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An Interpretive Study of Some Kentucky Biologists

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AN INTERPRETIVE STUDY OF SOME KENTUCKY BIOLOGISTS

(Audubon, Rafinesque, & Wilson)

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INTRODUCTION

This study was undertaken with the idea of bringing together information concerning some of the most important Kentuckians who have made contributions to the biological sciences. In order that we may better understand and appreciate the work done by these men, it was thought best to give a brief discussion of the major periods in the history of biological development. An attempt will be made to interpret the contributions of the men discussed, according to the period in which they lived. Only a sufficient number of men are discussed in each epoch to give a correct picture of the trends of that period.

SECTION I

GENERAL BIOLOGICAL HISTORY

In its development biological history has gone through three rather distinct periods although definite boundaries between them cannot well be indicated. The first, a Period of Philosophy and Beginning Investigation extended from the beginning of biological history up to about the eighteenth century. During this time very little attention was given to classification. There was a maximum amount of philosophizing and a minimum amount of research. A mere beginning of scientific approach to biological problems may be noted.

The first half of the eighteenth century might well be called the Period of Taxonomy. During this time the idea was prevalent that the aim of zoology is to "furnish every animal with a name, to characterize it according to some easily recognizable features, and to classify it in a way to facilitate quick identification." [1] Emphasis was placed on classification by means of external features.

The third, or present period, is a Period of Physiology and Taxonomy. Much work is being done in both fields, but the emphasis is decidedly on the physiological, in its broadest sense.

1. Period of Philosophy and Beginning Investigation

Prehistoric peoples who reached a stage of primitive civilization had, through thousands of years, collected observations of nature which form the foundation of all our natural scientific knowledge. The first knowledge of

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[1] Richard Hertwig, A Manual of Zoology (New York, Henry Holt and Co., 1884), p.1.

the human body was gained through the preparation of dead bodies for disposal. Man's contact with the rest of the living creatures developed elaborate superstitious beliefs concerning various animals. This animal superstition quite naturally led to an increased interest in and knowledge of animal life, in regard both to mode of living and anatomy.

Medical science, of course, formed an extremely important source of biological knowledge. Attempts to cure various injuries to the body could not but lead to some small knowledge of human anatomy. Although diseases were regarded as of supernatural origin and therefore to be treated by various charms and enchantments, observations were made regarding the functions of the body in sickness and in health. At the same time was evolved the theory of pharmacology. This knowledge was gained primarily by the haphazard use of plants for magical purposes. The effects of various plants on the body were thus observed.

There is evidence that the Babylonians had considerable knowledge of anatomy. Their knowledge of higher animal forms seems to have been quite considerable.

In Egypt the art of healing, based on actual observations, was developed at an early date. Even as early as 1500 B.C. the Egyptians had written several rather complete books dealing with the art of healing. Many of the incantations against disease found in their records betray the fact that their cures were concerned largely with the supernatural.

Mr. Locy, in his Story of Biology, says:

> "Before the advent of the Greeks science was an anonymous social product; the Greeks, however, thought and worked as an individual, so that, beginning with the Greek period, we have contributions to knowledge connected with the names of individuals." 2

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2 William A. Locy, The Story of Biology (Garden City, The Garden City Publishing Co., Inc., 1925), p. 19.

They were mankind's earliest natural philosophers. These ancient philosophers came to be called physicists because they studied the general problems of nature. Later on this term was reserved for those who carried out research in a limited sphere of natural science.

One of the earliest of the Greek natural philosophers was Thales of Miletus. Very little is known concerning him. Even the dates given for the period of his life vary by centuries.

Anaximander was a younger fellow-countryman of Thales and may have been one of his disciples. Very little is know about his life. He is thought to have lived between the years 611 and 546 B.C. He described the results of his scientific researches in a poem, On Nature, which has been quoted by later philosophers. Living beings, he thought, had evolved through a kind of "primordial procreation" in the mud which at one time covered the earth. Animals and plants first arose and then human beings, who at first were formed like fishes and lived in the water, but afterwards threw off their fish-skin and went up on dry land to take up their abode. Thus we see that Anaximander had evolved a complete, though clumsy, theory of evolution.

Diogenes of Apollonia, who lived in the first half of the fifth century, has described the ramifications of the venous system in mammals and this description is still partially in existence--the earliest anatomical work known.

Other Greek students of natural philosophy were Hippo, who is said to have engaged in embryological research, Pythagoras, Xenophanes, Parmenides, Empedocles, Heracleitus, and Democritus, who was the first to differentiate between the higher and lower animals according to the quality of their blood.

The greatest of the Greek physicians was Hippocrates whose teachings in many respects form the basis of modern medical practice. Although history has preserved the memory of seven Greek physicians called Hippocrates, the famous

"father of modern medicine" is generally spoken of as Hippocrates the Second, or the Great. He is thought to have lived between the years 460 and 377 B.C. His fame rests chiefly on his medical authorship, although it is believed that only a few treatises out of what is known as the Hippocratic Collection can be accepted as having really been written by him. In this collection the treatises which deal with anatomy and physiology, and are thus interesting in the light of biological history, are all believed to have been written at a later date than Hippocrates but they show the influence of his views. To his work is probably due the art of clinical inspection and observation. He gave the first great blow to the power of superstition and mysticism in treating disease when he recognized disease as an abnormal process of nature, and called attention to the part played by nature in healing. He has become the model of countless generations of physicians for nobleness of professional character. His "Physicians' Oath," an impressive document of medical ethics, is even to-day considered modern enough to be a guide for physicians in their contacts with patients and in their general moral and ethical practices.

The Hippocratic treatises assume that all matter is composed of the four elements--fire, air, water, and earth. To these elements correspond four "juices" in the body: blood, phlegm, yellow bile, and black bile. The condition of the body was believed to be due to these four elements. Health was the result of the existence of these juices in the proper proportions. When harmony between them was disturbed, sickness resulted.

Although this was a period of philosophy, some attempts were made at classification as is shown by the existence of a treatise On Diet in which there is a definite classification of fifty-two different edible animals. There are:

> "first the quadrupeds, tame and wild, birds, fish of several kinds, including coastfish, mud-fish, river-fish, mussels, and crayfish. This animal system has the advantage of differentiating

between various categories of living creatures—a first primitive attempt at proper systematization."

Aristotle, who lived from 384 to 322 B.C., was one of the most many-sided natural philosophers of all time and, perhaps, the greatest biologist of antiquity. However, it is not so easy to separate his positive contributions to the knowledge concerning animals from his philosophical speculations. His claims to consideration in the history of science rest chiefly on the fact that he was undoubtedly the greatest investigator of antiquity. In the sphere of embryology he made his most important contributions to biological science.

> "Of his purely biological works the following are extant: ten books On the History of Animals, of which, however, three are considered false; four books Of the Parts of Animals; five books On the Reproduction of Animals; and three books On the Soul. In these treatises he has collected all contemporary knowledge of animal life, not only his own and his pupil's personal observations, but also all the knowledge that his extensive collections of books could impart regarding the observations of the early philosophers." [4]

Although Hippocrates had concerned himself to some slight extent with classification, Aristotle was in reality the originator of biological classification. He differentiated between, analyzed, and characterized from different points of view a number of systematic categories. He believed that animals might be characterized "according to their way of living, their actions, their habits, and their bodily parts." [5]

Next in line for consideration is Pliny the Elder, a Roman general who lived from 23 to 79 A.D. This energetic man spent his days in attending to government business and his nights in reading and writing. His Natural History, which is an attempt to cover the whole field of science, has been preserved in its complete form. It is a voluminous work which contains as much fancy as fact. It is a confused group of notes taken from two thousand books of various authors. As unreliable as it is, it was for 1500 years the main source of

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[3] Erik Nordenskiold, The History of Biology (New York, The Tudor Publishing Co., 1935), p. 23.
[4] Ibid., p. 37.
[5] Ibid., p. 39

knowledge of natural history. Pliny was not an original student; he can be rated only as a popularizer.

Galen, who lived from 131 to about 211 A.D., was an investigator of truly scientific spirit, but also an experimenter. Although he was the leading anatomist of his day, it seems that he was not greatly appreciated by his contemporaries. However, throughout the Middle Ages he was proclaimed as an unfailing authority in all branches of medicine. He was a prolific writer and of his 131 medical treatises, eighty-three are still in existence. The following quotation gives us an idea of how he influenced biological history:

> "Although Galen was perhaps the founder of scientific medicine based on experimentation, he was also the leader of that unfounded dogmatism which was responsible for holding back medicine for 1500 years. In spite of his contributions, probably no other one individual has played a more important role in retarding medical advancement." [6]

From Galen to Vesalius there was no one who made scientific contributions worthy of being noted in so brief a summary as this.

Andreas Vesalius (1514-1564) made so many discoveries that it is difficult to enumerate them. Through his work anatomy became an accurate division of medical science. Rather than use animals for dissection and draw comparisons from them, Vesalius used the human body and in many instances proved that Galen was not the infallible authority which he had been considered. Although he made important discoveries in details, his work in correcting old fallacies was more important. Vesalius was, without doubt, one of the greatest biologists who have every lived.

William Harvey, an Englishman who lived from 1578 to 1657, stands out as one of the great contributors to seventeenth century medical knowledge. His discovery of the circulation of the blood and the chemistry of respiration really marks the beginning of modern scientific medicine.

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[6] C. V. Langton and M. Isaminger, The Practice of Personal Hygiene (New York, Harper and Brothers, Publishers, 1938), pp. 12-13.

Antony von Leeuwenhoek (1632-1723), a self-taught Dutch scientist, who is known for the development of the first microscope, actually opened up for biology a long series of facts of fundamental importance. He explained and completed the knowledge of capillaries, described the blood corpuscles, discovered the Infusoria and Rotifera, explained reproduction in ants, and demonstrated the difference in stem structure of monocotyledons and dicotyledons.

2. Period of Taxonomy

Practically the first persons, so far as we know, who devoted any scientific study to an attempt at grouping plants and animals were Plato and Aristotle. Plato originated grouping in species and genera, while in Aristotle's works are found only the groupings, species and family. Neither of these men gave us a worked-out system.

In the field of botany it was imperative that some means of systematic classification be devised in order that the information at hand not remain a jumbled mass of facts. Before the Renaissance, botanical knowledge was essentially supplementary to pharmacology.

The physicians were necessarily botanists, and the botanists were physicians as a matter of course. When the revival of learning came, botany was the first of the sciences to recover because its value was most obvious. Plants were divided simply into herbs, bushes, and trees. During the Renaissance botany became an independent science.

One pioneer in this work was Otto Brunfels (1488-1534), whose published work, Herbarum vivae eicones, inspired Linnaeus to call him the "father of botany."

Between Brunfels and Linnaeus, men worthy of note in the development of an attempt at classification are: Leonhart Fuchs, Cesalpino, Bauhin, Jung, Rivinus, Tournefort, and John Ray.

Carl Linnaeus, the great Swedish botanist, displayed in his earliest childhood a keen interest in botany. One of his teachers, recognizing his great gift for natural science, urged Carl's family to allow the boy to study medicine, rather than prepare himself for the priesthood as had been planned.

He studied at Lund and at Upsala and at the age of twenty-eight made extended tours on the Continent.

Even as a young man Linnaeus always showed the capacity of exciting the admiration and sympathy of those he met whose interests were similar to his own. He became widely known in Europe after publication of his most important work, Systema naturae, which was a classification of seed plants in which he included brief descriptions and the scheme of giving each species a generic and specific name. This marked the establishment of the system of binomial nomenclature and gave a great impetus to plant study. However, we must admit that "in the zeal for naming and classifying animals which followed, the higher goal of investigation, knowledge of the nature of animals and plants, was lost sight of and interest in anatomy, physiology and embryology lagged."[7]

From about 1735 until 1741 Linnaeus succeeded in making a living as a physician in Stockholm. In 1741 he became professor of botany at Upsala. He taught summer and winter to ever increasing audiences of both Swedes and foreigners.

> "As a founder of schools and an organizer of work he has had few equals in the history of biology. Every year he sent out pupils on research expeditions, whose collections and observations were afterwards worked up under the master's own guidance. He himself was acknowledged throughout the whole civilized world as an authority

[7] Hertwig, Op. cit., p. 8.

on natural-scientific questions, his advice being sought by governments as well as individuals. His native country also learnt to appreciate him; he received several high honors; among other things he was ennobled and took the name of von Linne." 8

Georges de Buffon was born in 1707 in Burgundy. He grew up in a home where there were cultural interests and wealth. By chance the young man became interested in nature and this interest grew to be the dominating factor in his life. He undertook to write a general natural history which was to include all the knowledge of nature that could be brought together. In 1748 he published the first part of this work, the Histoire naturelle. This work became very popular, undoubtedly because of Buffon's brilliant style of writing. He produced vivid descriptions of nature and of animal habits and was also able to deal with difficult physical and cosmological problems in an unusually clear and comprehensive manner. This work had great practical advantages and its influence on the future development of biology has been very great.

In his Natural History of Animals he established the fact that there is no absolutely definite line of demarcation between the plant and animal kingdoms, but that transition forms do exist. This is directly in keeping with modern knowledge.

Buffon has played a fundamental part in the history of biology, not because of discoveries he made, but because of new ideas he produced. He was, in the purely theoretical sphere, the foremost biologist of the eighteenth century.

Lazzaro Spallanzani, an Italian, (1729-1799) applied himself to experimental research, particularly in regard to regeneration and fertilization. He used amphibians in his studies of regeneration and his work was as exhaustive as the conditions under which he worked would permit. In his experiments with

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8 Nordenskiold, op. cit., p. 205.

the phenomenon of fertilization ... proved that the spermatozoa were essential to fertilization but he remained a firm believer in the preformation theory and thought that he had incontestible proof that the entire animal is ready-formed in the egg.

Jean Baptiste Pierre Antoine de Monet, usually called Chevalier de Lamarck, (1744-1829) developed the first complete and logical theory of organic evolution. He developed a theory of man's descent from the anthropoid apes,--but added that this theory might have been acceptable if it were not known that man had a different origin from the animals. He evidently did not dare to draw the obvious conclusion from his theory.

He says, "For nature time is nothing. For all the evolution of the Earth and of living beings, nature needs but three elements, space, time, and matter."[3] Lamarck believed that animals are induced to react to environmental changes and so adapt themselves. He believed that these somatic changes, or acquired characteristics, are transmitted to the offspring and so bring about evolution of organisms. It is for this theory that he is best known.

Caspar Friedrich Wolff was born in Berlin in 1733. Though he was destined to lead the science of embryology into new paths, he did not win fame until after his death. He completed a course at the College of Medicine in Berlin and then proceeded to Halle, where he took up the study of philosophy. In 1759 he published a treatise as part of the requirement for his doctor's degree. This treatise, Theoria generationis, made his name famous, but not until many years later. Biologists of that period paid very little attention to the work. He was misunderstood by his contemporaries mainly because of the fact that he began his work with a ready-made theoretical program, then collected and presented facts for the express purpose of proving his convictions which were already firmly established.

[3] L. L. Woodruff, Foundations of Biology (New York, The Macmillan Co., 1931), pp. 488-89

Wolff is generally credited with the introduction of the doctrine of epigenesis into biology in place of the preformation theory, but actually this theory is older than that of preformation. He merely accepted this ancient theory and gave it his own. His advantage lay in the fact that he saw more correctly in his microscope than his contemporary preformationists. They believed, since everything was ready formed before, that embryological study was mainly unnecessary. Wolff showed that there was, in this sphere, an immense amount to be discovered and investigated. In this way he opened up fresh fields of research in which very successful work was done during the period which followed.

Karl Ernst von Baer was born in Esthonia in 1792 and died there in 1876. He studied medicine at the University of Dorpat, and later in Vienna. Upon leaving Vienna he went to Wurzburg to obtain training as a theoretical scientist. He was for a while a professor at Konigsberg and here it was that he carried out his principal investigations. In 1834 he became an academician at St. Petersburg. While in this position his activities were brilliantly successful and honors were lavished upon him.

Without doubt, von Baer's fame rests chiefly on his embryological work done in his youth.. In his work De ovi mammalium genesi, which was published in 1827, he described the most important of his discoveries in the embryological field. This was the discovery of the egg of mammals in the ovary.

In the study of the hen's egg, he carefully followed its evolution and published his observations in a work called Uber Entwicklungsgeschichte in 1828 and 1837. In this he summarized all the then existing knowledge of the subject, thus causing it to become a pioneer work on which all subsequent research has been based. In the last half of this book he gave a survey of the embryonic development of all the vertebrates.

Von Baer is given credit for creating modern embryology, not only as an independent field of research, but also as an important branch of comparative anatomy.

4. Period of Physiology and Taxonomy

We may consider that George Cuvier, of France, marks the beginning of the present period. As a personality Cuvier has been variously judged, but as to his vital importance for the development of biology there can be no two opinions. He believed his mission in life to be the creation of a general comparative anatomy; he worked for it throughout his life and his other writings often referred to this work. However, it was never completed.

As a result of his work he has been called the founder of modern comparative zoology, not because of new facts brought to light by him, but because of having introduced comparative anatomy in the modern sense of the term. The correlation between separate organs in the same body was studied in detail by Cuvier and represented to him, the very basis of his conception both of animals' habits of life and their systematic classification. He pointed out that a carnivorous animal which possesses a digestive canal suited to its particular type of food must also possess sharp teeth for tearing meat, claws which enable it to clutch its prey, and the power of rapid locomotion. According to Cuvier's views, a practiced naturalist should thus be able to determine from the shape of one single, suitably selected part of the whole animal's structure, habits, and place in the system. The creation of a system based entirely upon conformity in the organs became one of the missions in life that Cuvier never let out of sight.

He also attempted to explain the cause of the dissimilarity between the animal world of the past and that of the present. He observed the strata that make up the earth's crust and that the animals of each stratum differ

from those in the layers above and below. In explanation he offered what is known as his "cataclysm or catastrophe theory." In this he states that at intervals in the history of the world there have occurred violent cataclysms which destroyed all life as it existed at that time; then new forms, totally different from those just done away with, were created. Thus were formed the various strata, each with its own type of animal and plant life. This theory was generally accepted until replaced by Lyell's "actualistic theory" which is the accepted one today.

Charles Robert Darwin, another English scientist, was born in 1809 and died in 1882. He was the grandson of the physician and natural philosopher, Erasmus Darwin. He was, according to the family tradition, sent to Edinburgh to study medicine, but gave up his work there after two years. He was much interested in geology, and also collected insects and plants for his own amusement. In 1831 he took the unsalaried post of naturalist on the Beagle which was to circumnavigate the world. After his return home he spent several years working up the natural objects and materials that he had collected during the voyage. It was during this time that there slowly developed in his mind the familiar theory which bears his name. For two decades Darwin kept this theory to himself in an unceasing search for fresh proofs of its universal application. Finally, in 1859, he published it in a work called On the Origin of the Species by Means of Natural Selection. This proved to be one of the most famous works of natural history ever written and probably furthered biological science more than any other one thing has ever done. It focused attention on biology and proved a great stimulus and encouragement to the study of biological sciences.

August Weismann, of Germany, (1834-1914) was inspired with an interest in biology by his teacher, Leuckart. His special subject was the evolution of lower animals. His theory of descent and heredity tries to explain heredity

in a biological sense. He evolved the idea of a separate and distinct germ-plasm and soma-plasm and performed long and painstaking experiments in an effort to prove that acquired characteristics cannot be inherited and that the various life-forms have arisen in the course of ages by means of natural selection.

Johann Mendel was born in 1822 in a German colony in Austrian Silesia. At an early age he showed remarkable intelligence. He first attended a grammar school, then later entered an Augustine monastery at Brunn, in Moravia. As a monk he adopted the new name "Gregor," and it is by this name that he is known to posterity. He was sent by the monastery to study in Vienna. Here for three years he devoted his attention to mathematics and natural science. When he returned home he became a schoolmaster and during his leisure hours cultivated plants in the cloister garden. It was on these plants that he made his scientific observations.

Mendel's long delayed fame rests chiefly on two short essays published in a journal brought out by the natural science society at Brunn. These essays were the result of many years' work and show a keen observation of nature and a thorough grounding in mathematics. He devoted himself to the study of the phenomena of heredity in garden plants. He chose, to begin with, certain easily observable characters and studied their modifications in different generations. From these observations he formulated the now famous "Mendel's Law of Heredity." During his own lifetime his work attracted no attention at all, probably because the results of his research were published in such an obscure little journal. However, he would probably have encountered difficulty in getting those results published in any of the more important publications of the day because his statements were so utterly at variance with the then prevailing conception of biology. Mendel denied any variability in the characters observed by him, while at the same time, all the biologists were seeking

variations as proof of natural selection. Sixteen years after his death, which occurred in 1884, three observers--de Vries, Correns, and Tschermak--simultaneously pointed out the agreement between Mendel's observations and their own results. From that time on, Mendel's name has been one of the best known in biology.

It is only by the aid of Mendelism that the practical improvement of seeds and domestic animals has been successfully based on exact principles instead of on mere chance.

SECTION II

KENTUCKY BIOLOGISTS

After having dealt with the general history of biology to an extent sufficient to give some idea of the background upon which our Kentucky scientists based their work, the remainder of this paper will deal with a few of the most outstanding scientists who are Kentuckians either by birth or by adoption.

No difficulty is encountered in attempting to place these men in the same general periods as were indicated in the preceding pages, except that we have no Kentuckians who may be classified as belonging to the Period of Philosophy and Beginning Investigation, due to the fact that this section of the United States was settled late in this period.

As representatives of the second period, or Period of Taxonomy, we find such outstanding men as Rafinesque and Audubon, who, though not native to the state, lived and worked in Kentucky.

With the exception of Rafinesque and Audubon the remainder of the men discussed belong in the Period of Physiology and Taxonomy. As true representatives of the period, we find that some of them are physiologists, some are taxonomists, and some are a combination of the two.

Constantine Samuel Rafinesque

The first of the noteworthy men to be considered is Constantine Samuel Rafinesque. Though he can hardly be called a Kentuckian, it was in Kentucky that he did much of his work. He may be considered an excellent representative of the period which stressed taxonomy. Description and classification were almost a mania with him.

Rafinesque was born in Turkey, in Galata, a suburb of Constantinople, October 22, 1783. His father was a French merchant in that city, while his mother, though born in Greece, was of German parentage. The business of the father necessitated that he be away from home a great part of the time, consequently, the education of the boy and his brother and sister was left almost entirely in the hands of the mother. Of this mother very little is known, but it appears that she was a most intelligent woman, and had great concern for the proper education of her son. She seems to have performed her duty well and conscientiously. When the boy was nine years old he was taken by his mother to live near Leghorn, Italy. There remained for four years, meanwhile being taught by private teachers. It was while he was living at Leghorn that he began regular investigations in the field of botany.

During the years which followed 1796 his residence varied between Genoa, Pisa, and Marseilles. During this time his care was successively in the hands of his mother and grandmother. Of the time spent at Marseilles, Rafinesque himself says:

> "It was there among the flowers and fruits that I began to enjoy life, and I became a botanist. Afterwards the first premium I received in a school was a book on animals, and I became a Zoologist and Naturalist." [10]

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[10] R. E. Call, Life and Writings of Rafinesque (Louisville, J. P. Morton and Co., 1895), p. 5.

Thus we see that he gives his interest in scientific matters from that time. He seems to have given the greater part of his attention to a study of plants, but he was also interested in other branches of natural history.

Concerning a time when he was merely a boy, Rafinesque has the following to say:

> "I had made to myself a small garden in a wild and remote place. I began the study of Fishes and Birds, I drew them and collected shells and Crabs. Laudin, of Paris, who published then a natural history of Birds, was my first correspondent among the learned, and I communicated to him some observations on birds. I drew maps, copied those of earlier works, and took topographical surveys; these were my first essays in geography." [11]

In 1802 Rafinesque came, with his younger brother, Anthony Augustus, to America. Here, at the age of eighteen, in a new land, among strangers who spoke a strange language, he turned at once to the woods and fields, a real student of nature. Taking up residence in Philadelphia, he occupied himself with mercantile pursuits and filled his leisure time with the study of the plants of that vicinity. Quite characteristically, he declares that during this period he minutely described all the plants he found.

In 1804 he began giving his whole time to the collection of the plants and the animals about Philadelphia and in neighboring states. During this time he received an offer to become botanist for the Lewis and Clark survey of Missouri, but he refused the offer to go with his brother to Sicily.

Rafinesque wrote very little concerning the ten eventful years which he spent on the lovely island of Sicily. Here he married a Sicilian woman, Josephine Vaccars. However, it seems probable that this marriage was never consummated in legal form. To them were born two children, Emily and Charles Linnaeus. The little boy died when only a year old. Neither child is mentioned

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[11] Ibid., p. 9.

anywhere by Rafinesque except in his will. In this same document he speaks of his wife as an "unworthy" woman.

During the time he lived in Sicily Rafinesque was successively manager of a brandy-still, dispenser of spirits to America and Europe, candidate for a state office, and editor of a magazine. He was, of course, naturalist and collector always. He became personally and by correspondence known to many of the scientific men of Europe. He became an intimate friend of Swainson, the English naturalist, during the time that Swainson was stationed in Sicily. They are known to have collected and studied together.

In 1815 Rafinesque left Sicily and Europe forever and came again to America. The ship which had brought him and his possessions safely across the Atlantic was wrecked in a dense fog at the eastern end of Long Island Sound and went down carrying with her the results of years of toil and labor, both mercantile and scientific. Of this misfortune Rafinesque says:

> "I had lost everything, my fortune, my share of the cargo, my collections and labours for 20 years past, my books, my manuscripts, my drawings, even my clothes. . . all that I possessed except some scattered funds and the Insurance ordered in England for one third the value of my goods." [12]

It appears that Rafinesque never again knew prosperous business ventures. From this time on he seems to have felt that the world was against him.

In 1818 he met, in Philadelphia, his old friend J. D. Clifford, who was a resident of Lexington. Mr. Clifford persuaded Rafinesque to visit Kentucky. So, in the summer of 1818 we find Rafinesque journeying down the Ohio by flat-boat. He remained at Shippingport, now a part of Louisville, with his friends, the Messrs. Tarascon, for two weeks. He says that he spent the time studying the fishes and shells of the river, of which he made a large collection, drawing them at the same time.

All the way from Louisville to Henderson he made botanical and other collections. Immediately upon arriving at Henderson he sought out John James

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[12] Ibid., p. 13.

Audubon, the naturalist, to whom he had a letter of introduction and with whom he remained for three weeks.

Although Mr. Audubon says he found Rafinesque to be a"most agreeable and intelligent companion" [18] he played some rather cruel tricks on his poor visitor. He committed a most unmanly act, one which has caused great annoyance and loss of time to succeeding naturalists. Perhaps he played the trick merely to gratify some spirit of mischief. At any rate, he surely did not realize the trouble he was causing. It seems that he supplied Rafinesque with drawings of impossible fishes, gave them gaudy coloration and glowing descriptions, and supplied his credulous victim with what were represented to be notes of fact. All of this was duly noted in Rafinesque's notebook, and still more unfortunate, the results were published soon afterward. Ten of the fictitious species of fish "communicated by Mr. Audubon" first appeared as a series of articles in The Western Review and Miscellaneous Magazine.

Rafinesque took the position as teacher of modern languages and natural history in Transylvania University, at that time the most important seat of learning in the West. He entered upon his work at this school in the autumn of 1818, at a time when there were internal dissentions. To this unfavorable condition must be added the fact that he was a stranger, a foreigner, and his chair was new and considered of little importance. Those were the days when emphasis was placed on a classical education. Rafinesque and his associate professors were quite different in tastes and pursuits, as unlike as men could be. He was not able to adapt himself readily and so made few friends.

During his stay in Lexington he made many excursions and made extensive collections, chiefly in conchology and botany. He wrote numerous papers of which many were published. At the same time he was attending to the duties

[18] Lucy Bakewell Audubon, The Life of John James Audubon the Naturalist (New York, G. P. Putnam and Son, 1868), p. 70.

of the classroom and acting as secretary of the Kentucky Institute, the first scientific society formed within the state. It was at this time that he prepared his most remarkable work, Ichthyologia Ohiensis.

When Rafinesque began his investigations of the natural history of the Ohio Valley, he found an almost inexhaustible and virgin field. Only the larger and most common food-fish were known and these were mostly without scientific name. In the presence of such a wealth of material there was a great temptation to publish, even before the various forms found had been studied carefully enough. Rafinesque produced a great many scientific papers, some of which were printed in various magazines, scientific and literary; others found a place in the proceedings of learned societies, while still others were put into book form.

Two works in particular which deserve mention are The Fishes of the Ohio River, and A Monograph of the Fluviatile Bivalve Shells of the River Ohio. These works were published about the same period, one as a serial in the Western Review and Miscellaneous Magazine, at Lexington, and the other as a monographic article in Annales Generales de Sciences Physique, at Brussels. The work on fishes was also published in book form and given the title Ichthyologia Ohiensis. This was the first work ever written on the Ohio River fishes, and has become the groundwork for all succeeding investigations.

During his stay at Lexington, Rafinesque made an attempt to found a botanical garden there. In 1824 he visited Frankfort to secure aid for his garden, but in spite of a splendid start, his plan failed to materialize. Concerning it he said:

> "I never owned an acre of ground, this garden would have been my delight. I had traced the plan of it with a retreat among the flowers, a Greenhouse, Museum, and Library; but I had to forsake it at last and make again my garden of the woods and mountains." [14]

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[14] T. J. Fitzpatrick, Rafinesque, Life and Bibliography (Des Moines, Historical Department of Iowa, 1911), p. 21.

The eight years which Rafinesque spent at Transylvania University were years of unceasing toil, with no one to sympathize with his work. The exposure and hard work, coupled with a lack of sympathy, had their influence in undermining the once strong and vigorous mind. The close of his residence at Lexington marks the beginning of the decadence of the mental clearness of Rafinesque.

He left Lexington, in anger and haste, in the year 1825. He became again a citizen of Philadelphia, where for fifteen years he engaged in a lonely struggle, finally becoming almost a complete mental wreck. Reduced finally to abject poverty, he concocted and sold medicines which were advertised much as are quack remedies today. He really believed in the curative powers of his medicines, especially in his "Rumel," which he sincerely believed had cured him of pulmonary tuberculosis.

Rafinesque died in 1840, at the age of fifty-six. He passed his last days alone in a lonely attic, in filth and poverty and in the direst misery. His body barely escaped the dissecting table through the loyalty and quick action of some of his remaining friends. He was buried in an unmarked grave in Ronaldson's Cemetery, Philadelphia.

In his books, monographs, and papers of various sorts, which run to nearly a thousand titles, Rafinesque seems to have treated nearly everything of interest in natural history. His best work, in the opinion of competent students, was that done upon the fishes of Sicily and the natural history of the Ohio Valley. His Medical Flora also possessed a real value, but his writings are now sought after as literary or scientific curiosities.

Mention has already been made of John James Audubon, who is today probably the best known of Kentucky's naturalists. There have been many conflicting stories concerning Audubon's ancestry. He himself contributed much to this uncertainty by the varied statements he made regarding his parentage and date of his birth. However, definite information in regard to these facts is now available. There are in existence the bill of the physician who assisted at his birth, and authentic records of his subsequent adoption and of his baptism, as well as other documentary evidence concerning these matters.

Mr. Herrick[15] says that there is definite proof that the naturalist was the son of Jean Audubon, a French sailor who made his fortune in Santo Domingo, and a woman whom he, Jean, described only as a creole of Santo Domingo who was known by the name of Mlle. Rabin. On the other hand, Lucy Bakewell Audubon, wife of John James Audubon, states that the father, while residing in the West Indies, frequently visited North America, and on one of these trips married a beautiful and wealthy lady of Spanish origin who became the mother of our naturalist.[16] Mrs. Audubon says that Anne Moynette was the name of John James' own mother, while the records of the legal adoption of Audubon and his sister by their father and step-mother show that Anne Moinet was the name of the step-mother and that she was married to Jean Audubon previous to the birth of either of her foster children.

The man whom we know as John James Audubon was sometimes referred to in early documents as "Jean Rabin, Creole de Saint-Dominique." At other times

15 Francis H. Herrick, Audubon the Naturalist (New York, D. Appleton and Co., 1917), p. 53.

16 Lucy B. Audubon, The Life of John James Audubon the Naturalist (New York, G. P. Putnam's Sons, 1900), p. 13.

he was called "Fougere." Six months before his sixteenth birthday he received the baptismal name of Jean Jacques Fougere. Later, young Audubon, disliking the names Fougere and Rabin, and wishing to rid himself of their early associations, adopted the name of "La Forest." Some of his early drawings of birds are signed "J. L. F. A." or "J. J. L. Audubon."

In 1794 when Captain Audubon left the West Indies he took with him the four-year-old Fougere or Jean Rabin and his two-year-old half-sister Muguet or Rosa. He proceeded with them to his home at Nantes, in France. Here Madame Audubon, who had no children of her own, tenderly received them. She became very proud of the handsome boy and was a most kind, though over-indulgent, foster-mother. The father soon left the children in her care while he returned to the United States in the employ of the French government.

John was an ardent and imaginative youth, and he was allowed as he grew older to take long rambles in search of objects of natural history. He brought home birds' nests, birds' eggs, curious stones and such things. It was at Nantes that he began making sketches of French birds. He realized how crude his early drawings were and said that his pencil gave birth to a family of cripples. On each of his birthdays it was his custom to burn these drawings and then set to work to make better ones.

When Audubon was about eighteen years old his father sent him to take charge of his farm "Mill Grove," which was located on the Schuylkill River near Philadelphia. There he entered upon a life just suited to his temperament. He said that all of his time was occupied by hunting, fishing, drawing, and music.

Of his personal appearance at this time, Audubon has left the following description:

> "I measured five feet ten and a half inches, was of a fair mien, and quite a handsome figure; large, dark, and rather sunken eyes,

light coloured eyebrows, aquiline nose, and a fine set of teeth; hair, fine texture and luxuriant, divided and passing down behind each ear in luxuriant ringlets as far as the shoulders." 17

Audubon soon found himself in love with Lucy Bakewell, a lovely young neighbor of his. On April 8, 1808, they were married. The following day he and his bride and his good friend, Mr. Rozier, started on a journey to Louisville, Kentucky, where they planned to open a store.

It was during his residence in Louisville that Alexander Wilson, a noted ornithologist, called upon him. He examined Wilson's drawings and showed him his own. They hunted together and obtained some birds which were new to the visitor. He did not subscribe to Wilson's work because he felt that his own collection was the greater. Although in his diary, Wilson mentioned Audubon and his rambles with him, he later stated that while in Louisville he did not receive an act of civility nor see one new bird and found no naturalist to keep him company.

Audubon and his partner soon determined to move their store to Hendersonville, Kentucky, now knownas Henderson. Business there proving dull, they moved on to St. Genevieve, a settlement on the Mississippi River. Not liking it there, Audubon soon returned to his family at Hendersonville.

He continued his drawings of birds, but in the meantime he entered upon several unsuccessful business ventures, one of which was the erecting and operating of a steam grist and saw mill at Hendersonville. Always when he found himself in very reduced circumstances he would turn to portrait painting and the giving of drawing lessons.

Three times during his career his drawings met with disaster. Once two hundred of them were damaged by having a bottle of gunpowder broken in the chest with them. At another time two hundred of them, left in the charge of a friend at Hendersonville, were completely ruined by rats. At still another time some of his drawings were destroyed by fire.

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17 Ibid., p. 28.

There seem to have been no sacrifices that Mrs. Audubon would not make to aid in the forwarding of her husband's plans. She practically assumed support of the family while Audubon devoted himself to the painting of his beloved birds.

In May, 1826, he set out for England and the Continent where he remained for three years exhibiting his drawings, arranging and supervising the publication of his Birds of America, securing subscriptions, and meeting distinguished people, among whom was Baron Cuvier, the scientist.

> "Audubon's capacity for work was extraordinary. His enthusiasm and perseverance were equally extraordinary. His purpose and ideas fairly possessed him. Never did a man consecrate himself more fully to the successful completion of the work of his life, than did Audubon to the finishing of his American Ornithology." [18]

Audubon divided his time between England and America, gathering new specimens, painting, and supervising publication. The first volume of his bird pictures was completed in the summer of 1831. Few enterprises which involved such expense have ever been carried through against such odds. He could never have done the work had it not become a family affair, his son John aiding in the collecting and drawing, his son Victor taking charge of business affairs, and Mrs. Audubon assisting in countless ways.

"Audubon owed more to his wife than the world ever knew. She was always a reliance, often a help, and ever a sympathizing sister-soul of her noble husband." [19]

His works include Birds of America, A Synopsis of the Birds of North America, and The Viviparous Quadrupeds of North America. He lived to see only one volume of the text of the Quadrupeds finished. Although he had been possessed of a wonderful vitality, both his mind and health failed before his death. "His feebleness increased, till at sunset January 27, 1851,

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[18] John Burroughs, John James Audubon (Boston, Small, Maynard, and Co., 1911), pp. 80-81.

[19] Ibid., 161.

in his seventy-sixth year, the 'American woodsman,' as he was wont to call himself, set out on his last long journey." [20]

Audubon was a pioneer in painting birds in their natural poses. His drawings are spirited and lifelike. They reflect his own temperament, we might even say his nationality. They are sometimes demonstrative, sometimes even theatrical. In some cases this is quite out of keeping with the nature of the bird as in the case of the song sparrow or the cuckoo, while at other times as with the catbird or the Carolina wren, it is quite all right. The colouring of his birds is sometimes exaggerated. However, no one realized more clearly than he did just how far short of perfection his drawings were.

Audubon was never a man of science like Cuvier or Darwin. His wife said of him:

> "Audubon was not at heart a man of science. He gathered much, speculated little, and was more a backwoodsman than a philosopher. In his rough great way he did good service, but his great physical energy, not his mental resources, was the secret of his success." [21]

Mr. Burroughs, in his discussion says:

> "Audubon belonged to the early history of the country, to the pioneer times, to the South and West, and was, on the whole, one of the most winsome, interesting, and picturesque characters that have ever appeared in our annals." [22]

Many people have become familiar with Audubon's name through the Audubon Bird Clubs. His name is especially honored in Henderson. Miss Susan Starling Towles, a resident of that city, says:

> "His name is all about the town, being given to a park, a school, a street, a tourists' camping ground. The name may be seen on milk

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[20] Ibid., p. 126

[21] Lucy B. Audubon, op. cit., p. 25

[22] John Burroughs, op. cit., p. 142.

and ice wagons, and many humble enterprises bear it. Audubon coffee and cigars are offered for sale. An important enlargement east of the town, and near to his old refuge at Dr. Adam Rankin's farm 'Beaver Brook,' is called 'Audubon'." 25

Charles Wilkins Short

During the time that Audubon was living in Henderson and Louisville, there was in Lexington a younger man who was to contribute much to the study of botany in Kentucky. This man was Dr. Short.

Dr. Charles Wilkins Short was born at "Greenfields," Woodford County, Kentucky, October 6, 1794. He received his early education in the school of the celebrated Joshua Fry. He graduated with honor from the Academic Department of Transylvania University in 1810, and very soon afterward began the study of medicine with his uncle. In 1813 he became a private pupil of Dr. Casper Wistar, who was professor of Anatomy in the University of Pennsylvania. From this university Dr. Short received the degree of Doctor of Medicine in the spring of 1815. Soon afterward he returned to Kentucky.

In 1825 he became connected with the Medical Department of Transylvania University. In lecturing to his medical students in Materia Medica and Medical Botany he always read from his manuscript and, although the lectures were read with a good voice and correct emphasis, the fact that they were read detracted somewhat from his impressiveness. Despite this, his pupils were always attentive and respectful. They held him and his teaching in high esteem.

Dr. Short was an upright, conscientious, and modest gentleman. He was a most zealous and industrious botanist and one of his greatest pleasures was derived from work with his extensive herbarium which contained not only native plants of Kentucky collected by himself, but also specimens from other regions which he had obtained by exchange with other botanists.

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25 Susan Starling Towles, John James Audubon in Henderson (Louisville, Kentucky, John P. Morton and Co., Inc., 1938), p. 1.

In connection with professors H. H. Eaton, A. A. Griswold and Robert Peter he contributed to the Transylvania Journal of Medicine several papers on the plants of Kentucky. Some of his published papers were: Instructions for Gathering and Preserving Plants in Herbaria, Botanical Bibliography, and A Sketch of the Progress of Botany in Western America. In 1838, he wrote, Observations on the Botany of Illinois, which was published in the Western Journal of Medicine and Surgery.

In 1838 Dr. Short severed his connection with the Transylvania Medical School and allied himself with the Medical Institute of Louisville. He remained in this school until 1849, when his colleagues elected him Emeritus Professor of Materia Medica and Botany.

Dr. David Yandell, one of his co-workers, has the following to say of Dr. Short as connected with the Medical Institute of Louisville:

> "Dr. Short was a most valuable officer. His high scientific attainments, the soundness of his judgement, high dignity and urbanity of manner, his amiable temper and blameless life added much character and weight to the institution. Botany was his favorite pursuit. He found the flora of this region (Louisville) virgin and unknown, and so collected and arranged and classified it that his successors in this field have been able to change nothing and to add but little to his work." [24]

Dr. Short died at his beautiful country residence, "Hayfield," near Louisville, on March 7, 1865. At his death his vast collection of botanical specimens was bequeathed to the Smithsonian Institute at Washington. However, this institution had no appropriate place in which to display so large a collection and it was turned over to the Academy of Natural Sciences, at Philadelphia. During his life no less than five of the distinguished botanists of the age honored this Kentuckian's name by attaching it to six new genera and species of plants.

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[24] Robert Peter, The History of the Medical Department of Transylvania University (Louisville, John P. Morton and Co., 1905), p. 9.

Robert Peter

One of Dr. Short's most able co-workers was Dr. Peter, who has already been mentioned. In the town of Launceston, Cornwall, England, on January 21, 1808, was born Robert Peter, who was destined to become a pioneer chemist in the far away state of Kentucky. When Robert was twelve years old his family moved to America. Settling in Pittsburgh, Pennsylvania, they placed the lad in a wholesale drugstore and it was here that he acquired a passion for chemistry.

He entered the Rensselaer Institute Scientific School at Troy, New York, when he was twenty-three years of age. He acquired the title of Lecturer on the Natural Sciences after one session in this school. That year he delivered a course of public lectures on chemistry and made scientific, literary, and poetical contributions to the Hesperus, a periodical published in Pittsburgh. In 1828 he delivered a course of lectures on the natural sciences to the Pittsburgh Philosophical Society. In 1830-31 he lectured on chemistry in the Western University of Pennsylvania.

He came to Lexington in 1832 and early in 1835 he was unanimously elected to the Chair of Chemistry in Morrison College of Transylvania University. He received the degree of Doctor of Medicine at Transylvania University in 1834.

Dr. Peter served as Dean of the Medical College from 1847 until 1857, at which time the College was closed.

In 1839 he and Dr. James M. Rush made a trip to London and Paris for the purpose of buying books, apparatus, and other equipment for the medical department of Transylvania University. Concerning this trip Dr. Peter says:

> "A very large addition was made to the library, museum, and apparatus, by extensive purchases in Europe bringing the former collection up to eight thousand volumes and making the latter equal, if not superior, to any in the United States." 25

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25 J. S. McHargue, Dr. Robert Peter (Reprint from Journal of Chemical Education, Vol. 5, No. 2, Feb., 1928), p. 152.

From London, August 11, 1838, he wrote to his wife:

> "We have bought a great many fine books and a great deal of excellent apparatus and anatomical and other models. Transylvania will shine. No other institution in our part of the world will be able to compare with her in means of instruction. In fact, I have seen none in Europe that is more completely prepared to teach modern medicine." [26]

After returning from Europe, Dr. Peter engaged in much valuable chemical research in medicine. He also gave much attention to geology, mineralogy, zoology, and botany.

Dr. Peter was one of the founders of the Kentucky School of Medicine at Louisville and during the first three years of its existence, 1850-53, he occupied the Chair of Chemistry.

In 1854 he demonstrated that by soil analysis the elements necessary to increase and preserve the fertility of the soils could be determined. He was probably the first in America to apply quantitative and qualitative methods of analysis in this manner. He was certainly the first to apply them to any great extent.

In 1854 at the instigation of Dr. Peter, the First Geological Survey of Kentucky was begun. This was also the first large State enterprise of the kind undertaken west of the Alleghanies. In his work in connection with this organization Dr. Peter accomplished an almost unbelievable number of soil analyses. At the same time he was lecturing daily six times a week in two colleges, never omitting to prepare experiments in illustration of his subject.

In 1865 Kentucky University was moved to Lexington and united with Transylvania University. The State Agricultural and Mechanical College was organized as a College of Kentucky University. Dr. Peter accepted the Chair of Chemistry and Experimental Philosophy in this newly organized university.

When the State College was separated from the Kentucky University in 1878, Dr. Peter remained at the head of the department of chemistry of the

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[26] Ibid., p. 153.

State College. He retained this position until 1907 when he was made Emeritus Professor of Chemistry in the State College. He was at that time eighty-two years old and had given fifty years of active service to the science of chemistry in Kentucky.

He retained his activity of body and mind and his cheerfulness almost until his death, which occurred April 26, 1934, at his home near Lexington. As it is said he so often wished, he had "worn out rather than rusted out." A colleague of more than twenty years' standing thus summarized his life and character:

> "Intense devotion to physical science and work of the laboratory, purity of speech and modesty of manner, fidelity to settled convictions and principles; above all, his long and illustrious career in educating so many thousands of the young, and in setting before them a model so worthy of their imitation and remembrance; these were the traits, this was the service that crowned his busy life of nearly ninety years with honor, admiration, and renown." 27

Alfred Meredith Peter

> "It is only once in a great while that the mantle of an illustrious father falls upon a son; however, that this does happen is to be gleaned from the life and labors of Dr. Alfred Meredith Peter, who not only shared heavily in the voluminous work during the last twenty years of his father's busy career, but has continued to carry on in a quiet and unassuming way the chemical work relating to geology, soils, and crops at the Kentucky Agricultural Experiment Station for more than forty years." 28

Alfred M. Peter was the tenth child in a family of eleven born to Dr. Robert Peter and his wife. His birth occurred on May 25, 1857, in Lexington, Kentucky. He says that his early childhood was spent in following his father about the campus and classrooms of Transylvania. He often, while only a little lad, sat in the classroom and watched with interest the experiments performed by his father in demonstration of his lectures in chemistry and

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27 Ibid., p. 157.

28 J. S. McHargue, American Contemporaries: Alfred Meredith Peter (New York, American Chemical Society, Reprinted from Industrial and Engineering Chemistry, Vol. 19, No. 9, Sept., 1927).

physics. He began very early to help in his father's laboratory in the preparation of samples for analysis, and in other odd jobs.

He received his B. S. degree from the Agricultural and Mechanical College in 1880, his major subject being chemistry. Immediately following his graduation he was appointed assistant professor of chemistry in the State Agricultural and Mechanical College. He also became, at this time, assistant chemist to the Kentucky Geological Survey.

In 1885 he received his Master's Degree from the same institution, that is, the Agricultural and Mechanical College.

In 1913 his Alma Mater recognized his scholarly and distinguished scientific attainments by conferring upon him the degree of Doctor of Science.

Dr. Peter has always been loved by his associates. Dr. Joseph H. Kastle, a life-long friend, said of him:

> "I always think of him as one of the dependable men of the community, one whose good judgment and helpful advice are beyond all questions of immediate compensation. I have never seen him in a hurry, never angry; on the other hand, he is always busy, always helpful, always ready to render to others the most valuable expert service in his chosen field of work." [29]

From his early youth Dr. Peter has been familiarly known as "Little Doc." Until 1925, when Mrs. Peter died, their home was famed in the community for its charming and gracious hospitality.

He has been connected with Kentucky Agricultural Experiment Station in the capacity of chemist since June 1886. He has held various responsible positions in connection with his work and is a member of several learned societies. Since he has been Emeritus Professor of Chemistry at State University.

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[29] Ibid., p. 8.

The following is a partial list of his published works:

"Calcium Metabolism in the Laying Hen," II. G. D. Buckner, J. H. Martin and A. M. Peter, Kentucky Agricultural Experiment Station (Research) Bulletin 254, pp. 1-36, March, 1924.

"Chemical Studies of the Oviduct of the Hen," G. D. Buckner, J. H. Martin and A. M. Peter, American Journal of Physiology, Vol. 71, No. 2, pp. 343-352, Jan., 1925.

"Relation of Calcium Restriction to the Hatchability of Eggs," G. D. Buckner, J. H. Martin and A. M. Peter, American Journal of Physiology, Vol. 71, No. 3, pp. 545-547, Feb., 1925.

"Concerning the Mode of Transference of Calcium from the Shell of the Hen's Egg to the Embryo During Incubation," G. D. Buckner, J. H. Martin and A. M. Peter, Poultry Science, Vol. 4, No. 5, pp. 165-170, July, 1925.

"Effect of a Calcium Carbonate Supplement in the Diet of Hens, on the Weight, Protein Content and Calcium Content of the White and Yolk of Eggs," G. D. Buckner, J. H. Martin and A. M. Peter, American Journal of Physiology, Vol. 72, No. 3, pp. 458-465, May, 1925.

"The Calcium and Phosphorus Content of Strong and Weak Chicks from Hens With and Without Calcium Carbonate in their Diet," G. D. Buckner, J. H. Martin and A. M. Peter, American Journal of Physiology, Vol. 76, No. 1, pp. 28-34, March, 1926.

"Concerning the Growth of Chickens With and Without Grit," G. D. Buckner, J. H. Martin and A. M. Peter, Poultry Science, Vol. 5, No. 5, pp. 203-208, June-July, 1926.

"Loss of Nitrogen from Chicken Droppings During Drying," G. D. Buckner and A. M. Peter, Poultry Science, Vol. 6, No. 2, pp. 89-90, December-January, 1926-1927.

"The Relative Utilization of Different Calcium Compounds by Hens in the Production of Eggs," G. D. Buckner, J. H. Martin and A. M. Peter, Journal of Agricultural Research, Vol. 36, No. 3, pp. 265-269, 1928.

Joseph William Pryor

Another of our important contemporary Kentucky scientists is Joseph William Pryor, Head of the department of anatomy and physiology at the University of Kentucky since 1890. He was born in Palmyra, Missouri, April 3, 1856. He has done much to further the knowledge of bone development. Most of his published works concern differences in time of ossification of the male and female skeleton.

The following is a list of his publications:

"Development of the Bones of the Hand," Bulletin, State College of Kentucky, Series 2, No. 8, June, 1905.

"Ossification of the Epiphyses of the Hand," Bulletin, State College of Kentucky, Series 3, No. 6, October, 1906.

"The Chronology and Order of Ossification of the Bones of the Human Hand," Bulletin, State University, Lexington, Kentucky, New Series 1, No. 2, April, 1908.

"Some Observations on the Ossification of the Bones of the Hand," Bulletin, University of Kentucky, Vol. viii, No. 11, November, 1908.

"Difference in the Time of Development of Centers of Ossification in the Male and Female Skeleton," Anatomical Record, Vol. 25, No. 5, June, 1925.

"Time of Ossification of the Bones of the Hand of the Male and Female and Union of Epiphyses with the Diaphyses," American Journal of Physical Anthropology, October, December, 1925.

Harrison Garman

Having just considered the work of a physiologist we next turn our attention to a man who is primarily a taxonomist, though he has given a great deal of attention to the physiology of insects.

Harrison Garman, Kentucky's most eminent entomologist, was born in Lena, Illinois, December 27, 1855. He graduated from Illinois State Normal University and later received a degree of Doctor of Science from John Hopkins University. He has held the position of entomologist and botanist at the Kentucky Experiment Station, Lexington, since 1889. From 1892 to 1896 he was professor of zoology and entomology at the University of Kentucky. He is now professor of entomology at the same institution. He has been state entomologist since 1897.

His published works form quite an extensive list. They include the following:

"The Life-History and Habits of the Corn-ear Worm," (Chloridea obsoleta) Bulletin 187, Kentucky Agricultural Experiment Station, pp. 87c-88l, 1916.

"The Curing of Bluegrass Seeds as Affecting their Viability," Bulletin 198, Kentucky Agricultural Experiment Station, pp. 27-48, 1916.

"The Locust Borer," Bulletin 200, Kentucky Agricultural Experiment Station, pp. 93-108, 1916. Also published by the Kentucky State Forester.

"Observations and Experiments on the Bean and Pea Weevils in Kentucky," Bulletin 216, Kentucky Agricultural Experiment Station, pp. 303-338, 1917.

"The Broods of the Tobacco Worms," Bulletin 226, Kentucky Agricultural Experiment Station, pp. 3-44, 1920.

"Observations on the Structure and Coloration of the Larval Corn-ear Worm, the Bud Worm and a Few Other Lepidopterous Larvae," Bulletin 227, Kentucky Agricultural Experiment Station, pp. 55-84, 1920.

"The White Flies of Hothouses," Bulletin 241, Kentucky Agricultural Experiment Station, pp. 77-82, 1922.

"The Bluegrass Plant Bug," Bulletin 265, Kentucky Agricultural Experiment Station, pp. 21-44, 1926.

"The Green Bug," (Toxoptera graminum) Bulletin 265, Kentucky Agricultural Experiment Station, pp. 44-47, 1926.

"The Sudden Appearance of Great Numbers of Fresh-water Medusae in a Kentucky Creek," Science, N. S., Vol. xliv, pp. 858-860, December 15, 1916.

"The Fresh-water Jellyfish (Craspedacusta sowerbyi)in Kentucky Again," Science, Vol. lx, pp. 477-478, November 21, 1924.

"Two Interesting Crustaceans from Kentucky," Transylvania Kentucky Academy of Science, Vol. 1, pp. 85-84.

"The Nut Bearing Trees of Kentucky," Bulletin 27, Kentucky State Department of Agriculture, 1924.

Thomas Hunt Morgan

There is probably no living biologist whose contributions to science are more important than those which Professor Thomas Hunt Morgan has made to our knowledge of the mechanism of heredity.

Morgan was born in Lexington, Kentucky, September 25, 1866. He earned his degrees at the Kentucky State College and John Hopkins University. From 1891 to 1904 he was professor of biology at Bryn Mawr. Later he was appointed professor of experimental zoology at Columbia University. In 1928 he became director of the William C. Kerchkoff laboratories of biological sciences at the California Institute of Technology.

Morgan's work, which is physiologic in character, with no attention to taxonomy has laid a foundation on which all further development of knowledge of heredity, variation, and evolution must rest. Due to his work on the fruit fly, Drosophila melanogaster, it is now definitely known that the genes carry the factors which determine the constitution of the offspring. His work has solved many of the questions that have puzzled biologists. Among these are mechanism of "crossing-over" and "sex-linkage." He has not only contributed very materially to the field of pure science, but his work has wide practical applications in the life of man. His scientific interests have not been limited to genetics. His first work was done in experimental embryology and he still returns to this field at intervals.

Morgan is known by his associates as

> ". . . a man of strong individuality, with crisp, vigorous, and humorous speech, and with sharply defined opinions that are quickly and forcibly expressed, but readily changed as objective knowledge increases." 80

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80 Oswald Garrison Villard, "Award of Nobel Prize for Medicine," Nation, CXXXVIII (1933), 497.

Dr. Morgan's works include:

The Development of the Frog's Egg

Regeneration

Evolution and Adaptation

Experimental Zoology

Heredity and Sex

Critique of the Theory of Evolution

The Theory of the Gene

and monographs and papers on biological and embryological subjects.

His work has never lacked recognition but the crowning honor came in 1933 when he was awarded the Nobel Prize for Medicine for his work in mapping the genes in the chromosomes of Drosophila melanogaster.

William Delbert Funkhouser

One of our best known contemporary Kentucky scientists is William Delbert Funkhouser who was born in Rockport, Indiana, March 13, 1881. He received his A. B. from Wabash College in 1905, his M. A. from Cornell University in 1912, and his Ph. D. from the same institution in 1916. He was for several years headmaster of a high school in Ithaca, New York. He has been professor of zoology and head of the department at the University of Kentucky since 1918, and dean of the graduate school since 1925. His attention has been centered on taxonomy.

He is author of:

Biology of Membracidae of Cayuga Lake, 1917

Outlines of Zoology, 1919

Wild Life in Kentucky, 1923

Birds in Kentucky, 1926

Catalogue of Membracidae, 1927

and also many articles in entomology journals.

Although Mr. Funkhouser is primarily a zoologist, he has done a considerable amount of work in geology.

CONCLUSION

From the preceding sketches we see that though Kentucky is not generally known for her contributions to science, some very valuable scientific information in various fields, including physiology, genetics, botany, and zoology, has been contributed by Kentuckians. Of the men discussed in this paper, A. M. Peter, Garman, Morgan, and Funkhouser are still living. The calibre of the work of these men and other Kentucky scientists is held in high regard by contemporary leaders in their particular lines of investigation. On the whole, Kentucky's outlook for the future in scientific fields is very bright.

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