An ecological survey of the Crawford Woods, Clark County, Indiana

Jack B. Secor

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Butler University
Botanical Studies
(1929-1964)

Edited by

Ray C. Friesner
The Butler University Botanical Studies journal was published by the Botany Department of Butler University, Indianapolis, Indiana, from 1929 to 1964. The scientific journal featured original papers primarily on plant ecology, taxonomy, and microbiology. The papers contain valuable historical studies, especially floristic surveys that document Indiana’s vegetation in past decades. Authors were Butler faculty, current and former master’s degree students and undergraduates, and other Indiana botanists. The journal was started by Stanley Cain, noted conservation biologist, and edited through most of its years of production by Ray C. Friesner, Butler’s first botanist and founder of the department in 1919. The journal was distributed to learned societies and libraries through exchange.

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.

Requests for use of materials, especially figures and tables for use in ecology text books, from the Butler University Botanical Studies continue to be granted. For more information, visit www.butler.edu/herbarium.
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.

The Crawford Woods are located approximately one mile south of the southern-most point of the town. The terrain is generally beechned. Soils are generally well drained, and the presence of forest cover is probably typical of oak species, since the forest cover is inadequately stocked with them.

This study was conducted in a 100-meter square, which was divided into ten 10-meter squares, each of which was divided into four 10-meter sections. A 10-meter section was subdivided into four 2.5-meter sections, and a 2.5-meter section into four 1.25-meter sections. The total number of quadrats was 16 per 100-meter square.

Wooden circles, 10 meters in diameter, were placed at the corners of the quadrats, and the trees were measured and identified. All stems one inch in diameter or larger were measured, and the frequency and abundance of each species were recorded. The results are presented in the following tables.

The data were collected in January, 19...
This study is based upon data obtained from twenty-five 100-square-meter quadrats. Quadrats were laid 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.

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 styraciflua* (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 stem mortality rate (3) the possibility of young stems being shown in the Crawford woods presents ideal conditions for the development of young stems (table I).

It is interesting to note that *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).
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 Illinois 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.
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occurs before Acer saccharum
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and Friesner (8), in their study
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us-Carya type.
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that a mature forest supports
Fagus in the ability in the formation as evi-
dings and excellent representation likely that the edaphic modifica-
have to occur before the true

CONCLUSIONS
results of an ecological study of
situated in the Illinoian Drift
-five 100-square-meter quadrats.
a area with little or no drainage, dominated by Fagus grandifolia.
leads in basal area, frequency, 
eter size classes (table I),
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are Carya ovata, Nyssa sylvatica,
and Liquidambar are present in
but their presence, in quantity, is

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 in-
vade and cease. 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 (im-
proved drainage and increased soil aeration) will have to occur before
the true Acer-Fagus climax can be reached.

ACKNOWLEDGMENT
The writer is grateful to Dr. Ray C. Friesner for his suggestion of
the problem and aid in laying out the quadrats and in making the
tablulations.

LITERATURE CITED
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**TABLE I**—(Continued)

Results of twenty-five 100-square meter quadrat study in Crawford Woods.
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TABLE I—(Continued)
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