Analysis of Two Old-growth Forests on Poorly-drained Clermont Soils in Jennings County, Indiana

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Abstract

The canopy tree, shrub and herb strata in Tribbetts and Commiskey Woods in Jennings County, Indiana, were sampled by taking nested 1/40, 1/400 and 1/4,000-hectare rectangular plots, respectively. Both stands have high basal areas (33.6 and 38.2 square meters per hectare) and relatively low stand densities (184 and 242 trees per hectare, respectively). Dominant canopy tree species are *Fagus grandifolia* Ehrh., followed by *Liquidambar styraciflua* L. and *Acer rubrum* L., which collectively comprise 76 and 69 per cent, respectively, of stand importance. Both stands are very similar in composition to presettlement forests on Clermont soils, and to contemporary old-growth stands on similar sites.

Smilax rotundifolia L., *Asimina triloba* (L.) Dunal and *Lindera benzoin* (L.) Blume dominate the shrub layer of both stands. *Rhus radicans* L., plus the above three shrub species and *Nyssa sylvatica* Marsh. seedlings dominate the herbaceous stratum. The shrub layer contains 23 and 26 species totally, and the herb layer 39 and 50 species in Tribbetts and Commiskey Woods, respectively.

Introduction

Interest in locating and describing additional natural areas in Indiana remains at a high level. As a result of this continuing search, some 30 new areas have been reported since *Natural Areas in Indiana and their Preservation* was published in 1969 (6). The two stands reported herein were encountered during our visits to Indiana natural areas.

Our aims are to provide detailed descriptions of these fine old-growth forest remnants, to compare our findings to presettlement forest composition, and to earlier studies of contemporary "flatwoods" stands, particularly those occupying poorly-drained Clermont silt loam soils.

Few forested regions in the Indiana area have received greater attention from ecologists than the Illinoian tillplains. Braun (1), Chapman (2) and McCoy (8) studied major portions of that region. Earlier investigations of individual stands in the area include Officers South Woods (Jefferson County) and Conboy Woods (Jennings County) by Schmelz and Lindsey (12), Biehle and Guthrie Woods (Jennings County) by Secor (13), Klein Woods (Jennings County) by Keller (5) and succession patterns within several Ripley County stands by Potzger and Liming (10). Versailles State Park forests were examined in detail by Potzger (9), Potzger and Potzger (11), Stearns (14) and Jackson and Allen (4).

Description of Study Sites

Tribbetts Woods is located approximately 5 miles northwest of the Village of Commiskey, Marion Township, Jennings County, Indiana. The old-growth section contains about 13.4 hectares (33 acres) in the SW ¼, NE ¼, Sec. 15, Twp. 5 N, Range 7 E. The present owner, Mr. Clifford Tribbetts, stated that his family has owned the farm since 1887, and that only dying trees (primarily species other than American beech) have been harvested during that period. The entire woods is on poorly-drained, Clermont silt loam soil, since the mean sea level elevation of 610 feet does not vary more than 1 or 2 feet.

Commiskey Woods adjoins the southwest side of Commiskey in Montgomery Township. The mature portion contains 6 hectares (15 acres) in the western part of the NW ¼, SW ¼, Sec. 21 and the adjacent NE ¼, SE ¼, Sec. 20, Twp. 5 N, Range 8 E. Roger L. and Charles M. Wells are the current owners of the tract, which has been in continuous ownership by their family for about 80 years. According to the owners, the tract has never been grazed, with past cutting limited to the removal of dying or defective trees. The soil is mostly Clermont silt loam, grading to slightly better-drained Avonburg silt loam near the western stand border. Elevations vary from about 688 to 692 feet above mean sea level.

Both stands are located on Illinoian age glacial till typical of the Muscatatuck Regional Slope Physiographic Province. Canopies are high and full as is characteristic of remnants of old-growth flatwoods of that part of Indiana.

Methods

Both stands were sampled by taking line strips located systematically throughout the better old-growth sections. Nested rectangular plots were taken as follows: 1) tree stratum—10 m x 25 m (1/40 ha); 2) shrub stratum—2.5 m x 10 m (1/400 ha); and 3) herbaceous stratum—1 m x 2.5 m (1/4,000 ha). Forty plots were sampled for trees in Commiskey Woods; 64 tree samples were taken in the larger Tribbetts Woods. Twenty samples were taken in the shrub and herb layer in each stand.

Trees greater than 10 cm (4 inches) dbh were measured with diameter tapes. Densities of trees >3 m tall <10 cm diameter were recorded per plot by species. Densities of aboveground stems and percentage cover estimates were determined for species in the shrub and herb strata. All woody individuals $>$ ½ m $<$ 3 m tall were considered as shrubs; all woody and herbaceous individuals $<$ ½ m tall were tallied in the herb layer. Presence of species which fell outside the sampled areas was recorded by stratum.

Crown height and length of clear bole were measured with an Abney level for several trees in each stand. Soil pH was determined by a Beckman pH meter.

Importance values for tree species are averages of the relative values of density, frequency and basal area. Relative cover values were substituted for basal area when computing importance values for shrub and herb species.

Stand Descriptions

American beech heavily dominated the tree stratum at 44 and 54% importance values in Commiskey and Tribbetts Woods, respectively (Table 1). Red maple and sweet gum replace sugar maple, the usual co-dominant with beech on glaciated topography, on these acid, poorly-drained planosol soils. pH values of three topsoil samples in each stand averaged only 5.0 and 5.2 in Tribbetts and Commiskey Woods, respectively.

Both stands are remarkable for their low densities (242 and 184 trees per hectare), high basal areas (38.2 and 33.6 m^2/ha) and large average tree size (41.4 and 43.9 cm diameter) (Table 1). These basal area values place Commiskey and Tribbetts Woods at the No. 3 and 5 positions among all surveyed Indiana stands. Only Wesselman Woods (Vanderburgh County) at 43.0 and Davis Forestry Farm (Randolph County) at 39.8 m^2/ha exceed the basal area in Commiskey Woods.

Density-basal area relationships for the 10 most important species are shown in Figure 1. Oak and hickory species are represented by few large individuals, particularly in Tribbetts Woods. Beech, both gums and red maple have higher densities of smaller trees.

Size-class relationships are depicted in Figure 2. Under-representation within the 8-inch size class plus numerous large stems distributed throughout both stands contribute to the large mean stem diameters. Our 2.6-hectare (6.4-acre) sample included 41 stems in the 75-cm (30-inch) or greater size classes for an average of 15.8 large trees per hectare. Large trees measured for key species (not all within sample plots) are: beech 94 cm (36.9 inches), sweet gum 78 (30.6), red maple 102 (40.2), white oak 133 (52.2), black gum 72 (28.4), tulip tree 90 (35.6), swamp chestnut oak 146 (57.6), red oak 96 (37.9), swamp white oak 91 (35.8), Shumard's red oak 98 (38.4), pignut hickory 76 (30.1), shagbark hickory 65 (25.5), big shellbark hickory 78 (30.9), red hickory (*C. ovalis*) 50 (19.7), green ash 80 (31.3), and pin oak 90 (35.5).

Both stands have very high canopies and long, clear boles, even on relatively small diameter stems. Height data for eight trees taken at random in both stands follow:

Species	Diameter in inches	Total Height in feet	Clear Length in Feet
Qmi (T)	34.2	152	80
Lt (C)	33.6	147	70
Qa (C)	45.0	141	52
Ls (C)	15.0	132	72
Or (C)	38.1	130	54
Qa (C)	27.1	126	72
Cov (T)	26.4	122	77
Lt (T)	23.8	117	62
Mean	30.4 (77.2 cm)	133.4 (40.7 m)	67.4 (20.5 m)

Species richness is not high in either stand (15 and 19 species). Swamp chestnut oak (*Quercus michauxii*) is the most unusual tree present.

The shrub stratum contains 26 and 23 species in Commiskey and Tribbetts Woods, respectively (Table 2). Seventeen species are common to both stands. *Smilax rotundifolia*, *Asimina triloba* and *Lindera benzoin* dominate both stands at combined importance values of 52 and 49% (Table 2). Beech reproduction at 13% and wahoo (*Euonymus atropurpureus*) at 9% importance in Tribbetts Woods represent the major shifts in dominance. Six additional species, *Juniperus virginiana* L., *Clastrus scandens* L., *Sambucus canadensis* L., *Viburnum dentatum* L., *Viburnum acerfolium* L. and *Rubus idaeus* L. occurred in Commiskey Woods, but did not fall in the sample plots. All observed shrub species were tallied in Tribbetts Woods.

The exotic Japanese honeysuckle, *Lonicera japonica*, is common along the south and east margins of Commiskey Woods. Roundleaf greenbrier is so dense in both stands that it hampers field work. Total shrub densities are quite similar in both stands (Table 2).

The herbaceous stratum contained 50 and 39 species in Commiskey and Tribbetts Woods, respectively, 35 and 26 of which fell within our sample plots in late August (Table 3). *Rhus radicans* predominates numerically in both stands, totaling 56 and 39% relative densities. *Euonymus atropurpureus* replaces roundleaf greenbrier as the second dominant in Tribbetts Woods. Total densities were remarkably similar (Table 3). No rare or endangered species were observed in either stand. Additional species not recorded in sample plots appear in Appendix 1.

Coefficients of community between the two stands were 57.5, 59.7 and 75.3% for the herb, shrub and tree strata, respectively. Such high similarity values are expected for two stands occupying the same soil type, and which were part of a single presettlement plant community, before widespread clearing isolated these remnants.

Discussion

Despite the numerous investigations of the forest communities on Illinoian Tillplain soils, our understanding of the vegetation patterns of that region is still incomplete. Of particular interest is the presence of American beech and white oak as principal canopy trees on very poorly-drained Clermont soils. These are most characteristically mesic and dry mesic to xeric species, respectively, rather than members of lowland-depressional forest communities. Also of interest is the replacement of sugar maple as a co-dominant by red maple, sweet gum and black gum.

Crankshaw's (3) analysis of presettlement forest composition on Clermont soils revealed 59% importance value for beech and 9% for white oak (Table 4). Overall, 21 species contributed 122 stems and 181 square feet of basal area per acre. Commiskey and Tribbetts Woods had similarity coefficients of 75 and 80% when compared with the presettlement "stand" on Clermont soil (Table 4). Such close correspondence reflects the homogeneity typical of uniform site conditions (such as level planosol soils) and the lack of modification of Commiskey and Tribbetts Woods from presettlement composition.

TABLE 1. *Comparison of species attributes for the major tree species in Commiskey and Tribbetts Woods, Jennings County, Indiana. Importance values are averages of the relative values of density, basal area and frequency. Species symbols used elsewhere in the text are in parentheses following latin names for trees.*

Species	Density/ha		Basal Area in m^2/ha		Importance Value		X Diameter in cm.	
	C	T	C	T	C	T	C	T
							in cm.	
Fagus grandifolia Ehrh. (Fg)	135	109	16.8	20.7	44	54	38.1	47.0
Liquidambar styraciflua L. (Ls)	31	16	5.1	3.3	14	9.1	45.5	50.5
Acer rubrum L. (Ar)	20	24	4.6	2.9	11	13	51.6	33.5
Quercus alba L. (Qa)	17	.63	6.2	.57	11	.89	63.8	108.7
Nyssa sylvatica Marsh. (Ns)	14	5.0	1.2	.94	6.0	3.6	30.0	45.0
Liriodendron tulipifera L. (Lt)	9	3.8	1.7	.19	5.2	2.2	39.9	22.6
Quercus michauxii Nutt. (Qmi)	5	3.1	.60	2.4	2.1	4.1	33.0	95.0
Quercus rubra L. (Qr)	2	—	.74	—	1.5	—	56.1	—
Quercus bicolor Willd. (Qbi)	1	—	.64	—	.98	—	90.9	—
Ulmus americana L. (Ua)	2	5.0	.06	.24	.90	2.7	20.3	20.6
Acer saccharum Marsh. (As)	2	—	.02	—	.86	—	11.2	—
Quercus shumardii Buckl. (Qsh)	1	—	.37	—	.73	—	69.6	—
Carya glabra (Mill.) Sweet (Cg)	1	1.9	.07	.52	.47	1.5	30.7	58.9
Carya ovata (Mill.) K. Koch (Cov)	1	2.5	.05	.38	.47	1.7	26.2	41.1
Carpinus caroliniana Walt. (Cpc)	1	6.3	.01	.09	.47	3.0	10.7	13.5
Other species[1]	—	6.3	—	1.4	—	4.6	—	42.2
Total	242	184	38.2	33.6			X = 41.4	43.9
Per Acre Values	(98)	(74)	(166)	(146)			(16.3)	(17.3)

[1] Other species are: Carya laciniosa (Michx. f.) Loud. (Cl), Ulmus thomasii Sarg. (Ut), Fraxinus pennsylvanica Marsh. (Fp), Quercus palustris Muenchh. (Qp), Prunus serotina Ehrh. (Ps), Sassafras albidum (Nutt.) Nees (Sa), and Ulumus rubra Muhl. (Ur), in order of decreasing importance value.

TABLE 2. *Comparison of species attributes for the major shrub species in Commiskey and Tribbetts Woods, Jennings County, Indiana. Importance values are averages of relative densities and relative frequencies.*

Species	Density/0.1 ha		Importance Value	
	C	T	C	T
Simlax rotundifolia L.	1,224	318	39	15
Asimina triloba (L.) Dunal	292	354	13	18
Lindera benzoin (L.) Blume	178	346	10	16
Nyssa sylvatica Marsh.	34	24	4.5	3.1
Liquidambar styraciflua L.	38	44	4.2	6.0
Cornus florida L.	30	2	4.0	.45
Rhus radicans L.	64	2	3.2	.45
Fagus grandifolia Ehrh.	14	216	2.8	13
Liriodendron tulipifera L.	14	—	2.4	—
Acer rubrum L.	12	22	2.3	3.4
Lonicera japonica Thunb.	22	—	2.2	—
Fraxinus pennsylvanica Marsh.	10	30	1.9	3.7
Prunus serotina Ehrh.	10	10	1.9	1.9
Quercus michauxii Nutt.	6	4	1.4	.90
Sassafras albidum (Nutt.) Nees	6	6	1.4	1.0
Carpinus caroliniana Walt.	14	6	1.2	1.3
Carya ovata (Mill.) K. Koch	4	10	.90	1.9
Euonymus atropurpureus Jacq.	—	164	—	9.0
Ulmus americana L.	—	8	—	1.4
Fraxinus americana L.	—	10	—	1.1
Other species[1]	28	20	4.7	2.6
Total	2,000	1,596		

[1] Other species are: 1) Commiskey—Quercus rubra L., Ribes cynosbati L., Rubus allegheniensis Porter, Aralia spinosa L., Morus rubra L., Quercus shumardii Buckl., Quercus alba L., Crataegus L. sp., and Ulmus rubra Muhl.; 2) Tribbetts—Rubus allegheniensis Porter, Sambucus canadensis L., Morus rubra L., Ulmus thomasii Sarg., and Vitis L. sp.

Braun (1) listed the most important species on Clermont soil in the original forest of Ohio as beech, white oak, pin oak, red maple, American elm, hickory and sweet gum, in that order. The only major departure from Braun's sequence of species is the near-absence of pin oak in our data and those of Crankshaw. Successional studies (1, 10, 11 and 14) suggest that pin oak is replaced by more mesophytic species as successional maturity is neared, possibly accounting for its near absence from the stands reported here.

Sweet gum was a subdominant species in presettlement flatwoods stands (Table 4), and consistently fills that role in old-growth remnants, except Officers South Woods where it was not recorded (6). Black gum apparently had much lower importance than sweet gum in presettlement forests on Clermont soil and substantially lower than the 3.6 and 6% values recorded in these stands (Table 1).

Red maple contributes about twice the 5.5% importance it had in presettlement forests on Clermont soil (Table 4). Several earlier studies (1, 2, 5, 6, 8, 9, and 13) listed red maple as the third or fourth most important species at importance values ranging from 5 to 8%, but listed sugar maple as an important component of flatwoods communities.

TABLE 3. *Comparison and species attributes for the major herb species in Commiskey and Tribbetts Woods, Jennings County, Indiana. Importance values are averages of relative densities and relative frequencies.*

Species	Dnsity/.0.1 ha		Importance Value	
	C	T	C	T
Rhus radicans L.	6,960	4,960	32	23
Smilax rotundifolia L.	1,480	540	13	6.3
Nyssa sylvatica Marsh.	780	320	8.3	4.2
Lindera benzoin (L.) Blume	500	460	5.3	5.1
Asimina triloba (L.) Dunal	360	660	4.7	6.3
Acer rubrum L.	160	180	3.0	2.8
Cornus florida L.	120	—	2.3	—
Epifagus virginiana (L.) Bart.	220	840	2.3	6.2
Quercus rubra L.	140	—	2.0	—
Smilax glauca Walt.	120	—	1.9	—
Impatiens biflora Walt.	120	600	1.9	4.0
Liquidambar styraciflua L.	100	180	1.8	3.6
Liriodendron tulipifera L.	60	—	1.6	—
Lonicera japonica Thunb.	220	—	1.4	—
Mitchella repens L.	180	—	1.2	—
Prunus serotina Ehrh.	40	20	1.1	.50
Geum canadense Rydb.	40	260	1.1	1.8
Fagus grandifolia Ehrh.	40	300	1.1	4.1
Parthenocissus quinquefolia (L.) Planch.	20	280	.54	3.6
Carya ovata (Mill.) K. Koch	20	80	.54	2.0
Sanicula canadensis L.	20	80	.54	2.0
Euonymus atropurpureus Jacq.	—	2,340	—	13
Galium triflorum Michx.	—	600	—	4.0
Pilea pumila (L.) Gray	—	200	—	2.4
Other species[1]	640	280	9.9	5.7
Total	12,340	13,180		

[1] Other species are: 1) Commiskey—Carex L. sp., Rubus allegheniensis Porter, Ribes cynosbati L., Acer saccharum Marsh., (Carpinus caroliniana Watt., Euonymus obovata Nutt., Botrychium virginianum (L.) Sw., Grass sp., Quercus shumardii Buckl., Sassafras albidum (Nutt.) Nees, Quercus michauxii Nutt., Polygonatum pubescens (Willd.) Pursh, Quercus alba L., and Juniperus viriginiana L.; 2) Tribbetts—Phryma leptostachya L., Quercus michauxii Nutt., Smilax hispida Muhl., Sassafras albidum (Nutt.) Nees, Ulmus americana L., Senecio aureus L., Rubus allegheniensis Porter and Polygonum virginianum L.

Mesic species typical of "better sites", such as tulip tree, white ash, black walnut, and sugar maple, consistently are weakly represented on planosol soils. Braun (1) felt that low levels of organic matter (hence nitrogen) limited establishment of mesophytic seedlings. Chapman (2) attributed waterlogging of soils until late May with reducing both seed germination and seedling survival of all but swamp forest species. He felt that as the soils dry out in late summer, soil moisture is removed rapidly by the canopy trees and water levels drop faster than seedling roots elongate, thereby greatly increasing seedling mortality. Most mesic seedlings that do survive become established on better-aerated low mounds created by uprooted trees and other microrelief features.

Careful examnation of both Tribbetts and Commiskey Woods and other old-growth stands of the region reveals a patchwork pattern with

TABLE 4. *Comparison of importance value percentages of 12 key species in presettlement "stands" (after Crankshaw (3)) and for the stands reported herein. Soil types are well-drained, moderately well-drained and poorly drained, respectively, from left.*

Species or Species Group	Presettlement Forest Composition by Soil Type			Contemporary Stands	
	Cincinnati	Avonburg	Clermont	Commiskey	Tribbetts
Fagus grandifolia	44.7	55.5	58.7	44	54
Quercus alba	15.3	10.3	9.4	11	.89
Liquidambar styraciflua	3.0	3.9	6.3	14	9.1
Acer rubrum	<1	2.2	5.5	11	13
Carya spp.	4.5	5.3	5.1	.94	4.0
Quercus spp.	<1	1.8	5.0	3.0[1]	4.1[1]
Liriodendron tulipifera	8.0	8.7	3.6	5.2	2.2
Ulmus americana	<1	1.3	1.3	.90	2.7
Acer succharum	10.4	2.4	<1	.86	—
Quercus rubra	1.1	1.2	<1	2.2	—
Quercus velutina	3.3	1.7	<1	—	—
Fraxinus spp.	2.5	2.8	<1	—	.72
Basal Area/Acre	153.3	159.6	180.5	166.1	146.1
Density/Acre	91.7	108.3	122.3	105.2	80.0
Mean Diameter	15.5	14.6	14.6	16.3	17.3
Number of Species	38	23	21	15	18
Sample Size (# Trees)	2,805	713	782	242	294

[1] Quercus consists of Quercus michauxii and Q. bicolor.

swamp species, such as red maple, sweet gum, swamp white and swamp chestnut oaks, American elm and wet-site hickories in the lower depressions which are always ponded in the spring and into midsummer during wet seasons. Beech, tulip tree, white and red oak, ash and sugar maple occupy the slightly better-drained sections. Such a pattern occurs even in Tribbetts Woods where the 1 to 2-foot elevation change is scarcely discernible to the eye, but which seems critical to success of mesic seedlings.

As drainage improves, mesic species increase in importance. Presettlement forest data (3) for soil types in the same catena (Table 4) reveal substantial increases in sugar maple, white ash, tulip tree, black oak and ash, with corresponding declines in swamp species such as sweet gum, red maple, swamp white and swamp chestnut oaks and American elm. Since General Land Office surveyors lumped both wet and dry site species of hickory into a single category, little change in importance was detected or expected (Table 4).

The decline in importance of beech with drainage improvement is also noteworthy (Table 4). Studies of contemporary old-growth stands on well-drained Cincinnati soils in Ripley County by Jackson and Allen (4) listed sugar maple as co-dominant with beech at importance values of 25 and 39% for the two stands examined. On Clermont soils, beech becomes the overwhelming dominant (59%, Table 4) by being the most shade tolerant species in the stand. Tolerance of wet, acid soils, which restrict sugar maple success, and a reproductive strategy which involves both seedling establishment on low mounds and vigorous root sprouting enhances the survival of beech. The sensitive control of sugar maple by drainage was noted in Commiskey Woods where the only two sugar maples (4.1 and 4.7 inches dbh) were tallied near the western edge of the stand where Clermont soil grades into Avonburg. No sugar maples were recorded in flatter Tribbetts Woods (Table 1).

Both total basal areas and densities of presettlement forest decline with improved soil drainage, thereby keeping the mean tree diameter nearly constant (Table 4). Both stands reported herein had lower basal areas and densities than presettlement stands on Clermont soils, but the mean tree diameters are considerably larger. Species diversity increases rapidly in presettlement forests as drainage improves (Table 4), reflecting the increased availability of niches on heterogeneous topography.

Both Commiskey and Tribbets Woods have reduced density of trees, particularly beech and both gums, in the 8 and 16-inch size classes (Figure 2). This situation contrasts with the usual survivorship curves for old-growth forests, which typically approach a downtrending straight line relationship on a log density plot. Although stand history indicates otherwise, such density-size class profiles suggest extensive grazing by cattle and possibly hogs for several years, then release from grazing perhaps 20 years ago. Grazing of even high quality woodlots is a common practice in that region. We doubt that these stands escaped grazing completely. Such disturbance would account for the paucity of small trees, which were in the sizes to be eaten or broken down when grazing occurred. The abundant 2-4-inch trees have grown up since grazing was discontinued. Over-representation of mid-sized trees repre-

sents release, faster growth and survival of those trees (which were above the animals when grazing occurred) in the absence of competition from smaller individuals. Reductions in the 34 and 38-inch size classes probably resulted from selective cutting. However, the presence of very large trees of several species (Figure 2), (with particularly large specimens of high quality oaks and tulip trees) indicate that cutting has been slight, as the owners suggest. Several very large white oaks escaped our samples in Tribbetts Woods.

Reproduction of oak and hickory species is weak in both stands (Figures 1 and 2), a pattern which continues through the shrub and herb strata (Tables 2 and 3), except for red oak in the herb layer of Commiskey Woods. Improved drainage of surrounding tillplain soils for agriculture may favor oaks and hickories in the future. Other major canopy species are represented in both the shrub and herb strata and seem to be maintaining their contribution to the stand; black gum, especially, has high densities and may be increasing. Beech reproduction is much stronger in Tribbetts than in Commiskey Woods (Tables 2 and 3). Both stands are expected to maintain the present composition in the coming decades, if protection from disturbance continues. It will be interesting to resurvey the stands at a future date to examine the expected recovery from density reductions in the smaller size classes as young trees grow into the canopy.

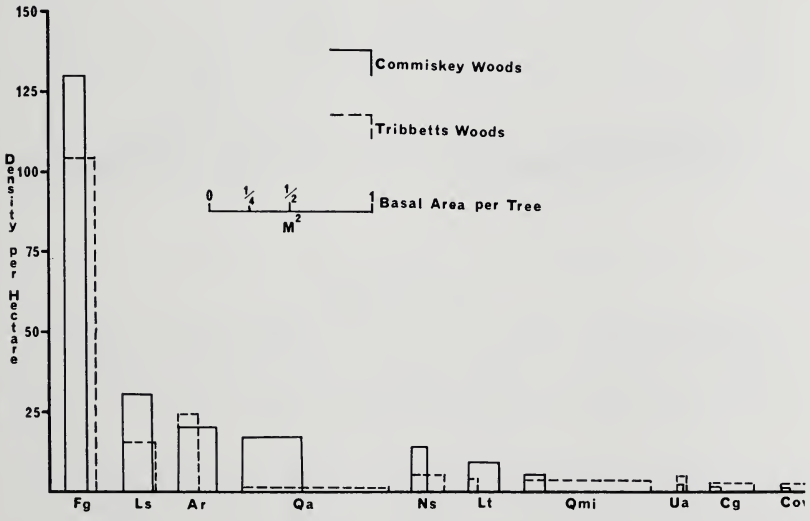

FIGURE 1. *Composition diagrams for ten major tree species in Commiskey and Tribbetts Woods. The areas contained within the bars are proportional to the total basal areas per hectare for the respective species. Species symbols appear in Table 1.*

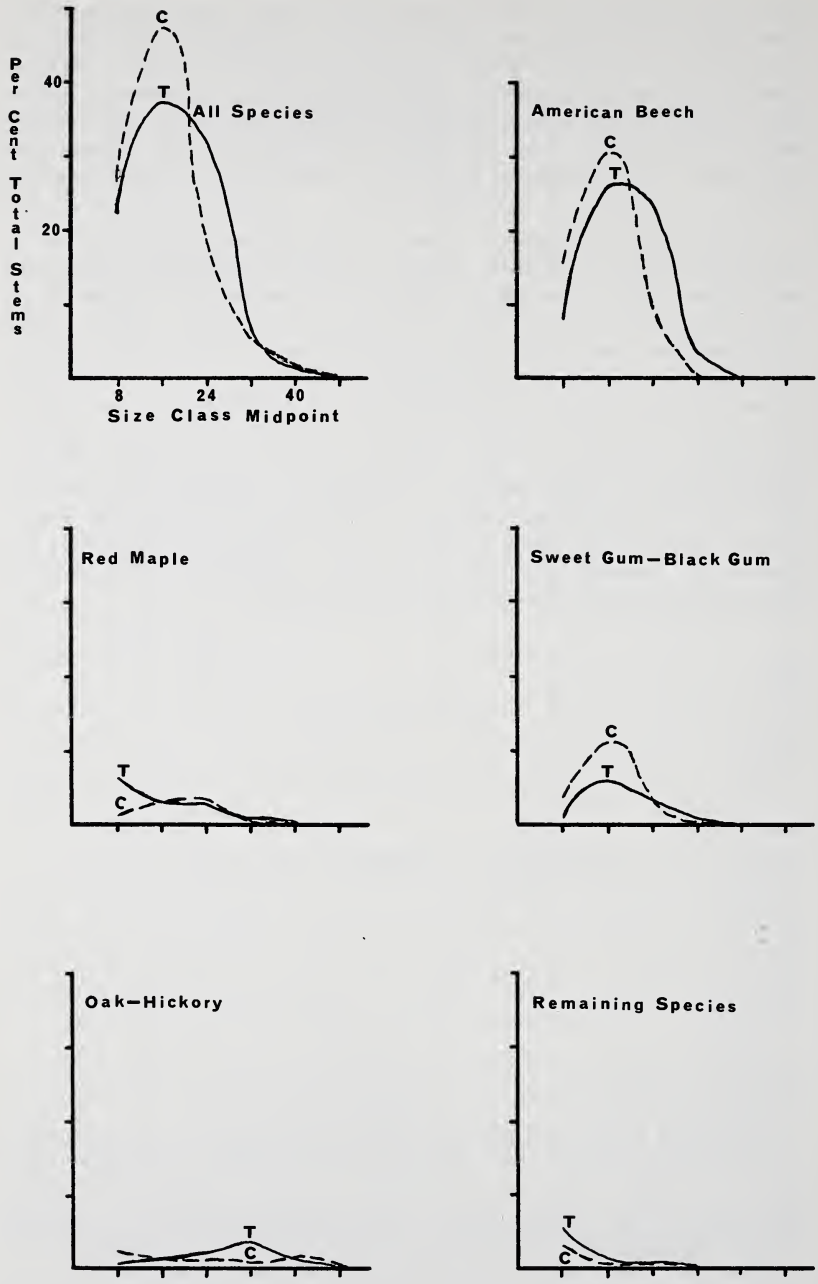

FIGURE 2. *Comparison of percentage of total stems as distributed by size class midpoints for all species collectively and for selected canopy tree species for Tribbetts Woods (T) and Commiskey Woods (C). Subcanopy trees, such as blue beech and flowering dogwood, were omitted from the computations.*

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APPENDIX 1. *Presence list of species*[1] *appearing in the herbaceous stratum, but not within sample plots.*

Commiskey Woods: *Arisaema triphyllum* (L.) Schott, *Asarum canadense* L., *Brachyelytrum erectum* (Schreb.) Beauv., *Circaea quadrisulcata* (Maxim.) Franch. & Sav., *Corallorhiza wisteriana* Conrad, *Dioscorea villosa* L., *Dryopteris hexagonoptera* (Michx.) Christens., *Eupatorium rugosum* Houtt., *Galium circaezans* Michx., *Phytolacca americana* L., *Prenanthes alba* L., *Saxifraga pennsylvanica* L., *Solidago caesia* L., *Vitis labrusca* L.

Tribbetts Woods: *Amphicarpa bracteata* (L.) Fern., *Athyrium filix-femina* (L.) Roth., *Carex* sp., *Carpinus caroliniana* Walt., *Carya cordiformis* (Wang.) K. Koch, *Celastrus scandens* L., *Dryopteris noveboracensis* (L.) Gray, *Dryopteris hexagonoptera* (Michx.) Christens, *Fraxinus pennsylvanica* Marsh., *Galium circaezans* Michz., *Prenanthes alba* L., *Vitis labrusca* L.

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[1] Nomenclature in this list and throughout the text follows *Gray's Manual of Botany.*