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ENTOMOLOGY

Timing Cacodylic Acid Treatments to Kill Mountain Pine Beetles Infesting Lodgepole Pine.—Cacodylic acid (dimethylarsenic acid) introduced into the sapwood of host trees has been shown to cause mortality to adults and larvae of *Dendroctonus adjunctus* (Hopk.), *D. rufipennis* (Kirby), *D. pseudotsugae* Hopk., and *D. ponderosae* Hopk. while they are under the bark (Chansler and Pierce, J. Econ. Entomol. 59:1357-1359. 1966). Cacodylic acid has been applied both before and after beetle flight (Chansler et al. USDA Forest Serv. Res. Note RM-161, 1970). Living ponderosa pine (*Pinus ponderosa* Laws.) treated with cacodylic acid before beetle flight were intended to act as attractive trap trees, but attack densities were less on these trees than on untreated trees and, therefore, the treatment was not effective in controlling the beetle population. Postflight application of cacodylic acid was successful, causing almost 100% mortality of parents and brood under the bark.

In 1976, lodgepole pine trees (*Pinus contorta* Dougl.) were treated with cacodylic acid immediately after attack by mountain pine beetles in a pine forest in the Cariboo Forest District. In the spring of 1977 a random selection was made from these trees. Nineteen were sampled at 1.5 m height, eight at 3 m and seven at 6 m. Sampling consisted in taking two 10.16 cm diam samples at each height and counting live and dead parents and progeny. The data obtained (Table 1) show that, when the treatment was applied soon after attack, its lethal effect was not diminished with height on the boles of the trees up to at least 6 m, which, in many trees, included the attacked portion.

An experiment to determine the effective timing of cacodylic acid treatment to cause mortality of *D. ponderosae* in lodgepole pine was carried out in the Cariboo Forest District in the summer and fall of 1977. One hundred and fifteen naturally infested pines were selected for postflight treatment, and other surrounding attacked pines were used as checks. Twenty-five trees were treated on 10, 15, 22, and 29 August, and a further 15 trees were treated on 19 September. These dates represented 16, 21, 28, 35, and 56 days, respectively, after the main beetle flight and attack. Treatment for each tree consisted of 1 mL full-strength Silvisar 510^{R} (cacodylic acid, Ansul Co., Marinette, Wis., U S A) for each 2.5 cm circumference, applied in a continuous shallow ax frill around the bole about 25 cm above the ground. Care was taken to ensure that the cacodylic acid was concentrated in the outer sapwood that was adjacent to the cambium and inner phloem in the area where the beetles developed. In treatments of spruce (Dyer, Can. J. Forest Res. 3:486-494, 1973), poor results were obtained when the ax frill was cut unevenly into the sapwood.

On 29 September, nine trees, selected at random from the 25 trees of each of the first four groups of treated trees, and 20 untreated infested trees were sampled by taking two 10.16 cm diam circular bark samples from each tree at breast height. In mid-October, all 15 of the trees

TABLE 1
Mortality of mountain pine beetles at various heights in lodgepole pine trees treated with cacodylic acid immediately after beetle attack in 1976 and sampled in June 1977

Height of sample (m)	No. of trees sampled	No. of beetles[1]					
		Parent adults		Larvae		Pupae	
		Live	Dead	Live	Dead	Live	Dead
1.5	19	1	56	0	67	0	0
3.0	8	0	23	0	101	0	0
6.0	7	1	11	0	166	1	0

[1]Based on two 10.16 cm diam bark samples per tree at each height.

TABLE 2
D. ponderosae adult and larval mortality in lodgepole pine treated with cacodylic acid (Silvisar 510) after beetle attacks, 1977

Days after attack when treated	Days after attack when sampled	No. of bark samples[1]	No. of adults per sq m			No. of larvae per sq m		
			Mean	SE[2]	% dead	Mean	SE[2]	% dead
16	56	18	144	37	95	1906	177	96
21	56	18	116	27	100	1885	202	99
28	56	18	145	33	57	2618	168	25
35	56	18	226	39	58	1412	183	38
56	71	30	111	21	0	2213	42	0
Untreated	58	40	80	13	42	1934	159	3

[1]Two samples at breast height per tree.
[2]SE—Standard error.

treated on 19 September were sampled in the same way. The numbers of attacks, live and dead adults, and live and dead brood were counted for all samples. There was no significant difference ($p < .05$) in attack or subsequent brood density among trees of any treatments.

Table 2 shows brood densities and percentage mortality for treatments and checks. Those trees treated up to 3 wk after the initial beetle attack showed 95 - 100% parent and brood mortality, but this rapidly decreased for treatments made during the next few weeks. Treatment after 5 wk produced no mortality in either parents or brood.

Treatment with cacodylic acid on infested lodgepole pine is effective in killing both adult and immature mountain pine beetles throughout the infested parts of the boles. However, application must be made within 3 wk after attack to be fully effective. Five weeks after attack application is partially effective but 8 weeks after attack it is ineffective.—E.D.A. Dyer and P.M. Hall, Pacific Forest Research Centre, Victoria, B.C.

PATHOLOGY

Stem Decay in Balsam Fir Damaged by Balsam Woolly Aphid.—Schooley (For. Chron. 52:143-144, 1976), describing the recovery of young balsam fir (*Abies balsamea* [L.] Mill.) damaged by the balsam woolly aphid (*Adelges piceae* Ratz.), pointed out that 40% of the tops of dominant and codominant trees were killed. Virtually all of these trees reestablished height growth on primary branches that turned upward to assume the leader position. Tree stems were not usually seriously deformed, but the dead leaders remained as potential sites for the development of decay, as Stillwell (Forest Sci. 2:174-180, 1956) has shown to be the case with leaders killed by the spruce budworm. The hypothesis that decay enters through dead leaders is supported by Lortie (Laval Univ., Forest Res. Found. Bull. II, 1968), who studied a young stand in which 75% of the trees showing evidence of leader replacement had decay. Aphid-killed leaders on young trees were thought to be favorable infection courts because they retain a near vertical orientation and could be subjected to high moisture conditions for many years. A study was therefore conducted to determine if decay actually occurs at this location on aphid-damaged balsam fir and what fungi are associated with the decay.

TABLE 1
Types and percent frequency of organisms isolated

Microorganisms isolated	Number of leaders with these organisms	Number of isolations	Percent frequency of total isolations
Bacteria	12	29	21.3
Imperfect fungi	11	41	30.2
Polyporus sp.	1	5	3.7
Stereum sanguinolentum	1	12	8.8
Sterile	14	45	33.1
Contamination	4	4	2.9

Eighteen fir trees from the stand described by Schooley (1976) were examined. They averaged 25 yr of age at the stump, 5 cm dbh, and 3.2 m in height, and had an average of 13 yr of stem growth acquired after the recovery of their tops. The original leader, or portion thereof, was still visible on all trees, and many more years of growth would be required by most trees to overgrow or enclose these dead leaders within the stem. The dead leaders on all trees were less than 2.5 cm in diameter. A 30 to 60 cm stem section that included the point of attachment of the original leader was cut from each tree and split longitudinally. At least six isolation samples were taken from each stem section and cultured on 2% malt agar medium.

The organisms isolated and their frequency are given in Table 1. Culturing showed that 85% of isolations were sterile or contained only non-decay-causing microorganisms. More than eight species of imperfect fungi were present, but an ascomycete, *Ascocoryne sarcoides* (Jacq. ex Gray) Groves and Wilson, that often occurs in balsam fir (Etheridge, Laval Univ., Forest Res. Found. Bull. 13, 1970) was not found. The decay fungi, *Stereum sanguinolentum* (Alb. & Schw. ex Fr.) Fr., and a *Polyporus* sp. were present. Each infected one tree.

It is reported that *S. sanguinolentum* is a primary invader of injuries in living balsam fir and that the infection occurs mainly the year of the injury (Etheridge, Can. J. Bot., 47:457-479, 1969). This means that further infection by *S. sanguinolentum* of the type of wound studied is unlikely. No other basidiomycetes are known to occur as frequently as *S. sanguinolentum* in decay of balsam fir, and the *Polyporus* sp. was not isolated frequently enough to be of significance in causing decay.

The diameter of dead leaders has been indicated as the main factor influencing their susceptibility to infection (Davidson and Etheridge, Can. J. Bot., 41:759-769, 1963). Stillwell (1956) found that dead leaders of less than 1.3 cm diameter are not infected and Lortie (1968) reported that dead leaders less than 2.5 cm in diameter on young and vigorous fir are not infected. This size limitation on infection could possibly apply also in the small diameter, aphid-damaged trees examined.

The present study has shown that young fir with aphid-killed leaders are usually not susceptible to decay, and further assessments of the impact of aphid damage should consider these findings.—H.O. Schooley, Newfoundland Forest Research Centre, St. John's, Nfld., and G.J. Laflamme, Entomology and Pathology Service, Quebec Ministry of Lands and Forests, Ste. Foy, Que.

Sexuality in *Scirrhia pini*.—*Dothistroma pini* Hulbary, the conidial state of *Scirrhia pini* Funk and Parker, is very widely distributed in the world and causes a serious needle blight of pines. The ascigerous state is common in western North America but is rarely found in New Zealand or East Africa, where the disease may be severe. Ivory (Trans. Br. Mycol. Soc. 50:563, 1967), in East Africa, unsuccessfully attempted to produce the ascigerous state in infected pine needles and in cultures by simulating conditions found in western Canada. This note describes an experiment designed to determine the functionality of the spermatia in naturally infected needles and to make possible the observation of the reproductive organs.

Materials used in this study were obtained from southern Vancouver Island, the type locality of *S. pini*, where the fungus has a 1-yr life cycle. Naturally infected needles of lodgepole pine (*Pinus contorta* Dougl.) were used to obtain the sexual structures as well as the ascospores and conidia from which cultures were made on 2% Difco malt agar.

Because the spermatia are adapted to water dispersal, a large number of heavily infected branches of pine were kept completely dry during the spermatization period and were then compared with those subjected to natural wetting. In both cases, 4-5% of the infections produced the ascigerous state (100 stromata of each were sectioned and observed).

The ascogonia with trichogynes and the spermagonia (spermatial locules) are produced in separate stromata. Trichogynes usually arise from a small stroma beneath the host epidermis and extend well above it. Spermatia usually form in erumpent stromata in which macroconidial locules are also commonly found. Trichogynes are brown, septate, 36-100 μm long, and 4-5 μm wide at the base; ascogonia are brown, coiled, or flexuous and approximately 20 μm long, and the width of the widest cells is 6 μm.

Spermatial locules vary in size and position in the stroma and may attain a depth of approximately 60 μm. Columnar chains of spermatiferous cells, each with a protuberant, lateral phialide, are found in the locules. Spermatiferous cells are short, squarish, and hyaline or light brown and measure 3-4 μm in length and breadth. Spermatia are rod-shaped, hyaline 1.5 - 2.0 x 0.5 μm, and embedded in mucus and ooze out when spermogonia are moistened.

Neither spermatia nor ascogonia were produced in cultures made from ascospores or conidia. Spermatia did not germinate or grow in culture but swelled to approximately twice their original size when placed in water, indicating viability.

Scirrhia pini is shown to be morphologically bisexual, but there is no proof that the spermatia are necessarily functional or that the fungus is heterothallic. Rarity of the ascigerous state in many parts of the world might suggest the existence of mating types, but the presence of sexual structures has not been reported from other places where the fungus occurs.—A. Funk, Pacific Forest Research Centre, Victoria, B.C.

GENETICS AND TREE IMPROVEMENT

Height Growth of Russian Scots Pine Populations in Saskatchewan and Manitoba 15 Years after Planting.—A cooperative provenance test of Scots pine (*Pinus sylvestris* L.) from the USSR was initiated in May 1960, when 3-yr-old seedlings or transplants reared at the Petawawa Forest Experiment Station were planted at 20 locations across Canada (Teich and Holst, For. Chron. 46:325-328, 1970). In western Canada, plantations were established at Holbein and Indian Head, Sask., and at Carberry and Piney, Man. The Manitoba plantations have 10 populations in a randomized block design, with four replicates and 49-tree square plots at 1.8 m spacing. The Holbein plantation design differs only in having nine populations and 100-tree plots. The Indian Head plantation originally had two replicates with single-row plots of 50 trees at 1.2 m spacing, but the cutting out of some plots eliminated one population and left four of the remaining nine unreplicated. Eight of the 10 populations are present at all four locations. Local jack pine was planted adjacent to the Scots pine at Holbein. The Indian Head plantation is on a clay loam soil; the others are on sandy soils. Location and climate of the plantations and provenances are presented in Table 1.

Results were reported for the Saskatchewan plantations 7 yr after planting (Teich and Holst, 1970) and for the Manitoba plantations 9 yr after planting (Klein, Can. For. Serv. Inf. Rep. NOR-X-2, 1971). Three populations from the southern margin of the species' range in central Russia and the Ukraine (Voronezh, Orlov, and Kiev provenances) had above-average heights in all four plantations. One population, from western Siberia (Tobol'sk), was consistently below average. The other six populations, originating in central Russia and the Ural region, varied from below average to average or above average in their plantation height means. Survival was generally satisfactory at Indian Head and Piney, poor at Holbein, and variable among populations at Carberry.

These plantations were remeasured in 1974, after the 15th growing season from planting. Virtually all trees in all four plantations had

TABLE 1
Location and climate of plantations and provenances

Place name	Latitude	Longitude	Mean temp., °C Jan.	Mean temp., °C July	Mean annual precipitation mm
Plantations from west to east					
Holbein, Sask.	53°13'N	106°12'W	-19	18	380
Indian Head, Sask.	50°31'N	103°40'W	-17	19	380
Carberry, Man.	49°53'N	99°32'W	-17	19	480
Piney, Man.	49°05'N	95°55'W	-17	20	560
Provenances in order of overall height in source regions					
Voronezh	52°N	39°E	-10	20	520
Orlov	53°N	37°E	- 9	20	580
Kiev	50°N	30°E	- 5	20	620
Smolensk 2	54°N	32°E	- 8	20	580
Smolensk 1	54°N	32°E	- 8	20	580
Kaluga	54°N	36°E	-10	19	550
Chkalov	52°N	53°E	-13	22	250
Molotov	58°N	57°E	-15	19	600
Bashkiria	55°N	57°E	-14	20	580
Tobol'sk	58°N	68°E	-21	17	480

TABLE 2
Mean height at 15 yr from planting, by provenance and plantation, as a percentage of the plantation mean[1]

Provenance	Plantation: Holbein	Indian Head	Carberry	Piney	All plantations
Voronezh	108.9 ab[2]	106.6	114.1 a	105.5 b	108.8 a
Orlov	112.7 a	104.6	103.2 ab	104.4 b	106.2 ab
Kiev	103.7 abc	101.5	102.4 ab	111.7 a	104.8 ab
Smolensk 2	97.3 abc	100.8	100.0 b	103.9 b	100.5 abc
Smolensk 1	90.4 bc	101.0	103.2 ab	103.4 b	99.5 bc
Kaluga	91.7 bc	98.5	96.3 b	97.9 c	99.1 cd
Chkalov	-	104.1	99.2 b	104.4 b	102.6
Molotov	95.5 abc	96.7	99.3 b	90.7 d	96.6 cd
Bashkiria	100.0 abc	90.2	81.5 c	82.4 e	88.5 d
Tobol'sk	89.2 c	-	90.1 bc	85.2 de	88.2
Jack pine	100.0 abc	-	-	-	-
Plantation mean, cm	232	603	393	554	446
F-ratio provenances[3]	1.89 NS	-	4.56*	30.92*	6.19*
Coefficient of variation, %[4]	12.3	-	9.7	3.5	5.3
No. pair diff.	4		13	33	11

[1]Chkalov and Tobal'sk were excluded from the analysis across plantations, and from the plantation means in this table.
[2]Means in the same column followed by a common letter are not significantly different at Duncan's Test 5% protection level.
[3]Symbol * means significant at P = .05.
[4]Error standard deviation ÷ plantation or test mean.

stem crooks resulting from loss of the terminal shoot due to insect attack or other causes. There were minor incidences of gall rust at Holbein and Piney. This report deals with mean height based on all living plot trees at least 0.9 m tall. Analysis of variance and Duncan's New Multiple-Range Test were performed on plot means within each of the three replicated plantations. The same two statistical procedures were also performed across all four plantations, the input used being the plantation means for the populations, expressed as a percentage of plantation mean height. The plantation analyses included all populations, while the analysis across plantations included the eight populations common to all plantations.

The relative heights of the populations, presented in Table 2, show only minor changes from the previous reports. The three southwestern populations are still above average at all locations, but only Voronezh remains close to its earlier degree of superiority. All three are significantly superior to Kaluga, Molotov, Bashkiria, and Tobol'sk in mean height across plantations. The relative inferiority of Bashkiria to both Chkalov and Molotov, and Kaluga's performance similarity to distant Molotov rather than to nearby Orlov, indicate that the sample of populations in this test is inadequate for realistic inference of geographic pattern from these results. The mean height of the jack pine plots at Holbein was equal to the plantation mean and was not significantly different from the mean height of any Scots pine population in that plantation.

In planting Scots pine in environments similar to those of the test plantations seed from the top-ranked populations should be utilized when rapid height growth is desired. Provision of operational amounts of seed can be achieved by propagation of trees of the best populations, selected from within the test plantations. Only the Holbein plantation is capable of indicating whether the use of Scots pine rather than jack pine would be advantageous, but the available evidence is inconclusive.

The Petawawa Forest Experiment Station, the provincial forestry agencies of Saskatchewan and Manitoba, and the PFRA tree nursery at Indian Head, Sask., established and maintained the test plantations.
—J.I. Klein, Northern Forest Research Centre, Edmonton, Alta.

FOREST PRODUCTS

Kraft Pulping of *Larix* species.—Considerable interest has been shown lately in the potential use of the *Larix* species for kraft and mechanical pulps in North America. Few literature data are available on pulping North American *Larix* species, although these species are widely used for pulp in the USSR and elsewhere.

As part of a continuing program of evaluating the pulping potential of Canadian wood species, the Fibre Products Section of the Western Forest Products Laboratory studied the kraft pulping of tamarack (*Larix laricina* [Du Roi] K. Koch), alpine larch (*L. lyallii* Parl.) and Siberian larch (*L. sibirica* Ledeb.), all grown in Alberta and obtained from the Alberta Forest Service.

Three bolts (1 m long) from each of three trees per species were chipped and screened. The accept chips were kraft-pulped by conventional means with a "BK" precision digester assembly (Bagley and Keays, Tappi 53(10):19, 1970). Pulp strength evaluations and chemical tests were done according to standard TAPPI methods.

The organic-soluble contents of all three species were similar, but hot-water solubles of the heartwood (Table 1) were large (>15%) and diverse, the order being Siberian larch > tamarack > alpine larch. In general, all three species chipped normally and chip quality was good.

Kraft pulp yields were similar for all three species (Table 1). All three yields were lower (3 to 4% o.d. wood) than for other sound softwoods, with the exception of western red cedar, which also has a large and variable extractives content.

Pulp strength values of burst index and breaking length were hard to distinguish between species, but somewhat greater differences in tear

TABLE 1
Larix species pulp characteristics

Species	Unscreened pulp yield at 20 permanganate no.	Heartwood hot-water solubles	At 300 mL Csf[a]		
	Percent ovendry wood	Percent ovendry wood	Burst index	Tear index	Breaking length (m)
	Average values				
Tamarack	42.3 (41.4 - 43.3)[b]	23.5 (20.8 - 28.1)	8.4	15.9	11,400
Siberian larch	42.2 (40.6 - 43.6)	29.8 (25.8 - 34.3)	8.1	14.4	11,275
Alpine larch	40.6 (38.8 - 43.1)	19.6 (15.7 - 24.8)	8.8	13.7	10,900

[a]Canadian standard freeness.
[b]Figures in parentheses represent the ranges found for the three trees of each species.

index were noted (Table 1) for the small number of samples studied. The high tear and low burst index and breaking length are similar to values for Douglas-fir pulp, so that in mixed Douglas-fir—western larch stands, such as those adjacent to the Castelgar, B.C., pulp operation, separation of the larch has not been necessary.

The high hot-water solubles of the heartwood of all three species is disadvantageous in pulping, since the solubles consume some alkali, which then is not available for pulping; this results in considerably increased loads to the recovery boiler. Extraction of the hot-water solubles (arabino-galactan) before pulping leads to a commercial product sold in the United States under the trade name "Stractan" by St. Regis Paper Co. of Libby, Mont. This material competes successfully with gum arabic (Anon., North. Logger 11(7):16, 1963) in the market place. Gum arabic finds many uses as a stabilizer and emulsifier in various chemical, food, and pharmaceutical preparations.

This extraction procedure is practiced in the USSR on a fairly wide scale (Zaitseva, Tr. Inst. Lesokhoz. Probl. Akad. Nauk Latv. S.S.R. 16:223-32, 1958).

In the light of the high densities (ovendry weight/green volume) reported for the larches — tamarack 496 kg/m³ and western larch 449 kg/m³ (we have found alpine larch and Siberian larch to have values similar to those of western larch) compared with 368 kg/m³ for western hemlock — the three species studied give at least as good a pulp yield per unit volume of digester as other softwoods, in spite of their high solubles content (Wells and Rue, USDA Dep. Bull. 1485, 1927).

In all probability, for the time being, only small amounts of larch chips will be available to any mill (up to 5% of the chip supply), and the presence of any of the *Larix* species tested would not change the overall pulp product to any extent. If the larch chips were derived from sawmills, a higher proportion of sapwood would exist with its considerably lower solubles content; thus the effect of the larch sawmill chips would be even less than that of roundwood chips.—K. Hunt, Western Forest Products Laboratory, Vancouver, B.C.

FOREST PRODUCTS TECHNOLOGY

Formaldehyde Numbers of Solvent Extracts from Some Western Conifer Barks.—Steiner and Chow (Some factors affecting the use of western hemlock bark extracts for adhesives, paper presented to the IUFRO Adhesives Symposium Madison, Wis., May 1975) studied the adhesive potential of western hemlock bark extractives by physicochemical methods. The present study evolved from their work.

Differential thermal analysis and gelation studies showed that these extractives reacted with formaldehyde. The reaction had the character of a phenol-resorcinol-formaldehyde polymerization. The age of the bark and the temperature of the extraction greatly influenced the extractives' reactivity.

The objective of this research was to quantify the contribution of each extractive component, and the contribution of specific polyphenols to their adhesive potentials. Basic and practical knowledge gained could lead to a bark-derived adhesive as an acceptable replacement for the phenolic adhesives used either in exterior (plywood) or interior (particleboard) adhesive-type applications.

Samples of bark from *Abies amabilis, Picea glauca, Pinus contorta, Pseudotsuga menziesii,* and *Tsuga heterophylla* were obtained from freshly cut timber, through the efforts of our liaison section. The barks were air-dried, comminuted in a Wiley mill, and extracted with solvents in soxhlets.

The solvents were used in the sequence alcohol-benzene (1:2), ethyl alcohol, and water; each extraction was for 24 h. After the sequential extraction, the bark was taken out of the thimble, air-dried, and extracted with 1% aqueous sodium hydroxide. To obtain the base-soluble material, the air-dry, extractive-free bark was stirred overnight at room temperature with 100 mL of 1% aqueous NaOH. The suspension was filtered and the residue was discarded. The filtrate was acidified while being stirred with 1 N aqueous HCl to pH 3. The precipitate was recovered on the filter, washed with distilled water, and dried in a desiccator. Thus four extractives fractions (alcohol-benzene, ethanol, water, and base) were obtained from each bark sample.

The solvents were removed from the extractives fractions in a rotary evaporator and then dried in a vacuum (about 1 kPa) desiccator at room temperature over anhydrous calcium sulphate. Yields were recorded and calculated on an ovendry-bark basis.

TABLE 1
Sequential extraction of whole-bark extractives yield and formaldehyde number (FN)

Species	Alcohol-benzene		Alcohol		Water		Dilute base		
	Percent yield	FN	Percent yield	FN	Percent yield	FN	Percent yield	FN	Total yield
Abies amabilis	10.7		2.6	98	2.9	78	1.0	59	17.2
Pseudotsuga menziesii	18.6		2.0	87	1.7	96	7.5	36	29.8
Tsuga heterophylla	13.2	97	7.7	110	1.0	81	3.5	60	25.4
Pinus contorta	8.5		1.5	120	3.8	68	3.0	66	16.8
Picea glauca	10.2	52	4.9	106	5.0	83	2.5	77	22.6

Yields are based on oven-dry unextracted bark. Formaldehyde number determined by the method of Hills and Urbach. Catechin FN was 175 and a commercial wattle was 160.

The individual fractions were characterized by their formaldehyde numbers (FN), which were determined by the methods of Hillis and Urbach (J. Appl. Chem. 9:665-673, 1959). The reaction, with excess formaldehyde, was run at pH 8 for 2 h at about 95°C.

Table 1 shows the data obtained from this sequential extraction of various British Columbia bark species. The FN's were also determined for catechin (160) and a commercial wattle tannin (175) to have these data available for comparison with the other FN's.

The highest FN's were the 110 and 120 for, respectively, western hemlock and lodgepole pine bark-alcohol solubles. Catechin is a known component of all softwood barks. Therefore, catechin's FN represents the highest potential for an extractive from western conifer bark and was the bench mark used to measure the efficacy of bark extracts as possible adhesives. The FN's of the bark extracts were always lower. The reasons for this were that either the fractions were contaminated with nonreactive compounds (for example, the fats and waxes in the alcohol-benzene solubles) or the fractions contained polyphenols that had condensed with themselves leaving fewer sites for formaldehyde to condense (for example, the western hemlock bark water solubles).

It was concluded that the sequential solvent extraction was an appropriate method of studying the contribution of each class of extractives to the adhesive potential of the whole bark extract.—H.S. Fraser and E.P. Swan, Western Forest Products Laboratory, Vancouver, B.C.

MISCELLANEOUS

Absence from Maple Sap of Dimilin® Applied as a Soil Drench.—Because the sap of sugar maple (*Acer saccharum* Marsh.) is used to produce an edible product, prescribed pesticides must not be absorbed and translocated. Dimilin sprayed from an aircraft at the rate of 70 g (active ingredient) /4.67 L per ha (1 oz/0.5 U.S. gal per acre) is effective in controlling forest tent caterpillar (*Malacosoma disstria* Hbn.) on trembling aspen (*Populus tremuloides* Michx.) and presumably on sugar maple (Retnakaran et al., Bi-mon. Res. Notes 32:26-27, 1976; Retnakaran et al., Can. Entomol. in press, 1979). The objective of this study was to determine whether Dimilin appeared in the sap of maple trees after massive doses had been applied as a soil drench.

Maple trees are tapped for maple sap in early spring, before the forest tent caterpillars emerge. The optimum time for foliar application of Dimilin is when the insect is in the first- and second-instar stages and the trees are beginning to flush. In view of the low dosages of Dimilin sprayed on the trees, detection of it in the sap collected in the spring following application would be difficult. To increase the chance of detecting Dimilin in sap, a heavy soil drench was applied in late fall around the test trees.

A massive dose of Dimilin, 25% WP (322 g, active ingredient) was sprayed with a backpack sprayer around six sugar maple trees in Hilton Township, St. Joseph Island, in a 10 m² area in late October. The following spring (April) sap was collected from six trees by piping sap to

TABLE 1
Analysis for presence of Dimilin in concentrated maple sap

Sample	Dimilin application to soil 30 Sept. '76 (g/11.35 L per 10 m²)	Volume of sap collected 8 Apr. '77 (mL)	Volume of sap concentrate (mL)	Concentration ratio	Amount of Dimilin detected (ppm)
1. Maple syrup (control)	0	–	250	approx 40	<0.05
2. Sample A (3 trees)	322 g (0.71 lb)	6 000	100	60	<0.05
3. Sample B (3 trees)	322 g (0.71 lb)	4 000	200	20	<0.05

TABLE 2
Recovery of Dimilin added to maple-sap concentrate

Sample	Volume used (mL)	Made to (mL)	Amount of Dimilin added (ng)	Recovery of Dimilin (ng)	% recovery = $\frac{\text{ng found}}{\text{ng added}} \times 100$
A	10	50	0.000	<0.025	–
	10	50	0.050	0.041	82
	10	50	0.050	0.042	84
B	10	100	0.000	<0.025	–
	10	100	0.050	0.040	80
	10	100	0.050	0.046	92

two drums (1 drum/set of three trees). From one set of three (sample A) 6 000 mL and from the other set (sample B) 4 000 mL were collected. The sap was concentrated to 100 (60-fold) and 200 (20-fold) mL respectively in a rotary evaporator. On an average, a 40-fold concentration of the sap is required in commercial maple syrup production.

Samples of sap were sent to the Thompson-Hayward Company, Kansas City, Kans., for extraction and analysis. Their procedure for detection of Dimilin is as follows: A 10 g sample of sap was extracted in 50 mL of an ammonium chloride solution in phosphoric acid (20 g ammonium chloride in 300 mL water + 10 mL 85% phosphoric acid, the whole solution being diluted to 1 L with water). Ten mL of methanol was added, blended for 2 min and filtered to remove sugars. The filtrate was combined with the filter-paper wash, extracted in dichloromethane, concentrated, and analyzed on a Tracor-560 Gas liquid chromatograph equipped with a 1.8 m, 4 mm ID glass column containing 10% OV 17 on Gaschrome Q (100/120 mesh) at 188°C and detector (Ni^{63}-electron capture) at 300°C. The retention time for Dimilin under these conditions was 3 min and the detection limit was 0.1 ppm. The detection of less than 0.05 ppm of Dimilin indicated the absence of Dimilin in the sap (Table 1). To check whether the extraction procedure was adequate, known amounts of Dimilin were added to the two samples, A and B, and recovery was analyzed. The results indicated that >80% of the added Dimilin was recovered (Table 2).

Further work to determine whether any metabolites of Dimilin are present in the sap is now in progress.—A. Retnakaran, L. Smith, and W. Tomkins, Forest Pest Management Institute, Sault Ste. Marie, Ont.

Effects of Fenitrothion and Aminocarb on Aquatic Decomposing Fungi.—The freshwater Hyphomycetes are extremely important decomposers of forest litter (Kaushik and Hynes, Arch. Hydrobiol. 68:465-515, 1971). Forest litter, particularly autumn-shed foliage, is the principal source of nutrients in most freshwater ecosystems. Any disruption of the decomposition of this litter could seriously affect nutrient cycling and productivity in these systems. We speculated that the insecticides defining apositive fenitrothion and aminocarb, which are currently used extensively to control spruce budworm, *Choristoneura fumiferana* (Clem.) might interfere with the growth and development of Hyphomycetes and hence with the decomposition process. We designed two simple experiments to give general answers to this question to determine the need for more detailed investigation.

In the first experiment, 1 cm disks of preleached leaf tissue were incubated for 9 wk at 14°C in 75 mL of water inoculated with 1 mL of reduced stream foam (which contained thousands of hyphomycete spores) and spiked with various concentrations of insecticides. Included were all combinations of: two species — speckled alder, *Alnus rugosa* (Du Roi) Spreng., and yellow birch, *Betula alleghaniensis* Britton; two types of water — agitated streamwater and still swampwater; seven concentrations of chemicals — fenitrothion at 13, 130, and 1,300 μg/L, aminocarb at 0.9, 9, and 90 μg/L, and controls; four replicates. Measured were change in ash-free weight of the leaf tissue and fungal density on the leaf tissue. Actively growing spores on the leaf tissue were identified.

In the second experiment, disks of preleached speckled alder leaf tissue were incubated in a Warburg respirometer for 42 days at 10°C in 4.5 mL of streamwater inoculated with 0.5 mL of reduced stream foam and spiked with six insecticide treatments. Included were fenitrothion at 15, 150, 1 500 μg/L, aminocarb at 5, 50, and 500 μg/L, and controls, each twice replicated. Measured were: respiration as oxygen consumption in μL/h five times weekly, and fungal density on the leaf tissue. Actively growing spores on the leaf tissue were identified.

Insecticide-water mixtures were sampled for insecticide concentration twice during the first experiment, but too few samples and analytical problems made full interpretation of the results impossible. Concentrations of both chemicals diminished drastically during the experiments (fenitrothion 1 300 μg/L to 22 μg/L in 64 days and aminocarb 90 μg/L to 3.9 μg/L in 66 days), although not as fast as in streams where sunlight and flushing are factors (Eidt and Sundaram, Can. Entomol. 107:735-742, 1975). In streams, after operational sprays, peaks of fenitrothion seldom exceed 15 μg/L and decline exponentially to negligible concentrations within 24 h (Symons, Residue Rev. 38:1-36, 1977). At one-third the application rate, expected residues of aminocarb are correspondingly lower.

There were no differences in ash-free weights that could be attributed to the treatments. Some samples actually increased in weight that was due to fungal growth. This was attributed to the fact that, in the flasks, dissolution products were not washed away as they are in streams. Thus change in ash-free weight was not a suitable measure of decomposition rate in the flasks.

In the first experiment, but not in the second, there was significantly better (P=0.05) fungal growth on alder leaves in the controls than in the three fenitrothion treatments in streamwater, but there were no significant differences among the treatments. We did not get this result with alder in swampwater nor with birch leaves in stream or swampwater. There was thus no real evidence of an effect of the insecticide.

There was less growth of fungi with increasing concentration of aminocarb when birch leaves and alder leaves were used in streamwater (but not when they were used in swampwater). This result was not statistically significant, nor was it repeated in the second experiment with alder leaves in streamwater.

It was not possible to conclude that differences in microbial respiration occurred among the insecticide treatments and controls during the 42 days of the experiment with alder. Differences between the two controls were as great as among the treatments, and the treatment results bore no apparent relationship to dose.

Germination of spores and growth of mycelia occurred at all concentrations of aminocarb and fenitrothion. In the first experiment, *Alatospora acuminata* Ingold and *Lemonniera aquatica* de Wild sporulated in the highest concentration of fenitrothion and aminocarb, *Dendrospora* sp. in the highest concentration of fenitrothion, and prob. *Tetrachaetum elegans* Ingold in the highest concentration of aminocarb. In the second experiment, *Flagellospora curvula* Ingold sporulated in the highest concentration of fenitrothion, *A. acuminata* in the highest concentration of aminocarb, and *Lemonniera terrestris* Tubaki in the intermediate concentration of aminocarb. Some of these and other species sporulated in lower concentrations of both insecticides and in the controls used in both experiments. Sporulation of Hyphomycetes in the laboratory is ordinarily erratic; thus no treatment effect is inferred.

We conclude that the chemicals had no significant effects at the rates used. This being so, the possibility of any deleterious effect in the

field, where insecticide concentrations in freshwater resulting from operational sprays are much lower and transitory, is extremely remote.—D.C. Eidt and P.O. Salonius, Maritimes Forest Research Centre, Fredericton, N.B.; J.H. Meating, University of New Brunswick, Fredericton, N.B.

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