Interphase I stage through the three active prediplotene stages to the inactive diplotene stage by the end of November. The inactive diplotene stage persisted throughout the winter, until late March-early April, when the PMC's resumed their activity and passed through the active stages from diakinesis to the formation of microspores. In samples obtained 7 April up to 87.5% of PMC's were in stages of active division, and by 27 April all PMC's had formed microspores. In two of the trees, 5% of the PMC's advanced from diplotene on 4 and 24 January for no apparent reason; the remaining PMC's completed cell division in early April at the same time as those in the other trees. No chromosomal abnormalities were observed in any of the trees studied. The phenomenon whereby a small proportion of PMC's complete meiosis in midwinter has been reported for *L. decidua* (Eriksson, Stud. Forest Suec. 63, 1968) and for *L. kaempferi* and *L. decidua* (Hall and Brown, Silvae. Genet. 25:3-4, 1976). If a large proportion of PMC's were to complete meiosis in midwinter, it could be expected that nonviable pollen would be produced because temperatures below -2° to -3°C cause chromosomal damage (Ekberg et al., 1968). The net effect would be to reduce seed production, the reduction being proportional to the number of trees with nonviable pollen. In seed orchards or seed-production areas these trees would have to be identified and removed.

These data show that microsporogenesis occurs during the winter in *L. laricina* and that the stages of most active cell division occur in late March-early April. The study is being continued to determine the effect of climate on seed production of *L. laricina* in eastern Newfoundland.—J. Peter Hall, Newfoundland Forest Research Centre, St. John's, Nfld.

PATHOLOGY

Conifer Seed Pathogenicity Tests with Forest Cup Fungi.—Recently, we (Paden et al., Can. J. Bot. 56:2373-2379) showed that *Caloscypha fulgens* (Pers.) Bouldier (Ascomycetidae, Pezizales) is the perfect state of the fungus causing a serious disease of conifer seeds. Since numerous other operculate discomycetes occur in habitats similar to that of *C. fulgens*, and also fruit during the spring, we suspected that they might affect seedling establishment by killing naturally shed or direct-sown seeds. The object of this study was to determine the potential pathogenicity of several of these fungi to Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, and Sitka spruce, *Picea sitchensis* (Bong.) Carr. seeds.

The fungi tested were: *Pithya cupressina* (Fr.) Fuckel, *P. vulgaris* Fuckel, *Plectania melastoma* (Sow. ex Fr.) Fuckel, *P. milleri* Paden & Tylutki, *P. nannfeldtii* Korf, *Sarcosoma latahensis* Paden & Tylutki, and *Urnula hiemalis* Nannf. These fungi had been cultured from germinating ascospores from ascocarps collected at several locations in the northwestern United States and British Columbia. Potential for pathogenicity was assessed by sowing seeds in sand, in petri dishes, inoculating them with a test fungus (Salt, Trans. Br. Mycol. Soc. 63:339-351), and then germinating the seeds at 20°C for 16 h (no light) and 30°C for 8 h (2260 lx). Since a preliminary study showed that all of the fungi grew well at 10-20°C, two experiments were made. In the first, inoculated seeds were incubated at 10°C for 1, 2 or 4 wk and then germinated; in the second, they were incubated at 20°C for 4 wk before being germinated. Seeds that failed to germinate were surface-sterilized with 30% H_2O_2 for 0.5 h (Sutherland et al., Bi-mon. Res. Notes 34:20-21), plated on 2% water agar, and incubated at 20°C for 3 wk to detect the presence of the test fungi. For analysis, the germination data were transformed to the arcsin and subjected to analysis of variance; the means were compared by means of the Student-Newman-Keul's test (Steel and Torrie, Principles and procedures of statistics, McGraw-Hill, New York, 1960).

Table 1 shows that, regardless of incubation period or temperature, none of the fungi affected germination of Douglas-fir or Sitka spruce seeds. When germination of Douglas-fir seeds, kept at 10°C, was compared over the 1-, 2-, and 4-wk incubation periods, some significant differences in germination were observed. However, these differences were not likely caused by fungi, because germination of inoculated seed did not differ from that of control seeds within each incubation period. None of the test fungi were isolated from any of the seeds that failed to germinate, and no germinants showed any evidence of disease. We conclude from these data (Table 1) and observations that none of the test fungi are pathogenic on seeds or germinants of Douglas-fir and Sitka spruce. To our knowledge, this is the first time that the fungi used here have been tested for pathogenicity. Our negative results do not imply that these or similar fungi should not be tested further for pathogenicity to other species of seeds or germinants or that they do not cause other diseases such as foliage or root diseases.—Jack R. Sutherland, Pacific Forest Research Centre, Victoria, B.C., and J.W. Paden, Department of Biology, University of Victoria, Victoria, B.C.

TABLE 1
Results of pathogenicity tests with seven species of cup fungi and seeds of Douglas-fir and Sitka spruce

Fungi	Incubation temperature, seed species inoculated, and pregermination period*							
	10°C						20°C	
	Douglas-fir			Sitka spruce			Douglas-fir	Sitka spruce
	1 wk	2 wk	4 wk	1 wk	2 wk	4 wk	4 wk	4 wk
Pithya cupressina	79def	50ab	84def	78a	88a	80a	47a	86a
P. vulgaris	85def	40a	93f	85a	87a	98a	44a	90a
Plectania melastoma	66bcd	46a	73cde	87a	81a	94a	40a	94a
P. milleri	73cde	61a	83def	83a	83a	84a	47a	85a
P. nannfeldtii	89ef	57abc	83def	87a	90a	95a	40a	94a
Sarcosoma latahensis	78def	49ab	77def	83a	86a	87a	34a	87a
Urnula hiemalis	81def	55abc	78def	82a	83a	91a	42a	90a
Control (no fungus	82def	72cde	84def	89a	89a	91a	46a	93a

*Column values are mean (based on four replicates of 50 seeds each) percentage germination. Valid statistical comparisons can be made among or within those columns underlined by the same line, wherein means followed by the same letter do not differ significantly (P=.05).

ENTOMOLOGY

Cocoon Parasite of the European Pine Sawfly Introduced into Newfoundland from Ontario.—The European pine sawfly (*Neodiprion sertifer* [Geoff.]), an important pest of hard pines (*Pinus* spp.), was accidentally introduced into North America. It was first collected in New Jersey, U.S.A., in 1925 (Hamilton, J. Econ. Entomol. 36:236-240, 1943) and near Windsor, Ont., Canada, in 1939 (Raizenne, Can. Dep. Agric. Publ. 1009, 1957). This sawfly was first recorded in Newfoundland in 1974 (Clarke et al., Can. For. Serv. Inf. Rep. N-X-129, 1974), where it appeared on ornamental pines in St. John's. Since that time it has spread, and can now be found on ornamental pines and in pine plantations within a radius of about 15 km around that city.

Several native and introduced parasite species attack the European pine sawfly in Ontario (Griffiths, Can. Entomol. 91:501-512, 1959; Griffiths et al., Commonw. Inst. Biol. Control, Tech. Commun. 4:150-162, 1971). In Newfoundland, however, laboratory rearings showed a general lack of parasites attacking this sawfly. It was therefore decided to introduce some of the more important parasite species from Ontario. *Pleolophus basizonus* (Grav.), a European ichneumonid that attacks the cocooned sawfly prepupae, was selected for introduction first because it is an abundant and constant parasite of the European pine sawfly in Ontario (Lyons, Proc. Entomol. Soc. Ont. 94:5-37, 1964). This note presents data on this introduction and on the recovery of the parasite progeny.

P. basizonus were obtained from a stock of this species maintained at the Great Lakes Forest Research Centre in Sault Ste. Marie, Ont. Rearings of this parasite in Ontario were carried out, by standard techniques (Griffiths, Can. Entomol. 101:907-914, 1969), from January to June 1977. Sawfly cocoons exposed to *P. basizonus* were stored at 2°C until shipment from Sault Ste. Marie on 4 July. The cocoons were received on 5 July in Newfoundland and were reared in lots of about 500

in a cardboard box equipped with a clear plastic emergence vial. The boxes were kept at 21°C and 70% RH. Parasites began to emerge on 18 July; they were removed from the vials twice a day and, to ensure mating, were kept in a screen cage (30 x 30 x 56 cm), with raisins and water provided until release. The parasites were released twice a week from 21 July to 15 August inclusive at 9.7 km outside of St. John's (52°47' long. and 47°37' lat.) in a sawfly-infested plantation comprising Scots pine, *Pinus sylvestris* L., and Jack pine, *Pinus banksiana* Lamb. in about equal proportion. Totals of 631 males and 376 females were released.

Parasitism by *P. basizonus* was determined on naturally occurring cocoons and on planted cocoons. Naturally occurring cocoons were collected from 20 litter and soil samples (30 x 30 x 8 cm) taken from under the crown of sawfly-infested trees. Three trays (20 x 20 x 3 cm, covered with 0.5 cm mesh screen on the bottom and top) were placed at the release site with laboratory-reared cocoons to expose them to attack by *P. basizonus*. Each tray contained 50 sawfly cocoons, which were replaced once a week with fresh ones. Cocoons totalling 600 were exposed to parasites in this manner. These and the cocoons obtained from the soil samples were reared in the laboratory at 21°C and 70% RH until October, then stored at 2°C for 3 mo, and then reared again.

Only five sawfly cocoons were obtained from the 20 soil samples, and no parasites emerged from them. Of the 600 sawfly cocoons exposed to parasites in the trays, 30% emerged as sawfly adults, 37% died of unknown causes in the cocoon stage, 11% were parasitized by *Mastrus aciculatus* (Prov.), and 22% were parasitized by *P. basizonus*.

M. aciculatus, an ichneumonid, has been reared from the European pine sawfly in Ontario (Griffiths, Can. Entomol. 91:501-512, 1959), but this is the first record of it from this host in Newfoundland. The recovery of *P. basizonus* from such a large percentage of the planted cocoons indicates that at least one generation of parasites has survived. However, the successful establishment of this parasite may be verified only through several years of monitoring.

Technical assistance in this study was provided by D.L. Oliver and K.E. Pardy.—Imre S. Otvos, Newfoundland Forest Research Centre, St. John's, Nfld., and K.J. Griffiths, Great Lakes Forest Research Centre, Sault Ste. Marie, Ont.

Biological Observations on Overwintering Larvae of the Large Aspen Tortrix in Alberta.—The large aspen tortrix, *Choristoneura conflictana* (Wlk.), is a serious pest of aspen in North America. The life history of this insect and the damage caused by it have been reported in Canada (Prentice, Can. Entomol. 87:461-473, 1955), in California (Wickman, J. Econ. Entomol. 56:593-596, 1963), and in Alaska (Beckwith, USDA Forest Serv., Pac. Northwest Forest Range Exp. Stn. Res. Note PNW-81, 1968). Eggs of the large aspen tortrix are laid from mid-June to early July and hatch in July. First-instar larvae feed on leaf surfaces. In late July or August they undergo their first molt and then hibernate; second-instar larvae apparently do not feed the first summer, remaining in hibernation until new growth starts in the spring. Pupation usually occurs in early June, but this depends on the climate. This note reports on the site and parasites of overwintering larvae of the large aspen tortrix in Alberta.

According to Prentice (1955), in Manitoba and Saskatchewan the second-instar larvae overwinter in bark crevices and moss at the base of living trees. In their current studies on the biological control of *C. conflictana* in Alberta, however, W.G.H. Ives and J.A. Muldrew (pers. commun.) have noted that overwintering larvae were found beneath the slightly loosened bark of the trunk and branches of dead trembling aspen. Their observations agree with those of Wickman (1963) in California and Beckwith (1968) in Alaska.

The parasites associated with the large aspen tortrix in Manitoba and Saskatchewan have been listed by Prentice (1955), who also produced survey rearing records for New Brunswick, Ontario, and Alberta. Three additional species of parasites not listed by Prentice (1955) have been identified in Alberta. They were recovered from overwintering second-instar larvae collected by Ives and Muldrew in early March 1978 at Hondo, Alta., and sent to J.C. Cunningham, Forest Pest Management Institute, Sault Ste. Marie, Ont., for virus host range studies. About 2,500-3,000 surplus larvae were reared on an artificial diet (Grisdale, Can. Entomol. 105:1553-1557, 1973) in 21.3 mL cream cups kept at 23.9°C with a relative humidity of 50-55% (Cunningham et al., Can. Entomol. 105:767-773, 1973). An approximately 50% level of parasitism was noted for these second-instar *C. conflictana* larvae from Alberta (D. Grisdale, pers. commun.). The parasites were returned to the Edmonton laboratory, where they were identified as *Macrocentrus iridescens* French (Hymenoptera: Braconidae), *Glypta inversa* Cress. (Hymenoptera: Ichneumonidae), and *Agathis annulipes* (Cres.) (Hymenoptera: Braconidae). Collecting overwintering larvae in late winter and rearing them revealed also that the three parasites attacked the large aspen tortrix larvae in their first year.

The most common parasite was *M. iridescens*, followed by *G. inversa* and then by *A. annulipes*. The recovery of the latter two species in Alberta confirms observations by Torgersen and Beckwith (Can. Entomol. 106:1247-1265, 1974) that *G. inversa* and *A. annulipes* attack first- or second-instar larvae of *C. conflictana*, and the rearing results indicate further that *M. iridescens* also attacks first- or second-instar larvae of *C. conflictana*.

It is interesting to note that Torgersen and Beckwith (1974) found *G. inversa* to be the most common parasitoid attacking early larvae of the large aspen tortrix in interior Alaska but did not recover any *M. iridescens*, which was predominant in Alberta. The predominance of *Macrocentrus* over *Glypta* in Alberta is suggestive of the relationship between the same two parasitic genera of the oriental fruit, *Grapholitha molesta* (Busck), in Ontario. Steenburgh and Boyce (Annu. Rep. Entomol. Soc. Ont. 69:65-74, 1938) observed that as *Macrocentrus ancylivorus* Roh. became more plentiful, *Glypta rufiscutellaris* Cress. became increasingly less important. This may offer an explanation for the absence of *Macrocentrus* and the predominance of *Glypta* in the interior of Alaska.—H.R. Wong, Northern Forest Research Centre, Edmonton, Alta.

High Populations of a Carabid Beetle Associated with Spruce Budworm.—Numerous large, black carabid beetles (*Calosoma frigidum* Kby.) were noted in two white spruce (*Picea glauca* [Moench] Voss) plantations near Sault Ste. Marie, Ont., in early June 1977. The beetles were seen eating late-instar spruce budworm (*Choristoneura fumiferana* [Clem.]) larvae, and it is possible that they played some part in reducing budworm populations in the plantations.

The two plantations were visited at least once a week from mid-May to the end of July in connection with other studies. Plantation A (250 ha) was planted with white spruce and, in one location, with Norway spruce (*P. abies* [L.] Karst.), in 1925-28; plantation B (12 ha) was planted during the same period with white spruce only. Both plantations now contain considerable jack pine (*Pinus banksiana* Lamb.) and occasional white pine (*P. strobus* L.). The dominants are 15-17 m tall, but there are numerous small openings dominated by *Vaccinium* species. Located on sandy, gravelly river terraces on either side of the Goulais River, a few kilometers north of Searchmont, these are the only white spruce plantations in the vicinity. Natural stands dominated by balsam fir (*Abies balsamea* [L.] Mill.) and white spruce occur in small patches along river valleys nearby, but most of the area is covered by hardwood with a low proportion of white spruce.

Twenty-five 45 cm branch tips were taken from each plantation on 26 May, 1977, and examined for spruce budworm larvae. In plantation A counts averaged 32.0 larvae/branch tip and in B they averaged 31.8. At this time, fourth-, fifth-, and sixth-instar larvae accounted for 25%, 45%, and 30%, respectively, of the total. On 30 June, pupal populations averaged 0.08/45 cm branch tip in A and 0.04 in B—99.8 and 99.9% less, respectively. Egg populations, sampled on 27 July, averaged 0.86 egg masses/45 cm branch tip in A and 0.71 in B (equivalent to approximately 85 and 70/10 m^2, respectively).

The carabids were first noticed on 6 June, on the lower stems of the spruce. A quantitative assessment was made on 16 June. Initially, attempts were made to obtain estimates of density by beating foliage over drop sheets. However, only five beetles were dislodged from 50 trees. Several beetles remained on the foliage after beating, and more were observed on the higher foliated branches that were out of reach of the beaters than on the dead lower branches. A visual assessment was therefore made on both foliated and defoliated portions of trees. Fifty trees 8-10 m high, all in plantation B, were examined. Observations were restricted to the base and to branches up to 2 m above ground. The trees were categorized as (a) having no living needles on the observed branches, (b) having foliage on the periphery of some branches, (c) having well foliated branches down to the ground. Beetle counts are given in Table 1. Fifty-two beetles were seen on the 50 trees—six on the tree boles and 46 on branches. As many as six were seen on one tree, but 25 trees had no beetles, although 20 of the 35 well-foliated trees had at