THE VEGETATIVE COMPOSITION OF A BEECH-MAPLE CLIMAX FOREST IN THE GLACIATED PLATEAU OF NORTHEASTERN OHIO[1]

WILLIAM H. SCHLESINGER[2]
Department of Biological Sciences, University School, Shaker Heights, Ohio

ABSTRACT

Survey was made of a beech-maple forest by the quarter point method during August, 1968. The forest is located on a mesic, level upland of the glaciated Allegheny Plateau in eastern Cuyahoga County, Ohio, in the Chagrin River drainage basin. Geologically the upland is underlain by Mississippian formations capped by a thin cover of till, in which soils of the Ellsworth soil catena—the Rittman and Wadsworth silt loams—are developed.

The dominant plant species in this forest are American beech and sugar maple, which together comprise 68% of the trees recorded and have a total combined importance value of 62%. Red oak, red maple, and cucumbertree are important secondary dominants, but white ash and tuliptree are of little significance in the woodland composition. A greater overall abundance of secondary-associate mixed-mesophytic species than is normally found in such forests occurs. This composition supports the concept of a polyclimax beech-maple association and is suggested to be a result of past selective lumbering and a variation in topography and soils.

Although there is some evidence of past selective lumbering, the forest appears to be in an essentially undisturbed, virgin state. It has been partially destroyed as the forest is now part of a tract of land developed as a new secondary school campus.

INTRODUCTION

The survey presented here is part of a complete ecological survey of the proposed campus of the University School in Hunting Valley, Ohio, which was made in August, 1968. In addition to supplying data on another site of original Ohio vegetational composition to scientific literature, the survey was made to provide

[1]Manuscript received August 8, 1969.
[2]Present address: Dartmouth College, Hanover, New Hampshire 03755.

data on the pre-construction ecology of the entire tract that could be used for comparative studies in the future when the changes brought about by the operation of a school can be observed in the remaining undeveloped areas. This survey was made as an Extended Research Project of the 1968 Summer Science Project at University School (Schlesinger, 1968).

The twenty acres of forest surveyed are in the center of the 173-acre University School tract located east of Ohio 91 between Shaker and Fairmount Boulevards. This tract lies twelve miles east of Cleveland and four miles northeast of Chagrin Falls, in the village of Hunting Valley, and is approximately at 41° 29′ 15″ north latitude and 81° 25′ 30″ west longitude (fig. 1).

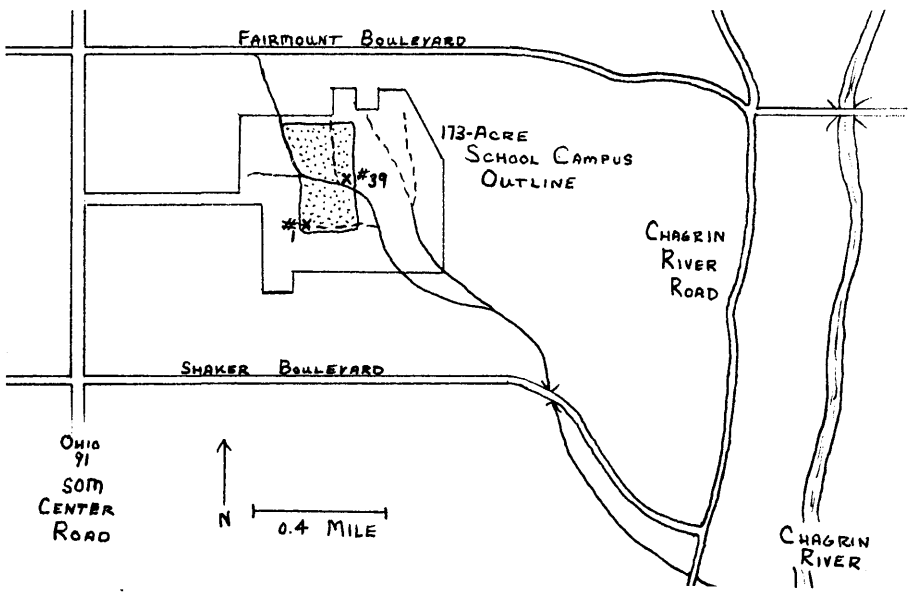

FIGURE 1. The location of the University School tract in Hunting Valley, Ohio. The forest studied is the shaded portion of the tract.

The forest studied lies on the generally level eastern highlands of Cuyahoga County, one and one half miles west of the Chagrin River. These highlands are part of the glaciated Allegheny Plateau and occur at elevations of from 1050 to 1090 feet. The creeks and streams of the forest, their ravines, and the Chagrin River and its 800-foot-elevation valley are all of postglacial origin.

The forest is cut approximately in half by one major, unnamed stream which drains the entire area and which flows southeast to join the Chagrin River at an elevation more than 250 feet below that of the upland. It has eroded a very steep-sided, 50–70-foot-deep, cool ravine-like valley. The forest is also crossed by several other smaller, intermittant streams, all of which drain into the main creek. None of these other streams has formed such a deep ravine or changed the topography so significantly. The survey was confined to the level, upland areas on each side of the main ravine. These areas have a slope of between two and six percent and are covered with beech-maple climax forest.

The area is underlain by Mississippian shales and sandstones which are buried by glacial till to an average depth of seven feet, except where exposed by erosion along the main ravine (Herron Testing Laboratories, 1968). Soils in the area of the forest are the Rittman and Wadsworth silt loams described by Duane Bosworth (personal communication, 1968) as light-colored, medium-textured soils in the Ellsworth soil catena formed from Wisconsin glacial till (Braun, 1950) on

gently sloping land. The area would best be described as ranging from mesic to wet-mesic in character. The soils are moderately well drained, but have heavy clay subsoils that form a "hardpan" at a depth of approximately 20 inches below the surface which interferes with normal root development of deep-rooted plants and restricts favorable movement of air and water at this level.

Climatic data for the area are not available. No weather station is present in the immediate vicinity, and, due to time limitations of the survey, no data could be collected during the study.

Historically the forest appears to have been originally preserved from clear cutting by the presence of the large, deep ravine which crosses it. Until recently, the area was held in a large private estate which also insured its safety. Some selective cutting appears to have been conducted in the past in a few areas.

The forest is now part of a tract of land being developed as the campus of a new independent secondary school. At the time of this survey, pre-construction clearing had already been begun in some areas of the full tract, including some disturbance in the forest studied. Prior to this clearing, forest with similar growth was continuous on the north, west, and south, while an open fallow field occurred on the east. Subsequent to this work, more of the forest surveyed was destroyed for construction. Inevitably there will also be drastic changes in the drainage and light penetration of remaining areas, as well as erosion in cleared areas.

PROCEDURES

The quarter point method of ecological survey of plant communities was employed in the study, as described by Cottam and Curtis (1956, 1962). Point number one was permanently placed at a site located 2200 feet west and 700 feet north of the southeastern corner point of the University School campus tract. Using compass and pacing, a 100-foot grid was laid out south of the main ravine, which consisted of 38 quarter points. Point 39 was then permanently marked at 1400 feet west and 1300 feet north of the school's southeastern property corner

TABLE 1

Quarter Point Data

Species	No. of Points	No. of Trees	Total Basal Area	Relative Frequency (RF)	Rel. Density (RD)	Rel. Dominance (RDo)	Importance Value (IV)
Fagus grandifolia American Beech	68	155	26,369	31.4%	41.3%	38.6%	111.3
Acer saccharum Sugar Maple	56	102	14,225	25.8	27.2	20.8	73.8
Quercus rubra Red Oak	20	22	10,067	9.2	5.9	14.7	29.8
Acer rubrum Red Maple	22	36	6,361	10.2	9.6	9.3	29.1
Magnolia acuminata Cucumbertree	13	16	3,709	6.0	4.3	5.4	15.7
Prunus serotina Wild Black Cherry	11	11	1,945	5.1	2.9	2.8	10.8
Carya ssp. Hickory	5	9	1,228	2.3	2.4	1.8	6.5
Quercus alba White Oak	6	6	1,390	2.8	1.6	2.0	6.4
Nyssa sylvatica Tupelo or Black Gum	5	5	1,242	2.3	1.3	1.8	5.4
Others combined*	11	14	1,901	5.2	3.9	2.6	11.7
Totals	217	376	68,437	100.3%	100.4%	99.8%	300.5

*Others in order of importance: *Betula lenta* (Black Birch), *Sassafras albidium* (Sassafras), *Ostrya virginiana* (Ironwood or Hophornbeam), *Liriodendron tulipifera* (Tuliptree), *Fraxinus americana* (White Ash), *Tilia americana* (Basswood), *Ulmus americana* (American Elm).

and served as the starting point for the 56 quarter points, numbered 39 to 94, in the similarly constructed grid north of the main ravine. Extending in all directions from these starting points, grid points were laid out wherever feasible as regularly and with as little bias as possible. Boundaries for the grid were established when additional grid extension would have entered areas already cleared for construction, or into plant communities of obviously different composition. A few points within the grid were also impossible to complete due to construction disturbances.

Data on the tree species were collected at the 94 completed quarter points, as described by Cottam and Curtis (1956, 1962). Using compass bisects, the space around each point was divided into quarters, within each of which the nearest tree over twelve inches in circumference was recorded by species, circumference, and distance from the quarter point. The data for the tree species were then tabulated as described in Curtis and Cottam (1962), and the standard measures of vegetation in forest surveys calculated, all materials of which are presented in Table 1. Data on other vegetation were collected by a qualitative vegetational survey using modified transects based upon the quarter-point grid. North-south transects connecting the quarter points were placed 100 feet from one another, and the species of vegetation growing within five feet of these lines were recorded (Table 2). All plants listed are those recognizable in August.

TABLE 2

Qualitative Vegetational Survey

Trees (not recorded at quarter points):
- Black Oak, *Quercus velutina*
- Sycamore, *Platanus occidentalis*
- Yellow Birch, *Betula lutea*

Shrubs:
- Barberry, *Beris* ssp.
- Choke Cherry, *Prunus virginiana*
- Early Sweet Blueberry, *Vaccinium vacillans*
- Flowering Dogwood, *Cornus florida*
- Low Sweet Blueberry, *Vaccinium augustifolium*
- Maple-leaf Viburnum, *Viburnum acerifolium*
- Witch Hazel, *Hamamelis virginiana*

Herbs and Wildflowers:
- Beech Drops, *Epifagus virginiana*
- Canada Mayflower, *Maianthemum canadense*
- Canada Violet, *Viola canadensis*
- Common Violet, *Viola papilionacea*
- False Solomon's Seal, *Smilacina racemosa*
- Indian Pipe, *Monotropa uniflora*
- Jack-in-the-Pulpit, *Arisaema triphyllum*
- Jewelweed, *Impatiens capensis*
- May Apple, *Podophyllum peltatum*
- Partridge Berry, *Mitchella repens*
- Solomon's Seal, *Polygonatum biflorum*
- Squaw Root, *Conopholis americana*
- Trillium, *Trillium grandiflorum*
- Twisted Stalk, *Streptopus amplexifolius*
- White Baneberry, *Actaea pachypoda*
- Wild Sarsaparilla, *Aralia nudicaulis*
- Wintergreen, *Gaultheria procumbens*
- Wood Sorrel, *Oxalis stricta*

Ferns:
- Christmas Fern, *Polystichum acrostichoides*
- Marginal Woodfern, *Dryopteris marginalis*
- New York Fern, *Thelypteris noveboracensis*
- Spinulose Woodfern, *Dryopteris spinulosa*

Vines:
- Green Brier, *Smilax rotundifolia*
- Northern Fox Grape, *Vitis labrusca*
- Virginia Creeper, *Psedera quinquefolia*

DISCUSSION

The dominant species of trees in the University School forest in Hunting Valley are American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) which have relative densities of 41.3% and 27.2%, respectively, and a total combined importance value of 61.7%. Red oak (*Quercus rubra*), red maple (*Acer rubrum*), and cucumbertree (*Magnolia acuminata*) are important secondary dominant species. Four other mixed-mesophytic species (*Prunus serotina*, *Carya* ssp., *Quercus alba*, and *Nyssa sylvatica*), classed as incidental dominants, are of significant abundance in the vegetative composition, while seven other species recorded are of little importance. The trunk of at least one dead chestnut (*Castanea dentata*) still stands in the forest, although there is a conspicuous absence of fallen chestnut logs on the ground. The central ravine is evidently not environmentally favorable for the growth of hemlock (*Tsuga canadensis*), which is found commonly in the deep, cool ravines in the eastern highlands of the county above the Chagrin River (Williams, 1949). However, yellow birch (*Betula lutea*), commonly found with hemlock in such associations, was observed in the forest, though not at a quarter point. The sides and bottom of the large ravine support a small growth of an upland swamp forest, but it was not sampled with the quarter-point study.

Northern fox grape (*Vitis labrusca*) is present in large tangles in the forest and, following the reasoning of Williams (1936), is classified as a secondary dominant species. Green brier (*Smilax rotundifolia*) is an extremely abundant vine. Maple-leaf viburnum (*Viburnum acerifolium*) is unquestionably the most widespread shrub. Canada mayflower (*Maianthemum canadense*), partridge berry (*Mitchella repens*), wintergreen (*Gaultheria procumbens*), and other herbaceous representatives of northern coniferous forests are all found commonly. False solomon's seal (*Smilacina racemosa*), white baneberry (*Actaea pachypoda*), and jewelweed (*Impatiens capensis*) are also important herbs. Among the parastic plants of the ground surface, squaw root (*Conopholis americana*) is far more common than are beech drops (*Epifagus virginiana*) or Indian pipe (*Monotropa uniflora*). Ferns are not abundant, but are observed commonly, the four species recorded all being characteristic of the beech-maple climax forest (Gordon, 1969).

The University School forest in Hunting Valley, Ohio, lies within the general boundaries of the American beech-sugar maple climax association as outlined by Braun (1950). The association is described by her as a very uniform, mesic forest growth occurring in Ohio on Wisconsin till plains and the glaciated Allegheny Plateau. It occurs between the hemlock-hardwoods association of southern Canada and the mixed mesophytic forests of the unglaciated Allegheny Plateau of southeastern Ohio. A more recent study by Gordon (1969) suggests that the beech-maple climax growth is more likely a polyclimax or forest continuum. Within the general uniform beech-maple climax region, environmental variations are responsibile for variations in composition from place to place. Gordon (1969) also suggests that natural and artificial selection in pioneer days, such as the selective lumbering of valuable hardwoods, may have led to the establishment of stable beech forests. These forests are characterized by high proportions of American beech, sugar maple, and mixed mesophytic species such as oak and ash. In northeastern Ohio, the beech-maple forest was originally the dominant growth (Gordon, 1966), and Williams (1949) concludes that it was once practically continuous throughout the eastern portions of Cuyahoga County.

Variations in the composition of the forest in Hunting Valley, Ohio, and in that of the forest studied by Williams (1936) a few miles to the north (at North Chagrin Reservation) perhaps support the polyclimax hypothesis of Gordon. North Chagrin Reservation is covered by a distinct beech-maple climax forest over a large portion of its level upland area. American beech makes up 52.6% and sugar maple 32.7% of the trees recorded (Williams, 1936). Although it is also part of the same beech-maple association, the University School forest is quite different in composition. American beech and sugar maple are dominant, though

not quite as strongly as at North Chagrin (Williams, 1936). The University School forest is also comprised collectively of a higher proportion and individually higher importance values for secondary-associate mixed-mesophytic species, such as red oak, red maple, and cucumbertree, than the North Chagrin Reservation forest. Williams (1936) lists red maple, tuliptree (*Liriodendron tulipifera*), and white ash (*Fraxinus americana*) as important secondary dominant species in his study. In contrast, although red maple is important in the forest at Hunting Valley, tuliptree and white ash are of insignificant importance in woodland composition. In their place, red oak and cucumbertree are the more important secondary-dominant species. Williams (1936) does state that lumbering occurred at North Chagrin in 1871, which removed many large red oaks. Hemlock, which was absent in the University School woods, was recorded by Williams (1936) as common along the edges of deep ravine in the North Chagrin woods. These differences are summarized in tabular form in Table 3.

TABLE 3

Comparative Composition of Vegetation at North Chagrin Reservation (Williams, 1936) and University School, Hunting Valley, Ohio

	North Chagrin Reservation	University School, Hunting Valley Tract
Primary Dominants:		
	American Beech	American Beech
	Sugar Maple	Sugar Maple
Secondary Dominants:		
	Red Maple	Red Oak
	Tuliptree	Red Maple
	White Ash	Cucumbertree
	Fox Grape	Fox Grape
Incidental Dominants:		
	Hickory	Wild Black Cherry
	Cucumbertree	Hickory
	Red Oak	White Oak
	White Oak	Tupelo

The differences in composition of the two forests are felt to be the result of differences in topography, soil, and past selective lumbering history. Thus the variation in composition of the generally uniform beech-maple climax association in two nearby forests supports Gordon's (1969) polyclimax hypothesis. While the 1871 lumbering of red oak at North Chagrin probably best explains that species' low importance value there, in comparison to its high importance at Hunting Valley, most of the differences in composition between the two forests can be explained better by differences in topography and soils. For example, selective cutting does not adequately explain the low importance values of the few large trees of tuliptree and white ash at Hunting Valley, as opposed to their high dominance at North Chagrin. This hypothesis is supported by the presence of only a few stumps in the Hunting Valley woods, and these occurring only in outlying areas of the quarter-point grid. The absence of stumps along the main ravine at Hunting Valley points to environmental variations rather than to lumbering as the explanation for the absence of hemlock in the University School woods; the greater slopes and depths of the North Chagrin ravines perhaps suggests that topography may be the determining factor in the distribution of this tree. The absence of poorly drained wet areas within the Hunting Valley forest probably accounts for the conspicuous absence of spicebush (*Lindera benzoin*) which Williams (1936) lists as the most important shrub at North Chagrin.

Selective cutting can explain some vegetational variations, such as the greater collective abundance of secondary-associate mixed-mesophytic species in the Hunting Valley forest. In areas in the outlying portions of the quarter-point grid (not along the main ravine through the center of the forest), there is evidence of some selective cutting, although the wood of the few stumps still visible was too decayed for identification or aging. It is from these outlying areas that many of the mixed mesophytic species were recorded, and perhaps this accounts for their collective and individual higher importance values, when the data for the entire forest are tabulated together.

In summary, the author feels that the polyclimax hypothesis of Gordon (1969) is supported by the variation in composition recorded in the two nearby tracts of beech-maple forest lying on the eastern highlands of Cuyahoga County. Variations in topography and soil, and in past selective lumbering history can explain variations in the composition of the two forests, both of which lie within the general area of beech-maple climax. Although it has been partially destroyed by construction, part of the University School forest in Hunting Valley should remain as a representative tract of original Ohio vegetation for future years.

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