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JOHN THOMAS PATTERSON

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A Biographical Memoir by

THEOPHILUS PAINTER

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Biographical Memoir

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J. T. Patterson

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BY THEOPHILUS S. PAINTER

JOHN THOMAS PATTERSON, known as "Pat" to his colleagues on the campus and "Dr. Pat" to his many students, was born on a farm near Piqua, Ohio, on November 3, 1878. As an undergraduate at the College of Wooster he was trained by such men as H. N. Mateer and the elder Compton, and as a graduate student at the University of Chicago, by C. O. Whitman and others. He brought to the University of Texas in 1908 an understanding and appreciation of the importance of research in any university and set about building up a Department of Zoology molded in the best traditions of true scholarship. A man of broad vision and boundless enthusiasm, and a prodigious worker, by precept and example he exercised a great influence not only on his colleagues but on the many administrative officers under whom he served for more than fifty years. Officially placed on emeritus status in 1950, he regularly came to his office and carried on research until well into his eightieth year.

His paternal grandfather was John Patterson, a well-educated young Irishman who, after several years of travel on the continent, decided to come to America. He left home in the early part of 1800, but when his ship was in sight of Philadelphia young Patterson was taken off and impressed into the service of His Majesty's Navy. He remained in service for eight years, but when Napoleon was sent to Elba, young Patterson was released and was set ashore at Philadelphia. He started west, walking (for the most part) across Pennsylvania and a part of what is now Ohio, and stopped at the Indian village of Piqua. Here he purchased 320 acres of land from the "territorial government" (for Ohio was not yet a state) and began to clear his land for cultivation. This farm is still in possession of members of the Patterson family and is located at the southern edge of Shelby County about four miles from the present town of Piqua.

In 1813 John Patterson married a neighbor's daughter and they reared a family of eight children. The youngest of these was James N. Patterson, the father of John Thomas Patterson. Patterson's father, in addition to considerable mechanical skill and ingenuity, had a lively interest in mathematics, astronomy, and other sciences, and wrote and published several articles. Undoubtedly, it was from his father that Patterson inherited these talents; and in watching his father and helping to make farm implements and household appliances, he acquired considerable skill in the use of his hands, which in later years was very useful in his experimental work.

Patterson's maternal grandparents were William and Margaret Linn. The forebears of this family came from Scotland and settled in Pennsylvania before the Revolutionary War. Later they moved to a farm some two miles from Piqua. Their daughter, Anna (Linn), attended McLane Female Seminary in Indianapolis, Indiana, and taught school several years before her marriage to James N. Patterson. This couple had five children, the youngest of whom was John Thomas Patterson.

John Thomas was reared on the family farm and remained there until he was eighteen. With a father of broad intellectual interests and a mother who had been to college, and who was a teacher as well, it is clear that he was raised in a very unusual environment for a farm boy. When Patterson was in his teens he contracted pneumonia, and for several years afterwards his parents were concerned about his health. He was encouraged to spend time out of doors, and in wandering about the countryside Patterson developed a collecting instinct with two major interests that dominated his activities the rest of his life. One was a great interest in the animals and plants of the region in which he lived, and the other was the collection of Indian artifacts that abounded in the region where he was raised.

While he was living on the farm, Patterson attended a nearby country school and completed nine grades. The precarious state of his health prevented him from making the four-mile trip into Piqua every day, so his family employed tutors who came to his home. In his late teens, with health fully restored, he prepared for college by going to a normal school at Ada, Ohio (now known as Ohio Northern University). In the fall of 1900, young Patterson entered the College of Wooster and came in contact with three men of whom he frequently spoke in later years, Dr. H. N. Mateer, professor of biology, W. H. Wilson, professor of mathematics, and Dr. Elias Compton, professor of philosophy. It was from these men that he gained an appreciation of scholarship.

After completing the work for a B.A. degree in three years at the College of Wooster, Patterson taught for two years in Buena Vista College, located at Storm Lake, Iowa. But since childhood he had planned to go into medicine. In the summer of 1905 he went to the University of Chicago to better prepare himself for this profession. As it turned out, the courses available during the summer quarter were those dealing with zoology. Here he came to know Professors C. O. Whitman and C. M. Child, and by the end of the summer quarter

Whitman had persuaded him to devote his life to teaching and research. So Patterson remained on at the University of Chicago and received his Ph.D. in June of 1908.

In later years, in talking about the men who had been major influences in his life in addition to the men at the College of Wooster, Patterson always spoke fondly of Whitman, especially, and of Child, Coulter, and Williston. It is not surprising that Patterson acquired from such men a keen appreciation of true scholarship and the value of research.

While Patterson was teaching at Buena Vista College he met Alice Jane Tozer. Miss Tozer was a graduate of Western Reserve University of Cleveland, Ohio, and was teaching classes in English and Latin. They were married in 1906, and while Patterson was completing his degree Mrs. Patterson took some graduate work in the University of Chicago. This couple had three children: Edith Ruth (wife of Col. E. F. Simpson) of Austin, Texas, John Thomas, Jr. (deceased), and Robert Maitland of Tulsa, Oklahoma.

Mrs. Patterson was an extremely bright woman with serious intellectual interests. She thoroughly understood her husband and served as a balance wheel when Patterson's Irish genes threatened to take over. Patterson adored his wife and had great respect for her judgment. All in all, one seldom sees two people so well suited to each other. Patterson was a devoted parent and in the earlier years, when the children were small, one could usually tell by the sound of Patterson's footsteps in the hall when anything was amiss at home—measles and the like. While neither Patterson nor his wife took any part in the social life of Austin, they were extremely cordial hosts to members of the department, and in earlier days when we were all afoot and calling was in vogue on Sunday afternoon, the Pattersons might be seen making the circuit.

It is appropriate to mention that soon after coming to Austin in 1908 Patterson bought a house at Woods Hole, Massachusetts, and for years he would take his family there in the summer. This not only served to keep him in close touch with current problems and with men who were making biological history but afforded a chance to meet and talk with young men and learn at firsthand something about their teaching ability and research potential. It was in Woods Hole that Patterson first met T. S. Painter, E. J. Lund, and H. J. Muller, each of whom, in order, became members of Patterson's department in Austin.

Genetically Patterson was a heterozygote—a mixture of Irish and Scotch-Presbyterian genes—and this showed in everything he did either within or outside of the laboratory. Phenotypically he was Irish and his first reactions were often just what could be expected of an Irishman. Sandy-haired and short of stature, he had a ready wit, a love of repartee, and the ebullient temperament we traditionally associate with the Irish people. This impression was greatly heightened by the short pipe he continuously smoked and his frequent reference to himself as a "short-bellied Irishman." Among his intimates he was very outspoken and frank; sometimes he was very abrupt in his manner, and what he regarded as Gaelic wit might offend those who did not know him well. But the vigor with which he expressed himself in his office or laboratory, especially when irritated, was never displayed in public, and in faculty meetings he spoke with restraint even when he was in violent disagreement with some other faculty member. Although Pat's first reactions were often those of an ebullient Irishman, if he was given a little time for thought his Scotch genes came into play and he showed the canniness and conservatism that we associate with Scotsmen. I well remember saying to the late H. Y. Benedict, who was President of the

University of Texas at the time, that while Pat's initial reactions might be a little colored with Irish emotion, when he expressed his considered (Scotch) judgment he was well worth listening to. And President Benedict nodded in vigorous approval. Later, when in the course of events the writer became President of the University, like my predecessor in this office I often sought Patterson's counsel and advice.

Patterson enjoyed all sorts of games which call for physical skill or mental dexterity. He took a great interest in collegiate athletics, baseball being a special favorite, and he was a member of the Athletic Council for a time. For many years it was his custom to leave the laboratory about four o'clock and go to the University Club where a group of faculty members played chess almost every afternoon.

I well remember how I first met Patterson. It was at Woods Hole in the summer of 1915, I was playing the "ball in your hat" game just outside of the old Mess Hall with some of the undergraduate students taking the Invertebrate Zoology course. In this game each player places his hat on the ground and stands beside it. The player who is "It" tosses a softball into someone's hat. Everyone scatters, for the man who receives the ball must hit someone else with it or suffer the penalty of stooping over and allowing all the players to throw the softball at him. It is a hilarious game to play or to watch. Patterson, who had been watching us play, asked if he might take part, and we welcomed him with pleasure. He was not quite as nimble as the rest of us and he frequently suffered a penalty. A year later when there was an opening at the University of Texas and I was considered for it neither Patterson nor I needed an introduction!

This love of play was deeply ingrained in Patterson and made him a very congenial colleague. The fact that he enjoyed winning made it a joy to beat him. We played golf together for many years and, recurrently, each one of us tried to demonstrate superior skill in rifle shooting. But win or lose we never forgot that it was a game even though there might be a good deal of bantering for a day or two after some notable victory.

Together with his love for any contest Patterson took great pride in everything he owned or was a part of. He had great confidence in his own judgment, which was justified in areas of his competence or experience. There was strong feeling of camaraderie between Patterson and his colleagues, especially when the staff was small; he made us all feel that we were a part of the team. It was his custom to drop into the office of each of us every day or two to tell the latest joke he had heard or just talk. Subjects covered a wide range. Biological problems were uppermost, and Patterson's earlier associations with Whitman and Williston, plus his many contacts in Woods Hole, were a fitting background for profitable discussions. At other times campus problems were in the foreground. Patterson habitually "viewed with alarm" many local developments and he was very outspoken about the wisdom of many decisions made by administrative officers, including, no doubt, many I made while I was President! He was naturally suspicious of anything new and he was often inclined to question the motivation of other faculty members. We, his intimates, soon learned the futility of trying to convince Patterson he might be wrong, so we heard him out secure in the knowledge that when Patterson's Scotch genes gained the ascendancy, he would see things in a proper perspective.

One outstanding personal trait of Patterson's was the following. Extremely sensitive as he was in all personal matters, over a period of four decades and more of association I never detected any trace of envy over the honors another staff member might receive. Instead, he seemed to take great pride that a man he had selected for his departmental staff had made good, and while he might not mention it to the man honored we all knew that he would bring it to the attention of the Dean and the President.

Such was the man who came to the University of Texas in 1908 and who built up one of the outstanding departments of zoology, notable for its many contributions to knowledge.

As a scientist Patterson was a meticulous and careful observer and experimenter who considered all possible explanations. He always concerned himself with big biological problems subject to frontal attack, and once he decided that an undertaking was worth while he undertook it with great vigor and singleness of purpose and would talk of nothing else for days. No amount of physical work seemed to daunt him. Two examples will serve to illustrate these traits.

One of the first problems Patterson undertook when he came to Austin was an investigation of the embryology of the armadillo, which, as was well known, always gives birth to identical quadruplets. Now single armadillos are relatively common in the hill country west of Austin, but they are nocturnal in habit and catching the numbers needed for embryological studies was a tremendous and expensive operation calling for careful organization and planning, as well as the help of many men and dogs. Patterson, who was a splendid organizer, often told of his experiences with the hill people on these hunting expeditions and of the many stories he heard while sitting about a campfire in the middle of the night. One can well imagine the initial reactions of the hill people to a college professor, but Patterson was the sort of enthusiastic, even burly, individual whom they came to admire and respect.

When Patterson's interests turned from embryology to speciation in the genus Drosophila, he was not content to study the fauna of this region but organized collecting expeditions which went all over the western part of this continent and into Central America. Eventually, through exchanges and collections, representatives of some 150 species were brought to his laboratory and were studied by Patterson and his students and his colleagues.

Patterson's extensive knowledge of and his intense interest in all biological phenomena within his ken made him an extremely good and stimulating teacher at both the undergraduate and the graduate levels. He always prepared his lectures with great care; they were models of clarity and a simple straightforward explanation of the essential facts. He had the happy faculty of enlivening his lectures, which at times were a bit on the serious side, with apropos anecdotes of events or personalities drawn from his many contacts in his graduate student years, or from his Woods Hole associations. He was at his best in the laboratory when during the course of long afternoons he would talk with students. His door was always open to his students, good and poor alike, and Patterson was kind and sympathetic to all. Many of the graduate students found Patterson willing to help them out with a temporary loan, when this was needed to keep them in school. All of his students liked and admired "Dr. Pat," and invariably when one met an older graduate the first question was, "How is Pat?"

At the graduate level Patterson gave very few formal lectures but the endless hours he spent in the laboratory informally explaining and discussing subjects with graduate students made him a very effective mentor. A total of thirty-one students received their M.A. degrees under him (a formal thesis was required of all) and twenty-nine completed the work for the Ph.D. degree during the forty-eight years of his active teaching career.

When evaluating the lifework of any man in science, we usually speak in terms of his contributions to knowledge in his chosen field; and indeed, in institutions with a long-established tradition for scholarship and with an appreciation of research and funds for its support, this is a proper measure. Men in the biological field, quite rightly, esteem the researches of Patterson in embryology, especially his studies on the armadillo and other polyembryonic forms, and his work in the area of genetics and speciation. His election to the National Academy of Sciences attests the magnitude and quality of his contributions. But those of us who are familiar with the conditions which obtained at the University of Texas when Patterson came here in 1908 would place another achievement, in its over-all beneficial effect on this institution and to education in Texas, far above his many personal contributions to knowledge. We esteem Patterson for two reasons: first of all, for his activities and influence in putting graduate work and research in proper perspective in an educational environment not sophisticated enough to know or appreciate the importance of research in any university worthy of the name; and second, because Patterson knew what it takes to provide conditions conducive to research, and because he singlehandedly went out and obtained funds for research. To see this picture in proper perspective, it will be necessary to describe conditions as Patterson found them in 1908, and then show how he gradually changed them during the years following. In this light, Patterson grows in stature and the reader will understand why his associates think of him as a builder for the betterment of this institution, in addition to his personal research activities.

Although the university opened its doors in 1883, no formal work was offered in the biological sciences until 1892, when a School of Biology was set up to include courses in botany, geology, and zoology. By 1899 the biological disciplines had attracted enough students to justify the separation of these subjects into independent schools (departments). In the early years the amount of money assigned to any school for materials and equipment was determined by the number of students enrolled. This caused the School of Zoology to offer a considerable number of service courses. The results were satisfactory, as far as student numbers were concerned, but the teaching load placed on the staff was very heavy and an integrated series of courses was lacking. It is interesting to note that, in these days when young scientists feel put upon if they are asked to do much teaching, Dr. W. M. Wheeler taught four and a half courses per term and still had the time to do the field work which was the foundation of his monumental book on ants. T. H. Montgomery, who followed Wheeler as head of the department, continued this earlier practice of service courses.

When Patterson came to Austin the School of Zoology was faced with two serious problems. The first was the lack of integrated courses to serve eventually as the foundation for graduate work. (At the time there was no institution in the entire South or Southwest prepared to give adequate training in the biological sciences to serve as the basis of graduate training.) It was recognized by Patterson that in the long run the strength of a university department must be measured by its advanced and graduate courses and its graduate students. Accordingly, steps were taken to discard as many service courses as possible and to replace these with an integrated series so coordinated that all students majoring in zoology could not avoid knowing something about the major biological fields and about the prevailing biological concepts of the time. After the basic introductory course a student spent one whole year on Vertebrate Zoology, in which emphasis was placed on the evolution and the natural history of the members of this group as well as the standard comparative anatomical studies on the organ systems and their functions. In the third year, one term was devoted to Embryology and the second semester to Cellular Biology. Patterson insisted that if these courses were taught in an interesting way students would elect courses in zoology whether they planned to go into medicine (as the majority did) or took the courses for their interesting content. And in Patterson's selection of new members for his staff, teaching ability, as well as research potential, was a prime essential. Patterson's contention proved to be correct, and the teaching done by the zoological staff was quickly recognized as about the best on the campus. This fact predisposed the University's administration to grant any reasonable request, and Patterson succeeded in convincing the Dean of the College of Arts that it was the better part of wisdom to offer a limited number of integrated courses and have these well taught rather than have the staff expend its energy in teaching the same number of students in several different subjects. It was in this way that Patterson provided time for research for himself and the other members of the staff.

The second major problem Patterson faced, and about which his predecessors had done nothing, was to provide an adequate library, including current journals in areas in which the staff did research. Fortunately, the Administration and the Regents recognized this need and on occasions made special grants to the Department for buying journal sets. In addition, Patterson suggested to the Budget Council that it would be wise to devote some of the money allocated for maintenance and equipment to the library. For a period of some thirty years, $500 was set aside each year from M. and E. funds and added to the normal university allotment for books. By 1920 the departmental library was up to date in current journals and some of the available money could be used for filling in journal sets.

From what has been said, it must be obvious that Patterson was a man of considerable wisdom and a constructive builder for the future of his department and for the good of the university he served.

To appreciate the difficulties Patterson faced in getting funds for a separate building for the biological sciences and for research needs of the staff, it will be necessary to outline certain background facts which are unique to the University of Texas.

When the University of Texas was established, the Founding Fathers stipulated that it was to be an institution of the first class, and to this end some two million acres of the public lands were set aside to provide new buildings as the institution grew. While in the end this land was to be the source of great wealth because of the presence of oil under it, in the early years of Patterson's career the only money available for permanent buildings was from grazing leases on the university's land. This amounted to about $200,000 a year.

While the Founding Fathers provided funds for buildings of the future, it was left to the Legislature to appropriate money from the general revenue for ordinary operating expenses. This was done biennially and took the form of a line item appropriation bill. As a result, the only "free" money available to the Administration for unforeseen expenses, or for buildings, was the income from the land and student fees. Under such conditions one can well understand why any President was very reluctant to spend the free money for anything except absolute essentials for the operation of the University. Some idea of Patterson's aggressive nature and his influence with the Administration can be gained from the fact that in 1919 a large and modern Biology Building was under construction. The completion of a separate building in 1920 allowed the departments of Botany and Zoology to move from the upper floors of the bat-infested Main Building and from temporary wooden shacks to adequate quarters for both students and staff. When I expressed my personal appreciation to Dean Benedict (later President), he remarked, "When you have as little free money as we have, you want to be sure you are betting on a winning horse."

The discovery of oil on the university's land in the early twenties soon was bringing in an income of several million dollars a month but paradoxically initiated an era of financial stringency more severe than in any other period of the University's history. The Attorney General ruled that the income from oil leases and royalties was a capital asset and must be invested in types of securities prescribed by law for any school funds. The pinch came when it was realized that another statute prevented the purchase of securities above par. Now, all the available and eligible bonds at the time were selling at a premium, so the Regents had to use student fees and grazing lease money to pay the premium on eligible bonds. To try to persuade the Administration to use their precious cash for research would have daunted anyone except Professor Patterson.

In the spring of 1926, Mr. Halsten J. Thorkelson, from the Division of Studies and University Education of the General Education Board, was making a trip to appraise the research potential of southern educational institutions. Here he made contact with Professor Patterson. When he returned to New York he gave an enthusiastic report on the University of Texas, in general, and the Department of Zoology in particular. There followed correspondence and visits from President Splawn and the upshot was that the General Education Board appropriated, in 1928, the sum of $65,000, designated "for the development of graduate instruction and research in zoology, and to be expended over a period of seven years." It is interesting to note that because of the temporary financial straits in which the University found itself (due to bond premiums) it was arranged that the University's matching funds would be made during the later period of the grant. Research support has continued from the Rockefeller Foundation up to the present time and through 1959 had amounted to $318,520. Over this period the university has substantially matched the grants made by the Rockefeller Foundation.

When the writer came to Austin, in 1916, Patterson was teaching, in addition to cytology and embryology in alternate terms, courses in evolution and in genetics. Influenced, no doubt, by his summer contacts with T. H. Morgan and later with Sturtevant, Bridges, and Muller, Patterson decided to place emphasis on research in genetics and persuaded H. J. Muller to join our faculty here. But Austin proved to be an unfavorable environment in which to breed fruit flies in the summertime without refrigeration. With characteristic vision and persuasiveness Patterson convinced the Administration that it would be wise to make available to Dr. Muller an X-ray machine—with which he made his basic discoveries—and to air-condition a large laboratory so that genetic research might go on the year round. In view of the financial stringency of the mid-twenties this was a tremendous accomplishment.

With adequate funds for research from 1928 on, progress in genetic and cytogenetic research was very rapid. It was feasible to maintain a great number of mutant stocks and the routine handling of these provided employment for a number of graduate students. Along with these minor positions a few graduate fellowships were given each year.

Patterson was designated Director of Research in charge of the distribution of available funds to members of the staff.

He was so fair and judicial in this matter that the writer never heard any criticism of his actions.

A great asset to the Department was the existence of a good print shop on the campus and the fact that for many years there had been issued University of Texas Publications on a variety of topics. Patterson used this setup for the publication of much of the genetic work done by himself and fellow workers in genetics. Issued now in nearly annual series, each issue consists on the average of perhaps three hundred pages. To offset the local nature of these publications, copies are sent to libraries and individual geneticists all over the world.

As a glance at the appended bibliography will show, Patterson was very active in research from 1907 to 1954, and during this period published some 122 papers. Most of these are in the general fields of embryology and genetics with a sprinkling of papers dealing with the local fauna and with Indian artifacts. In furnishing the Home Secretary with an account of his work, he wrote: "It is difficult for one to evaluate his own contributions. I have selected thirteen contributions which are generally regarded as important. Most of these were discovered in experiments designed to test out some idea, and some of them represent co-authorship." The writer has accepted Patterson's list of accomplishments in the following review of his work.

SCIENTIFIC WORK

Patterson's first major scientific contribution dealt with the process of gastrulation in the pigeon's egg, a problem suggested to him by Professor C. O. Whitman. The main point at issue was the way in which the primitive streak is formed. With a thoroughness which characterized all his later work, Patterson began his study with the formation of the blastodisc and showed that at about twenty-one hours after fertilization the blastoderm cells begin to thin out into a single layer. Between thirty and thirty-one hours after fertilization the region where the marginal cells are open to the white yolk becomes interrupted, giving the posterior region of the blastoderm a free edge. At about thirty-four hours this free edge of the blastoderm rolls under and simultaneously there is a forward growth of these involuted cells. Following this process, which forms a tongue of involuted cells, the rounded posterior margin thickens up, partly by the *in situ* multiplication of cells, but mainly by the movement of cells from the left and right side of the dorsal lip which coalesce in the middle line. This median region formed by the coalescence of the lips of the blastopore is the primordium from which the primitive streak is formed. Patterson carried out some experiments in which he injured sites at various places along the blastoderm and showed, for example, that a wound made ten degrees to the right of the median line eventually showed on the right neural fold in the mid-brain region. In short, Patterson concluded that the gut-endoderm is formed by an invagination and that concrescence is the method by which the embryo is formed.

Immediately after coming to Austin, Patterson became interested in the embryology of the nine-banded armadillo, *Dasypus novemcintus,* which had long been known to give four identical quadruplets at birth. Already, by the mid-eighties of the past century, H. von Ihering was led to suspect that all the young of a litter in the armadillo were from a single egg because, in a pregnant female which he examined, all the embryos (1) were enclosed in a single chorion and (2) were all of one sex. But it was not until 1909 that more specific information was forthcoming. Fernandez (1909), who worked with the South American species, *Dasypus hybridus,* after examining several embryonic stages obtained from pregnant females, reached the conclusion that all the fetuses from a single female came from a single egg. And Newman and Patterson (1909), quite independently of Fernandez, from their study of a few late stages in the Texas species, were led to the same conclusion. But the exact mechanism which led to polyembryony was obscure. It was not until Patterson had collected a large number of female armadillos (Newman having left the University of Texas in 1911) that the critical stages were obtained, and it was Patterson who worked out the entire story and published it in the *Journal of Morphology* in 1913. His series began with late cleavage stages and extended to full-term quadruplets. In brief, Patterson found that the monodermic blastocyst of the armadillo is similar in every respect to that of many other mammals but it lies free in the uterine cavity for a matter of some weeks. (The armadillo breeds sometime before the 15th of August, but the blastocyst does not become attached to the uterine wall until sometime in October or November.) While in the unattached state the blastocyst becomes differentiated into ectoderm and entoderm, and then attachment occurs. Following this, owing to the movement of ectoderm cells downward, the entoderm all but completely surrounds the ectoderm. The ectodermal sphere soon shows a vesicle with the walls initially equally thick on all sides. It is about this stage that there is the first evidence of polyembryonic development. First, two thickenings are formed in the ectoderm and subsequently each splits, forming the primordia of the four embryos.

Patterson's interest in the way in which quadruplets are formed from a single egg in the armadillo very naturally led him to extend his researches to other polyembryonic forms. Material for such research was available locally, for in the fall the cabbage plants in truck gardens are invaded by the caterpillars of the Autographa moth and these caterpillars are frequently parasitized by the wasp *Paracopidosomopsis floridans.*

One to three wasp eggs are layed in the egg of the Autographa moth and there emerge hundreds of adult wasps from a single parasitized caterpillar.

The writer remembers well many pleasant afternoons in the fall spent in cabbage patches around Austin helping Patterson collect material for his studies. From 1917 to 1925 there appeared many papers dealing with some aspect of the life history of this parasitic wasp, the most important one being a complete history of its development, published in 1921. In brief, Patterson found that the process of maturation is completed in about one and one-half hours after the egg is deposited, and this is followed by cleavage. The eggs of polyembryonic insects differ from those of typical insects in that cleavage nuclei are accompanied by cytoplasmic segmentation, which leads to a morula stage. Following this, the embryonic cells differentiate into two classes. Certain blastomeres become transformed into spindle-shaped cells, while others retain their polygonal form and become arranged into groups. The spindle-shaped cells gradually fuse and give rise to a nucleated membrane which serves to divide the true embryonic cells into "primary masses." This stage is spoken of as the polygerm stage. In the completed polygerm each primary mass consists of several embryonic cells surrounded by a relatively thick inner membrane. Soon after the polygerm is formed the primary masses begin to multiply by fission. This results in a higher number of secondary masses, and these in turn each undergo fission and tertiary masses appear. It is from these tertiary masses that adult wasps are formed.

From his study of parasitic wasps Patterson turned to the wasps which produce galls on the oak trees around Austin and spent many days collecting these and studying several aspects of the life history of the Cynipidae. But in general the gall wasps did not open up a very profitable field of investigation, and when Muller showed that X rays produce mutation in Drosophila Patterson's interests shifted to the field of genetics and speciation.

It is not often that an investigator trained and well established in one field of research shifts to an entirely different one, but Patterson was such a man. In my conversations with him on numerous occasions he expressed the opinion that straight morphological embryology had made its major contribution to biology and that he thought genetics promised greater returns in the future. Patterson's interest in evolution, and in genetics which underlies it, was of long standing. Patterson always thought in terms of fundamental biological problems, and soon after he came to Texas he extended departmental offerings to include courses in both evolution and heredity. In many respects this was a daring thing to do at the time and, indeed, many of the Fundamentalists of the state regarded this move as additional evidence of the godlessness of this institution! Several notoriety-seeking preachers challenged Patterson to public debates on these subjects, but no notice of such challenges was ever made. Actually, there was never any serious trouble, for in courses in comparative anatomy or evolution all of us were careful to say, in effect, "These are the facts which have led many thoughtful men to believe that higher forms of life have evolved from lower and more primitive animals and plants. We do not try to persuade you to accept the theory but you must know the facts."

Through his Woods Hole associations Patterson was quite familiar with the work being done by Morgan, Sturtevant, Bridges, and Muller. Indeed, when he was teaching an undergraduate course in genetics, he obtained mutant stocks from Morgan's laboratory and had the better students make various crosses illustrating the way in which genes segregate in the first and second generations. Believing as he did in the great future of genetics, Patterson persuaded the Administration to support research in this area and to bring H. J. Muller to head up such research work. He was able to obtain from the Regents money with which to buy the X-ray equipment which Muller used in making his fundamental discovery of the mutagenic effect of ionizing radiations.

After Muller made the initial discovery in 1927, Patterson undertook a series of genetic studies that required the laborious and time-consuming examination of large numbers of fruit flies. He was a very astute observer and was never daunted by tedious work provided the information was needed to establish some point of fundamental importance.

The first extended genetic research dealt with the question: If X rays produce mutations by the irradiation of germ cells, could such mutations be induced in soma cells during embryological development? The general plan of his study was to irradiate, at various dose levels, eggs, larvae of various ages, and pupae, and follow the behavior of certain sex-linked characters in the males. Males, of course, carry only one X chromosome; should mutations be produced during the development of males carrying a dominant sex-linked character, this could be picked up in some of the offspring. A typical experiment was to use wild-type males and females and, after irradiating the eggs, larvae, or pupae, to examine the adults for any change in the red eye color. Thus some 1,838 eggs were exposed to X rays and from the culture 841 adults emerged. None of the 413 females showed any change in eye color, but among the 428 males there were nine individuals which showed patches of white in their eyes ranging from one to two hundred ommatidia.

In another experiment Patterson crossed wild-type females with yellow white males, and from 2,230 eggs which were irradiated he obtained 1,133 adults. Among the 587 females there were twenty-seven which showed white areas in one or both eyes, and among 546 males there were three with some white ommatidia. Altogether, in a lengthy paper which appeared in 1929, Patterson gives the results of nine sets of experiments which showed that genes in cells of developing embryos do mutate following irradiation and, in general, that the younger the larvae or egg, the more numerous the mutations are.

While he was carrying out the above work Patterson ran one set of experiments in which eggs and larvae of a white-eyed male and female were irradiated and then he examined the adult offspring for changes in eye color. Among 4,661 irradiated eggs and larvae he found one adult which showed a few red ommatidia—a reverse mutation. The experiment was so set up as to avoid misleading results. This clean-cut demonstration of the occurrence of a reverse mutation had considerable theoretical implications for a question which was very much in the foreground at this early period. Do X-ray induced mutations consist merely of losses and rearrangements of portions of chromosomes, or do these include "progressive" gene changes (point mutations) which might have selective value in the evolution of the species? Both Muller and Patterson had a good deal of pertinent information on this question so they pooled their data and, in addition, set up additional experiments, carried out by Patterson, aimed at producing more reverse mutations. In a joint paper sent to press late in 1929 Muller marshaled his data and discussed the general question, and from this it appeared extremely likely that point mutations were being produced, presumably by some chemical change in the gene, but the most convincing and direct evidence was the occurrence of reverse mutations, of which Patterson found quite a number. The demonstration that mutations can be produced in both of two opposite directions at the same locus is, of course, irreconcilable with the suggestion that all mutational changes induced by irradiation are due to loss of genes.

The next extended series of experiments, the results of which were published in 1931, was the production of gynandromorphs by the irradiation of the germ cells of both males and females. The fundamental question which prompted this study was: Is there a sex factor carried in the X chromosome? In earlier studies Patterson had shown that if a female heterozygous for a sex-linked gene is irradiated and a whole or a part of the X chromosome is eliminated, then recessive genes will show in the variant area. Patterson thought that if there is a sex factor carried by the X chromosome it should be possible to prove this by broken X chromosomes and to indicate its approximate position along the X chromosome.

In carefully designed experiments Patterson found ninety-three gynandromorphs among 190,299 F_1 flies from parents of which one had been X-rayed. This gives one gynandromorph for every 2,046 flies. In his control flies he found nineteen gynandromorphs among 116,116 flies—a ratio of one in 6,126 flies. It was clear from these results that irradiation of one of the parents causes a threefold increase in the production of gynandromorphs.

Taking advantage of breaks in labeled X chromosomes, Patterson showed that if there is in fact a sex factor it must lie at some point between the loci of singed and forked, or their normal allelomorphs.

Muller left the University of Texas early in the summer of 1932 and the direction of genetic research largely fell on Patterson and Dr. Wilson Stone. It was here that Patterson's capacity of making all his colleagues feel that they were part of a team came into play. Each man was made to feel that he had a special contribution to make in a joint effort to solve problems and that the matter of who did what first was not too important. Stone had grown up taking care of our Drosophila stocks and knew exactly what was available, and, like Muller, he had a flair for developing new stocks carrying genes which would give critical evidence on some point. Stone would spare no effort in placing in the hands of his fellow team members what was needed to determine the point, for example, at which a chromosome had been broken, so that the colleague could determine the exact site of a gene along a salivary gland chromosome. Patterson, with an interest in broader aspects of genetics and with his tremendous drive, gave direction to much of the team work, as will appear below.

For some three years—from 1932 to 1935—there was intense activity in our laboratory, and Patterson published a number of papers dealing with details of genetic interest. Thus, along with Meta Suche, he published a paper showing that crossing over in male flies took place following irradiation (normally, there is no such exchange between homologous chromosomes in males) or that aneuploidy of autosomes could follow irradiation. But by the mid-thirties Patterson seemed to tire of the tedious type of work he had done for so long and turned to one of his first loves, the collection of Indian artifacts. There are Indian mounds scattered all over Texas in the vicinity of relatively permanent water holes, and with his characteristic vigor and enthusiasm Patterson set about collecting arrow heads, flint knives of all sorts, awls, and other implements. But he made a careful record of all of his finds and in 1936 published a fifty-four page University of Texas Bulletin entitled *The Corner-tang Flint Artifacts of Texas.* This paper is well illustrated with many beautiful specimens which Patterson had found in his collecting trips covering a circle within a radius of perhaps one hundred miles of Austin.

In 1937 Patterson published a second booklet dealing with *Boat-shaped Artifacts of the Gulf Southwest States.* In a 131-page Bulletin Patterson describes and illustrates a considerable number of boat-shaped artifacts, most of which were loaned him by other collectors. He was especially interested in the question of the use made of these artifacts and reached the conclusion that they were attached to throwing sticks or atlatls. As is true of everything he did and published, Patterson made a thoroughgoing study of the material which was available.

Patterson had many amusing experiences while he was making his collections of Indian artifacts. One can well imagine the reaction of the "hillbillies" and ranchers to a college professor, but since he was willing to pay for choice specimens, they assisted Professor Patterson in collecting a variety of artifacts, some of which they had manufactured themselves! But Patterson was not to be fooled; he always examined all specimens under a low-power binocular microscope. Fresh chipping either by the use of antlers, or by nails, was easily identified!

One day while Patterson was collecting in one of his favorite areas, he found a specimen chipped to represent an Indian head, such as one sees on coins. Whether or not this specimen was the product of some artist of long ago is not clear, but as soon as Patterson evinced an interest in such finds the local inhabitants sought to supply additional specimens! Too often the mark made by a nail was found which threw doubt on the whole matter!

It is not to be inferred that during the Indian artifact interlude Patterson had given up genetic research, for he assigned many interesting problems to his graduate students. But from my almost daily conversations with him I gained the impression that Patterson was less interested in subtile genetic details than in larger problems. By 1937 it was obvious to Patterson that there was need for a thoroughgoing study of speciation in the genus Drosophila, especially as the salivary gland chromosomes made it possible to detect changes induced by chromosome rearrangements.

With the vigor and enthusiasm which characterized all that he did, Patterson set about collecting and identifying all the species of Drosophila in this region and eventually organized collecting expeditions covering the whole Southwest and a part of northern Mexico. He realized that the first step was to identify correctly all the species of Drosophila brought into the laboratory, and as the work progressed his attention was centered more and more on mechanisms which effectively isolated closely related forms.

One of the problems which Patterson faced from the late thirties on was the matter of a publication outlet for his own works, as well as those of his associates and graduate students. Because of high printing costs, genetic and other journals were sharply restricting the length of papers accepted for publication. Patterson solved this problem by using the University of Texas Publications series of bulletins. The campus printing establishment could produce bulletins at minimum cost, and to offset the local nature of the bulletins Patterson distributed copies to geneticists and libraries all over the world.

The first issue of what has become a series of publications was printed early in 1942 and dealt largely with systematics. Patterson contributed a paper on some new species of the subgenera Hirtodrosophila and Drosophila.

In 1943 there was another issue of some 327 pages, including a paper by Patterson on "The Drosophilidae of the Southwest," which in some 203 pages summarized much of the basic work that had been done. A second article by Patterson with one of his graduate students, R. P. Wagner, dealt with the "Geographical Distribution of Species of the Genus Drosophila in the United States and Mexico." And there was a third article in which one of Patterson's students, Dr. Linda T. Wharton, gave an analysis of the metaphase and salivary chromosome morphology with the genus Drosophila.

In 1944 the fourth issue of this publication contained a

223-page article dealing with the taxonomy, nutrition, cytology, and interspecific hybridization in Drosophila. Patterson wrote four of the seven papers, and the rest were by students working under his direction.

The fifth issue of Studies in the Genetics of Drosophila appeared in 1947. It consisted of 184 pages and included ten articles by Patterson and others working with him. Here for the first time special attention was given to the various types of isolating mechanisms encountered. Sexual isolation between members of the Virilis group was described by Patterson, Wharton, and Stone. The second article, written by Patterson, dealt with sexual isolation in the Mulleri subgroup. The third article dealt with the insemination reaction, which Patterson discovered, and then followed seven other papers, some of which were written by Patterson.

The sixth issue, consisting of 233 pages and published in 1949, contained fifteen articles by Patterson and his students and associates, and included papers on the genetics, cytology, and taxonomy of Drosophila. And in 1952 the seventh issue contained additional articles on these subjects, with a number written by Patterson.

In 1952 the long study which Patterson had envisioned in the late thirties had been concluded; he had given the world the most complete picture we have had up to the present about any animal or plant genus. It is very fortunate that Patterson, with Stone as co-author, published a book entitled *Evolution in the Genus Drosophila,* issued by the Macmillan Company in 1952, in which their work is summarized along with discussions of pertinent aspects and conclusions. The scope of this volume will be apparent by indicating the nature of the several chapters. After an introduction to the general problem, there is a chapter dealing with the genus and its species, a section on the geographical distribution and speciation, and a description of the chromosome changes which have occurred, including a description of the salivary gland chromosomes. After a chapter on gene variation and genic balance come two chapters dealing with isolating mechanisms, followed by a section dealing with hybrids and hybrid sterility. A special chapter is devoted to the Virilus species group, on which Patterson had written so many papers, followed by a chapter dealing with comparisons and general conclusions. While much of the information given in this book deals with a variety of details of primary interest to students of evolution, some of the broad conclusions will be of general interest.

During the evolution of the genus Drosophila the chromosome number varies between 12 rod-shaped chromosomes and 6 v-shaped elements. The formation of a v-shaped element from two rods results from a "centric fusion," which presumably results from a translocation in which the point of spindle fiber attachment of one of the chromosomes is lost. Otherwise it appears that translocations have played no significant role in the speciation of this genus. On the other hand, inversions within one arm of a v-element are extremely common, but are less frequent between the two arms, as salivary gland chromosomes show. There is no evidence that deletions have persisted or that large amounts of heterochromatin have been lost in the evolution of species.

To students of evolution the two chapters on isolating mechanisms will prove very informative in that it is shown that in addition to geographical isolation there is also ecological isolation due to food habits or preferences, breeding seasons, and many other factors. One of the most interesting isolating mechanisms was uncovered in Patterson's discovery of the insemination reaction.

After the publication of his book on the evolution of the genus Drosophila, Patterson continued to work and to publish articles in the Studies in the Genetics of Drosophila series.

As might be expected, during his lifetime Patterson received many academic honors. His graduation from the University of Chicago *summa cum laude* carried with it election to the Chicago chapter of Phi Beta Kappa. He was starred in the 1921 edition of American Men of Science. In 1928 he was made Director of Research in Zoology and administered the research grants made by the General Education Board and matched by the University of Texas for almost three decades. He was appointed Distinguished Professor of Zoology at the University of Texas in 1937. In 1938 he was given an honorary D.Sc. by his alma mater, the College of Wooster. In 1941 he was elected to the National Academy of Sciences. He received in 1947 the Daniel Giraud Elliot Medal for his paper on isolating mechanisms.

He held many elective offices. In 1941 he was Vice President of the American Association for the Advancement of Science, Section F. He served as President of the American Society of Zoologists in 1939. He was elected Constitutional President of the International Society for the Study of Evolution in 1947. He was elected President of the Genetics Society of America in 1954.

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KEY TO ABBREVIATIONS

Am. Naturalist = American Naturalist
Anat. Anz. = Anatomischer Anzeiger
Anat. Record = Anatomical Record
Biol. Bull. = Biological Bulletin
J. Exp. Zool. = Journal of Experimental Zoology
J. Heredity = Journal of Heredity
J. Morphol. = Journal of Morphology
Proc. Internat. Congr. Genet. = Proceedings of the International Congress of Genetics
Proc. Nat. Acad. Sci. = Proceedings of the National Academy of Sciences
Records Genet. Soc. Am. = Records of the Genetics Society of America
Univ. Texas Bull. = University of Texas Bulletin
Univ. Texas Publ. = University of Texas Publication

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