Rush Woods, A Lowland Extension of the Beech-Maple Climax, Montgomery County, Indiana

Robert Petty and Daniel Harwood
Wabash College and East Union School

INTRODUCTION

Southwestern Montgomery County is characterized by a mildly rolling landscape derived from a complex of Wisconsin morainal deposits. Abberant drainage, typical of this portion of the Tipton Till Plain, produced a presettlement landscape dotted with wide depressional troughs, shallow swamps and wet prairie. Descriptions by the first white settlers (circa 1820) record "a land of the shakes and fever" where malaria came routinely with the rigors of frontier life. Farm land had to be "made" either by clearing the timbered high ground or draining the low land. In the last 50 years extensive drainage ditches and tiled fields have eliminated most of the natural swamps, however, numerous depressional areas still exist, where the surface soil is at or near field capacity much of the year. Rush Woods is a remnant of virgin timber occupying a depressional phase of Brookston silt loam. The stand has been preserved by the owners, Helen and Doyne Rush of Alamo, Indiana, out of a genuine interest in its natural history. The authors are grateful to them for permission to conduct the study.

Location and History of the Stand

Rush Woods is located in the southeast quarter of Section 27, T18N, R6W, Montgomery County, Indiana. The woods is bisected by a narrow abandoned road which was last used in 1907. Since that time the roadbed has passed through an extended early succession and only recently have maple (*Acer saccharum*), tulip poplar (*Liriodendron tulipifera*), and oak (*Quercus macrocarpa*) begun to invade this strip. In the low area at either side of the road, a large stand of elm (*Ulmus rubra* and *U. americana*) was dominant until 1952. At that time *Ceratocystis ulmi* became prevalent in the stand. Subsequent death of the large elm has opened the crown in the stand's interior (Plate I-2). A small section at the southern edge of the woods was selectively cut in 1902. This section is currently dominated by sugar maple and basswood, (*Tilia americana*). The remaining area has been relatively undisturbed except for the natural processes of death and windthrow.

Procedure

During the late summer and fall of 1961 four areas were delimited within the woods, their total area comprising 12 acres. The corners of each area were marked with steel fence posts to allow subsequent analysis. The total tally area involved all of the stand except a strip 20 yards in width at each edge of the woods and did not include the abandoned road. All stems 4 inches *dbh* and above were measured to the nearest 0.1 inch and recorded (Table 1). From these data, relative basal

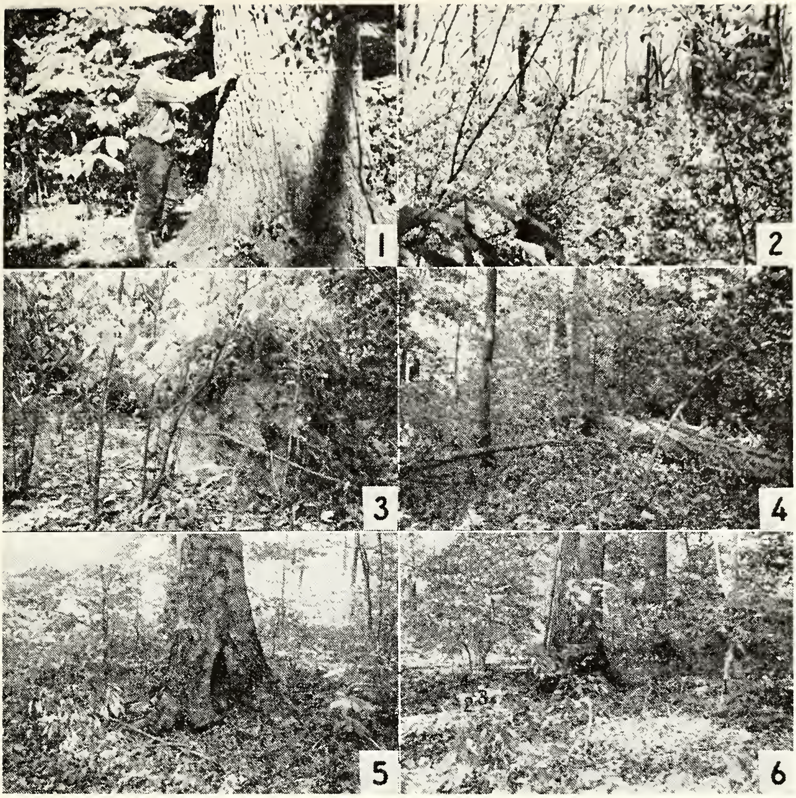

PLATE I (1) *Quercus macrocarpa* 47.2 inches *dbh*, located near the center of the woods.

(2) Extensive blight death of mature *Ulmus americana* and *Ulmus rubra* in the low interior of the stand, with vigorous regrowth of elm saplings and spicebush (*Lindera benzoin*). Man gives scale.

(3), (4) Two of the many windthrown stems which characterize aspect in the stand's interior.

(5) *Fagus grandifolia* at the limits of moisture tolerance, showing "alligator fissuring," butt-swell and basal decay typical of beech on poorly drained soils.

(6) *Fagus grandifolia* showing excessive root sprouting in poorly drained soil; these near the west edge of the woods.

area and relative density per acre were determined for each species (Table 2). Species nomenclature follows Gleason and Cronquist (1). Available moisture at the 6-inch soil level was measured with Bouyoucos plaster blocks and potentiometer on a weekly basis from August 2 to October 20. Soil texture analysis was made using the Bouyoucos hydrometer method.

TABLE 1. Size Class Midpoints (12-acre tally)
Rush Woods, Montgomery County, Indiana

	Diameter in Inches									
Species	6	10	14	18	22	26	30	34	above 36	total stems
Fagus grandifolia	47	2	10	27	32	45	14	2		179
Acer saccharum	367	64	17	2	1					451
Liriodendron tulipifera	5	13	17	21	3	3				62
Tilia americana	2	11	10	5	1					29
Ulmus rubra	7	11	9	4	1					32
Quercus rubra	2	4	8	5	1		1			21
Quercus macrocarpa		1	1						2	4
Prunus serotina	2	8	4	2						16
Fraxinus americana	5	4	2	1						12
Carpinus caroliniana	16									16
Ulmus americana	7		4							11
Fraxinus pennsylvanica	2	3	3							8
Juglans nigra	1	5		2						8
Gymnocladus dioica	2	2			1					5
Carya cordiformis		4	1							5
Carya ovata	2	1				1				4
Celtis occidentalis	3	2								5
Sassafras albidum	1	2								3
Quercus prinoides	3									3
Juglans cinerea				1						1
Carya glabra			1							1
Acer Negundo	1	1								2
Aesculus glabra	1									1
									total	879

TABLE 2. Stand Attributes

Species	B_2	B_3	D_2	D_3	V_3
Fagus grandifolia	33.47	50.41	19.47	20.39	35.40
Acer saccharum	10.98	16.55	49.02	51.38	33.97
Liriodendron tulipifera	7.49	11.28	6.74	7.06	9.17
Tilia americana	2.59	3.89	3.15	3.30	3.60
Ulmus rubra	2.32	3.49	3.48	3.64	3.57
Quercus rubra	2.19	3.20	2.28	2.39	2.80
Q. macrocarpa	2.02	3.03	.43	.45	1.74
Prunus serotina	.95	1.42	1.74	1.82	1.62
Fraxinus americana	.93	1.39	1.30	1.36	1.36
Carpinus caroliniana	.2	.30	1.74	1.82	1.06
Ulmus americana	.48	.73	1.19	1.25	.99
Fraxinus pennsylvanica	.93	.97	.87	.91	.94
Juglans nigra	.52	.77	.87	.91	.84
Gymnocladus dioica	.38	.57	.54	.56	.56
Carya cordiformis	.29	.43	.54	.56	.50
C. ovata	.36	.53	.43	.45	.49
Celtis occidentalis	.19	.28	.54	.56	.42
Sassafras albidum	.14	.20	.32	.33	.27
Quercus prinoides	.04	.05	.32	.33	.19
Juglans cinerea	.12	.17	.11	.11	.14
Carya glabra	.08	.11	.11	.11	.11
Acer Negundo	.07	.10	.08	.08	.09
Aesculus glabra	.01	.01	.11	.11	.06

Results

Twenty-three tree species were recorded in the 12-acre tract with 879 individuals above 4 inches *dbh* (Table 1). *Fagus grandifolia* contributed 33.47 sq. ft. per acre basal area; *Acer saccharum* and *Liriodendron tulipifera* were co-dominants with 10.9 and 7.4 respectively. Numerical expression of density and basal area for all species is presented in Table 2. Attribute symbols are those of Lindsey (3): D_2, density per acre; D_3, relative density; B_2, basal area per acre; B_3 relative basal area; Y_3, importance value, here the average of the D_3 and B_3 figures. While beech contributed the majority of larger stems, the largest diameter recorded was of bur oak (*Quercus macrocarpa*), 47.2 inches *dbh*. Another individual of the same species measured 46.7 (Plate I-1).

Characterization of the soil moisture pattern in late summer may be served by comparing data from Rush Woods with concurrent readings taken in a mesic forest in Parke County (8). Both areas received the same total precipitation.

	Percent Available Moisture (Weekly Interval)								
	Aug. 2							Oct. 20	
Mesic Upland (Allee Woods)	70	73	40	50	32	21	24	57	60
Mesic Lowland (Rush Woods)	90	92	85	89	78	38	37	78	80

Texture analysis of soil samples taken throughout the tract averaged 45% clay, 13% silt and 42% sand. The pH at the 6-inch level ranged from 4.6 to 5.6.

Discussion

In an extensive study of floodplain phytosociology, Lindsey, et al (5). list 15 tree species of major importance in mature bottomland forests. Their list includes 13 of the 23 species tallied in the Rush Woods given here in order of increasing flood-susceptibility: *Fraxinus pennsylvanica, Ulmus rubra, U. americana, Juglans* sp., *Acer Negundo, Quercus macrocarpa, Gymnocladus dioica, Celtis occidentalis, Tilia americana, Aesculus glabra, Carya cordiformis* and *Quercus rubra.* In his analysis of a virgin floodplain and upland forest in Wabash County, Illinois, Lindsey (4) reports *Quercus macrocarpa* and *Ulmus rubra* exclusive to the bottomland where they were 5th and 15th respectively in importance value. These two species dominate the interior of the Rush Woods. Although the stand is clearly dominated by *Fagus grandifolia* and *Acer saccharum,* the prevalence of the above species indicates a lowland phase of the *Fagus-Acer* climax. It is hazardous to assume that the Rush stand authentically reflects the species aggregation which occupied depressional areas in the presettlement forest; it well may, however, small isolated stands are subject to many influences outside the edaphic factor considered here.

It has been noted by many workers in Indiana (5, 6, 9, 10) that beech is decidedly more tolerant of poorly drained soils than is sugar maple. The tolerance spectrum for maple on the other hand extends beyond beech into xeric but well aerated soils (11). This can be seen in wide spread oak to maple transition stands in Indiana in which beech is not represented. The condition of aeration markedly alters *Fagus-Acer, Acer-Quercus* composition on soils within the same narrow climatic regime. However, recognition of drainage and aeration classes does not provide an explanation of how this edaphic factor is discriminatory to species involved. Oxygen-deficit is an obvious factor and may be the over-riding one. Kramer and Kozlowski (2) point out that very wet soils hinder the biological activity necessary for the decay release of nitrogen and other elements. In this connection, we observed densely developed ectotrophic mycorrhizas on beech roots in the Rush Woods. These were clearly more profuse than those of beech growing on better drained soils of the surrounding area. The ecological significance of the mycorrhizal relationship to species competition and forest composition is still poorly understood, i.e. whether they confer a nutrient advantage during competitive stages, or are more accurately seen as simply opportunizing on the photosynthetic excess of the chlorophyllous plant. Certainly, too little is known of the mechanisms and the extent to which various soil biota-root complexes arbitrate the availability of nutrients, moisture, etc. thereby modifying the general edaphic parameters used by community ecologists. There is little doubt, however, that beech enters into these interactions at suboptimum O_2 levels more successfully than either maple or tulip poplar.

There is a high prevalence of windthrown beech in the Rush Woods which results principally from decay of the shallow root systems (Plate

I-3, 4, 5). This may support the thesis of nitrogen tie-up. Nitrogen deficiency results in a species inability to adequately metabolize carbohydrates (2) which then accumulate in root tissues. These carbohydrate excesses may provide substrate for pathogens in addition to mycorrhizas and could allow normal symbionts to elaborate their metabolism to a pathogenic degree. There is apparently a concurrent decrease in the tree's vigor and disease resistance. The phytosociological result in the Rush Woods is an aspect of widespread disturbance with various stages of gap-replacement and the absence of the older and larger trees one normally expects in a virgin stand. In this way, windthrow frequently reduces the D_2 and D_3 figures for beech on these poorly drained, poorly aerated soils. There is a complementary increase in these parameters for sugar maple. Figure 1 contrasts the response of density, basal

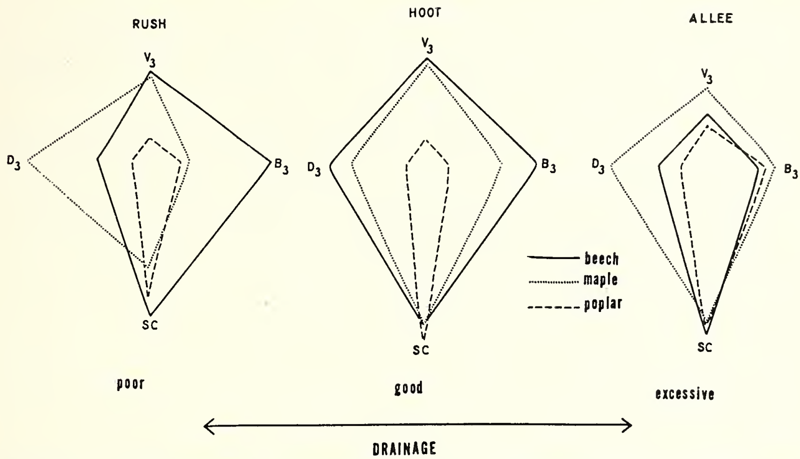

Figure 1. A comparison of the response to soil drainage of the relative stand attributes of dominant species in three virgin upland forests; Rush Woods, Montgomery Co., Hoot Woods, Owen Co., Allee Woods, Parke Co., Indiana. Attribute abbreviations: D_3, relative density; B_3, relative basal area; V_3, importance value; SC, maximum size class.

area, maximum sizeclass and importance values for beech, maple and tulip poplar in 3 Indiana stands of diverse drainage (7) (8).

In terms of future succession, it is interesting to speculate what species will replace *Ulmus rubra* and *U. americana* in the Rush Woods and elsewhere. It is apparent that there will be an extended period of crown disturbance in as much as vigorous elm saplings dominate the secondary growth under the dead elm (Plate I-2). Until the regrowth cycle (to disease susceptibility) of these young trees is diminished, their dense foliage and that of associated spicebush (*Lindera benzoin*) will eliminate intolerant species from the sere. This question of a replacement species for elm in wet phases of mesic forest will make the Rush Woods a particularly interesting stand to observe in subsequent years.

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