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During the years of the journal's publication, the Butler University Botany Department had an active program of research and student training. 201 bachelor's degrees and 75 master's degrees in Botany were conferred during this period. Thirty-five of these graduates went on to earn doctorates at other institutions.

The Botany Department attracted many notable faculty members and students. Distinguished faculty, in addition to Cain and Friesner , included John E. Potzger, a forest ecologist and palynologist, Willard Nelson Clute, co-founder of the American Fern Society, Marion T. Hall, former director of the Morton Arboretum, C. Mervin Palmer, Rex Webster, and John Pelton. Some of the former undergraduate and master's students who made active contributions to the fields of botany and ecology include Dwight. W. Billings, Fay Kenoyer Daily, William A. Daily, Rexford Daudenmire, Francis Hueber, Frank McCormick, Scott McCoy, Robert Petty, Potzger, Helene Starcs, and Theodore Sperry. Cain, Daubenmire, Potzger, and Billings served as Presidents of the Ecological Society of America.

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AN ECOLOGICAL SURVEY OF THE CRAWFORD WOODS, CLARK COUNTY, INDIANA

By JACK B. SECOR

Numerous surveys of forested areas throughout Indiana have yielded a wealth of ecological knowledge, especially in regard to factors controlling and regulating the invasion and ecesis of deciduous tree species making up these forest formations. Perhaps no other area in the state has undergone a more intense study by ecologists than the Illinoian Drift Plain region, located in the southern part.

The Illinoian Drift Plain in Indiana includes that region of the extensive Illinoian glaciation not covered by the two succeeding Wisconsin ice sheets. This area is composed of two prongs extending into the southern portion of the state; an eastern lobe of 3,100 square miles, and a western lobe comprising 4,100 square miles (5).

The topographical uniformity of the Illinoian Drift Plain had previously led to certain misconceptions regarding forest types in the area. The idea of a homogeneity of forest cover throughout the two lobes has since been dispelled by the more recent work of Braun (1), Keller (4), and McCoy (6), who noted the variable nature of the forest stands. Keller (4) believes that these stands represent transitional types of the mixed-mesophytic forest in various stages of development from the approximate flood-plain type of forest to the near climax formations.

In a region where topography is uniform but forest stands differ in their species composition, it has become apparent that micro-climatic factors exert a controlling influence. Variations in drainage and soil structure have been used to explain forest cover changes, and the author, from recent work in the area, has come to feel that these plus soil surface moisture are probably predominant in influencing the entrance and ecesis of various tree species (9).

This paper deals with a survey of another forest stand in the Illinoian Drift Plain. The author hopes that it may add to our increasing understanding of the forest types represented in this area.

LOCATION

The Crawford woods is located in Clark County, Indiana, one mile south of the town of Solon. Clark County is included in the southern-most tier of Indiana counties bordering the Ohio River, and most of it is situated in the eastern lobe of the Illinoian Drift Plain. The terrain of the area studied is very flat, thus affording little or no drainage.

SOIL FEATURES

The soil of the Illinoian Drift Plain area is rather uniform, and the typical soil structure is a compact, whitish clay. This clay soil generally becomes compact at the surface and forms a hardpan layer beneath. Subsoil drainage is hindered by the fine texture of the soil and the presence of this hardpan layer. The author's previous study of soil moisture in the area, in which he compared a well and a poorly drained forest stand (9), has led him to feel that the surface horizon is probably the most "critical" in controlling the ecesis of certain species, since only in the moisture content of this soil layer (moisture content of 6- and 12-inch horizons was also determined) did the inadequately drained stand greatly differ from the well drained tract.

METHODS

This study is based upon data obtained from twenty-five 100-square-meter quadrats. Quadrats were run in two parallel sectors, 10 meters apart. These were laid out by means of a stout cord with loops ten meters apart, the loops being slipped over stakes to form the corners of the areas to be recorded. A skip of ten meters separated each quadrat.

Wooden calipers were used in making the DBH. measurements. All stems one inch or over in diameter were measured and recorded. Stems with a diameter of less than one inch but one meter or more in height were also counted. Results of this quadrat survey are presented in tables I and II. Tables include diameter size-classes, frequency index, basal area, basal area per acre (approx.), and abundance. Basal area computations do not include those stems under one inch DBH., which are presented simply to show what is occurring in the dynamics of reproduction. The quadrats were taken in January, 1947.

OBSERVATIONS

In the Crawford woods survey, 23 different woody species were recorded. These included 14 tall trees, 4 small trees, 2 shrubs, and 3 lianas.

A study of table I indicates almost total control of the crown cover by *Fagus grandifolia.* Fagus is far ahead of any other tall tree species in total basal area (17,887 sq. in.), being very distantly followed by *Carya ovata* (1,220 sq. in.), *Nyssa sylvatica* (713 sq. in.), and *Liquidambar styraciflua* (486 sq. in.).

Fagus also leads in frequency (100%), followed by *Carya ovata* (80%), *Nyssa sylvatica* (80%), and *Liquidambar styraciflua* (76%) (table I). *Fagus grandifolia* is the only tall tree species showing high representation in all stem-diameter size classes. Nyssa and Liquidambar are also present in a majority of the stem-diameter classes, but their quantity does not nearly equal that of Fagus in most cases, especially when the higher diameter categories are checked (table I).

Fagus again shows prominently in stem abundance below one inch DBH., with a total of 171 stems counted. In this respect, Fagus is followed by *Fraxinus americana* (109), *Liquidambar styraficlua* (97), *Nyssa sylvatica* (92), and *Carya ovata* (49) (table I). *Fraxinus americana* makes a good showing in this small stem category, but is entirely absent in the larger diameter classes.

A total of 877 stems were recorded in the 25 quadrats taken in the survey. It is interesting to note that *Acer saccharum* is not present, and that *Acer rubrum* is only sparsely represented in the survey results (table I). *Fagus grandifolia* is by far the most prominent tall tree species encountered, leading in basal area, frequency, abundance, and most of the stem-diameter classes (table I).

DISCUSSION

Upon a perusal of the Crawford woods survey results, one immediately notices the almost complete dominance of the crown cover by *Fagus grandifolia.* McCoy (6) and Keller (4) had previously noted the great abundance of this species in poorly-drained regions such as the Crawford woods, as well as in more mesophytic habitats where soil moisture conditions are still adequate for its growth and reproduction.

The high frequencies of Nyssa, Liquidambar, and *Carya ovata* are quite in line with results of previous studies in the area (4, 6), especially in the more poorly-drained regions. *Acer rubrum* has also been shown to occur prominently in the forest cover, but its presence in the Crawford woods is negligible, even though the level terrain presents ideal conditions for the establishment of this species.

It is interesting to note that *Fraxinus americana* is high in number of young stems, but is completely absent from the larger stem-diameter classes (table I). Three factors, acting singly or as a unit, may explain the apparent deficiency of this and other species in the larger stem-size brackets. These are: (1) good germination but a high mortality rate, (2) intolerance after the initial stages of growth, and (3) the possibility that these species are late invaders of the area. Weaver and Clements (10) state that various woody species tend to remain tolerant during the early growth years, but lose this ability and drop from competition with maturation. Griffin (3) has concluded that in a flood-plain forest, where soil moisture is always adequate, elimination of stems is largely the result of the light factor. Since the poorly drained Crawford woods apparently does not lack for sufficient soil moisture throughout the growing season, it seems entirely likely that the light factor does play a part in eliminating certain tall tree species from a place in the crown cover. The high mortality of certain species, particularly *Acer saccharum*, has been previously noted by Potzger and Friesner (8), who found Acer to show excellent germinative powers, but greatly reduced ability to develop into the mature tree.

McCoy (6) and Keller (4) observed the absence of *Acer saccharum* from the more poorly drained forest sites. Potzger and Friesner (8), while surveying central Indiana forests, noted that *Acer saccharum* ranges from mesophytic to drier habitats, but rarely invades, with success, more hydrophytic areas. Friesner and Ek (2), in their study of micro-climate and species distribution in Shenk's woods, felt that soil aeration was probably the "critical" factor limiting the distribution of *Acer saccharum*. The author in a recent survey of two contrasted forest stands in the Illinoian Drift Plain (9), has also come to feel that drainage, soil structure (including soil aeration) and surface moisture are the most important conditions delimiting the presence of this species in the area. Keeping these

points in mind, it seems likely that considerable modification in drainage and soil structure would have to occur before *Acer saccharum* could successfully invade the Crawford stand.

The fact that only 23 different species were recorded is further indicative of the rigorous micro-climatic factors controlling species distribution throughout the Illinoian Drift Plain. McCoy (6) lists from 18 to 30 species, Keller's Klein woods survey (4) also disclosed 30 species, and the author's previous quadrat study (9) showed only 23 species. In contrast, Potzger and Friesner (8), in their study of central Indiana forests, listed 61 species in the Acer-Fagus type of forest, and 58 species for the Quercus-Carya type.

An examination of the survey results indicates that the Crawford woods is not a virgin stand, but rather is in a mature stage of secondary succession. Potzger (7) has found that a mature forest supports less than 300 stems per acre, and the Crawford stand, with a total of 877 stems counted in only 25 quadrats, has a considerably higher number. Viewing the almost absolute dominance of Fagus in the Crawford stand, and its apparent stability in the formation as evidenced by the number of young seedlings and excellent representation in all stem diameter classes, it seems likely that the edaphic modifications presented above will definitely have to occur before the true Acer-Fagus climax can be attained.

SUMMARY AND CONCLUSIONS

1. Presented in this paper are results of an ecological study of the Crawford woods, a forest stand situated in the Illinoian Drift Plain area of southern Indiana.

2. Results are based upon twenty-five 100-square-meter quadrats.

3. The Crawford woods, a level area with little or no drainage, has a crown cover almost completely dominated by *Fagus grandifolia*. Among the tall tree species, Fagus leads in basal area, frequency, abundance, and most of the stem-diameter size classes (table I).

4. Other tall tree species appearing to a lesser extent in the crown cover, but showing high frequencies, are *Carya ovata, Nyssa sylvatica,* and *Liquidambar styraciflua.* Nyssa and Liquidambar are present in many of the stem-diameter divisions, but their presence, in quantity, is limited to the smaller classes.

5. *Fraxinus americana* is high in number of stems below one inch, but is absent from the larger stem-diameter classes. There is a possibility that this species is a later invader in the Drift Plain area, requiring edaphic modification before it is able to successfully invade and ecese. It is also suggested that a high mortality rate and intolerance after the initial stages of growth may be factors limiting its presence in the area.

6. *Acer saccharum* is not present, and *Acer rubrum* is only sparsely represented, although the area presents ideal conditions for the establishment of the latter species.

7. In view of the prevalence and apparent stability of Fagus in the Crawford woods, it seems likely that edaphic modifications (improved drainage and increased soil aeration) will have to occur before the true Acer-Fagus climax can be reached.

ACKNOWLEDGMENT

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LITERATURE CITED

1. Braun, E. Lucy. Forests of the Illinoian Till Plain of southwestern Ohio. Ecol. Monog. 6:89-150. 1936.
2. Friesner, Ray C. and Charles M. Ek. Correlation of microclimatic factors with species distribution in Shenk's woods, Howard County, Indiana. Butler Univ. Bot. Stud. 6:87-101. 1944.
3. Griffin, Charles D. A study of ahundance of stems per acre in relation to age of stand. Butler Univ. Bot. Stud. 8:219-232. 1948.
4. Keller, Carl O. An ecological study of the Klein woods, Jennings County, Indiana. Butler Univ. Bot. Stud. 8:64-81. 1946.
5. Malott, Clyde A. The physiography of Indiana. Indiana Dept. Conservation Pub. 21:59-256. 1922.
6. McCoy, Scott. A phytosociological study of the woody plants constituting twenty-five type forests of the Illinoian Till Plain in Indiana. Indiana Acad. Sci. Proc. 48:50-66. 1939.
7. Potzger, J. E. The phytosociology of the forest primeval in central northern Wisconsin and upper Michigan. Ecol. Monog. 16:211-250. 1946.
8. ——— and Ray C. Friesner. What is climax in central Indiana? A five-mile quadrat study. Butler Univ. Bot. Stud. 4:181-195. 1940.
9. Secor, Jack B. A comparative ecological study of two forest stands in the Illinoian Drift Plain area of southern Indiana. Butler Univ. Bot. Stud. 9. 1949.
10. Weaver, J. E. and F. C. Clements. Plant Ecology. McGraw-Hill Co., New York. 1938.

TABLE I

Results of twenty-five 100-square meter quadrat study in Crawford Woods.

Species	Diameter Size Classes									Total Stems Above 1 in.	Total Basal Area in Sq. In.	Approx. Basal Area per Acre in Sq. In.
	Below 1 in.	1	2	3-5	6-10	11-15	16-20	Over 20	F. I.			
Acer rubrum	8		1		1			1	24	3	584.226	934.762
Asimina triloba	17								8			
Carpinus caroliniana	4		1						12	1	3.141	5.026
Carya ovata	49						3	1	80	4	1,220.278	1,952.345
Celtis occidentalis	1								4			
Cornus florida	7								8			
Evonymus atropurpureus	23								24			
Fagus grandifolia	171	12	4	2	4	12	45	11	100	78	17,887.193	28,619.509
Fraxinus americana	109	2							60		1.570	2.512
Juniperus virginiana	11	1							40		0.785	1.256
Lindera benzoin	12								12			
Liquidambar styraciflua	97	6	1	3		2	1		76	7	486.854	778.966
Liriodendron tulipifera	8	1	1	1		1			32	3	186.889	299.022
Morus rubra	2								8			
Nyssa sylvatiea	92	13	10	10	4	1	1		80	26	713.001	1,140.802
Platanus occidentalis	1								4			
Prunus scrotina	4								12			
Quercus alba	11		1						28	1	3.141	5.026
Q. michauxii	1								4			

TABLE I—(Continued)

Results of twenty-five 100-square meter quadrat study in Crawford Woods.

Species	Diameter Size Classes									Total Stems Above 1 in.	Total Basal Area in Sq. In.	Approx. Basal Area per Acre in Sq. In.
	Below 1 in.	1	2	3-5	6-10	11-15	16-20	Over 20	F. I.			
Rosa sp.?	3								4			
Sassafras albidum	2				1				12	1	28.269	45.230
Smilax rotundifolia	78								40			
Ulmus americana	3	1	1		1	1			20	3	164.902	263.843