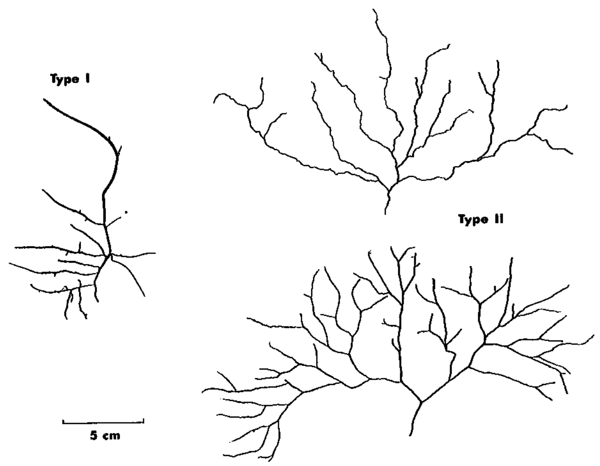

Figure 1. Type I and Type II rhizomorph growth habits.

Among isolates used in the study, two rhizomorph growth habits were observed; rhizomorphs produced by inoculum segments in soil branched either monopodially (Type I) or dichotomously (Type II, Fig. 1). Rhizomorphs of isolates that grew well in alkaline soil had Type I growth habits, whereas Type II isolates preferred acidic soil. This suggests that each type has a different pH optimum for rhizomorph growth.

This work formed part of a thesis submitted to the University of Cambridge for the degree of Ph.D. I express my gratitude to Dr. J. Rishbeth for his advice and encouragement.—D. J. Morrison, Pacific Forest Research Centre, Victoria, B.C.

Effect of Soil Extracts on Ecologically Different Fungi.—Sensitivity to effects of soil extracts seems to vary between fungi (Vaartaja and Agnihotri, Phytopath. Zeits. 60:63-72, 1967) and *Pythium ultimum* Trow, one of the most important seedling pathogens, has been found to be strongly inhibited (Vaartaja, Bi-Mo. Res. Notes 23:14, 1967a; 25:25-26, 1969). In the 1967a study, one extract was tested by placing it in agar at a colony edge of each of 27 fungi. In the 1969 study each of 22 extracts were incorporated in agar medium and one fungus studied. Further exploration of the varying sensitivity of fungi is reported here. In particular, this study was to determine whether the large variation found between fungal species in the 1967 study could be confirmed with the methods used in 1969, where only *P. ultimum* was used.

Samples were collected in May 1968, at Maple, Ont. from two sandy soils: one under mature pines; the other one from a nearby grassy pasture. The soils were extracted with distilled water, and the extracts passed through (0.2μ) filters, incorporated in agar and tested in petri dish cultures as reported in 1969. Cultures of the following pathogens were used as inocula: (1) *Ceratobasidium cornigerum* (Bourd.) Rog. (isolate No. 5651B; low virulence to conifer seedlings, Vaartaja, Phytopathology 57:765-768, 1967b), (2) *Pythium* sp. (probably a new species related to *P. splendens* Braun (9336), (3) *P. coloratum* Vaartaja (6030B; low virulence to conifer seedlings, Vaartaja, Mycologia 57:417-430, 1965), (7) *P. salpingophorum* Drechsler (9167A), (8) *P. ultimum* (9248) and (9 and 10) *Waitea circinata* Warcup & Talbot (7101 and 7745B; medium virulence to conifer seedlings (Vaartaja, 1967b). For comparison, a common mycorrhiza-forming fungus (11) *Cenococcum graniforme* (Sow.) Ferd & Winge (8902C), and a common antagonist of various fungi (12) *Gliocladium fimbriatum* Gilman & Abbott (7047) were also included. After 4 days of incubation at 15 C radial growth of these fungi was measured and expressed as a percentage of that in distilled water controls. The two replicates gave nearly identical results (mostly within 5%).

TABLE 1
Effects of two soil extracts on growth of fungi.

Species	Virulence[1] on conifer seedlings	Pine Soil	Pasture Soil	Avg
	(avg radial growth, control = 100)			
I. STIMULATION				
P. salpingophorum	low	141	127	134
C. cornigerum	low	133	113	123
II. NO EFFECT				
C. graniforme	(symbiotic)	90	95	93
G. fimbriatum	low	93	93	93
III. INHIBITION				
P. debaryanum I	high	80	68	74
P. debaryanum II	high	61	85	73
Pythium sp.	high	57	65	61
P. pyrilobum	high	45	62	53
P. ultimum	high	38	64	51
W. circinata (avg)[2]	medium	25	60	42
IV. STIMULATION OR INHIBITION				
P. coloratum	low	118	91	104
AVERAGE		76	82	79

[1] As determined from studies cited or unpublished results.
[2] Results for two isolates were similar.

Table 1 shows the main results. Microscopic observations indicated that the density of colonies and hyphal diameters were affected in the same way as radial extension growth. Thus the differences in the amount of growth were greater than those shown in Table 1. Furthermore, inhibited growth was accompanied by early lysis. Two morphologically different isolates of *P. debaryanum* responded differently while two identical isolates of *W. circinata* responded identically.

Data in Table 1 confirm the findings of the earlier study (Vaartaja and Agnihotri, *loc. cit.*), that different fungi have greatly different responses to soil extracts. Three of the fungi of Table 1 (*C. cornigerum*, *C. graniforme* and *W. circinata*) were tested earlier with similar results. In the tests employed here, the soil solution was in a uniform 1-1 dilution. In soil, however, the inhibitors likely occur in greater concentrations in certain micro-environments than in others, particularly when the soil is not saturated. Furthermore the degree of inhibition has been shown to vary greatly when the extracts are obtained at different times from the same soil (Vaartaja, 1969). Those *Pythium* species that are known to be virulent pathogens of tree seedlings were consistently inhibited. These data indicate that the sensitivity of *P. ultimum*, isolate 9248, represents a response common among virulent *Pythium* isolates. Therefore this isolate is being used extensively in further assays of soil mycostasis.

Prevailing ecological theories suggest that virulent soil-borne pathogens have evolved from saprophytes and usually have not retained their high tolerance of mycostatic factors. These fungi are saprophytic prior to contacting the living host. This is the stage in which mycostasis operates and which could be utilized for disease control. The antagonist *G. fimbriatum* and the mycorrhiza fungus *C. graniforme* may exert biological disease control. Since these fungi seem tolerant of at least some mycostatic factors, attempts should be made to utilize them in disease control.—O. Vaartaja, Forest Ecology Research Institute, Ottawa, Ont.

SILVICULTURE

Effect of Four Site Treatments on Survival and Growth of White Spruce and Lodgepole Pine Seedlings.—The usual machine for mechanical site preparation of moist white spruce/alpine fir [*Picea glauca* (Moench) Voss/*Abies lasiocarpa* (Hook.) Nutt.] sites in the Prince George Forest District of British Columbia is a bulldozer. Whether the machine is equipped with a standard or a toothed, land-clearing blade, the sites are commonly scalped. Duff and uppermost mineral soil is thereby pushed out of reach of the newly planted seedling. This drastic treatment has been adopted because seedling survival may be greatly reduced by competing vegetation. Scalping must be deep enough to eliminate the roots of competing 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 ex-