

Indiana Botany in Retrospect

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It would be difficult to pinpoint the beginnings of botany in Indiana. The early European settlers, like the prehistoric inhabitants who had been here for centuries, made profound observations at their levels of understanding and accumulated much information about the beneficial and harmful properties of the plants that they found around them. They knew which plants could be used for food, which should be avoided, and which had medicinal properties. They were especially well acquainted with the durability, strength, elasticity, and other physical properties of the many kinds of wood, and they recognized many fundamental ecological relations. They doubtless noted also many other interesting plant characteristics which they were not immediately able to put to use. This primitive lore is often brushed aside as of little consequence, but when we sift it judiciously, we find in it much to command respect. Although practically none of it was ever published and little was even written in letters or diaries, it was, in quality, not far behind what was known about plants in Europe up to late Medieval times.

Whether we should dignify this volume of knowledge by calling it *botany* is a matter of definition. Etymologically, the word refers to food value, and in this sense, these early observers were truly botanists. But if we prefer to reserve the term for more sophisticated activities, involving precise observations, good records, better organization, possibly some experiment, and a degree of theoretical consideration, some time was yet to elapse before real botany made an appearance in Indiana.

Early Floristics

The first studies in our area to measure up in any substantial degree to this latter definition of botany were made in the closing years of the eighteenth century and the beginning of the nineteenth, before Indiana became a state. Some of the early visitors had far more than a mere utilitarian interest in botany and brought with them the more or less refined techniques in use in the eastern states and in Europe. In a list of these, we find such names as Rafinesque, Michaux, Thomas, Nuttall, Lapham, and Maximilian, along with many others with more diverse interests including botany. The work of these men was summarized in some detail by John Merle Coulter and mentioned incidentally by W. S. Blatchley, Barton W. Evermann, and others in the Indiana Centennial program of this Academy fifty years ago.

As these pioneer botanists began to explore the new area with its rich and unknown flora, their main interest was in collecting and naming the plants and preparing herbarium specimens for their own use and for exchange with other collectors in the more advanced cultural centers. Their interests were limited mainly to the vascular plants. This was a kind of activity well adapted to the time and place. It required only a minimum of technical training and no elaborate equipment, and it provided answers for many of the urgent questions that

were being asked about the plants of the New World at that time. It is the natural approach to the botany of any underdeveloped country and one that can still be profitably engaged in in many parts of the world.

This phase of the history of botany in Indiana will be treated more fully in other parts of this program, but it is introduced here as a bridge to certain other points frequently overlooked. These botanists are usually thought of as taxonomists, but few of them were really systematists in the modern sense of the word. They recognized similarities and differences as guides to what was then a useful classification, and they attached names to plants which could be used in talking or writing about them, but, except for an occasional maverick like Rafinesque, they were restricted by the idea of the immutability of organisms and the fixity of species. Without any sound and generally accepted concept of evolution, they had nothing to give to systematics a philosophical basis of meaning.

In these early floristic studies there was also as much geography as taxonomy. This is reflected by the prevalence of lists of plants limited to counties, river valleys, the environs of certain towns, or the State as a whole. A sophisticated systematics certainly recognizes distributional boundaries, but these do not often coincide with lines separating political divisions. There is no intention here to discount the value of regional catalogs of plants. They will always serve useful purposes, but they usually do not solve many problems of theoretical systematics.

A vast wealth of information, not necessarily a part of the taxonomic picture is also to be found in these early publications. The pioneer botanist had a deep human interest in plants and an active and widely ranging curiosity. He often noted interesting characteristics beyond those useful as guides to classification, such as unique economic values, striking morphological features, adaptations to soil, moisture, and light, and many baffling variations which have since yielded to physiological or genetic analysis. A perusal of Deam's *Flora*, the *Gray Manual*, Britton and Brown, or any other comprehensive treatment of this kind will disclose much of this lore still carried along. It is largely lost because the modern taxonomist employs criteria better suited to his purposes, and the morphologist, physiologist, or geneticist seldom has the patience to ferret it out.

A New Emphasis—1875 to 1900

As the nineteenth century passed the three-quarter mark, important world-wide changes were occurring in botany. The recently promulgated theory of organic evolution by natural selection was giving new meaning to everything. American botanists were going to Europe for graduate study and coming back to introduce new ideas at home. In due time, Indiana felt the impact of this catalyst. So here we part company with early floristics and look at some of the new developments. The spirit of the times may be sensed by examining the activities of this Academy as recorded in the first few volumes of its *Proceedings*.

For a time, morphology took the lead. It was passing out of the old, largely descriptive phase, in which investigators pictured what

they saw but usually had little framework of basic theory on which to attach their observations. The brilliant work of Hofmeister and others in Europe had shown that the many diverse life histories in the plant kingdom tended toward a common theme, and evolution was giving these homologies a rational basis. Men like Coulter at Wabash, Arthur at Purdue, Hay at Butler, and Jordan at Indiana were disseminating the new views with missionary enthusiasm in the backwoods of Indiana. This stimulated others to look for new items of information to fill in the gaps in the rapidly developing integrated picture. Since this picture could not be complete without them, the bryophytes, and then the algae, began to assume a prominent place in a range of studies which had been largely limited to the vascular plants. Some years were yet to elapse before the intricate life histories of most of the fungi could be incorporated.

Along with these studies centered largely in phylogeny came many isolated items of anatomy and histology which were ultimately to contribute to a background for physiology, pharmacology, and developmental morphology.

A few examples from the field of morphology in its broadest sense will give some concrete indication of what was happening. Before leaving for Stanford University in 1891, D. H. Campbell, of Indiana University, presented a few papers of a series which, continuing for many years, was to lead to his being recognized as an international authority on the liverworts, mosses, and ferns. D. M. Mottier read several papers on the cytology and embryology of angiosperms. Katherine Golden discussed a variety of subjects, such as the application of mathematics to botany, the use of the auxanometer in physiological investigations, and the anatomy of wood. Stanley Coulter spoke on topics related to forestry and plant anatomy. John S. Wright, who was to continue for so many years his generous support of the Academy, was discussing drug plants as early as 1892. Two or three early papers gave detailed description of apical meristems and contributed toward the abandonment of the older idea that an apical cell ought to be found in the tips of all stems and roots, at least below the level of the angiosperms. Besides all these, there were many other tantalizing titles of morphological papers which may have been read but were not published — some of them by investigators who have apparently disappeared from botanical history.

One important stimulus for the morphological studies of this period was the development of methods for making thin serial sections, and in the early meetings of the Academy there were occasional discussions of the paraffin and celloidin techniques and new methods of staining.

As plant morphology moved rapidly toward the brilliant climax at the end of the century, Indiana botanists continued to play significant parts. Chromosomes had been discovered, and the more readily visible aspects of cell division were described. With the discovery of meiosis and of fertilization in the angiosperms, the picture of the sexual life cycle was clarified. It was unfortunate, however, that meiosis was not at that time equated with fertilization in significance, and we were to

be saddled for a long time with the concept that the gametophyte was the *sexual* and the sporophyte the *asexual* generation.

An important phase of the morphological story passed its zenith at the very end of the century as the details of the embryology of the angiosperms were discovered. This definitely brought the flowering plants into alignment with the gymnosperms and cryptogams and almost completed the picture which Hofmeister had sketched in outline 50 years earlier. It also laid a firm foundation for the genetic structure which was soon to rise. For Indiana, it may be noted that many important contributions toward the completion of this picture were made by Mottier and his students. He had, for example, seen double fertilization in the lilies a few years before it was announced by Nawaschin and Guignard, only to have the discovery suppressed by the dogmatic Strasburger with whom he was studying.

Meanwhile, plant physiology was also developing, but at a slower tempo. We were well along in the twentieth century before physiology began to pass out of the stage of description and simple demonstration. Reasons for this are not hard to find. The close connections between biology and chemistry, which are now yielding phenomenal results, had not yet been established, and electricity, that versatile servant of all science, was still a fickle and poorly controlled agent. At the turn of the century, and even later, the comparative merits of direct and alternating currents for domestic use were still being debated. Take away from modern laboratories all the electric equipment for analysis and measurement, all the devices for the control of light and temperature, all the shakers, stirrers, centrifuges, etc., operated by simple motors, and all the electric computers, the x-ray techniques, and the electromicroscope, and you can begin to realize some of the limitations under which physiologists worked only half a century ago.

A few specific examples, some from even a later period, will emphasize this point. The basic experiments which established the principle of photoperiodism, just previous to 1920, were carried out, not by control of artificial light, but by carting the plants from greenhouse to dark room and back each day. A device in use at about the same time in the Bureau of Plant Industry for photographing experimental plants, consisted of a round table on which the plant and the camera could be rotated before an open window and illuminated on all sides.

To bring the illustrations closer home, as an undergraduate student at Indiana University in 1912, I performed some of my first physiological experiments with a spring-operated clinostat and auxanometer, which, when needing repairs, had to be sent back to the manufacturer in Germany. At Purdue, in 1895, they had devised equipment for maintaining a uniform head of water for operating similar equipment, since neither the water pressure nor the electric current was dependable. There also, a year earlier, they announced the completion of a "vegetation house," which seems to have been an unheated greenhouse in which experimental plants could be grown in summer. In 1912, Indiana University was petitioning the State legislature for steam heating equipment for the greenhouse, which was then being heated with a coal stove. It was common practice in those days to lower the temperature and

turn off the electricity in all classrooms and laboratories at night and on week-ends.

Several reports indicate that, in spite of these handicaps, botanists were plugging away on a variety of physiological studies, such as: nitrogen nutrition in wheat, periodicity in root pressure, symbiosis in orchids, ash content as an index to mineral nutrition, water culture methods, fermentation of some of the less common sugars, movement of the protoplasm in cells of aquatics, and the mechanism of abscission of leaves and twigs.

A notable contribution illustrating the state of plant physiology in those days was the presidential address of J. C. Arthur in 1893. Because of the prominence which he later achieved as a specialist in the taxonomy and physiology of the rust fungi, we might easily make the mistake of thinking that this was his only interest. In addition to his status as a mycologist, he was a fine example of the broadly trained oldtime botanist. In his address on "The Special Senses of Plants," he described many of the ways in which plants respond to stimuli and noted that their responses were usually advantageous, but he quickly refuted any teleological interpretations. He suggested that the spectacular behavior of the mimosa plant might protect it from hail. Plant tropisms had him puzzled. He cited experiments on the responses of roots to gravity and showed that the downward curvature was not the same as the bending of an inanimate, flexible rod. He concluded that the principal mechanism of tropisms was by movement of water, "complicated," as he said, "by growth and other conditions too recondite to be explained here." Before his death almost half a century later, he could, and doubtless did, reshape this statement to attribute tropisms to growth, regulated by auxins and complicated by the movement of water and other factors.

Stagnation—1900 to 1940

The first four decades of the twentieth century were not particularly fruitful of botanical progress in Indiana. There were some good studies in ecology and floristics, the latter culminating, in 1940, in the publication of Deam's *Flora of Indiana*, but there was little attention paid to taxonomy in the modern sense.

Morphological studies were continued, most of them tending toward the elucidation of taxonomic and phylogenetic problems rather than toward the development of morphology itself. Among these were a number of good contributions from graduate students, many of whom have gone on to successful careers in botany in Indiana and elsewhere.

Plant cytology remained largely at a standstill during this period. The old descriptive aspects of the subject had been pretty well worked out, and there was no one ready to give it the new life that it was receiving elsewhere through liaisons with either genetics or cellular physiology.

There was little substantial activity in plant physiology. Although the basic facts of photoperiodism had been established by 1920, Indiana added little to its further development or applications except for a few studies at Purdue University on the effects of light of different wavelengths. Studies begun there on plant respiration during this period

have since grown in significance. The very fruitful approach to the explanation of the mechanisms of plant responses through the action of hormones bypassed Indiana almost completely.

The most important work on plant genetics during this period was done at Purdue University in the improvement of crop plants, especially corn. Largely sidestepping an older program of corn breeding, mainly pre-Mendelian in character, a group of energetic young investigators there began to apply the new genetic principles soon after their rediscovery in 1900, and this led to an active role in the development of hybrid corn. Many of the leaders in this spectacular enterprise in later years—J. R. Holbert, George Hoffer, Glenn Smith, Ralph St. John, John Trost, and Arthur N. Brunson, for example—had at least brief connections with this program at Purdue.

With due credit given for the items of progress that we have noted, we must admit that Indiana did not keep pace with botanical progress in other parts of the country during these forty years preceding the second world war. For this lag there may be many explanations, but, as I look back over the years, I see what seem to me to be three outstanding factors operative at least in the two state universities which should have been taking a long lead. One of these, the one easiest to explain and substantiate, was a lack of financial support. It was a time of rapid increases in enrollment in colleges, demanding more classrooms, more equipment, and more teaching personnel, and most of the facilities needed for research, especially in such fields as physiology, were expensive. Industrialization had not yet produced a broad tax base, and public interest in higher education was not yet aroused. There was simply not enough money to go around.

Closely coupled with this lack of funds, there were often frugal and unimaginative administrative policies in both universities which failed to make the best use of the resources that were available. The third, and probably most important factor, was the static personnel in the two state universities. A survey of their departments of botany over a long period shows very few changes in staff, and the lack of a system of retirement kept aging men in positions of influence to the point where youthful initiative was suppressed.

For a brighter picture in the history of these forty years, we take note of some excellent undergraduate teaching, especially in the smaller, independent colleges. On the roster of great teachers of this period are the names of such men as Mason B. Thomas, at Wabash, T. G. Yuncker, at DePauw, Ray C. Friesner, at Butler, M. S. Markle, at Earlham, and many others. Eloquent testimony is given on this point by the long procession of graduates of these institutions who have gone on to advanced study and illustrious careers in botany. There is hardly a single one of the smaller colleges that cannot claim credit for at least some small part in this contribution.

Another significant educational enterprise carried on for many years during this period was the commercial manufacture of microscope slides by Professor M. S. Markle and some of his colleagues at Earlham College. Combining superior histological techniques with an uncanny consideration for learning processes, slides bearing the Markle label gave

to thousands of students far and wide, their first glimpse into the fascinating field of plant morphology.

Botanical Publication

In the founding and sponsoring of organs of botanical publication, Indiana has played a long and active role.

In 1875, John Merle Coulter, then at Hanover College, began publishing a little periodical known as *The Botanical Bulletin*. A year later, its name was changed to *The Botanical Gazette*, under which it continues to the present as one of the outstanding botanical publications of the world. The Gazette accompanied Coulter as he moved successively to Wabash College and Indiana University, and then out of the State in 1893.

The American Midland Naturalist was founded by J. C. Nieuwland, at the University of Notre Dame, in 1909. Like the *Proceedings* of this Academy, it publishes a wide variety of papers, many of them botanical. With a flexible and independent editorial policy, it publishes many articles which would automatically be ruled out of many other periodicals because of their length.

Since 1929, the *Butler University Botanical Series* has published at irregular intervals a series of articles, mainly by Butler students and faculty members, on many botanical subjects, especially ecology.

A short-lived journal which had been overlooked until brought to light by L. J. King in the *Proceedings* of this Academy in 1939, was the *L. B. Case Botanical Index*, published at Richmond from 1877 to 1881. At first scarcely more than a trade catalog, it quickly grew into a scientific publication with a circulation of 5,000. It carried a number of articles on the flora of Indiana.

The American Botanist, which began publication in Binghamton, N. Y., in 1901, was brought to Indiana when its owner and publisher, Willard N. Clute, came to Butler University in 1929. It ceased publication soon after Mr. Clute's death in 1950. Making no pretense at being a highly technical journal, it employed the popular approach with an assortment of items of human interest about plants.

Botanical Gardens

Since the State of Indiana has never had a really great botanical garden, the few attempts that have been made to establish such collections of living plants deserve special mention.

One of these gardens, at Butler University, and another established by the late Fred A. Loew, at Huntington College, have served as useful adjuncts to the educational equipment of these institutions. The garden at Huntington has, for many years, been the focus for an annual meeting which has done much to keep alive a public interest in botany.

The Holliday Park Garden and Woolen's Garden of Birds and Botany, both at Indianapolis, have had similar purposes, but have probably fallen short of their full possibilities through not being formally connected with educational institutions.

Near the beginning of this century, an elaborate plan was drawn up for converting the entire campus of Indiana University into a botanical garden, in which the plantings would reflect taxonomic relationships. For some reason, probably economic, the plan was never carried out, but the subsequent development of the area was directed by botanists for many years. The result is a fine, informal collection of plants, especially trees and shrubs, so located as to preserve most of the natural features of the original woodland. A program now in operation is adding many species to this collection. The Ross Biological Reserve at Purdue University and the Christy Woods at Ball State University serve similar purposes. A college campus would seem to be an ideal location for such a development at minimum cost.

Partial compensation for the lack of any large formal botanical garden is provided by our city and state parks, state and national forests, lake recreational areas, and special holdings such as those of the Nature Conservancy and many private individuals. Some of these, however, must operate as compromises between scientific interests on the one hand and recreational, economic, or political pressure on the other. A continued healthy public interest in plants and animals as living things is our best bargaining power for maintaining a favorable balance in this conflict of interests.

Current Trends

World War II has been followed by a period of scientific ferment which promises to continue bubbling for a long time to come, and botany in Indiana has been adding a creditable share of catalyst to the process. This influence is reflected to a certain extent in the number and quality of papers presented in the meetings and published in the *Proceedings* of this Academy. But these contributions do not tell the whole story, for many active investigators are finding outlets for expression through other, more highly specialized organs of publication.

This rebirth of vigor in all the sciences has been due to many things. Our war experiences and many subsequent developments created a new awareness of and interest in the sciences and a far greater public confidence in their practical and cultural values. This has released generous funds for education and research. But probably the greatest influence, as far as Indiana is concerned, has been the infusion of new blood into the stream of scientific activity through additions of vigorous, new personnel.

One striking manifestation of this scientific renaissance has been the fading of the rigid lines which have long been drawn between the various disciplines. The mycologist and phycologist no longer limit themselves to the publication of lists of species new to certain areas, but are finding in their taxonomic areas of interest many new approaches to basic problems of morphology, physiology, and genetics. The morphologist, without forsaking the descriptive and phylogenetic aspects of his subject, is looking for underlying chemical mechanism of development and differentiation. Physiology is penetrating deeply into the biochemical foundations of observed phenomena. Taxonomy, mourned as a dead subject only a generation ago, has come to life with the utilization of genetics, cytology, physiology, and mathematics to probe

deeply into phylogeny and the species concept. These are all world-wide trends, but in every one of them Indiana is now playing a most creditable role.

Research is no longer limited so much as it once was to the two older state universities. There is a growing recognition that productive scholarship is a significant function of college faculties and advanced students everywhere, and the college that is wise enough to support research activity with funds and recognition and flexibility of program is the one that will attract and hold the most stimulating teaching personnel.

To attempt to describe and evaluate the many botanical activities in progress in Indiana today would take us far beyond the scope of this discussion and involve the hazard of premature judgments. So that appraisal is left to some future narrator who can view this era in better perspective—perhaps to the one who will continue this story on the occasion of the Indiana bicentennial.

It seems very likely that, when this narrative is continued to include our current activities, it will be an account of our progress in solving broad biological problems rather than a history of botany and zoology as separate disciplines. The subject matter will be oriented around such topics as: the genetic code, enzyme and hormone actions, protein synthesis, theories of phylogeny, organic evolution, the origin of life, and, quite likely, extraterrestrial life. The emphasis will fall on the development of general principles, and botany and zoology will have receded to secondary roles in the drama.

The vigor with which we are now engaged in erasing the lines that used to separate the conventional divisions of science sometimes leaves the impression that the original recognition of botany, zoology, physics, chemistry, and geology, and their further fragmentations into specialties, was some sort of academic sin for which we must now seek atonement. But there was very good reason for making these divisions. It was the simple principle of divide and conquer. What we are now doing is to cut through the extensive and complex volume of subject matter in new directions so that we can employ new techniques to carry out this ancient strategy of conquest. And it would be naive, indeed, to expect that these new subdivisions would not, sooner or later, come to have defects of the same order as those inherent in the system that we now try to eliminate.

The pendulum of biologic thought and interest is always swinging this way and that in conformity with fashions and the development of new techniques. It seldom tarries long on dead center, and it is in the long swings that our greatest progress is made. But it is usually a lopsided progress, and, when we are riding the crest of a wave of popularity and success, we are prone to the very human failing of thinking that we have at last found the only true *open-sesame*.

For botany it is particularly regrettable that, in a highly specialized search for principles, we so often relegate the plants themselves to the background. It is, after all, the individual plant that counts. It is the entity that we are trying to understand. It is necessary that we

take it apart and concentrate on its separate organs and processes, but it is equally important that we frequently put the pieces together again to see how they contribute to form and function in the living individual. It is only when botany does this that it can have its broadest cultural impact on mankind.