Mortality from *Caloscypha fulgens* and Other Fungi on Spruce Seed in Oregon and Washington

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ABSTRACT

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Geniculodendron pyriforme, the imperfect state of *Caloscypha fulgens*, caused mortality of Engelmann and Sitka spruce in Oregon and Washington. This fungus killed 0.4–4.8% of the seeds in 13.4% of the seed lots. Twenty-one genera of fungi were isolated from samples of 67 seed lots, and most of these also caused seed mortality under laboratory conditions.

Additional key words: *Picea engelmanii, P. sitchensis,* preemergence mortality

In 1964, Epners (1) reported an unidentified fungus causing conifer seed mortality in Ontario nurseries with losses reaching 98%. Salt (4) subsequently described the fungus as *Geniculodendron pyriforme* gen et sp. nov. Reports on the taxonomy and importance of *G. pyriforme* have been published by Gordon et al (2) and Sutherland and Woods (5). Paden et al (3) reported that *G. pyriforme* was the imperfect state of *Caloscypha fulgens* (Pers.) Boudier.

C. fulgens is a mesophilic fungus that exhibits optimum growth at 20 C. *C. fulgens* kills seeds before germination has begun (3) and losses are most severe at about 10 C (4), which is warm enough for fungal growth but not for immediate seed germination. The fungus is reported to survive in dead seeds in soil for up to 4.5 yr (1). Losses generally occur during stratification or when cool moist conditions prevail for extended periods immediately after seed sowing.

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Reduction in germination of spruce seed has occurred in Great Britain and British Columbia and was attributed primarily to *C. fulgens*. In Great Britain, spruce seeds are stratified in pits of alternating layers of sand and seed. Risk of infection is greater in these pits than in storage containers where seeds are stratified "naked" (G. A. Salt, *unpublished*, 1973). Nurseries in Oregon and Washington have not recognized this fungus as a problem; consequently, the main objective was to determine if *C. fulgens* occurred enough in local spruce seed to pose a potential problem. A secondary objective was to identify genera of fungi isolated from within spruce seed coats.

MATERIALS AND METHODS

Wind River Forest Service Nursery in Carson, Washington, provided samples from 67 Engelmann (*Picea engelmanii*) and Sitka spruce (*P. sitchensis*) seed lots collected throughout Oregon and Washington. Each sample contained 250 seeds collected in 1976-1978. Seeds had been stored at −17.7 C since extraction. Sixty-one samples were Engelmann spruce collected at elevations of 914–1,981 m, and the remaining six were Sitka spruce from 152 to 457 m elevation.

Seeds were surface-sterilized by soaking them in 30% hydrogen peroxide for 30 min and were rinsed once in sterile distilled water (J. R. Sutherland, *personal communication*). The 250 seeds were placed, 25 per petri dish, on 2% water agar and incubated at room temperature with natural daily photoperiods.

Seed plating required 5 days. The first seed lot was examined 7 days after incubation was started, and the last seed lot was examined 26 days after the start of incubation. Fungi that were not detected on the first examination were detected in a second examination between 27 and 39 days after the start of incubation.

RESULTS AND DISCUSSION

Of the 16,750 seeds examined, 1,500 were Sitka spruce and 15,250 were Engelmann spruce; 78% (13,063) of the seeds germinated, and 23.5% (3,940) of the seeds were colonized by fungi. Table 1 lists isolated fungi by frequency of occurrence and elevation of seed lot.

C. fulgens was found in 13.4% of the seed lots (nine lots) and caused between 0.4 and 4.8% seed mortality in affected lots. Twenty other fungal genera were identified, and the remaining fungi were categorized as unknown. No *C. fulgens* was found in Sitka spruce seed, and the incidence of infection by other fungi was considerably lower than in Engelmann

Table 1. Oregon and Washington Sitka and Engelmann spruce seedborne fungi by frequency of occurrence and elevation

Fungus	Frequency (% of total)	Elevation (m) 152	305	457	914	1,067	1,219	1,372	1,524	1,676	1,823	1,981	Total
		Picea sitchensis (no. of seeds infected)			*P. engelmanii* (no. of seeds infected)								
Alternaria	4.50	...	...	...	21	32	143	66	340	102	20	30	754
Trichoderma	3.62	19	...	...	20	67	222	78	185	5	...	11	607
Penicillium	3.13	1	9	1	13	34	114	140	186	26	...	1	525
Cladosporium	2.45	...	1	...	1	16	105	95	180	11	...	2	411
Cephalosporium	1.76	...	...	...	...	...	19	236	39	...	...	...	294
Cylindrocarpon	1.12	...	...	...	...	35	57	26	70	...	...	...	188
Trichothecium	0.53	...	...	...	...	9	41	31	7	...	...	...	88
Gonatobotryum	0.47	...	...	...	...	8	50	8	12	...	...	...	78
Polyscytalum	0.44	...	...	...	...	1	13	5	37	6	6	5	73
Fusarium	0.38	...	13	...	...	4	10	11	26	...	...	...	64
Mucorales	0.36	...	...	...	...	1	4	28	...	27	...	...	60
Papulaspora	0.31	...	...	...	...	2	31	3	...	16	...	...	52
Caloscypha	0.21	...	...	...	5	9	13	5	4	...	...	...	36
Teteracoccosporium	0.11	...	...	...	...	...	3	...	9	2	...	5	19
Pyrenochaeta	0.07	...	...	...	...	3	2	1	6	...	...	...	12
Aspergillis	0.06	...	...	...	...	2	8	...	...	...	...	...	10
Epicoccum	0.03	...	...	...	...	...	...	5	...	...	...	...	5
Chalara	0.01	...	...	...	...	...	...	2	...	...	...	...	2
Oidiodendron	0.01	...	...	...	...	...	2	...	...	...	...	...	2
Streptomyces	0.01	...	...	...	...	...	...	1	...	...	...	...	1
Paelomyces	0.01	...	...	...	...	1	...	...	...	...	...	...	1
Unknown	3.93	16	3	2	32	125	210	159	91	15	3	2	658
Total	23.52	36	26	3	92	349	1,047	900	1,192	210	29	56	3,940
Percent by elevation	...	7.2	5.2	0.6	12.3	12.7	25.4	25.7	39.7	28.0	11.6	22.4	

spruce (Table 1).

The incidence of infection was lower in Sitka spruce than in Engelmann spruce. However, the sample size was so much smaller that any conclusions about susceptibility would be premature.

Although it is not known how many of the identifiable genera would be pathogenic to spruce seed in normal field nurseries, all were pathogenic in the laboratory. The probable pregermination field pathogenicity of any one fungus is conjectural except for *C. fulgens,* which affects seeds only before germination begins. Many of the other genera isolated are known plant pathogens, however, and might be implicated in tree seed failure in field nurseries.

Occurrence of *C. fulgens* on seed collected only between 914 and 1,524 m (Table 1) may be related to handling and storage of collected cones before shipment to the nursery, but data were not available to substantiate this. *C. fulgens* is more commonly seen fruiting at high elevation (914–1,524 m) at the margin of receding snow (J. R. Sutherland, *personal communication*), and inoculum might therefore be more prevalent there.

The 0.21% frequency of *C. fulgens* infection of examined seeds (Table 1) may seem insignificant until viewed in connection with the number of seeds sown in the nursery. For example, a million seeds would yield approximately 2,100 foci for infection of entire seed lots. If stratification or germination were conducive to spread of *C. fulgens* throughout the seed lot, a considerably larger percentage of the seed would be infected.

C. fulgens is a soilborne fungus that infects seeds only after cones contact soil (5). Therefore, cones that have had prolonged contact with the ground (from squirrel caches in particular) should be avoided. Similarly, it is advisable to avoid prolonged storage of cones in contact with the ground before extraction either at the nursery or after collection. If infection is suspected, however, treatment with a registered fungicide can control the spread of *C. fulgens.*

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