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AN ORDINATION OF THE FOREST HERB STRATUM OF ABNER'S HOLLOW, SOUTH-CENTRAL OHIO[1]

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Abstract. We analyzed the herb stratum of Abner's Hollow, a south-central Ohio watershed with deciduous forest vegetation, with a Bray-Curtis ordination. The results indicated that parent material is the primary environmental factor correlated with variation in the herbaceous layer. We described 3 herbaceous communities. That on the low elevation dolomite/limestone parent material was dominated by such species as *Uvularia perfoliata* and *Smilacina racemosa*. The herbaceous community of the midslope noncalcareous shale had *Dioscorea quaternata* and *S. racemosa* as dominants. *Dioscorea quaternata*, *S. racemosa*, and *U. perfoliata* were also the most important herbaceous species on the sandstone parent material of the upper slopes and ridgetops. The total number, average number per quadrat, and cover of the herbaceous species decreased from the dolomite/limestone to the sandstone to the shale communities. The findings for the herbaceous communities complement those of the study published earlier on the woody plants (Bot. Gaz. 139: 241–248, 1978).

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The Mixed Mesophytic Forest is of special interest in south-central Ohio where it borders two other deciduous forest regions (the Western Mesophytic and the Beech-Maple) and occurs on land of two physiographic provinces (the Appalachian Plateau and Interior Low Plateau). Previous studies on the forest communities of this area concentrated on woody vegetation (*e.g.* Anderson and Vankat 1978, Bell 1978, Braun 1928, 1969). Some studies contained observations on herbaceous vegetation, which although valuable, were generally brief and qualitative. The objectives of our study were to characterize quantitatively the herbaceous vegetation of a site in this area, to interpret correlations between vegetational and environmental variations, and to compare results with a previously published analysis of the woody vegetation of the same area.

Study Area

The study area was the approximately 80 ha deciduous forest of the upper portion of Waggoner Run watershed in Adams County, Ohio. The site is known as Abner's Hollow and is approximately 7 km north of the Ohio River and 2 km east of Ohio Brush Creek. Waggoner Run is mapped on the Concord, Ohio-Kentucky Quadrangle of the U.S.G.S. 7.5 min series topographic map. The study area is bounded on 3 sides by ridges that are up to 175 m above Waggoner Run in elevation. Several soil types are produced by 3 major kinds of parent material: dolomite/limestone and calcareous shale at the low elevations, non-calcareous shale at mid and upper slope positions, and sandstone along some ridge tops (see Anderson and Vankat 1978 for further details and a site map).

Adams County has a temperate continental climate, with a mean annual temperature of around 12 °C and an average annual precipitation of approximately 100 cm. The average growing season is 161 days (Miller 1969). Microclimates in Abner's Hollow are influenced by topographical factors such as slope exposure and inclination.

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The Waggoner Run watershed has been logged several times beginning in the 19th century. Other disturbances include farming of the upper north ridge and grazing of the upper east slopes and ridge until approximately 1955. Fires have burned areas in the watershed, especially on the south-facing slope. Most of Abner's Hollow was donated to The Nature Conservancy in 1974; the northern portion of the watershed was privately owned at the time of this study, but had been treated as a nature preserve for several years.

Anderson and Vankat (1978) analyzed the woody vegetation of Abner's Hollow and delineated 8 plant communities. The major types were a mixed mesophytic type on dolomite/limestone and dominated by *Liriodendron tulipifera*, *Fraxinus americana*, and *Acer saccharum*, a chestnut oak type on noncalcareous shale and dominated by *Quercus prinus*, and a mesophytic type on sandstone and dominated by *A. saccharum*, *A. rubrum*, *Q. prinus*, and *Sassafras albidum* (nomenclature follows Gleason 1952).

METHODS AND MATERIALS

Our sampling method followed that of Vankat *et al* (1977) and Anderson and Vankat (1978), producing 74 quadrats of 10 m x 20 m size for which we listed herbaceous species and recorded slope inclination, exposure, and position, type of parent material, soil pH, and estimated percentage of canopy cover. We mapped herbaceous cover by species with a 0.5 m x 2 m grid frame placed 2 m from each corner along the long dimension of each quadrat. Sampling dates were May through August 1975; supplementary observations were made during the summer of 1976.

We constructed an ordination of the type developed by Bray and Curtis (1957) using modifications described by Mueller-Dombois and Ellenberg (1974). We used presence/absence data from the 74 large quadrats to calculate a matrix of Sörenson's (1948) coefficient of similarity values and calculated dissimilarity values by substracting similarity values from 1.00. We tested the validity of the spatial orientation of the points on the ordination by the same statistical method employed by Anderson and Vankat (1978) using 70 randomly selected quadrat pairs. The ordination was statistically valid at the $\alpha = .01$ level. The array of quadrats was easiest to interpret when viewing the Y–Z axes. These are used on a 0–100 scale for the ordination figure.

Using the data from the 296 small (0.5 m x 2 m) quadrats, we calculated relative frequency and relative cover and averaged these values to calculate an importance percentage for each species. We analyzed the distributions of species on the ordination by plots of absolute cover values and investigated correlations with various environmental factors (*e.g.* quadrat parent material, slope position, and slope exposure) by plotting quadrat values for these factors on the ordination.

RESULTS

The 74 large quadrats contained 114 herbaceous species of 85 genera and 41 families. The 296 small quadrats contained 86 species of 64 genera and 31 families. The most important herbaceous species of the entire study area were *Smilacina racemosa* (importance percentage of 8.66%), *Dioscorea quaternata* (7.63%), *Uvularia perfoliata* (5.89%), *Geranium maculatum* (3.84%), *Danthonia spicata* (3.59%), *Botrychium virginianum* (3.36%), *Anemonella thalictroides* (3.34%), and *Potentilla simplex* (3.09%) (see table 1).

The majority of the 46 quadrats from noncalcareous shale were found in the upper half of the ordination with most of the 18 quadrats from dolomite limestone in the lower half; the 10 quadrats from sandstone lay primarily in the middle of the Y axis (see fig. 1). This spatial arrangement indicated that parent material is a key environmental factor correlated with major variations in vegetation. Our field observations supported this hypothesis by showing that abrupt vegetation transitions occurred between but not within parent material types. This finding more or less eliminated elevation as a factor of high importance in major vegetation gradients as observed on the ordination and in the field. Therefore, we described the 3 herbaceous plant communities as corresponding to the 3 major parent material types.

A total of 82 herbaceous species occurred in the 18 large quadrats on dolomite/limestone parent material, and the average number of species per quadrat was 19.1. The 72 small quadrats had an average herb cover of 9.3% and contained 59 species. The most important species were *Uvularia perfoliata* (8.89 importance percentage), *Smilacina racemosa* (8.75%), *Geranium maculatum* (7.05%), *Cimicifuga racemosa* (5.82%), *Anemonella thalictroides* (4.47%),

TABLE 1

Percent cover (Cov.), frequency (Fre.), and importance percentages (I.P.) for herbaceous species in Abner's Hollow.

Species	Small Quadrat (0.5 x 2 m)												Large Quadrat (10 x 20 m)		
	All Parent Materials*			Dolomite/Limestone**			Shale+			Sandstone++			D/L†	Shale††	Sand-stone†††
	Cov.	Fre.	I.P.	Cov.	Fre.	I.P.	Cov.	Fre.	I.P.	Cov.	Fre.	Fre.	Fre.	Fre.	Fre.
Adiantum pedatum	0.02	0.3	0.29	.08	1.4	0.58	—	—	—	—	—	—	11.1	—	10.0
Agrimonia rostellata	—	—	—	—	—	—	—	—	—	—	—	—	—	2.2	10.0
Agrimonia spp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.0
Allium vineale	0.04	0.3	0.48	—	—	—	0.06	0.5	1.27	—	—	—	—	2.2	—
Andropogon scoparius	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Anemone quinquefolia	<0.01	0.3	0.11	—	—	—	—	—	—	0.01	2.5	0.79	—	—	10.0
Anemone virginiana	<0.01	0.7	0.21	—	—	—	<0.01	1.1	0.55	—	—	—	5.6	4.3	—
Anemonella thalictroides	0.11	8.1	3.34	0.32	20.8	4.47	0.04	3.3	2.10	0.04	7.5	2.45	83.3	15.2	30.0
Antennaria plantaginifolia	0.03	1.4	0.76	<0.01	1.4	0.23	0.05	1.6	1.58	—	—	—	11.1	4.3	—
Arisaema triphyllum	0.07	5.1	2.07	0.14	11.1	2.25	0.03	1.6	1.17	0.11	10.0	4.06	61.1	15.2	40.0
Asarum canadense	0.12	1.0	1.56	0.47	5.2	3.09	—	—	—	—	—	—	55.6	—	—
Asclepias quadrifolia	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Aster praealtus	0.01	0.3	0.18	—	—	—	—	—	—	0.07	2.5	1.56	22.2	6.5	20.0
Aster spp.	<0.01	0.7	0.23	0.02	1.4	0.27	<0.01	0.5	0.27	—	—	—	11.1	12.2	—
Athyrium filix-femina	<0.01	0.3	0.22	—	—	—	0.02	0.5	0.60	—	—	—	—	2.2	—
Aureolaria laevigata	0.02	0.3	0.34	—	—	—	0.04	0.5	0.89	—	—	—	—	2.2	—
Botrychium virginianum	0.12	7.8	3.36	0.31	2.08	4.42	0.07	4.3	3.12	—	—	—	61.1	17.4	10.0
Brassica spp.	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Carex platyphylla	<0.01	0.7	0.27	0.03	1.4	0.32	—	—	—	0.02	2.5	0.84	11.1	4.3	10.0
Cassia nictitans	—	—	—	—	—	—	—	—	—	—	—	—	—	2.2	—
Cerastium arvense	—	—	—	—	—	—	—	—	—	—	—	—	—	2.2	—
Cimicifuga racemosa	0.19	3.0	2.93	0.78	12.5	5.82	—	—	—	—	—	—	61.1	2.2	20.0
Circaea quadrisulcata	0.03	1.0	0.58	0.03	1.4	0.35	—	—	—	0.15	5.0	3.35	16.7	6.5	40.0
Conopholis americana	<0.01	0.3	0.09	<0.01	1.4	0.19	—	—	—	—	—	—	27.8	10.9	10.0
Cubelium concolor	0.02	0.3	0.33	0.09	1.4	0.66	—	—	—	—	—	—	16.7	—	—
Cystopteris bulbifera	<0.01	0.7	0.26	0.03	2.8	0.54	—	—	—	—	—	—	27.8	—	—
Danthonia spicata	0.18	5.7	3.59	0.27	8.3	2.54	0.17	4.3	4.99	0.10	7.5	3.22	55.6	41.3	30.0
Dentaria laciniata	<0.01	0.7	0.24	—	—	—	<0.01	1.1	0.65	—	—	—	—	6.5	—
Desmodium nudiflorum	<0.01	0.3	0.10	—	—	—	<0.01	0.5	0.27	—	—	—	11.1	21.7	20.0
Diarrhena americana	0.04	0.7	0.59	—	—	—	<0.01	0.5	0.35	0.24	2.5	4.06	5.6	2.2	10.0
Dioscorea quaternata	0.35	14.2	7.63	0.32	16.7	3.94	0.33	12.5	11.42	0.47	17.5	11.01	66.7	43.5	50.0
Erythronium albidum	<0.01	0.3	0.12	0.01	1.4	0.25	—	—	—	—	—	—	5.6	—	—
Eupatorium purpureum	<0.01	0.3	0.18	—	—	—	—	—	—	0.06	2.5	1.53	—	—	10.0
Eupatorium rugosum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.0
Eupatorium serotinum	0.02	0.7	0.40	—	—	—	0.03	1.1	1.06	—	—	—	5.6	4.3	—
Festuca obtusa	0.03	0.3	0.47	—	—	—	0.05	0.5	1.22	—	—	—	—	2.2	—
Galium aparine	0.02	0.7	0.37	<0.01	1.4	0.35	0.02	0.5	0.51	—	—	—	5.6	4.3	—
Galium asprellum	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Galium boreale	<0.01	0.3	0.15	—	—	—	—	—	—	0.04	2.5	1.24	—	—	10.0
Galium circaezans	0.05	5.4	1.98	0.06	9.7	1.59	0.04	3.3	2.22	0.06	7.5	2.75	61.1	28.3	40.0
Galium triflorum	0.07	6.1	2.43	0.13	9.7	1.97	0.04	3.3	2.12	0.14	12.5	4.97	50.0	10.9	50.0
Galium spp.	<0.01	1.3	0.45	0.03	4.2	0.69	<0.01	0.5	0.29	—	—	—	22.2	2.2	—
Gentiana spp.	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Geranium maculatum	0.16	7.8	3.84	0.63	27.8	7.05	<0.01	1.1	0.58	0.02	2.5	0.85	66.7	6.5	50.0
Geranium robertianum	0.03	0.3	0.41	0.12	1.4	0.82	—	—	—	—	—	—	5.6	—	10.0
Geum vernum	0.01	1.7	0.58	0.01	2.8	0.44	<0.01	0.5	0.36	0.04	5.0	1.76	16.7	6.5	10.0
Gillenia stipulata	0.15	1.3	2.04	—	—	—	0.23	1.6	4.85	0.06	2.5	1.53	—	8.7	10.0
Goodyera pubescens	<0.01	1.0	0.32	<0.01	1.4	0.20	<0.01	1.1	0.58	—	—	—	22.2	30.4	—
Goodyera repens	<0.01	0.3	0.09	—	—	—	<0.01	0.5	0.26	—	—	—	—	2.2	—
Helianthus divaricatus	—	—	—	—	—	—	—	—	—	—	—	—	—	2.2	—
Helianthus occidentalis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.0

Helianthus spp.	0.04	3.4	1.34	0.11	6.9	1.50	<0.01	1.6	0.88	0.06	5.0	2.13	38.9	13.0	50.0
Hepatica acutiloba	0.13	2.4	2.09	0.54	9.7	4.16	—	—	—	—	—	—	61.1	—	—
Heracleum lanatum	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Heuchera americana	0.02	1.0	0.48	—	—	—	0.01	0.5	0.49	0.07	5.0	2.25	—	10.9	20.0
Houstonia longifolia	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Hystrix patula	<0.01	0.3	0.15	0.02	1.4	0.31	—	—	—	—	—	—	11.1	—	—
Impatiens pallida	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20.0
Krigia biflora	<0.01	1.0	0.37	—	—	—	0.01	1.6	0.97	—	—	—	—	4.3	—
Lactuca canadensis	0.01	1.0	0.40	—	—	—	0.02	1.1	0.74	0.02	2.5	0.92	—	8.7	10.0
Lamium amplexicaule	<0.01	0.3	0.09	<0.01	1.4	0.18	—	—	—	—	—	—	5.6	2.2	—
Laportea canadensis	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Lithospermum canescens	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Lobelia inflata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.0
Lysimachia quadrifolia	0.08	5.1	2.20	0.01	1.4	0.25	0.12	7.6	5.48	—	—	—	11.1	45.7	—
Medeola virginiana	0.07	2.4	1.37	—	—	—	0.11	3.8	3.61	—	—	—	5.6	28.3	—
Osmorhiza claytoni	<0.01	0.3	0.11	<0.01	1.4	0.22	—	—	—	—	—	—	5.6	—	—
Osmorhiza longistylis	<0.01	0.3	0.18	0.02	1.4	0.27	—	—	—	—	—	—	5.6	—	—
Oxalis stricta	0.02	1.7	0.65	0.07	5.5	1.12	—	—	—	0.01	2.5	0.76	16.7	6.5	10.0
Oxalis violacea	0.02	1.0	0.48	0.04	1.4	0.40	0.01	1.1	0.72	—	—	—	5.6	2.2	—
Panax quinquefolium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20.0
Panicum barbulatum	0.08	1.7	1.31	0.21	1.4	1.31	0.03	1.1	1.03	0.05	5.0	1.89	11.1	—	30.0
Panicum dichotomum	0.03	2.7	1.09	<0.01	1.4	0.18	0.05	3.3	2.33	0.02	2.5	0.84	27.8	34.8	20.0
Phlox paniculata	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Phryma leptostachya	0.05	3.0	1.38	0.12	5.5	1.38	0.02	0.5	0.58	0.08	10.0	3.59	33.3	10.9	30.0
Phytolacca americana	—	—	—	—	—	—	—	—	—	—	—	—	5.6	2.2	20.0
Podophyllum peltatum	0.01	1.0	0.42	<0.01	1.4	0.23	<0.01	0.5	0.36	0.05	2.5	1.37	5.6	2.2	10.0
Polemonium reptans	0.02	2.0	0.73	0.06	6.9	1.22	<0.01	0.5	0.35	—	—	—	11.1	2.2	—
Polygonatum biflorum	0.10	6.7	2.92	0.24	12.5	2.93	0.07	6.0	3.88	0.01	2.5	0.74	55.6	34.8	40.0
Polymnia uvedalia	0.02	0.7	0.36	0.07	2.8	0.73	—	—	—	—	—	—	22.2	—	10.0
Polystichum acrostichoides	0.10	2.4	1.76	0.30	4.2	2.17	<0.01	1.1	0.57	0.18	5.0	3.75	38.9	28.3	50.0
Potentilla simplex	0.13	6.1	3.09	0.06	5.5	1.04	0.15	5.4	5.05	0.19	10.0	5.22	38.9	28.3	20.0
Potentilla spp.	<0.01	0.3	0.17	—	—	—	0.01	0.5	0.47	—	—	—	5.6	4.3	—
Ranunculus abortivus	0.01	0.7	0.33	0.06	2.8	0.68	—	—	—	—	—	—	16.7	2.2	—
Ranunculus spp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.0
Sanguineria canadensis	0.05	1.4	0.95	0.21	4.2	1.66	—	—	—	0.02	2.5	0.84	16.7	—	10.0
Sanicula trifoliata	<0.01	0.3	0.13	0.02	1.4	0.27	—	—	—	—	—	—	11.1	—	—
Sedum ternatum	0.08	0.7	1.11	0.16	1.4	1.02	0.07	0.5	1.56	—	—	—	5.6	2.2	10.0
Senecio aureus	—	—	—	—	—	—	—	—	—	—	—	—	11.1	—	—
Senecio viscosus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.0
Senecio spp.	—	—	—	—	—	—	—	—	—	—	—	—	—	2.2	—
Sisyrinchium albidum	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Smilacina racemosa	<0.01	15.5	8.66	0.98	26.4	8.75	0.19	9.8	7.73	0.36	22.5	10.63	72.2	50.0	80.0
Solidago erecta	0.04	0.3	0.53	—	—	—	0.06	0.5	1.39	—	—	—	—	2.2	—
Solidago flexicaulis	0.05	0.7	0.69	0.19	2.8	1.89	—	—	—	—	—	—	22.2	4.3	—
Solidago spp.	0.10	2.7	1 82	<0.01	2.8	0.39	0.10	1.1	2.25	0.27	10.0	6.34	38.9	2.2	20.0
Stylophorum diphyllum	<0.01	0.3	0.14	0.02	1.4	0.30	—	—	—	—	—	—	5.6	—	—
Swertia caroliniensis	0.13	2.0	1.97	0.25	5.6	2.05	0.11	1.1	2.45	—	—	—	22.2	4.3	—
Thalictrum dioicum	0.01	1.0	0.39	—	—	—	0.01	0.5	0.48	0.02	5.0	1.47	—	2.2	20.0
Thaspium trifoliatum	—	—	—	—	—	—	—	—	—	—	—	—	5.6	—	—
Thelypteris hexagonoptera	<0.01	0.3	0.13	—	—	—	<0.01	0.5	0.37	—	—	—	—	4.3	—
Thelypteris noveboracensis	0.04	0.3	0.53	—	—	—	0.06	0.5	1.40	—	—	—	5.6	2.2	—
Tipularia discolor	<0.01	0.3	0.09	—	—	—	<0.01	0.5	0.26	—	—	—	—	2.2	—
Tradescantia virginiana	<0.01	0.7	0.17	—	—	—	<0.01	1.1	0.57	—	—	—	—	2.4	—
Trifolium repens	<0.01	0.3	0.10	<0.01	1.4	0.23	—	—	—	—	—	—	5.6	—	—
Trillium grandiflorum	0.08	3.0	1.64	0.20	8.3	2.17	0.04	1.6	1.48	—	—	—	38.9	4.3	20.0
Urtica dioica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.0
Urtica spp.	0.01	0.3	0.24	0.05	1.4	0.45	—	—	—	—	—	—	5.6	2.2	20.0
Uvularia perfoliata	0.32	8.8	5.89	1.01	26.4	8.89	0.04	1.1	1.17	0.36	12.5	8.20	61.1	8.7	50.0
Viola conspersa	<0.01	0.3	0.10	<0.01	1.4	0.22	—	—	—	—	—	—	5.6	—	—
Viola papilionacea	0.04	8.4	2.63	0.10	22.2	3.46	0.02	3.8	1.98	0.02	5.0	1.45	77.8	21.7	40.0
Viola selkirkii	0.01	1.7	0.60	0.06	5.5	1.03	<0.01	0.5	0.25	—	—	—	16.7	2.2	—
Viola triloba	0.07	8.1	2.90	0.12	15.3	2.68	0.06	6.0	3.65	0.02	5.0	1.47	72.2	32.6	20.0
Viola spp.	0.05	3.0	1.35	0.08	6.9	1.34	0.05	2.2	1.72	—	—	—	22.2	2.2	20.0

*Based on 296 quadrats. **Based on 72 quadrats. +Based on 184 quadrats. ++Based on 40 quadrats. †Based on 18 quadrats. ††Based on 46 quadrats. †††Based on 10 quadrats.

Botrychium virginianum (4.42%), *Hepatica acutiloba* (4.16%), *Dioscorea quaternata* (3.94%), *Viola papilionacea* (3.46%), and *Asarum canadense* (3.09%) (see table 1 for additional data).

The 46 large quadrats on noncalcareous shale had 72 herbaceous species and the average number of species per quadrat was 7.5. The 184 small quadrats had an average herb cover of 2.7% and contained 57 species. The most important taxa were *Dioscorea quaternata*

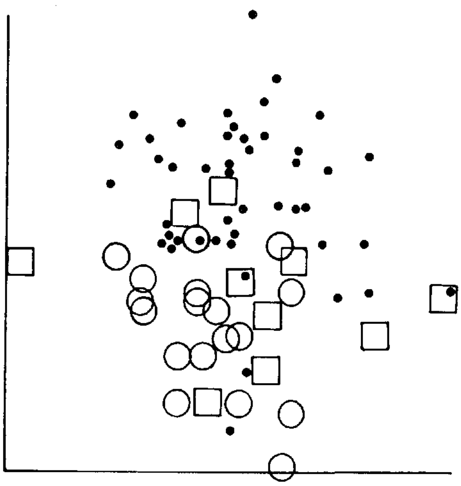

FIGURE 1. Quadrat parent material illustrated on the ordination. The Y and Z axes have a 0–100 scale. Parent Material: ○ dolomite/limestone and calcareous shale ● non-calcareous shale; □ sandstone.

(11.42 importance percentage), *Smilacina racemosa* (7.73%), *Lysimachia quadrifolia* (5.48%), *Potentilla simplex* (5.05%), *Danthonia spicata* (4.99%), *Gillenia stipulata* (4.85%), *Polygonatum biflorum* (3.88%), *Viola triloba* (3.65%), *Medeola virginiana* (3.61%), and *Botrychium virginianum* (3.12%) (see table 1 for additional data).

The 10 large quadrats on sandstone parent material contained 56 herbaceous species and the average number of species per quadrat was 12.5. The 40 small quadrats had an average herb cover of 3.5% and contained 34 species. The most important taxa were *Dioscorea quaternata* (11.01 importance percentage), *Smilacina racemosa* (10.63%), *Uvularia perfoliata* (8.20%), *Solidago* spp. (6.34%), *Potentilla simplex* (5.22%), *Galium triflorum* (4.97%), *Arisaema triphyllum* (4.06%), *Diarrhena americana* (4.06%), *Polystichum acrostichoides* (3.75%), *Phryma leptostachya* (3.59%), *Circaea quadrisulcata* (3.35%), and *Danthonia spicata* (3.22%). Many weedy species, including *Phryma leptostachya*, *Circaea quadrisculata*, *Lactuca canadensis*, and *Phytolacca americana*, were present on sandstone. This occurrence probably reflects the disturbance from farming, grazing, and/or soil slumping that was observed within nine of the large quadrats on sandstone.

Of the 82 herbaceous species in the large quadrats on dolomite/limestone, 25 or 30% were recorded only for the dolomite/limestone parent material. The corresponding figures for noncalcareous shale are 15 of 72 species (21%) and for sandstone are 12 of 56 species (21%). Altogether, 52 or 46% of the 114 herbaceous species were recorded for only one parent material. For the small quadrats, 42 or 49% of the 86 species were similarly recorded. An example of such a species is *Cimicifuga racemosa*, which for the small quadrats was recorded only on dolomite/limestone. This is one of only 4 species from the lists of the previous three paragraphs that were restricted to one parent material in the small quadrats. Most species with a narrow range had low importance percentages. All other taxa occurred in the small quadrats of at least 2 parent materials. For example, *Geranium maculatum* is listed as important only for dolomite/limestone; however, at low levels of absolute cover it also occurred on noncalcareous shale and sandstone. There also are species such as *Dioscorea quaternata* that were important on more than one parent material.

DISCUSSION

Ordination analysis was used to determine what environmental factors correlated with vegetation variations. Generally, the ordination approach is associated with the view of vegetation as a continuum (Curtis 1959, Greig-Smith 1964, Whittaker 1967); nevertheless, ordinations are also capable of revealing discontinuities in vegetation (Greig-Smith 1964). In 1978 Anderson and Vankat used ordination techniques to illustrate both vegetation continua and discontinua in the Abner's Hollow study area. The Bray-Curtis type of ordination was selected for our study because of its high information content and facilitation of comparison with the observations of Anderson and Vankat (1978).

Our finding that parent material is the primary factor correlated with major variations in herbaceous vegetation agrees with Vankat *et al* (1977) and with Anderson and Vankat's (1978) conclusions for the woody vegetation of the study site. Braun (1928, 1969) also noted the importance of parent material in the distribution of vegetation in Mineral Springs and Fort Hill, areas in south-central Ohio with similar parent material types, and indicated that slope exposure also was important in the distribution of plant communities. Vankat *et al* (1977) and Anderson and Vankat (1978) found little evidence for a slope exposure effect in Abner's Hollow. Among the previously listed important herbaceous plants, only *Uvularia perfoliata* had a distribution that correlated primarily with slope exposure, but slope position within parent material type appears to be a factor correlated with the distribution of a larger number of these herbaceous species (Howell 1977). Anderson and Vankat (1978) also noted that slope position within parent material type was an important factor. They reported that human disturbance was primarily responsible for the distribution of at least one species (*Sassafras albidum*). Our observations that several weedy species are common in the herbaceous plant community on sandstone supports their observation of the importance of disturbance in portions of Abner's Hollow.

The herbaceous plant community on dolomite/limestone had the largest number of species, the greatest species richness (in terms of the average number of species per large quadrat), and the highest cover value of the 3 communities. Anderson (1976) found that this parent material had the largest number of woody species and the highest absolute density in both the seedling and sapling size classes. Anderson and Vankat (1978) classified the woody plant community of the dolomite/limestone as mixed mesophytic. This term remains appropriate when the herbaceous community is considered; its important species are all characteristic of mixed mesophytic forests as described by Braun (1928, 1950, and 1969).

The herbaceous plant community on noncalcareous shale had the fewest species, the lowest species richness, and the lowest cover value. Anderson (1976) reported similar findings for the density of the woody understory layers, *i.e.* seedling and sapling size classes. Braun (1928, 1969) noted for 2 other areas with similar parent material that herbaceous cover was lower on forested noncalcareous shale than on other parent materials. She also reported that there was an abrupt vegetation transition between the dolomite/limestone and noncalcareous shale parent materials. We observed this change in the plant communities of Abner's Hollow. The abrupt transition probably resulted from differences in soil chemistry and possibly leaf litter thickness (Braun 1928).

The herbaceous plant community on sandstone was between the others in number of herbaceous species, species richness, and herb cover, thus correlating with Anderson's (1976) findings for the woody understory. Anderson and Vankat (1978) noted that the sandstone plant community was intermediate in composition between the communities of the other 2 parent material types. In fact, the sandstone quadrats occupy an intermediate position on both the woody and herbaceous plant ordinations. Reflecting this, most of the important species on sandstone are also important on one or both of the other parent materials (table 1). In comparing our findings with Braun's 1928 and 1969 studies in south-central Ohio, there was little resemblance of herbaceous plant communities on sandstone. Anderson (1976) reported evidence of a successional trend toward a more mesophytic forest on sandstone, and such a change could result in decreased importance of weedy species and possibly greater resemblance to other herbaceous plant communities on sandstone (and perhaps dolomite/limestone) in south-central Ohio. Anderson and Vankat (1978) stated that the abundance of *Sassafras albidum* in portions of the sandstone parent material band was the result of relatively recent agricultural disturbances. The widespread presence of such weedy herbaceous species as *Phryma leptostachya*, *Circaea quadrisculata*, *Lactuca canadensis*, and *Phytolaca americana* also reflected such disturbances.

Our study of the herbaceous vegetation of Abner's Hollow has produced results that are generally comparable to Anderson and Vankat's (1978) findings for the woody vegetation but we were not as successful in correlating environmental gradients with vegetation variation within individual parent material types. This reduced success may be the result of the relative lack of ecological information on individual herbaceous species as opposed to woody species. Relatively recent human disturbance in areas of sandstone parent material was evidenced by the presence of a variety of weedy herbaceous species, but only by one woody species. Local disturbances within the other parent material types were marked by the presence of several weedy herbaceous species, but similar effects on the woody vegetation were not noted. Our observations complement and add to those of Anderson and Vankat (1978) on the woody plants and provide a quantitative analysis of the plant communities of a vegetationally and floristically interesting area.

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