ISSN 0317-6908

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Vol. 35, No. 2, MARCH-APRIL 1979

Environment Canada | Environnement Canada

Forestry Service | 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 the Environment. A French edition is published under the title of Revue bimestrielle de recherches.

BOTANY

Postglacial Fossil Tamarack (*Larix laricina*) Wood from the Mackenzie Delta, N.W.T.—The identification of fossil wood presents certain difficulties because the wood may be discolored by groundwater containing various minerals or by weathering, or it may be deformed by pressure. Differentiation of fossil spruce (*Picea*) and larch (*Larix*) is particularly difficult, as illustrated by the identification of driftwood found on Arctic beaches (Blake, pages 77-104 *in* Proc., Symposium on climatic changes in Arctic areas during the last ten-thousand years, Univ. Oulu, Finland, 1972). Only half (14) of the samples were identified to genus (either *Picea* or *Larix*); the other half were undifferentiated between *Picea* and *Larix*.

A piece of wood was recovered, in the summer of 1977, from the base of a perennially frozen peat deposit, in the Pleistocene Mackenzie Delta. Radiocarbon analysis, performed by the Department of Geological Sciences, Brock University, yielded a date of 7510 ± 140 years before present (BGS-472). We identified the wood as *Larix laricina* on the basis of cell structure, after comparing it with tamarack and spruce wood from different parts of Canada.

The site is a thick peat deposit on the shores of a small lake about 20 km east of Swimming Point on the East Channel, Mackenzie River, and some 75 km north of Inuvik at 69° 05'N latitude and 133° 52'W longitude. The site is on the Pleistocene Coastlands of the Mackenzie Delta in the Tununuk Low Hills Section (Mackay, Geol. Surv. Can., Misc. Rep. 23, 1963), formed mainly by Pleistocene fluvial and deltaic deposits. Most of the area lies below 60 m above sea level, but the elevation at the peat section is approximately 80 m ASL.

The peat exposure is adjacent to a large actively thawing massive sheet of ground ice. Thawing has exposed a 4.5 m headwall in the massive ice and in the adjoining high-center peat polygons. The peat deposit under the polygon is 332 cm thick, consisting of 32 cm of well-decomposed peat at the top underlain by somewhat decomposed peat of *Sphagnum* and other mosses, with scattered wood between 185 and 305 cm. Between 305 and 332 cm, freshwater gastropod shells are abundant in the peat, including a 12 cm marl layer. This stratum rests on an organic-rich mineral soil to the 335 cm level, where sparingly stony mineral soil is found.

A tree stump 28 cm in diameter, consisting of lateral roots and the basal part of the stem, was found in growth position partially encased in perennially frozen peat at the 298 cm level. One lateral root with the attached basal stem was collected. Examination of growth rings showed 89 annual rings, but a small (est. 3 cm diameter) portion of the center was missing.

The site is in a treeless, shrubby tundra, dominated by shrub birch, alder, and dwarf heath shrubs. The nearest trees are spruce (*Picea glauca* [Moench] Voss and *P. mariana* [Mill.] B.S.P.) and balsam poplar (*Populus balsamifera* L.) growing on the modern Mackenzie Delta some 35 km to the southwest. The nearest known occurrence of tamarack (*Larix laricina* [Du Roi] K. Koch) is 80 km to the south, near Inuvik.

The surficial geology and depositional sequence at the site preclude the possibility of postglacial long-distance transport of any organic debris. The site was originally occupied by a shallow lake on a morainic upland, as shown by marl and freshwater gastropod shells. Infilling of the lake by peat provided habitat for mosses and trees, including the sampled fossil. Continued peat deposition buried the wood; later permafrost development helped to preserve it.

The wood sample was partially fossilized. The fine-textured wood was brash, superficially gray, powdery, and weathered when dry, light brown in the broad band of springwood, and darker brown in the narrow summerwood. The growth rings were up to 1 mm wide. The sample was in excellent condition for sectioning with a blade and for pulping.

Two methods were used to identify the fossil wood. Sections of wood were examined under a microscope, according to the technique of Panshin and de Zeeuw (Textbook of wood technology, vol. 1, third ed., McGraw-Hill, New York, 1970). In addition, macerated wood tissue was also examined to observe the cellular detail of wood tissue, because woody stems are often difficult to section by microtome and because the sections rarely convey an accurate conception of the real nature of the cells of which they are composed (Johanson, Plant microtechnique, first ed., McGraw-Hill, New York, 1940).

Radial and tangential sections of wood specimens were prepared

TABLE 1
Anatomical data of fossil wood and known wood of tamarack, spruce, and Douglas-fir

Species	Tracheids	Longitudinal parenchyma	Rays and resin canals
Fossil wood	Diameter up to 42 μm. Spiral thickenings in summerwood. Bordered pits in 1-2 rows on radial walls. Pits in ray crossings piciform, 1-8 in double rows.	Terminal	Uniseriate ray 1-16+ cells in height. Fusiform ray with resin canal, 2-3 seriate, up to 16+ cells high. Ray tracheid slightly dentate, mostly nondentate. Resin canals with thick-walled epithelium. Diameter of longitudinal canals up to 90 μm. Transverse canals 20 μm.
Tree-line tamarack (*Larix laricina*)	Diameter up to 42 μm. Spiral thickenings in summerwood. Bordered pits in 1-2 rows on radial walls. Pits in ray crossings piciform, 1-8 in double rows.	Terminal	Uniseriate ray 1-16+ cells high. Fusiform ray with resin canal, 2-3 seriate, up to 16+ cells high. Ray tracheids slightly dentate, mostly nondentate. Resin canals with thick-walled epithelium. Diameter of longitudinal canals up to 90 μm. Transverse canals 20 μm.
Southern latitude tamarack	As in tree-line tamarack, but has only occasional spiral thickenings.	Terminal	As in tree-line tamarack.
Tree-line white spruce (*Picea glauca*) and black spruce (*P. mariana*)	Diameter up to 30 μm. No spiral thickenings. Bordered pits in one row on radial walls. Pits in ray crossings piciform, 1-4 in 1-2 horizontal rows.	None	Uniseriate rays numerous, 1-16+ cells high. Fusiform ray with resin canal, 2-3 seriate, up to 16+ cells high. Ray tracheids nondentate. Resin canals with thick-walled epithelium. Diameter of longitudinal canals up to 60 μm. Transverse canals 20 μm.
Douglas-fir (*Pseudotsuga menziesii*)	Diameter up to 40 μm. Spiral thickenings in spring- and summerwood. Bordered pits in one row on radial walls. Pits in ray crossings piciform, 4 in 2 horizontal rows.	Terminal	Uniseriate ray up to 12+ cells high, biseriate sparse. Fusiform ray with resin canal, 3-4 seriate in central portion, up to 16+ cells high. Ray tracheids nondentate, with spirals. Resin canals with thick-walled epithelium. Diameter of longitudinal canals up to 60 μm. Transverse canals up to 30 μm.

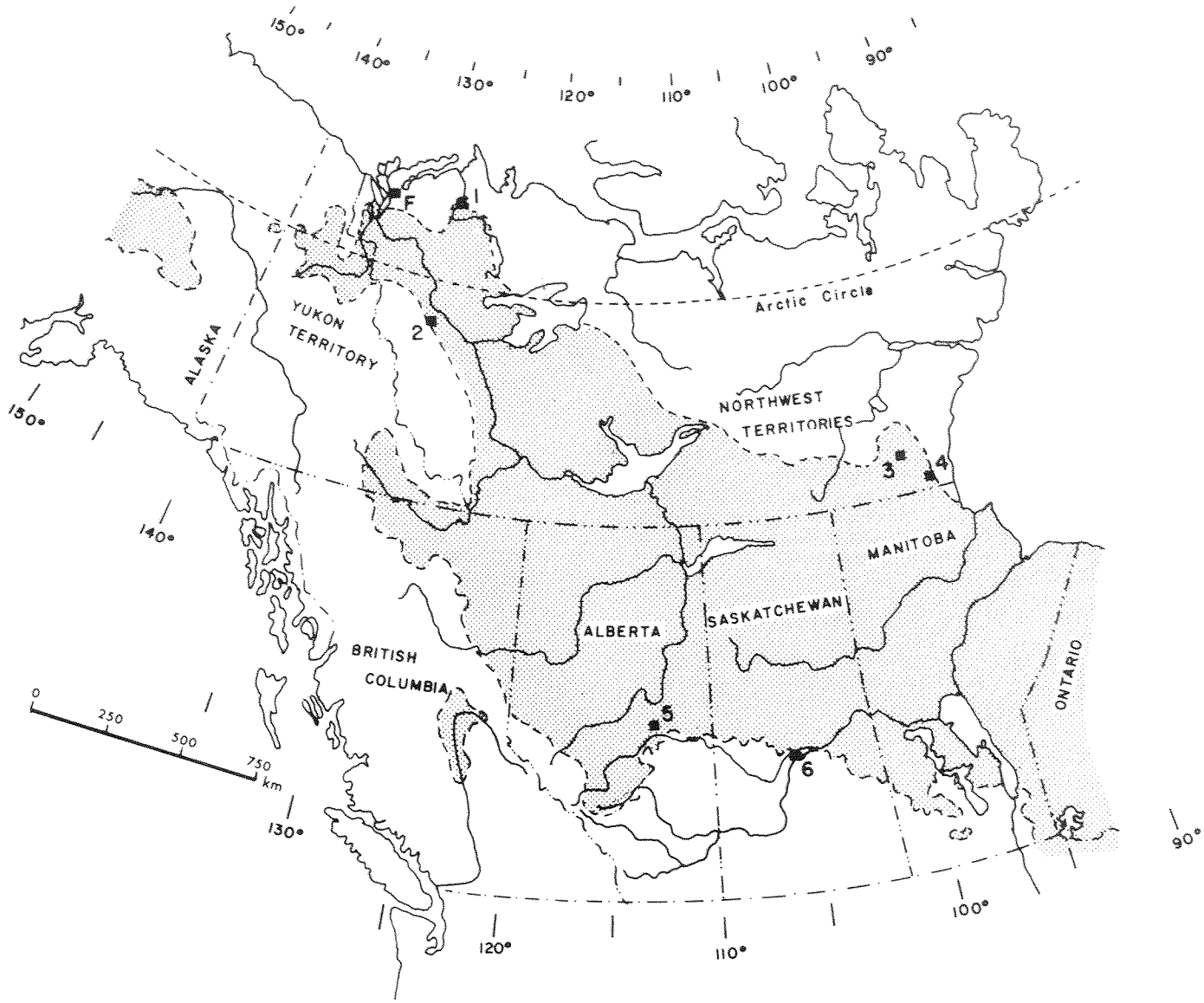

Figure 1. Map of western Canada showing the present range of tamarack (shaded), the location of the fossil tamarack find (F), and sites of modern tamarack wood collection (1-6).

with and without staining and mounted on glass slides. Pieces of wood were macerated by being cooked in an autoclave as outlined by Zalasky (Can. For. Serv. Bi-mon. Res. Notes 34:13-15, 1978). Both the sections and the macerated tissues were microscopically examined for vessels, which separate hardwoods from softwoods, and for markings on tracheids, rays, resin canals, and longitudinal parenchyma that are important in softwood genera and species identification (Panshin and de Zeeuw, 1970).

The initial examination of living *Larix* species wood showed that the fossil, because of its dimorphous summerwood tracheids, is *L. laricina* and not *L. occidentalis* Nutt. or *L. sibirica* Ldb. To verify this identification, the fossil wood sample was compared with *Larix laricina* specimens from near the northern tree line (Fig. 1, sites 1, 2, 3, 4) and from near the southern limit of their distribution (Fig. 1, sites 5, 6). Comparisons were also made with wood of white and black spruce from the vicinity of these areas and with wood samples of Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco var. *glauca* [Beissn.] Franco) from the Banff and Jasper areas of Alberta. All wood samples were taken from the lowest portion of stems of mature (over 60 years old) trees to allow comparison with the fossil material.

The findings of cellular and tissue details are summarized in Table 1. The cellular and tissue details of the fossil wood are identical to those of *Larix laricina* samples from northern environments. This indicates that tamarack grew some 80 km north of its present range about 7,510 years ago.

Summerwood tracheids of fossil wood had two types of spiral thickenings described for tree-line tamarack (Zalasky, Can. For. Serv. Bi-mon. Res. Notes 34:38). The presence of spiral thickenings in the summerwood of tamarack appears to be influenced by extremes of summer temperatures, which are more generally prevalent in northern latitudes of the tree line than in southern latitudes. Therefore, it is advisable to compare any unknown wood material with living wood of known species in the vicinity, because some anatomical features may not be constant for the whole range of a temperate species.—S.C. Zoltai and H. Zalasky, Northern Forest Research Centre, Edmonton, Alta.

PHYSIOLOGY

Use of the Rhizometer to Estimate Foliar Surface Area.—Leaf functions such as transpiration, photosynthesis, and gaseous exchange are often monitored during scientific investigations of hydrologic cycles, plant growth, or the environmental impact of pollutants. These functions can be closely correlated with foliar surface area. The surface area of leaves or needles can be measured or estimated by several methods (Baker, Can. Dep. For. Rural Dev., For. Branch Publ. 1219, 1968; Strong and Zavitkovski, USDA Forest Serv. Res. Pap. NC-153, 1978), including the use of planimeters, grids, photosensitive papers, and even direct measurement of various foliar dimensions. All of these methods, however, are extremely time-consuming and rather laborious.

A more rapid photometric "rhizometer" method, originally developed to measure the surface area of seedling roots (Morrison and Armson, For. Chron. 44[5]:21-23, 1968), appeared to have a potential for leaf-area measurement. This method employs the principle of a photocell and intercepted light, assumes roots to be cylindrical, and uses a correlation formula related to the diameter of the cylinder. Because needles are neither cylindrical nor smooth, but convoluted, half-moon shaped, or rhomboid, the rhizometer method had to be used indirectly to obtain accurate measurements. Foliar-surface areas estimated by the rhizometer were correlated with those measured by the accurate glass-bead technique, and standard curves were established to be used with the rhizometer for lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.), Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco), white spruce (*Picea glauca* [Moench] Voss), Colorado spruce (*Picea pungens* Engelm.), and Siberian elm (*Ulmus pumila* L.).

The rhizometer was modified to use a phototransistor and a digital panel meter instead of a photoelectric cell and a galvanometer. The amount of light directed toward the phototransistor was regulated in two ways: (1) by varying light intensity and (2) by varying the size of openings (masks). In measuring small needles the latter way was used to increase the resolution of the rhizometer (e.g. the percentage of light intercepted by 1 cm^2 of leaf in a 100 cm^2 opening is only 1%; however, 1 cm^2 of leaf in a 10 cm^2 opening intercepts 10% of the light). Calibrations were made frequently, and care was taken to stop or to compensate for fluctuations in readings when there were voltage surges in the laboratory.

Surface area can also be measured by using fine glass beads to coat the leaf or the needle and then relating bead weight to some standard surface area (Thompson and Leyton, Nature 229(5284):572, 1971). This method, which is accurate but can take as long as 15 min per needle, uses beads of 0.11 mm diameter and thinned rubber cement (1 part cement to 7 parts thinner by weight). In our study, the leaves and needles were coated with an adhesive, weighed, coated with beads, and reweighed. The weight of the beads was then compared with standards to obtain the total surface area. Three rods of different diameters (0.32258, 0.24384, and 0.11938 cm) were used as standards; they were individually coated to give a total surface area of 1 cm^2. The average bead weight was 23 mg/cm^2.

Each needle or leaf was first measured by the rhizometer, then by the glass-bead technique. Needle and leaf measurements were conducted in daily "runs" by species groups. The number of runs per species and the number of needles or leaves measured per run varied from four runs of 30 to 60 needles per run for white spruce to one run of 30 leaves for Siberian elm.

Data from each run and the combined data for each species were analyzed by least-squares regression techniques. The surface area measured by the bead technique as the dependent variable (Y) and the rhizometer estimate of surface area as the independent variable (X) were used. The following regression model, a power or geometric curve, proved to be most appropriate for the five species studied:

$$\ln Y = \ln a + b(\ln X)$$

Covariance analyses were used to compare the individual curves for each species run with the common curve for each species. The covariance analyses indicated no overall significant differences between the run and common curves for each species. None of the comparisons showed significant differences in the slope (b) coefficients, and only for white spruce was a significant difference noted between the intercept coefficient (a) of a run equation and the common equation. Therefore, the common equations listed in Table 1 are considered to be representative of each species.

TABLE 1

Regression statistics for estimating leaf or needle surface area (cm^2) from rhizometer estimates (cm^2) for five tree species

Species	Regression coefficients a	b	No. obs.	$s_{y.x}$ (ln units)	R^2
White spruce	3.546	0.830	180	0.118	0.788
Colorado spruce	4.860	0.978	70	0.082	0.885
Lodgepole pine	1.949	0.826	130	0.107	0.857
Douglas-fir	2.540	0.812	140	0.115	0.780
Siberian elm	2.659	0.995	30	0.036	0.995

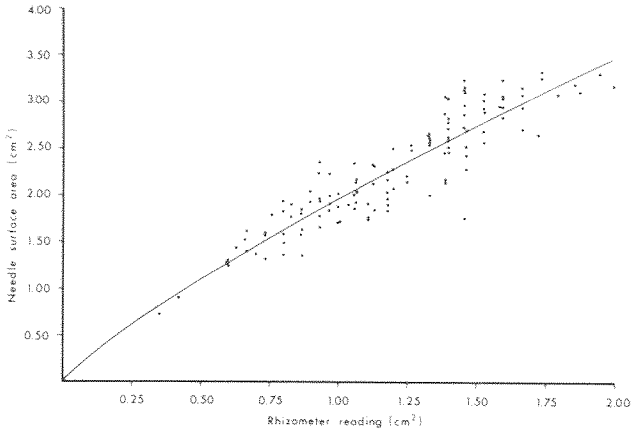

Figure 1. Standard curve for estimating the surface area of lodgepole pine needles with the rhizometer.

These results show the strong correlation between the two methods of surface-area measurement. The rhizometer method described will provide reliable estimates of needle or leaf surface area in a matter of seconds. Once standard curves, similar to the curve for lodgepole pine shown in Fig. 1, have been established between the rhizometer estimates and the highly accurate bead-technique estimates, only periodic spot-checks of the rhizometer itself need be conducted to ensure proper calibration.—L.W. Carlson, Forest Management and Conservation Branch, Ottawa, Ont., and W.D. Johnstone, Northern Forest Research Centre, Edmonton, Alta.

ENTOMOLOGY

A Release-recapture Experiment with Normal and Irradiated Spruce Budworm Males.—The depression of insect population fertility by the release of genetically altered males is attractive because it is species-specific and environmentally safe. Experience gained since the successful control of the screw worm (Bushland, Int. At. Energy Publ. STI/PUB/265:3-14, 1971) indicates that three main methodological challenges are associated with the approach. First is the development of a genetic control system appropriate to the target species. Second is the requirement that released insects remain fully competitive. Third is the necessity for an effective method of detecting released males and monitoring their dispersion. Underlying all these aspects is the concern that the laboratory-reared vector insects may differ from feral males in some subtle but significant genetic manner, thereby decreasing the effectiveness of the release.

A part of the 1978 research in this laboratory has been directed towards the development of a simple and effective method of detecting dispersal of released males into the target population, by the use of pheromone trapping. The results obtained also suggest differences in response of laboratory stocks to pheromone traps in the field.

Males released were from four sources. Field males ($+^f$) were

collected as fifth- and sixth-instar larvae from the Thessalon, Ont., area and reared on fresh spruce foliage. Normal laboratory males ($+^{l}$) were obtained from stocks maintained here at the Forest Pest Management Institute. The orange-eye marker mutant stock (or^{l}) is also maintained here (Ennis, Can. J. Genet. Cytol. 20:427-429, 1978). A fourth group of males, both orange-eye (or^{bx}) and normal ($+^{bx}$), were derived from the cross (orange-eye x field-collected 1977 material) x orange-eye. This transfer of the orange-eye marker gene to a genetic background containing variable proportions of field-type genes would be expected to alleviate adverse effects on the vigor of 6 years of intensive inbreeding of the orange-eye mutant stock.

All laboratory rearings were carried out at 20°C, 70% RH, and a 16-h photophase, according to the method of Grisdale (Can. Entomol. 102:1111-1117, 1970). Males released were less than 2 days old. In some experiments, males were exposed 6 h before release to 2,000 R (400 R/min) of X-irradiation in a Faxotron^{R} 804 unit (Field Emission Corporation, McMinnville, Oreg.). This dosage is very effective in producing inherited delayed sterility (Ennis, unpublished). All released males were marked by a light dusting of red, pink, or blue Day-Glo^{R} fluorescent powdered dye to detect possible cross-trapping between plots; none, in fact, was found.

Preliminary experiments were carried out in a planted white spruce plantation on Second Line West, Sault Ste. Marie, to determine recapture rates in plots of different sizes before field flight had begun. Three plot sizes were tested (Table 1). A single Pherocon 1C^{R} trap (Zoecon Corporation, Palo Alto, Calif.) baited with 100 μg of 11-tetradecenal (*trans*/*cis* ratio 96/4) in a polyethylene stopper (Sanders and Weatherston, Can. Entomol. 108:1285-1290, 1976) was placed at a 1.5 - 2 m height at each corner of the plots. Males were released from paper containers placed in the center of each plot, and traps were collected and budworm counted the third day after release. There was a progressive, though marginally significant, increase in recapture rate between the 4 x 4 and the 20 x 20 m plots (Table 1). A 10 x 10 m plot size was chosen for all succeeding releases, primarily to ensure maximum separation between plots, and 50 males were released per plot.

Subsequent releases were carried out in a white spruce plantation of mixed age and spacing in the Thessalon, Ont., area; some jack and red pine were also present, as were isolated stands of hardwoods, primarily maple. Plots were chosen in such a way that the minimum separation between adjacent plots was 120 m.

Six releases were made between 26 June and 11 August, 1978 (Table 2). The flight of feral males began before the first release and ended before the last. Because of uncertainty introduced into any release-recapture experiment by such factors as dependence of flight activity on weather and prevailing winds, competition between trap pheromone and feral females, and saturation of sticky trap surfaces at high population levels, quantitative comparisons are of uncertain validity. However, several qualitative conclusions can be drawn. First, it proved possible to recapture released males even during periods of high feral male population levels. In fact, the proportions of any one type of male recaptured did not vary greatly, despite the large differences in the number of feral males caught per trap over the period from 11 June to 4 August. Second, recovery of the stock orange-eye males was consistently poor, only 2 of 400 released being recaptured. Recapture of normal laboratory males was as good as or better than recapture of marked field stock. Though the numbers available for release were low, the males with orange eye on a field-type genetic background were recaptured in numbers similar to those of their normal-eye brothers and regular laboratory stock. Recapture rates for these last two classes of males were also similar to those of previous releases, suggesting that recovery of orange-eye males in this case was due to an improvement in their genetic background (the orange-eye stock is highly inbred) and not to exceptional conditions existing during release. Overall, the following percentages of untreated males were recaptured: or^{l} - 0.3%; $+^{l}$ - 13.9%; $+^{f}$ - 5.0%; or^{bx} - 40%; $+^{bx}$ - 28%. Finally, low-level irradiation of males had no detectable effect on their subsequent recapture rates: 1% for or^{l}, 15.5% for $+^{l}$, and 15% for $+^{f}$.

Results of these experiments indicate that released males can be detected even when their numbers (50/plot) are low in relation to the indigenous population. A genetically effective dose of 2,000 R appears to have little effect on short-range flight in the field, at least as far as this is measured by pheromone trapping. The use of pheromone trapping to monitor dispersal of genetically altered males in an inundative release therefore seems quite feasible and useful.—T.J. Ennis and N. Charlebois, Forest Pest Management Institute, Sault Ste. Marie, Ont.

TABLE 1
Plot size and ratios of recapture of released laboratory-reared males

Plot size	No. of plots	Recaptured/released (%)
4 x 4 m	2	16/60 (27)
10 x 10 m	4	55/160 (34)
20 x 20 m	4	66/160 (41)

TABLE 2
Recapture ratios of normal and irradiated males from four different stocks released in 10 x 10 m plots

Date	Type of male*	No. of plots	Recaptured/released (%)	Feral males/trap
78-06-30	or^{l}	2	0/100 (0)	68
	2KR or^{l}	2	1/100 (1)	68
	$+^{f}$	2	9/100 (9)	61
	2KR$+^{f}$	2	15/100 (15)	82
07-11	or^{l}	4	1/200 (0.5)	140
	$+^{l}$	4	24/200 (12)	133
	$+^{f}$	2	1/100 (1)	151
07-21	$+^{l}$	3	22/150 (15)	134
	2KR$+^{l}$	3	30/150 (20)	105
07-28	$+^{l}$	3	21/150 (14)	14
	2KR $+^{l}$	3	21/150 (14)	17
08-04	$+^{l}$	3	26/150 (17)	2
	2KR $+^{l}$	3	19/150 (13)	2
08-11	or^{bx}	1	20/50 (40)	0
	$+^{bx}$	1	14/50 (28)	0
	$+^{l}$	2	11/100 (11)	0

* l = laboratory stock.
f = field stock.
bx = backcross segregants.
2KR = irradiated.

MISCELLANEOUS

An Improved Equation for the Estimation of Ambient Fluoride Concentrations from Fluoridation Plates Data.— In an assessment of the effects of a fluoride-emitting industry on extensive areas of forest vegetation, it is essential to have an absolute measure or, at least, some reliable estimate of the concentrations of fluoride in the air for a minimum of one growing season. Such an assessment requires a large number of permanent air- and vegetation-monitoring stations.

For monitoring the fluoride concentrations in the air, two static methods are available: (1) the use of fluoridation plates (filter papers impregnated with lime or sodium formate) and (2) the use of one of several monitoring instruments that involve the passing of a known volume of air through fluoride-absorbing chemicals or chemically treated filters. The second method necessitates large investments in procuring, maintaining, and operating such instruments, but the first is inexpensive and has been commonly used for the past two decades. The data obtained with the fluoridation plates are in the form of total fluoride deposited on the plates over a selected period (commonly 30 days) and are usually presented in the form $\mu gF/dm^2/30$ days.

Several authors have used such results obtained under field and/or laboratory conditions to estimate ambient fluoride-concentrations (Adams, Int. J. Air Water Pollut. 4:247-255, 1961; Israel, Atmos. Environ. 8:159-166, 1974; Robinson, Am. Ind. Hyg. Assoc. J. 8:145-148, 1957; Sidhu, Air Pollut. Control Assoc. 70th Annu. Meet., Pap 77-30.2, Toronto, 1977; Wilson et al., Am. Ind. Hyg. Assoc. J. 27:254-259, 1967). The general form of the formulae established has been:

$$Y = bX$$

where Y = exposure factor — expressed as time of exposure (in hours) multiplied by F-concentration ($\mu gF/m^3$) in air during exposure and

X = total fluoride accumulation on the plates expressed as $\mu gF/dm^2$.

Measuring X after a particular time of exposure permits the estimation of the ambient concentration ($\mu gF/m^3$). The aforementioned authors established that fluoridation plates provided good estimates of the ambient concentrations of fluoride and could be used as an informative and inexpensive means for the surveillance of fluoride contamination of extensive areas. However, because factors such as the concentrations emitted at the source, wind speed, humidity, and temperature variations can alter the relationship between "exposure factor" and the rate of F-deposition on plates, a single regression equation may not be universally applicable. It would be more accurate and helpful to establish a separate equation for each area under investigation.

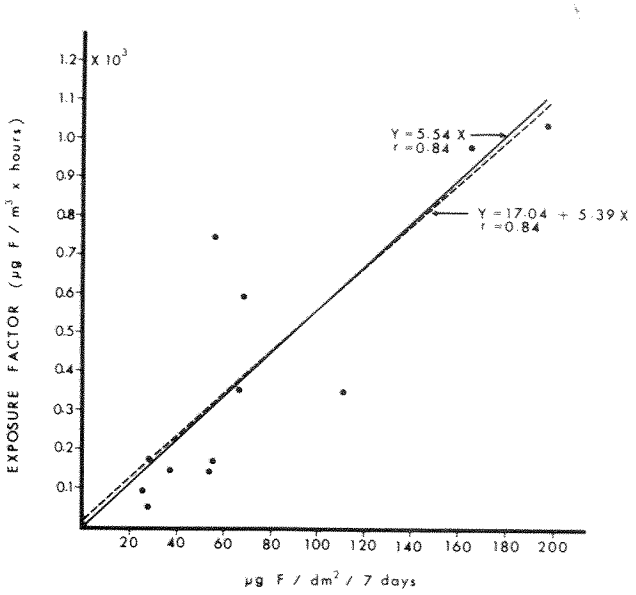

Figure 1. Relationship between exposure factor ($\mu gF/m^3$ x hours of exposure) calculated from sequential sampler data and weekly fluoride accumulation on Na-formate plates ($\mu gF/dm^2/7$ days).

In the Long Harbour area of Newfoundland, Sidhu (1977) was able to establish the following formula for estimating concentrations of fluoride in air:

$Y = 17.04 + 5.39 X$

The author found, however, that under field conditions in which ambient fluoride concentrations were very low ($<0.02\ \mu g/m^3$) or in which periods of exposure were short (<30 days) the use of the intercept in the foregoing equation led to the overestimation of actual ambient concentrations of fluoride. Therefore, theoretically, a desirable regression equation is one intercepting the Y-axis near the origin ($Y = bX$). Such an equation was calculated to be $Y = 5.54 X$. The improved equation was not significantly different from the one previously presented (Fig. 1).

For the convenience of users of the equation $Y = 5.54 X$, the component (5.54/number of hours of exposure) has been calculated for durations of 24, 168, and 720 h as:

$\mu gF/m^3 = 0.2308 X$, where $X = \mu gF/dm^2/24$ h (1 day)
$\mu gF/m^3 = 0.0328 X$, where $X = \mu gF/dm^2/168$ h (7 days)
$\mu gF/m^3 = 0.0076 X$, where $X = \mu gF/dm^2/720$ h (30 days)

The use of fluoridation plates as air monitors is instrumentally more convenient and inexpensive. In addition a significant correlation has been established between the levels of fluorides deposited on plates and those accumulated in plants, animals, and soils (Israel, Atmos. Environ. 8:167-181, 1974; Sidhu, Air Pollut. Control Assoc. 71st Annu. Meet., Pap. 78-24.7, Houston, Tex., 1978). In both cases the deposits are cumulative and are the result of interaction between the emitted levels at the source and such environmental factors as wind speed, humidity, and temperature. The foregoing facts support not only the use of both fluoridation plates as air-quality monitors but also the adoption of regression equations relating data to ambient concentrations and levels of accumulations in the biophysical components of the ecosystem.—S.S.Sidhu, Newfoundland Forest Research Centre, St. John's, Nfld.

NEW PUBLICATIONS

Mathur, V.N.P. 1978. R & D in solid wood products - a review of nonfederal government programs and activities. Dep. Environ., Can. For. Serv. Inf. Rep. DPC-X-7, Ottawa.

Abstract

The wood products industry has limited capabilities to meet its R & D needs, but the federal Forest Products Laboratories (FPLs) can perform an essential function by solving the industry's medium- and long-range R & D requirements.

This study recommends that all sectors — industries, universities, federal and provincial government supported laboratories, machinery manufacturers, and other suppliers — should coordinate their activities and cooperate in increasing their commitments to meet the future R & D needs of the nation in forest resource utilization, energy from wood residues, structural composite wood products, improvements in codes and standards for increasing the legitimate markets for wood products at home and abroad, and implementation of new technology from research laboratories into production facilities.

The programs and potentials of the nonfederal government research and development (R & D) facilities in Canada were examined by visits to more than 200 individual operations in solid wood products (excluding pulp, paper, and converted paper products).

Rose, A.H., and O.H. Lindquist. 1978. Insects of eastern spruces, fir and hemlock. Can. For. Serv. For. Tech. Rep. 23. Available from Department of Supply and Services (Printing and Publishing) and bookstores. Price in Canada, $5; in other countries, $6.

Abstract

This handbook deals with insects feeding on spruces, balsam fir, and hemlock in Canada from the Rockies to the Atlantic. Seventy-five species or species groups causing damage or which are commonly found on these trees are covered. Color illustrations aid in the identification of insects and trees. Flow chart keys help identify the insect and the injury found. Included are biological sketches of causal insects, illustrations of life stages, and the injury caused. Control is discussed along with the required type and timing of applications of pesticides. Injury by birds, mammals, mites, and other agents is also included.

RECENT PUBLICATIONS—MARCH-APRIL 1979

10 **Barton, G.M., J.A. McIntosh, and S. Chow. 1978.** The present status of foliage utilization. AIChE Symp. Ser. 177(74):124-131.

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