A Brief History of Biology at Indiana University

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Indiana University is the oldest state university west of the Allegheny Mountains.[1] It was established by law as the Indiana Seminary by the legislature in 1820, became Indiana College in 1828, and Indiana University in 1838. The university became coeducational in 1867. Biology Hall now Swain East was finished in 1910. Jordan Hall of Biology was occupied in 1955.

The first self-conscious courses in biology were offered in Bloomington in the academic year 1853-1854, but even as early as 1828 *John H. Harney* was appointed to teach mathematics and "such of the natural sciences as were considered of sufficient importance to engage the attention of aspiring youth." The faculty at that time consisted of three professors. We do not really know what was taught in the early days, but we may surmise from the textbooks used that there was a lot of anatomy, a little embryology and physiology, some biogeography, and much systematics. Certainly not the smorgasbord of modern biology from which students may choose today.

The early socialistic experiments of *Robert Owen* at New Harmony, Indiana, produced an important feedback with the addition of Robert Owen's son Richard to the I. U. faculty in 1864. *Richard Owen* was a remarkable man. He graduated from the Nasvhille Medical College in 1858, but apparently never practiced medicine. He commanded the 60th Indiana Volunteers during the Civil War, and must have been an exemplary officer because in the entry to the I. U. Memorial Union is a tribute to him provided by contribution from Confederate prisoners who were confined in the prison camp which he commanded. There is no group of people under the sun less likely to thus honor a man without due cause.

Richard Owen's chief interests were in geology rather than biology as such, but to judge from the records, a great deal of zoology and botany were included in his teaching. Even the then new ideas about organic evolution were not neglected although they were probably not as central a theme as they are today. Richard Owen, in his teaching, often mentioned the names and work of such greats as Cuvier, Linnaeus, Darwin, and Huxley. By the 1869-70 academic year, zoology and botany appeared as separate courses among the natural sciences.

Richard Owen's tenure at I. U. terminated in 1879. He was followed by a more remarkable man, *David Starr Jordan*, after whom Jordan Hall, Jordan Avenue, and the Jordan River were named. The manner of Jordan's appointment is somewhat curious. He was then teaching at Butler University in Indianapolis and came to Bloomington to speak on behalf of a friend who sought an appointment at I. U. The trustees unanimously voted to offer the professorship of natural sciences to Jordan. Later in 1884 a somewhat similar incident resulted in Jordan's accedence as president of the university. He had been asked to recommend someone else and again was unanimously selected. *David Starr Jordan* may have been the last person anyone would want to send to speak for him, but there is absolutely no imputation that he was not a man of the highest moral and ethical character.

1. I. U. is actually the oldest established by a state legislature. Michigan claims precedence as a church-related college before statehood.

Jordan did not assume his duties as Professor of Natural Sciences immediately. As *W. J. Moenkhaus* commented in the *Indiana Student*, although he was appointed in 1879 he was granted a year off to go fishing. Actually he was collecting fish in the Pacific Northwest under the auspices of the U. S. Fish Commission. During his years at I. U. he continued his research on fish, and aquatic biology has remained one of the strong areas in I. U. biology down to the present.

Following the leadership of Jordan, biology, and later the whole curriculum of the university, was changed. I think we can say that it was modernized because we still maintain many of the central themes of Jordan's reforms. One of these is the free elective system under which a student has "the right to choose in accordance with his own powers and tastes." Of course we have had to provide some guidelines for this procedure to protect the guileless ones. In 1886-87 the university curriculum was reorganized on the major subject and departmental basis.

In the summer of 1883 an event occurred which greatly modified the future of I. U. This was the burning of the then new Science Building near what is now College and West Second Street (now designated "Seminary Square"). The loss of the Science Building with all the collections and library spurred a move on the part of the university to its present site on what was then called Dunn's Woods. Owen and Wylie Halls, named after *Richard Owen* and *Andrew Wylie* (the first president), were the first buildings erected in the central quadrangle. A wooden structure still standing may have been the first building on the new campus to have classes held in it.

An interesting little sidelight on the library was that after a new library was organized, the loss due to the 1883 fire turned out not to have been as great as it might have been. A number of professors had all the important books in their fields in their offices or at home, and after the new library was available books which were thought lost began to be returned.

In 1884 Jordan became president and was free to use his charismatic personality on the trustees and faculty. He brought about a veritable revolution in biology and in the university as a whole. Despite his administrative duties, he continued his own research. Years later, *Barton W. Everman*, the co-author with Jordan of massive works on the fishes of North America, paid this homage to Jordan at a meeting of the Indiana Academy of Science which Jordan helped to found in 1885:

> "The greatest impetus ever given to zoological research and investigation in Indiana occurred when *David Starr Jordan* came to Indiana in 1874 as a teacher of natural history.The twelve years spent by Dr. Jordan at Indiana University were among the most productive of his life, not only in relation to zoological science in general, but to zoology in Indiana in particular. The influence upon the state was epoch-making. The effect of training so many of its young men and women in methods of science and sending them out over the state and beyond its borders imbued with the spirit of the real naturalist who seeks truth, who sees things as they are, and who knows animals when he meets them in the open, cannot be overestimated. Many and varied were the problems in zoological science that these young men and women investigated, studied, and attempted to solve. They were by no means confined to the fauna of Indiana. In Ichthyology their field was world wide. It is true, however, that the richness of the Indiana fauna appealed to many of these young naturalists, and the zoological literature has been greatly enriched by their contributions."

Jordan's influences were not confined to zoology. The teaching in botany, geology, chemistry, and other areas was affected by his ideas and reforms. When he left in 1891 to become president of Stanford University, he was succeeded as head of the Zoology Department by *Carl H. Eigenmann*, who was succeeded by *Fernandus Payne*, who was succeeded by *Theodore W. Torrey*. These three men bridge the gap between the 19th century and the present.

I cannot leave *David Starr Jordan*, however, without a few comments. He made many important contributions to the educational program at I. U. including the summer session and extension education. Yet in his voluminous correspondence he seldom mentioned I. U., but dealt extensively with the importance of his own research. He was an elitist in education although it must be admitted an elitist of intellect not wealth or political power. He left precipitously in 1891, apparently with little regret although he made a moving address to the faculty and students on his departure. Rumor has it that *Leland Stanford* offered him a bonus for each top-notch faculty member he took with him. His bounty hunting cost I. U. 12 of the best of its then 29 faculty members. Even more heinously, he also took with him 39 of the best students including the cream of the football team.

The Botany Department (later Plant Sciences), established by Jordan in 1885, has had an equally distinguished series of leaders. *John Merle Coulte* (1851-1928) was president of I. U. from 1891 to 1893 and also taught a course in botany. Bacteriology was first offered separately in 1896, and a full curriculum was introduced in 1940 by *Leland McClung*. This remains as the core of Microbiology. This field too has had active and able leaders beginning with McClung, *Howard Gest*, *Dean Fraxer*, and *Eugene D. Weinberg*. Recently the three former departments were united under the Department of Biology with *John Preer* as first chairman.

With *Carl H. Eigenmann* we enter the modern period of biology at Indiana University. Eigenmann's interests were primarily in fishes, but he and his students undertook studies of many aspects of evolutionary biology. He established in 1895 one of the first field stations in the United States at Turkey Lake (now called Lake Wawasee). The original objectives were to study the fauna, flora, and environmental factors in detail to see what correlation they had with the variation of organisms. Eigenmann became Professor of Zoology in 1891 and in 1894 Dean of the Graduate School. His influence was considerable. He assembled about him a faculty of able people, and at the time of his death in 1927 the biology faculty included *Will Scott*, *Fernandus Payne*, *A. C. Kinsey*, *David M. Mottier*, *Paul Weatherwax*, *Frank M. Andrews*, and *James Van Hook*. By this time physiology and anatomy had more or less drifted away following a separate course correlated with the medical program.

When Eigenmann died in 1927, the reins of Zoology and the Graduate School passed to *Fernandus Payne*. During his tenure, biology at I. U. reached one of its highest points. Distinguished faculty were added to all the science departments as well as biology. These included among others in zoology protozoologist *Tracy M. Sonneborn*; Nobel Laureate geneticist *H. J. Muller*; endocrinologists *Robert L. Kroc* and *William R. Breneman*; limnologists *William Ricker*, *Louis A. Krumholz*, and *Shelby Gerking*; ecologist *Lamont C. Cole*; biochemist *W. J. van Wagtendonk*, and embryologist *Theodore W. Torrey*. Botany added geneticist *Ralph E. Cleland*, biosystematist *Charles B. Heiser*, physiological ecologist *Stanley Cain*, mycologist *Harold J. Brody*, algologist Richard C. Starr, and physiologist *Charles W. Hagen*. Bacteriology was established as a separate department in 1946 under *Leland McClung* and added among others *Irwin C. Gunsalus* and *Salvador E. Luria* (later Nobel Laureate).

With the coming of the 20th Century the directions of biological research began to change. The rediscovery of Mendel's work was one important event. In part this discovery had a retarding effect on the development of biology. The "billiard ball" theory of genetic inheritance died hard. Today with discoveries in many organisms of multiple genes, duplicate genes, and even "jumping" genes this theory seems riduculous. It had, however, great appeal to some. It restored some of the stability which seemed to have been lost with the introduction of the concept of chance mutation acted upon by natural selection and the inception of the relativistic concept of the universe.

One of the greatest appeals of Darwin's proof of the fact of organic evolution was the neatness with which it fit the already established classification of animals and plants which had been worked out without any such process in mind. The new genetic theory also, eventually, proved to explain and to correlate with facts already discovered especially in the field of cytology. The "dances" of the chromosomes in mitosis and meiosis made perfect sense when correlated with Mendel's genetic ratios.

Cary Joyce (1949) says that the role of the novelist is to help break through the crusts which form on men's minds. One of the I. U. botanists had observed the double fertilization in maize before the end of the 19th Century, but was so sure that he knew the real truth that he threw away the slides as "abnormal" thus losing the opportunity of first reporting a most important phenonmenon. Fortunately, all of the I. U. biologists did not have such encrusted minds. *Fernandus Payne* soon began introducing the new science of genetics despite opposition from some of the "old guard."

With the election of *Herman B Wells* as president in 1938 and with the aid of new state retirement laws much of the "dead wood" was chopped out of the faculty as humanely as possible. Linked with a concerted effort to attract teachers and researchers of distinction and the phenomenal growth of the University after World War II this produced a new revolution in biology and the university as a whole.

The role of *H. B Wells* in the development of biology at I. U. cannot be denied. He was dedicated to excellence in every area of university life, and dedicated himself to achieving it. Under his leadership I. U. grew from a small, provincial school into an internationally recognized center of learning and research. His support toward efforts to obtain excellence was unfailing. His defense of the academic freedom of his faculty was always positive. Without this positive support work such as that done by *A. C. Kinsey* would have been impossible.

The influence of *Fernandus Payne* as Dean of the Graduate School as well as chairman of the Zoology Department extended far beyond biology in the reorganization and growth of the University. He came to I. U. in 1902, a simple Indiana farm boy backed with a tradition of absolute honesty and hard work. He evolved into a master cytologist and an administrator of great ability. After taking the Ph.D. degree at Columbia University, where he worked with *E. B. Wilson* and *T. H. Morgan*, he returned to I. U. in 1909. He was chairman of Zoology from 1927 until 1948 when he was succeeded by *T. W. Torrey*.

Payne was a courteous, very formal man. In his teaching he made his students learn. At the dedication of Jordan Hall in 1955, one of his former students, then chairman of zoology in an Indiana college, remarked to me, "Popsy Payne's courses were tough. I hated them when I took them, but I later realized I learned more in them than in any others I took at I. U."

In research, Payne worked mainly in the field of classical cytology but before leaving I. U. for Columbia he had worked with *Drosophila melanogaster* and his

paper "Sixty-nine Generations in the Dark" is a classical disproof of Lamarkian principles. He worked on the structure of the insect egg and widely on the chromosome structure of insects. He was among the first to recognize the involvement of the mitochondria with the nuclear material during spermatogenesis. He became Professor Emeritus in 1951, but continued working on spermatogenesis in *Gelastocoris* and other insects, taught himself to use the electron microscope which he recognized as creating a new horizon in cytology, and completed an intensive study of the cytology of the endocrine glands in aging. As a student he took *Drosophila melanogaster* from Bloomington to Columbia, and although he never acknowledged the source *T. H. Morgan* soon adopted it as an experimental animal. He was working on a final paper only a short time before his death. (See also Meserve, 1981, p. 5.)

One of the innovations of Jordan, Eigenmann, and *Fernandus Payne* was the attempt to involve all students in biology in basic research. Under Jordan many undergraduate students already had one or more research publications to their credit before graduation. The policy was not publish or perish but publish with pleasure. Many of those students never forgot that lesson and went on to distinguished careers in biology and other fields. With over 30,000 students on the I. U. Bloomington campus today we have had to modify this policy, but we still attempt to involve as many undergraduates as possible in research either during the regular semesters or the summer sessions.

Another concept stemming from long ago is that in graduate studies a student at I. U. must work with one of the faculty members competent to direct him and preferably directly in the area of that faculty member's interest.

The following notes on some of the biologists who have worked at Indiana University may be of interest to students. I have tried to include some analysis of their biological research as well as their service to Indiana University as teachers or administrators. T. W. Torrey's unpublished supplement to his 1949 paper should be consulted for details of several programs and individuals, especially for details of the sex research program initiated by *A. C. Kinsey*.

Research and Teaching at Indiana University

Anatomy and Physiology

The department of Anatomy and Physiology was separated from Zoology in 1904 after the establishment of the medical school. *W. J. Monenkhaus*, a student of Eigenmann's, was the first chairman. Later, anatomy and physiology were placed in separate departments and still later recombined. The development of the teaching and research programs in this area was largely tied to the medical program. Important research continues in these areas both at Bloomington and in Indianapolis, but much of its history is more closely related to medicine than biology as considered here.

However, I. U. physiologists and anatomists also have contributed basic studies in their areas. Currently *Roderick A. Suthers* is doing important studies on acoustic behavior in bats, and *Henry D. Prang* is studying the basic physiology and behavior of sea turtles. *Robert W. Bullard* did important work on comparative physiology of vertebrates at I. U. from 1956 until his untimely death in 1971. *Sid Robinson* did research on the physiology of exercise from 1930 until after his retirement, and *Bruce Dill*, after retiring at Harvard University, also worked here. Workers in other divisions of the University have also made extended studies in the physiology of exercise; notably *John M. Cooper* in the School of Health, Physical Education, and Recreation, and *James E. Counsilman* in the same school.

Aquatic Biology

With the interests of *David Starr Jordan* and *Carl Eigenmann* centered in fishes, aquatic biology had an early start at I. U. Eigenmann made pioneering studies on the blind fish of the cave system in what is now Spring Mill State Park. *A. M. Banta*, later at Brown University, did research as an undergraduate on the fauna of Mayfield's Cave just west of Bloomington, and other students made studies of aquatic habitats as well as fishes.

The development of a modern program in aquatic biology, however, began with the appointment of *Will Scott* as instructor in 1908. He received the A. B. and A. M. degrees from I. U. that same year and the Ph. D. in 1911. For many years he taught the large beginning course in zoology and directed students in work on lake and stream morphometry and sedimentation as well as in more directly biological studies. His primary contribution was as a teacher and as director of the I. U. Biological Station at Winona Lake from 1920 until his death in 1937.

The I. U. Biological Station had by this time become the principal site at which summer courses in biology were offered by I. U. Even such courses as comparative anatomy, histology, microtechnique, and embryology were offered there rather than on the I. U. campus. These courses were not moved to Bloomington until after Will Scott's death. The field oriented courses offered at Winona Lake inspired a number of later eminent biologists not only in aquatic biology but even in other disciplines.

As a man, *Will Scott* was a paragon. To quote *T. W. Torrey* (1949):

> "*Will Scott* was widely informed and that knowledge accrued to the benefit of the student. I have heard Doctor Breneman (*W. R. Breneman*) say that he learned more general biology in Scott's course in limnology at Winona Lake than from any combination of other sources. From personal experience I can attest that *Will Scott* was one of the kindest, most generous and thoughtful men I have ever known. Many instances of his help and kindly criticism come to mind. As a cub instructor I needed that help and he gave it unselfishly. In the same way he gave time and energy toward the betterment of the community. Science and humanity could use more men like *Will Scott.*"

The lacuna in aquatic biology was filled in 1939 by the appointment of *William E. Ricker* as assistant professor and director of the lake station. Ricker revived the research program at the station and at I. U. *Louis A. Krumholz* (1909-80) was added to the staff in 1945 and *Shelby Gerking* in the following spring under an agreement with the Indiana Department of Conservation. Ricker, Krumholz, and Gerking developed a strong program of lake and stream studies throughout Indiana. Ricker is widely known for his studies of fish biology, productivity, the dynamics of fish populations, and the application of mathematics to aquatic studies as well as his taxonomic studies on stone flies. He left I. U. in 1950 to return to his native Canada where he has since occupied important positions in fisheries research and conservation, and was elected to the Canadian National Academy of Science.

Ricker was succeeded in 1950 by *David G. Frey* who, together with Gerking, continued the program in aquatic biology. Frey's interest in the chydorid crustacea has extended the work of himself and his students far beyond the boundaries of Indiana—from Alaska and Southhampton Island to the tropics and into Europe and Asia. Frey's research on crustacea, the history of lakes, and other aspects

of limnology have become basic in several areas of limnology. (See also Eoyang, 1979, pp. 19-21.)

The Indiana University Biological Station and the Indiana Lake and Stream Survey

The Biological Station established at Turkey Lake in 1895 by Eigenmann flourished in its early days. As noted previously it was not until 1936 that the teaching of many summer courses was moved back to Bloomington. In 1899 the station was moved to Winona Lake, and in 1964 a new and modernized laboratory building was erected at Crooked Lake near Columbia City, Indiana. *Shelby Gerking* was instrumental in developing this new facility. The station continued as a center for research by faculty and students into the 1970s, but continuing changes in research interests led to its administrative transfer to the campus of Indiana University-Purdue University at Fort Wayne in 1980.

The Water Resources Center

The completion of the large Lake Monroe reservoir just south of Bloomington about 1967 brought various concerns about aquatic resources to focus. The Water Resources Research Center was established at I. U. and it was envisioned that the Crooked Lake Station, a new station for which land was acquired on Lake Monroe, and the Research Center would all be under the direction of a single director. The distinguished British limnologist *H. B. N. Hynes* accepted this post, but before arriving at I. U. had second thoughts and remained in Canada. The Research Center now directed by *Robert V. Ruhe* remains under the direction of the Geology Department, but the Lake Monroe station was never developed. (See also Meserve, 1981, pp. 12-16.)

Botany

Botany and Geology were separated from Zoology in 1885. *John C. Branner*, later a distinguished geologist at Stanford University, was the first in charge of both geology and botany. When he left with Jordan for Stanford in 1891, *John Merle Coulter* became professor of botany and president of the university. Coulter's research was primarily in the morphology of angiosperms and gymnosperms. He later published a number of botanical textbooks, one of which included the then new field of plant ecology (1911, with *C. R. Barnes* and *H. C. Cowles*).

David M(yers) Mottier (1864-1940) received his doctorate in Bonn in 1897. He had joined the staff at I. U. in 1891 as instructor and on his return from Germany remained with the department as associate professor, professor, and head until 1938. His research was primarily cytological, but he did some important work on the effects of centrifugal forces on reproductive cells and on the nature of plastids.

Associated with Mottier was *James M. Vanhook* (1870-1935). He was a student at I. U. and on the botany faculty from 1907-35. His work was primarily with plant pathology and mycology. *Frank M. Andrews* (1872-1940) was also associated with the department from his student days until his death. He taught and did research in physiological botany.

Paul Weatherwax (1888-1976) began his teaching career in a one-room schoolhouse near Worthington, Indiana, in 1907. He began college courses at DePauw University in 1909, and continued at Wabash College and I. U. His college training was interrupted several times by the necessity of returning to teaching in order to obtain funds, but he received the Ph.D. degree from I. U.

in 1918. After a brief period of teaching at the University of Georgia he returned to I. U. in 1921 and remained here until his retirement in 1959. He did not, however, stop teaching, and he taught at Franklin and Hanover Colleges until 1966. His teaching career thus spanned nearly 60 years.

His principal research interest was in the morphology of grasses particularly maize or Indian corn. His early interpretation of the structure of the corn plant, especially its flowers, was basic for the understanding of the origin of maize. His *Indian Corn in Old America* published in 1954 summarizes much of his research on maize. He was also an expert draftsman, and among other works illustrated C. C. Deam's *Grasses of Indiana* (1929).

Paul Weatherwax' principal contribution to Indiana University was through his teaching, but he was interested in every aspect of university life and contributed largely through his service on many committees. One of his last papers, *The Woodland Campus of Indiana University* (1966), is still a valuable guide for faculty, students, and visitors. (See also Meserve, 1981, p. 4.)

Ralph E. Cleland (1892-1972) came to I. U. as chairman of the Botany Department in 1938 from Goucher. He became dean of the Graduate School in 1950. He was an outstanding administrator, teacher, and research worker.

> "His position in the history of science is secure, and today he stands as the foremost student of *Oenothera* (the evening primrose). As a young scientist, he made the critical observations on the behavior and structure of the chromosomes that led to an understanding of the unorthodox genetic mechanism in *Oenothera*. This was followed over the years by a series of beautifully executed investigations on the evolutionary history of the genus. He remained active in research to the last, and his book *Oenothera, Cytogenetics and Evolution*, summarizing his life time work and that of others, was sent to press the day before his death." (Hagen *et. al.*, 1972)

He died at his desk in Jordan Hall June 11, 1972.

Herbarium of Indiana University

The herbarium of Indiana University is presently housed in Jordan Hall. It now contains over 100,000 accessioned sheets of specimens of vascular plants. Of these some 73,000 came from the collection of *Charles C. Deam* and are mainly the voucher specimens for his "Flora of Indiana" (1940), and other books.

The herbarium began bravely in 1892 under the direction of *Jonh M. Coulter*, but two years later on Coulter's move to Lake Forest College the herbarium went with him cases and all. The collection was begun again in 1895. Various students and faculty members contributed to the collection so that by 1931 it consisted of nearly 10,000 sheets. *Martha Springer* was instrumental in initiating an extensive program of exchanges from 1944 to 1947, when *C. B. Heiser, Jr.* became the curator.

Besides the Deam material the herbarium also houses part of an extensive collection of oaks made by *A. C. Kinsey* and important material from the studies of Heiser and his students who have worked extensively on wild and cultivated plants.

Drosophila Genetics

H(ermann) J(oseph) Muller (1894-1967) came to I. U. in 1945. He had previously taught and done research at the University of Texas, in Germany, the Soviet

Union, Scotland, and at Amherst College. He received the Ph.D. degree from Columbia University in 1916 under the direction of *T. H. Morgan*. His research interests were primarily with the fruitfly, *Drosophila melanogaster*. He made basic contributions in the area of linkage of genes, crossing over, multiple factor inheritance, the theory of the gene, gene mutations, chromosomal changes and their artificial production, the biological effects of radiation, the properties of chromosome parts, and in the broad area of evolutionary theory, speciation, and human genetics. His work on the effects of radiation resulted in his being awarded the Nobel Prize in 1946.

One of Muller's special talents was in the production of genetic strains of *Drosophila* with which various hypotheses could be tested. His designs, written mainly on small cards, showing the way into, through, and out of these crosses were often as intricate as those of any medieval necromancer. A significant difference was that Jo's diagrams worked. Several of his strains, such as the CIB, are still widely used in *Drosophila* genetics laboratories.

One of Jo's special concerns was the widespread abuse of diagnostic x-ray in medicine and dentistry with the associated hazard to both patients and operators. He gave a principal address at the 3rd International Congress of Human Genetics in Chicago in September, 1966, and his strong interest in the betterment of mankind through the application of genetics continued until his death in the spring of 1967.

The *Drosophila* laboratory at I. U. soon became a major national scientific resource not only for Muller and his students, but for others throughout the world. At first Muller operated it himself with the aid of graduate students and a few technicians. However, the task became so large and complex that a full time position of Research Executive was added. This position was first occupied by *Irwin Herskovitz*, followed successively by *Irwin Oster*, *S. Zimmering*, *W. Lee*, and *R. Reinhardt*, all of whom remain active in teaching and research at various universities and laboratories. *Helen U. Myers* and *Louise Petoe* were long associated with the laboratory. The majority of the *Drosophila* strains developed by Muller and his students are maintained at Bowling Green University, Ohio, at Pasadena, California, and in other laboratories.

Maize Genetics

Since Indiana is definitely in the corn belt of the United States, it is not surprising that a considerable amount of research on maize has been done in the state. I. U., however, was late getting into this field.

Mention has been made already of Paul Weatherwax' pioneer studies on the structure of the flowers in maize. He also encouraged the conservation of the Amerindian stocks of this plant which he considered to be of great value for future studies. He collected these stocks widely in Mexico and South America.

In 1958, *Marcus M. Rhoades* came to I. U. as chairman of the then Botany Department. He had already distinguished himself in cytogenetics of maize in the U. S. Department of Agriculture, at Columbia University and the University of Illinois. He is a member of the National Academy. He brought with him an active research program, and with the able assistance of *Ellen Dempsey* continues his studies in retirement. He and Dempsey have worked extensively on the genetic effects of heterochromatin.

Rhoades' early work at Cornell was on cytoplasmic sterility in maize. He also first recognized preferential segregation and neocentromere formation, and discovered that B chromosomes could induce loss of knobbed members of the regular chromosome complement.

In 1961, Rhoades was instrumental in bringing *Drew Schwartz* to I. U. Schwartz was one of Rhoades' first graduate student at Columbia. Schwartz introduced a new area of maize genetics in the study of isozymes. One of his goals is to determine what regulates gene expression, and how the controlling elements contribute to an organism's development. He continues a program of refined biochemical research on the genetics and other aspects of maize biology. (See also Meserve, 1981, pp. 11-14.)

Developmental Biology, Molecular Biology, and Microbiology

Although pioneer work on the embryology of the armadillo and the badger was done at I. U. by *G. W. D. Hamlett*, some of Eigenmann's work on the eyes of cave vertebrates can be considered developmental, and embryologists *Charles Zeleny*, later at Illinois, was in the Zoology Department from 1904 to 1909, intensive research did not begin until the appointment of *Theodore W. Torrey* to the Zoology faculty in 1932.

Torrey's research was mainly in the field of descriptive and experimental embryology of vertebrates. He studied the degeneration of nerves and sense organs, embryonic sense organs, and especially the embryology and physiology of vertebrate excretory organs. He worked extensively on the early embryogeny of the human kidney and was among the first to recognize that bone preceded cartilage in the evolution of the vertebrate skeleton.

His principal contributions to biology at I. U., however, rest upon his ability as a great teacher and a superb administrator. He was among the first to combine the then conventional comparative anatomy and embryology courses into an integrated developmental course. His textbook on developmental biology was highly successful and is still in print. He was instrumental in the planning of the general biology course for non-majors, and in establishing the Master of Arts for Teachers degree in cooperation with the then Botany Department.

As a departmental administrator *Ted Torrey* ("Terrible Ted" or "T-Square" to the students) had no superior and few peers. His management of Zoology's menage of primadonnas was masterful. He should have written a book on the care and feeding of intellectual tigers. Yet throughout there was never any feeling of neglect among those of us who did not attain international reputations. He was Chairman of Zoology from 1948 until the fall of 1966 when he was succeeded by *W. R. Breneman.*

Following World War II, the phenomenal growth of the university brought need of additional teaching faculty. *Sears Crowell* joined Zoology in 1948, and continues in retirement his research on the morphogenesis of coelenterates here at I. U. and at the Woods Hole Biological Laboratory in the summers. His discovery of stolon fusion in sessile coelenterates and the occurrence of compatible and incompatible strains is noteworthy. He also has used time-lapse photography to study the growth and tissue movements in hydroids.

By 1950, the outlines of the new biology were beginning to emerge, and this was especially apparent in embryology and genetics. Torrey (1968) points out that the physiological and biochemical factors that lie behind visible differentiation and morphogenesis began to be a focus of developmental biology. Attempts were being made to translate such concepts as induction, determination, potency, and gradients into measurable entities. There were hints that nucleic acids were involved in the synthesis of protein, and the first attempts to relate nucleic acids to gene reproduction were being made. Developmental, genetic, and molecular biology were converging. In recognition of the changing direction of research, a search was made for a young biologist in this field.

James E. Ebert joined the Zoology faculty in 1951 and remained until 1956. He did some of his pioneer work on the origin and early function of the vertebrate heart-forming proteins here, and produced a number of outstanding students still active in the field of experimental biology. He left in 1956 to become Director of the Department of Embryology of the Carnegie Foundation in Baltimore where he developed a magnificent program in developmental biology. He is currently president of the Foundation.

Robert W. Briggs came in 1956 upon Ebert's departure. He served as chairman of the Zoology Department from 1969-75. He is noted for his work in collaboration with *T. J. King* on the analysis of changes in embryonic nuclei by nuclear transplantation. At I. U., he and his students have worked on many aspects of embryology using the Mexican axolotl as a primary research organism. He continued his research until his death in 1983.

R(ufus) R(ichard) Humphrey (1892-1977) retired in 1957 after a distinguished career as Professor of Anatomy at the University of Buffalo School of Medicine. He moved his colony of Mexican axolotls and his research program to I. U. and continued working here until his death in 1977. During his long career he studied many aspects of amphibian embryology including anatomy of the testis, interstitial cells of the testis, origin of germ cells, sex reversal, genetics of sex determination, spontaneous and induced polyploidy, and the offspring of polyploids. The axolotl colony with its many strains and mutants has proven to be a valuable aid to research. About 1965 Humphrey produced an axolotl-type albino salamander by hybridizing an albino *Ambystoma tigrinum* with the non-albino white axolotl, *Ambystoma mexicanum.*

The boundary between developmental and molecular biology has become obscure in recent years, and just as those between zoology, botany, and microbiology have already faded, may soon disappear. Most of the workers in the preceding section could also be considered to be molecular biologists. This field has only become self-conscious in the last few years, but parts of it have been around for a long time. In modern biology the boundaries between various areas are definable mainly by the techniques employed so that departmental associations are now largely meaningless.

Salvador E. Luria taught and did research at I. U. from 1943 to 1950. His pioneer work on the genetics of bacteria and bacterial viruses won him the Nobel Prize in 1969.

Irwin C. Gunsalus was briefly at I. U. from 1947 to 1949. He continued his research on microbial biochemistry at the University of Illinois.

Roger Yate Stanier was briefly at I. U. from 1946 to 1947. His research here and at the University of California-Berkeley on the biology of the myxobacteria, bacterial metabolism, and metabolic pathways has won him many honors.

W. Dean Fraser was the last chairman of Microbiology before the departmental fusion. He joined the staff at I. U. in 1955. His research on the morphology, molecular biology, and genetics of bacterial viruses and on the biology of mycoplasma has been outstanding.

Leland S. McClung as mentioned earlier was appointed to the I. U. faculty in 1940 and organized the program in microbiology. He became chairman of the newly established Department of Bacteriology in 1946 and served in that capacity until 1966. He was assistant director of the Division of Biological Sciences from 1965 until 1968. His research has covered many aspects of bacteriology including the taxonomy and ecology of clostridia, food poisoning organisms, bacteriophagy of *Clostridium*, and other aspects of bacterial biology. He continues research at I. U. as Professor of Microbiology Emeritus.

Howard Gest was appointed chairman of the Department of Microbiology in 1966. After retiring from administration he has continued his research on the comparative biochemistry of photosynthetic processes. His work has won him wide recognition. He and *Gary Sojka* form the Photosynthetic Bacteria Group at I. U. (See also Eoyang, 1978, pp. 2-6).

The I. U. molecular biologists persuaded the University early of the need for a specially equipped (P-3) laboratory for research on the transfer of genetic material from one organism to another. This area has created considerable discussion throughout the world, but many of the earlier fears concerning the dangers of such research have abated if not disappeared. Recombinant DNA research may be the key to the solution of many biological problems in several areas.

Endocrinology

In the fall of 1933, *Robert L. Kroc* joined the I. U. Zoology staff to take charge of the beginning biology course and to teach in his speciality, endocrinology. The program which he developed was taken over by *W. R. Breneman* when Kroc left in 1944 to join the research division of Maltine Company of New Jersey (now Warner Lambert).

William R. Breneman received his Ph.D. from I. U. in 1934 and after a National Research Fellowship at Wisconsin and a year of teaching at Miami University returned to I. U. in 1936. His main research interests centered in the endocrinology of the white leghorn chicken, and he has made significant contributions in this field particularly in regard to the pituitary gonadotrophins.

Breneman is noted for his ability as a master teacher and has received several awards. His pre-Christmas lecture "Kalamazoo to You" is deposited in audio in the University archives. The beginning course which he took over from Kroc became a popular and increasingly important core of the undergraduate program in Zoology. In 1966 he became chairman of the Zoology Department and served ably in that capacity until 1969. He retired as Luther Dana Waterman Professor of Zoology in 1977. (See also Meserve, 1981, pp. 4-6.)

General and Systematic Entomology

Among the biologists assembled about *Carl Eigenmann* and *Fernandus Payne* was *Alfred Charles Kinsey* (1894-1956). He occupies a unique position in having achieved prominence in two major fields of biology—entomology and human behavior. He came to I. U. in 1920 after working under *William Morton Wheeler* and *Charles T. Brues* at Harvard.

Kinsey's entomological work represented a distinct departure from that of his predecessors, and he did much to introduce the modern techniques of research in taxonomy in general. His insistence upon massive series, wide geographical coverage, and detailed analyses of every biological aspect of an organism was unique at the time, but has become standard practice in present day taxonomic studies. He was also a pioneer in the introduction of statistics as a tool in systematic studies.

Shortly before World War II, Kinsey became interested in the study of human sexual behavior. The "crusts" which he broke reverberated around the world. Until his death, he maintained that he was a taxonomist applying taxonomic methods to an important social phenomenon. His work continues at I. U. under the direction of *Paul Gebhard*, Director of the Institute of Sex Research which continued to make important contributions in this field. (See also Meserve, 1981, pp. 2-6). Torrey (1965) gives a detailed account of the development of the Institute.

General Protozoology and Protozoan Genetics

Tracy Morton Sonneborn (1905-80) joined the I. U. faculty in 1939, bringing with him his enthusiasm, charisma, and elegant research program. He previously had worked at Johns Hopkins University where he did his graduate studies under *H. S. Jennings*. Sonneborn continued his research at I. U. until shortly before his death. His work centered around the protozoan, *Paramecium aurelia*, in which he studied cellular differentiation, the role of nuclear and cytoplasmic factors in inheritance, serotypes, and mating types. The killer trait was a subject of study for many years, and although it eventually proved to involve a bacterium, its study inspired continuing study of the origin of cellular organelles and other factors.

Tracy Sonneborn was a magnificent lecturer and teacher. One of his greatest contribution to biology was the many students he trained and sent out to teach and do research. Most of them are still active in the field of protozoology.

In 1961, *Mary L. Austin* retired after a long and distinguished career as a teacher and researcher at Wellesley College. She joined the Sonneborn laboratory as a Research Scholar and continues her work on antigenic transformations and other mutations in *Paramecium*.

John R. Preer, Jr. came to I. U. shortly before World War II to work with *A. C. Kinsey* on insects. Kinsey at that time had shifted his interests, and John shifted his interest to protozoan genetics with *Tracy Sonneborn*. After receiving his doctorate in 1947, he moved to the University of Pennsylvania where he distinguished himself in teaching, administration, and research. He returned to I. U. in 1968, bringing as a research associate his wife, *Lousie B. (Bertie) Brandau Preer*, who had received the doctorate from I. U. working with *Ralph L. Cleland* on the cyto-genetics of *Oenothera*. They have continued work on the genetics of protozoa and cell biology of *Paramecium*.

Ruth V. Dippell received her Ph.D. from I. U. in 1950, and joined the Sonneborn laboratory as a research associate. She was appointed to the faculty in 1967, and has continued research and teaching on many aspects of protozoan biology. Her influence extends beyond her teaching and research. Her willingness to cooperate with others and her expertise are always available to students and instructors alike. Her willingness to share cultures has enlivened and enriched many classes.

Myrtle V. Sneller received the M. A. degree from I. U. in limnology in 1949. She has since served as research associate and has done research on mating types, rapid lysis killers, and other aspects of *Paramecium* biology. She was responsible for the maintenance of over 400 genetic strains of *Paramecium* maintained in the laboratory. These strains are now maintained by the National Type Culture Collection.

W. J. van Wagtendonk joined the staff in 1947. He carried on sophisticated experiments on the biochemistry of *Paramecium* until 1965 when he departed for the University of Miami where he recently retired. He developed interesting devices for "purifying" *Paramecium* for chemical studies using the protozoan reaction to an electric current. His major contribution was the development of a defined medium for culturing *Paramecium*.

Ornithology

A general course in ornithology was taught at I. U. for many years, but it was not until *Val Nolan* accepted a joint appointment in biology and the Law School that a research oriented program was introduced. Nolan began studies on the prarie warbler shortly after coming to I. U. in 1949. His monograph published

in 1978 is a masterful analysis of many aspects of the biology of this bird. His recent studies have centered on reproductive strategies and behavior, and broadly on the general ecology and behavior of birds.

Terrestrial Ecology, Evolution, and Ethology

Although aquatic biology developed early at I. U. the teaching and research in general and terrestrial ecology lagged behind. *Stanley Cain* was briefly associated with the botany department in the 1930s but no plant ecology program was ever developed in that field. This seems strange when one considers the seminal influence of the Chicago botanists and their pioneer work on plant succession in the Indiana dunes.

The first formal offerings of ecology were in 1946 and 1947 by *Lamont C. Cole*. As already noted Cole came to I. U. to fill the vacancy in the teaching program caused by the withdrawal of *A. C. Kinsey* into research. Cole developed a general course in ecology the catalog description of which remained unchanged for over twenty years. The contents of the course, however, changed radically during that period.

Charles J. Krebs joined the zoology staff in 1964. He had done his doctoral work in British Columbia and postdoctoral work with *Charles Elton* in England and at the University of California. Krebs developed an active graduate program in the ecology of microtine rodents. His work on population cycles in *Microtus* are now classic, and his successful textbook has done much to encourage the study of the population ecology.

Krebs decided to return to British Columbia in 1966, and *Donald R. Whitehead* joined the botany staff in 1967.

The Division of Biological Sciences

> "It was becoming increasingly evident as early as 1960 that the departmental structure of the biological sciences at Indiana was not appropriately geared to the biology of the times. The prominent research issues of the day were more often biological than zoological or botanical or bacteriological; molecular and genetic biology nurtured by sophisticated biochemistry and the elucidation of the architecture and replicative mechanisms of DNA, were revolutionizing studies of the genetic control of differentiation. A new breed of biologists, few of whom considered themselves botanist, zoologists, or bacteriologists *per se*, was emerging. A new generation of students, conditioned by modernized textbooks, was coming out of high schools. Our conventional departments were being challenged by these circumstances and the simple kind of informal cooperation that had served us well no longer seemed able to meet the challenge. How might we design new types of courses and curricula? How could we recruit faculty personnel who did not identify themselves with conventional disciplines? How could we move frontally toward the acquisition of money, equipment, and laboratory space essential to the advancing frontiers of biology?" (Torrey, 1968).

After much soul-searching, discussion, debate, compromise, and a little acrimony, a charter for a new Division of Biological Sciences emerged. This united the departments of Anatomy and Physiology, Botany, Microbiology, and Zoology. *Tracey Sonneborn* served in 1963-64 as chairman of the executive committee of the Division, and *Charles W. Hagen, Jr.* as Acting Director in 1964-65. *Frank W. Putnam*, a distinguished immunochemist, came in the fall of 1965 from the Univer-

sity of Florida Medical School to be Director with *Leland McClung* as Assistant Director.

Putnam reestablished his laboratory at I. U. and in addition to his administrative duties carried on an active program of research. He has continued teaching and research since his retirements from administration. His work has been basic to the modern understanding of immune reactions. His lab first established the amino acid sequence in the Bence-Jones protein, an immunoglobulin produced by patients with plasma cell tumors. From these studies it is possible to elucidate the principles of antibody structure and specificity. (See also Eoyang, 1980, pp. 11-14.)

Under the divisional organization, the various departments created a variety of courses and programs designed to integrate biology in a modern sense. An instrument center was established to manage expensive equipment such as electron microscopes which could be used by members of any department. Morrison Hall was redecorated to house the expanding faculty and increased numbers of students. Jordan Hall was also extensively remodeled to provide for new types of equipment and laboratories. Approval was finally obtained in 1981 to go ahead on the long planned addition to Jordan Hall.

In 1969, another distinguished biochemist, *C. H. Werner Hirs* became director of the Division. He too carried on an active program of research on the structure, function, and chemistry of proteins and glycoproteins. In 1977 Hirs moved with his laboratory to the University of Colorado Medical School.

During the tenure of Putnam and Hirs the faculty in all departments increased, and many new and innovative research programs were established. The pattern of courses and the laboratory equipment were also modernized so that a student today can work in a wide variety of areas or even in the interstices between areas.

The Present Biology Department

In 1977 it was decided to abandon the divisional organization and integrate the departments (with the exception of Anatomy and Physiology) in a single Department of Biology. *John Preer* became the chairman from 1977 to 1979, and *Gary Sojka* was chairman from 1979 to 1981. *Albert L. Ruesink* served as acting chariman (1981-82). *Rollin C. Richmond* is currently chairman.

Epilogue

Historians more often are rewarded by criticism of their omissions than their commissions. I have tried to make this brief history as complete and informative as possible to reveal the pathways down to the present and the present breadth and direction of research. I have largely neglected teaching which has been an intrinsic part of the whole process, but almost without exception teaching at the upper undergraduate and graduate levels has closely followed research.

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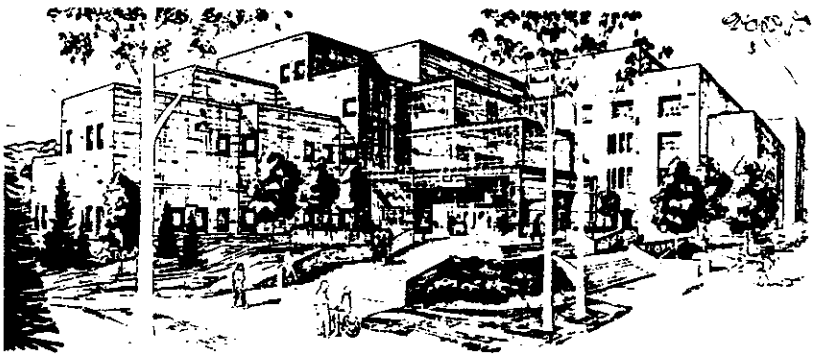

New Addition to Jordan Hall's Department of Biology — Now under construction.