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THE IMPORTANCE OF *SAPERDA INORNATA* AND *OBEREA SCHAUMII* (COLEOPTERA: CERAMBYCIDAE) GALLERIES AS INFECTION COURTS OF *HYPOXYLON PRUINATUM* IN TREMBLING ASPEN, *POPULUS TREMULOIDES*¹

John C. Nord and Fred B. Knight²

Trembling aspen, *Populus tremuloides* Michaux, and bigtooth aspen, *P. grandidentata* Michaux, are hosts of numerous species of injurious insects and microorganisms (Harrison 1959). Only a few of those organisms, however, are directly responsible for mortality of healthy trees. The fungus *Hypoxylon pruinaum* (Klotzsch) Cke. is most important in that respect, killing 1-2% of the standing volume annually in the Lake States (Anderson 1964). It invades and spreads in cambial tissue, killing it and eventually the branch or stem by girdling. Initially, a canker appears as a sunken, yellowish-orange area in the bark (Anderson 1956). In a later stage the outer bark raises in blister-like patches and sloughs off exposing blackened, crumbling cortex.

H. pruinaum apparently can establish itself only in a bark wound (Gruenhagen 1945) or possibly in non-wounded bark tissue above branch axils according to French and Oshima (1959). Gruenhagen (1945) called *H. pruinaum* a wound parasite because he was able to establish infections by inoculation only in wounded bark. He listed the various causes of wounds which could serve as infection sites of *H. pruinaum*: 1. weather; e.g., wind, ice, lightning; 2. man; e.g., ax wounds, logging damage; 3. animals and birds; e.g., deer scraping, porcupine chewing, sap-sucker borings; 4. insects; e.g., bark borers, chiefly *Saperda calcarata* Say. The primary cause(s) of wounds which serve as infection courts for *H. pruinaum* has not been ascertained.

Gruenhagen (1945) examined all insect-borer holes up to 8 feet above the ground in trunks of trembling and bigtooth aspen on eleven 1/10 acre plots in Wisconsin and found only 14 of 1018 (1.4%) to be at the center of hypoxylon cankers. He thought that borers like the poplar borer, *S. calcarata*, were not vectors of the fungus since so few of their galleries were infected. However, it was postulated that the sap which oozes out of the entrance hole serves as a spore trap and culture medium for the fungus in which it germinates, grows, and subsequently invades the cambium via the entrance hole.

Graham and Harrison (1954) found hypoxylon cankers associated with the galleries of wood boring insects, especially the cerambycid, *S. calcarata* and 2 buprestids, *Agrilus* sp. and *Dicerca tenebrica* Kby. However, the importance of the galleries of those species as infection courts of *H. pruinaum* has not been evaluated.

Harrison (1959) also found *H. pruinaum* associated with the galleries of 3 other cerambycids: *S. concolor* LeConte (= *S. inornata* Say), *S. moesta* LeConte, and *Oberea schaumii* LeConte. The larvae of these cerambycids live in the stems of aspen suckers and seedlings and also in the twigs of larger trees. The biologies of *S. inornata* and *O. schaumii* were reported by Nord *et al.* 1972a and 1972b. Reported here are the results of 2 surveys designed to evaluate the importance of the galleries of *S. inornata* and *O. schaumii* as infection courts of *H. pruinaum* in large trees and in young suckers of trembling aspen.

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METHODS

The location and the methods of the borer and *H. pruinatum* survey in 12 stands of large trembling aspen trees are given in another paper (Nord and Knight 1972). In 1963 a survey of borer galleries and the incidence of *H. pruinatum* was conducted in 6 sucker stands of trembling aspen. The trees in those stands ranged from 2-5 years of age, 0.3-1.3 inches in diameter 6 inches above the ground and 4-16 feet tall. In each stand all suckers, galleries, and hypoxylon cankers in 2 parallel, 0.1 acre strips (6.6 ft wide and 660 ft long) 132 ft apart were tallied. Hypoxylon-like cankers were identified by their outward appearance. Cultures were not made for positive identification of the fungus so the cankers are referred to as hypoxylon-like cankers.

RESULTS

Injury to the Host

Except for occasional wind breakage at *S. inornata* galls, there was no killing of twigs in large trees or suckers infested by *S. inornata* and *O. schaumii* (Nord et al. 1972a and 1972b). *H. pruinatum* infections killed twigs and suckers (when on the main stem) by girdling. Infections on twigs, whether associated with borer galleries or not, were localized and did not spread very far from the point of entry. The twig died beyond the infection and the fungus looked as if it died also or was arrested soon afterward. Thus, the infection did not spread to the main branch or stem.

Survey in Large Trees

The incidence of hypoxylon-like cankers in the branches of large trembling aspen was low (Table 1). Of 1750 branches examined, only 40 (2.3%) had cankers. However, 7 (17.5%) of the 40 cankers were associated with *S. inornata* galls (Fig. 1) and 7 (17.5%) were associated with *O. schaumii* galleries (Fig. 2).

Only 1 first-year gallery was found associated with a hypoxylon-like infection; that was an *O. schaumii* gallery in a twig from a large tree (Fig. 2). On the basis of Bier and Rowat's (1962) finding that *H. pruinatum* infection probably does not take place during the growing season when bark moisture content is high, and because of the virtual absence of infection in first-year galleries in this study, first-year galleries were considered not susceptible to infection. All other galleries were considered susceptible to infection for the purposes of discussion. Of 448 susceptible *S. inornata* galls only 1.6% had been or were infected by *H. pruinatum* while 3.3% of 211 susceptible *O. schaumii* galleries had been or were infected (Table 1).

Survey in Sucker Stands

The incidence of hypoxylon-like cankers in the 6 sucker stands sampled was also very low. No cankered stems were found in 3 of the stands and only 7 were found in the other 3 (Table 2). One canker was associated with a *S. inornata* gall and 1 with an *O. schaumii* gallery. Both of those infections were found in the same stand. Only 2% of the 51 susceptible *S. inornata* galls were infected while 7.7% of the 13 susceptible *O. schaumii* galleries were infected.

Very few gallery-centered infections were found in suckers collected during the biology studies (Nord et al. 1972a and 1972b). Only 1 sucker stand was found in which many galls of *S. inornata* served as infection courts of hypoxylon-like cankers. That was in a little patch of trembling aspen less than 1/4 of an acre in area near Ann Arbor, Michigan.



Fig. 1. Hypoxylon-like canker associated with a *S. inornata* gall (scale in inches).



Fig. 2. Hypoxylon-like canker associated with an *O. schaumii* egg niche (arrow).

Table 1. The incidence of hypoxylon-like cankers associated with the susceptible *S. inornata* galls and *O. schaumii* galleries in the crowns of 180 large trembling aspen.

A S Number r i Branches e t Sampled a e	Branches With Cankers*		Susceptible† <i>S. inornata</i> Galls			Susceptible† <i>O. schaumii</i> Galleries			
	Number	Percent	Number	Number Cankered	Percent Cankered	Number	Number Cankered	Percent Cankered	
I 40	138	10	7.2	50	0	0	26	1	3.8
50	136	4	2.9	47	1(1)‡	2.1	11	1	9.1
60	147	3	2.0	42	0	0	19	0	0
II 40	150	4	2.7	49	2	4.1	18	0	0
50	148	0	0.0	11	0	0	13	0	0
60	144	0	0.0	23	0	0	13	0	0
III 40	150	3	2.0	60	0	0	23	1(1)	4.3
50	145	5	3.4	28	2(1)	7.1	17	2(1)	11.8
60	145	1	0.7	48	0	0	21	0	0
IV 40	147	8	5.4	26	2	7.7	18	2	11.1
50	150	2	1.3	36	0	0	16	0	0
60	150	0	0.0	28	0	0	16	0	0
Total -1750	40	2.3	448	7(2)	1.6	211	7(2)	3.3	

* Also equals the number of cankers.

† Total number of galls or galleries minus current year's attacks (see text).

‡ Number of cankered galls where the site of infection was questionable in parenthesis.

DISCUSSION

The percentage of borer galleries associated with hypoxylon-like cankers in large trembling aspen was low, but the number of cankers (40) found was low also. What may be important is, that of the cankers found, a relatively high percentage (35%) was associated with borer galleries, 17.5% with *S. inornata* and 17.5% with *O. schaumii*. Likewise, in the 6 sucker stands sampled, 2 of the 7 (28.6%) cankers found were associated with these borers.

It may be that under certain conditions borer galleries become even more important as infection courts of *H. pruinatum*. The prevalence of hypoxylon canker does fluctuate. Smiege and Anderson (1960) reported that the percentage of trees infected on permanent sample plots in northern Minnesota from 1953 to 1959 ranged between 1.8% and 3.3%. Under more favorable conditions extensive spread of the fungus from twig infections may occur leading to a serious stem infection which would kill part or all of the crown. Therefore, the prevalence of infected galleries and the ability of the fungus to spread during exceptionally favorable years should be investigated.

On the other hand, it was not surprising that the incidence of infection in *S. inornata* and *O. schaumii* galleries, especially in the active galleries, was low. It may have been necessary for the survival of the species that they adapt some kind of mechanism to avoid the high mortality that such an infection would cause. Such a mechanism may involve the selection

Table 2. The incidence of hypoxylon-like cankers associated with the susceptible *S. inornata* galls and *O. schaumii* galleries in six young trembling aspen sucker stands.

Stand Number	Per		Suckers with Cankers*		Susceptible† <i>S. inornata</i> Galls			Susceptible† <i>O. schaumii</i> Galleries		
	Suckers Sampled	Acre Sucker Density	Number	Percent	Number	Number Canker-ed	Percent Canker-ed	Number	Number Canker-ed	Percent Canker-ed
1	1346	6730	0	0.0	2	0	0.0	0	0	0.0
2	1162	5810	1	0.1	8	0	0.0	3	0	0.0
3	1069	5345	3	0.3	6	1	16.7	1	1	100.0
4	1058	5290	3	0.3	9	0	0.0	1	0	0.0
5	731‡	4873	0	0.0	13	0	0.0	8	0	0.0
6	882§	4410	0	0.0	13	0	0.0	0	0	0.0
Total	6248	--	7	0.1	51	1	2.0	13	1	7.7

* Also equals the number of cankers

† Total number of galls or galleries minus current year's attacks (see text).

‡ Two 0.075 acre strips sampled instead of two 0.10 acre strips

§ 49 bigtooth aspen suckers included

of the oviposition site by the female, timing of oviposition, or some other behavior of the female or larva.

Bier and Rowat (1962) suggested that infection by *H. pruinatum* probably occurs during the dormant season when bark turgidity is most likely to be below 76%. If this is true of Michigan trembling aspen, the reason that most of the borer wounds were not infected may have been egg inviability and the high mortality occurring soon after oviposition in both species (Grimble and Knight 1970, 1971), which allowed callusing over of the wound before fall. Infection of galleries where the larva survived the first summer may have been prevented by the antibiotic effects of other fungi and bacteria which undoubtedly inhabit the injured bark and wood tissues. Or perhaps rapid callusing over of the wound or a physiological change in the injured tissue before the onset of the dormant season might have prevented infection in those cases.

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