962. Generally, the point-centred quarter method (Curtis, Ecology 37: 451-460) was employed for sampling. In addition to furnishing data on population levels, this method also provides a rough description of the stand at the time of sampling. This description covers approximate tree densities which, with regression data on d.b.h., tree height, and foliage area per tree (Morris, Can. Jour. Zool. 33: 225-294), may be used to estimate the total area of foliage per acre. The pertinent data from the 1961 and 1962 samples are incorporated in Table I.

Obviously, the spruce budworm population is extremely low but somewhat limited rearing data indicate that parasitism is relatively high. To date, the presence of *Glypta fumiferanae* (Vier.) and *Apanteles fumiferanae* Vier., the major parasites during the outbreak period (McGugan and Blais, Can. Ent. 91: 758-783), has not been detected in endemic populations. Parasites considered to be of minor importance during the outbreak, *Horogenes cacoeciae* (Vier.), *H. conodor* (Vier.), *Exochus nigripalpis tectulum* Tow. & Tow. and *Synetaeris tenuifemur* Wly., have been reared in the current studies. Several of these parasites have also been reared from other members of the spruce-fir defoliator complex, indicating that these hosts may serve as reservoirs for spruce budworm parasites.

Noteworthy among the samples were the large numbers of insect-damaged buds caused by various spruce-fir defoliators (Table I). These defoliators include *Zeiraphera* spp., *Eucordylea* spp., *Griselda radicana* Wlshm., the black-headed budworm, *Acleris variana* (Fern.), and miscellaneous sawflies. The black-headed budworm is known to cause considerable damage in localized areas, and is under close observation for this reason. It also harbours a large number of parasites in common with the spruce budworm and may serve as a major reservoir of these parasites during periods of budworm endemism. The interchange of parasites between the two species will come under more intense consideration in 1963.

If one considers the stands in their approximate physiological age sequence (Table I), one notes a tendency for higher insect populations in the older stands. Stand B should be noted particularly since it is 35 to 40 years of age and harbours the most consistent detectable population of budworms. This tends to corroborate the current concept of budworm hazard, which places stand maturity as the major factor responsible for susceptibility to spruce budworm attack. The data also indicate the budworms' preference for white spruce during periods of endemism. Samples from relict trees, which survived the recent outbreak in the Black Sturgeon Lake area, also demonstrate the apparent preference for white spruce. In fact, further research may point to these survivors as major reservoirs for the spruce budworm during endemic periods.

Although data are somewhat limited, they indicate that current levels of the spruce budworm are not of immediate economic importance. However, the young stands have a volume of foliage that could adequately support population levels higher than those noted in 1961 and 1962. Only with continued observations through endemic periods can we establish the factors responsible for the paucity of spruce budworm in these young forests, and on this knowledge introduce some simple manipulation that may delay the next outbreak.

Grateful acknowledgment is made to the members of the Entomology Research Institute, Canada Department of Agriculture, Ottawa, for identifications of the insects of the spruce-fir insect complex and to Mr. O. H. Lindquist, Forest Insect Laboratory, Sault Ste. Marie, and Dr. J. M. McLeod, Forest Entomology and Pathology Laboratory, Sillery, P.Q., for useful suggestions for identifying the larval material.—R. E. Fye.

PRAIRIE PROVINCES

Chlorosis of White Spruce Seedlings in a Saskatchewan Nursery.—Although the seed beds and transplant plots have been fertilized according to the recommended schedule (Bi-Monthly Progress Report Vol. 10, No. 2:2 and No. 5:2) the chlorosis of white spruce transplant seedlings (3-1) appeared again in 1961. One application of $(NH_4)_2SO_4$, (4 oz/60 sq. ft. in 5 gal. of water) partly corrected the chlorosis, and seedlings produced good growth and overwintered without damage.

Ammonium sulphate is an acidic fertilizer, and by lowering soil pH the solubility of iron and manganese oxides could be affected.

To investigate this possibility the affected seedlings were treated in 1962 with acidic and basic nitrogenous fertilizers, namely $(NH_4)_2SO_4$ and urea. Besides these fertilizers, iron and manganese chelates (Sequesterene 330 DTPA, 10% iron metallic and Na_2Mn EDTA, 12% manganese metallic, Geigy Agricultural Chemicals, Yonkers, N.Y.) alone and in combination with the above fertilizers were also used. All chemicals were applied in aqueous solution in four replications.

At the end of the 1962 season the results indicated that application of 364 lb./acre of $(NH_4)_2SO_4$ or 164 lb./acre of urea corrected the chlorosis of white spruce seedlings. Lower

TABLE I

Foliage estimates and insect populations in white spruce and balsam fir. Black Sturgeon Lake, Ontario, 1961 and 1962.

	Foliage per acre in square feet		Insect population per 10 sq. ft. of foliage				Insect damaged buds per 10 sq. ft. foliage	
			Spruce budworm		Other defoliators			
	wS	bF	wS	bF	wS	bF	bF	wS
Stand A**								
1961	9,592	125,538	.10	.01	2.4	.2	3.0	.5
1962	6,560*	88,062*	0	0	1.4	.7	3.5	2.4
Stand B								
1961	—	—	.10	.02	7.6	1.0	15.6	2.8
1962	—	—	0	.03	4.5	.9	10.7	1.6
Stand C								
1962	17,374	15,744	0	0	6.7	.6	10.7	1.2
Stand N								
1962	4,420	89,640	0	0	0	.7	5.0	1.2
Stand P								
1962	11,840	61,506	.33	0	3.0	.8	4.7	1.7
Relicts								
1961	—	—	.37	0	29.1	.1	—	—
1962	—	—	.10	.10	15.3	1.1	48.9	3.0

*Discrepancies in successive foliage estimates due to broad variance inherent in the sample method.
**Stand A, N, and P are regeneration with physiological age 15 to 25 years
Stand B is regeneration with physiological age 35 to 40 years
Stand C is regeneration with physiological age 5 to 10 years

rates of application were without effect. The application of iron (48 lb./acre) and manganese (40 lb./acre) chelates did not affect the chlorosis. They also did not improve the growth of seedlings when applied in combination with the nitrogenous fertilizers.

The results of this experiment indicate that the white spruce seedlings were suffering from severe deficiency of nitrogen.

Application of nitrogeneous fertilizers not only corrected the chlorosis but also considerably improved the growth of the seedlings. The treated seedlings on the average produced 15 cm. (12-18 cm.) of growth, whereas controls produced only 5 cm. (3-8 cm.).—M. I. Timonin.

White Birch Mortality at Candle Lake, Saskatchewan.—Many white birch (*Betula papyrifera* Marsh.) between 10 and 25 years old and 2 to 6 inches D.B.H. died during the summer and early autumn of 1962 near Candle Lake, Saskatchewan. Many more were in a weakened condition, having dead parts in the crown, or only a few living branches, usually near the base of the tree. On the dead twigs, the leaves and buds had developed normally, and the dead leaves were still attached in late August. Excessive numbers of cones were a conspicuous symptom. The bark of the main stem was alive only in the vicinity of the remaining living basal branches and below. On affected living trees the fine feeder roots were dead, but the roots ⅛ inch in diameter and larger were usually healthy. Decay of undetermined cause had developed in roots ½ to ¾ inch in diameter in one affected living tree, and several of the dead trees examined had similar root rot. Varying proportions of the stem heartwood and sapwood were stained yellowish-brown in affected trees, and in some instances the stained wood was distinctly brash. Usually the stain appeared to be advancing downward from the top portion of the tree; however, in some trees it was present only in the lower stem and the basal parts of several branches. Although a number of fungi and bacteria were isolated from the stained wood, these have not yet been identified and the cause of the stain has not been determined.

Trees in the Candle Lake area have suffered two successive years of severe drought, 1961 and 1962, and low soil moisture, resulting in heavy feeder root mortality, is thought to be the main cause of death. In some trees root rot and stem decay of undetermined causes are also apparently contributory factors in hastening tree death.—R. D. Whitney.

BRITISH COLUMBIA

Attraction of the Bark Beetle, Dolurgus pumilus Mannerheim, to a Barrel Previously Containing Commercial BHC.—An instance of strong chemical attraction of a scolytid beetle is here described. An ambrosia beetle experiment, involving numbers of cut logs, had been set up in a partially thinned stand of second growth Douglas fir. At this site, three 45-gallon barrels had been filled with water, for fire protection. They were located along a narrow forest road, with the outer barrels about 130 and 190 feet, respectively, from the middle one. On June 14, 1962, the latter was noted to have hundreds of the small bark beetle, *Dolurgus pumilus* Mannerheim, on the water surface, but none of these beetles were seen in the other barrels.

All scolytids were collected from the water surface of all barrels on June 15, 21, and July 19 and 24; in addition, on July 19, the water was drained and the bottom sediment collected and later examined for beetles. Numbers of *D. pumilus* were seen on the water of the middle barrel after July 24, but sank during rains in the August 3-6 period or later and were not counted. Results of the various collections are given in Table I.

TABLE I

Scolytid beetles trapped by three water barrels[1]

Barrel No.	Dolurgus			Trypodendron			Hylastes			Other scolytids		
	1	2	3	1	2	3	1	2	3	1	2	3
June 15	0	2820	0	1	2	0	4	27	2	2	2	2
June 21	0	730	0	0	0	0	2	10	0	0	0	0
July 19 surface	0	110	0	0	1	0	0	2	0	0	1	0
Sediment	0	255	1	0	0	0	0	23	0	0	0	0
July 24	0	353	1	0	0	0	0	0	0	0	0	0
Total	0	4268	2	1	3	0	6	62	2	2	3	2

[1]On surface of water unless otherwise indicated.

It is clear that a strong attractant for *D. pumilus* occurred in barrel No. 2. It smelled strongly of BHC during the season and originally had contained an insecticide solution prepared by Chipman Chemicals Ltd., Winnipeg, in 1959 for helicopter spraying of felled logs that year. The solution consisted of technical BHC, velsicol AR 55 (a refined methylnaphthalene solvent), xylene and Dupont oil red dye. In April, 1962, the barrel was opened again and the small amount of liquid residue still remaining was washed out with cold water. The other two barrels came from another source and neither had the distinctive odour of commercial BHC.

During the time represented by the *Dolurgus* collections there were many other scolytids flying about in the same location. *Trypodendron lineatum* (Oliv.), *Dendroctonus pseudotsugae* Hopk., and *Hylastes* sp. were present in large numbers and the genera *Gnathotrichus, Dryocoetes, Pseudohylesinus, Scolytus* and probably others, were represented. Although the data suggest that the barrel previously containing BHC showed some attraction of *Hylastes* also, the attractiveness must be considered very weak because there were large numbers of these insects flying about during the observation period. It is clear that the chemical attraction of *D. pumilus* was not only strong but specific, being limited almost entirely to this species.

On one warm July day many living *D. pumilus* were seen on the water surface of the attractive barrel, indicating recent and direct landings. Apparently, the response to odour so dominated the beetles' behaviour that they landed readily on the water, although its physical characteristics are quite different from that of bark, the normal landing substrate.

The above observations indicate that if specific chemical attractants can be found for various scolytid beetles, they can probably be usefully employed in sampling and control procedures for these insects.—J. A. Chapman.

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Change of Editorship of the Bi-Monthly Progress Report.—In February, 1963, the Forest Entomology and Pathology Branch suffered the loss, through retirement, of the services of Eric B. Watson who has been editor of the Bi-Monthly Progress Report since 1946, and of Alan W. McCallum who has reviewed all contributions on forest pathology since 1951. Their periods of service in the Branch and its antecedent units in the Department of Agriculture were 39 and 43 years, respectively. Editorship of the Report passes to A. G. Davidson, who joined the Forest Entomology and Pathology Branch in 1948 and transferred from the Fredericton Laboratory to Ottawa Headquarters in 1962.—M. L. Prebble.

QUEBEC

Aerial Spraying against the Larch Sawfly, Pristiphora erichsonii (Htg.) in Quebec.—In recent years the larch sawfly population in southwestern Quebec has increased steadily so that it is currently the most damaging forest insect in the Province. High populations were recorded in the Abitibi region in 1957 and progressively southeastward toward Gaspé during the following years. In 1960 a new infestation was recorded in a 200-acre plantation of 30-year-old European larch and red pine owned by the Southern Canada Power Company Limited at Drummondville, Que. The following year, the sawfly population had increased to such numbers that the Company decided to spray the plantations by aircraft to control the insect.

Since the larch sawfly has an extended emergence and oviposition period, it is difficult to reduce the larval population with a single application of insecticide unless the timing is precise. Therefore, it was originally recommended that two applications be made: one in early June and another in mid-July. However, due to the difficulty in hiring an aircraft in early June, it was later decided to spray only once, at a time when the earliest larvae are about half grown. This date depends on the weather in any given year and in 1962 was determined to be at the end of June.

The traditional one pound of DDT in one gallon of fuel oil was used at the rate of one gallon per acre. The spray was applied shortly before sunset on June 27 and shortly after sunrise the following morning. Weather conditions were ideal with negligible air currents. For the operations, a private air strip owned by the Southern Canada Power Company (within five miles of the spray area) was used. The cost of the operation was as follows:

66 gals. of DDT concentrate (30%)	$106.40
134 gals. fuel oil	26.80
Overhead	50.00
Aircraft (Twinn Pest Control, Ottawa, Ont.)	300.00
Total Cost for 200 acres	$483.20
Cost per acre	$ 2.42

The results, as indicated in the table, are very good considering that only one application of insecticide was made.

Year	Shoots examined	Shoots infested	Infestation level
1960	532	96	Moderate
1961	531	167	Severe
1962	389	26	Light

While the infestation had increased from moderate in 1960 to severe in 1961, it dropped to light in 1962 after spraying. Population levels were estimated by using the sequential sampling technique developed by Ives and Prentice in 1958 (Can. Ent. 90: 331-338).—R. J. Finnegan.

ONTARIO

Termites in Ontario.—Of the several species of termites in North America, only the eastern subterranean termite, *Reticulitermes flavipes* (Kollar), is established in Ontario. How termites were introduced into this Province is unknown, but as early as 1929 they were collected at Point Pelee in Essex County (Watson, E. B. Bi-Mon. Prog. Rept. 5(1): 2, 1949). In more recent years they have been recorded from Windsor and Oxley, also in Essex County, Kincardine in Bruce County, and Toronto in York County. Termites are of primary importance as pests of wood in buildings and various wood derivatives, but they may also be found at times in the roots of shrubs and on the trunks of shade trees, although they seldom seriously injure living hosts.

In 1948, a general survey was made of the southern counties of Ontario. Some 1,200 bait-stakes were set out in woodlots and timbered areas south of a line connecting Hamilton, Brantford, London, and Sarnia; the entire area from the Niagara Peninsula to the Detroit River being sampled. No traces of termites or indications of feeding were evident when the stakes were examined after several months in the soil. However, a concurrent survey in the City of Toronto, where bait-stakes were set out at approximately 500 locations, showed there were about eight heavy but extremely localized infestations in the southeastern part of the City. Re-examination of the stakes in 1949 showed there had been very little spread, with the exception of an isolated case in the adjacent part of Scarborough Township.

A second survey of the Toronto area was conducted in 1952-1953 by the same bait-stake method used earlier. This survey showed only slight extensions of the previously known infested zones and no new infestations.

In the past decade, the infestations in the Toronto region have become sufficiently well established and widespread to cause appreciable public concern. The City has, accordingly, appointed a full-time termite inspector, and personnel in the building, sanitation, or health departments of some of the other Metropolitan municipalities have received training in the recognition of termite injury. A new, continuing survey by the Department of Forestry is incorporating confirmed records of these civic officials and licensed Pest Control Operators, supplemented by examination of buildings, wood debris, and shade trees to establish the periphery of present infestations.

The results to date indicate that several of the previously isolated infestations in the eastern part of Toronto have extended and coalesced into large pockets encompassing several city blocks. The old boundary lines of Yonge Street on the west and Danforth Avenue on the north no longer delineate the area of general infestation. In fact, termites have now been reported in all wards except 3 and 9. An area east of Bathurst Street and north of Dundas Street is probably the most heavily infested in the western part of the City, and continued sampling is expected to show this area to be somewhat larger than present records indicate. Termites have also been found in the Metropolitan municipalities of Scarborough, East York, North York, and Etobicoke townships.—C. S. Kirby and A. Harnden.

Defect Associated with Trunk Wounds in Young Second-Growth Sugar Maple.—In 1959 the Research Branch of the Ontario Department of Lands and Forests carried out preliminary studies on the relationship between growth rate and quality of sugar maple saplings in second-growth stands with the ultimate objective of reducing, through management, the high proportion of defective trees in most maple stands of the Haliburton-Muskoka region of Ontario. These studies indicated that, at least for some conditions, such a relationship existed and that under different environmental conditions various degrees of thinning or partial cutting would probably result in good quality stand growth. On the basis of these results, Mr. H. W. Anderson of the Department of Lands and Forests began more intensive studies the following year.

The Laboratory of Forest Pathology at Maple was asked to assist in these studies by providing information concerning the extent of heart rot and stain originating from branch stubs and different kinds of trunk injuries and the identity and potential detrimental effects of the associated fungi. This information would provide a sound basis for assessing the potential quality of young sugar maple trees.

A total of 455 trees from 16 localities in the Haliburton-Muskoka region of Ontario have been felled since the start of these joint investigations. The trees ranged from small saplings to trees approximately 9.5 inches D.B.H. and

125 years in age. From these trees 224 trunk wounds, 70 dead branches, and 976 branch stubs have been examined and described. Each trunk wound was sectioned at roughly 6-inch intervals, and several cultures were made from the associated defects. Discs were cut from the uninjured parts of wounded trees, and in each study area several trees without external evidence of wounding were felled and sectioned.

Trunk defect originating from dead branches and branch stubs was almost entirely stain, and limited in extent except when the larger branches, or those that had been dead for longer periods, were considered. Isolations made from the stubs and adjacent stem tissue yielded many Ascomycetes and Fungi Imperfecti, but very few Basidiomycetes with the exception of *Corticium vellereum* Ellis and Cragin. This fungus is not believed to be capable of initiating decay in maple (Nobles, M. K., and V. J. Nordin. Studies in wood-inhabiting Hymenomycetes. II. *Corticium vellereum* Ellis and Cragin. Can. J. Bot. 33: 105-112. 1955). Instances in which heart rot was encountered in unwounded trees, or in the discs cut 5 feet or more from the externally visible limits of trunk wounds, were very rare. Practically all of the decay encountered in the sample trees was associated with trunk wounds. At present few results are available concerning the identification of fungi and their association with various wounds, or the relation of factors such as tree vigour, season of injury, and size and location of wound to injury susceptibility and rate of spread of introduced defect. Nevertheless, it is felt that some of the preliminary results concerning the amount of heartwood defect associated with wounds of different origin are of sufficient interest to warrant their presentation at this time.

The origin of 172 of the 224 trunk wounds has been determined with reasonable certainty. Of the remaining 52 wounds, 14 have been classified as narrow seams pending further investigation of the causal agent or agents involved. The 186 classified wounds fall into 12 categories, however, four of these, namely, sugar maple borer injuries, branch stub seams, broken crotches, and broken tops are not included in this report because of insufficient sampling. The remaining wounds were classified as follows: 44 fire scars, 37 felling scars, 28 sun scald injuries, 14 narrow seams, 13 cankers caused by *Eutypella parasitica* Dav. & Lor., 12 skidding scars, 12 frost cracks, and 11 dead leaders. These include all the principal causes of trunk injuries in young sugar maple stands in the region investigated.

Several methods may be used to indicate the amount of internal defect associated with trunk wounds. The increase in the percentage of the cross-sectional area defective attributable to wounding in the region of the injury can be a misleading defect index because neither the proportions of advanced rot and stain, nor the vertical extent of the defect, are considered. In assessing the amount of defect associated with each wound, the amount of advanced heart rot found within the injured portion of the trunk was rated from 0 (none) to 4 (well over 50% of the cross-sectional area). Similarly, the vertical extent of heart rot was rated from 0 (none) to 4 (extending a considerable distance beyond the externally visible upper and lower limits of the wound). A numerical rating of the quantity of defect was obtained from the product of these two numbers. Figure 1 shows the relationship between these numerical ratings of decay and the

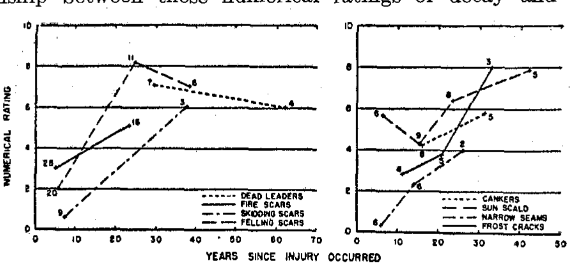

Fig. 1 The amount of heart rot associated with sugar maple trunk injuries.

time since the occurrence of injury for the different wound categories. Wounds of each category were grouped according to age of injury, and points representing the average injury age and numerical rating for each group were plotted. In Fig. 1 the number of wounds in each group is indicated, and the points for each wound category have been joined by straight lines to facilitate interpretation. It should be emphasized that these lines should not be construed as regressions or time trends. Further intensive analysis is proposed in which the effects of wound location and size, and tree age, size, and vigour, on the extent of defect will be studied.

Figure 1 indicates that the greatest amount of heartwood decay was associated with sun scald injuries and felling scars. Frost cracks and dead leaders also appeared to be responsible for the introduction of considerable defect. It should be noted here that a considerable amount of heart rot was assciated with *Eutypella* cankers, but there was very little vertical extent of rot beyond the cankered region. This explains the moderate numerical rating for this wound type.

Although fire scars were sampled more frequently than any other kind of wound, they were relatively rare in the region studied. From casual observations it might appear that frost cracks are one of the most common causes of trunk injury on young sugar maple. Careful examinations of several such wounds have revealed that the majority originated as felling scars or sun scald injuries followed by repeated separation of the callus, presumably due to sudden temperature changes, resulting in frost ribs. Close scrutiny of trunk wounds, and extensive searches for specific wound types, in several areas have indicated that felling scars and sun scald injuries are the most frequent causal agents of sugar maple trunk injury in the young, disturbed maple stands that are so prevalent in the Haliburton-Muskoka region. The fact that these two wound types were responsible for the introduction of more heart rot than the other categories stresses their significance in regard to the quality of second growth sugar maple stands in this region of Ontario.—G. N. Vasiloff and J. T. Basham.

Correction—In the article by R. E. Fye entitled *"The Status of the Spruce Budworm in the Black Sturgeon Lake Region of Ontario"*, Vol. 19 No. 1, the host headings for the last two columns in Table I, page 3, should be interchanged.

PRAIRIE PROVINCES

Pine Shoot Moth in Manitoba.—Dead and broken leaders of jack-pine regeneration, resembling damage by a *Eucosma* sp., were reported in 1950 by McDowall in the northern part of the Sandilands Forest Reserve, Manitoba (Annual Report of Forest Insect and Disease Rangers, Winnipeg Laboratory, 1951). Damage recurred in the same area in 1951 covering about three acres. This type of damage was not observed again in the Southern District until 1962 when light to moderate attack was observed in three other areas of the Sandilands Forest Reserve burned in 1955. Larvae collected in late July and early August were identified as *Eucosma gloriola* Heinrich according to the keys to larvae of the North American Olethreutidae by MacKay (Can. Ent. 91. Suppl. 10. 1951). This identification has since been verified by the examination of reared adults by T. N. Freeman, Entomology Research Institute, Ottawa. This insect was also observed attacking jack-pine regeneration in an old burn at Gypsumville in the Interlake area, and in jack-pine reproduction near Telford in the Whiteshell Provincial Park.

Tallies of the trees in three plots in the Sandilands Forest Reserve disclosed that larvae were prevalent in stands of jack-pine regeneration of 3,240 to 9,640 stems per acre. The damage appeared to be confined to trees from 3 to 8 feet in height. Trees in the 3 to 4 foot and 7 to 8 foot classes were only lightly attacked, with moderate damage confined to trees in the 5 to 6 foot class. Leaders up to three years of age and 12 to 22 inches in length were killed.

Field observations in late July suggested that the larva enters the leader through or near the needle sheath, and bores down the centre of the shoot. The mature larva girdles the leader near the basal end of the tunnel leaving the bark intact. It then proceeds part way up the tunnel and emerges in late July and early August to pupate in the soil. The winter is passed in the pupal stage. Only one larva was observed in each of the infested leaders examined.—H. R. Wong and J. J. Lawrence.

ROCKY MOUNTAIN REGION

Damage to Spruce by the Spruce Budworm.—In August 1962, a survey of spruce budworm damage to white spruce along the Wabiskaw River was undertaken at the request of the Alberta Department of Lands and Forests. A base camp was established at Wadlin Lake, 125 air miles northeast of Peace River, Alberta. Personnel and equipment were flown in by fixed wing aircraft. A helicopter was used to transport personnel between the base camp and the survey plots and to map the affected area. Both aircraft were provided by the Department of Lands and Forests.

Most of the damaged stands were overmature white spruce and white spruce-aspen. Balsam fir were present, but this area is near the western limit of this species and the amount of balsam fir in the stands was very small (an average of .03 per cent on the plots).

One hundred and eight tenth-acre plots were sampled. The approximate locations of the sample points were placed on a map within an area of the susceptible timber type but the actual location of each central plot was selected by the field party. Satellite type plots were used to remove some of the bias in selecting plot locations. Each group of plots consisted of a central plot and four satellites placed on the cardinal compass lines, the distance (up to half a mile) of each satellite from the central plot was preselected from a table of random numbers. On each plot tallies were made of: trees killed by budworm, trees dead from other causes, trees with dead tops resulting from budworm damage, and the total number of trees.

Tree mortality from budworm feeding had occurred in an area of 21.4 square miles. The boundaries of this area were considered to be those of the stands in which mortality occurred on one or more plots. Tree mortality on the individual plots within this area averaged 6.3 per cent ranging from 2.0 to 15.6 per cent.

Trees with dead tops as a result of budworm feeding were present in the 21.4 square miles where mortality occurred and in an additional 14 square miles where no mortality was recorded. The percentage of dead tops on individual plots averaged 22.9 per cent, ranging from 1.3 to 83.3 per cent of the trees. The plot with the highest percentage of budworm-killed tops was however, outside the area of tree mortality.

Sequential sampling of egg masses indicated that this infestation will continue at a high level in 1963; the area of moderate to severe defoliation could expand from 50 square miles in 1962 to approximately 65 square miles in 1963.—C. E. Brown.

Recent Population Trends of the Lodgepole Needle Miner.—High populations of the lodgepole needle miner, *Recurvaria starki* Free., were present in the Rocky Mountain National Parks in the 1940's but were reduced by cold winter temperatures in the 1950's. High winter mortalities were particularly evident in valley bottoms where temperatures were most severe. Trends continued downward until 1960, when a sharp reversal was detected (Table I). By the end of the first generation (1960-1962) following the increase, noticeable yellowing of trees had occurred in a few areas.

TABLE I

Population per 100 tips at Mount Eisenhower

Generation	Valley Bottom			Valley Bottom + 500′		
	1st Instar	Pupae	% Wint. Mort.	1st Instar	Pupae	% Wint. Mort.
1948–50	3015	2	84.6	3990	414	78.3
50–52	25	NS*		2500	1600	32.6
52–54	505	5	99.9	2709	1250	45.2
54–56	98	0	100.0	1114	105	69.3
56–58	0	NS		308	139	16.2
58–60	NS	NS		229	112	34.5
60–62	386	35	81.3	1359	649	6.7
62–64	1840			2764		

*NS—not sampled.

At the time of the decline it was thought that winter temperature was the most important factor controlling population levels (R. W. Stark. Can. J. Zool. 37: 753-761, 1959). Later, however, a series of successive mild winters did not result in population increases as expected. In 1960 there was a marked increase in oviposition rates; during the oviposition period the weather was exceptionally warm and winds were light. This led to speculation that weather during the oviposition period also regulates the population, i.e., increases in population occur when winter mortality is low and weather during moth flight permits a high oviposition rate; populations remain static or decrease when winter mortality is high or when weather during the oviposition period is cool, rainy, and windy. Observations have showed that the moth is sensitive to wind. Gentle breezes which just sway branch tips are enough to reduce adult activity significantly. The adults are crepuscular, with activity being concentrated in a few hours close to sundown when temperatures are usually dropping rapidly. Unless the weather is unusually warm, temperatures can drop below the threshold of activity and reduce the time available for oviposition.

Another interesting characteristic of these populations is their distribution over the valley slopes. Discoloration by the needle miner first became evident in a band of 250-700 ft. above the valley bottom, both in the outbreak of the 1940's and in the recent population rise. Regular sampling has indicated that high populations are found most consistently at these elevations. Previously it was thought that such a distribution was due to valley inversions in the winter, where temperatures were coldest at the bottom of the valley and increased up the slope to the inversion level and decreased again. Winter mortality was presumed to follow the same pattern, thus leaving the heaviest population near the inversion levels. Recently, however, winter temperatures were measured up a mountain slope and it was found that temperatures continued to become less severe above the band of high population. This would indicate that the temperature pattern was not only a result of cold air drainage in the valleys but also the result of strong inversions which are characteristic of cold arctic air masses in winter. These air-mass inversions are much deeper than the valley inversions. A brief survey of representative tephigrams for Edmonton, Alberta, showed that they are commonly more than 1,000 ft. deep. If these temperatures measured up the slope are generally characteristic of these valleys then winter mortality would be expected to be greatest at valley bottom and decrease up the slope without showing any reversal. As measurements of winter mortality do follow this trend, some other explanation is needed to explain the decrease in populations at the higher elevations. The theory of weather during the period of moth flight could offer a logical explanation.

At higher elevations summer evening temperatures are probably lower than at valley bottom. This would reduce adult activity and decrease the rate of oviposition. Temperature observations made during the moth flight in 1962 illustrate this point. Degree hours above 50°F. for the period 6 to 10 P.M. on comparable days were extracted from thermographs exposed at the upper crown level of trees. At 900 ft. above the valley bottom the average degree hours per evening was 26.1, while at 400 ft. the average was 31.3. Exact comparable data for the valley bottom are not available, but degree hours determined from a thermograph positioned at 4 ft. above the ground in a large stand opening averaged 49.3 per evening. These temperatures indicate that there could be 37 per cent more adult activity at valley bottom than at the 400-ft. level and 47 per cent more than at the 900-ft. level. Further supporting evidence for this appears in the population data showing the ratio of increase $\frac{\text{(No. of first instar larvae)}}{\text{(No. of pupae previous generation)}}$ between generations (Table II).

TABLE II

Distribution of population densities, winter mortality, and ratio of increase at oviposition up a mountain slope

Elevation above Valley Bottom (ft.)	Min. Temp. 1961–62 (°F.)	Winter Mort. 1961–62 (%)	Population/100 tips		Ratio of Increase (Fall 1962) / (Spring 1962)
			Spring 1962 (Pupae)	Fall 1962 (1st Instar)	
VB	−50	88.6	1.3	184	142.0
170	−38	12.5	7	249	36.0
220	−34	0	23	115	5.0
275	−32	5.8	945	1,567	1.5
335	−36	0.9	526	1,161	2.2
600	−32	1.0	2,416	2,560	1.2
800	−28	2.3	205	229	1.1
900	−18	2.3	180	175	1.0

At valley bottom the rate of population increase was extremely high, but at the upper elevations the rate of increase was negligible. While it is possible there is some movement of moths towards the valley bottoms, no consistent movement in this direction could be detected visually. If, however, moths tend to move slowly from high elevations into valley bottoms over a period of two or three weeks an advantage in the natural control of the needle miner would be gained, for it is in valley bottoms that the greatest winter mortality occurs.

Present knowledge indicates that at elevations of 250 to 700 ft. above valley bottoms only a modest rate of population increase has occurred but, because winter mortality has been usually low at these elevations, there is a persistent high population. Above 700 ft. the rate of increase has been low, and moth emigration has probably been high, so that large populations are unlikely to build up quickly provided winter mortality remains low. However, a series of consecutive warm winters is rare enough that populations seldom reach outbreak proportions in valley bottoms. Further observations are needed to verify or modify these impressions.—R. F. Shepherd.

BRITISH COLUMBIA

Distribution of Trypodendron Attacks Around the Circumference of Logs.—During studies in 1961 of the effect of exposure of hibernation sites on the time of the ambrosia beetle, *Trypodendron lineatum* (Oliv.), spring flights (Dyer, E.D.A. Can. Ent. 94: 910-915, 1962), 4-foot logs were placed on the ground near the locations of hibernating beetles. These were primarily to indicate the time of attack in relation to flight from hibernation sites in shaded and exposed locations; they also provided information on the attack distribution around the circumference of logs shaded by a dense forest compared with that on logs exposed to direct sunshine. Fifteen logs, from nine trees cut in November and December, 1960, were placed at each site with their long axes lying northeast-southwest. Each tree was represented at both sites. At the sunlit site, the upper and southeast sides of the logs were thus exposed to direct sunshine. Most of the attacks occurred during sunny days of March, April, and May.

In August, each log was peeled and the number of entrance holes tallied by quadrants which spanned the upper, lower, and two side surfaces. The attack on fifteen logs at each site is shown in the following table.

TABLE I

Distribution of *Trypodendron* attacks around the circumference of logs exposed to attack in direct sunshine and in shade

Quadrant	Exposed site			Shaded site		
	No. of holes	Holes per sq. foot	% of total	No. of holes	Holes per sq. foot	% of total
Lower	1925	69.8	47.3	5916	210.5	22.3
Northwest	1305	47.3	32.0	6877	244.7	25.9
Southeast	776	28.1	19.1	7075	251.8	26.7
Upper	66	2.4	1.6	6662	237.1	25.1
Total	4072	36.9	100.0	26530	236.0	100.0

The logs exposed to direct sunshine were scarcely attacked at all on the upper quadrant and had light attack on the southeast quadrant. Nearly 80 per cent of the attack occurred on the shaded lower and northwest quadrants. The attack on the shaded logs, although much denser, was uniformly distributed on all quadrants. These distributions might differ under other circumstances of partial shade or during unusual spring seasons when it is warm and cloudy at the same time.

The main reason that attack is sparse on the sunlit tops and sides of logs appears to be high bark temperature. That bark temperature can be lethally high has been confirmed by direct observations. Beetles have been seen to land on a sunlit log, search briefly, attempt to fly, and failing, move about excitedly before dying on the bark. However, in such a situation most beetles either succeed in taking flight again or crawl quickly to shaded portions of logs were they subsequently start to burrow. On clear days, the bark surface is often very hot even when air temperature is comparatively low. The sum effect of lethal temperature and avoidance by the beetles of hot surfaces, is the concentration of holes on the lower and shaded parts of logs exposed to direct sun.—E. D. A. Dyer.

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ATLANTIC PROVINCES

Radial Growth Studies.—Growth analysis techniques developed by Duff and Nolan (Can. J. Bot. 31: 471-513. 1953) were used to assess the radial growth of five species of broad-leaved trees growing in the Green River area of northwestern New Brunswick. Coniferous species show definite growth patterns which apparently result from nutritional and light gradients within the crown. The aim of this study was to determine whether similar patterns are evident in broad-leaved species and to compare growth sequences in large branches to those in the main stem. The species examined were: yellow birch, *Betula alleghaniensis* Britt.; white birch, *B. papyrifera* Marsh.; trembling aspen, *Populus tremuloides* Michx.; red maple, *Acer rubrum* L.; and pin cherry, *Prunus pensylvanica* L.f.

Seven open-growing trees were examined and all were relatively young with clearly defined main stems. As was expected all five species showed the typical pattern in the oblique sequence of maximum ring width near the apex of the tree. In the red maple, pin cherry, and trembling aspen, maximum width occurred within the first five internodes and in the white and yellow birch within the first ten internodes. A branch from the basal portion of the crown of a pin cherry and one from a red maple were examined and these tended to show the same growth patterns as the main axis of the parent tree. The results suggested that major growth disturbances might be revealed from an analysis of large branches rather than the main stem, although the confounding effects of the position of the branch within the crown (Forward and Nolan, Can. J. Bot. 39: 385-409. 1961) and lower growth rates would have to be taken into consideration—G. A. McDougall.

QUEBEC

The Basswood Looper in Quebec in 1962.—Populations of the basswood looper, *Erannis tiliaria* Harr., increased in Quebec in 1962. The insect was recorded throughout the range of sugar maple, but four main infestations were centred in the following counties: Portneuf; Lotbinière, Beauce, and Mégantic; Montmagny and L'Islet; and Rivière du Loup. Although the majority of maple stands were affected in these counties, the degree of infestation varied from light to severe. Effects of the virus disease reported previously (Martineau, R. Bi-Mon. Prog. Rept. 17(5): 1. 1961) and identified as a nuclear polyhedrosis (Smirnoff, W. A. J. Ins. Path. 4: 393-400. 1962) were very obvious in areas of severe infestation but were seldom evident where populations were low.

Development of the looper was followed in maple stands where the degree of infestation had been determined in 1961. In the Laplante sugar bush at St. Sylvestre, Lotbinière County, the infestation had been classified as moderate and conspicuous defoliation occurred the same year, the virus disease having practically no effect until late in the period of larval development. Observations were continued until late in the fall and some interesting data were obtained on the adult stage. Adult emergence began on October 17, one day after an early frost in the area, and continued until the end of November, a period of approximately 1½ months during which the ground was twice covered by a light fall of snow. The wingless females could easily be captured in tangle-foot bands around tree trunks. Ten banded maple trees, varying from 4 to 15 inches in diameter, yielded an average of 138 females per tree. Dissection of the female ovaries showed an average of approximately 300 eggs per individual, giving an average potential of 40,000 eggs per tree which would normally result in severe defoliation in 1962.

On May 16, 1962, a few days before the opening of the buds, the first larvae were seen wandering from branch to branch in search of food. The bud scales were only half-open when the young loopers attacked the folded leaves inside the buds. The hatching period lasted approximately two weeks. Counts made on May 30 established the population at 41 larvae per 100 sugar maple leaves in the crowns of the overstory and 65 per 100 leaves in the lower stratum. These numbers would be capable of causing complete defoliation of sugar maple since laboratory studies have shown that one larva can eat four or five leaves in the course of its development.

Defoliation of maples, however, was considerably reduced because of the virus disease. The sequence of events in the infested stand was as follows. Insect development was normal until a lack of food occurred in the most heavily infested parts of the stand creating conditions ideal for the development of the virus disease. This took place in the crowns of the preferred hosts, basswood and ironwood, and in the lower strata of the forest canopy where numerous larvae congregated after dropping from the crowns. From these locations, the virus subsequently spread throughout the stand. On June 4, the first diseased larvae were collected on sugar maple; one week later, the population had declined to less than one larva per 100 leaves and relatively few of these succeeded in pupating. As a result of this mortality only 50 per cent of the foliage of sugar maple was consumed and their crowns remained green. These conditions were typical of those observed in other severely infested stands in 1962.

The same phenomena had been observed in 1961 in two areas of severe infestation in the vicinity of St. Benoit, Beauce County, 40 miles south in the same region. As predicted on the basis of adult emergence in the fall of 1961, larval populations were very low in these areas in 1962. Abundant foliage was produced in the spring and tree crowns remained practically intact throughout the summer season. Only a small number of living larvae were observed and the few dead ones found on the branches may be an indication that the population was still affected by the disease.

In moderate infestations the insect had access to more foliage, and food shortage did not occur until later in the season. Although some larvae died of the disease as evidenced by cadavers on the trunks of severely defoliated trees, the majority had reached the fifth and last instar before the virus disease became very effective, and a good proportion of them pupated. Such conditions were encountered in the sugar maple stands of St. Anselme, Lévis County, and St. Aubert, L'Islet County, where numerous pupae could be found in the soil.

Among other natural control factors, a few species of parasites were reared, these have not been positively identified. —R. Martineau and C. Monnier.

Further Observations on the Recurrence of White Birch Dieback in the Lac Saint-Jean Area.—In a previous note (Bi-Mon. Prog. Rept. 18(5): 1-2. 1962), recurrence of dieback was reported on white birch in the Lac Saint-Jean area. Data were presented which showed that a sudden deterioration of healthy white birch trees had taken place between 1956 and 1957. Subsequent observations in the same study area reveal that the number of healthy trees has remained practically unchanged since 1957 (Table I). However, trees that had deteriorated from healthy classes to 3A or worse between 1956 and 1957 have shown further deterioration between 1957 and 1961.—M. Lortie.

TABLE I

Number of healthy birch trees between 1956 and 1961 in 4 sample plots in the Lac Saint-Jean area

Plot No.	Number of healthy* birch trees in			
	1956	1957	1959	1961
122	29	16	15	No observations
124	11	2	2	2
125	29	14	14	14
127	12	1	0	0

*Trees were considered healthy having a crown deterioration class of 1A, 1B, 2A and 2B.

ONTARIO

Field Trials with Helicopter Spraying for Control of White Pine Weevil.—Aerial spraying to control white pine weevil populations was undertaken in Ontario for the first time in 1961. A 10 per cent solution of DDT in No. 2 fuel oil was applied by a Stearman fixed-wing aircraft to 416 acres of 30-year-old white pines in the Kirkwood Forest Management Unit. Application at the rate of 4 pounds of

DDT in 4 gallons of spray per acre reduced the level of infestation in two sample plots from 10.6 per cent and 20.9 per cent in 1960, to less than 1 per cent in 1961 (Kirby, Harnden, and MacLeod. Bi-Mon. Prog. Rept. 18(5): 2. 1962).

Approximately 395 acres of 32- and 21-year-old trees in the same general area of the Kirkwood Unit, were sprayed by a Bell G2 helicopter in 1962. This machine, with an operating tank capacity of 30 gallons, was equipped with a 22.5-foot spray boom bearing 23 nozzles spaced 12 inches apart at a 45° angle toward the centre. A 7 per cent solution of DDT in No. 2 fuel oil was applied at the rate of 1.9 pounds DDT in 2.5 gallons of fuel oil per acre. Spraying was conducted between May 5 and May 7, under commercial contract to the Ontario Department of Lands and Forests.

Post-spray assessments made on October 16 and 17 indicated that the level of weevil infestation in one sample plot had been reduced from 64.9 per cent in 1961 to 23.8 per cent in 1962. In a second sample plot the infestation was reduced from 19.4 per cent to 1.6 per cent. Current infestations in companion check plots were 31.5 per cent and 21.8 per cent, respectively.

In general, the results of the helicopter spray applications were inconsistent and below expectations. Failure to obtain satisfactory control is believed due to several factors: (1) Visual examination of spray deposit assessment cards, set out in openings across the sample plots, showed that the spray droplets tended to be coarse, indicating unsatisfactory delivery; (2) tall, mature trees scattered throughout the plots necessitated varying the altitude of the helicopter, thus altering the down-draft effect of the rotor and producing a less uniform deposit of spray; (3) a period of unseasonably warm weather during April resulted in earlier than usual emergence of hibernating weevils. Adults were feeding and mating on young Scots pine trees in an adjacent Christmas tree plantation more than a week previous to the commencement of the spraying operation. Although it was expected that weevil emergence would be somewhat later under the closed canopy of the spray plots, and while it is recognized there is an interval of a few days between initial spring-feeding and egg-laying, it is possible that some adults may have migrated to the spray plots and oviposited prior to the spray application; (4) it is also possible that the dosage was slightly below the minimum necessary for effective control of this insect.

Although the results of the 1962 operation were disappointing, it would be unwise, on the basis of this trial, to reject the helicopter as a means of applying insecticides for control of the white pine weevil. Under "ideal" or uniform plantation conditions and with more accurate calibration and timing of application, it is felt that control more comparable to that obtained in the fixed-wing aircraft trials could be realized, and further tests should be conducted.—C. Kirby, H. McPhee, and A. Harnden.

Fumigation of Nursery Stock as a Possible Means of Retarding the Spread of the European Pine Sawfly.—Since the European pine sawfly, *Neodiprion sertifer* (Geoff.), was first reported near Windsor in 1939 it has advanced northward and eastward at a rate of about 15 to 20 miles per year. The distribution of the sawfly in 1962, as reported by Sippell, MacDonald, and Rose (Ann. Rept. For. Insect and Disease Survey 1962, pp. 55-56), covered most of the Lake Huron and Lake Erie forest districts, with extensions into the Lake Simcoe and Lindsay districts and a small infestation at Belleville. These infestations, while not extensive, indicated a striking increase in the known distribution of the insect during a short period, and suggested that the sawfly was being disseminated by means other than normal flight of the adults. As the insect overwinters in the egg stage, and oviposition had been observed on trees less than two feet in height, it was logical to suspect that shipments of nursery stock and balled ornamental pines might be contributing to the rapid spread of the insect.

Preliminary experiments were begun in early 1962 to determine if the sawfly eggs could be prevented from hatching by treatment with fumigants. Branch tips containing a good population of eggs were collected on January 8 and 9 from red pine trees at the Provincial Trout Rearing Station at Chatsworth near Owen Sound, and taken to the Pesticide Research Institute, Canada Department of Agriculture, London. This material was evenly divided into lots and carefully pre-conditioned to the fumigating temperatures of 40, 50, 60, and 68°F. Fumigation exposures of 2 hours were made with methyl bromide at all four temperatures, and with ethylene dibromide at 60°F. The average number of eggs per individual test was 82. After fumigation, the twigs were gradually warmed to 70°F and then placed in a room at this temperature and 70 per cent R. H. until hatching was complete in about three weeks.

In these preliminary trials complete mortality of the eggs was obtained with methyl bromide in concentrations of 64 and 32 mg/l at temperatures of 50 and 68°F respectively. (For all practical purposes milligrams per litre are equivalent to ounces per 1000 cubic feet). However, the results with ethylene dibromide at 60°F were not encouraging and a dosage of 16 mg/l produced only 29 per cent mortality.

Because these preliminary experiments showed promise for the use of methyl bromide, further tests were made with this fumigant at a time corresponding to the spring movement of pine nursery stock. Further collections of red pine twigs were made at Chatsworth on March 27 and 28, 1962, and four lots were again pre-conditioned at the same four temperatures. Between April 3 and 18, fumigations with methyl bromide were carried out at 50, 60, and 68°F for both 2- and 4-hour exposure periods, but at 40°F only a 4-hour treatment was made. This time there was an average of 131 eggs per test. The results may be summarized as follows:—

Temperature degrees F.	Lowest dose in mg/l causing 100% mortality	
	2 hours	4 hours
40	—	80
50	80*	64
60	48	40
68	40	16

*At this temperature the highest mortality recorded for two hours exposure was 98%.

These results show that complete mortality of the eggs can be obtained under spring conditions with treatments that would be well within the limits of plant tolerance for dormant pine seedlings, as indicated by previous experience with the European pine shoot moth (Science Service Laboratory, London, Ontario, Report for 1951-56, p. 37).

This study is being continued to determine the susceptibility of the eggs of *N. sertifer* to fumigation at the time of the fall shipping season for pine nursery stock.

The technical assistance of Messrs. C. T. Buckland and E. Upitis is gratefully acknowledged.—H. A. U. Monro and C. S. Kirby.

PRAIRIE PROVINCES

Germination of White Spruce Seed not Affected by Extreme pH.—Seed of white spruce (*Picea glauca* (Moench) Voss) sometimes germinates poorly in nurseries, especially when sown in the spring. Either stratification or fall sowing gives better germination. To explore other factors which may be involved, germination tests were made with normal and overheated seed on natural media of wide pH range. The seed used had been collected in 1957 near Prince Albert, Saskatchewan, extracted at about 55°C in the Saskatchewan Government kiln, and stored at 0°C for a year. It was then cleaned and sieved for uniform size.

The seed was divided into two lots which were treated as follows: (a) stored dry at 7°C for 6 months; (b) kept in an incubator at 90°C for 1 hr. (in test tubes, 50 seeds in each); it was estimated that the seed reached a temperature of at least 80°C; the seed was then stored dry at 7°C for 6 months as in (a).

Germination of the seed was tested by sowing in glass jars, 100 seeds per jar. Each 4 jars contained a different soil medium as follows: (a) alkaline sand mixed with vermiculite (2:1); pH 8.2 initially, and 8.1 at the end of the experiment; (b) sand as in (a) but with KOH added until pH 8.3 was reached; final pH (at the end of experiment) 8.2; (c) clay soil; pH 7.4; finally 7.5; (d) mixture (1:1) of alkaline sand and screened sphagnum moss; pH 6.3, finally 7.0; (e) forest humus from a balsam fir-poplar stand; pH 5.8, finally 6.6; (f) as in (e) but autoclaved for 30 min.; pH 5.6, finally 6.6; (g) screened sphagnum moss; pH 3.9, finally 4.2; (h) as in (g) but with sulphuric acid added until pH was 3.4, finally 3.6.

One jar of each medium was kept at 24°C under each of four light treatments. As the light treatments had only negligible effects on germination, they will not be described here. Table I gives the average germination on each medium.

TABLE I

Germination percentage of heat-damaged and unheated white spruce seed on different media at 24°C (averages of different light treatments).

	Alkaline sand + KOH	Alkaline sand	Clay	Sand + sphagnum	Forest humus	Sterilized forest humus	Sphagnum	Sphagnum + H_2SO_4	Ave.
Ave. pH	8.3	8.2	7.4	6.6	6.2	6.1	4.0	3.5	
Heated	8	10	8	13	11	11	13	11	10
Unheated	71	74	71	71	79	68	68	69	71
Average	40	42	40	42	45	39	40	40	41

Excessive heat had greatly injured the seed, demonstrating the importance of temperature control in the extraction of spruce seed. The germination was surprisingly uniform on the different media, even with extremes of pH. Whatever effects pH may exert on the establishment of spruce stands, direct effect on germination cannot be one of them.—O. Vaartaja. (Experiments conducted in Saskatoon. Present address: University of Adelaide, Adelaide, South Australia.)

A Pine Tube Moth, Argyrotaenia tabulana Free., in Saskatchewan.—In 1962, the infestation of this insect reported in the Home Block of the Nisbet Provincial Forest (Bi-Mon. Prog. Rept. 17(5): 2. 1961) continued for the second consecutive year and increased in extent and intensity. Defoliation of both current and old foliage of young jack pine was severe within some 5,800 acres and light to moderate within an additional 6,500 acres. Populations causing very light defoliation were common throughout the remainder of the Home Block, suggesting that the area of more serious defoliation may increase markedly in 1963. Larvae were also commonly found in Prince Albert National Park, near Waterhen Lake (20 miles north of Meadow Lake), and at several locations between the Clearwater River and Lake Athabasca in the northwestern part of the Province.

Results of initial studies of the life history and feeding habits of *A. tabulana* were presented in 1961 (loc. cit.). Further observations in 1962 indicate the following. Pupae overwinter in or under the needle litter, usually in contact with the mineral soil or compacted humus layer. The adults emerge during an approximate four-week period (from May 22 to June 15 in 1962) and mate. The eggs are laid in small clusters on the inner or concave surface of jack pine needles and hatch during a period corresponding in length to the adult emergence period (as late as July 12 in 1962). The larvae apparently develop through six instars. They are solitary feeders that spend the first and second instars, and part or all of the third, within mines in the old needles, and the remaining instars within tubes or bundles constructed from either new or old needles. Each larva may construct more than one tube, utilizing from one to five needle pairs. When fully grown, the larva chews a hole in the wall of the tube, drops to the needle litter on a silken thread, and pupates. In 1962, "larval drop" commenced about August 25 and was mainly completed by September 15.

The needles are not severed from the twig during either the mining or tube-making stages; mainly the upper layers of the needles are consumed in the tubes and the lower epidermis is left intact or nearly so. As the feeding progresses, the remaining parts of the needles dry out, die, and turn straw-coloured with some reddish tints. The over-all colour of a severely attacked tree is reddish-brown but this is lost during the winter when most of the dead needle bundles drop from the branches.

The larvae do not damage buds and attack the new foliage only after the current shoots are fully, or almost fully, developed. Permanent damage to severely defoliated trees appears unlikely, therefore, provided normal growing conditions occur in subsequent years and that the loss of foliage does not interfere with the opening of buds. These observations may explain why host mortality was not recorded in previous infestations in eastern Canada. Studies will be continued to determine the ultimate effect on host trees and the causes of outbreak decline.—K R. Elliott and L. L. McDowall.

ROCKY MOUNTAIN REGION

Fungi Inhabiting the Bark and Branches of Living Lodgepole Pine in Alberta.—Dead branches are likely infection courts for fungi causing heartwood stains and decays in lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.). In an attempt to relate stand density to the frequency of dead branches in lodgepole pine stands, information was also obtained on the identity, incidence, and location of fruit bodies of several different fungi.

A number of trees ranging in age from 60 to 250 years were felled and cut into 4-foot sections above a 1-foot stump. The bark surfaces of 90 stem sections, 1,523 dead and 774 living branches were examined for sporophores. The sporophores were recorded according to species and the aspect (N-E-S-W) in which they occurred. Each species was recorded only once per aspect for each stem section and branch.

Most of the sporophores had developed on the bark of the stem and on dead branches below the live crown. With the exception of *Atropellis piniphila* (Weir) Lohman and Cash, they were fairly evenly distributed according to aspect (Table I). This fungus was most common in north aspects of lodgepole pine.—A. A. Loman.

TABLE I

Occurrence of fungi on stems and branches of living lodgepole pine

Species	Incidence of sporophores*				
	N	E	S	W	Total
ASCOMYCETES					
Lachnella hahniana Seaver	23	29	28	23	103
Atropellis piniphila (Weir) Lohman and Cash	18	9	9	11	47
Biatorella resinæ (Fr.) Mudd	3	—	2	3	8
Scoleconectria cucurbitula (Tode ex Fr.) Booth	1	1	1	1	4
Tympanis hypopodia Nyl	1	1	—	—	2
Unknown ascomycetes	9	6	1	5	21
BASIDIOMYCETES					
Peniophora pseudo-pini Weres. and Gibson	4	3	3	3	13
Poria purpurea (Fr.) Cke	—	—	1	1	2
Merulius ambiguus Berk	—	—	1	—	1
Pleurotus mastrucatus (Fr.) Sacc	1	—	—	—	1
Unknown basidiomycetes	—	1	1	1	3
Total	60	50	47	48	205

*Occurrence in one or more aspects of 90 stem sections, 1,523 dead and 774 living branches.

The Poplar and Willow Borer.—The poplar and willow borer, *Sternochetus* (*Cryptorhynchus*) *lapathi* (L.), a native of Europe and Asia, was first recorded in North America in 1882 at Williamsbridge, New York City (Matheson, R. 1917. The poplar and willow borer. Cornell Univ. Agr. Exp. Stn. Bull. 388). The first Canadian record was at High Park, Toronto in 1906 (Caesar, L. 1916. Ann. Rept. Ent. Soc. Ont. Vol. 46). It was first recorded in Alberta in 1961 at Ptolemy Creek in southwest Alberta (Kusch, D. S. Bi-Mon. Prog. Rept. 18(1): 3) where it had caused an infestation on *Salix myrtillifolia* Anderss. Subsequent investigations showed the insect to be distributed over a large part of southern Alberta as far east as Medicine Hat. It is apparently not established north of Aldersyde, 30 miles south of Calgary. Its presence only in southern Alberta and its occurrence as heavy infestations only in the Crowsnest Pass and Waterton Lakes areas indicate that it could have spread into Alberta from southeast British Columbia. Numerous infestations have been reported for this part of British Columbia (Cottrell, C.B. 1959. A brief history of the poplar and willow borer, *Sternochetus lapathi* (L.), in British Columbia. Proc. Ent. Soc. of B.C. 56: 46-48).

The weevil attacks and kills natural growing and shelterbelt willows with stump diameters of one-half to six inches. The most commonly attacked trees are two to four inches in diameter. Of the many species of willow in Alberta only two are known hosts of this insect, the sandbar willow (*Salix interior* Rowlee var. *pedicellata* (Anderss.) Ball) and the blueberry willow (*Salix myrtillifolia*). The weevil attacks species of alder, birch, and poplar in areas outside of Alberta. Investigation of the life history of *S. lapathi* in Alberta was begun in 1961.

Adults were collected in late April (1962) from duff samples beneath infested trees and pupae were collected at the same time from infested trees, indicating that the borer overwinters in at least two stages. Adults were observed mating from June to August, and larvae were observed for the first time on July 3rd (Medicine Hat, elev. 2,000 feet). Third- and fourth-instar larvae were observed on July 10th (Pincher Creek, elev. 3,400 feet) along with mating adults. Emerging adults were observed mating on July 18th (Ptolemy Creek, elev. 4,200 feet). Infestations have been found at elevations of up to 5,000 feet in Alberta.

Many willows have been destroyed in southern Alberta, and in the most heavily infested areas average mortality is about 40 per cent. While willow has no commercial value it is an important watershed and shelterbelt species. Infestations are common along the South Saskatchewan River in the vicinity of Brooks and Taber and could spread from there to become a serious pest in willow shelterbelts.—E. J. Gautreau.

BRITISH COLUMBIA

Spruce Beetle Epidemic in Prince George Forest District, B.C.—In the fall of 1962 an insidious epidemic of a native spruce beetle, *Dendroctonus* sp., was discovered in several mature spruce stands in the Prince George Forest District. Reports from personnel of the British Columbia Forest Service during the ensuing winter months added considerably to the known number of infestations. In March, and again during April and May, 1963, rangers of the Forest Entomology Laboratory at Vernon made several brief surveys, and by mid-May some 50 discrete infestations were on record. The worst and most numerous of these occurred in the low-lying areas northeast and north of Prince George where 10 to 30 per cent of mature spruce stands were infested in areas ranging from 5 to over 2,500 acres. Lesser infestations occurred northeast and north of Quesnel.

It was observed that many beetles above snow-level in the bark of standing trees had been removed by woodpeckers but a large population still persisted in the basal foot of infested trees. Windfalls also contained large numbers of living beetles. Some measure of control was probably effected where clear-cutting operations of infested spruce stands were carried out in the winter of 1962-63. In spite of this, high populations still persist in the Prince George District. It is forecast that in 1963 the spruce beetle will show further increases in numbers in the extensive 1962 blowdown and will attack mature living trees, not only in blowdown areas but also where little or no blowdown has occurred.

The great majority of beetle infested trees were still green when examined in May, 1963. These will probably discolour during the summer and a more complete appraisal and report of the outbreak will be made at that time.—D. A. Ross.

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Evidence of DDT-Resistance in Spruce Budworm (Choristoneura fumiferana Clem.) from Forest Populations Subjected to Repeated Large-scale DDT Sprays.—The possibility for a given species of insect to become resistant to an insecticide is controlled by the variation in susceptibility present in the original population. The magnitude of change in the susceptibility factor of that population will, in turn, determine the future field life of the particular insecticide in question. At present the log dosage-probit mortality line is the only quantitative measure by which a change in susceptibility to an insecticide may be determined. The line for an unselected susceptible strain is a straight steep slope. This slope decreases when, because of selection pressures, resistant type individuals make up a greater proportion of the population. With increased selection, the slope line may change shape and eventually assume a new straight line position at a higher insecticide concentration due to the preponderance of resistant individuals. The change in slope from the original therefore is indicative of a change in the proportion of susceptible to non-susceptible individuals in the existing population, and thus serves as an index of the development of resistance to an insecticide.

To determine the future field life of DDT in New Brunswick and the possibility of the development of resistance within the spruce budworm population, laboratory toxicological studies were carried out on the effect of technical DDT sprays on 5th instar spruce budworm larvae collected from isolated un-sprayed and repeatedly sprayed areas. The insecticide was applied by means of a spray tower in varying concentrations at a volume dosage comparable to field applications of ½ gallon per acre, and calculated on the basis of micrograms of insecticide per unit of surface area.

Results obtained in 1959, 1960, and 1962 with larvae collected from isolated unsprayed areas showed a consistent straight log dosage-probit mortality line. Larvae collected in 1962 from infestation centres previously subjected to three and four applications of non-consecutive DDT large-scale field sprays showed a significant departure from the straight log dosage-probit line previously obtained. The departure occurs as a change in the shape of the line as well as a shift of the line to the higher concentration range of DDT. In addition, the magnitude of change appears to be correlated with the frequency and number of sprays to which the residual population was exposed. Results obtained in 1963 from larvae collected at identical sites from the 1962 heavily sprayed areas confirmed the previous findings. Larvae from areas subject to five years of DDT applications showed a further change in the probit slope. These changes, which at the present time are small but significant deviations from the normal probit line of susceptible population, indicate a progressive development of resistance to DDT. The data and results of these findings will be published in detail at a later date.—A. P. Randall, Chemical Control Section.

QUEBEC

Preparation of Virus Sprays for the Control of Forest Insects.—In the last 15 years important advances have been made in the use of virus diseases for the control of forest insect pests. The principal results obtained to date with this method have been summarized by F. T. Bird, Insect Pathology Research Institute, Sault Ste. Marie, Ont., in a paper presented at the International Colloquium held in Paris in October, 1962. The artificial dissemination of viruses was successfully used in North America to control the European spruce sawfly, *Diprion hercyniae* (Htg.) (F. T. Bird and J. M. Burk, Can. Ent. 93: 228-238, 1961), the pine sawfly, *Neodiprion sertifer* (Geoff.) (F. T. Bird, Can. Ent. 85: 437-446, 1953), and the jack pine sawfly, *Neodiprion swainei Midd.* (W. A. Smirnoff, J. Ins. Path. 3: 29-46, 1961), (W. A. Smirnoff, J. J. Fettes and W. Haliburton, Can. Ent. 94: 477-486, 1962), and in France to control *Thaumetopoea pityocampa* Schiff. (P. Grison and C. Vago, Rev. For. française, 11: 353-371, 1959).

There is no doubt that this method of control will be employed to a greater extent when more information is available on the behaviour of the pathogens and methods of application. This report describes the preparation of virus sprays for the control of the sawfly, *Neodiprion swainei* Midd., an important pest of jack pine in Quebec. In the present case it was necessary to formulate a spray which would ensure efficient dispersion of the pathogen over the forest when applied by either ground sprayers or by aircraft. Furthermore the spray material had to meet the following requirements:

(1) The pathogen must remain in suspension at a pre-fixed concentration; (2) thorough wetting of the foliage should be achieved; (3) the polyhedra should adhere to the substratum after evaporation of the water, so as to prevent washing by rain; (4) the evaporation of the solution should be reduced to a minimum at the time of spraying.

Several formulae were tested but only two were retained and used in the large scale aerial spraying operations conducted in 1960 (Smirnoff, Fettes, and Haliburton, loc. cit., 1962).

Formula A.

Latex[1]	2.4 gallons
Dried blood[2]	431.9 grams
Water	93.0 gallons
Polyhedra (concentration: 52,000,000 pol./ml.)	4.6 gallons

[1] Geon Latex 652: B. F. Goodrich Chemical Co.
[2] Soluble Dried Blood: Canada Packers Ltd., Toronto.

The latex is dissolved in 82.6 gallons of the water and the dried blood separately in 10.4 gallons. After 6 hours, the dissolved blood is poured into the water-latex solution while stirring continuously. (It is very important to proceed as indicated to avoid blood precipitation.) The final product which has a creamy consistency and is pale brown in colour will remain in that condition for several days. The quality of the preparation can be easily checked by immersing a clean microscope slide into it. A good solution will allow the liquid to wet the glass completely without the formation of air bubbles and leave a waterproof film on its surface after drying. Just before spraying, the polyhedral suspension is added to the mixture and the whole stirred vigorously. The final emulsion contains 2.10^6 pol./ml.

Formula B.

Bentonite Magma[1]	43.2 gallons
Furnace Oil No. 2	48.0 gallons
Span 80[2]	3.9 gallons
Polyhedra (concentration: 52,000,000 pol./ml.)	4.9 gallons

[1] Bentonite Powder Tech. AC-976T: Anachemia Chemicals Ltd., Montreal, Que.
[2] Span 80: Atlas Powder Co., Wilmington, Delaware, U.S.A.

Bentonite absorbs the virus polyhedra, causing them to spread thinly over the foliage, while the oil acts as a fixative and Span 80 serves as an emulsifier.

a) Add 59.5 pounds of bentonite to 80 gallons of hot tap water (70°C) without stirring. When all the bentonite is wet, stir vigorously. After 24 hours, add enough water to make 100 gallons of suspension.

b) Mix the fuel oil with the Span 80 and after a few hours add the mixture to 43.2 gallons of (a) and stir vigorously with a strong electric stirrer for at least 30 minutes or until the mixture becomes milky white. The mixture should be filtered through a cloth when pumping it into the spray tank. The mixture remains stable for 24 hours but it is advisable to stir again if it is not used within that period.

The pH of this mixture is usually between 8.5 and 9.2. Before adding the polyhedral suspension, it is necessary to verify its pH value with a pH meter and buffer it to 7.0 by adding a little concentrated sulphuric acid and stirring continuously. The pH value of the mixture is very important since the polyhedra deteriorate rapidly in alkaline or acid solutions.

Both mixtures described above can be used in aerial spraying. Formula A, which contains latex and dried blood, gave very good results so far as its homogeneity, dispersion, wetting, and adhesive qualities were concerned. Furthermore, this mixture is easily prepared and is more convenient to use with ground spraying equipment when evaporation of the fine droplets is not as important a factor as it is with aerial spraying. Formula B, which contains bentonite magma, fuel oil and Span 80, is especially recommended for aerial spraying because it can be sprayed in very fine droplets which do not readily evaporate.

Formula B can also be used for spraying with other pathogens such as *Bacillus thuringiensis*.—W. A. Smirnoff and A. Juneau.

ONTARIO

Summer and Fall Mining by the Jack Pine Needle Miner, Exoteleia pinifoliella Cham.—Although the life history of *Exoteleia pinifoliella* Cham. has been briefly described by T. N. Freeman (Can. Ent. Suppl. 16, 1960) and R. J. Finnegan (Bi-Mon. Prog. Rept. 17(6): 1, 1961), little is known about the habits and parasites of the early larval stages of this common needle miner on jack pine. In 1962, periodic collections from an infestation in Lake Simcoe District provided supplementary information on the early larval instars.

The first mining occurs near the base of a new needle within the sheath in late June. The initial feeding invariably kills the needle, which turns yellowish by mid-July. The larva mines distally along one edge; before reaching the tip of the needle it reverses direction and mines along the opposite edge towards the base. It continues feeding in the dead needle, which by August has turned greyish-brown in colour and usually supports a fungus growth near the base. Empty mines at this time of year indicate that more than one needle is often mined by each larva. The dead needles often persist on the tree for two or more years.

A change in mining habits occurs in September when larvae are found in green needles with the entrance hole about midway on the flat side of a needle and mining directed towards the tip. Both current and older foliage are attacked in the fall. By early December needle tips are almost completely mined with the larvae oriented toward the base of the needle and frass packed into the mined tip. Also, at this time of the year the entrance hole and mine wall surrounding the larvae are covered with silk.

A chalcid parasite, *Derostenus silvia* (Grlt.), (Hymenoptera: Eulophidae) caused 22 per cent mortality in a sample of 177 larvae collected in late fall. It apparently overwinters as a full grown larva in the needle mine. In the laboratory pupation occurred almost immediately following the usual period of cold storage, with adult emergence about two weeks later. The chalcid was identified by Dr. C. D. Miller, Entomology Research Institute, Ottawa, with confirmation from the United States National Museum, Washington.—O. H. Lindquist and A. A. Harnden.

Natural Hybrids between Coccinellid Species.—The twice-stabbed lady bird beetle is an economically important predator on soft scale insects that attack a wide variety of fruit, ornamental, and forest trees. In Canada, this common name is unwittingly applied to three species in the genus *Chilocorus*, namely, *stigma* Say (=*bivulnerus* Muls.), *hexacyclus* Smith, and *tricyclus* Smith (Smith, S. G. Proc. X Int. Congr. Genet. 1: 444-450, 1959). The three are superficially indistinguishable as adults, but the first appears to be distinct in the larval stage. They have different geographical distributions: *stigma* ranges from Nova Scotia to western Alberta and south into Florida; *hexacyclus* is known only from Saskatchewan and Alberta, usually at moderately high elevations; *tricyclus* is largely confined to the interior of British Columbia, for (with the one exception referred to later) our locality records show it to be restricted to the west of the height-of-land.

Despite the adults' apparent lack of external diagnostic features, the three species can be readily categorized by chromosome differences. *C. stigma* is cytologically polymorphic, the chromosome numbers of different individuals covering the whole spectrum from 26 down to 18 inclusive. (The mean chromosome number of local populations decreases steadily as sampling proceeds west from Nova Scotia (Smith, S. G. Nature 193: 1210-1211, 1962).) *C. tricyclus* and *hexacyclus* are entirely monomorphic, the former having 20 and the latter 14 chromosomes. In all three species, numbers lower than 26 have originated by fusion of pairs of different chromosomes.

Collections of *Chilocorus* from the general area around Coleman, Alberta, just to the east of Crowsnest Pass through the Rocky Mountains, were received from the Forest Insect and Disease Survey, Calgary, in 1957, 1961, 1962, and 1963. The single 1957 collection consisted solely of *hexacyclus* but was too small to rule out the possibility of other entities being present in the same population. The 1961 material, collected late in the season, comprised two *hexacyclus*, one *tricyclus*, and three hybrids. Larger samples in 1962 consisted, in all, of 32 *hexacyclus*, two *tricyclus*, and 14 hybrids; and the early season collection in 1963 contained ten *hexacyclus*, no *tricyclus*, and eight hybrids. Of the total of 25 hybrids examined, 11 proved to be first generation offspring (F_1), 11 were progeny of such hybrids backcrossed to the numerically predominant *hexacyclus*, and two or probably three were F_2 individuals. These observations proved conclusively that *tricyclus*, having invaded the range of *hexacyclus* via Crowsnest Pass (c. 4500′ above sea level), succeeded in cross-breeding with the resident population.

Because of the well known sterility of the mule, it is commonly believed that interspecific hybridization is an evolutionary dead-end. However, the chromosomal features that distinguish *tricyclus* from *hexacyclus* permit the rigorous demonstration that this is not necessarily so: that following breakdown of geographic isolation and subsequent hybridization, although fertility of the F_1 is reduced to about 30 per cent, these mate indiscriminantly, primarily with the dominant local *hexacyclus*, to a lesser degree among themselves, and in proportion to their availability (we must assume) with any additional *tricyclus* that cross the Great Divide.

The high sterility in the F_1 generation is demonstrably ascribable to malorientation of configurations (trivalents) formed by a *hexacyclus* chromosome pairing with its two counterparts from *tricyclus*, the unbalanced germ cells so formed sterilizing the eggs they fertilize. Backcrossing to either parental species greatly reduced sterility by lowering the frequency of resulting trivalents.

The act of interbreeding, introgression as it is called, increases the evolutionary plasticity of the population enormously. First, random reassortment of equivalent chromosomes from the two species at germ-cell formation on its own provides a potential of 5,103 different chromosomal recombinants. Second, because of the segmental exchange (genetic crossing over) that invariably accompanies chromosome pairing, diversity is further enhanced theoretically to more than 137 billion chromosomally distinct forms. Those that possess adaptive utility will be selected and confer increased genetic versatility upon the eastern populations.

As also in *Pissodes* weevils (Smith, S. G., and Y. Takenouchi. Science 138: 36-37, 1962), it is solely due to their pronounced cytological differences that these *Chilocorus* species can provide such a conclusive, unambiguous proof of the reality of interspecific hybridization in nature.—S. G. Smith.

Acantholyda erythrocephala (L.) New in Canada.—Seven larvae of this web-spinning sawfly were collected by the junior author from mugho pine in Scarborough Township, Ontario, on July 6, 1961, and reared at Fredericton, N.B., as part of a broad study of the pamphiliid sawflies being conducted by the senior author. From these a single male emerged on May 30, 1962. This is the first record of this European species in Canada. *A. erythrocephala* was first found in North America in 1925 when two males were beaten from pine and *Cornus* sp. at Chestnut Hill, Pennsylvania (Wells, A. B. Ent. News 37: 254-258, 1926). In 1937 it defoliated several acres of 5- to 12-foot red and Austrian pines in a nursery at Franklin Lakes, New Jersey, and was found to be widely distributed in the State (Soraci, F. A. J. New York Ent. Soc. 46: 326 and 444, 1938). In his comprehensive account of cephalcine pamphiliids, W. W. Middlekauf (U. of California Pub. in Ent. 14: 51-174, 1958) notes that it has since been found in New York State and Connecticut, and larvae have been found feeding on *Pinus resinosa, P. strobus, P. mughus, P. Montana, P. sylvestris, P. densiflora, P. Austriaca, P. pungens*, and *P. nigra* in the United States. Its Old World distribution is Great Britain, Central and Northern Europe to Lapland, Caucasus and Western Siberia, and Korea (by introduction) (Benson R. B. Handbooks for the identification of British insects, Roy. Ent. Soc. London, vol. 6, pt. 2(a), 1951). The significance of this insect in Ontario arises from its ability to cause serious defoliation to pines, which have been planted extensively in the southern part of the Province. —D. C. Eidt and J. R. McPhee.

Preliminary Decay Studies on Unaltered Samples Acquired from Wet and Dry Heartwood Areas of Living White Pines.—The heartwood of eastern white pine is characterized by the occurrence of distinct wet areas which surround embedded branches and also extend up and down the tree for various distances in the central and outer regions (Linzon, S. N. For. Chron. 34: 48-49, 1958). In artificial inoculations of living white pines with *Fomes pini* (Fr.) Karst, the relative rates of decay were similar in wet and dry portions of the heartwood (Linzon, S. N. For. Sci. 8: 163-167, 1962). Moisture contents of the wetwood were more than twice those of adjoining dry areas and fluctuated about the 200 per cent level (based on oven-dry weight (O.D.B.)). These were much higher than the moisture contents reported by previous investigators to be most favourable for decay in laboratory studies. Etheridge (Can. J. Bot. 35: 935-944, 1957) found for trunk-rotting fungi, including *F. pini*, that the most favourable moisture range for decay of sterilized and moisture-adjusted spruce wood was between 11 and 39 per cent of saturation (or approximately 49 to 103 per cent (O.D.B.)). Cartwright and Findlay (*In* Decay of Timber and its Prevention, p. 38, 1958) reported that moisture contents between 35 and 50 per cent of saturation were most favourable for the growth of wood-rotting fungi. In an attempt to resolve the apparent differences in moisture relations obtained by the author in the forest, experiments were initiated in the laboratory. This report presents reasons why specimens of fresh heartwood from eastern white pine altered as little as possible from the natural state should be acquired for use in laboratory decay studies and how these pieces were aseptically obtained.

Previous laboratory studies in which specific moisture contents of excised wood specimens were desired have always involved the sterilization of the test pieces prior to moisture adjustment. The sterilization has been carried out by various methods including autoclaving with superheated steam under pressure, fumigating with chemicals, or swabbing with alcohol (Basham, J. T. Can. J. Bot. 35: 31-34. 1957). These methods, however, were considered to alter the chemical and physical properties of the wood and it would be misleading to apply these results to those occurring "in vivo". Moreover, in white pine heartwood discs removed from the tree, water was lost rapidly from the wet zones upon exposure. When the discs were soaked in water after drying, the moisture permeated the discs uniformly. Individual pieces of dried wetwood rarely absorbed sufficient water to regain their original water content. Consequently, unaltered heartwood specimens were collected as follows and used in the laboratory studies. The outer bark of the portion of the felled tree to be dissected was disinfected with a 95 per cent aqueous solution of ethanol. Discs 1½ inches thick were cut and the sapwood and bark removed with disinfected tools. The remaining blocks of heartwood, containing wet and dry portions, were wrapped securely in new aluminum foil to prevent loss of moisture during transportation to the laboratory.

In an inoculation room ½-inch squares were cut from wet and dry areas under aseptic conditions and without any sterilization, each was placed in a flask containing *F. pini* growing on malt agar. The flasks were then closed with rubber stoppers. Moisture contents (O.D.B.) were determined for the wet and dry areas of heartwood immediately adjoining the pieces of heartwood which were used in the tests. No contamination appeared in any inoculation chamber by the end of the second year and certain of the wood specimens were thoroughly decayed irrespective of their derivation from wet or dry regions of the heartwood.

Further studies are being considered to compare the effects of *F. pini* on unaltered samples acquired from wet and dry heartwood areas of eastern white pine with that on wood that has been sterilized by various methods and moisture-adjusted. —S. N. Linzon.

ROCKY MOUNTAIN REGION

Notes on Itame loricaria julia Hlst.—This Geometrid is a common defoliator of trembling aspen and willow in Alberta, but also feeds on other deciduous trees and sometimes on white and Engelmann spruces. Alberta Forest Insect Survey records show that in the past 15 years it has caused light to moderate defoliation in localized area. The numbers have varied from area to area but it appears to have been most abundant in outbreak areas involving other aspen defoliators such as the Bruce spanworm, *Operophtera bruceata* (Hulst) and the forest tent caterpillar, *Malacosoma disstria* Hbn. Since 1960 it has increased in numbers in the east, central, and north-western parts of the Province. In that year 96 collections comprising 258 larvae were received through normal survey channels. Ninety-four samples were received the following year containing 344 larvae. By 1962 the number of collections had increased to 180 (875 specimens) with an average of 4.9 larvae per collection.

Mature larvae are about one inch long and vary from yellowish-green to medium brown. The yellowish-green phase is unmarked except for a solid yellow lateral line. The head is pale green. The brown phase usually has dark slanted lateral marks on the third, fourth, and fifth abdominal segments. The head is reddish-brown and the yellow lateral line is broken. It is distinguishable from the Bruce spanworm by having thin, longitudinal lines forming a body pattern and by lacking the distinct dorsal and subdorsal lines that characterize the Bruce spanworm.

Nothing was found in the literature regarding the biology of this insect, but collection and rearing records at Calgary show that the eggs hatch from about the middle of May to early June and that feeding lasts for 2-3 weeks. Feeding may continue until near the end of June. The adults emerge about ten days after pupation.

Male adults have pectinate antennae and a wing expanse of approximately one inch. The forewings are silver grey with a brownish pattern. The hind wings are pale yellow with a greyish border. Female adults have filiform antennae. Their wings are light grey with brownish tips, and are reduced to an expanse of less than 0.5 inches which makes them unserviceable for flight.—D. S. Kusch.

Effects of White Pine Blister Rust in Limber Pine Stands of Alberta.—Limber pine, *Pinus flexilis* James, is native to the mountains and foothills of Alberta and extends from the International Boundary to the North Saskatchewan River. It occurs in either small pure stands or singly in mixture with alpine fir. It has little commercial value, but by occupying an ecological niche unsuited to any other tree species it has a significant effect on watershed stabilization. White pine blister rust was detected in 1952 on limber pine in the Alberta foothills west of Pincher Creek. Since then other infections have been found from the International Boundary north for about 90 miles. The rust has been taken on ribes as far north as the Red Deer Ranger Station, which is approximately 100 miles north of the nearest known infection on limber pine.

In September, 1962, an extensive survey was made of the Alberta foothills to determine the incidence of the rust and the amount of damage caused by this disease. Most of the stands in the areas of Mill Creek, North Fork Drywood River, Spiankop Creek, Yarrow Creek, Dunvarvan Lake, and all of the stands of limber pine in Waterton Lakes National Park were heavily attacked. Up to 97 per cent of the trees were infected and mortality as high as 39 per cent was recorded. Mortality attributable to rust had not occurred north of these areas but in the vicinity of Connelly Creek, Cow Creek, and Todd Creek about 80 per cent of the trees were infected. Some of the trees at Cow Creek had up to 3 trunk infections and as many as 42 active rust cankers on their branches.

Sample plots were established in representative stands at three locations designated as the southern, central, and northern parts of the limber pine region of Alberta. The following summary illustrates the decreasing incidence of rust from south to north. The incidence of rust cankers in the southern plot could not be obtained because of heavy tree mortality in that area.

Location	Percentage of total trees[1]			Av. no. infections per tree	
	Infected	Top-killed	Dead	Active	Total
Southern	100	100	83	Unknown	Unknown
Central	96	74	29	2	19
Northern	79	29	Nil	6	10

A special survey was made of limber pine on the east slopes of Sofa Mountain in Waterton Lakes National Park in 1958. At that time 75 per cent of the stand was infected. A resurvey in 1960 showed that 100 per cent of the stand was infected and that light tree mortality had occurred. Another survey of the same area late in 1962 revealed that 83 per cent of the trees had been killed by rust and that about 25 per cent of the trees had died in 1962. All of the limber pine regeneration in the area was heavily infected.

Limber pine appears to be uniformly highly susceptible to white pine blister rust in the Alberta foothills. In many cases gaps in the range of the host have been effectively bridged by the rust through long distance spread. Intensification within stands appears to have been very rapid and by all indications the rust threatens complete eradication of limber pine in Alberta.—E. Gautreau.

BRITISH COLUMBIA

Translocation of Actidione and its Persistence in Douglas Fir Foliage.—During the fall of 1960, a series of Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) trees were stem-treated with different concentrations of Actidione BR Concentrate. The purpose of the experiment was to demonstrate systematic movement of the fungicide and to establish a period of time during which the material could be detected in the foliage of treated trees.

Trees were sprayed with concentrations of 100, 200, 400, and 800 ppm of the antibiotic in a stove oil carrier, and one tree of each concentration was sampled on each of 11 sample days between August, 1960, and February, 1961. Two 400-gram samples of foliage were collected from each tree, one from the middle and one from the upper third of the crown. The samples were packaged separately and quick-frozen prior to processing.

The process techniques used were developed by Lemin et al (For. Sci. 6: 306-314, 1960) for use in similar studies on western white pine (*Pinus monticola* Dougl.). Macerated Douglas fir foliage, when treated with methylene chloride, gave excessive amounts of residue which was reduced in amount through the addition of reagent grade acetone. Only that portion of the residue soluble in acetone was used in chromatographic separation. Aliquots of extracts 0.1 ml in volume were spotted on Whatman No. 1 paper and 0.005 ml of a solution of crystalline Actidione (cycloheximide) in methanol was spotted on the same paper as a standard. Papers were equilibrated overnight in a chamber saturated with a 1:1:2 mixture of benzene, methanol, and distilled water and were developed with the upper phase of the mixture as the solvent. Developed chromatograms were air-dried, placed on an agar tray previously inoculated with the yeast assay organism, and incubated overnight at 30°C. The agar trays showing inhibition caused by cycloheximide were photographed immediately after incubation.

The results of the experiment showed that detectable amounts of Actidione may be found in the foliage of trees 192 days after being stem-treated with concentrations of Actidione as low as 100 ppm. Evidence of upward translocation of the antibiotic was found in the upper foliage extracts of all trees sampled the first day after spraying.

Some trees failed to give positive results. These failures, occurring in 25 per cent of the sampled trees, have been attributed to differences in translocation rate and pattern between trees as shown by Hendrickson and Vité (Contrib. Boyce Thompson Inst. 20: 353-362, 1959) and to dissipation of the antibiotic prior to sampling. One-half of the negative results occurred in samples taken after 4 months and the remaining half were interspersed with positive results throughout the earlier sampling periods.

The data indicate that Actidione, applied to the stems of Douglas fir trees under 20 years of age will, in the majority of cases, be translocated to the foliage and persist for at least six months.—L. C. Weir.

Pine Butterfly Infestation in Interior British Columbia.—A localized infestation of pine butterfly, *Neophasia manapia* Feld., was discovered in a discrete open stand of ponderosa pine in the summer of 1962 at Okanagan Landing, Vernon, B.C. This is the first known pine butterfly infestation in the interior of British Columbia; several have been recorded in Douglas fir at the Coast. The Okanagan infestation blanketed some 400 acres of lightly timbered hill-side facing eastward onto Okanagan Lake. Excepting several trees, defoliation in 1962 was barely noticeable; on the other hand production of adults and eggs was tremendous. The number of eggs per cluster ranged up to 30, with an average of 7.6 and mode of 12. A sample ponderosa pine tree, 14 inches d.b.h. and 40 feet tall, bore about 26,000 eggs on the old foliage and almost 25,000 eggs on the new foliage.

The majority of eggs overwintered successfully and hatching began late in May, 1963. The larval population was extremely large but severe defoliation did not become apparent until the first week in July; by that time some 100 acres of ponderosa pine 2 to 14 inches d.b.h. had been almost completely stripped of needles. By June 28, pupae were present; by July 9, male butterflies were in flight. By mid-July butterflies were flying about the infested trees in spectacular numbers.

The population in this stand of marginal ponderosa pine may decline because of the current unfavourable weather conditions and reduction in the available foliage. Nevertheless a good population probably will persist in 1964 around the periphery of severe infestation and it is predicted that some tree mortality will occur.

Some dispersal of adults beyond the infested stand occurred late in July on hot, calm days and this could result in an increase in the number of infestations.—D. A. Ross.

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QUEBEC

Frost Injuries on Branches of Aspen.—In July, 1962, a striking leaf dwarfing in 15- to 18-year-old aspen stands along the Matapedia Valley was brought to the author's attention (personal communication, R. Martineau).

Field and laboratory observations were made on a few hundred branches which were collected in 1962 and 1963 from three of the most severely affected areas, within a band approximately ½ mile wide, extending over a distance of 5 miles west of Routhierville. The characteristic symptoms in 1962 were dwarfing, deformation, and blighted-like portions of the leaves, and one to many canker-like lesions (from 2 to 17 mm. in length and 1 to 5 mm. in width) on the twigs. The following table presents data on the occurrence and the average frequency and size of these small lesions.

Age of twig	No. examined	No. with visible lesions	Average no. of lesions per affected twig	Average length of lesions (in mm.)	Average width of lesions (in mm.)
2-year-old (1960)	315	207	2.0	5.3[a]	3.0[a]
1-year-old (1961)	382	277	2.7	4.8[a]	2.5[a]
Current year (1962)	248	55	1.6	3.8[b]	1.8[b]

[a]—102 lesions measured
[b]—45 lesions measured

These lesions were observed most commonly opposite a leaf or twig insertion. Cross-sections through the central portions of the lesions indicated completely necrotic and distorted phloem and xylem tissues. This disorder often extended to the opposite side of the twig but was not visible externally. On living branches, callous tissues had developed, which sometimes extended from the pith at the extremities of the wounds, and gave rise to new xylem and phloem elements. Similar differentiation had occurred in the pericycle. Because high temperatures had been recorded throughout the Province in the spring, winter drought was at first thought to have been the initial cause of the lesions. However, their occurrence over a distance of a few inches from the base on the current (1962) shoots indicated that late frost was most probably involved. Below-freezing temperatures were registered in the area on June 4, 6, 7, and 19, 1962.

Of a total of 700 twigs examined in 1962, 274 were already dead or had no living buds. In July 1963, leaves on the current shoots were normal, but the trees had thin crowns because the majority of twigs affected in 1962 had fallen.

The following fungi, listed by decreasing order of frequency, have been either isolated from (60 wounds) or observed fruiting on the twigs: *Cytospora chrysosperma* (Pers.) Fr.; *Pleurostromella* sp.; a Dothidea-like fungus; *Alternaria tenuis* series; *Pezicula ocellata* (Pers.) Seav.; *Aureobasidium pullulans* (de Bary) Arnaud; *Coniothyrium* sp.; a Fumago-like fungus; and *Nodulisporium* sp. Some of these fungi may have acted as weak pathogens and ultimately caused the death of twigs. Basidiomycetes were not encountered, except for *Corticium galactinum* (Fr.) Burt in two instances, and *Peniophora* sp. which was isolated once.—G. B. Ouellette.

ONTARIO

Some Field Observations on the Cicada, Okanagana rimosa (Say).—In the fall of 1961 numerous cicada nymphs were found feeding on the roots of young red pines in sections of the Kirkwood Forest Management Unit, Sault Ste. Marie District. The species was later identified by Mr. John E. H. Martin, Entomology Research Institute, Ottawa, as *Okanagana rimosa* (Say). Reference to available literature did not reveal any information on the habits or destructive potential of this insect. Consequently, some field observations on the pest were made in the spring and early summer of 1962 as a contribution to knowledge of the insect complex believed to be deleteriously affecting the growth of planted trees in the Kirkwood area.

Although unseasonably warm weather prevailed throughout the district during April and early May, emergence of adult cicadas did not begin until the last week of May and reached a peak in mid-June. Cast skins were commonly found in groups at the burned bases of large, old pine stumps, individually on the lower branches of young pine trees and deciduous shrubs, and on the soil surface. Some adults were observed mating as late as July 3 but no adults were observed after July 10.

The first egg scars were noted on June 26. Hosts for oviposition included trembling aspen, serviceberry, white birch, red maple, willow, hazelnut, large tooth aspen, choke cherry, and pin cherry. Oviposition was most frequent upon trembling aspen, but this may have been due to the fact that it was the most common species of tree in the immediate area. Egg scars were prevalent on trees up to six feet high, but none were noted in the upper branches of tall trees that were felled and examined. No oviposition was observed on any coniferous hosts, probably because of the pitch characteristics of these species.

The eggs are creamy white, elongate, and spindle-shaped, and are arranged in a double row at an acute angle to the stem. They may be deposited on any side of a branch or on the leader. The female assumes a position parallel to the branch and progresses toward the apex, cutting egg pockets and depositing eggs as she advances. Thus, the eggs nearest the base of the branch are always laid first. The diameter of twigs used as oviposition sites ranged from 3/32 to ¼ inch. Counts of 100 oviposition scars showed that the number of egg pockets per scar ranged from one to 23, and the number of eggs per pocket from seven to 12. The time required to make an individual slit and to deposit its complement of eggs was noted on several occasions and averaged 11 minutes. Egg masses tagged in the field immediately following deposition on July 4 hatched on July 12, whereas eggs taken to the laboratory for rearing required 10 days of incubation. Oviposition activities frequently caused twig mortality.

During 1962, adults of *O. rimosa* were collected in the Bridgeland, Haughton, Kirkwood, Rose, Shields, and Parkinson townships, and on St. Joseph's and Cockburn islands. In each case the general site was a dry, sand flat with scattered hardwoods growing among red pine plantings. It is believed this insect may have a four-year life cycle as adults were numerous and collected by A. A. Harnden, Forest Insect Survey, in Parkinson, Haughton, and Township 188 in 1958. Obervations to confirm this will be continued during the next few years.—C. S. Kirby and H. G. McPhee.

Apion simile Kirby, a Weevil Inhabiting White Birch Cones.—In 1962 larvae and pupae of *Apion simile* were found in mines within maturing female cones of white birch (*Betula papyrifera* Marsh.) near Black Sturgeon Lake, Ontario.

A. simile is holarctic, occurring in Europe, Algeria, Asia Minor, Siberia, in Canada from Newfoundland to Manitoba, and throughout much of the United States (Kissinger, D.G. Proc. U.S. Natl. Mus. 110: 247-389, 1959). Little biological information is conveyed in the literature beyond casual observations on the occurrence of the adults, although this species has been reported as common in France and abundant in New England. Some records associate this weevil with galls but generally, the adults have been taken from leaves or obtained by sweeping vegetation.

The present observations on *A. simile* commenced in late June. By this time the larval stage was well advanced. Mature larvae collected July 14 had head capsules measuring 0.44 mm. in width. One smaller cast head capsule was collected from larval mines, perhaps indicating only two larval instars. Pupation occurred during the second week of July, with the duration of the pupal period estimated at approximately two weeks. Adults first appeared in containers of infested cones on July 17 and were common by the beginning of the third week of July. Peak adult emergence occurred during the last week of July and first week of August. Additional collections of cones in early August did not contain weevils, although their abandoned mines could be readily identified. A few adults were observed crawling on birch leaves in mid-August.

Caged adults extensively skeletonized the surface of leaves. The weevils are believed to overwinter as adults, perhaps in the litter on the ground.

Larvae of *A. simile* mine through successive seeds in the basal portion of the scales, adjacent to the rachis of the cone, destroying them. Short, frass-filled tunnels circle the rachis of infested cones. Damage by individual larvae is not extensive, a few seeds being sufficient for their requirements. External characteristics of infested cones include: asymmetry caused by growth retardation of scales near the feeding sites; browning of some scales in the immediate vicinity of the damaged area; and slight crooking. Twenty collections of 50 cones from 16 trees were dissected. Between 10 and 98 per cent of the cones in these collections were infested. In 13 collections, the infestation exceeded 50 per cent of the cones. Frequently, the number of larvae or pupae per cone was only one or two, although as many as eight individuals were collected from a single cone. Only one larva was found in each mine.

Larvae of *A. simile* are frequently parasitized. Species of parasites reared from white birch cones, and identified by personnel of the Entomology Research Institute, Ottawa, include: *Pteromalini* sp., *Euderus* sp., *Tetrastichus* sp., *Amblymerus* sp., and *Elasmus* sp. In addition, larvae and adults of an unidentified cecidomyiid, nymphs and adults of a pentatomid, and eggs of two other insect species were collected from infested cones. Occurring less frequently were lepidopterous larvae of *Eucordylea* sp., *Epinotia* sp., and an olethreutid, identified by Mr. O. H. Lindquist, Forest Insect Laboratory, Sault Ste. Marie, Ontario. Adults of *A. simile* were identified by Dr. D. G. Kissinger, Atlantic Union College, South Lancaster, Massachusetts, U.S.A.—H. Herdy.

Melanagromyza schineri (Giraud) on Trembling Aspen in Ontario.—During 1961 and 1962, all stages of *Melanagromyza schineri* (Diptera: Agromyzidae) were collected from galls on trembling aspen (*Populus tremuloides* Michx.) in the vicinity of Black Sturgeon Lake, Ontario. The biology and behaviour of this insect have apparently never been studied in detail. *M. schineri* is also known to occur in Europe in *Salix* spp., and on *Populus* spp. in Massachusetts, Colorado, and Washington in the United States (Frick, K.E. Proc. U.S. Natl. Mus. 108:347-465, 1959).

M. schineri usually attacks young aspen reproduction less than 1 inch D.B.H., ranging from 2 to 10 feet in height, in sheltered, sunny clearings. The incidence of galls in a typical stand was recorded in one area of approximately one-half acre. Of 1,488 stems, 14.6 per cent bore one or more galls.

During the first half of June, at about the time aspen shoots commence to elongate, the adult flies emerge from galls formed the previous summer. Swellings, 7-20 mm. in length, occurring singly and in clusters of six or more, are noticeable near the end of June on the current year's growth at the base of the buds of the leader and laterals. By mid-June, cylindrical eggs, 0.40 by 0.17 mm., bearing the developing embryo are present immediately beneath the surface of the swellings above a point where the shoot has been penetrated. *M. schineri* larvae, approximately 0.48 mm. in length, are present in the third week of June and continue development throughout the summer. Overwintering within the galls, the larvae, which are approximately 3 mm. long, pupate during the latter part of May. Before pupation, the larva tunnels from the center of the gall toward the surface. The puparium is formed at the distal end of this tunnel immediately beneath the surface of the gall. Several days prior to emergence of the adult, a small, circular, darkish spot, indicating the position of the exit hole, is noticeable on the gall surface. During early June, mating of adults was observed in cages containing young aspen. Oviposition was not observed, but subsequent swelling and gall formation occurred on many stems.

Adults of *M. schineri* and those of two chalcids, *Eurytoma* sp. and *Halticoptera aenea* (Walker), have been reared from galls and identified by personnel of the Entomology Research Institute, Ottawa. However, there is some confusion as to the association of the chalcid species with *M. schineri*. Eggs bearing a pedicel were found in galls from early August to September and some have been located adjacent to *M. schineri* larvae. It is suspected that these are eggs of *Eurytoma*. A female chalcid identified as *Eurytoma* sp., was observed piercing a gall with its ovipositor on July 31. Larvae of *Eurytoma* sp. are present in galls by mid-August, when they are actively mining. These larvae overwinter within the galls, pupating in early May, and emerge about the same time as *M. schineri* adults.

Only about 21 to 33 per cent of the galls yield adult insects. This was demonstrated when galls in eight replicates from 25 trees were collected and the adults recorded as they emerged. The incidence of *Eurytoma* sp. and *H. aenea* was frequently two or three times that of *M. schineri*.—H. Herdy.

PRAIRIE PROVINCES

Viability of Basidiospores of Polyporus tomentosus Fr. Following Storage.—In September, 1962, basidiospores of *Polyporus tomentosus* Fr. were collected near Candle Lake, Saskatchewan, on sterile glass slides placed beneath 29 sporophores *in situ* for periods of 24 to 48 hours. The slides and sporophores were covered with sheets of plastic. The basidiospores were tested for viability, and the slides were placed in sterile petri plates and stored overwinter in an unheated building. Basidiospores from 21 of the sporophores were viable when collected; when tested eight months later (May 30, 1963), spores from four sporophores were still viable (0.4 to 7.5 per cent germination).

On September 14, 1962, basidiospores were collected in the same way from 12 of the above sporophores. On the day of collection, the slides bearing the spores were placed in sterile petri plates containing moist cotton. The plates were divided into four groups and a group was placed at each of 0, 20, 32, and 45°F. Basidiospores collected from the sporophores on other slides were viable when collected. Tests on November 19 showed that spores from two sporophores stored at 0° and from one stored at 20° were still viable. On November 27, the slide containing the latter (germination of 38 per cent) was cut into four pieces and one piece was placed at each of 0, 20, 32, and 45°F in moist petri plates. On March 1, 1963, 22 per cent of the spores stored at 0° germinated but no germination was obtained from those stored at 20°. Those stored at 32° and 45° were heavily contaminated with bacteria, yeasts, and other fungi and were apparently not viable. A further test on May 21, 1963, resulted in an average of 1.3 per cent germination at 0° and 0.8 per cent at 20°.

No germination was obtained when the spores from the two slides stored continuously at 0° and viable on November 19, 1962, were again tested on May 21, 1963.

The above tests indicate that, although viability is much reduced, some basidiospores of *P. tomentosus* can germinate after exposure to normal winter temperatures in Saskatchewan. They also show that freshly collected spores placed immediately and stored at 0°F can survive for at least eight months and that germination from one fruiting body was still fairly good (22 per cent) after 5½ months under these conditions. Considerable variability in basidiospores was indicated by lack of viability of those from some sporophores and by the variable conditions under which germination takes place with spores from different sporophores.—R. D. Whitney and J. Belcher.

Saperda calcarata Say in the Root Collar of Poplars.—Observations have been continued on the species of *Saperda* reported earlier (Bi-Mon. Prog. Rept. 17 (2): 2. 1961) attacking the root collar of trembling aspen (*Populus tremuloides* Michx.) and balsam poplar (*Populus balsamifera* L.) in Manitoba and Saskatchewan. Adults reared from larvae removed from the root collar area of these hosts have been identified as *Saperda calcarata* Say by H. F. Howden, Entomology Research Institute, Ottawa. According to the literature, this insect feeds in the trunk and larger branches of the hosts.

Field observations to date indicate that the life history of the root-collar form is similar to that attacking the trunks and branches as described by Peterson (Ann. Rept. Ent. Soc. Ont. 78: 56-61. 1948). The occurrence of the two forms in distinctly different ecological situations, however, is of particular interest. Peterson's account of the bole form in this region indicates that it occurs principally on trembling aspen around the margin or in openings of parkland stands. Oviposition and larval feeding occur almost exclusively on the main stem below or in the lower section of the crown canopy and only rarely below one foot above ground level. Within the range of 2 to 5 inches D.B.H., larger trees are preferred and trees below this range appear to be avoided. The root-collar form appears to be restricted to small, scattered trees less than 2 inches D.B.H., 5 to 18 years of age, growing on poor, dry sites and feeds in the heartwood only slightly above or below ground level.

Linsley (Ann. Rev. Ent. 4: 99-138. 1959) points out the need for additional attention to the taxonomy of this genus, with particular reference to the probable occurrence of sibling species and host strains. Further study of the taxonomic identity of the two forms appears to be warranted.—H. R. Wong, B. B. McLeod and J. A. Drouin.

ROCKY MOUNTAIN REGION

Insects Associated with the Engelmann Spruce Weevil, Pissodes engelmanni Hopkins.—A number of parasites and one predator of the Engelmann spruce weevil, *P. engelmanni*, have been individually and mass reared from leaders of western white and Engelmann spruce collected in southwestern Alberta and adjacent southeastern British Columbia. Specimens reared in 1960 have been identified as follows:

Order	Family	
Hymenoptera	Eurytomidae	*Eurytoma pissodis* Gir.
	Ichneumonidae	*Dolichomitus terebrans nubilpennis* (Vier.)
		Exeristes comstockii (Cr.)
	Chalcididae	*Rhopalicus pulchripennis* (Cwfd.)
		Amblymerus sp.
	Braconidae	*Helcostizus rufiscutum* Cush. (first record for C.N.C.)
		Eubadizon strigitergum Cush.
		Eubadizon sp. A (first record for C.N.C.)
		Eubadizon sp. B. (first record for C.N.C.)
		Bracon pini (Mues.)
Diptera	Lonchaeidae	*Lonchaea* sp. nr. *corticus* Tayl.

Complete information is not yet available but differences were apparent in the geographic distribution of six species making up the parasite complex. Only one species, *Eurytoma pissodis,* was common to all collection areas.

All parasites have been found to be univoltine, overwintering as larvae or prepupae in weevil pupal chambers. The incidence of parasitism during the excavation of pupal chambers by weevil larvae in late July was 29 per cent; this percentage was based on an examination of 358 pupal chambers.

Parasite and predator rearings from weevil infestations in northern Alberta and the Northwest Territories are currently being conducted. The results of these rearings and observations on parasite life histories will be reported at a later date.—R. E. Stevenson.

BRITISH COLUMBIA

Decline and Mortality of Douglas Fir in the Interior Wet Belt.—Decline and mortality of Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) prior to the established rotation age of 160 years has been evident for several years in parts of the Nelson and Kamloops forest districts. The diameter and height increment of affected trees is reduced markedly and reduction in foliage density is common. Symptoms occur in trees as young as 60 years old. The percentage of dead trees and those with decline symptoms varies considerably, although as much as 50 per cent of the Douglas fir in some stands are affected. Initial results of a survey in several areas of the Interior Wet Belt suggest that no single factor is responsible for all the decline and mortality encountered.

Although root rot caused by *Poria weirii* Murr. resulted in considerable mortality in areas of the Interior Wet Belt transitional to the Interior Douglas Fir Zone (Krajina, V. Univ. Brit. Col., Bot. Series No. 1. 1959), this disease seems to account for little of the mortality encountered in the Interior Hemlock Zone. The characteristic laminated rot present in the stumps of fallen trees provides ready identification of the disease in established infection centers. It is considered likely that advanced decay would be evident at the root collar of some of the trees that had been dead for several years if Poria root rot had caused an appreciable percentage of the mortality present in the Interior Hemlock Zone.

Unlike *Poria weirii, Armillaria mellea* (Vahl ex Fr.) Kummer was frequently found in the Interior Hemlock Zone at the root collar of both dead trees and living trees with decline symptoms. However, there is doubt that Armillaria root rot plays a significant role in the decline of trees without host pre-disposition. The presence of callused Armillaria lesions at the root collar of some trees indicates that invasion by this fungus has been checked. The occurrence of adventitious branching on many trees with callused lesions likewise suggests a sequence of host weakening and subsequent recovery of vigour.

Polyporus schweinitzii Fr. was associated with root and butt rot in some windthrown trees. Fruiting bodies were also found near the butt of living thin-crowned, and standing dead Douglas fir. However, evidence of *P. schweinitzii* infection was so infrequent that this fungus was thought not to contribute significantly to the decline encountered.

Douglas fir needle blight caused by *Rhabdocline pseudotsugae* Syd. was recognized for the first time during this survey as the cause of severe defoliation of pole-sized Douglas fir in the Interior Wet Belt. In many trees, defoliation had occurred for at least six years, leaving little but the current year's foliage and giving twigs a characteristic "fish-tail appearance. While repeated severe defoliation could weaken trees sufficiently to cause death, the occurrence of *R. pseudotsugae* was too inconsistent to warrant assigning this fungus a primary role in decline.

Douglas fir bark beetles (*Dendroctonus pseudotsugae* Hopk.) cause some mortality each year in the Interior Wet Belt, but outbreaks are less severe than in the Interior Dry Belt (Annual Reports, Forest Insect and Disease Survey, Can. Dept. Forestry). Although assessment is difficult in Douglas fir which has been dead for some years, few of the dead trees in the stands examined showed evidence of severe bark beetle attack. Douglas fir bark beetles, therefore, probably account for a relatively small proportion of the mortality present in the Interior Hemlock Zone.

On shallow-and coarse-textured soils, the death of some trees may be directly attributable to drought. On other sites, drought is more likely to act as a predisposing factor promoting invasion by organisms which could eventually result in decline and death. Water deficit may be a factor in the decline which sometimes follows partial cutting. When dominants and co-dominants have been cut on a diameter limit basis, residual trees which were formerly in the protected lower canopy are likely to be exposed to greatly increased transpiration stress. Such stress may render residual trees susceptible to attack by relatively weak pathogens.

Douglas fir, like western white pine (*Pinus monticola* Dougl.), is a pioneer species which rarely occurs with a frequency of more than a few trees per acre in overmature stands in the Interior Hemlock Zone. The prevalence of these species in adjacent immature stands suggests, however, that they were more numerous when such overmature stands were young. A reduction in the frequency of white pine and Douglas fir following the pole stage is therefore to be expected. Pole blight, evident on certain sites during the past few decades, may be an unusually sudden decline in the vigour of pole-sized white pine brought about because the summers between 1930 and 1946 were abnormally hot and dry. The occurrence of decline and mortality of Douglas fir, most of which likewise cannot be ascribed to a specific organism, may have been similarly initiated. It should not be concluded, however, that decline in Douglas fir will necessarily result in losses as great as those attributable to pole blight. A comprehensive study of the silvics of Douglas fir in the Interior Wet Belt, including the role of insects and pathogens, would be necessary for a proper understanding of the origin of decline and for the determination of appropriate rotation ages for specific sites.—A. C. Molnar, R. G. McMinn, and A. T. Foster.

A Note on the Use of Tetrazolium Chloride for Sapwood Staining.—Tetrazolium chloride (2,3,5, triphenyl tetrazolium chloride—TTC) has recently been used in this laboratory for indicating viability or metabolic condition of sapwood cells in Douglas-fir logs. Although a number of tests of tetrazolium staining have been made with plant material, only a few have involved sapwood (e.g., Kayll, A. J. Canada Dept. Forestry Pub. 1006. 1963.). Because of this, a brief description of our experience with this stain may be useful to others.

It was found, using small blocks of sapwood, that the time required for staining is considerably longer than one is led to expect from published information. One often finds a recommended staining time of four hours, or even less. We noted little or no indication of staining in this interval. Usually colour is faint even at 24 hours and reaches full intensity only after 48 to 72 hours or more at room temperature (68°F.) The long time needed for colour to appear may be due to slow penetration of the tetrazolium into the sapwood cells where the reaction takes place.

After staining, radial surfaces of freshly cut sapwood show conspicuous red streaks, due to colouring of the ray parenchyma cells. Cells associated with resin ducts are also coloured. After logs are cut, a gradual loss of ability of sapwood to stain with tetrazolium occurs. Samples tested some months after felling are negative in reaction or show only occasional light pink streaks associated with the ray parenchyma. A subjective scale of staining intensity has proved useful in comparing different samples.

When thin radial sections, cut from fresh material with a sliding microtome, were first tested the results were unexpected, as no staining occurred. On the basis of many subsequent tests it was found that with sections less than a certain thickness there was little or no staining, although blocks from which the sections were cut showed a strong reaction. But as section thickness was increased, the staining reaction became stronger until finally it was comparable with that in the blocks. Mechanical damage such as scratches, bruises, or cuts results in localized loss of staining reaction in sapwood blocks. We assume, therefore, that pressure of the knife or bending of the thin sections as they are cut, stress or damage the living cells, resulting in loss of their staining ability.

A series of tests were made with sections of different thickness cut from sapwood of Douglas fir, western red cedar, and western hemlock (logs of the former, sapling material of the latter two). Results are summarized in the accompanying table and illustrate the relation between section thickness and staining reaction. Each rating represents a combined subjective value from two to four replications. The data also show that this phenomenon differs in various tree species. This may be due to differences in sapwood physical properties and, therefore, in the stresses to which the living cells are subjected as thin sections are cut.

Time and section thickness in relation to tetrazolium staining reaction in three tree species

Section thickness-microns	Douglas fir 24	Douglas fir 48	Douglas fir 72	Hemlock 24	Hemlock 48	Hemlock 72	Cedar 24	Cedar 28	Cedar 72
	Time—hours								
30	0[1]	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0
50	0	x	x	0	0	0	0	0	0
60	x	x	x	0	0	0	0	0	0
80	x	x	x	0	0	x	0	0	0
100	x	x	x	0	x	x	0	0	0
140	x	x	x	x	x	x	0	0	0
180	x	x	xx	x	x	x	0	0	0
200	x	x	xx	x	x	x	0	0	0
300	x	x	xx	x	x	x	0	x	x
400	xx	xx	xx	x	xx	xx	x	x	x
800	xx	xx	xx	xx	xx	xx	x	x	x
block	xx	xx	xx	xx	xx	xx	xx	xx	xx

[1]0—no colour
x—pink
xx—red

—J. A. Chapman and S. H. Farris.

Effects of Systemic Antibiotics on Needle-cast of Douglas Fir Three Years after Application.—In 1960, trees infected with *Rhabdocline pseudotsugae* Syd. were treated with various concentrations of Phytoactin, Actidione (cycloheximide), and chemical derivatives of cycloheximide (Weir, L.C., For. Chron. 39: 205-211). Infected needle and tree mortality counts for these trees have been recorded annually since 1961. In 1961 it was found that basal stem applications of concentrations ranging from 100 to 800 ppm resulted in the death of 51 per cent of the trees so treated. By 1963 this value had increased to 59 per cent. Corresponding figures for trees treated with foliar applications were 5 per cent and 7 per cent. No mortality has been recorded for the check trees during the three-year period.

Two compounds, Phytoactin and cycloheximide thiosemicarbazone, appear to be the most promising of the materials used. Little phytotoxicity, and good control of needle-cast resulted from their application both as basal stem and foliar sprays. The percentage of infected needles for check trees in 1961 was 34 per cent while those for trees treated with the two compounds were 8 per cent and 7 per cent respectively. In 1962 the check tree infection level rose to 51 per cent and the levels for the Phytoactin and cycloheximide thiosemicarbazone treated trees were 18 per cent and 20 per cent. However, in 1963, the check tree level rose to 53 per cent but the levels for the two compounds returned to 8 per cent and 9 per cent. No explanation can be offered for this apparent lack of consistency.

Where tree survival has permitted assessment of infection levels on trees treated with basal stem applications, the highest percentage of infected needles recorded in 1963 was 17 per cent. Similar levels of infection were recorded for foliar sprays with the exception of cycloheximide methyl hydrazone which, as in 1961, resulted in an infection level not significantly different from check trees.—L. C. Weir.

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ATLANTIC PROVINCES

Notes on Laricobius erichsonii, an Introduced Predator of the Balsam Woolly Aphid, in Newfoundland.—A biological control program against the balsam woolly aphid, *Adelges piceae* (Ratz.), in Newfoundland was initiated in 1952. Since then, 40,548 adults of a predacious beetle, *Laricobius erichsonii* Rosen., have been introduced from Europe to southwestern Newfoundland. These notes are based on recovery records and field observations on adult beetles in the Humber Valley where 7,969 were released in 1958 and 1959.

Recovery methods included the use of glass barrier flight traps, detailed inspections, and sweeping of tree stems. The barrier trap (Chapman, J. A. and J. M. Kinghorn. Can. Ent. 87:46-47. 1955) consisted of a 5.7 square-foot glass pane over a tray of detergent-treated water. Each trap was suspended between two trees in a relatively open area under the forest canopy. Ten traps were placed in an east-west line at variable intervals up to 10 miles from the Humber Valley release site in 1961 and 16 traps up to 20 miles in 1962 and 1963. Daily inspections of tree stems were made from early April, when snow still covered the forest floor, to the beginning of May. The sweeping technique, used by European collectors, involved sweeping the lower 8 feet of the bole with a soft-bristle brush, and collecting the adults from a white sheet placed around the root collar of the tree.

The overwintering site of the beetle is near the ground surface. Spring emergence patterns suggest that callow adults disperse at random to the bases of trees and overwinter in the humus layer. Similar habits have been reported in Europe (Franz, J. Entomophaga III(2):109-164. 1958), but in New Brunswick the beetles overwinter at a depth of 1 to 4 inches in the mineral soil (Clark, R. C. and N. R. Brown. Can. Ent. 90:657-672. 1958).

Activity of mature *L. erichsonii* adults in the spring is related to snow cover and temperature. No beetles were seen on tree stems whose root collars were covered with snow, a few were found where the snow had receded 6 inches on the trunk, and high numbers were observed where a foot or more of ground was exposed around the base of the tree. In 1960, six crawling beetles were seen on April 29 on the sunny side of a tree; two of them were mating. Similar activity was observed on April 17 in 1963 and peak numbers occurred on April 28; the number of beetles collected from each tree decreased daily after April 29. Spring emergence in Europe commences around the beginning of April and at the beginning of May in New Brunswick. In Newfoundland, crawling and mating adults were observed when the daily temperature exceeded 45° F. and adults flew when temperatures exceeded 55° F. The first barrier trap record in 1963 was obtained on April 22 and peak captures were made between May 9 and 24. It appears that mating was the primary activity after emergence and flight was probably indicative of host searching and egg laying. Franz found that mating commenced at 52° to 55° F. with most specimens mating and flying at 57° to 59° F.

The 1961 trap records showed that the greatest flight activity of callow adults occurred during the first half of August. In New Brunswick and Europe, peak emergence from pupae was observed 2 to 3 weeks earlier.

The accompanying table shows that sweeping tree stems was the most productive and efficient method of obtaining *L. erichsonii* adults. Barrier captures were erratic because some trap locations were changed between the years. Nevertheless, the records showed that the predator had spread 1.65 miles east of the release site by 1961 and 0.75 miles west by 1962. No further extension was recorded in 1963. The front of the aphid infestation had advanced eastward about 20 miles between 1958 and 1961.

L. erichsonii has become established in the Humber Valley as shown by the recovery and dispersal records. However, severe crown deterioration of balsam fir, *Abies balsamea* (L.) Mill., from aphid feeding was prevalent in areas of high predator numbers. It appears that *L. erichsonii* has been unable to maintain aphid densities at acceptable low levels.—D. G. Bryant.

NUMBER OF *LARICOBIUS ERICHSONII* ADULTS COLLECTED DURING TWO GENERATIONS FROM 1961 TO 1963

	Collection method		
	Hand picked	Barrier traps	Sweeping
1961 callow	3	54	—
1962 mature	2	5	—
1962 callow	0	1	—
1963 mature	61	51	2,000

QUEBEC

Factors Predisposing Sugar Maple to Premature Leaf Coloration and Leaf Fall.—Premature leaf coloration and leaf fall were very pronounced on sugar maple in Quebec in 1962. To determine the factors predisposing trees to this condition, 245 sugar maples in Beauce, Lévis, and Portneuf counties were examined *in situ* in late August. Foliage condition and the presence of cankers, wounds, decay, and other abnormalities were recorded.

Of the trees examined, 148 showed premature leaf coloration and leaf fall and of these, 140 were diseased or wounded. Forty-three had frost cracks; 28, trunk cankers including sunscald; 8, mechanical wounds on trunk or main branches; 6, root injury and/or root rot; 8, signs of trunk rot without visible wounds; 14, diseased or broken branches; and 33, more than one of the abnormalities listed. A close relationship appeared to exist between the severity of wounds, cankers, and decay and the extent of the condition. Sixty-eight of the 97 trees with healthy foliage possessed one or more abnormalities. These were generally less severe than those on trees with affected foliage.

Twenty-six affected branches, mostly from trees on which they were the only parts showing damage, were examined in the laboratory and found to have wounds as follows: 16, sunscald-like injuries; 4, dead bark patches as the result of branch bending; 3, many hail-like injuries; 2, sapsucker injury; and 1, a mechanical wound. The sunscald-like injuries, which sometimes were from a few inches to 1 or 2 feet long, had occurred mostly in the springs of 1961 and 1962 on the underside of branches. Winter drought and subsequent freezing may have been involved.

In 1963, premature coloration was much less apparent. However, the foliage on some trees was affected and this was again associated with wounds or disease.

The above observations indicate that trees with wounds, decay, or other diseases respond more drastically than healthy trees to the conditions that are responsible for premature leaf coloration and leaf fall.—G. B. Ouellette and G. Bard.

Notes on the Red-headed Pine Sawfly, Neodiprion lecontei (Fitch), in Quebec.—For several years this insect has occurred in large numbers in a few widely separated plantations of red, jack, and Scots pine in the Eastern Townships of Quebec. In uneven-aged plantations, where the three pine species are intermixed, the sawfly is found more abundantly on red pine, and infestations intensify from the smaller trees (3 to 4 feet in height) to the larger trees (25 and more feet in height). In some plantations mortality has been evident for the past three years, mostly in smaller trees. In the most heavily infested plantation, near Drummondville, about 75% of the trees in a 5-acre area of 6-year-old red pine, and about 1% of the trees in a 15-acre area of 30-year-old red pine have been killed since 1960. Although the sawfly is abundant in blocks of jack pine and Scots pine in this plantation, no mortality is evident in these hosts.

In an endeavour to determine the role played by larval parasites in controlling the sawfly population, about 2,000 larvae were collected in the field during the first week of September in 1962 and allowed to spin cocoons in cages. After 2 months of cold storage the cocoons were placed in a rearing room at high humidity. The parasite, *Perilampus hyalinus* Say, emerged from about 20% of the cocoons, and *Spathimeigenia* sp. emerged from about 2% of the cocoons. Traces of a virus disease were found during the 1962 rearings. Subsequent field observations indicated that populations of the sawfly were substantially reduced by this virus in 1963.—R. J. Finnegan.

Correction.—In the article by G. B. Ouellette entitled *"Frost Injuries on Branches of Aspen"*, Vol. 19, No. 5, *Corticium galactinum* (Fr.) Burt should read *Corticium polygonium* (Pers. ex Fr.) Fr.

ONTARIO

The European Spruce Sawfly in Ontario, 1936 to 1962.—The European spruce sawfly, *Diprion hercyniae* (Htg.), was first reported in Ontario in 1936 (Balch, R. E. Pulp Paper Mag. Can. 38(3):249-255. 1937), but probably was present in this Province somewhat earlier because a specimen was captured in Quebec near Ottawa in 1922. The insect spread rapidly, as shown on the accompanying map, and in 1938 was found near Michipicoten, which was widely separated from the principal infestation (Balch, R. E. Pulp Paper Mag. Can. 40(3): 199-204. 1939). Another isolated infestation of moderate intensity appeared in 1947 at Kirkwood, about 50 miles east of Sault Ste. Marie. A striking increase in distribution was noted in 1950, when a few specimens were collected in northwestern Ontario near Fort Francis. This extremely light infestation probably originated from the adjacent State of Minnesota, where the sawfly had been reported as early as 1942. From 1950 to 1960 infestations tended to enlarge and coalesce, and by 1962 infestations in northwestern and northeastern Ontario had almost merged. The sawfly now occurs in all jurisdictional forest districts with the exception of the Sioux Lookout District.

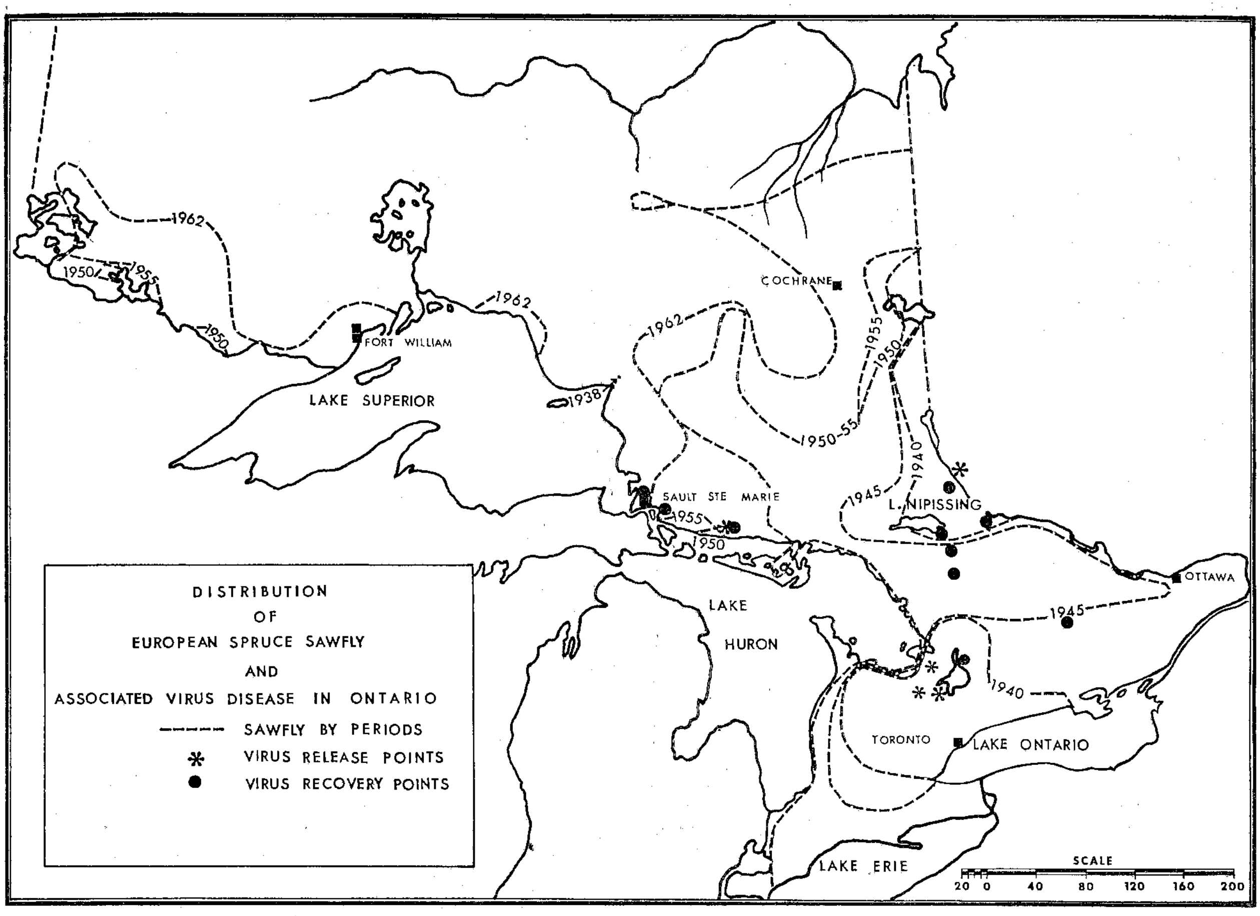
Sawfly population levels have never approached those in the Gaspé Peninsula or New Brunswick in the 'thirties, although exceptional tree-samples yielded up to 400 larvae. Populations have fluctuated strikingly from year to year in the same stands, but appreciable defoliation occurred only rarely. In 1960, the Forest Insect Survey established 55 spruce sampling stations in this Province. These are sampled in May, July, and September. Within the limits of its known distribution, the sawfly has consistently been the most abundant defoliator in these samples, although the sample trees have shown only a trace of defoliation.

Prospects of damage to spruce stands stimulated attempts at biological control in Ontario through the use of a virus and introduced parasites. Artificial dissemination of the virus in or near Ontario was tried seven times at five locations: 1941, Angus; 1942, Laniel, P.Q., Angus, Ont.; 1945, Stroud and Orr Lake Forest; 1949, Kirkwood; and 1950, Kirkwood. Except for the Laniel attempt, the early introductions were not followed by adequate studies on establishment. Possibly faulty timing or unsatisfactory application were the causes of apparently poor establishment in some instances, but more sophisticated procedures in the 1950 application (Bird, F. T. and J. M. Burk. Can. Ent. 93: 228-238. 1961) were strikingly successful. The year following the 1950 application at Kirkwood, larval mortality from the virus occurred on seven sprayed trees, with none on the 13 check trees, and the virus had spread one-half mile. The sawfly and associated virus were studied for ten years, and Bird and Burke concluded that the virus kept the sawfly population below the level that could cause economic damage.

Since 1951, the Ontario Section of the Forest Insect Survey has been examining diseased or unhealthy larvae in field-collected samples of forest insects. Provisional identifications are checked by specialists of the Insect Pathology Research Institute. In 12 years 64 samples of *D. hercyniae* (one to 12 or more larvae per sample) were examined, and 17 showed positive virus infection, but the source of infection in seven samples is questionable because of possible contamination in the laboratory. The distribution of the remaining 10 positive samples (see map) falls far short of the actual distribution of the virus because the procedure was not designed solely as a virus survey. Nevertheless, there is no evidence of the establishment of the virus in northwestern Ontario.

Attempts to control *D. hercyniae* by parasite introductions covered the period 1936 to 1951, and the results of this program to 1958 were reviewed by McGugan and Coppel (*In* Review of the Biological Control Attempts Against Insects and Weeds in Canada. Tech. Comm. 2, C.I.B.C., Trinidad. 1962). The parasites released against the sawfly in Ontario included three species of cocoon parasites and 10 species of larval parasites. Only four species were recovered from the sawfly to 1958, one species of cocoon parasite, *Dahlbominus fuscipennis* (Zett.), and three larval parasites, *Drino bohemica* Mesn., *Exenterus amictorius* (Panz.), and *E. confusus* Kerr. Because of light cocoon populations and lack of quantitative sampling, the true value of the introduced parasites is not known in Ontario outside the Kirkwood area. However, A. H. Rose, of the Sault Ste. Marie Laboratory, has been studying the distribution of cocoon parasites by "planting" sawfly cocoons in small cages buried in the forest floor. The source material consists of *D. hercyniae* and *Neodiprion sertifer* (Geoff.) collected as larvae and reared to the cocoon stage, with *sertifer* predominating. The cocoons are then placed in cages with a mesh that will permit entry of cocoon parasites while excluding mammalian predators. By this method Rose has demonstrated wide distribution of *D. fuscipennis* in southern Ontario. At the same time he has recovered additional samples of *D. bohemica* and *E. amictorius* from *D. hercyniae*. The distribution of these will be reviewed in a later paper.

High host density was considered to be a requisite for the successful establishment of *D. fuscipennis* on *D. hercyniae*



(Reeks, W. A. Can. Jour. Agr. Sci. 33: 405-429. 1953), but this opinion was questioned by Turnbull and Chant (Can. J. Zool. 39: 697-753. 1961) in their account of biological control in Canada. These authors erroneously state that "*D. fuscipennis* is not a parasite of *D. hercyniae* or *D. polytomum* in its native home", and suggested that this reason, rather than low host density, accounts for "the failure of the parasite in Canada." Actually, *D. fuscipennis* was reported as a primary parasite of *D. polytomum* in Europe when *polytomum* and *hercyniae* were synonymous (Morris, R. K. S., E. Cameron, and W. F. Jepson. Bull. Ent. Res. 28: 341-393. 1937), and absence of the parasite from European collections before 1935 was attributed to the solitary habits and comparative scarcity of *D. polytomum*. Recent studies on the European pine sawfly, *N. sertifer*, by L. A. Lyons and K. G. Griffiths (unpublished report), suggest that *D. fuscipennis* may be no more successful on *N. sertifer* in Ontario than it was on *D. hercyniae*. Fall counts of new cocoons of *sertifer* on a study plot near Chatsworth averaged 3.4, 2.6, and 0.6 per sq. ft. in the years 1960, 1961, and 1962, respectively. None of the cocoons were parasitized by *D. fuscipennis* in spite of the fact this species was recovered from cocoons placed artificially on the forest floor in 1960 and 1961. Whether density is a requisite for the successful establishment of *D. fuscipennis* has been neither satisfactorily proved nor disproved, but there is growing evidence that accessibility of host cocoons is important to the success of this parasite.

Although Turnbull and Chant (*op. cit.*) caution against introducing many species of organisms to control a single pest species, the danger of multiple introductions is not confirmed by field studies on *D. hercyniae* in eastern Canada. Admittedly, some of the parasite introductions against *hercyniae* cannot be justified, but Bird and Burke (*op. cit.*) showed very clearly that control of *D. hercyniae* was more effective in New Brunswick by virus and introduced parasites combined than in Ontario by virus alone. The advantages and disadvantages of the single species over the multiple species concept in biological control is an intriguing subject that warrants much more study.—W. A. Reeks.

Excessive Red Oak Mortality Following Ice-storm Damage.—During the summer of 1963, heavy mortality and severe deterioration were observed in a 250-acre, two-storied, mixed hardwood stand about 25 miles north of Toronto. Red oak, black cherry, and white ash were the species most seriously affected. The site has a southeasterly aspect and the exposure is open. It is situated on rolling sand dunes covered by a layer of humus 2-8 inches thick. The site is rated very good for red oak and growth has been rapid. Stocking density based on stems per acre and including all species is high. The stand originated from a fire about 80 years ago, and today the oaks average 14.0 inches d.b.h. and 90 feet in height. Oak is estimated to comprise 65% of the basal area of the stand. Light selective thinning has been carried out during recent years.

In a one-acre sample representative of oaks in the area, mortality was 42%. The remaining oaks were stag-headed or showed serious dieback symptoms. The most seriously diseased trees were characterized by browning and dying of all leaves and by numerous adventitious shoots particularly on the lower parts of their stems. The adventitious shoots also showed foliar symptoms and dieback. Stem cores from representative specimens of severely diseased trees showed that a sharply reduced increment (approximately 50%) had occurred between the 1959 and the 1960 growing seasons and that this decline had continued so that very little growth was made in 1963. Similar, but less pronounced reductions were observed in cores taken from trees representative of healthier oaks in the stand.

Examination of the roots and stems of dying and recently dead trees revealed signs of the shoestring root rot fungus, *Armillaria mellea* (Vahl ex Fr.) Kummer. These consisted of mycelial fans and rhizomorphs which occurred consistently in the cambial region of the roots of all trees examined and the mushroom-type fruiting structures which were generally present at the base of the most decadent trees throughout the area. Two ascomycetous fungi consistently associated with the dieback condition in the crowns were *Pseudovalsa longipes* (Tul.) Sacc. and *Diatrypella quercina* (Pers. ex Fr.) Nits. *P. longipes* is usually considered a weak parasite capable of causing cankers and dieback in weakened oak; *D. quercina* is a saprophyte.

In 1959, this stand was in a healthy condition. However, during the winter of 1959-60 an unusual series of three ice storms occurred in rapid succession throughout the south-central region of southern Ontario. The resulting heavy accumulation of ice caused widespread and severe breakage of large branches in the crowns of dominant and co-dominant hardwoods. Besides providing infection courts for fungi such as *P. longipes* and *D. quercina* this damage caused an abnormally small crop of new leaves to be formed in the spring of 1960. Undoubtedly, this reduced the vigour of the oaks and other dominant species by curtailing photosynthesis, food production, and wood formation and so predisposed them to infection by *A. mellea*. This predisposition was aggravated by overstocking combined with the root-grafting habit of oak which is conducive to the spread of this root-transmissible pathogen.

When the natural thinning process now in progress has been completed, it can be expected that the residual trees will regain vigour and benefit from the reduced competition.—B. W. Dance and D. F. Lynn.

BRITISH COLUMBIA

The European Pine Shoot Moth in British Columbia.—The European pine shoot moth, *Rhyacionia buoliana* (Schiff.), was first observed in British Columbia at Victoria in 1927. Its discovery in Vancouver in 1938 resulted in an eradication program in 1939. During the past 20 years it has been collected only in occasional samples from the Vancouver and Victoria areas.

The moth was first found in the Interior of British Columbia on two ornamental pine trees at Kelowna in 1961, and again in 1962. By this time the insect had been detected in Washington and Oregon, and entomologists were particularly concerned about its presence in Spokane. If the moth became established there is might accept ponderosa pine as a host, possibly becoming a problem in the important pine stands of the Inland Empire. An eradication program was initiated, and all known infested pines in the Spokane area were destroyed.

In 1963, a comprehensive survey was carried out in the southern part of British Columbia. More than 11,000 pine trees were examined during May and June. Over 5,100 of these were from major population centres in the Okanagan Valley, 200 were in the Trail and Creston areas, and the remainder in Vancouver and Victoria. All infested pine shoots were collected and caged for rearing.

A number of shoot-boring insects were recorded from the reared material, but the European pine shoot moth was identified only in 16 collections from the coastal region; eight from greater Vancouver and eight from greater Victoria. Six of these collections were from nurseries and ten from trees in private and public gardens. The number of records indicates that the species is established in the two major urban centers although the intensity of attack is quite light.

In the Interior, no insects were present on trees examined at Trail and Creston, but shoot moth adults were reared from collections made at Kelowna, Westbank, Summerland, and Penticton. One mugho pine in a retail outlet at Vernon was also infested, and another pine in Polson Park contained evidence of an old attack, but no adults were obtained for positive identification. All but three of the records from the Okanagan Valley were from nurseries.

The most significant record was an European pine shoot moth female reared from a mature ponderosa pine collection from the Summerland Experimental Station. The female mated with a male from mugho pine and laid eggs on a caged ponderosa pine at Vernon. At least three larvae hatched and mined into shoots. The female was identified by T. N. Freeman, Entomology Research Institute, Ottawa, as *R. buoliana*.

The presence of the European pine shoot moth in the Okanagan Valley represents a potential danger for several reasons. Although no extensive infestations were found either on native or ornamental host species, there is evidence that the insect is capable of overwintering in the Interior climate.

Although only a single record of the shoot moth on ponderosa pine was obtained, it does show that the insect will accept ponderosa pine as a host in its native habitat.

There is a possibility that the shoot moth could be more prevalent than the survey indicated. The time during which the major portion of the survey was conducted, April and May, is now regarded as too early in the season to detect all infested shoots. This was indicated when a re-examination of a nursery on May 27 and 28, over a month after the initial survey during which four infested trees were found, resulted in the detection of a dozen more infested trees. In addition less than 300 ponderosa pine were examined as the survey was concentrated on the preferred ornamental hosts.

The use of pines for landscaping is becoming more widespread, thus increasing the risk of introducing more shoot moth into the region. In some localities the number of trees in nurseries is greater than the number already planted out. In Kelowna, where the survey was conducted on a systematic street by street basis, less than 400 ornamental pines were found. Nurseries in the Kelowna-Westbank area had over 2,700 ornamental pines in stock.

It is possible that the European pine shoot moth might not develop into an economic problem in the Interior. Further surveys and studies will be required to determine the population trend, but it could be several years before the significance of this pest in British Columbia has been adequately assessed. In the meantime officials of the Plant Protection Division, the Department of Forestry, the British Columbia Forest Service, and the Provincial Entomologist are studying the situation to determine if preventive measures should be taken to reduce the likelihood of establishment of this pest.—G. T. Silver and D. A. Ross.

Use of Organic Residues in Forest Nurseries.—Residues such as sawdust, cereal straw, mushroom manure, and hay have been added as soil amendments and as mulches to reduce frost heaving in British Columbia nurseries. Several instances have been noted recently which suggest that the indiscriminate addition of organic residues to seedling beds is potentially a dangerous practice.

In Douglas-fir beds at the Duncan nursery, a prolific crop of a mushroom, *Hebeloma sordidulum* (Peck) Sacc., occurred in the autumns of 1961 and 1962 following the application of mushroom manure. Other species of this genus have been reported as mycorrhiza formers in conifer seedlings (Trappe, Bot. Rev. 28: 538-606, 1962) but the possibility of parasitic invasion of roots should not be dismissed. At the Chilliwack nursery, an unidentified mushroom grew prolifically following the use of hardwood sawdust as a mulch. In Douglas-fir and white spruce beds at the Cranbrook nursery, extensive patches of dead seedlings were observed after alfalfa hay was applied. There were no such patches in beds to which the mulch was not added. A high count of *Rhizoctonia* colonies was recorded in agar plates in which samples of the hay and of the dead seedlings were plated. This fungus is often found associated with damping-off disease. It seems probable that in all three cases the fungus population was either introduced or increased by the organic residue. In addition, it is possible that toxic decomposition products of the hay predisposed the seedlings to attack by the fungus (Patrick and Koch, Can. J. Bot. 36, 621-647, 1958).

Of the types of mulches currently in use at the nurseries, fresh sawdust from sound conifer logs seems to be preferable to the others. For example, hemlock sawdust yielded less than one-half the number of fungus colonies that wheat straw did when plated on malt agar using sterilized sand dilution. *Trichoderma* predominated in the sawdust plates; this fungus is believed to restrict the growth of pathogenic fungi (Wood and Tveit, Bot. Rev. 21: 441-492, 1955). *Alternaria* was the main fungus in the wheat straw; it is often found in damped-off seedlings (Hartley and Merrill, J. Agr. Res. 15: 521-558, 1958; Vaartaja and Cram. Phytopath. 46: 391-397, 1956; Peace, Clarendon Press, Oxford. 1962) and may be pathogenic under some conditions. In view of the experience so far with organic residues as mulches, it is proposed to carry out routine assays of the microbial content of materials intended as additives in the nurseries.—W. J. Bloomberg.

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