Epiphytes on White Elm, *Ulmus americana*, near Thunder Bay, Ontario

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White Elm (*Ulmus americana*) stands near Thunder Bay, Ontario were investigated for epiphyte cover. Lichens dominated the cover in upper quadrats and mosses dominated in quadrats near the ground. In both upper and lower quadrats, mean cover was about 10%. Total cover was greatest on the north sides of the trees and tended to increase as the distance from the city increased. The stand located close to a kraft pulp and paper mill had the lowest number of species. Three species of liverworts, 12 mosses, and 17 lichens were recorded.

Key Words: northern Ontario, White Elm, epiphytes, pollution.

White Elm, *Ulmus americana*, is rapidly disappearing from much of its former range in Canada and the United States owing to large-scale mortality caused by the introduced Dutch Elm Disease. This unfortunate circumstance has resulted in increased interest in studies relating to White Elm, such as that of Mahoney (1973) in northern Michigan and Newberry (1974) in Wisconsin. A further point of interest is that the groves in our region, the northwest shore of Lake Superior, form part of the northern boundary of White Elm's range. The purpose of this study was to record the epiphytes on White Elm near Thunder Bay before Dutch Elm Disease removes the elm population, and to note epiphyte variability in relation to distance from the city of Thunder Bay.

Methods

During September and October of 1973, 50 trees were examined in five natural stands (10 trees per stand) located at various distances from the city of Thunder Bay. These stands were as follows:

1. Great Lakes Paper. On the south bank of the Kaministiquia River directly south of the Great Lakes Paper kraft pulp and paper mill. This small stand is on the south end of Thunder Bay city and is considered to be at 0 km (48°21′W, 89°19′N, 194 m above sea-level (asl)).
2. Pointe de Meuron. This relatively large stand of elm is on the north bank of the Kaministiquia River adjacent to the reconstructed Old Fort William and is 3 km west of the Great Lakes Paper site (48°21′W, 89°21′N, 195 m asl).
3. Slate River. This medium-sized stand is on the west bank of the Slate River just north of Highway 608 and is 16 km southwest of Great Lakes Paper (48°16′W, 89°29′N, 224 m asl).
4. Kakabeka Gorge. This is a small stand located on the east bank of the Kaministiquia River about 300 m downriver from Kakabeka Falls (36 m high) and is 23.4 km west-north-west of Great Lakes Paper (48°24′W, 89°37′N, 229 m asl).
5. Blind Line Road. This small stand is on the south bank of a small creek just north of Blind Line Road and 250 m west of Highway 11-17. This site is 25.6 km west-north-west of Great Lakes Paper (48°25′W, 89°38′N, 284 m asl).

All sites have Balsam Poplar (*Populus balsamifera*), Black Ash (*Fraxinus nigra*), Mountain Maple (*Acer spicatum*), and Red-osier Dogwood (*Cornus stolonifera*). Also generally present are Eastern White Cedar (*Thuja occidentalis*), White Birch (*Betula papyrifera*), Speckled Alder (*Alnus rogosa*), and Red Raspberry (*Rubus idaeus*). Table 1 shows additional characteristics of the sites and of the trees in the stands.

TABLE 1—Mean soil and tree characteristics. DBH = Diameter at breast height (range in parentheses)

Site	Soil pH	% Carbon	Trees, DBH (cm)	Bark pH
Great Lakes Paper	5.9	11.0	44.9 (30.5–71.1)	4.2
Pointe de Meuron	5.9	13.1	37.7 (19.7–55.9)	6.2
Slate River	5.8	14.4	38.0 (22.9–49.5)	6.4
Kakabeka Gorge	6.8	5.3	24.8 (17.2–45.7)	6.5
Blind Line Road	6.4	18.8	21.3 (15.9–31.8)	6.6
Mean	6.2	12.5	33.3 (15.9–71.1)	6.0

TABLE 2—Presence (X) and frequency of epiphytes on White Elm at the five study sites. Frequency figures are out of a possible total of 50 trees. *t* = found only in top quadrats; *b* = found only in bottom quadrats; no notation = found in both top and bottom quadrats. GLP = Great Lakes Paper; PM = Pointe de Meuron; SR = Slate River; KG = Kakabeka Gorge; BL = Blind Line Road

	Presence					Frequency		
Species	GLP	PM	SR	KG	BL	Top quadrats	Bottom quadrats	Whole tree
Frullania eboracensis		X	X	X	X	28	15	31
Frullania bolanderi				X		5	1	5
Porella platyphylla		X^b		X^b		0	2	2
Anomodon minor	X^b	X	X		X	6	20	20
Orthotrichum speciosum			X	X^t	X	15	7	19
Brachythecium salebrosum		X		X	X	8	13	15
Pylaisiella selwynii		X	X		X	5	7	11
Pylaisiella polyantha		X^t		X		10	10	11
Brachythecium reflexum		X		X^b	X	3	3	5
Platydicta subtile	X					1	5	5
Plagiothecium denticulatum		X^b				0	2	2
Amblystegium juratzkanum				X^b		0	1	1
Orthotrichum obtusifolium				X^t		1	0	1
Dicranum montanum	X^b					0	1	1
Mnium cuspidatum					X^b	0	1	1
Physconia grisea	X	X	X	X	X	30	23	33
Candelaria concolor		X^t	X	X	X^t	28	10	29
Parmelia sulcata	X	X	X^t		X	21	9	21
Physcia orbicularis		X	X	X	X	18	6	19
Physcia adscendens			X	X^t	X^t	11	3	12
Physcia aipolia		X		X^t	X	7	3	9
*Bacidia chlorococca**	X					4	7	8
Lepraria membranacea		X				3	4	5
Lecanora impudens		X	X		X	3	3	4
Lobaria pulmonaria		X	X^t		X	4	1	4
Xanthoria polycarpa				X^t	X^t	4	0	4
Cetraria ciliaris			X^t			3	0	3
Lecanora conizaea		X				2	2	3
Evernia mesomorpha		X^t				2	0	2
Lepraria neglecta		X				1	1	2
Parmelia saxatilis		X^t				2	0	2
No. of species, top	4	18	12	12	15	$\bar{X} = 12$		
No. of species, bottom	6	16	9	10	13	$\bar{X} = 11$		
No. of species per tree	6	20	12	15	16	$\bar{X} = 14$		

**Bacidia chlorococca*, while not noted in the quadrats, was also present on the elms at both Slate River and Blind Line Road.

Each of the 10 trees in each stand was analyzed for epiphyte presence using the method employed by Rao and Le Blanc (1967). In this method, two circular quadrats were used per tree. One quadrat (bottom) was from the tree base at 0 cm to 30 cm above the base; the second quadrat (top) was also 30 cm deep and was located at 120 cm to 150 cm above the tree base.

All mosses, liverworts, and lichens were recorded. Cover was also estimated using the Domin Scale for this purpose. Conversion of the Domin Scale data to percent cover was based on the following equivalents: 10 = 100%, 9 = 75%, 8 = 60%, 7 = 40%, 6 = 30%, 5 = 20%, 4 = 5%, 3 = 3%, 2 = 1%, 1 = 0.5% and X = 0.25%. The directional quarter of greatest cover for each tree was noted.

Sorensen's Coefficient of Similarity was used to compare quadrats and trees and also as a basis for a Bray and Curtis (1957) ordination in which each tree (top and bottom combined) was used as one quadrat.

All field studies were done by the second author. Determinations were also done by the second author with assistance from C. Garton (bryophytes) and the first author (macrolichens). All crustose lichens were verified by J. W. Thompson. Voucher specimens were deposited in the Lakehead University Herbarium.

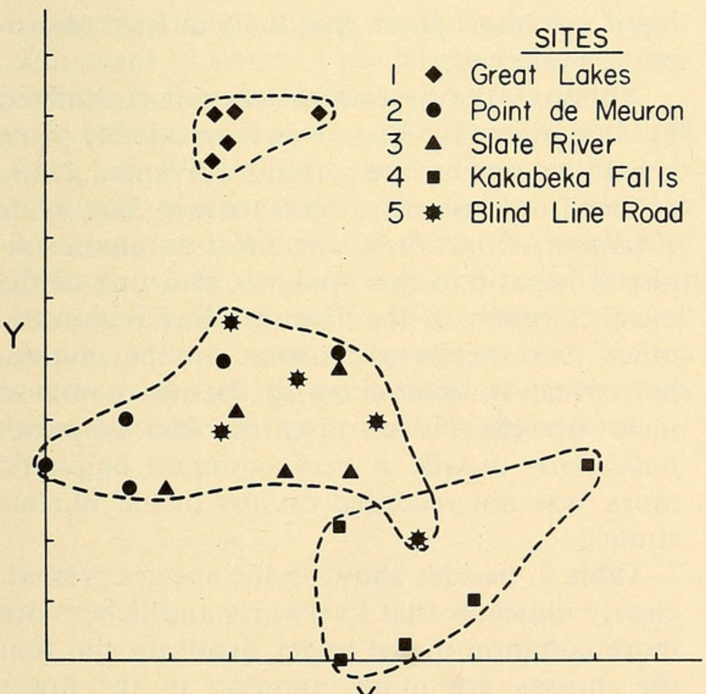

FIGURE 1. An ordination of whole trees from five sites using the Sorensen Coefficient of Similarity method of Bray and Curtis (1957).

Results

The species of lichens and bryophytes present at each site, the number of species per tree, the number of species in top quadrats, the number of species in bottom quadrats, and the number of species per site in all quadrats are shown in Table 2. The total number of species for all sites is 32, made up of 3 hepatics, 12 mosses, and 17 lichens.

The coefficient of similarity ordination of whole trees is illustrated in Figure 1 to show relationships between sites.

Percent cover values by site are shown in Figure 2. When all five sites are considered

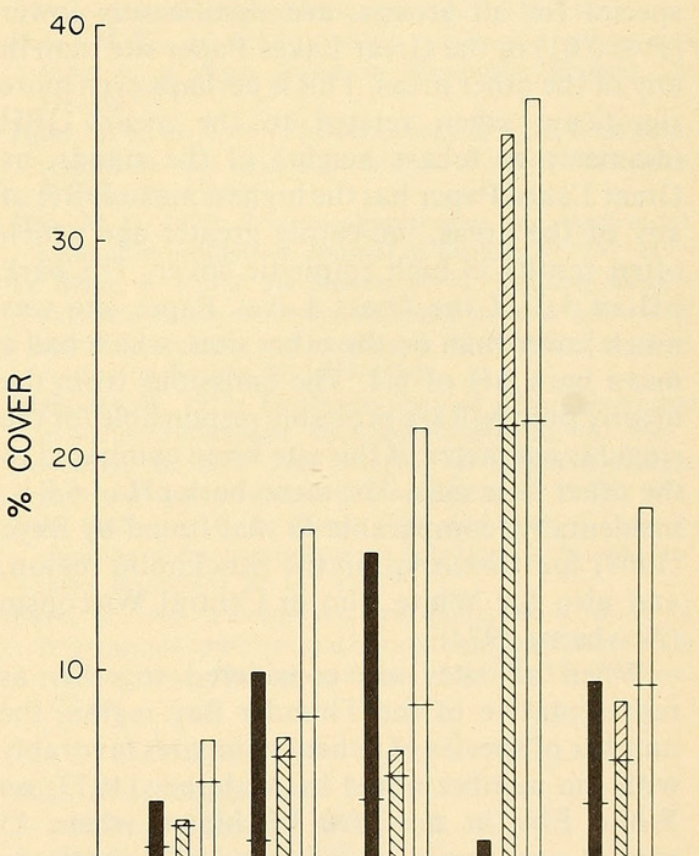

FIGURE 2. Cover relationships of bryophytes and lichens showing values for top quadrats (above line) and bottom quadrats (below line) at the five study sites. The sites are arranged in order of increasing distance from Thunder Bay. L, lichens; B, bryophytes; T, total of both lichens and bryophytes; GLP, Great Lakes Paper site; PM, Pointe de Meuron site; SR, Slate River site; KG, Kakabeka Gorge site; BR, Blind Line Road site.

together, lichens contribute a mean cover of 5.9% in the top quadrats and 2.1% in the bottom quadrats. Byrophytes contribute 3.6% in the top quadrats and 8.0% in the bottom quadrats. Overall mean epiphyte cover was 9.5% in the top quadrats and 10.2% in the bottom quadrats. In 68% of the trees the greatest cover is on the north quarter of the trees, 14% on the west, 10% on the east, 2% on the south, and in 6% two or more quarters were equal.

Discussion

The most obvious observation from the data obtained in this study is that the Great Lakes Paper site is quite different from the other four areas. The number of species of epiphytes in each of the three groups, and the total number of species for all groups, are significantly lower ($P \leq 0.01$) in the Great Lakes Paper site than in any of the other areas. This is perhaps even more significant when related to the mean DBH (diameter at breast height) of the stands, as Great Lakes Paper has the highest mean DBH of any of the areas, indicating greater age which often results in high epiphytic cover. The bark pH of 4.2 of the Great Lakes Paper site was much lower than on the other sites, which had a mean bark pH of 6.4. The emissions from the nearby pulp mill are probably responsible for the singular character of this site when compared to the other four sites. The mean bark pH of 6.0 is, incidentally, comparable to that found by Skye (1968) for *Ulmus* sp. in the Stockholm region, and also for White Elm in Central Wisconsin (Newberry 1974).

When all sites are considered together as representative of the Thunder Bay region, the number of species of lichens compares favorably with the number noted by Mahoney (1973) on White Elm in northern Michigan, where 15 species were found in one area and 8 species in another for a total of 17.

Other publications that have included data on White Elm epiphytes are Hale (1952, 1955), Culberson (1955), Le Blanc and De Sloover (1970), and Newberry (1974). For various reasons (e.g., data for elm are combined with that of other species: whole trees were investigated: trees were of urban environments) comparison with all but Newberry (1974) are perhaps not very useful, except for the obvious conclusion that generally the more trees and the larger the area of the tree included, the greater the number of epiphyte species that will be encountered. Newberry's (1974) study, however, does give separate White Elm data and is related to sulphur dioxide emissions from a kraft paper mill. In Newberry's study a species list is not included but 18 species and three varieties of lichens are common on White Elm and eight more lichen species are classified as rare (six more fruticose lichens are present but the phorophyte is not specified). *Candelaria concolor, Parmelia sulcata, Physcia orbicularis,* s.l., and *Physconia grisea* are apparently common in Thunder Bay as well as in northern Michigan and central Wisconsin. *Physcia setosa,* the most common lichen in the Michigan study, is rare in Thunder Bay and was not noted on the elms studied. *Physcia elaeina*, a ubiquitous species in Wisconsin, has not been reported in the Thunder Bay region. *Parmelia rudecta* and *P. caperata* were present in both the American studies, but although present in Thunder Bay, were not recorded on the elms investigated. One of the most common epiphytes in the Thunder Bay area is *Hypogymnia physodes*. This species, however, was not noted on the White Elms of this study or by Mahoney (1973) in Michigan and was reported as rare in Wisconsin, indicating if not phorophyte specificity at least phorophyte preference.

Although the bryo-flora was not considered by Mahoney (1973) or Newberry (1974) some general comments are perhaps warranted. None of the three liverworts found are rare. But, while *Frullania eboracensis,* the most common epiphytic hepatic in this study, is also one of the most common in the Thunder Bay region the other two species are scarce. In the mosses, moreover, *Anomodon minor*, the most common moss on elm, is also scarce, and *Hypnum pallescens*, usually a very common epiphytic moss, was not recorded on any of the 50 elms studied.

Table 2, besides showing the species present, clearly indicates that liverworts and lichens are more common in the upper quadrats and that the mosses are more common in the lower quadrats.

The ordination (Figure 1) based on presence-absence data also shows the Great Lakes Paper site to be rather different from the other four sites. The Kakabeka Gorge site is set off as well, but not to the same extent and the ordination indicates relationships among the Pointe de Meuron, Slate River, and Blind Line Road sites. A second ordination using the reciprocal averaging technique (Hill 1973) gave essentially the same results except that the Kakabeka Gorge stand is quite separate from the other groups.

The cover relationships between groups are similar to the species numbers relationships, with bryophytes being greater in the lower quadrats and lichens greater in the upper quadrats. Cover relationships between sites, however, are quite different from species numbers relationships. In Figure 2 the sites are arranged according to increasing distance from Thunder Bay City. Coincidentally, this is in decreasing order of tree DBH which probably represents decreasing mean age of stands as well. Increasing distance from Thunder Bay results in increasing cover, attributable at least in part to decreasing aerial pollutants. The pattern is not as straightforward as this, however, as the very high bryophyte cover at Kakabeka Gorge must be related to the higher humidity levels resulting from spray from nearby Kakabeka Falls. In any event the Great Lakes Paper site has the lowest cover values and Blind Line Road, although it is apparently the youngest stand, has cover values equivalent to those of the larger-diameter trees at both Pointe de Meuron and Slate River.

In conclusion it can be stated that the epiphyte flora of White Elms near Thunder Bay is relatively comparable to the floras of elms in Michigan and Wisconsin. Also, if Dutch Elm Disease, which was first reported near Thunder Bay in 1976 (Anonymous 1976), should become severe in these isolated stands of elms in this northern part of the tree's range, some record is now available of the present epiphyte flora.

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