vegetation if regrowth is to be adequately controlled. This depth of scalping may reduce soil fertility and increase susceptibility to frost heaving, especially in clay soils. Observations (e.g. Prochnau, B.C. For. Serv., Res. Note 37, 1960; Gagnon, Bi-mon. Res. Notes 25:7, 1969) suggest that incorporation of the duff with the underlying mineral soil may improve seedling growth. Excessive regrowth of competing vegetation can, however, offset the advantage of retaining the uppermost horizons within the outplanting spot. If adequate control of competing vegetation could be achieved by the process used to incorporate surface horizons, soil mixing would merit consideration as an alternative to scalping for mechanical site preparation.

A field trial was initiated in 1972 to evaluate the effect of various site preparation alternatives on survival and growth of outplanned tree seedlings. The following treatments were investigated: 1. removal of competing vegetation without disturbing the duff (clipped treatment); 2. removal of competing vegetation together with the duff (scalped treatment); 3. incorporation of competing vegetation and duff with the underlying mineral soil (mixed treatment); 4. no disturbance of either competing vegetation or duff (no treatment). The test area, which covered approximately 8 ha, was located in a clear-cut about 80 km northeast of Prince George on Tree Farm License No. 30 (Northwood Pulp and Timber Ltd.). Before cutting, which was done during the winter of 1970-71, the site supported an overmature white spruce/alpine fir stand. Lesser vegetation was characteristic of the Oplopanax Site Type (Illingworth and Arlidge, B.C. Forest Service, Res. Note No. 35, 1960). The soil was a Bisequa Gray Luvisol. The duff layer, which averaged 4 cm deep, was generally undisturbed because the area had been logged in winter.

The four treatments were prepared as follows:

Clipped Treatment. All vegetation was clipped to ground line in early June 1972. Regrowth was clipped twice during the remainder of the 1972 growing season and three times during the 1973 growing season. The duff was left undisturbed.

Scalped Treatment. A D8H Caterpillar tractor equipped with a standard bulldozer blade removed the vegetation, duff and uppermost 5 cm of mineral soil in the usual manner to prepare exposed mineral soil strips which had an average width of 4 m.

Mixed Treatment. All vegetation and surface organic materials were mixed into the underlying mineral soil using a 9 hp, hand-operated, Mang rotovator. Removal of logs and large branches that would have impeded operation of the rotovator was the only disturbance to the site before rotovation. The new surface horizon was a homogeneous, organic-enriched, mineral layer about 7 cm deep after settling.

No Treatment. Both vegetation and duff were left undisturbed.

The effect of these treatments on survival and growth of 2 + 0, bare-root, white spruce and lodgepole pine [*Pinus contorta* Dougl. var. *latifolia* Engelm.] seedlings was assessed in a semi-randomized block experiment. Clipped, mixed and no-treatment plots, each approximately 100 m^2 in area, were randomly located in each of the eight blocks into which the test area was divided. A scalped strip, constituting the fourth treatment plot, was located on one side of each block. Thirty seedlings of each species were mattock planted in each of the eight replicates of each treatment during early June 1972. Their survival and height growth were measured at the end of the second growing season, in September 1973. Data were analysed by Duncan's new multiple range test. Percent survival data were transformed to the square root of the ARCSINE before analysis, but original values are reported in Table 1.

Survival was highest in the plots where both vegetation and duff had been disturbed (scalped and mixed treatments). Differences, however, were not statistically significant for spruce (Table 1). These results suggest that on such sites, increases in survival resulting from site preparation may only be modest when appropriate outplanting stock is used.

TABLE 1
Survival, total height and height increment during the second growing season following outplanting of 2 + 0, bare-root, white spruce and lodgepole pine seedlings planted in variously prepared sites.

Treatment	Survival %	Total height (cm)	2nd year incr (cm)
White spruce			
No treatment	81 a[1]	22 a	7 a
Scalped	91 a	23 a	8 ab
Clipped	84 a	25 a	9 b
Mixed	90 a	29	12
Lodgepole pine			
No treatment	87 a	23 a	11 a
Clipped	92 ab	27 a	13 ab
Scalped	98 b	27 a	14 b
Mixed	98 b	33	20

[1] Means followed by a letter in common do not differ significantly (p = .01).

Total height was greatest for both species in the mixed treatment plots (Table 1). Since increments during the year of outplanting were small and differed insignificantly among treatments, most of this improvement resulted from increments during the second growing season. Average 1973 increments for the mixed treatment surpassed those for the other treatments by 30 to 80%. These results suggest that considerable gains in height growth may be realized by incorporating the surface organic materials of white spruce/alpine fir clear-cuts into the underlying mineral soil during site preparation. Although vegetation regrowth did occur, its effects did not offset the advantage of retaining duff and uppermost mineral soil. Rotovation, the soil mixing process used in this experiment, apparently provided adequate control of competing vegetation.

The limited response of seedlings to vegetation removal without duff disturbance (clipped treatment) suggests that the presence of competing vegetation is only one factor affecting seedling performance when planting sites are not prepared. The low soil temperatures prevailing beneath the duff of undisturbed sites (Dobbs and McMinn, Bi-mon. Res. Notes 29:6-7, 1973) are possibly suboptimal for seedling growth. Consequently, these results suggest that a similarly modest response might be realized following herbicide treatment, since herbicides, like clipping, do not remove the duff. Survival and growth in the untreated plots were probably similarly affected by low soil temperature as well as competing vegetation.

The reduction of soil fertility inherent in duff removal by scalping may be offset not only by the control of competing vegetation afforded by this site treatment but also by the enhancement of soil temperature which follows exposure of mineral soil. Mixing, like scalping, probably provides the favorable soil temperature regime associated with exposure of mineral soil in this forest region. However, mixing, unlike scalping, preserves the fertility inherent in the duff and uppermost soil horizons. If the improved growth evident so far is maintained, the operational feasibility of soil mixing as a method of mechanical site preparation warrants further investigation.—R. G. McMinn, Pacific Forest Research Centre, Victoria, B.C.

Phytotoxicity of Four Insecticides to Germinants.—The collembolan, *Bourletiella hortensis* (Fitch), is a pest of young pine, spruce and hemlock seedlings in the nurseries of coastal British Columbia, and effective non-phytotoxic insecticides are needed for its control.

Observations in the United Kingdom (Bevan, XIIth Int. Congr. Ent., Lond. pp. 666-668, 1965) and preliminary work in British Columbia (Marshall, unpub.) indicated that conifer seedlings were attacked just before and at the "drumstick" stage, i.e., when the hypocotyl had straightened out but before the seed coat was shed. Certain insecticides were suggested for collembolan control (Spencer, 1968. Guide to the chemicals used in crop protection. Can. Dep. Agric. Publ. 1093), but the phytotoxic effects of these chemicals on germinating conifers were unknown. A greenhouse experiment was therefore carried out to determine the effect of four selected insecticides on three conifer species: Sitka spruce [*Picea sitchensis* (Bong.) Carr.], white spruce [*P. glauca* (Moench) Voss] and western hemlock [*Tsuga heterophylla* (Raf.) Sarg.], with the British Columbia Forest Service seedlot numbers 951 (Kingcome River 50N, 126W), 1522 (Ptarmigan Creek, 53N, 120W) and 1832 (Kitimat area, 54N, 129W), respectively.

In March 1972, plastic pots (10.2 x 10.2 cm) were filled with an unsterilized 1:1 sand:peat mixture and thoroughly soaked before seeding. Seeds were hand sown and covered with coarse sand to the depth of the seed, to permit observation of the development of seedlings. Enough seeds were sown to give approximately 100 germinants per pot. The insecticides were applied when 50% of the germinants in each pot reached the following stages: (1) seed stage (½ day following sowing when the seed coat began to split), (2) radicle stage (tip of the radicle exposed), (3) root stage (radicle penetrating the soil), (4) cotyledon stage (hypocotyl perpendicular with the seed coat enclosing the cotyledons), and (5) cotyledon stage (seed coat had dropped from the cotyledons). The insecticides and their equivalent application rates of active ingredients (a.i.) were: (1) Diazinon® [0,0-diethyl 0-(2 isopropyl-4-methyl-6-pyrimidyl) phosphorothioate] at 0.56 and 2.24 kg/ha, (2) Dyfonate® [0-ethyl s-phenyl ethylphos = phono-dithioate] at 2.24 and 6.72 kg/ha, (3) Malathion® [diethyl mercaptosuccinate, s-ester with 0,0-dimethyl phosphorodithioate] at 4.48 and 8.96 kg/ha, and (4) Vydate® [methyl N′, N′-dimethyl-N- [(methylcarbamoyl) oxy] -1-thiooxamimidate] at 1.1 and 3.4 kg/ha. They were applied as a water base emulsion at the rate of 9350 *l*/ha by an air sprayer with a nozzle delivering 1.4 kg/cm^2 in a solid cone-shaped spray pattern. Each treatment was replicated five times in a completely random design.

Pots were watered twice for the first 2 days following sowing, then once daily until the trial ended. Greenhouse temperatures were controlled at 20 C during the first 93 days of germination, but thereafter ranged from 15 to 41 C.

Ninety-three to 113 days after seeding, the seedlings were washed from the soil and data were obtained on: total number of seedlings; stem and tap root length of 25 randomly selected plants per treatment, and oven-dry (75 C) stem and root weight of 50 randomly selected plants from each treament. Treament means were compared using Dunnett's tables for multiple comparisons (Dunnett, Biometrics 20:482-491, 1964).

Table 1 shows the parameters that were significantly reduced or increased from controls. Each species behaved differently at each germination stage and with each insecticide concentration. Generally, the insecticide did not significantly (P = 0.05) affect germinants, as indicated by the large number of blanks in the table. Insecticide application at the seed stage had no adverse effect on white spruce and little on Sitka spruce; application at the cotyledon stage had the least adverse effect on Sitka spruce and western hemlock. In the absence of a pest, a positive or negative response in plant growth depends on complex interactions between phytotoxicity and the stimulatory effects of insecticides. Increased plant growth may result when phytotoxicity is outweighed by stimulation, which can occur at low or high dosages depending on the insecticide, plant species (Kabir and Khan, J. Econ. Entomol. 65:1179-1972) and stage of development (Table 1). A negative or positive response at a higher application rate for a particular germination stage was expected, but a negative response at a lower rate not accompanied by a similar response at a higher rate (e.g. Dyfonate on Sitka spruce at the radicle stage) was surprising. Such responses probably resulted from phytotoxicity at the higher rate being outweighed by the stimulatory effect of the insecticide. However, further work is required in such seemingly contradictory areas to determine the cause-effect relationship.

For Sitka spruce, Dyfonate and high concentration of Vydate depressed stem growth, but only the high concentration of Malathion, when applied at the seed stage, reduced numbers of germinants by 23%.

White spruce appeared to be insensitive to Dyfonate, but its germinants were reduced about 15% by Diazinon, Malathion and Vydate when applied at the radicle, root or hypocotyl stages. At the higher concentration, Vydate killed 39 and 32% of western hemlock germinants when applied at the seed and radicle stage, respectively. Even at the lower concentration there was at least a 20% reduction in root and shoot growth. The phytotoxic symptoms of Vydate on western hemlock were: twisted and chloritic primary needles, necrotic cotyledons, and completely aborted plants (Fig. 1).

TABLE 1
Effect of insecticides on seedling growth.

Dosage			Application Stage, Parameter and Response[a]																	
(Kg a.i./ha)		Seedling	Seed					Radicle					Root			Hypocotyl				Cotyledon	
Insecticide		species	NS	SW	SL	RW	RL	NS	SW	SL	RW	RL	SW	SL	RW	NS	SW	SL	RW	SW	RW
Diazinon	10.56																				
		White spruce				112															
		Western hemlock														87					
	2.24																				112
		White spruce				112															
		Western hemlock	111					85													
Dyfonate	2.24																				
		Sitka spruce									79			78							
	6.72																				
		Sitka spruce					111							74							
		Western hemlock																			113
Malathion	4.48																				
		Sitka spruce													113						
		Western hemlock				81													84		
	8.96																				
		Sitka spruce	77							113								112			
		White spruce	112					84													70
		Western hemlock				84														112	
Vydate	1.10																				
		Sitka spruce								112								112			
		White spruce						86													83
		Western hemlock		65	36	64			78		79										
	3.40																				
		Sitka spruce									85										
		White spruce												115		88					83
		Western hemlock	61	41	44	40	65	68	45	50	51	68	74		79		77				

[a] Parameters and seedling species for which there was no response are not shown; parameters measured include: NS = number of seedlings; SW = stem weight; SL = stem length; RW = root length. Only statistically significant (P = 0.05) decreases (underlined) and increases are given.

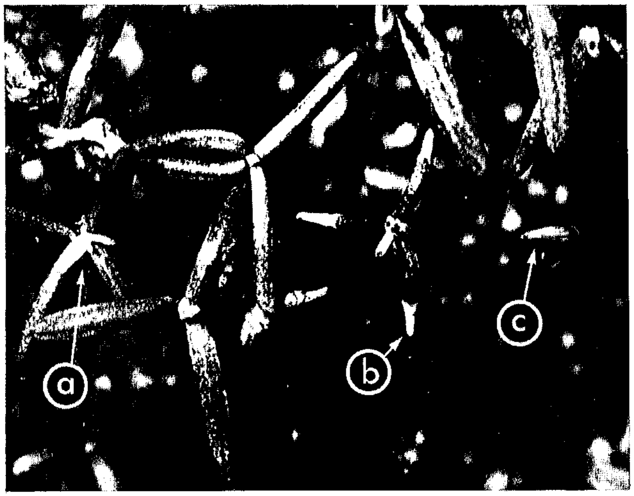

Figure 1. Some phytotoxic symptoms of Vydate on western hemlock seedlings:
a) twisted chlorotic primaries;
b) necrotic cotyledons, and
c) aborted seedling.

Chlorosis occurred mainly in primary needles, but the seedling became green again after 2 to 3 weeks.

For a seedlot under field conditions, a trade-off between collembolan control and phytotoxicity is expected, and the least phytotoxic chemical may not produce the best balance. Also, the less severely damaged seedlings should recover. Apart from high concentrations of Malathion on white spruce and Vydate on western hemlock, the average recommended dosages — intermediate between those tested here — should not seriously affect germination of Sitka spruce, white spruce and western hemlock seedlings.—S. Ilnytzky and V. G. Marshall, Pacific Forest Research Centre, Victoria, B.C.

RECENT PUBLICATIONS — MAY-JUNE 1974

11 **Arnott, J. T., and C. P. Brett. 1974.** Container-grown trees show response to fertilization at time of planting. *Tree Planters' Notes.* **24**(1):15-19.

12 **Bohlen, J. C. 1973.** Tension-perpendicular-to-glueline strength of douglas-fir lumber laminated at high temperatures. *Wood Fiber* **5**:21-25.

12 **Bramhall G. and S. McIntyre. 1973.** More and better lumber by better sawing control. *Can. For. Ind.* (Dec.).

11 **Carrow, J. R. 1973.** Free amino acids in grand fir needles and the effects of different forms of foliar-applied nitrogen. *Can. J. For. Res.* **3**:465-471.

10 **Cerezke, H. F. 1973.** Bark thickness and bark resin cavities on young lodgepole pine in relation to *Hylobius warreni* Wood (Coleptera: Curculionidae). *Can. J. For. Res.* **3**:599-601.

11 **Dyer, E. D. A. 1973.** Spruce beetle aggregated by the synthetic pheromone frontalin. *Can. J. For. Res.* **3**:486-494.

11 **Edwards, D. G. W. 1973.** Effects of stratification on western hemlock germination. *Can. J. For. Res.* **3**:522-527.

11 **Etheridge, D. E., and H. M. Craig. 1973.** A bilayer plate technique to detect broad-spectrum antagonism in microorganisms and its application to wood-inhabiting fungi. *Can. J. Microbiol.* **19**:1455-1458.

13 **Gaudert, Peter. 1974.** A new torsion test for particleboard. *For. Prod. J.* (Feb.).

12 **Hunt, K., and J. L. Keays. 1973.** Kraft pulping of trembling aspen tops and branches. *Can. J. For. Res.* **3**:535-542.

8 **Jurdant, M. Michel, M. Jean-Claude Dionne, M. Jean-Louis Bélair, M. Jean Beaulieu, et M. Vincent Gérardin. 1973.** Présenté au Colloque "Le Saguenay/Lac-St-Jean", par la section des études écologiques régionales du Centre de Recherches des Laurentides, Environnement Canada.

13 **King, F. W., and S. C. Juneja. 1974.** A new fire retardant treatment for western red cedar shingles. *For. Prod. J.* (February).

9 **Kondo, E. S., D. N. Roy, and E. Jorgensen. 1973.** Salts of methyl-2-benzimidazole carbamate (MBC) and assessment of their potential in Dutch elm disease control. *Can. J. For. Res.* **3**:548-555.

7 **Mahendrappa, M. K., and P. O. Salonius. 1973.** Ammonia Volatilization from black spruce raw humus treated with normal and controlled-release urea. *Soil Sci.* **17**:117-119.

4 **Manning, Glen H., et H. Rae Grinnell. 1974.** Les forêts du Canada: la resource et son utilisation d'ici l'an 2000. Can. For. Serv. *Publ.* 1304F.

7 **MacGillivray, H. G., and H. A. Hartley. 1973.** Influence of lath plot-separators on frost heaving and growth of seedlings. *Tree Planter's Notes* **24**:6.

12 **McIntosh, J. A. 1973.** Salvaging flood-killed timber. *Can. For. Ind.* (Oct.).

11 **McMullen, L. H., and S. F. Condrashoff. 1973.** Notes on dispersal, longevity and overwintering of adult *Pissodes Strobi* (Peck) (Coleoptera: Curculionidae) on Vancouver Island. *J. Entomol. Soc. B.C.* **70**:22-26.

13 **Mia, A. J., and D. J. Durzan. 1974.** Cytochemical and subcellular organization of the shoot apical meristem of dry and germinating jack pine embryos. *Can. J. For. Res.* **4**:39-54.

10 **Muir, J. A., and J. K. Robins. 1973.** Detection of dwarf mistletoe of jack pine on aerial photographs. *Plant Dis. Rep.* **57**:951-954.

10 **Powell, J. M. 1974.** Environmental factors affecting germination of *Cronartium comandrae* aeciospores. *Can. J. Bot.* **52**:659-667.

12 **Roff, J. W. 1973.** Brown mould (*Cephaloascus fragrans*) on wood, its significance and history. *Can. J. For. Res.* **3**:582-585.

13 **Shen, K. C. 1974.** Modified powdered spent sulfite liquor as binder for exterior waferboard. *For. Prod. J.* **24**:38-44.

13 **Shields, J. K., R. L. Desai and M. R. Clarke, 1974.** Ammoniacal zinc oxide treatment as an inhibitor of fungi in pine lumber. *For. Prod. J.* (February).

7 **Strunz, George M., Masatoshi Kakushima, Merlyn A. Stillwell and (in part) Christopher J. Heissner. 1973.** Hyalodendrin: a new Eungitoxic Fpidithiodioxopiperazine produced by a *Hyalodendron* species. *J. Chem. Soc. Perkin Trans.* I. pp. 2600-2602.

7 **Strunz, George M., Christopher J. Heissner, Masatoshi Kakushima, and Merlyn A. Stillwell. 1973.** Metabolites of *Hyalodendron* sp.: Bisdethiodi (methylthio) hyalodendrin. *Can. J. Chem.* **52**:325-326.

9 **Sutton, R. F. 1974.** Problems and approaches in biological research related to mechanized reforestation. *For. Chron.* 50 (Feb.).

9 **Sutton, R. F. 1974.** White spruce group planting in herbicide-treated, overmature mixedwood: 11-year results. *For. Chron.* 50 (Feb.).

9 **Takai, S., and M. Hubbes. 1973.** Polyphenol-oxidase activity and growth inhibition of *Hypoxylon pruinatum* (Klotzsche) Cke. by aspen bark meal. *Phytopath. Z.* **78**:97-108.

14 **Yeatman, C. W. 1974.** The jack pine genetics program at Petawawa Forest Experiment Station 1950-1970. Can.