

bi-monthly research notes

Field Test of Furadan and Baygon against Balsam Woolly Aphid in British Columbia

The Effects of Fumidil B on Spruce Budworm and Its Microsporidial Parasites

Some Parasites and Insect Predators of the Blackheaded Budworm in Newfoundland

Dothichiza Canker of Lombardy Poplar in Newfoundland

Use of the On-line Computer-densitometer System to Rapidly Produce Summary Density Profiles

Comparison of the Early Growth of Larix and Picea in Plantations in Newfoundland

Vol. 33, No. 2, MARCH-APRIL 1977



Fisheries and Environment
Canada

Forestry
Service

Pêches et Environnement
Canada

Service
des forêts

bi-monthly research notes

A selection of notes on current research conducted by the Canadian Forestry Service and published under the authority of the Minister of the Department of Fisheries and the Environment. A French edition is published under the title of Revue bimestrielle de recherches.

ENTOMOLOGY

Field Test of Furadan and Baygon against Balsam Woolly Aphid in British Columbia.—Field testing of promising systemic insecticides against the balsam woolly aphid (BWA), *Adelges piceae* (Ratz.), was conducted in British Columbia as a cooperative program between the Pacific Forest Research Centre and the Chemical Control Research Institute. Since Furadan® (carbofuran) and Baygon® (propoxur) had proven to be most effective in laboratory testing (Randall et al., Bi-mon. Res. Notes 2:18-19, 1967; Nigam, Can. For. Serv. Inf. Rep. CC-X-26, 1972), we decided to concentrate on these two materials.

The purpose of the stem injection test was to determine whether the two chemicals were sufficiently mobile in the xylem and phloem of larger trees to produce a toxic effect on aphids infesting the crown or stem. Consequently, the materials were injected directly into the xylem. Baygon (EC 12.8% a.i.) and Furadan (Technical grade 98% a.i.) were formulated at 1%, 5%, and 10% active (wt/vol) in a solvent containing 80% acetone, 15% benzene and 5% Tween 80 (vol/vol). Check treatments were solvent alone and untreated. Each formulation was injected into two trees. Baygon was tested on young amabilis fir, *Abies amabilis* (Dougl.) Forbes (10-15 m high), and Furadan on mature grand fir, *A. grandis* (Dougl.) Lindl. (over 40 m). All trees had stem populations of aphids. The crowns of the amabilis fir were also infested, but crown populations of grand fir were not studied owing to the difficulty of reliably sampling at the 30 to 40 m level.

Injection points were located at ca. 12 cm intervals around the stem at breast height; a 5-ml formulation was injected at each point with a Mauget applicator at a depth of 1-2 cm into the xylem. Treatments were done on August 8, 1973.

In the Baygon test, four BWA populations were delineated on the stem of each tree about 1 m above the injection points, and aphids were counted on August 7, before treatment. These populations were checked again 2 weeks after treatment, and aphids were classified as dead or live. Crown populations were assessed on August 21 by examining aphids on nodes at 15X magnification and classifying them as live or dead. One node (same one on each branch) was collected from ten 4-to-8-year-old branches on each tree. Two weeks after injection, mortality of aphids on all treated trees was similar to that in the check, indicating that none of the Baygon formulations were sufficiently mobile to affect BWA in the crown or on the stem.

In the Furadan test, only stem populations were observed. Four bark pieces (6 cm²), located about 3 m above the injection points, were removed from each tree before treatment, and live aphids on each piece were counted. Two weeks after treatment, bark pieces were collected from locations adjacent to the earlier samples, and live aphids were tallied. Furadan at 10% and 1%, as well as the solvent, produced small increases in mortality. Most of this mortality was associated with the first instar, or neosistens, stage.

These tests provided some indication that Furadan was mobile enough to be translocated through the xylem and into the phloem and outer bark, where the aphids fed.

In 1974, Furadan was tested in the field, to determine whether it had systemic activity when applied to the ground. Each of three

TABLE 1

Effect of ground application of Furadan—N fertilizer formulations on balsam woolly aphid infesting the crowns of amabilis fir (overwintering generation)

Treatment	Tree	No. of BWA ¹	% Mortality
4.4 kg/ha Furadan ² + fertilizer ³ (363 g Furadan + 7.9 kg crushed urea per tree)	600 3,805	6 83	100 81
2.2 kg/ha Furadan + fertilizer (182 g Furadan + 7.9 kg crushed urea per tree)	602 701	16 89	88 81
4.4 kg/ha Furadan (363 g Furadan + 7.9 kg sand carrier per tree)	700 3,803	25 18	48 61
Check (no treatment)	NF1 NF2	52 24	56 42

¹ Total population on 10 nodes/tree on June 17; live + dead.

² Furadan 10% granules.

³ Forestry-grade urea applied at 448 kg/ha.

treatments was applied to two amabilis fir (10-15 m high) infested with BWA, at rates and formulations listed in Table 1.

Each treatment was applied to the rooting zone (10 m diameter) around the trees on April 4. At this time aphids were in the diapausing neosistens stage of the overwintering generation. The application was followed by 19 mm of rain on April 4 and an additional 60 mm during the next 4 days.

Aphid populations in the crown and on the stem of each tree were examined in mid-June, about 10 weeks after treatment. At this time aphids were mostly adults of the overwintering generation. For crown populations, nodes were collected and examined as for the 1973 test. Results (Table 1) indicate that Furadan, when combined with fertilizer, increased the mortality of aphids infesting the crown; the mortality of crown populations was 30 to 50% greater than in the check treatment. Furadan applied without fertilizer was ineffective.

One might infer from these data that urea fertilizer, and not Furadan, caused the population decline. However, another field trial, with amabilis fir on the same site, indicated clearly that urea fertilizer (at 448 kg/ha) caused significant increases in aphid populations in the crown.

Stem populations were checked at the same time by removing four bark pieces (6 cm²) from each tree and determining the percent mortality on each piece. Aphid populations were unaffected by any of the treatments, except for tree 602, which had ca. 30% higher mortality than untreated trees.

About 4 months after application, during the subsequent (summer) generation of aphids, crown populations were examined by the same sampling system as in June. On check trees, population levels were 42 to 67% lower than in the overwintering generation sampled in June; population reductions on Furadan-treated trees were less than on untreated trees. Furthermore, the level of mortality among all populations of the summer generation was similar. These observations indicate that the treatment-related mortality observed during the overwintering generation did not persist into the next generation. Apparently, Furadan had little if any systemic residual effect for the summer generation, and the reduction observed during the overwintering generation was nullified by recolonization of the crown by progeny of the overwintering generation.

In summary, Furadan applied to the ground at either the 2.2 or 4.4 kg/ha rate appears to be xylem-mobile and toxic to BWA infesting the crown, provided the chemical is applied in combination with urea fertilizer. However, the beneficial effect of the treatment lasts only one generation. The reproductive potential of the aphid is so high that populations can recover to pretreatment levels in one generation. Furthermore, Furadan appears to have insufficient residual life in the tree to affect recolonization by the subsequent generation.—J. R. Carrow and G. S. Puritch, Pacific Forest Research Centre, Victoria, B.C., and P. C. Nigam, Chemical Control Research Institute, Ottawa, Ont.

The Effects of Fumidil B on Spruce Budworm and Its Microsporidial Parasites.—Wilson (Can. Entomol. 106:995-996, 1974) stated that Fumidil B could be used to suppress microsporidia in stock cultures of spruce budworm. This paper describes the effects of Fumidil B on stock cultures of budworm heavily infected with microsporidia.

Second-instar larvae from our laboratory stock, in which every adult was heavily infected with microsporidia, were reared on artificial diet to which the antibiotic, Fumidil B, had been added to give final concentrations of 0 (control), 453, 903, 2,709, and 4,505 ppm. Larvae were reared at 19.5 ± 0.5 C and 16-h photoperiod.

Survival of second-instar larvae to pupae was low at all treatment levels, being highest at the intermediate concentrations of the antibiotic (Table 1). Survival of pupae to adults was also low; male pupae suffered

TABLE 1
Effects of Fumidil B on spruce budworm infected with microsporidia

Observations	Treatment (ppm Fumidil B in diet)				
	0	453	903	2,709	4,505
No. second-instar larvae treated	500	500	500	500	500
No. pupated:					
male	70	106	108	86	68
female	100	95	84	67	54
% larval survival	34.0	40.2	38.4	30.6	24.4
No. adults emerged:					
male	17	29	27	17	12
female	52	35	36	34	18
% pupal survival:					
male	24.3	27.4	25.0	19.8	17.7
female	52.0	36.8	42.9	50.8	33.3
Overall survival, larval to adults*					
male	6.8	11.6	10.8	6.8	4.8
female	20.8	14.0	14.2	13.6	7.2
Days to 50% pupation:					
male	38	38	37	38	41
female	41	40	40	41	45

* Assuming a 1:1 ratio of males and females in the second-instar larvae.

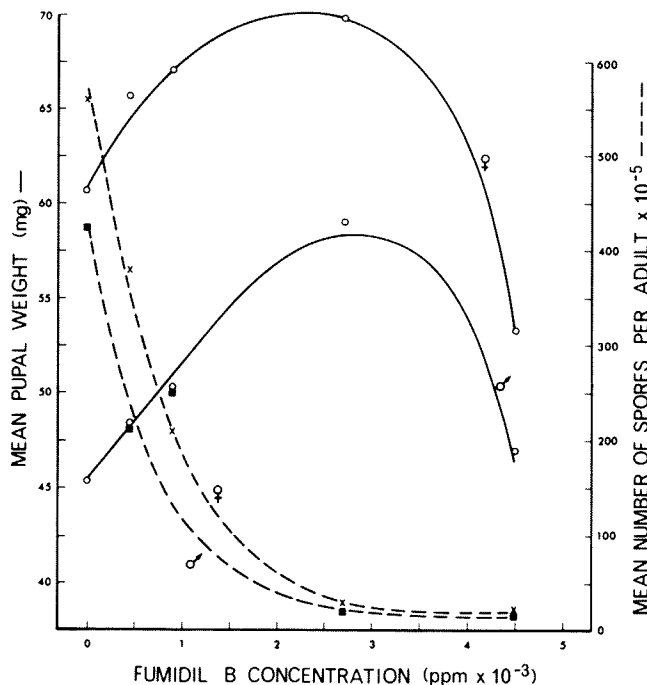


Figure 1. The effect of Fumidil B in larval diet on mean pupal weight and number of microsporidial spores in adult spruce budworm.

greater mortality than female pupae (76.7% vs. 56.2%). Overall survival of larvae to adults showed a difference between the sexes. The two lower concentrations of Fumidil B increased male survival, but at the higher concentrations any benefit to the males by the reduction in the number of microsporidia was apparently negated by toxicity of the antibiotic. The overall survival of females (Table 1) suggests that the antibiotic was more toxic than the microsporidia.

Pupal weights, and presumably fecundity of females, increased with increasing concentrations of Fumidil B up to 2,709 ppm, then decreased (Fig. 1). Spore counts decreased sharply with increasing concentrations of Fumidil B up to 2,709 ppm but showed very little decrease beyond this level (Fig. 1).

These data show results somewhat different from those obtained by Wilson (1974), the differences probably being due to the degree of infection. Wilson's stock was relatively lightly infected (208×10^5 spores/larva, male pupal weight 77 mg, female pupal weight 110 mg), whereas the Maritimes Forest Research Centre stock was heavily infected (525×10^5 spores/adult, male pupal weight 45 mg, female pupal weight 60 mg).

In budworm heavily infected with microsporidia, concentrations of Fumidil B up to 2,500 ppm have a relatively greater effect on the microsporidia than on the budworm, thus allowing increased fecundity of females; at higher concentrations this effect is negated by the increased toxicity of the antibiotic to the budworm.—A.W. Thomas, Maritimes Forest Research Centre, Fredericton, N.B.

Some Parasites and Insect Predators of the Blackheaded Budworm in Newfoundland.—The blackheaded budworm, *Acleris variaria* (Fern.), is native to North America. In Newfoundland it defoliates black spruce, *Picea mariana* (Mill.) B.S.P., balsam fir, *Abies balsamea* (L.) Mill., and white spruce, *P. glauca* (Moench) Voss. Two major outbreaks have been recorded on the Island since 1946 (Miller, Can. Entomol. 98:592-613, 1966). These outbreaks lasted for about 6 years and caused extensive defoliation and some top-killing and tree mortality in localized areas, particularly where stands had been weakened by other insects. The present outbreak started in 1971 and now covers about 163 000 ha (402,000 acres). Some of these stands are also infested by the spruce budworm, *Choristoneura fumiferana* (Clem.).

Studies were initiated in 1973 on the biology and population behavior of the blackheaded budworm and its parasites in Newfoundland. This note presents a list of parasites, reared from the blackheaded budworm in 1973 and 1974, and observations on some of the insect predators noted.

Totals of 1,487 blackheaded budworm larvae and 533 pupae were collected at several locations across the Island in 1973 and 1974 respectively. The larvae and pupae were reared in the laboratory at $21 \pm 2^\circ\text{C}$, 70% R.H. and 12-h photoperiod until the emergence of moths and parasite adults was completed. Parasite larvae that emerged from the host were permitted to pupate, and pupae that did not give rise to adults in the fall were allowed to overwinter, the technique used being that described by Otvos (Can. Entomol. 105:581-582, 1973).

The following parasites were reared from blackheaded budworm larvae and pupae (the parasites and predators being identified by specialists ¹W. R. M. Mason, ²J. R. Barrow, ³D. M. Wood, ⁴L. Masner, ⁵C. M. Yoshimoto, ⁶C. C. Loan and ⁷M. Ivanochko, Entomology Research Institute, Ottawa):

Hymenoptera

Braconidae

Apanteles sp. nr. *popularis* group¹

Capidosoma deceptor Miller⁵

Meteorus argyrotaeniae Johansen¹

Meteorus trachynotus Viereck¹

Microgaster peroneae Walley¹

Ichneumonidae

Apechthis ontario (Cresson)²

Exochus decoratus scitulus Provancher²

Glypta fumiferana (Viereck)²

Itoplectis conquisitor (Say)²

Itoplectis vesca Townes²

Phaeogenes hariolus (Cresson)⁷
Phytodietus vulgaris (Cresson)²
Phytodietus n. sp.⁶
Prosilomma columbianum (Ashmead)⁴
Mesochorus sp. 1 (hyperparasite)²
Mesochorus sp. 2 (hyperparasite)²

Diptera

Tachinidae

Actia diffidens Curran³
Actia interrupta Curran³
Erynnia tortricis (Coquillett)³

Two of these parasites, *Itoplectis conquisitor* and *Meteorus trachynotus*, were introduced into Newfoundland in 1950. However, *M. trachynotus* is probably native, because it was reared from the blackheaded budworm and spruce budworm before its introduction in 1950 (Clark, Otvos and Pardy, Inf. Rep. N-X-96, 1973).

Of the 17 species of primary parasites reared in this study, 10 have been reported from the blackheaded budworm either from Newfoundland (Forbes, Bi-mon. Prog. Rep. 8(2):2, 1952) or from the Maritime Provinces (Miller, Can. Entomol. 98:592-613, 1966). The blackheaded budworm is a new host record for the other seven species: three braconids, *Capidosoma deceptor*, *Meteorus argyrotaeniae*, *Apanteles* sp. nr. *popularis* group; and four ichneumonids, *Apechthis ontario*, *Glypta fumiferana*, *Phytodietus vulgaris* and *Prosilomma columbianum*. *P. columbianum* apparently represents also a first record of the genus *Prosilomma* from Newfoundland.

Total apparent parasitism by all species combined varied from 0.6% to 48% over the 2 years, depending on the location and the time of the collection. The overall percentage parasitism was about 16% in 1973 and 20% in 1974. These are probably an underestimation of the actual parasitism because some of the collections were made before oviposition by the parasites was completed. In 1973 more than half of the parasitism was caused by hymenopterous and the remainder by dipterous species, but in 1974 this ratio was reversed.

Percentage parasitism was not determined for each species because of high mortality of parasites especially in the overwintering pupal stage. The cause of this high mortality is unknown because the same rearing method was very successful when used to overwinter *Winthemia occidentalis* Reinh., a parasite of the hemlock looper (Otvos, 1973). Most of the parasites reaching the adult stage in this study were *Actia diffidens* and *Meteorus argyrotaeniae*.

Among the invertebrate predators, two species of ants, *Camponotus herculeanus* L.⁷ and *Formica fusca* L.⁷, have been found regularly in the larval and pupal samples. Both species of ants were frequently observed on trunks of infested trees and carried early instar blackheaded budworm larvae as "booty."

The increasing trend in parasitism, 16% in 1973 and 20% in 1974, suggests that parasites are important in the control of the blackheaded budworm, but their control value cannot be fully assessed before the present outbreak terminates.—Imre S. Otvos, Newfoundland Forest Research Centre, St. John's, Nfld.

PATHOLOGY

Dothichiza Canker of Lombardy Poplar in Newfoundland.—

Lombardy poplar, *populus nigra* var. *italica* Muenchh., is a common ornamental tree in Newfoundland. With increasing interest in urban forestry in recent years, this species has attracted considerable attention.

Dothichiza canker, also known as European poplar canker, caused by *Dothichiza populea* Sacc. & Briard [Perfect stage — *Cryptodiaporthe populea* (Fckl.) Butin], is an important disease of poplars, particularly Lombardy poplar. The disease is sporadic but causes serious damage in the United States and eastern Canada, particularly in Ontario, Quebec and New Brunswick (Hubbes, 1967. Pages 42-44 in Davidson and Prentice, eds. Important Forest Insects and Diseases of Mutual Concern to Canada, the United States and Mexico. Dep. For. Rural Dev., Can.). Although dieback and canker symptoms of the disease on ornamental Lombardy poplar have been observed in Newfoundland during the past few years, the first record of

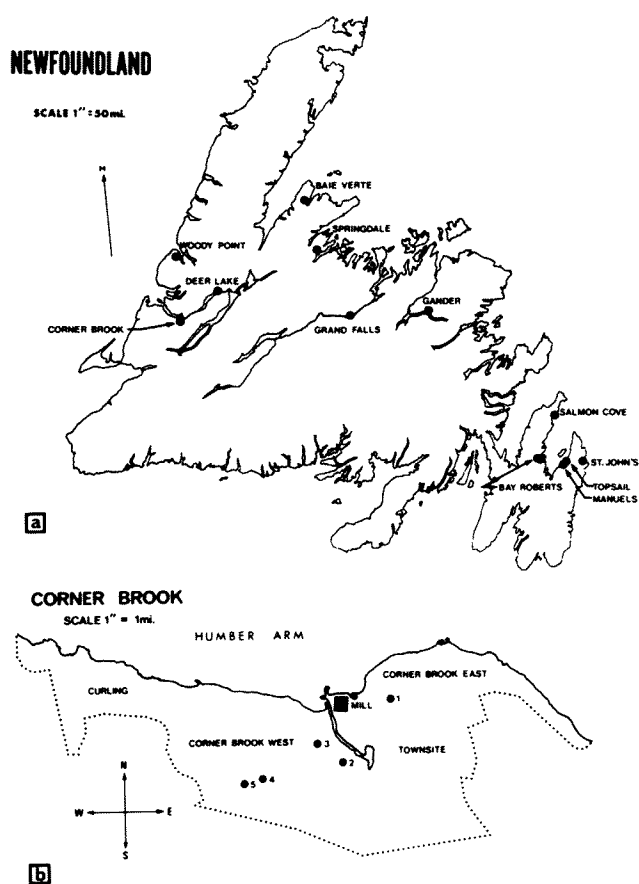


Figure 1. a. Map of Newfoundland showing distribution of *Dothichiza* canker of Lombardy poplar.
b. Map of Corner Brook with five study areas (nos. 1 to 5).

the disease from the Island was made only in 1975 (Forest Insect & Dis. Surv., Annu. Rep. 1975, Nfld. Reg., Dep. Fish. Environ., Can. For. Serv., in press). A preliminary survey was conducted in 1975 and 1976 to determine the status of the disease on the Island. This report describes the distribution, incidence and intensity of the disease and discusses the status of the disease problem.

Ornamental poplars (Lombardy, Carolina and balsam poplars and trembling aspen) in 12 communities throughout the Island were examined for the presence of the disease (Fig. 1a). Detailed investigation on the symptomatology, incidence and intensity of the disease was conducted in Corner Brook because of the greater abundance of Lombardy poplar in the town. Lombardy poplar trees, to a total of 213, in five different areas (42, 40, 41, 45, and 45 trees in areas nos. 1, 2, 3, 4, and 5 respectively) of the town (Fig. 1b, nos. 1 to 5) were examined and the following data were recorded: the number of infected and dead trees, the number of main stems infected and the proportion of the tree crown damaged (with dead leafless branches). Percent infection and percent tree mortality were calculated from the data.

Dothichiza canker was found only on Lombardy poplar and the disease is Island-wide in distribution (Fig. 1a). All stages of the symptoms and signs of the disease were evident except the perfect stage of the causal fungus. The cankers were almost invariably formed at nodes and spread either way. The cankers girdled young branches and stems rapidly and caused pronounced dieback. Rows of trees planted as windbreaks or fences seemed to be particularly susceptible. The data from Corner Brook showed that the incidence and severity of the disease was very high: about 97% of the trees were infected and mortality averaged 38%. Infection varied from 85% to 100% and tree mortality from 3% to 69% in the five areas of Corner Brook. Crown dieback averaged 62%, varying from 13% to 90%. Percentages of

infection, crown damage, and tree mortality were the lowest in area no. 2 and the six healthy trees were also found here. This area (no. 2) was located at the lowest elevation (53.3 m vs. 99 m in area no. 1, 68.5 m in area no. 3, 106.6 m in area no. 4, and 121.9 m in area no. 5) and had a larger number of other ornamental and shade trees than the other four areas. Since the disease spreads through conidia disseminated by air currents and rain water (Hubbes, 1967), it appears that the incidence and intensity of the disease in this area was less because the host trees were somewhat sheltered and escaped infection. Although no detailed data were collected from the other locations on the Island, observations indicate that *Dothichiza* canker was almost as severe in some of these locations as in Corner Brook.

Little is known about this disease in Canada, but it is understood from European and American literature that the fungus infects primarily the young and newly planted Lombardy poplars, and those that were weakened by other factors such as low spring temperature, transplanting in autumn, poor soil drainage, drought, wounding by pruning or by soil cultivation, and infertile soil. In Newfoundland, most of the infected Lombardy poplars were 15 to 40 years old, but the disease has been observed only during the last few years. Moss (Phytopathology 12:425-427, 1922) reported a similar severe incidence of *Dothichiza* canker on older trees of Lombardy poplar in Ontario. No explanation can be offered for the absence of the disease on the other poplar species. Since Lombardy poplar is one of the most common ornamental trees and the canker is causing a severe dieback of crown and tree mortality, research efforts should emphasize the epidemiology of the disease and the development of practical control measures.—Pritam Singh, Newfoundland Forest Research Centre, St. John's, Nfld.

FOREST PRODUCTS

Use of the On-line Computer-densitometer System to Rapidly Produce Summary Density Profiles.—A computerized scanning densitometer was developed at the Western Forest Products Laboratory several years ago (Parker et al., Wood and Fiber 5:237-248, 1973). The main function of this system has been to produce intraring specific-gravity data from radiographs of wood samples (Parker and Jozsa, Wood and Fiber 5:192, 1973). Another recent application has been the production of density profiles of particle board. The application of X-ray densitometry to particle-board quality studies has been demonstrated by Polge and Lutz (Holztechnologie 10:75-79, 1969) and a review of radiation densitometry has been presented by Parker and Kennedy (Proc. IUFRO, Cape Town and Pretoria, S. Afr., 17p, 1973).

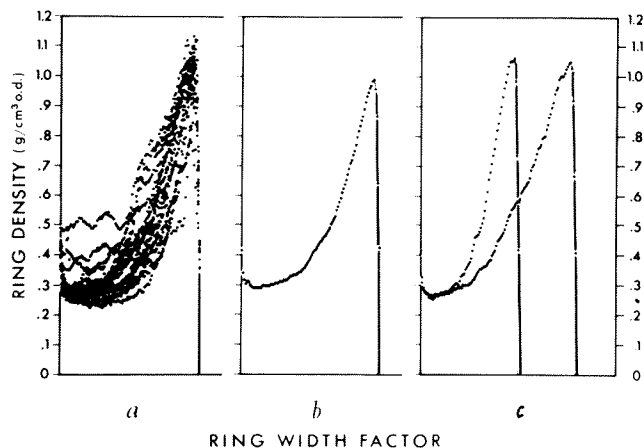


Figure 1. Annual ring density profiles

- Superimposed plots of profiles of 19 annual tree rings. Width of the annual rings is standardized by converting each into a common width factor consisting of 100 units.
- Summary of the density profiles shown in a.
- Mean width factor and density comparison of annual rings for 4-year time intervals, before and after application of a fertilizer treatment.

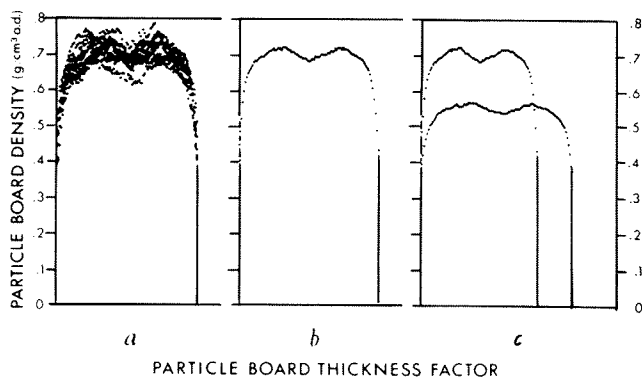


Figure 2. Particle-board density profiles

- Superimposed plots of density profiles of nine particle-board samples. Thickness of the samples is standardized by converting each into a common thickness factor consisting of 100 units.
- Summary of the density profiles shown in a.
- Density profiles of nine particle-board samples, before and after boiling treatment.

The computerized X-ray densitometry system at the Western Forest Products Laboratory was recently upgraded (Parker et al., Proc. IUFRO, Mariánské Lázně, Czech, p. 185-204, 1974). The system now has the capability of storing any number of density profiles on magnetic tape or magnetic disk. These density profiles may consist of intraring specific-gravity profiles of dated annual rings (Fig. 1) or of specific-gravity profiles of cross sections of particle-board samples (Fig. 2). The advantage of this is that many density profiles can be quickly averaged together by the computerized system.

For example, all of the annual-ring density profiles from a single tree can be summarized to produce a density profile that represents the mean profile for that tree; or all of the density profiles for rings produced in a particular year on many trees can be summarized; or all rings from a particular stand of trees, or species of tree, can be summarized, etc. Likewise, density profiles from multiple scans of particle board can be summarized into a single profile.—M.L. Parker and L.A. Jozsa, Western Forest Products Laboratory, Vancouver, B.C.

TREE BIOLOGY

Comparison of the Early Growth of *Larix* and *Picea* in Plantations in Newfoundland.—*Larix laricina* (Du Roi) K. Koch in Newfoundland grows singly or in small groups, on sites ranging from wet organic to dry rocky outcrops. Best development occurs on well-drained fertile sites, but the species is not well represented on these sites. Until now commercial use of larch has been limited to fuelwood, fencing, and the fishery. Recently the increased demand for fiber has indicated that all species suitable for pulping must be fully exploited if the forest industry is to remain viable.

The Newfoundland Forest Research Centre has for many years been engaged in research on the growth and development of native and exotic species including larch. Exotic larches tested include European larch (*L. decidua* Mill.), Japanese larch (*L. kaempferi* [Lam.] Carr.), and Siberian Larch (*L. sibirica* Ledeb.). Recent research by the Pulp and Paper Research Institute of Canada has shown that larch is inferior to other Canadian softwood species in terms of suitability for pulping and strength properties but is superior in terms of tear strength. Since larch has a high density compared with other Canadian softwoods, a given area of larch would be expected to yield more chemical pulp than would other softwoods in unit time (Kubes and Swan, Lab. Rep. 287 P.P.R.I.C., June 1974).

Plantations of native and exotic larch established in Newfoundland since 1967 were measured to assess early growth. This report

TABLE 1
Average total height of spruce and larch planted in Newfoundland

Plantation number	Forest section	Age of plantation (yr)	Average total height for each species (cm)				
			<i>Picea</i>		<i>Larix</i>		
			<i>glauca</i>	<i>mariana</i>	<i>laricina</i>	<i>decidua</i>	<i>kaempferi</i>
1	B28b	9	—	77	—	—	218
2	B28b	9	—	60	—	151	—
3	B30	9	57	—	323	—	—
4	B28b	5	71	109	218	117	116
5	B28a	5	30	61	157	80	85
6	B30	5	51	63	117	76	80

summarizes height growth data and compares height of larch with that of native *Picea* spp. planted at the same time on the same site. The plantations are in the three major forest regions (Rowe, Can. For. Serv. Publ. 1300, 1972) of the Island on different sites. Plantations 1 and 2 are on nutrient-poor blanket bogs, and plantation 3 is on an exposed upland heath, both sites having been ploughed before planting. The other three plantations are on well-drained upland sites that previously supported productive stands of black spruce (*Picea mariana* [Mill.] B.S.P.) and balsam fir (*Abies balsamea* [L.] Mill.). Soils on these sites consist of well-drained rocky loams with a high proportion of silt and clay. Burning of the sites supporting plantations 4 and 5 within 3 years of clear-cutting destroyed the lesser vegetation and some of the humus layer.

It is evident from the results that local larch has grown much faster than either of the local spruces and that the exotic larches have grown as fast or faster than the local spruces (Table 1). The general appearance of

all larch species is excellent, and to date none have been damaged by frost. As the plantations have not yet been attacked by insects, comparisons of capability to withstand insect damage cannot be made. As the plantations are too young, the ability to withstand insect damage cannot yet be assessed, but no damage has been recorded to date.

The faster rate of growth shown by larch, admittedly based on early results, suggests that it has considerable promise as a major species for use in reforestation and afforestation programs. The height development to date of both exotic larches also indicates that they are suitable for insular Newfoundland. These three species of larch are known to hybridize readily, and the F_1 progeny are often heterotic. Thus the progeny have the potential for producing far higher yields than their parents. These results indicate that further research with larch would yield valuable dividends for the forests of Newfoundland.—J. Peter Hall, Newfoundland Forest Research Centre, St. John's, Nfld.

RECENT PUBLICATIONS—MARCH-APRIL 1977

- 3 Andresen, J.W. 1976. Canadian shade trees go metric. J. Arboric., Oct. 1976.
- 9 Basham, J.T., J. Hudak, D. Lachance, and L.P. Magasi and M.A. Stillwell. 1976. Balsam fir death and deterioration in eastern Canada following girdling. Can. J. Forest Res. 6(3):406-414.
- 7 Bonga, J.M. 1976. Staining of pollen and callus of *Pinus resinosa* in lacto-propiono-dimethylsulfoxide carmine (LPDC). Tissue Cult. Assoc. Man. 2(3):411-412.
- 7 Bonga, J.M. 1976. Storage of microsporophylls (anthers) of *Pinus resinosa*. Tissue Cult. Assoc. Man. 2(3):387-388.
- 12 Bramhall, G. 1975. Fick's laws and bound-water diffusion. Wood Sci. 8:3:153-161.
- 13 Cech, M.Y. 1976. Programmes de séchage artificiel pour le Thuya occidental (cèdre de l'Est). Oper. for. June 1976.
- 12 Dobie, J., and A.A. Britneff. 1975. Lumber grades and volumes from lodgepole pine infected with dwarf mistletoe. Wood and Fiber 7:104-109.
- 12 Dobie, J., and J.A. McIntosh. 1976. Spruce foliage yields more than triple that of pine according to a study by the Western Forest Products Lab. on whole-tree logging of lodgepole pine and spruce in Alberta. Pulp Pap. Can., Oct. 1976.
- 15 Ennis, T.J., and S.S. Sohi. 1976. Chromosomal characterization of five Lepidopteran cell lines of *Malacosoma disstria* (Lasiocampidae) and *Christoneura fumiferana* (Tortricidae). Can. J. Genet. Cytol. 18:471-477.
- 11 Etheridge, D.E., and H.M. Craig. 1976. Factors influencing infection and initiation of decay by the Indian paint fungus (*Echinodontium tinctorium*) in western hemlock. Can. J. Forest Res. 6(3):299-318.
- 13 Feihl, A.O., V. Godin, and J.G.T. Whitaker. 1976. Canadian pilot study looks at panel manufacture with thin faces. Plywood and Panel magazine, Oct. 1976.
- 12 Foschi, Ricardo O., and J.D. Barrett. 1976. Stress intensity factors in anisotropic plates using singular isoparametric elements. Int. J. Numer. Methods Eng. 10:1281-1287.
- 11 Funk, A. 1976. The genus *Dermea* and related conidial states on Douglas fir. Can. J. Bot. 54(24):2852-2856.
- 12 Hatton, J.V. 1976. Kraft pulping equations: comparison of linear with nonlinear forms. TAPPI 59(12).
- 12 Hunt, K. 1976. Kraft pulp of beta-irradiated Douglas fir chips. TAPPI 59(10):89-91.
- 7 Jones, J.M., and A.G. Raske. 1976. Notes on the biology of the birch leafminer, *Fenusa pusilla* (Lep.), in Newfoundland (Hymenoptera: Tenthredinidae). Phytoprotection 57(2):69-76.
- 11 McMullen, L.H. 1976. Effect of temperature on oviposition and brood development of *Pissodes strobi* (Coleoptera: Curculionidae). Can. Entomol. 108:1167-1172.
- 15 Murphy, Dennis W., S.S. Sohi, and P.G. Fast. 1976. *Bacillus thuringiensis* enzyme-digested delta endotoxin: effect on cultured insect cells. Science 194:954-956.
- 13 Pnevmatikos, S.M. 1976. Better maple log allocation boosts profits. Can. Forest Ind., Dec. 1976.
- 14 Pollard, D.F.W., and K.T. Logan. Inherent variation in "free" growth in relation to numbers of needles produced by provenances of *Picea mariana*.
- 1 Potvin, Albert. Panorama des forêts du Canada. Environ. Can., Can. For. Serv.
- 9 Rose, A.H. 1976. The dispersal of *Lophyrophlectus luteator* (Hymenoptera: Ichneumonidae) on *Neodiprion sertifer* (Hymenoptera: Diprionidae) in southern Ontario. Can. Entomol. 108:1395-1398.
- 9 Sanders, C.J. 1976. Sex pheromone of the eastern spruce budworm (Lepidoptera: Tortricidae): Optimum blend of Trans- and Cis-11-tetradecenal. Can. Entomol. 108:1285-1290.
- 7 Thomas, A.W. 1976. Threshold temperature for spruce budworm pupal development (Lepidoptera: Tortricidae). Can. Entomol. 108:1223.
- 7 Van Groenewoud, H. 1976. Theoretical considerations on the covariation of plant species along ecological gradients with regard to multivariate analysis. J. Ecol. 64:837-847.
- 14 Wang, B.S.P. Dormancy and laboratory germination criteria of white spruce seed. Proceedings of the 2nd International Symposium on Physiology of Seed Germination of IUFRO, Working Party S2.01.06, held in Tokyo, Japan. Minist. Agric. Jap., Gov. Forest Exp. Stn.
- 12 Warren, W.G. 1976. Viewpoints on the design and analysis of multifactor pulping experiments. TAPPI 59(11):126-129.
- 9 Webb, D. Paul. 1976. Root growth in *Acer saccharum* Marsh. seedlings: effects of light intensity and photoperiod on root elongation rates. Bot. Gaz. 137(3):211-217.
- 10 Wong, H.R., and J.C.E. Melvin. 1976. Biological observations and larval descriptions of *Enargia decolor* (Lepidoptera: Noctuidae) on trembling aspen in northern Alberta. Can. Entomol. 108:1213-1220.
- 14 Yeatman, C.W. 1976. A Canadian example of government-industry collaboration in tree improvement. For. Chron. 52(6):283-288.
- 1 Yoshimoto, Carl M. 1976. Revision of the genus *Dicladocerus* (Eulophidae: Chalcidoidea) of America north of Mexico, with particular reference to species attacking larch casebearer (Lepidoptera: Coleophoridae). Can. Entomol. 108:1173-1206.
- 10 Zalasky, Harry. 1976. Structural changes in tissues of caragana seedlings after frost damage. Can. J. Plant Sci. 56: 941-945.
- 14 Zsuffa, L., and R.F. Calvert. 1976. Selecting shade trees for urban Canada. In John W. Andresen, ed. Trees and forests for human settlements. Cent. Urban Stud. Univ. Toronto Press. 417 pp.

recent publications

Addresses of the Canadian Forestry Service

Requests for recent publications should be addressed as shown by the code.

- 1 Information Team,
Environmental Management Service,
Department of Fisheries and the Environment,
Ottawa, Ontario
K1A 0H3
- 2 Forest Fire Research Institute,
Department of Fisheries and the Environment,
Nicol Building,
331 Cooper Street,
Ottawa, Ontario
K1A 0W2
- 3 Forest Management Institute,
Department of Fisheries and the Environment,
Majestic Building,
396 Cooper Street,
Ottawa, Ontario
K1A 0W2
- 5 Chemical Control Research Institute,
Department of Fisheries and the Environment,
25 Pickering Place,
Ottawa, Ontario
K1A 0W3
- 6 Newfoundland Forest Research Centre,
Department of Fisheries and the Environment,
Bldg., 304, Pleasantville,
P.O. Box 6028,
St. John's, Newfoundland
A1C 5X8
- 7 Maritimes Forest Research Centre,
Department of Fisheries and the Environment,
P.O. Box 4000,
Fredericton, New Brunswick
E3B 5G4
- 8 Laurentian Forest Research Centre,
Department of Fisheries and the Environment,
1080 Route du Vallon, P.O. Box 3800,
Ste. Foy, Quebec
G1V 4C7
- 9 Great Lakes Forest Research Centre,
Department of Fisheries and the Environment,
P.O. Box 490, 1219 Queen St. E.,
Sault Ste. Marie, Ontario
P6A 5M7
- 10 Northern Forest Research Centre,
Department of Fisheries and the Environment,
5320 - 122nd Street,
Edmonton, Alberta
T6H 3S5
- 11 Pacific Forest Research Centre,
Department of Fisheries and the Environment,
506 West Burnside Road,
Victoria, British Columbia
V8Z 1M5
- 12 Western Forest Products Laboratory,
Department of Fisheries and the Environment,
6620 N.W. Marine Drive,
Vancouver, British Columbia
V6T 1X2
- 13 Eastern Forest Products Laboratory,
Department of Fisheries and the Environment,
Montreal Road,
Ottawa, Ontario
K1A 0W5
- 14 Petawawa Forest Experiment Station,
Department of Fisheries and the Environment,
Chalk River, Ontario
K0J 1J0
- 15 Insect Pathology Research Institute,
Department of Fisheries and the Environment,
P.O. Box 490, 1195 Queen St. E.,
Sault Ste. Marie, Ontario
P6A 5M7