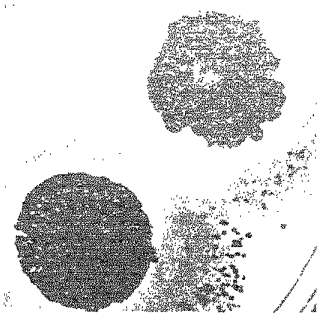

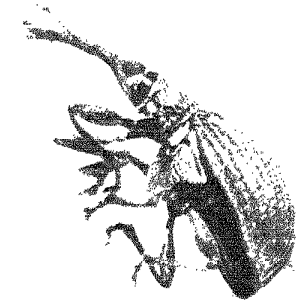

Fungus and Insect Injury to Yellow Birch Seeds and Seedlings

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Fungus and Insect Injury to Yellow Birch Seeds and Seedlings

Introduction

BECAUSE yellow birch (*Betula alleghaniensis* Britt.) is one of the most valuable species in our northern hardwood forests, much attention has been turned toward methods for obtaining better regeneration of this species after logging. Although regeneration of these trees is influenced by many factors, one of the most important is an abundance of healthy seeds. And one problem that has recently been recognized is the damage that is done to seeds and seedlings by fungi and insects.

Past research has not provided much guidance on this problem. The *Woody-Plant Seed Manual (U.S. Forest Service 1948)* and other publications either state that insects and diseases cause very little damage to yellow birch seeds *(Godman and Krefting 1960)*, or ignore the subject.

In a recent publication on seed-borne diseases *(Noble et al. 1958)* the fungus *Ciboria betulae* is listed as being seed-borne on

other species of birch, and *Septoria betulae* is thought to be; but proof is lacking. Sokoloff *(1940)*, reporting on the work done in 1938 at the Leningrad Seed Control Station, listed 48 species of fungi that had been isolated on malt agar from seeds of American ash, maple, oak, and birch. Some of the fungi isolated were *Coniothyrium olivaceum, Phoma samorarum, Pythium de baryanum, Rhytisma acerinum, Sclerotinia pseudotuberosa,* and *S. betulae*. But Redmond and Robinson *(1954)* reported that no fungi emerged from more than 1,000 yellow birch embryos that were excised and placed on bacto-malt-agar.

As for insect damage, reports in the literature are very scarce. Craighead *(1950)* states that the birch seed midge *Oligotrophus betulae* is the only insect known to cause injury to birch seed.

In 1959 the Northeastern Forest Experiment Station's research unit at Laconia, N. H., began studies of fungus and insect damage to seeds. Observations and preliminary experiments indicated that fungi and insects can cause considerable injury to seeds and seedlings of all northern hardwood species. This paper reports some observations and results of experiments on fungi and insects attacking seeds and seedlings of yellow birch.

Methods

The following materials and methods were used in the experiments.

Seeds to be tested were placed to germinate on a mixture of three parts vermiculite to one part washed sand, after the mixture had been sterilized by autoclaving and then spread out 1 inch thick in aluminum trays. The seeds were watered daily with sterile distilled water. To maintain the seedlings for the duration of the tests, overhead cool-white fluorescent lamps were used to supply 85 foot-candles of light to the surface of the trays from 8 a.m. to 5 p.m. each day.

Standard techniques were used for isolating fungi from inside the seeds and seedlings. The seeds and seedlings were surface-sterilized in a 10-percent solution of commercial Clorox bleach (5.25 percent hypochlorus acid) for 5 minutes, and rinsed in

sterile distilled water in petri dishes. A half milliliter of a 1-percent streptomycin solution was added to the last rinse to arrest the growth of bacteria.

The surface-sterilized seeds and seedlings were placed with sterile tools on a malt-yeast-agar medium in petri dishes. These plates were kept at room temperature for at least 5 days before the fungi growing from the seeds and seedlings were identified.

Results

Injury Caused by Fungi

In a preliminary experiment begun early in 1960, 1,100 seeds free of obvious injuries were selected from a collection made during the fall of 1959 from a single representative tree on the Bartlett Experimental Forest in Bartlett, New Hampshire. This study was directed mainly toward ascertaining fungus injury.

Of the 1,100 seeds tested, 385 (35 percent) germinated within 6 weeks. Of the 385 seedlings produced, 321 appeared chlorotic; and these were cultured to determine whether any fungus was present.

The fungus *Coniothyrium* sp. (tentatively identified as *C. olivaceum*) was isolated from 63 percent of these chlorotic seedlings (fig. 1). At the same time the same fungus was isolated from 84 percent of 220 seeds (picked at random) that had failed to germinate (fig. 2). *Penicillium* spp., *Aspergillus* spp., *Alternaria* sp., *Trichothecium roseum*, and a few other fungi were isolated from a small number of seeds.

(A similar experiment with seeds and seedlings of paper birch (*Betula papyrifera* Marsh.) indicated that *Alternaria* sp. was the principal fungus involved, and *Coniothyrium* sp. was seldom isolated from paper birch.)

The frequency of *Coniothyrium* sp. on the yellow birch seeds and seedlings from the 1-year-old collection warranted a further investigation. To make certain that the seeds were not infected by fungi during storage, a test was designed to make use of seeds immediately after they were collected. The first female strobili

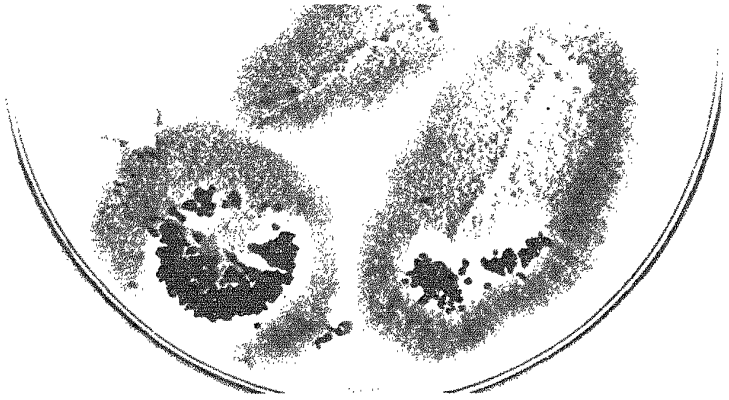

Figure 1.—*Coniothyrium* sp. growing from surface-sterilized seedlings that showed signs of poor vigor. This was the principal fungus found to be infecting yellow birch seeds and seedlings.

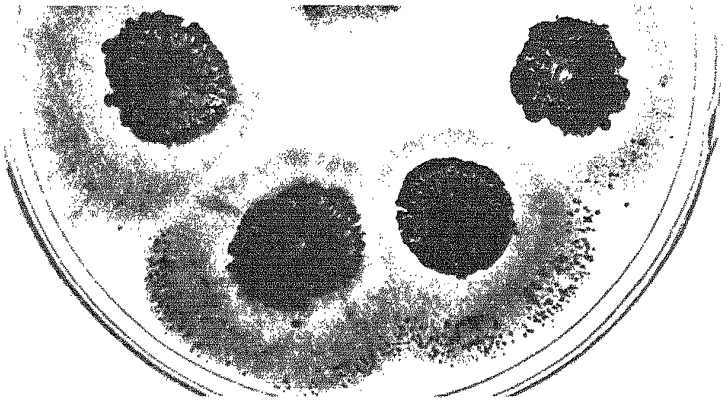

Figure 2.—*Coniothyrium* sp. growing from surface-sterilized seeds that did not germinate after 6 weeks.

(cones) were examined and collected in July 1960. At this time of the year cones are usually green, but many that were collected were partially or completely brown and distorted. Upon dissection of several of these cones in the laboratory, small white larvae were found in them.

Injury Caused by Insects

The larvae found in the cones were identified as a weevil, *Apion walshii* Smith *(Smith 1884)*. Identification was made by William E. Waters at the Northeastern Forest Experiment Station's Forest Insect Laboratory at New Haven, Connecticut, and by personnel at the U. S. National Museum in Washington, D. C.

Observations on this weevil were made throughout the summer. Larvae were abundant in July. Adults (fig. 3) were found in August. Active adults were collected as late as November both on the cones and inside them.

The larvae ate around the cones in a spiral towards the tip. Bracts and seeds were injured by the weevils (fig. 4). The continued growth of uninjured seeds and bracts caused the cones to become distorted. Weeviled cones stayed on the trees as long as those that were free of the insects.

By the end of the summer, 30 trees were examined and the weevil was found in cones from all of these. From one-fifth to

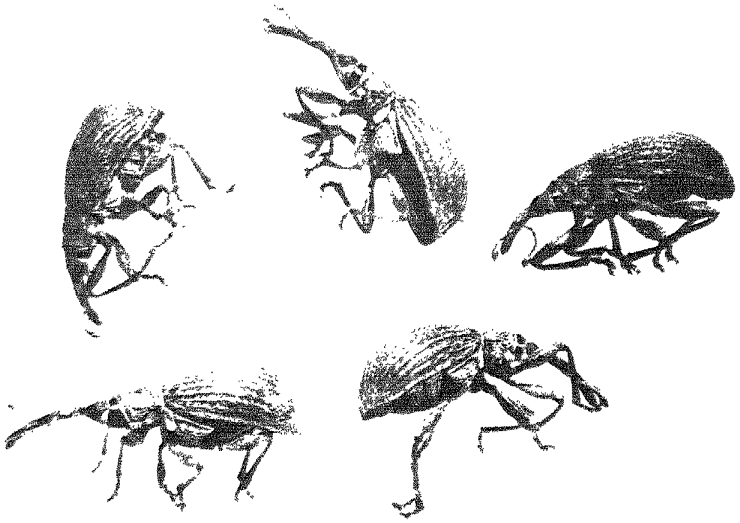

Figure 3.—The weevil *Apion walshii*. Larvae and adults of this weevil were found in many cones of yellow birch.

Figure 4.—Dissected yellow birch cones, showing areas injured by *Apion walshii*.

one-half of the seeds in each weeviled cone had been destroyed (fig. 5). Some trees had a high percentage of their cones injured. The uninjured seeds in the weeviled cones did not appear as healthy as those seeds from cones free of the weevil.

Injury Caused by Fungi and Insects

As a result of these observations, and since so many cones were attacked by weevils, it was thought necessary to alter the study in order to investigate the fungi active in weeviled cones. To this end, 100 dry cones were picked in November 1960 from each of 10 trees that had been cut for several weeks. To

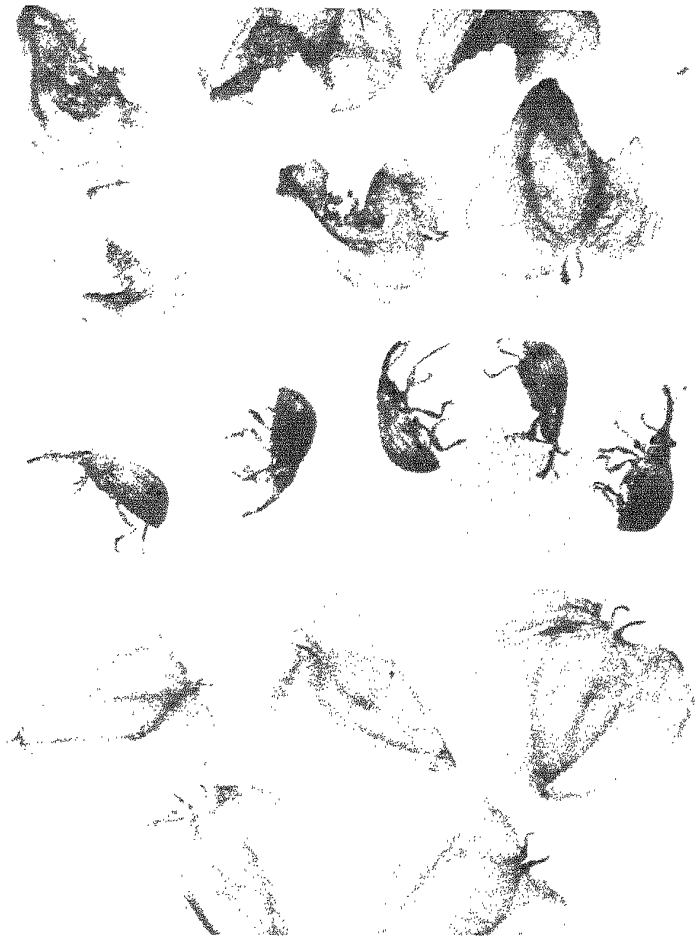

Figure 5.—Top, yellow birch seeds injured by the weevil *Apion walshii*. Center, the culprit. Below, sound seed.

insure a random sample, the dry seeds were mixed in a large paper bag.

The next day, 312 injured seeds picked at random from this collection were placed on moistened filter paper in petri dishes. Fruiting bodies (pycnidia) of *Coniothyrium* sp. could be seen on some of the seeds. All except 23 of these seeds yielded pycnidia of *Coniothyrium* sp. after 5 days. Because of this short incubation period, and because pycnidiospores are produced in a sticky mass only when the pycnidia are moistened, the possibility that some seeds might have been infected by spores from fungi

on other seeds while they were still in the bag was considered slight.

To check on this possibility of contamination, branches bearing obviously injured (weeviled) cones were brought into the laboratory. Each cone was taken separately from the branch, flamed lightly, and placed on the agar medium in a petri dish. This procedure was done with 24 cones. After 2 weeks all yielded *Coniothyrium* sp. Other fungi also grew from the strobili, but no species so consistently as *Coniothyrium* sp.

Adult weevils emerged from some of the cones after 4 weeks.

To determine whether or not fungi were present in or under the seedcoats of the apparently healthy seeds, individual seeds were taken at random from the 10-tree sample and were separated into two groups: apparently healthy (good color and form) and obviously injured (weevil injury and poor color and form). This random separating was done until 200 apparently healthy seeds were obtained. The number of obviously injured seeds taken before 200 apparently healthy seeds were obtained was recorded. The procedure was done 10 times, giving 10 subsamples each containing 200 apparently healthy seeds and a number of obviously injured seeds. The ratio of apparently healthy seeds to obviously injured seeds was 2.5 to 1.

The 200 seeds in each subsample of apparently healthy seeds were individually placed on the sand-vermiculite mixture in a tray. After 25 days, 50 percent of the seeds had germinated. Of the ungerminated seeds, 80 percent had visible fungus mycelium over them. And 44 percent of the seedlings had chlorotic, twisted cotyledons. These seedlings were usually shorter than the others. Microscopic examination of the roots of these seedlings revealed the presence of fungus hyphae.

At this time, 20 of the poorest seedlings from each of the 10 trays were carefully pulled, surface-sterilized, and placed on the agar medium in petri dishes. *Coniothyrium* sp. was isolated from 50 percent of these seedlings (fig. 1). The same fungus was isolated from 90 percent of 72 seeds selected at random that had not germinated (fig. 2).

The same procedure was repeated 1 week later, using 10 seedlings and 20 seeds from each tray. *Coniothyrium* sp. was isolated

from 72 percent of the seedlings and 80 percent of the seeds. And 2 weeks later, 10 of the best-looking seedlings and 10 of the poorest seedlings from each tray were surface-sterilized and placed on the agar medium. *Coniothyrium* sp. was isolated from 56 percent of the poorest seedlings and from 13 percent of the best ones.

Other experiments similar to those described above were conducted with the seeds from the 10 trees and from other trees in the same area, and *Coniothyrium* sp. was always the major fungus isolated.

The high percentage of cones injured by the weevil posed the question of the possible association of *Coniothyrium* sp. with the weevil. The seed crop failure in 1961 prevented further experiments that would have been necessary to prove this association. The only weevils collected were reared in the laboratory from a few cones found on several trees.

In 1962 there was a poor-to-fair seed crop and very few cones were found that were not injured by the weevil. *Coniothyrium* sp. was isolated frequently from uninjured seeds in weeviled cones. The weevils were found for the first time in a few paper birch cones.

Discussion

A preliminary investigation indicated that insects and fungi can cause considerable injury to yellow birch seeds and seedlings.

Coniothyrium sp. was the principal fungus infecting yellow birch seeds and seedlings. The fungus apparently is established in and on the seed before it falls to the ground. The sticky masses of spores forced out of the pycnidia when they are moistened are well adapted for insect dissemination.

The weevil *Apion walshii* was abundant in yellow birch cones. Larvae of this weevil destroyed many seeds. The seeds in the cones attacked by the weevil were usually infected by the fungus *Coniothyrium* sp. The possibility exists that the weevils may disseminate the spores; but proof is lacking.

In 1960, strobili and weevils were abundant; in 1961 both

were scarce; and in 1962 there were many weevils in the few cones produced. If yellow birch cones are essential to the weevils for the completion of their life cycle, then the weevil population probably was greatly reduced in 1961. An abundant weevil population such as that observed in 1960 may not be seen again for several years.

Healthy, unweeviled cones, and healthy seeds from such cones, were included in the collection picked at random, but were not treated separately. A more intensive investigation is needed before the importance of these destructive agents can be determined.

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