containing fulure, and this suggests that chemical cues, in addition to fulure, may be necessary to elicit courtship.

Full courtship behavior and copulatory attempts were evoked by a pair of fresh forewings from a male eastern spruce budworm together with PVC containing fulure. The use of male instead of female wings removed any possibility of contamination by traces of the female sex attractant but indicated that, if other chemicals are essential for full courtship and copulation, they must be present in both male and female wings.

Wings of male spruce budworm were then treated with various organic solvents to remove any possible chemical cues, and paper models were soaked in the resulting solutions. The forewings of other Lepidoptera were tried as well. All such models were pinned to the PVC containing fulure and then to the cheesecloth at the upwind end of the tunnel.

Soaking wings for 3 h in acetone, hexane, ether, chloroform and water, chloroform and methanol (3:1), and cold water had no effect on behavior: males continued to court and to attempt copulation. Soaking the wings in boiling water reduced response. No response could be elicited from various models soaked in the solution after it had cooled, probably because of a change in the physical characteristics of the wings (including the loss of numerous scales) resulting from heating rather than from the extraction of a chemical cue. No responses were evoked by paper models soaked in any of the solutions. It was therefore concluded that the necessary cue leading to courtship is not a chemical factor but the physical attributes of the wings. This conclusion is supported by the fact that, in the presence of fulure, the wings of male jack pine budworm (*Choristoneura pinus* Freeman) and male Douglas-fir tussock moth (*Hemerocampa pseudotsugata* [McD.]) also evoke full courtship behavior and copulatory attempts, for it is unlikely, if a chemical cue is involved, that it would be contained in the wings of other species. When wings were glued to paper so as to ensure that the whole wing surface adhered to the more rigid paper but that no glue soaked through to the upper surface of the wing, no courtship behavior was evoked. This suggests that the flexibility of the wing may be important.

Wing scales were removed from either the top or the bottom surfaces or from both surfaces of freshly killed male spruce budworm forewings. The results of presenting these forewings to pheromone-stimulated male budworm are shown in Table 1; they suggest that wing scales are necessary to evoke courtship and copulatory attempts. However, it has not been possible to evoke courtship by coating synthetic surfaces, such as paper or fabric, with the removed scales. Hence, the evidence is not conclusive.—C.J. Sanders, Great Lakes Forest Research Centre, Sault Ste. Marie, Ont.

SILVICULTURE

Hydrogen Peroxide Treatment of *Abies* Seeds.—Many grand fir, *Abies grandis* (Dougl.) Lindl., and amabilis fir, *A. amabilis* (Dougl.) Forbes, seedlots stored by the British Columbia Forest Service (BCFS) contain seeds that not only germinate poorly but have a high incidence of seed-borne fungi. Several researchers (Barnett, Tree Plant. Notes 27: 17-19, 24, 1976; Carter and Jones, USDA Forest Serv., Southeast. Forest Exp. Stn. Pap. 141, 1962; Ching and Parker, Forest Sci. 4:128-134, 1958; Neal et al., Forest Sci. 13:104-105, 1967; Riffle and Springfield, Forest Sci. 14:96-101, 1968; Trappe, Forest Sci. 13:121-130, 1967) have attempted to stimulate conifer seed germination or to reduce seed-coat microflora, or both, by using hydrogen peroxide (H_2O_2). Our study was made to determine the effect of H_2O_2 concentration and treatment duration on germination and numbers of fungi on seeds of grand and amabilis firs.

Two seedlots were studied: grand fir (BCFS no. 2904, 69% germination capacity) and amabilis fir (BCFS no. 2980, 41% germination capacity). Each treatment (Table 1) was carried out with 300 seeds from each seedlot. After treatment, seeds were germinated at alternating temperatures of 30°C for 8 h a day and 20°C at night, with fluorescent lights on during the day. Four replicates of 50 seeds each, placed at random in the germinator, were used to test the effects of each treatment. Germination was determined according to the International Seed Testing Rules (Anonymous, Seed Sci. Technol. 4:1-180, 1976). Germinants were counted daily, and the tests were concluded after 28 days. Treatments were organized so that all germination tests began on the same day. Germination capacity and germination value (Czabator, Forest Sci. 8:386-396, 1962) were calculated for each treatment that is based on a 28-day germination period. Amounts and kinds of seed-borne fungi were determined by plating, immediately after treatment, 100 seeds (25/150 × 25 mm petri dish) on 2% water agar and incubating them at 15°C. Because the fungi grew rapidly, the numbers of seeds from which fungi grew were determined after 3 days' incubation. Representatives of the predominant fungi were subcultured on PDA (Difco) for identification. The germination and fungus data, transformed to the arc sine when needed to correct for heterogeneity of variances, were subjected to analysis of variance, and the means were compared by using the Student-Newman-Keuls' test (Steel and Torrie, Principles and procedures of statistics, McGraw-Hill, New York, 1960).

Germination of H_2O_2 treated seeds was either unaffected or reduced (Table 1). Stratified seeds responded less than unstratified seeds to peroxide treatment. Only one instance of significant improvement in germination was observed, i.e. when stratified seeds of *A. amabilis* treated for 24 h with 3% H_2O_2 germinated approximately 13% better than the controls. Generally, increases in duration of treatment progressively reduced germination of unstratified seeds, regardless of peroxide strength, in both seed species. Differences due to solution strength were not evident in seeds treated for 0.5 h. A comparison between overall germination capacity (GC%) and germination rate (PV) shows almost identical trends for these two parameters. This near identity indicates that, where the peroxide had an effect, it did so largely by altering the germination rate.

TABLE 1

Germination and numbers of fungi on stratified and unstratified seed of *Abies amabilis* and *A. grandis* after treatment with hydrogen peroxide[1]

Treatments (concentrations and durations)	*A. amabilis*						*A. grandis*					
	Stratified			Unstratified			Stratified			Unstratified		
	GC %	PV	Fungi %	GC %	PV	Fungi %	GC %	PV	Fungi %	GC %	PV	Fungi %
3% H_2O_2												
0.5 h	16.5 ab	0.6 a	100.0 a	35.5 a	1.3 a	100.0 a	84.5 a	4.6 bc	8.8 a	82.0 ab	3.0 a	14.8 a
24 h	27.5 a	1.2 a	100.0 a	26.5 ab	0.9 abc	26.8 fg	80.3 a	4.5 bc	34.0 a	77.3 ab	3.3 a	18.8 a
48 h	17.0 ab	0.8 a	76.0 ab	8.5 cd	0.3 cd	42.0 cdef	88.0 a	5.4 a	18.0 a	75.5 ab	3.4 a	20.0 a
15% H_2O_2												
0.5 h	10.0 b	0.4 a	78.0 ab	35.0 a	1.2 ab	64.8 abc	83.3 a	5.1 ab	20.0 a	84.3 a	3.1 a	20.8 a
12 h	10.5 b	0.4 a	18.0 h	1.0 d	0.1 cd	8.8 i	79.3 a	3.9 c	8.0 a	69.5 bc	3.0 a	4.0 a
24 h	10.0 b	0.6 a	34.8 de	3.0 cd	0.2 cd	6.8 i	61.3 a	2.9 d	4.8 a	29.3 d	1.5 b	4.8 a
30% H_2O_2												
0.5 h	10.8 b	0.5 a	56.8 abcd	29.0 ab	1.0 abc	46.0 bcde	73.3 ab	4.0 c	8.0 a	83.0 ab	3.1 a	14.0 a
1 h	13.0 b	0.5 a	72.0 ab	16.5 bc	0.7 abcd	20.8 g	81.0 a	4.2 c	16.8 a	81.5 ab	3.2 a	10.8 a
3 h	12.0 b	0.6 a	34.0 eg	4.5 cd	0.3 cd	2.0 j	64.5 bc	3.2 d	6.8 a	61.0 c	2.8 a	10.0 a
Control[2]	14.0 b	0.5 a	100.0 a	37.5 a	1.3 a	100.0 a	83.0 a	4.5 bc	10.8 a	85.5 a	3.1 a	16.8 a

[1] GC% (germination capacity after 28 days) is given by the number of normal germinants expressed as a percentage of the number of filled seeds in the sample. PV (peek value) is the maximum quotient obtained by dividing daily the accumulated number of germinants by the corresponding number of days. PV is the rate component of germination value (Czabator, 1962). Fungi % is the percentage of seeds from which fungi grew after 3 days' incubation. In reading down columns, means followed by the same letter are not significantly different (P = 0.05).

[2] Control — Stratified seeds were presoaked for 48 h in tap water at room temperature, then stratified for 21 days at 1-4°C, without H_2O_2 treatment; unstratified seeds received no presoak, chilling, or H_2O_2 treatment.

None of the treatments affected the numbers of fungi that grew from stratified or unstratified *A. grandis* seeds. More than 80% of the fungi isolated from these seeds were *Trichoderma* spp. or Mucorales. Most of the remaining isolates were *Penicillium* sp. or *Papulospora* sp.; 3% of the stratified and 5% of the unstratified seeds yielded the pathogenic fungus *Geniculodendron pyriforme*, described by Salt (Trans. Br. Mycol. Soc. 63:339-351, 1974). The most effective treatments for reducing the numbers of fungi on stratified *A. amabilis* seeds were 15% H_2O_2 for 12 or 24 h or 30% H_2O_2 for 3 h (Table 1). The latter treatment was also the best for eliminating fungi on unstratified amabilis fir seeds. *Trichoderma* sp. accounted for 90% of the fungi isolated from both stratified and unstratified *A. amabilis* seeds. The remainder of the fungi were *Penicillium* sp., or Mucorales.

None of the H_2O_2 treatments were of any benefit in increasing the capacity or the rate of germination of *A. grandis* or *A. amabilis* seeds. Certain treatments effectively reduced the numbers of seed-borne fungi, but there were no corresponding increases in seed germination. More studies are needed to determine if these fungi affect viability of *Abies* seeds before germination.—D.G.W. Edwards and Jack R. Sutherland, Pacific Forest Research Centre, Victoria, B.C.

Assessment of the Necessity of Grinding Conifer Foliage for Chemical Analysis.—To study the nutrient status of forest sites, either soil or foliage samples may be analyzed. Soil analysis is relatively expensive, and foliar analysis may be the better method of assessing the nutrient regime of forest sites (Lowry, Soil Sci. Soc. Am. Proc. 39:125-131, 1975).

Before analysis, foliage samples are customarily ground to pass through 1 mm mesh (MacDonald, Can. For. Serv. Inf. Rep. M-X-78, 1977) because it is assumed that homogeneous and more representative subsamples are obtained from ground than from unground materials (Kalra and Edwards, IUFRO News 7:10-11, 1974). However, fine-ground materials cling to surfaces if they have acquired a charge of static electricity. This leads to difficulties in weighing and incomplete transfer of samples to micro Kjeldahl flasks. Grinding is time-consuming and therefore expensive. This note reports the results of a study designed to assess the efficacy of omitting the grinding of foliage before chemical analysis.

The material studied consisted of 25 balsam fir, 21 white spruce, 8 red spruce, and 54 black spruce oven-dried current foliage samples. Samples were analyzed for percentage concentration of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) by the methods used in the analytical service laboratory (MacDonald, 1977). Four replicates of each foliage sample, two ground and two unground, were analyzed for each element. Analytical results from all species were similar and were pooled for statistical analysis. Possible differences in the quantities of nutrients determined in ground and unground samples were assessed by the t-test. The measurement variance was calculated from differences between pairs of samples receiving identical preparation and analysis. The effect of grinding was assessed by an F-test applied to the ratio of the measurement variances for ground and unground samples. Analytical results, standard deviations, and indications of significant differences are presented in Table 1.

There was no significant difference in recovery of N, P, and K between ground and unground foliage; unground foliage yielded significantly more Ca, while ground foliage yielded significantly more Mg. Measurement variance, as indicated by standard deviations, was generally greater with unground foliage for all elements except N and was significantly greater for K and Mg. This was expected because of the more homogeneous nature of ground material. However, in the ground material, measurement variance was greater for N. A further N analysis was done to verify this unexpected result. During the second N analysis, the ground and unground foliage samples were wrapped in paper before digestion preliminary to Kjeldahl distillation. This precaution was taken to avoid possible variability in N analyses of ground foliage caused by the adherence of the fine-ground material to the outside of the Kjeldahl flask. This occurred during transfer of the samples and resulted from static charges on the glass. The results of the second N analysis agreed with those of the first analysis: there was no significant difference between analytical recoveries from ground and unground foliage. Again the measurement variance was significantly greater for the ground foliage. We are unable to account for this unexpected result. Samples from individual species were also statistically analyzed separately; results similar to those for the pooled data were obtained.

TABLE 1

Average percent concentration of nutrients in current foliage from four conifer species (standard deviations)

Nutrient	Nutrient concentration (%) in conifer needles†			
	Ground	(S.D.)	Unground	(S.D.)
N	1.14	(.091)*	1.14	(.072)*
P	0.17	(.011)	0.17	(.012)
K	0.71	(.047)*	0.69	(.067)*
Ca	0.35*	(.038)	0.37*	(0.044)
Mg	0.09*	(.012)*	0.08*	(.018)*

†Means of 216 determinations.
*Values within individual element analysis are significantly different (P = 0.05).

Generally, there may be some advantage in grinding foliar samples before analysis for elements other than N. However, many analysts may feel that the differences between ground and unground samples are so small that grinding is an unnecessary expense. The results presented here suggest that, if N is the only element being studied, grinding is unnecessary as part of the sample preparation routine; in fact, grinding would appear to contribute to increased variance of replicates during N analysis.—P.O. Salonius, C.C. MacDonald, and R.A. Fisher, Maritimes Forest Research Centre, Fredericton, N.B.

MENSURATION

Computer Graphics Display of Topographic Data.—Computer graphics systems have been used for investigating the visual effects of proposed landscape modifications. Some applications in forestry, such as in the visual impact of clearcuts, are given by Kojima and Wagar (J. For. 70:282-285, 1972). Additional applications are indicated for the MOSAIC system of the U.S. Department of Agriculture Intermountain Forest and Range Experiment Station (Anon., MOSAIC — a system for displaying a proposed modification before its impact on the environment, Intermt. Forest Range Exp. Stn. Pam., 1977). Many data bases related to topography have no visual impact; yet a visual display in relation to the topography would aid communication about the data and facilitate their subjective analysis. This paper describes some uses of a computer graphics system developed to display the relationship of data to topography.

A square grid is superimposed on a topographic map of the area of interest, and the elevation at each intersection is recorded. The scale of the grid is determined by the complexity of the surface and the desired accuracy of its reproduction. A FORTRAN-based computer program has been developed to draw the topographic surface, defined by the intersection elevations, on the screen of a graphics terminal. A permanent record of the display could be obtained by photography of the terminal screen. The purpose of the program is the display of data; thus, perspective effects are not included, as reduction of grid size owing to such effects obscures the shading intensity used to represent the data values within the grid.

A small grid size relative to the scale of topographic variations is required to give a good reproduction of the topography. In the examples provided, data were specifically obtained for each grid cell. Data, however, are often available only on a larger scale than is required for drawing the topography. If the scale of the data base is different from the grid scale of the topography, the program will compare the scales and shade in the block of squares of the topographic grid that corresponds to the area covered by a single datum value. In addition, once the topography and data for an area have been coded, any subsection can be selected for display.

The surface may be viewed from any rotation or elevation angle. This allows the production of stereo pairs of photographs, which may be viewed through a stereoscope. For display purposes, a stereo-projection method may be used. One view is produced as a red slide; the other as a blue or green slide. By the use of two projectors, the images are superimposed and viewed through a red filter, and a blue or green filter. A stereo picture is then observed on the screen.