

A COMPARISON OF COVER AND DISTRIBUTION OF CORTICOLOUS MACRO-EPIPHYTES IN THREE WOODLOTS IN AND NORTH OF COLUMBUS, OHIO¹

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Abstract. Three woodlots, one urban, one suburban, and one rural, were studied for cover and frequency of corticolous lichens and bryophytes. Epiphyte cover was measured by fitting aluminum foil over the epiphyte, cutting and weighing the foil. Lichens less than 1 cm in diameter were assumed circular and the diameter measured. Cover and presence were noted only within a cylindrical quadrat 1.3 to 1.6 m high. Trees were chosen by the random pairs method (10 pairs/site). The epiphytes found were the lichens *Physcia millegrana*, *Physcia orbicularis*, *Parmelia rudecta*, *Parmelia caperata*, and *Lepraria* sp. and the moss *Leskea gracilescens*. Only one species was found at the urban site, *P. orbicularis*. *P. orbicularis*, *P. millegrana*, and *L. gracilescens* were found at the suburban site. All 6 species were found at the rural site. Percent cover and percent frequency increased from the urban, to suburban, to rural sites for all species except *P. millegrana*, which was greatest at the suburban site. The probable cause of these differences in cover and frequency of macro-epiphytes is the greater concentration of atmospheric pollution, probably sulfur dioxide, in and near the city.

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Epiphytic corticolous (bark-inhabiting) lichens and mosses are very sensitive to atmospheric pollution and are generally absent or reduced around pollution centers such as cities and factories. Laboratory and field studies have implicated sulfur dioxide (SO₂) as a major cause of this paucity of epiphytes, although other pollutants are probably involved as well (LeBlanc and Rao 1975). The impact of the urban environment on lichen communities has usually been studied by mapping the distribution of various species of corticolous epiphytes within the urban area. Cover and frequency of occurrence were used by Stephenson and Merriam (1975) to study the effect of urban pollution on lichen communities in woodlots in Ottawa, Canada. My study compares the cover, frequency, and presence of corticolous macro-epiphytes in three wooded lots to determine if Columbus, Ohio has a similar pattern of reduction of macro-epiphytes near its urban centers.

METHODS AND MATERIALS

Greater Columbus is located in central Ohio (latitude 40° 00' N, longitude 83° 01' W) and has a population estimated to be 920,900 (Columbus Chamber of Commerce 1976). Columbus' industries are generally small and are not concentrated in any one area. The prevailing winds are S-SW at 8-9 mph, and the average annual rainfall is 940.1 mm. The reported pollution levels in Columbus are relatively low, especially sulfur dioxide, mainly because there are few major sulfur dioxide-producing industries in the area.

One urban, one suburban, and one rural site was chosen for study solely on the basis of availability and location near (within 200 m) the east bank of the Olentangy River. The urban site, Tuttle Park, is located north of the Ohio State University campus and 5.8 km from the intersection of Broad and High Streets (the approximate geographical center of Columbus). The wooded area is moderately disturbed by human activity, however, there is no evidence of mechanical removal of epiphytes. This site is approximately 1.2 km north of the University power plant. From 1937 to 1970 the power plant burned an average of 350-400 tons of Ohio coal per day (G. Hess 1976), a substantial past source of SO₂ directly upwind from the site. The power plant did not have scrubbers to remove effluent SO₂ but in 1970 it converted to natural gas and oil as the primary energy source. The University power plant is located 4.7 km from the intersection of Broad and High Streets.

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The suburban site is located in Worthington, Ohio, a northern suburb of Columbus, 14.6 km from the intersection of Broad and High Streets. The wooded area is approximately 120 m south of State Route 161. The site is free of local point sources of pollution, being surrounded by residential areas but SR 161, north of the site, and SR 315, west of the site, may contribute some airborne pollutants from vehicular exhausts.

The rural site is located at the western end of Boy Scout Camp Lazarus, 14 km north of Worthington in Delaware Co., and 29.6 km from the intersection of Broad and High Streets. The study was done in an area of the camp that has been essentially undisturbed for at least 10 years.

Trees used in this study were chosen by the Random Pairs Method of Cottam and Curtis (1949; 1955). Ten pairs of deciduous trees (minimum diameter 10.5 cm at 1.3 m height) were studied at each site. Each site was composed almost entirely of deciduous trees, with a few coniferous trees noted at the rural site. All 3 sites were alike in that they were very wet and had comparable tree densities. Cover and presence of lichens and bryophytes were measured within a cylindrical quadrat 1.3 to 1.6 m high on the tree.

The cover of lichens was measured either by direct measurement or by fitting aluminum foil over the lichen or aggregation of contiguous lichen thalli. Direct measurement was used only for lichens less than 1 cm in diameter, in which cases the lichens were assumed to be circular and the diameters were measured. The aluminum foil method was to fit a piece of aluminum foil over the lichen or aggregation of lichens and cutting the foil to the shape of the lichen or aggregate. The foil was then weighed to determine the amount of cover. For aggregations, a correction was made for uncovered areas. All cover of bryophytes was measured by the aluminum foil method. Percent cover for each species of epiphyte at each site was calculated by summing the area of the species at each site, dividing this by the sum of the areas of the quadrats at the site, and multiplying by 100. Percent fre-

quency shows the percent of all study trees at a site on which the epiphyte was found within a quadrat.

RESULTS

A total of 5 lichen species, 4 foliose (*Physcia millegrana* Degel., *Physcia orbicularis* (Neck.) Potsch., *Parmelia rufecta* Ach., and *Parmelia caperata* (L.) Ach.) and one imperfect crustose (*Lepraria* sp.) were found. One species of bryophyte (*Leskea gracilescens* Hedw.) was observed. *Physcia orbicularis* was the only species found at all 3 sites, *Physcia millegrana* and *Leskea gracilescens* were found only at the suburban and rural sites, and *Parmelia caperata*, *Parmelia rufecta*, and *Lepraria* sp. were found only at the rural site. Voucher specimens are on file in the Herbarium of the Ohio State University.

There is a trend from lesser to greater percent cover, percent frequency, and number of species in the order urban, suburban, and rural. The urban site was essentially devoid of lichens and bryophytes. Only one tree had any cover, one lichen, and this was less than 0.01%. The suburban site had values intermediate between the urban and rural sites for percent cover and percent frequency of *Physcia orbicularis* and *Leskea gracilescens*. The percent cover and percent frequency of *Physcia millegrana* were highest at the suburban site. Values for percent cover and percent frequency of *Physcia orbicularis*, *Parmelia rufecta*, *Parmelia caperata*, *Lepraria* sp., and *Leskea gracilescens* were highest at the rural site (table 1).

TABLE 1

Percent cover and percent frequency for species of epiphytes at 3 sites.*

Epiphyte	Urban		Suburban		Rural	
	% cover	% frequency	% cover	% frequency	% cover	% frequency
<i>Physcia millegrana</i>	0.0	0	0.6	50	0.07	35
<i>Physcia orbicularis</i>	0.0004	5	1.1	25	1.5	35
<i>Parmelia rufecta</i>	0.0	0	0.0	0	0.9	25
<i>Parmelia caperata</i>	0.0	0	0.0	0	0.004	10
<i>Lepraria</i> sp.	0.0	0	0.0	0	0.01	20
<i>Leskea gracilescens</i>	0.0	0	0.5	20	3.7	45

*The 3 sites were wooded lots located in and north of Columbus, Ohio. The urban site was Tuttle Park in Columbus; the suburban site was located in Worthington, Ohio, a suburb of Columbus, and the rural site was Boy Scout Camp Lazarus, located in Delaware County, Ohio.

DISCUSSION

My findings indicate a trend of lesser to greater cover, frequency, and number of species of corticolous macro-epiphytes at a tree height of 1.3 to 1.6 m as the distance from the center of the city of Columbus increases. Other studies have shown the same results for other cities. LeBlanc and DeSloover (1970), in Montreal, and Stephenson and Merriam (1975), in Ottawa, showed that as the distance from the center of the city increased, there was a corresponding increase in the cover of corticolous lichens and mosses. Showman (1975) concluded that local lichen damage downwind was due to the release of pollutants by a coal-fired power generating plant in southeastern Ohio. He found *Parmelia caperata* to be very sensitive to the pollutant, whereas *Physcia millegrana* was more resistant than either *P. caperata* or *P. rudecta*. The order of appearance of the various species of lichens from the urban to rural sites in my study is very similar to both the order noted by Showman (1975) and a ranking of tolerance to sulfur dioxide by Nash (1973). Further, this indicates that the level of atmospheric pollution in Columbus is or was high enough to reduce significantly the cover and number of macro-epiphytes within the city.

A probable cause of the paucity of macro-epiphytes at the urban site is the past activity of the Ohio State University power plant. Although the plant converted to natural gas and oil in 1970, its effects are still noticeable because of the long period of time characteristic of lichen recolonization. Brodo (1972) states that full recovery and recolonization of a previously polluted area may take several years or even decades. Effects from other industries and motor vehicles within the city is a likely cause of the reduction of epiphytic cover and the absence of *Parmelia caperata* and *P. rudecta* at the

suburban site. This site lies near 2 major highways, both of which are sources of atmospheric sulfur dioxide and other pollutants due to combustion. These 2 sites (urban and suburban) show the effects of the city environment by the absence of the more sulfur dioxide sensitive lichens. The rural area shows little effect from the city.

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