Near the mine, most eastern white pine are scattered, 200- to 300-year-old veterans. From data in Table 1 and an estimated frequency of 0.5 pine per acre there would be 235 dead pine in damage class 3 (all white pine dead) and 180 in damage class 4 (white pine affected). Another 135 trees have thin, yellow crowns and further mortality is expected. Increment cores from a few veteran white pine indicated that as much as 80% of some trees could be free of decay. Since they are highly susceptible to injury from SO_2, the prompt removal of any economically valuable stems should be considered.

Further mortality can be expected with continued exposure. The few remaining spruce and balsam fir in damage class 1 will decline as will an increasing number of the more susceptible species farther from the source. Additional losses include the reduction of increment in the living but affected trees, and reduced stand values through changes in stand composition. This will continue to be a problem until the fire is extinguished and the release of SO_2 stopped, or until the SO_2 is diluted by dispersion to non-toxic levels during the growing season.—G. A. Van Sickle, Maritimes Forest Research Centre, Fredericton, N.B.

SOILS

Biometer Flask for Determining Microbiological Respiration in Forested Soils.—Field measurements of soil respiration, which include microorganism, animal and root activity, generally overestimate microbial activity in the soil. Three aeration systems, continuous, intermittent and static, have been used in the laboratory to determine soil respiration in the absence of root activity. For the latter two systems, a variety of biometer flasks have been developed (Bartha and Pramer, Soil Sci. 100: 68-70, 1965; Nommik, Soil Sci. 112: 131-136, 1971). These flasks are expensive to purchase or construct (approximately $10-15). All systems use ground or extensively disturbed samples, which lead to increased respiration rates (Webley, J. Agr. Sci. 37: 249-256, 1947) and inaccurate measurement of microbiological activity as it exists within the undisturbed field soil. The flask described herein is inexpensive (approximately $1.35) and allows the use of samples which have undergone a minimum of disturbance.

The biometer flask (Fig. 1a) is a one-quart, wide-mouth mason jar with a plexiglass lid. The lid seals the container and holds the vial with alkali. Alkali is introduced and removed through a plastic syringe and needle held in place by a #00 rubber stopper. A three-way plastic aquarium valve is included so tha the system may be flushed with CO_2-free air at selected intervals, generally every 14 days, for long-term incubations. The alkali must be removed during this procedure.

32457 — Monthly Research Notes — Eng. GAL 4

Samples are collected in the field with a 5-cm core sampler (Burkard Mfg. Co. Ltd., Rickmansworth, England) and placed directly into the glass sample-holder and transported in a cooler to the laboratory. Sample and sample holder are placed in the mason jar; the closure with alkali vial is secured in place with a metal-O-ring and the alkali is introduced. The complete system is then incubated at the soil temperature present in the field at the time of sampling (Fig. 1b).

Sample moisure content is determined following the incubation period. In this way, sample disturbance and pretreatment is kept to a minimum.

Calculations of respiration rate are based upon the quantity of organic matter (weight loss on ashing oven-dry samples) present in each soil core. This reduces variation between samples taken from the same plot. Averaged values for each sample area are converted to grams CO_2 respired/meter^2/hr.

A 75-day incubation experiment was conducted to determine the minimum time required for maximum differences

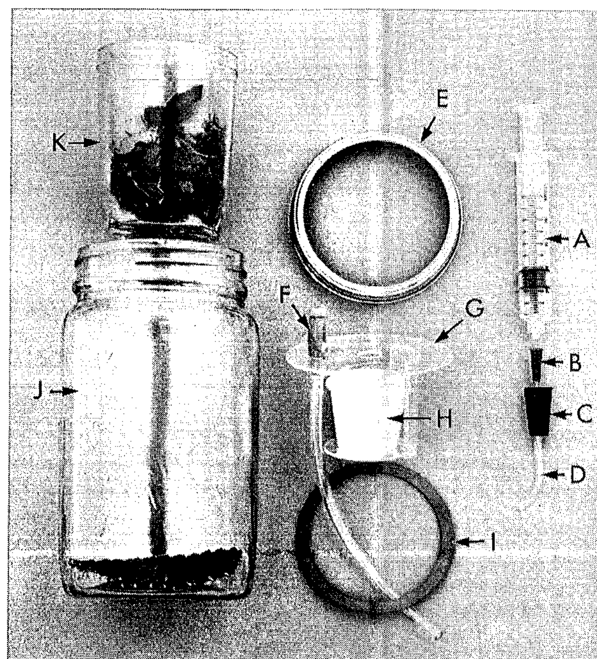

Figure 1. (a) Components of biometer flask. A. 10 cc plastic Luer lock syringe. B. 16G 1½ disposable hypodermic needle. C. #00 rubber stopper. D. 3.18 mm (1/8″) O.D. tygon tubing. E. Metal-O-ring. F. Plastic aquarium valve. G. Lid constructed from 1.59 mm (1/16″) clear plexiglass and quartered 3.18 mm (1/8″). H. Plastic vial. Lily #3/4 SP. I. Rubber-o-ring. J. 1 quart wide-mouth mason jar. K. Glass sample holder and sample.

between sample areas to become evident. Twenty-four cores were collected (March, 1972) from each of control and urea fertilized plots (448 kg N/ha applied March, 1971) under Douglas-fir and incubated at 13 C. After removing the alkali, the system was flushed with CO_2-free air every 14 days. Statistical analysis of data (Fig. 2) indicated that a significant difference ($P=0.05$) in respiration rates was detectable after 2 weeks, and this difference was maintained for the duration of the incubation. At 4 weeks, respiration rates were significantly different at the 1% level. This would suggest that measurement of respiration rate should be performed over a 4-week incubation period.

In a second experiment, respiration rates determined in the field and laboratory were compared by collecting cores (14) from each of three plots on the day the field rates were determined, using the method of Lieth and Quelette (Can. J. Bot. 40: 127-139, 1962). The cores were incubated at the same temperature (10 C) as the field soil at the time of sampling. Since the respiration rates determined in the laboratory exclude root respiration, the difference between laboratory and field values (Table 1) should represent root respiration. In this case, root respiration accounts for 60-75% of the total field respiration. Rieners (Ecology 49: 471-483, 1968) has suggested that root respiration may represent two-thirds of the field measured soil respiration in Minnesota forests. This comparison would suggest that the laboratory determined respiration values are in fact a reasonable measure of microbiotic activity as it existed in the field.

Maximum respiration rates of 0.25 gm and 0.10 gm CO_2/meter^2/hr were obtained for the March and mid-July samp-

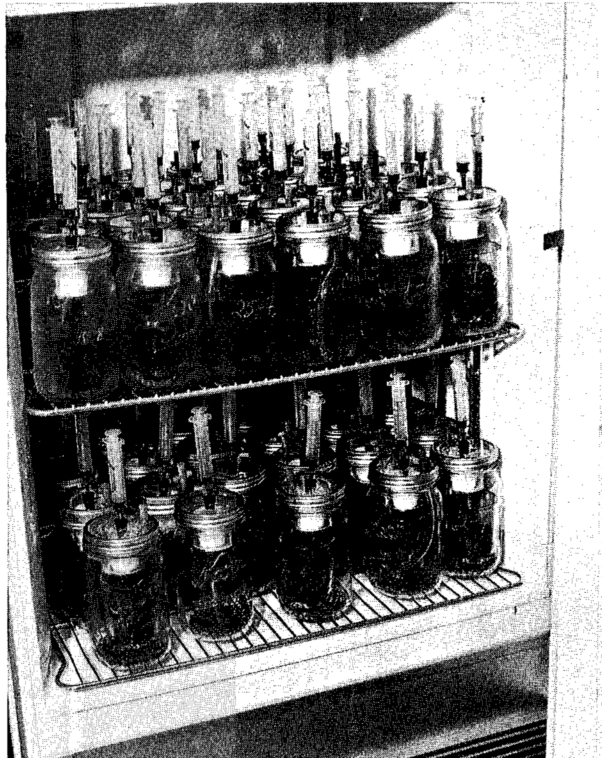

Figure 1. (b) Assembled flasks within incubator.

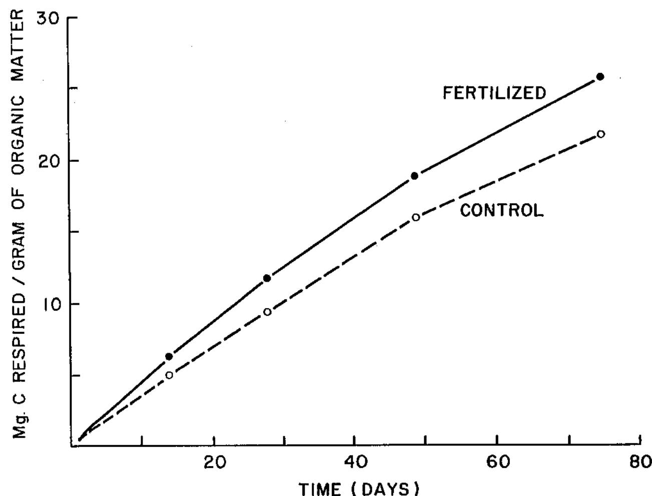

Figure 2. Statistical analysis of data.

TABLE 1
Field and laboratory determined soil respiration

Thinned Plots	Field Value* mg $CO_2/m^2/hr$	Laboratory Incubation** mg $CO_2/m^2/hr$	% of Field Value
No Fertilizer	260	65^a	25
224 Kg N as urea	256	108^b	42
448 Kg N as urea	216	90^{ab}	41

* Unpublished results, V. G. Marshall. Collected 20 July 1972.
** Cores collected for incubation 19 July 1972. Values followed by the same letter are not significantly different $P = 0.05$.

lings, respectively, of urea fertilized plots, using the described biometer flask. An average annual leaf fall of 1,780 kg C/ha could maintain a uniform respiration rate of 0.075 gm CO_2/meter^2/hr for the year, whereas a respiration rate of 0.3 gm CO_2/meter^2/hr could be maintained only for 91 24-hr days (Wiant, J. For. 65: 408-409, 1967).

The respiration rates calculated in our experiments fall between the values mentioned by Wiant and again suggest that a reasonable measure of field microbiotic activity has been obtained by using the minimally disturbed soil cores in the described biometer flask.—J. A. Dangerfield and P. E. Olsen, Pacific Forest Research Centre, Victoria, B.C.

(Continued from back cover)

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