Butler University Botanical Studies

Volume 2 *Butler University Botanical Studies* Article 15

The Merrillville White Pine

Alva J. Lindsey
Butler University

THE MERRILLVILLE WHITE PINE (PINUS STROBUS) BOG, LAKE COUNTY, INDIANA

By ALVA J. LINDSEY

The Merrillville bog is located one mile east of Merrillville, Indiana, in the extreme eastern part of Lake county, and about one-half mile north of State Road 30.

This bog was originally a morainic lake of the "kettle" hole variety (9). It is now near the close of hydrarch succession (4) but has not yet reached its climax stage. The one-time lake basin is now filled with twenty-five feet of peat, which is covered with a dense herbaceous and woody vegetation. The surface of the bog is dry except during wet seasons. During August, 1931, the water table was four feet from the surface.

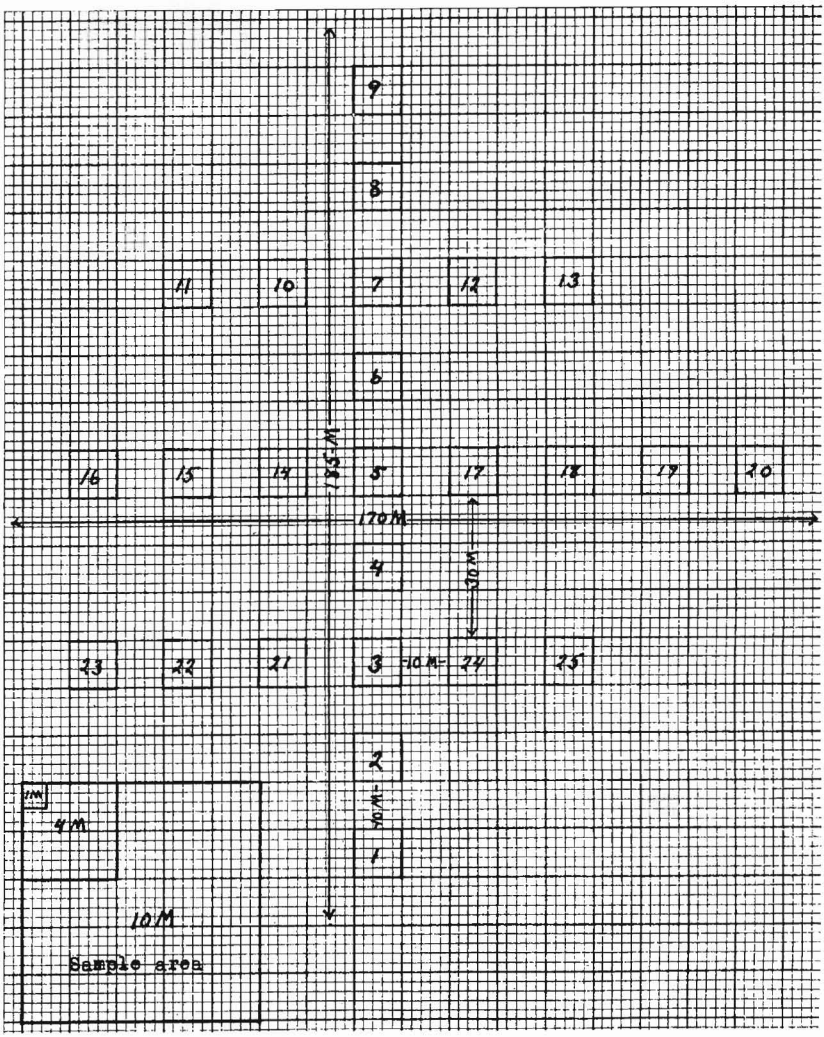
Interest in the vegetational composition of this bog was stimulated by the fact that it bears the only pure stand of *Pinus Strobus* in Indiana (1), and that it differs from the more common tamarack bog of the northern part of the state.

The approximate area of the bog is forty acres, and is divided into three distinct plant zones. *Pinus Strobus* occupies about nine acres in the center of the mat, completely surrounded by shrubs, of which the more common are *Rhus vernix, Rosa palustris* and *Spiræa tomentosa.* Encircling the shrubs is a sedge meadow. The adjacent untilled slopes are covered with an open and broken stand of oaks.

A quantitative survey was made in the white pine zone by the quadrat method (6). Twenty-five sample areas, each of three different sizes, were methodically arranged and equally spaced in accordance with Figure 1, so as to give a fair cross section of the flora. None of the quadrats touched the transition area next to the shrub zone where there were species intermingled characteristic of both areas. This precaution was taken to make the survey among the most homogeneous part of the vegetation. The species in each quadrat were located by symbols on sheets taken into the field (Figure 2). Quadrats, 1, 4 and 10 meters square, were used respectively for herbaceous species, shrubs and trees. Quadrats of these sizes permitted a 6 per cent. survey for trees, a 1 per cent. for shrubs, and 0.06 per cent. for herbaceous species.

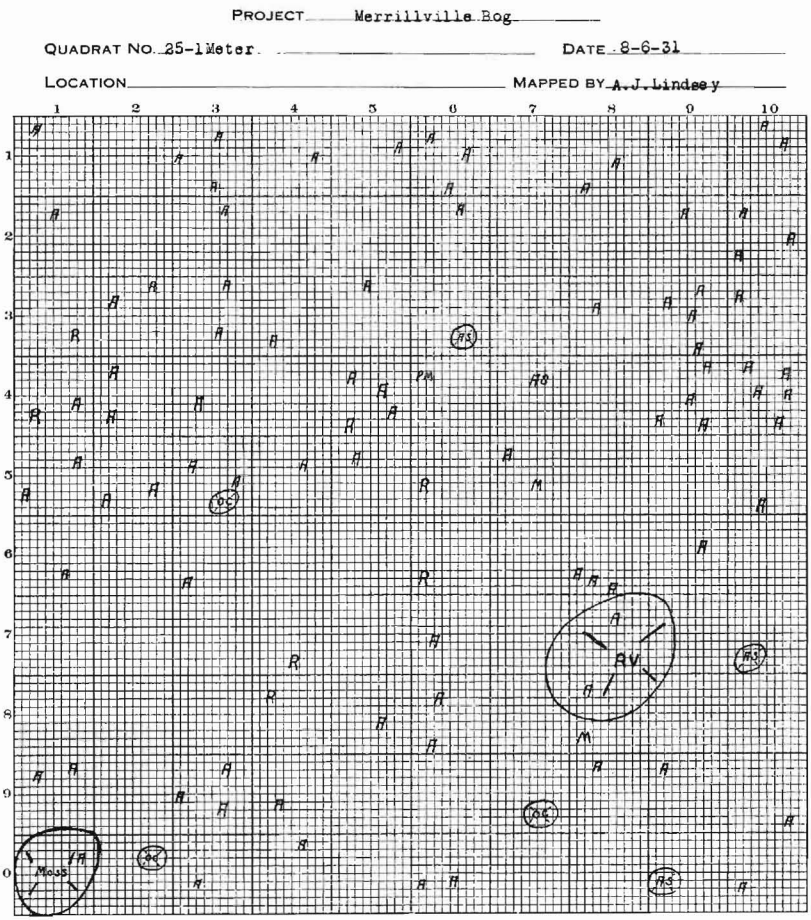
From the sample sheets plotted in the field were compiled the fre-

FIGURE 1. ARRANGEMENT OF QUADRATS IN WHITE PINE ZONE



quency, frequency class and density of each species in accordance with these concepts as set forth by Braun-Blanquet and Pavillard (2), and recently interpreted by Cain (3). Frequency indicates the percentage of

FIGURE 2. SAMPLE OF FIELD SHEET



the total number of quadrats in which a species is found. A frequency class indicates the range of frequency of the species it contains. The frequency of each species falls into one or the other of five classes, designated as A, B, C, D and E, with the respective frequency ranges of 1-20, 21-40, 41-60, 61-80 and 81-100 per cent. Density, a strictly numerical concept, gives the average number of individuals of a species per quadrat.

The results of the survey in the twenty-five one-meter quadrats are

given in Table I. A total of sixteen species was found, of which ten were herbaceous and sixteen were shrubs. The only tree species found was an oak seedling. The species of highest frequency were all herbs; and, with the exception of *Rubus hispidus,* had also the heaviest density. *Maianthemum canadense* had 96 per cent. frequence and was preponderately the most dense, but the ferns with a lower frequence and density were the more dominant because of their high surface coverage (Figure 4).

TABLE I. QUANTITATIVE COMPARISON OF SPECIES IN TWENTY-FIVE ONE-METER QUADRATS

SPECIES	FREQUENCY PER CENT.	FREQUENCY CLASS A	B	C	D	E	DENSITY
Aspidium cristatum L.	12	X					0.20
Aspidium spinulosum intermedium Muhl.	80				X		2.68
Eupatorium perfoliatum L.	4	X					0.04
Galium trifidum L.	4	X					0.04
Ilex verticillata L.	8	X					0.24
Lycopus sp.	12	X					0.72
Maianthemum canadense Desf.	96					X	90.24
Medeola virginiana L.	60			X			2.96
Osmunda cinnamomea L.	84					X	4.24
Pyrus melanocarpa (Michx.) Willd.	12	X					0.16
Quercus bicolor Willd.	4	X					0.04
Rhus vernix L.	56			X			0.76
Ribes americana Miller	4	X					0.04
Rubus hispidus L.	44			X			4.52
Vaccinium oxycoccus L.	4	X					0.04
Woodwardia virginica (L.) Sm.	16	X					0.36
Total (16)		10		3	1	2	

In the twenty-five four-meter quadrats (Table III) twelve woody species were found, of which nine were shrubs and the remainder trees. The species of the highest frequency and greatest density were the shrubs. By increasing the quadrats from 1 to 16 square meters, two trees came into the survey: *Pinus Strobus* and *Quercus macrocarpa. Quercus bicolor* and *Ribes americana* were found in the one-meter and four-meter quadrats but neither increased its frequency in changing from the smaller to the larger area. This condition may be accounted for by the fact that Quercus and Ribes are just coming in and are not distributed to any uniform extent. The established shrubs show an in-

crease in frequency and density (Table IV) when data from larger quadrats are compared with that of smaller quadrats.

TABLE III. QUANTITATIVE COMPARISON OF SPECIES IN TWENTY-FIVE FOUR-METER QUADRATS

SPECIES	FREQUENCY PER CENT.	FREQUENCY CLASS A	B	C	D	E	DENSITY
Ampelopsis quinquefolia Michx.	36		X				0.68
Corylus americana Walt.	8	X					0.08
Ilex verticillata L.	52			X			0.88
Pinus Strobus L.	24		X				0.36
Pyrus melanocarpa (Michx.) Willd.	32		X				1.12
Quercus bicolor Willd.	4	X					0.04
Quercus macrocarpa Willd.	12	X					0.16
Rhus vernix L.	100					X	4.60
Ribes americana Miller	4	X					0.04
Rubus hispidus L.	88					X	?
Sambucus canadensis L.	4	X					0.04
Sorbus subvestita Greene	4	X					0.04
Total (12)		6	3	1		2	

TABLE IV. SPECIES SHOWING INCREASE IN FREQUENCY AND DENSITY IN CHANGING FROM SMALLER TO LARGER QUADRATS

SPECIES	ONE-METER QUADRATS FREQUENCY PER CENT.	ONE-METER QUADRATS DENSITY	FOUR-METER QUADRATS FREQUENCY PER CENT.	FOUR-METER QUADRATS DENSITY
Ilex verticillata	8	.24	52	.88
Pyrus melanocarpa	12	.16	32	1.12
Rhus vernix	56	.76	100	4.60
Rubus hispidus	44	4.52	88	?
Pinus Strobus			24	.36

The increase in frequency and density in passing from the one-meter to the four-meter quadrats shows that the one-meter quadrats are too small for a shrub survey, and likewise the four-meter quadrats for trees. A quadrat that will not normally include all the more important species and some of the less important ones is too small for an adequate survey (6). *Nemopanthus mucronata,* a rather common shrub, appeared quite often just outside of the four-meter quadrats. It was a shrub too common not to have figured in a statistical survey. It might be said in this connection that even four-meter quadrats are too small for certain types of vegetation.

The increase in frequency of an area over that of a smaller one also raises a question regarding the relation between the number of species and quadrat size. Arrhenius attempted to show that the number of species will increase continually as the area increases and produced a formula to give the mathematical relationship (7). Gleason has exposed the fallacy of such a correlation by showing that it increases species to an incredible ratio. Gleason does admit a more or less logarithmic relationship between species and quadrat size up to the point where the quadrat is not extended beyond a size sufficient to include all species represented in a community. He has also shown that the rate of increase in the number of species is a progressive decrease toward the enlarged areas (7). The findings in this study are more in agreement with Gleason as against the formula of Arrhenius.

Table V shows that only four species of trees appeared in the twenty-five ten-meter quadrats. This is an increase of one species, *viz., Prunus serotina,* over the four-meter quadrats. *Quercus bicolor* and *Q. macrocarpa* show a very slight increase in frequency and density in passing from the four-meter to the ten-meter series. Again, it may be stated that the oaks are seedlings in the beginning of their succession and have no uniformity in their distribution. *Pinus Strobus,* with 24 per cent. frequency in the four-meter quadrats, jumps to 100 per cent. in the ten-meter quadrats. *Pinus Strobus* is the important tree at present, but it is doomed to yield its position to the incoming oaks. A pine seedling is rarely found on the forest floor, while oak seedlings are more common, thus indicating that the pines are yielding to an oak succession. And in addition to this apparent unsuccessful competition with the oaks, the pines do not display a vigorous vegetative condition, another indication of a passing species. In their present condition they are an illustration of a species unable to withstand a changing bog habitat (5).

TABLE V. QUANTITATIVE COMPARISON OF SPECIES IN TWENTY-FIVE TEN-METER QUADRATS

SPECIES	FREQUENCY PER CENT.	FREQUENCY CLASS A	B	C	D	E	DENSITY
Pinus Strobus L.	100					X	2.36
Prunus serotina Ehrh.	8	X					.08
Quercus bicolor Willd.	8	X					.08
Quercus macrocarpa Willd.	16	X				•	.36
Total (4)		3				1	

There seems to be no correlation between frequency and density in any quadrat study to the extent that a species of the highest frequency will always have the greatest density and tbat a species of lowest density will always have the lowest frequency. It happens in this survey, however, that the species of the highest frequence have also the greatest density. This numerical relationship does not hold good for all species in Tables I and III, for some of low density have a greater frequence than some whose density is much higher. While there is no hard and fast correlation between frequency and the density of individuals as a species, yet there is a rather definite logarithmic relationship between the two. Knowing the number of quadrats and the number of plants of an individual species found in tbe quadrats, it is possible to approximate the frequency per cent., and conversely, knowing the number of quadrats and frequency per cent., it is possible to approximate the number of individuals of a species appearing in the quadrats. Especially is this relation true among the species of low frequency. For a discussion of the formula used in establishing this relationship, reference should be made to Gleason (7) and Kenoyer (8).

The frequency curves in Figure 3 show the percentage of species in each of the frequency classes for the three quadrat series in comparison with the curve of Raunkiaer, which was based on the result of European surveys, and the curve of Kenoyer based on quadrat studies in Michigan. The present results are in agreement with Raunkiaer's curves in the four-meter and ten-meter quadrats in that there are two peaks, one in A and the other in E, but the four-meter quadrats show a total depression in D, and the ten-meter quadrats a total depression in B, C and D. The total depressions are not in agreement with Raunkiaer's gradual decrease through the intermediate classes. The curve of the one-meter group exhibits more of a departure from Raunkiaer's curve in that there are three peaks, one each in A, C and E, with a total depression in B.

The composition of the white pine and its contemporary flora present a very distinct stratification. Five different layer societies are thus composed. Mosses and *Maianthemum canadense* compose the lowest stratum, *i. e.,* up to 8 inches. This is followed by other strata in tbe following order: Osmunda and Aspidium, 8 inches to 4 feet; Ilex, Pyrus and Nemopanthus, 4-10 feet; *Rhus vernix,* 10-18 feet; and *Pinus Strobus,* 18-50 feet. The clean-cut way in whicb these layers are superimposed one upon another made it possible to estimate their dominance with

FIGURE 3. Curves Showing the Per Cent. of Species in Each of the Different Frequency Classes of the Three Different Quadrat Groups in Comparison with Raunkiaer's and Kenoyer's Standard Curves

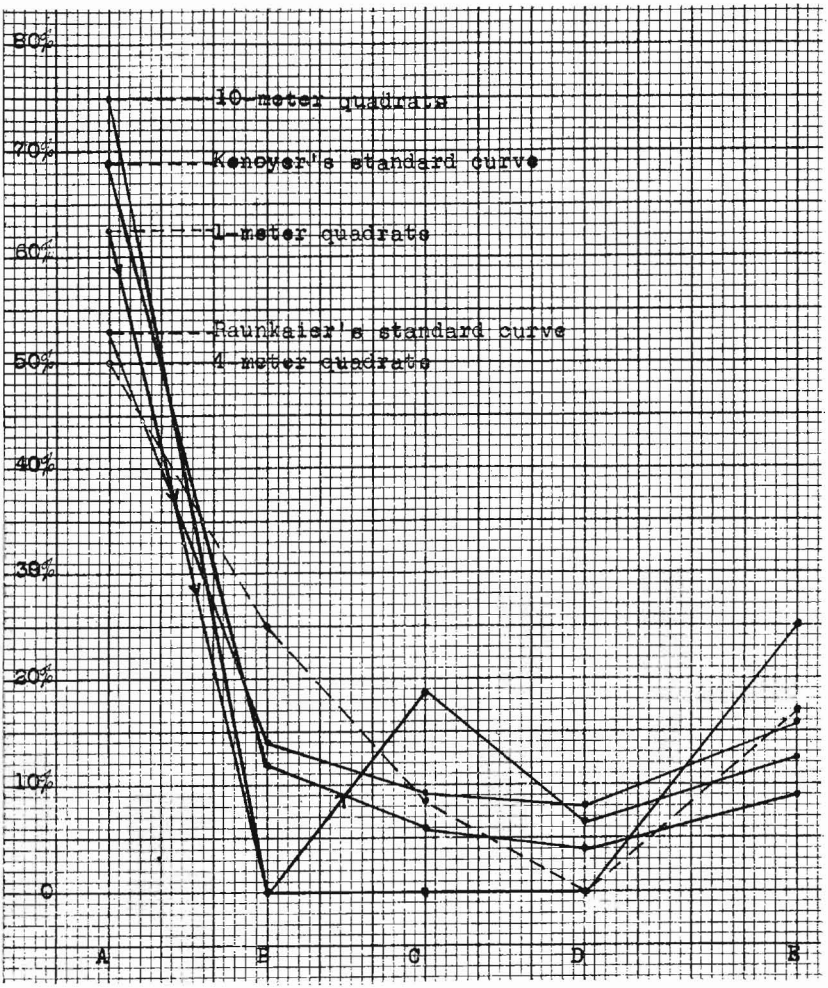
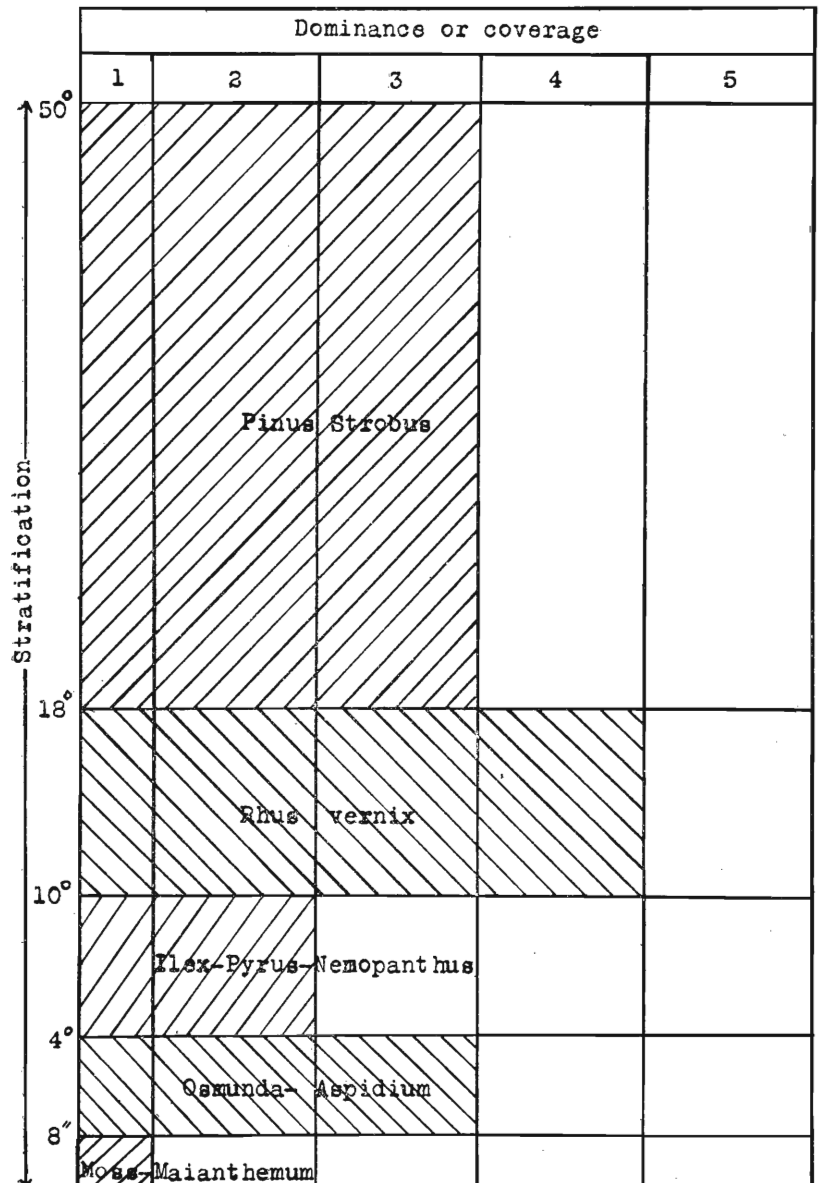


FIGURE 4. STRATIFICATION AND DOMINANCE OF SPECIES FORMING THE DIFFERENT STRATA



comparative ease. Dominance as here used refers to coverage and is divided into five classes: D-1, less than 1/20 of area; D-2, 1/20-¼; D-3, ¼-½; D-4, ½-¾; and D-5, more than ¾ of the area (2). Figure 4 shows the different vegetational strata in relation to their height and gives the dominance of each species or group of species forming a particular stratum. Special notice should be given *Pinus Strobus*, with a D-3 coverage, which shows it to be very open for a dominant tree in a pure stand. The shrubs are unusually dense, with reference to *Rhus vernix* in particular. The ferns also have more than ordinary dominance. The idea of the coverage-stratification diagram used in Figure 4 was advanced by Cain (3).

TABLE IV. LIST OF SPECIES FOUND OUTSIDE OF QUADRATS

Agrimonia sp.
Aralia nudicaulis L.
Aspidium Thelypteris (L.) Sw.
Carex impressa?
Carex sp.
Calamagrostis canadensis (Michx.) Beauv.
Gaylussacia baccata (Wang.) C. Koch.
Geum sp.
Lysimachia sp.
Nemopanthus mucronata (L.) Trel.
Osmunda regalis L.
Polygonum sagittatum L.
Prunus americana Marsh.
Quercus imbricaria Michx.
Rosa palustris Marsh.
Sagittaria sp.
Scirpus cyperinus (L.) Kunth.
Solanum Dulcamara L.
Spiræa tomentosa L.
Circium sp.
Vaccinium vaccillans Kalm.
Vitis sp. Total, 22

SUMMARY AND CONCLUSIONS

1. The species of highest frequency in each quadrat series also have the greatest density.

2. In general, the species of the highest frequency and greatest density are dominant in the stratum in which they are found.

3. One-meter quadrats seem sufficient in size for making an adequate survey of herbaceous species, and the ten-meter quadrats for trees, but four-meter quadrats seem undersized for a fair survey of shrubs.

4. *Pinus Strobus* has neither great density nor coverage for being a dominant tree in a pure stand.

5. In this study *Pinus Strobus* is the dominant tree, *Rhus vernix* the dominant shrub, *Maianthemum canadense* the dominant herb on the forest floor, and *Osmunda cinnamomea* and *Aspidium spinulosum intermedium* share dominance among the taller herbs.

6. Raunkiaer's law of frequence is not completely supported by the frequency curves of the different quadrat series.

7. *Vaccinium oxycoccus* is almost extinct and *Ampelopsis quinquefolia* is rather common in seedling form, thus indicating the increasing dryness of the bog.

8. The shrubs and ferns exhibit unusually heavy stands.

9. The Merrillville bog has not yet reached its climax stage. This fact is attested by the almost total lack of pine seedlings but with oak seedlings much more abundant.

Appreciation is here extended to Miss Dorothy Parker, who assisted in laying out the quadrats and mapping some of the areas, and to Dr. Stanley A. Cain for suggesting and supervising this study.

LITERATURE CITED

1. Blatchley, W. S. Indiana Geol. Rept. 22: 93. 1898.
2. Braun-Blanquet, J., and J. Pavillard. Vocabulaire de socialogie vegetale. 3d Ed. 1928.
3. Cain, S. A. Concerning certain phytosociological concepts. Ecological monographs 2: 475-508. 1932.
4. Cooper, W. S. The climax forest of Isle Royal, Lake Superior, and its development. I. Bot. Gaz. 55: 1-44. 1913.
5. Cowles, H. C. The succession point of view in floristics. Proc. Int. Cong. Plant Science 1: 687-691. 1926.
6. Gleason, H. A. Some applications of the quadrat method. Bull. Torr. Bot. Club 47: 21-33. 1920.
7. —— The relation between species and area. Ecology 3: 158-162. 1922.
8. Kenoyer, L. A. A study of Raunkiaer's law of frequence. Ecology 8: 341-347. 1927.
9. Logan, W. N. Handbook of Indiana Geology 393-394. 1922.