Beech bark disease - A survey of the Toronto area

Myriam R. Fernandez[1] and Michael G. Boyer[2]

Beech Bark Disease is caused by a scale insect, ***Cryptococcus fagisuga*** Lind, and a fungus, ***Nectria coccinea*** var. ***faginata*** Lohman, Watson & Ayres, or ***N. galligena*** Bres. Investigation of six forest stands in the Toronto area revealed the presence of only the scale insect. Small trees (up to 17 cm in diameter) were less susceptible to attack by the insect than larger trees, but trees in the 11-31 cm range were the most suitable ones for the development of heavy infestations.

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La maladie corticale du hêtre est causée par une cochenille ***Cryptococcus fagisuga*** Lind et un champignon, ***Nectria coccinea*** var. ***faginata*** Lohman, Watson & Ayres ou ***N. galligena*** Bres. Dans six peuplements forestiers de la region de Toronto, on n'a décelé que l'insecte. Les petits arbres (d'au plus 17 cm de diamètre) étaient moins sensibles a l'attaque de l'insecte que les gros arbres, mais les arbres d'un diamètre de 11 à 31 cm etaient les plus susceptibles de presenter une infestation grave.

Introduction

Beech Bark Disease (BBD) is caused by the interaction of two organisms, a scale insect, ***Cryptococcus fagisuga*** Lind., and a fungus, ***Nectria coccinea*** var. ***faginata*** Lohman, Watson & Ayres or ***N. galligena*** Bres. (Cotter and Blanchard, 1981; Mielke ***et al.,*** 1982; Shigo, 1963). This disease complex was introduced into Canada from Europe at the end of last century, and it is found in Eastern Canada on American beech (***Fagus grandifolia*** Ehrh). In 1934, Ehrlich reported the presence of BBD in Eastern Canada and indicated that it was depleting beech stands. BBD was then reported in Quebec in 1965 (Environment Canada, 1965), and the insect was first detected in Ontario at McKay Forest, Elgin County, in 1966, and again in 1981 at Holland Landing (FIDS, 1982).

C. ***fagisuga*** has a one-year life cycle, and it disseminates during the first-instar larval stage, from June to November (Ehrlich, 1934; Shigo, 1963). Insect infestations are reported to be followed 3-6 years later by ***Nectria*** infections (Shigo, 1963). Although the course of the disease may take several years, trees can be killed after two years of severe infection (Houston, 1975). However, differences in susceptibility of trees in affected stands have been reported (Ehrlich, 1934; Houston ***et al.,*** 1979; Shigo, 1963, 1964). These differences were thought to have a genetic basis (Shigo, 1964), or to be related to factors providing a better habitat for the pathogen, such as age of the tree and bark flora (Ehrlich, 1934), or be attributed to chance infestations (Houston ***et al.,*** 1979).

The aim of this study was to ascertain whether this disease complex was present in the Toronto area, and if so, the form in which it was present; and to determine whether there were differences among trees in susceptibility to the causal agents, and what the nature of these differences might be.

[1] Department of Botany, University of Toronto, Toronto, Ontario M5S 1A1.

[2] Biology Department, York University, 4700 Keele St., Downsview, Ontario M3J 1P3.

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Materials and methods

Six forest stands, around the Toronto region, were examined for evidence of the presence of BBD in the summer of 1982. All of them, with the exception of the York University stand, are residual or remnant cutover stands of the beech-maple forest association located on the cooler more northerly slopes of the Humber, Don and Highland Creek Valley systems. The stand at York University was a wet mesic stand dominated by American elm (***Ulmus americana*** L.), bur oak (***Quercus macrocarpa*** Michx.) and pignut hickory (***Carya cordiformis*** Wangenh. K. Koch). Beech was a relatively minor component of this stand.

Within these stands 100 m^2 plots were selected and the number of trees examined in each of them were: York University (44 trees), Sunnybrook (46 trees), Boyd Conservation Area (27 trees), Wilket Creek (17 trees), Earl Bales (14 trees) and Bestview (7 trees). Trees were grouped in eight diameter classes : 3-10, 11-17, 18-24, 25-31, 32-38, 39-45, 46-55, and >55 cm. Large trees predominated in Bestview and Earl Bales (86% and 57% respectively were over 31 cm in diameter); trees in the York University and Sunnybrook stands were mainly small (82% and 52% respectively had a diameter of less than 17 cm); and those in the Boyd Conversation Area and Wilket Creek were more or less evenly distributed among all diameter classes.

Trees infested with ***Cryptococcus fagisuga*** were tabulated and estimates of the degree of infestations recorded from ten randomly placed wire frames of 25 cm^2 each at breast height. Based on average values/25^2, the trees were grouped into five classes: 0 (no colonies or colonies scattered on branch stubs), 1-25, 26-50, 51-75, and 76-100 colonies/25 cm^2.

Within each stand trees representative of all diameter and infestation classes were examined for the presence of ***N. cinnabarina*** or ***N. galligena.*** A total of 47 trees were sampled. Sterile cotton pads were used to swab a portion of the bark approximately 5 cm^2. Dilution plates prepared on Oxoid malt agar (1.2%) amended with streptomycin were used to isolate the fungus from the bark. Plates were incubated for 7 days at 25°C prior to examination.

Table 1. Infestation of American beech trees by the beech scale insect in relation to diameter classes of trees.

Diameter classes (cm)	Infestation classes[a]					Percent infestation
	0	1-25	25+ - 50	50+ - 75	75+ - 110	
3-10	44	8	2	-	-	19
10+ - 17	13	15	1	-	1	57
17+ - 24	3	13	-	1	1	83
24+ - 31	4	14	2	1	0	81
31+ - 38	-	9	1	-	-	100
38+ - 45	1	10	1	-	-	92
45+ - 55	1	7	-	-	-	88
>55	-	2	-	-	-	100

[a]Number of colonies per 25 cm^2.

Results

C. fagisuga - Classification of the trees according to the degree of infestation with *C. fagisuga* is presented in Table 1. Statistical analysis showed that trees up to 17 cm in diameter were less infested than the rest (Chi-square for contingency table: X^2(.05), df:7, 56.18, P<.001), and that those in the lowest diameter class, 3-10 cm, were in turn less infested than those in the 11-17 cm class (X^2(.05), df:1, 12.32, P<.001). Table 1 also shows that trees with the heaviest infestations per unit area were of intermediate size (11 to 31 cm).

In agreement with these observations, percent values of scale infested trees by stand (Table 2) indicate an increase in incidence of scale infestation with increase in size of the trees in the community (Bestview and Earl Bales having all trees infested), and a decrease in percent infestation with an increase in the percent of small trees in the other stands. The stands with a high percent of juveniles, York University and Sunnybrook, had mainly trees with scattered infestation (0 class) and a smaller percent of infested trees than the other stands.

Nectria - No evidence of *N. coccinea* var. *faginata* (or of *N. galligena*) was either observed or obtained from any isolation attempt.

Table 2. Beech scale infestation by stand and diameter classes of beech trees.

Site	Diameter classes (cm)								Percent infestation[a]
	3-10	10+-17	17+-24	24+-31	31+-38	38+-45	45+-55	>55	
Bestview	1	-	-	-	-	2	2	2	100
Earl Bales	-	1	1	4	5	2	1	-	100
Wilket Creek	5	1	4	3	2	1	-	-	71
Boyd Conservation Area	7	9	2	5	3	1	-	-	63
Sunnybrook	18	6	6	5	-	6	5	-	57
York University	23	13	5	3	-	-	-	-	30

[a]Based on number of trees infested with *C. fagisuga* in each stand, regardless of their infestation levels.

Discussion

The observations reported here agree with those of Ehrlich (1934), Houston *et al.* (1979), and Shigo (1963, 1964). Where *C. fagisuga* was present in a community, beech trees were commonly infested. However, trees varied in their pattern of infestation. Small-sized trees (3-10 and 11-17 cm classes) were clearly less susceptible to attack. Colonies on most of the smaller trees were almost invariably associated with branch stubs, which have been reported as one of the most suitable habitats for the insect (Ehrlich, 1934; Shigo, 1964).

We feel that length of exposure was probably not a factor in determining levels of infestation. It would be expected that large trees are probably more prone to attack by the insect because of the larger surface area exposed and, although the sample size was small, large trees sustained the greatest percent infestation. They had, however, very low infestation levels. The possibility remains that these large trees may have sustained greater infestations in the past and that the insect may have started to die out.

The trees that seemed to be more prone to develop high infestations were in the 11-31 cm range, which points to the suitability of the bark of smaller trees as substrate for the insect, and to the importance of these medium-sized trees as a source of inoculum for scale infestations. This is not in agreement with the observation that large, old trees, are generally a source of infestation and that should therefore be considered in forest management (Houston *et al.,* 1979).

Although the nature of the bark is then clearly playing a role in the build-up of heavy infestations in medium-sized trees, other factors also seem to be determining their susceptibility. One of these may be the deterioration of the trees resulting from *Xylococculus betulae* (Perg.) Morrison infestations which were observed in a high number of trees and particularly in very high numbers in the Boyd Conservation Area, the stand with the highest proportion of trees in the highest infestation levels (23% of trees with more than 25 colonies/25 cm^2). *X. betulae* could predispose beech to *C. fagisuga* attack by creating suitable infestation sites and shelter for the insect (Shigo, 1964). In addition, the presence of the lichen *Lecanora conizaeoides* Barkm. observed in some of the trees, particularly in the Boyd Conservation Area, could also encourage insect colonization (Houston *et al.,* 1979).

The insect is undoubtedly influenced by the local climate at or near the northern extreme of its range, and this may be the most important factor governing its distribution. In the spring following the year these observations were made at least some colonies did not survive the winter. Whether survival is influenced by microclimatic differences related to tree age or size is not known at this time.

In any case, development of heavy insect infestations would be expected to determine the establishment of *Nectria* spp. and further progress of the disease (Houston, 1975), which warrants close monitoring of these and other stands in the Ontario region.

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