bi-monthly research notes

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ENTOMOLOGY

Exenterus vellicatus **Cushman in Ontario**— *Exenterus vellicatus* Cushman is an exotic parasite which attacks late-stage larvae of *Diprion hercyniae* (Hartig). It was first introduced into Canada under the name of *Exenterus adspersus* complex through a release in Quebec in 1933. Over the period 1934-1939, additional releases of the *Exenterus adspersus* complex were made in Nova Scotia, New Brunswick, Quebec and Ontario. Accounts of these releases and subsequent recoveries of the species concerned may be found in McGugan and Coppel (*In* Part II. Tech. Commun. Commonw. Inst. Biol. Control 2: 35-216, 1962) and Neilson, Martineau and Rose (*In* Part III. Tech. Commun. Commonw. Inst. Biol. Control 4: 136-147, 1971). Subsequent to these releases, Reeks (Can. Ent. 84: 76-86, 1952; Can. J. Agric. Sci. 35: 405-429, 1953) showed that three species were present in the *E. adspersus* complex releases, *viz.*, *E. amictorius*, *E. confusus* and *E. vellicatus*. However, by the time Reeks completed his investigation, it was impossible to determine which species were released at which points.

At present, *E. amictorius* is widely distributed on pine sawflies in Ontario and *E. confusus* has been commonly recovered in New Brunswick and Quebec since soon after its release, particularly when host populations are high. On the other hand, *E. vellicatus* became a common parasite of *D. hercyniae* in the Maritime Provinces some years later than *E. confusus*, and along with the more abundant *Drino bohemica* Mesnil is now considered to be an important control factor at low population levels (Bird and Elgee, Can. Ent. 89: 371-378, 1957). By 1958, *E. vellicatus* recoveries had been made at numerous locations in all provinces east of Ontario (McGugan and Coppel, *loc. cit.*). These same authors implied an Ontario recovery (p. 108) but this was not substantiated by later records (p. 198-199). Furthermore, Neilson *et al.* (*loc. cit.*) indicate no recoveries of *E. vellicatus* in Ontario between 1959 and 1968.

In 1973 the Commonwealth Institute of Biological Control (CIBC) requested the assistance of the Forest Insect and Disease Survey of the Canadian Forestry Service in obtaining cocoon parasites of *D. hercyniae* for release in Great Britain, and approximately 400 late-stage first-generation larvae were collected in south-central and southwestern Ontario. The larvae were mass reared in the laboratory and the cocoons were exposed to natural parasitism in two lots for 2 weeks each during July near Sault Ste. Marie. One hundred and sixty cocoons from which neither adults nor parasites had emerged were forwarded to Dr. H. Pschorn-Walcher, CIBC, Delemont, Switzerland for further rearing. No parasites which attack during the cocoon period were reared but seven *E. vellicatus* adults were recovered. Since *E. vellicatus* attacks late-stage larvae the exact location for the recovery is unknown; however, this record constitutes a first authenticated recovery of *E. vellicatus* in Ontario following a possible release in the area at least 35 years earlier. Whether this recovery originated from the early single release of the *E. adspersus* complex at Camp Borden in Simcoe County or spread from Quebec where it is now a common parasite is perhaps inconsequential. The fact that *E. vellicatus* exists in Ontario as an additional parasite of *D. hercyniae* is important. Ontario now has a parasite and disease complex similar to that of the Maritime Provinces where it is felt that the virus and introduced parasites have reached their maximum effectiveness in the regulation of *D. hercyniae* populations (Neilson and Morris, Can. Ent. 96: 773-784, 1964). Further efforts will be made to determine the parasite's distribution in Ontario. — A. H. Rose, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario. P6A 5M7

Mortality of Spruce Budworm on White Spruce Caused by *Entomophthora sphaerosperma* Fresenius. — Field collections of late-instar spruce budworm [*Choristoneura fumiferana* (Clem.)] occasionally contain a few with fungal infections. Collections obtained in 1973 from white spruce [*Picea glauca* (Moench) Voss] in Parkinson Township, some 75 miles (120 km) east of Sault Ste. Marie, Ont. showed an unusually high level of infection by the fungus, *Entomophthora sphaerosperma* Fresenius.

A small pocket of heavy infestation of budworm on open-grown mature white spruce and balsam fir [*Abies balsamea* (L.) Mill.] was first detected in Parkinson Township in the fall of 1968 (Annu. Rep. For. Insect Dis. Surv., Can. For. Serv., 141 p., 1968). From examination of defoliation early in 1969 it was evident that a population had existed in the center of the area since at least 1966. After some initial expansion, the population has persisted with little further expansion for at least 5 years, occupying an area of about 8 sq mi. (20.64 sq km). For most of this time defoliation has been severe in much of the area and trees of all ages in the central part have dead tops. This is an isolated infestation whose spread has been limited, at least partly, by local topography and scarcity of suitable hosts.

For a study of spruce budworm nutrition, insects and foliage have been collected weekly during the period of insect feeding from midcrowns of trees of both hosts on four sites in the infested area for the past several years. The insect collections were brought to the laboratory and reared to maturity, thus permitting accurate determination of parasites, fungi, etc. On 19 June, the date of the first collection in 1973, a few larvae were noted dead and mummified on the foliage at all four sites. These and insects that died during rearing contained mainly resting spores of *Entomophthora sphaerosperma* Fresenius. Other fungi, including *Beauveria* sp. and *Cephalosporium* sp., were also identified, but accounted for less than 2% of the fungus-killed insects, and are not included in the calculations and subsequent discussion. Many of the insects in the collections were infected with microsporida, incidence of which reached very high levels in this population in 1973 (Wilson, Bimon. Res. Notes 29(6):35-36, 1973); no attempt was made to diagnose the degree of infection by this organism in these collec-

TABLE 1
Percentages of fungus and insect parasites in 1973 spruce budworm collections from Parkinson Township.

Tree	Site	19 June				26 June			
		n	Instar mean	Fungus (%)	Insect parasites (%)	n	Instar mean[1]	Fungus (%)	Insect parasites (%)
White spruce									
S-20	1	100	6.5	42.0	20.7	18	7.0	5.6	29.4
S-22	1	—	—	—	—	48	7.0	0	12.5
S-29	2	42	6.2	33.3	17.8	7	7.0	14.3	0
S-31	2	63	6.1	33.3	25.3	10	7.0	0	0
S-33	3	107	6.3	17.4	16.0	58	7.0	1.7	7.0
S-34	3	51	6.3	15.7	11.6	13	6.9	0	0
S-23	4	78	6.0	39.7	6.4	20	7.0	15.0	0
Means (7)		(441)	6.2	30.6	16.3	(174)	7.0	5.2	7.0
Balsam fir									
B-38	2	137	6.0	1.5	22.2	75	6.8	0	22.7
B-41	2	165	5.9	2.4	38.0	49	6.4	0	32.6
B-42	2	213	5.9	1.4	26.3	82	6.7	1.2	9.9
B-43	3	76	6.0	2.6	28.2	26	6.4	0	30.8
B-44	3	60	6.0	1.7	26.2	17	6.7	0	29.4
Means (5)		(651)	6.1	1.8	28.2	(249)	6.6	0.2	25.1

[1]J. L. Bean and L. F. Wilson. J. Econ. Entomol. 57:925-928 (1964).

tions. The incidence of fungus-caused deaths expressed as a percentage of the total numbers collected is shown for the 19 June and 26 June collections for both hosts at the four sites (Table 1). Parasitism was not diagnosed in diseased insects, but was determined as a percentage of the uninfected insects (Table 1). The direction and approximate distance of the collection sites from the center of the outbreak were: Site 1 NE 2,750 m (1.7 mi.), Site 2 NNE 2,400 m (1.5 mi.), Site 3 NW 1,200 m (.75 mi.), Site 4 SW 1,200 m (.75 mi.).

Data in the table show clearly that in all areas the incidence of fungus was greatest on 19 June and was significantly higher on white spruce than on balsam fir. On Site 3, where population levels were lower and the accumulated defoliation less severe, the incidence of fungus in collections from spruce was somewhat lower than on the other sites. Collections from the same trees made throughout the season in 1971 and 1972 contained no insects infected with *Entomophthora*. However, this fungus was present in a collection made on 22 June 1971 from large white spruce trees in the area of heaviest populations, which was suspected of being the oldest part of the outbreak. On that date most of the 127 insects collected were in the sixth instar but a few had pupated. *Entomophthora* was present in and presumed responsible for the death of 10.2% of these insects and insect parasites for 48.5% of the remainder.

Levels of insect parasitism have been high in collections from this infestation for the past several years, with levels generally lower on white spruce than for insects feeding on balsam fir (Table 1). The incidence of parasitism on both white spruce and balsam fir in 1973 was only slightly below that of 1972. Parasitism by all major parasites of noninfected insects feeding on white spruce did not differ significantly between 1972 and 1973, despite the heavy fungal infections in 1973, nor did the percentage of parasitism vary with the proportion of fungus-killed budworm. Thus it would appear that there is little interference between the fungus and other natural parasites; indeed, the much larger proportion of fungus-killed budworm on spruce than on balsam more than compensates for the lower incidence of other parasitism on the former.

Such high levels of natural fungus-caused mortality of the spruce budworm have not been recorded previously. However, similar levels were encountered on virus trial-plots in the Pembroke area in 1973 (J. C. Cunningham, personal communication). Two species of *Entomophthora* caused mortality in spruce budworm in Newfoundland (Anon., Woody Points 5(6):6, 1973). Reconstruction of the course of events in any outbreak is difficult, particularly when the data are incomplete. In spite of intensive collection in 1971 and 1972 in the Parkinson area, no *Entomophthora* fungus was found only at the central location. Therefore, its appearance in 1973 at a substantial level at all these sites suggests that it may have spread from the center of the infestation for some 1,200 m (.75 miles) or more in several directions. The fungus warrants further study as a possible biological control of this important forest insect biologically. Such a control would be particularly important in Ontario as we have learned in the course of operational trials with chemical insecticides that it is more difficult to protect white spruce than balsam fir from damage by the spruce budworm. — G. T. Harvey, Great Lakes Forest Research Centre, and J. M. Burke, Insect Pathology Research Institute, Sault Ste. Marie, Ontario.

Hatching Rates of Forest Tent Caterpillar in the Laboratory. — Forest tent caterpillar [*Malacosoma disstria* Hbn.] larvae will hatch in the winter or early spring if brought into the laboratory and incubated at room temperature (Weinman and Hodson, Univ. Minn. Agric. Exp. Sta., Tech. Bull. 170, 1945). For laboratory studies it was important to know the incubation period, larval hatching rate, and the number of larvae obtainable from egg bands brought into the laboratory during winter. These variables were measured for the forest tent caterpillar in Alberta in 1966 and 1967.

Egg bands were collected on 2 Dec 1966, near Drayton Valley, Alta., where an outbreak was beginning and forest tent caterpillar diseases were thought least abundant. Most bands collected were from the top 60 cm (2 ft) of trees 9 m to 12 m (30 ft to 40 ft) high, and of good "quality". Good quality bands were symmetrical, of uniform thickness and spumilin covering, and had the eggs arranged in rows. A small sample of good quality bands were also collected from the lower half of the crown, and a small sample of poor "quality" bands from the tip of the crown. Poor quality bands were irregular in shape, had incomplete or no spumulin covering, and had eggs arranged irregularly.

All bands were stored at 5 C until the beginning of incubation. Ten bands were selected at random from the good quality bands collected from crown tips at approximately monthly intervals and incubated at a constant temperature of 22 C. The incubating bands were checked every 24 hours, and hatched larvae were counted and discarded. The incubation period is the average number of days from the beginning of incubation to hatching of the first larva from a band. Means presented are the average of 10 bands for number of larvae that hatched on successive days following the first hatch.

Length of incubation period, rate of hatch, and average total number of larvae per band were compared for bands incubated at various times during the winter and spring of 1967. These hatching characteristics were compared to those of egg bands from the same location but left in the field until natural hatch in spring of 1967. At the first sign of natural hatch 10 bands were brought into the laboratory for rearing at constant room temperature. Bands incubated in the laboratory on 15 Feb were compared to bands of poor quality incubated on the same date. Bands incubated on 2 Apr were also compared to bands collected from the lower half of the crown and incubated on 2 Apr.

Both the incubation period and hatching rate varied with length of storage in the laboratory (Table 1) but the average number of larvae hatching per band was about the same for all dates. When incubated in December, larval hatch began after 26 days. The incubation period shortened progressively to 2 days in May. The maximum rate of hatch increased from 15 larvae per day for the December incubation to 103 for the April treatment. The hatching rate of bands in the field for the winter did not differ from the rate of the 2 Apr bands, but only about half the number of larvae hatched.

Larvae hatch from egg bands in a characteristic pattern. Once hatch begins, most larvae emerge in a short time and thereafter a few larvae emerge each day for a comparatively long time. This is shown in the difference in number of days from maximum hatch to over 90% hatch and from over 90% hatch to last hatch (Table 1).

TABLE 1

Incubation period, maximum larval hatch rate, and total eggs per band of forest tent caterpillar egg bands incubated at different times.

	Beginning of Incubation						
	5 Dec	31 Jan	15 Feb	13 Mar	2 Apr	23 May	Field
Incubation period (days)	26	10	8	6	4	2	2
No. days to maximum hatch rate	30	14	12	7	5	3	3
No. days to over 90% hatch	43	18	13	9	5	4	4
No. days to last hatch	55	25	22	13	10	9	5
maximum hatch rate (larvae/day)	15	35	57	65	103	100	50
Total larvae per egg band	139	147	156	145	165	166	84

The number of larvae produced and length of incubation period were about the same for both good quality and poor quality bands. But the latter had a slightly lower maximum hatching rate (Table

2). Bands from crown tips differed little from bands from the lower crown except in the lesser number of hatched larvae per band of the latter group (Table 2).

In addition, 10 egg bands were collected in the fall of 1966 about 80 km (50 mi) west of Edmonton, Alta., from each of four stands where the population trend of the previous generation had been noted. Stand 1: an expanding population with low mortality in the late larval and pupal stages. Stand 2: an expanding population with egg bands deposited by moths that had immigrated from distances exceeding 60 m (200 ft). Stand 3: a declining population, with over 95% mortality from disease in the larval and pupal stages. Stand 4: declining population with about 70% mortality from parasites and disease in the larval and pupal stages. These egg bands were taken from cold storage on 6 Apr 1967, for incubation.

TABLE 2

Incubation period, maximum rate, and total eggs per band of forest tent caterpillar egg bands of different quality bands, at two crown levels, and at different population trends of the previous generation.

	Beginning of Incubation							
	15 Feb		2 Apr		6 Apr			
	Quality		Crown level		Stand			
	Good	Poor	Tip	Lower-half	1	2	3	4
Incubation period (days)	8	9	4	5	6	6	8	8
No. days to maximum hatch rate	12	12	5	6	8	8	10*	10
No. days to over 90% hatch	13	15	5	7	9	9	14	14
No. days to last hatch	22	22	10	10	12	15	18	17
Maximum hatch rate (larvae/day)	57	48	103	71	69	64	40*	52
Total larvae per egg band	156	155	165	115	162	178	171	129

*Average of two peaks.

The number of hatched larvae per band was about the same for the first three stands and lowest for stand 4 (Table 2). However hatching rates varied. Bands from expanding populations, stands 1 and 2, had higher maximum hatching rates, 64 and 69 larvae per day, and hatch was over 90% complete after 9 days. But bands from declining populations, stands 3 and 4, had lower and erratic hatching rates, and hatch was over 90% complete after 14 days.

Laboratory experiments that require many larvae of the same age should be performed in spring with fall-collected egg bands. Incubating the larvae in winter reduces the maximum hatching rate per day and increases the duration of larval hatch per band. Fall collecting and laboratory storage yields greater number of larvae per band than leaving bands in the field for the winter. This has also been recorded by Hildahl and Reeks (Can. Entomol., 93:199-200, 1960). Differences in egg band quality had only a slight effect on the rate of hatch. Egg bands collected from the top of trees are likely to yield more larvae than egg bands collected from the bottom half of the crown. Wellington (Can. J. Zool., 38: 289-314, 1960), in studies with the western tent caterpillar, associated position in the crown with vigor of the female that deposited the egg band. The greatest deviation from normal hatching rates was associated with heavy incidence of disease in the larval and pupal stages of the previous generation. Collecting from such areas should be avoided. — A. G. Raske, Northern Forest Research Centre, Edmonton, Alta. (Present address: Newfoundland Forest Research Centre, St. John's, Nfld.)

PATHOLOGY

Urea and Nitrate Fertilizers Fail to Inhibit Root Rot. — *Poria weirii*, root rot, is probably the most destructive disease affecting young stands of Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] in British Columbia and the Pacific Northwest of the United States. Initial infection of young stands occurs when healthy roots contact the fungus in roots and stumps of the previous stand. *Poria weirii* is a root-inhabiting pathogen which, although unable to compete with other microorganisms in the soil, develops extensively on the bark surface of roots and the root collar. Although this disease can probably be controlled by costly land-clearing operations, an acceptable economic procedure has not been found.

Suitability of fertilizers, applied at varying rates, for controlling the pathogen was examined. Urea was chosen because it is currently most accepted for forest fertilization, and nitrate because it is unavailable to the pathogen while being readily utilized by many of its competitors (Li *et al.*, Nature (Lond.) 213 (5078):814. 1967) and the tree. In addition, survival of *P. weirii* in alder-Douglas-fir stands, where nitrate concentration in the soil is high, appears to be adversely affected (Nelson, U.S. Forest Service Res. Note PNW-83, 1968).

The study was conducted in a 26-year-old Douglas-fir plantation at Shawnigan Lake, south Vancouver Island, British Columbia. In general, the climate (after Köppen) is transitional between cool summer mediterranean and marine west coast, with a mean annual temperature of 9.4 C, precipitation of 1.2 m (46.2 inches) and snowfall of 0.9 meters (34.5 inches), and a regular spring or summer drought of 4 to 8 weeks. The soils, classified as Mini Humo-Ferric Podzols (National Soil Survey Committee, 1970), and developed on a coarse textured till, are similar to the Shawnigan Series (Canada Dept. Agr., Soil Survey Rept. No. 6, 1959).

The root collar of each tree in the infection centers was examined to ascertain the presence of the pathogen. Infected trees were divided into four categories on the basis of crown symptoms: none, early, moderate and advanced. Diameter at 1.4 meters (4.5 ft) on the stem was recorded for all trees.

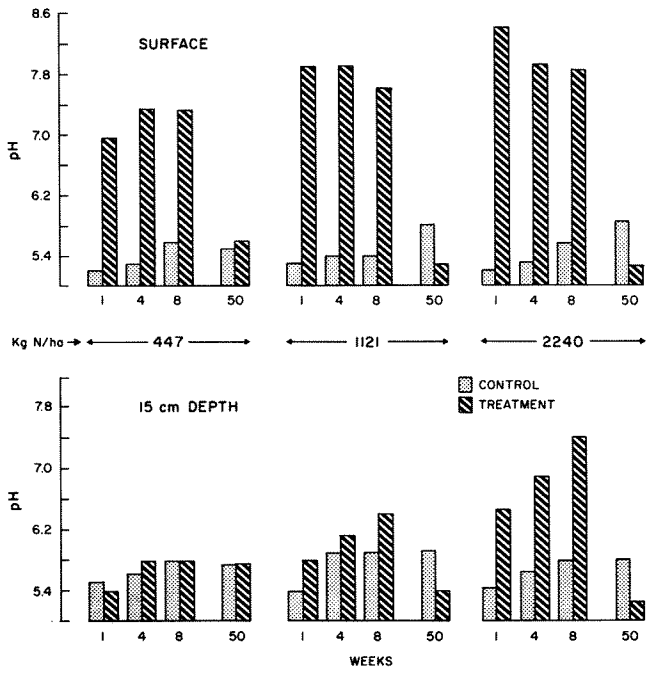

Figure 1. Soil reaction at the surface and the 15 cm depth after treatment with urea at 447, 1121 and 2240 kg N/ha as compared to untreated controls.

In March 1972, urea at 447, 1121 and 2240 kg N/ha (400, 1000 and 2000 lb N/acre), ammonium nitrate and calcium nitrate at 1121 and 2240 kg N/ha and sodium nitrate at 1121 kg N/ha were each applied to three separate root rot infection centers; the fertilizers were hand spread in two applications at right angles. Soil pH, using a water paste, was measured at the surface and at 15 cm in the mineral soil 1, 4, 8 and 50 weeks following treatment; control samples for the fertilized plots were taken adjacent to the treatments.

Soil pH of the controls varied from 5.1 to 6.0 through the year following treatment. Application of ammonium nitrate and calcium nitrate did not significantly alter this pH. Application of sodium nitrate at 1121 kg N/ha raised the pH sharply to approximately 6.8 in the surface samples during the first 2 months following treatment; the pH returned to the same level as the controls by the 50-week sampling. No significant change was measured in the samples from the 15 cm depth. Urea applied at 447 kg N/ha increased the pH of the surface layer approximately two units during the first 2 months (Fig. 1); however, as with sodium nitrate, the pH approximated that of the control by 50 weeks. No significant effect was seen at the 15 cm depth. Soil pH's of 8.0 to 8.5 were recorded in the first 2 months in the surface soil from areas treated with urea at 1121 and 2240 kg N/ha. By the 50th week, the pH had dropped to more than half a unit below that of the controls and is probably the result of a strong nitrification process in these soils under the conditions created by the urea. At the 15 cm depth, application of urea at 1121 and 2240 kg N/ha increased the pH by 0.5 and 2 units, respectively. These peaks were reached by 8 weeks following treatment and probably resulted from ammonium leaching with the relatively high precipitation on the site (2.4 and 12.7 cm (0.95 and 5.0 inches) for the first week and month, respectively). At 50 weeks, the pH had dropped well below that of the controls, similar to that noted for the surface samples.

With the exception of those sites receiving urea at 1121 and 2240 kg N/ha, minor vegetation showed early increased vigor and a darkening in color compared to the controls. Urea at 1121 kg N/ha caused minor foliage burn initially, but this was no longer evident by the second growing season following application. Minor vegetation growing on sites receiving urea at 2240 kg N/ha was severely damaged, most of the foliage being killed. Resprouting occurred in the second growing season following treatment, but growth was still poor 2 years following fertilization.

Basal area of fertilized dominant and codominant healthy trees increased 20 to 35% in the first 2 years following treatment compared to a 16% increase in untreated trees. Increase in basal area of infected trees was reduced relative to the extent of infection as expressed by the original crown vigor class.

At 12 and 20 months following fertilization, mycelial development on the root collar and peripheral roots was examined and decay samples were removed to the laboratory for culturing. All cultures from infected roots were viable; a profuse fungal growth developed on the surface of infected roots when they were split and wrapped in moist tissue. None of the treatments caused a visible degradation of the mycelium growing on the bark surface *in vivo;* the mycelium was viable, similar in appearance to that on control trees, and unchanged from that present before treatment.

TABLE 1

Percentage of *Poria weirii* infected trees showing change in crown vigor class or death following fertilization.

Fertilizer	Crown vigor class*	No. of infected trees	% with increased vigor	% with decreased vigor	% dead
Urea	1 - 2	56	3	12	25
	3 - 4	28	28	0	50
Amm. nitrate	1 - 2	21	5	19	19
	3 - 4	10	10	0	40
Cal. nitrate	1 - 2	26	12	4	15
	3 - 4	7	28	0	71
Sod. nitrate	1 - 2	19	0	5	0
	3 - 4	6	50	0	33
Control	1 - 2	26	4	54	0
	3 - 4	12	0	42	17

*Infected trees divided into four categories on the basis of crown symptoms: 1 = none, 2 = early, 3 = moderate, 4 = advanced.

Treated infected trees, except those treated with sodium nitrate, showed a higher mortality rate than untreated trees (Table 1). With few exceptions, foliage of surviving trees, even those with advanced crown symptoms, "greened up" following fertilization. As a result, by the end of the second growing season, 0 to 50% of the treated infected trees were judged to have a more vigorous crown compared to 0 to 4% of the untreated infected trees. However, in none of the trees showing increased crown vigor was there any detectable effect on fungal development, indicating that no reduction in spread of the disease or in losses will be achieved by the application of urea or nitrate fertilizers. — G. W. Wallis and G. Reynolds, Pacific Forest Research Centre, Victoria, B.C.

SILVICULTURE

Germination Dish for Testing Tree Seeds. — Most modern, cabinet-type germinators are equipped to provide 90-95% relative humidity. Such units are generally expensive, not always available or are not suitable for certain types of study, e.g. where uniform lighting is important. The need often arises for inexpensive germinators, either as the basic apparatus or in addition to more sophisticated equipment, that permit a variety of tests to be conducted. In many instances, small dishes can be used.

However, germination tests in shallow containers, such as petri dishes, particularly if left open, are unsatisfactory because they need frequent watering. Even in germinators equipped with humidity controls, water is lost from the substratum by evaporation. If covered, this evaporation is much reduced, but unfavorable gaseous conditions often develop within the closed dishes, particularly in tests on tree seeds that require several weeks to germinate completely. Gas exchange may be seriously limited by the water seal that frequently forms between the cover and the rim of the dish. This usually results in reduced germination (Allen and Bientjes, For. Chron. 30:183-196, 1954). Germination testing in small dishes is more cumbersome than using large water baths from which all samples are irrigated at one time, but small dishes can be fitted more readily into incubators that do not permit the use of larger water reservoirs.

A method for providing a near-continuous, uniform moisture supply while maintaining good aeration around the seeds has been devised from disposable, plastic petri dishes. Plastic dishes are cheaper and more convenient than glass ones, are less likely to break and, for comparable diameters, are deeper and hold more water. A disadvantage is that they cannot be autoclaved.

Dishes 15 cm (5.75 inches) in diameter were used in this method. A 19 mm (0.75 inch) hole was drilled in the center of each lid and a wick was made from two thicknesses of filter paper 125 mm (5 inch) x 19 mm (0.75 inch), folded as shown in Fig. 1. The free ends of the wick were pushed through the lid and into the water in the lower portion of the dish. Filter paper circles, 12.5 cm (5 inch) in diameter, which will accommodate 100 Douglas-fir seeds, were then centered over the wicks and the seeds were placed on the moist paper. The seeds were covered with an inverted glass funnel (Figs. 2, 3).

This system is particularly useful when testing, for example, the phytotoxicity of chemical solutions on seed germination. The treatments can be replicated in various spatial experimental designs; relatively small volumes (150-200 ml in a 15 cm diameter dish) of

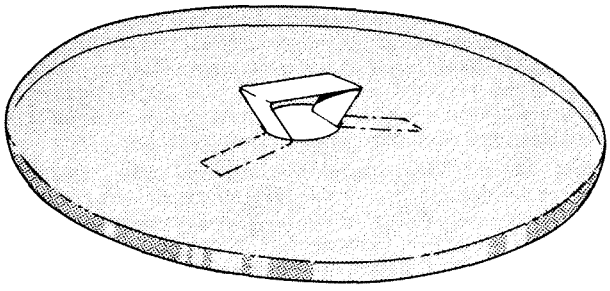

Figure 1. Method of folding and placing the wick.

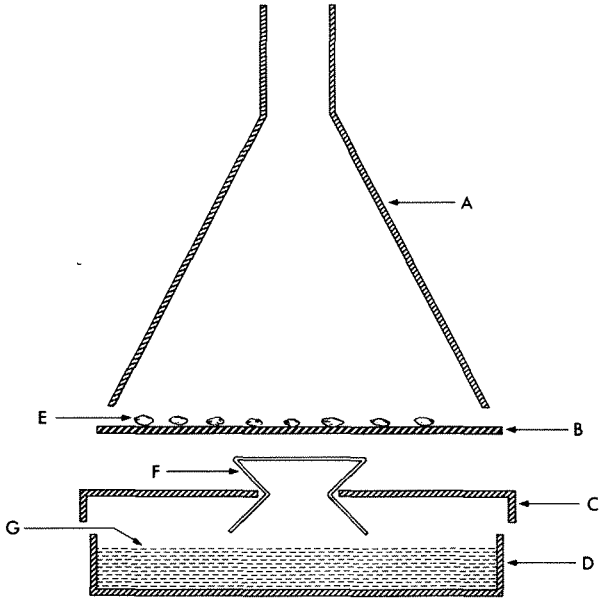

Figure 2. Exploded view of dish germinator.
A — cover; B — filter paper circle; C — lid; D — dish; E — seeds; F — wick; G — water level.

solution are required and since evaporational losses are minimized, there is less need for attention in maintaining solution levels. Supply of the solution (or water) to the seed is relatively constant. The system meets most of the requirements of the International Seed Testing Rules (Proc. Internat. Seed Testing Assoc. 31: 1-152, 1966). The amount of moisture in the filter paper, on which the seeds germinate, can be controlled by the size of the wick. Use of the wide-mouthed funnels, as covers, permits air exchange and some evaporation to occur; however, relative humidity of the air surrounding the seeds remains high (90-95%). Distribution of moisture in the filter paper should be more uniform, because of the central position of the wick, than in the procedure recently described by Knudson and Tibbits (Hort. Sci. 8: 472, 1973) in which the wick irrigates one portion of the edge of the filter paper. — D. G. W. Edwards, Pacific Forest Research Centre, Victoria, B.C.

Figure 3. Complete dish germinator.

Long Lasting Labels for Tree Branches. — A Scots pine Christmas tree plantation was selected as the site for several short- and long-term experiments in studies of the scleroderris canker of pines. It was necessary to designate and label trees and branches, some of which served as experimental units in more than one experiment. Labels were sought that could be prepared in the field with ease, provide legible coding for the duration of the experiment, be easily removed, and provide a marking system enabling easy and quick location of any given experimental unit even under adverse weather conditions (i.e., winter).

After some experimentation, we chose one of the inexpensive, commercially available, compact, embossing labellers that uses rolls of vinyl tape. Experiments and treatments were color coded. The code for a branch was embossed on the tape which was then cut to the required length, bent around the branch to be marked, and the two ends stapled together to form a band sufficiently loose to allow unrestricted growth for the duration of the experiment.

After 3 years, no labels were lost due to defective materials, their color did not change, and the coding on them remained legible. Moreover, field collecting of material, especially during the winter was done faster due to color coding.

This method of labelling is easy, fast, reliable, inexpensive and it appears amenable to many types of operations requiring long-lasting labelling. — L. P. Magasi and J. M. Manley, Maritimes Forest Research Centre, Fredericton, N.B.

RECENT PUBLICATIONS — JULY-AUGUST 1974

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