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OF

EDWIN OAKES JORDAN

1866–1936

BY

WILLIAM BURROWS

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Edwin A. Jordan

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Edwin Oakes Jordan was born July 28th, 1866, and died September 2nd, 1936. During his lifetime his chosen fields, bacteriology and public health, developed from their beginnings to their present outstanding position among the scientific activities of today. Although the initial contributions of Pasteur and Koch preceded Jordan's college days by a few years, the new knowledge was slow in reaching America in the form of actual practice and was beginning to come with increasing force when he started his college work. The effect of the heady stimulation of the new science of bacteriology on the young man, and the application to it of his own unusual abilities throughout the remainder of his life, go to make the development of the man and the scientist a brilliant facet of the history of the growth of bacteriology in this country.

Jordan was born at Thomaston, Maine. His grandfather, Oliver Jordan, was a master-mariner and shipowner who, after he retired from active life, lived in a dignified and beautiful home on Main Street, the street of fine houses in Thomaston. His father, Joshua Lane Jordan, was one of nine children and, like many others in his day, went to sea at an early age. By the time he was twenty-one he, too, was a captain and commanded first one and then another of the merchantmen then building at Bath and Thomaston.

Captain Joshua Jordan married his third wife, Eliza D. Bugbee, in 1865. When their first child, Edwin Oakes, was six months old, the father took command of the vessel, *Pride of the Port*, sailing from Thomaston. The family, augmented at Bombay by another child, did not return to this country for three years. Their home was, for the most part, the captain's cabin on board ship, with occasional brief stays ashore at such ports as Liverpool and Bombay. When Edwin Oakes was three and one-half years old, his father retired from seafaring, settled down in Thomaston in a house close to the grandfather's home, and engaged in the local banking business.

Mrs. Jordan was considerably younger than her husband. She was of Puritan stock which settled in this country early in the seventeenth century. After several years in the Normal Training School at Framingham, Massachusetts, she had taught in a country school. Although exceedingly shy and retiring, she was a woman of strong character, a devout Christian with a high sense of duty, with great potentialities for self cultivation and a saving sense of humor. She took a very active part in the education of her four children, interesting them both in good literature and in natural science. Jordan's self-effacing character, combined with an inner force which caused him to push forward any project that he felt to be good, without regard to the cost to his natural timidity, was undoubtedly derived directly from his mother. It was through her that he began a collection of minerals, an avocation that afforded great delight in his boyhood and a keen secondary interest throughout his life. During a number of his adolescent years he intended to become a mineralogist or geologist.

Thomaston was a small town in the seventies but a very busy and prosperous one with its shipbuilding, lime-quarrying and lime-burning industries. The life of the boy there was full of pleasant incidents, such as picnics upon land, mineralogical expeditions behind the pony, Nebuchadnezzar, and rowing and sailing a boat on the tidal river. Thomaston did not, however, present very good educational opportunities and on this account the family moved to Auburndale, Massachusetts, in 1881 where Jordan attended and graduated from the Newton High School. In 1884 he entered the Massachusetts Institute of Technology.

Already interested in natural science through his mother and having a nodding acquaintance with the methods of science through his collection of minerals, Jordan came in contact with William Thompson Sedgwick. Sedgwick exerted a strong influence on the young man, an influence whose impress remained with him throughout his life. This was evident not only from his continuous and lifelong devotion and loyalty to Sedgwick, but even more in his habits of thought and his marked tendency to think not only of the immediate consequences of experimental observations but, further, their relation to broad biological prin-

ciples. Undoubtedly this characteristic was innate in Jordan's own mind and very possibly his semi-philosophic attitude formed the nucleus of the close bond between him and Sedgwick.

Sedgwick was himself a young man, having been appointed Assistant Professor of Biology only the year before Jordan entered college. He became intensely interested in the newly born science of bacteriology and quickly grasped the significance of the new facts. The golden age of bacteriology was at its heyday in the eighties. New discoveries tumbled one after another with bewildering rapidity—the discoveries of the tubercle bacillus, the typhoid bacillus, the diphtheria bacillus, the meningococcus—and the giants of the day, Pasteur, Koch, Loeffler, Weichselbaum, Kitasato, Gaffky, Eberth, Pfeiffer, Roux and the rest, were not names only but active workers. Small wonder that those who took their first courses in biology with Sedgwick felt that a new world was opening up before their eyes. Jordan's active mind responded vigorously to this stimulation. It is much to his credit that he was not carried away in the whirl of medical discoveries but kept a solid footing on purely biological foundations. His interests followed those of Sedgwick into the sanitary and hygienic significance of the new knowledge, a field which remained of first importance to him all his life.

The year of Jordan's graduation, 1888, Sedgwick was appointed Consulting Biologist to the newly organized Massachusetts State Board of Health. Through Sedgwick, he was appointed Chief Assistant Biologist at the Lawrence Experiment Station and was intimately associated with the early experimental work carried out there on sewage and on the filtration of water. Before beginning the work at Lawrence, however, he spent two months with T. Mitchell Prudden at the College of Physicians and Surgeons in New York. Prudden, stimulated by the current discoveries in bacteriology, had gone back to Germany and spent a month in 1885 studying under Koch and had returned to America with the latest information. From him Jordan obtained first hand information on the differentiation of the typhoid and colon bacilli, the use of agar in semi-solid media, the Gram and Ziehl-Nielsen stains and other technics in use in Koch's laboratories. Something in Prudden's reticent but rich personality

appealed strongly to Jordan and the former's influence did much to augment the interest aroused by Sedgwick.

For the next two years, until 1890, Jordan carried on an intensive experimental study of the bacteria present in water and sewage. His efforts were devoted for the most part to the application of Koch's semi-solid gelatin medium to the study of flora characteristic of water and sewage. In later years he often spoke of the tedious methods used in the preparation of plates —the mixture of gelatin and water sample was poured on chilled rectangular plates of window glass and, after hardening, these were placed in tiers in shallow covered glass jars. Liquefying colonies, melted plates and other hazards made counting difficult and on a number of occasions in later years he remarked with solemn visage but a twinkle in his eye that "the method did not appeal to the engineers as highly accurate."

Two important points emerged from his work. One of these, the constant presence of the colon bacillus and closely related forms in sewage—and the absence of these organisms from water known not to have been exposed to sewage contamination —assumes great significance in the light of subsequent work. That he had hopes of finding a reliable biological indicator of pollution is evident from his remarks at the time, ". . . a study of the sewage bacteria as such may throw light on the vexed question of the possible pollution of water supplies; for, if certain species are found to be characteristic of sewage, and are never found in uncontaminated sources, then the presence of these typical 'sewage bacteria' in any given water supply will indicate undoubted pollution. We may perhaps look forward to the time when the bacteriologist will be able to say, of a given water: Such and such species of bacteria are present, therefore, at some time sewage must have entered this water; or, on the other hand: Only those species are present which are always found in pure uncontaminated water."

The other point has been generally overlooked by subsequent investigators. Jordan, with Ellen H. Richards, studied the nitrifying bacteria of soil and water. Following the work of the Franklands and others, they reached the conclusion that the microorganisms would not grow on gelatin plates and succeeded

in isolating cultures of nitrifying bacteria in inorganic solutions. Shortly before the experiments were complete, Winogradsky's first report appeared and Jordan's independent work had only the status of confirmation although published in the same year. He and Mrs. Richards were undoubtedly the first in America to study nitrification.

Meanwhile he had spent a summer or two at Woods Hole and there met Charles Otis Whitman and some of the other zoologists with whom he was to be associated later. As a result of Whitman's influence, Jordan became interested in zoology and experimental embryology and through him obtained a two year fellowship at the newly founded Clark University in Worcester, Massachusetts. He went to Clark in 1890 to finish his formal training with Whitman and received his Ph.D. in 1892. The new environment was highly congenial in many ways. Clark University had been founded by G. Stanley Hall for the purpose of establishing a strictly graduate and research institution. Whitman's own mind had much in common with this ideal. Speaking of the graduate student, he had said, "He is recognized, not as an irresponsible school-boy, to be marked for absences, ranked for recitations, and rewarded, after a prescribed number of years of study and decent behavior, with a 'graduating degree': but as a man who knows, or ought to know, his purpose, and who, if he ever expects to attain the distinction of a degree, must demonstrate his eligibility thereto by making some worthy contribution to the advancement of knowledge in his chosen field." This ideal, together with Whitman's strong conviction that a young man had best be given a problem and left largely to his own devices in working it out, were in complete accord with Jordan's own attitude. Despite the discrepancy in their ages—Jordan was twenty-four and Whitman fifty-eight—Jordan developed a great admiration for the older man and was undoubtedly greatly influenced by him. Both were interested in fundamental rather than superficial biological phenomena and shared the conviction that devotion to research was a prime means and chief end of higher education. Jordan developed a warm friendship with the other younger men, Shosaburo Watasé, Frank R. Lillie and William Morton Wheeler, and his associa-

tion with them went far in adding to his enthusiasm for his scientific work and in keeping his mind out of what might readily have become a narrow rut of sanitary biology. He was engaged at the time to Elsie Fay Pratt, whom he married shortly afterwards.

The experimental work he did at Clark University was reported in two papers. One of these was a study of the spermatophores of Dienyctylus and the second, entitled "The Habits and Development of the Newt," was his doctor's thesis. In the latter piece of work he supplemented the usual histological methods of study by continuous observations on the living embryo during gastrulation, and was able to see the movement of surface cells over the lips of the blastopore. This and other observations led him to support the theory of invagination rather than that of delamination in the formation of the mesoderm—a conclusion which has been strongly supported by later work.

When Whitman was offered the chair in zoology at the newly organized University of Chicago, Jordan readily accepted the invitation to accompany him and the other men in the department to Chicago as an instructor in zoology. The University opened in the fall of 1892 and Jordan began the active part he played in the development of the institution with which he was to remain the rest of his life. He was twenty-six years old when he went to Chicago.

Jordan's interest in the rapidly developing science of bacteriology and the application of the new knowledge and its methods to preventive medicine soon became evident in concrete form. In the spring of 1893, the first year he was at the University, he gave a course entitled "Sanitary Biology" which the announcement for that year describes as "The sanitary problem. The methods, objects, and results of the examination of drinking water; the examination of air, soil, milk, ice, etc. Sewage disposal and water supply. The filtration and precipitation of sewage. The nitrification of organic matter. Lectures and seminar." Wheeler gave the courses in embryology, Watasé those in cytology and Lillie finished his graduate work.

The following year, 1893-'94, Jordan expanded the course in sanitary biology to two courses, one in general bacteriology and

the other in advanced bacteriology. He gave, in addition, a course in general biology. He had already started experimental work in bacteriology, a study of the typhoid bacillus and the methods of differentiating and identifying it. He had not altogether abandoned experimental zoology at the time, for in 1894 he published with Eycleshymer a study of the cleavage of amphibian ova. After this, however, he devoted himself to bacteriology entirely insofar as his own experimental work was concerned and published no more work in pure zoology.

The next year he was made an assistant professor. He gave the same courses and continued his experimental work with the typhoid bacillus, a study of the conditions affecting its behavior in water. He went to Europe for a short time in the spring of 1895 and spent the six weeks he had available there at the Pasteur Institute in Paris. Although there was no time for extended experimental work, the stimulation and the contacts with men such as Roux and Duclaux were valuable and he took full advantage of the opportunity to obtain first hand information with regard to European practice. He returned to Chicago for the year 1895-'96, gave again his courses in general biology and elementary zoology but expanded the work in general bacteriology to two courses, *one introductory and dealing with the* biological and sanitary aspects of bacteriology and the other covering the pathogenic bacteria, disinfection, *et cetera*.

By 1897-'98 bacteriology at the University of Chicago began a rapid expansion under Jordan's direction. Charles Manning Child joined the faculty and took over the course in elementary zoology, leaving Jordan more time to devote to bacteriology. Albert Lincoln Smith, who had received a Ph. D. from the University of Berlin seven years before, registered as a special student in the University and gave a course in water and water supplies. Howell Emlyn Davies, a graduate student who held a fellowship in bacteriology, gave a course in elementary bacteriological technic. Jordan continued with general and pathogenic bacteriology and, in addition, introduced a seminar in immunity. The lack of texts of bacteriology in English for the benefit of those who did not read German with facility had been evident for some time, and Jordan attempted to fill in the

gap with a translation of Ferdinand Hueppe's well-known "Naturwissenschaftliche Einführung in die Bakteriologie" into English under the title of "The Principles of Bacteriology." The translation was published in 1899 and although regarded as a remarkably good translation of difficult, idiomatic German, did not enjoy a great popularity. Its lack of popularity undoubtedly had roots in Hueppe's highly individualistic concept of disease. He differed from Koch in that he felt that disease was a process resulting from varying causes and that on dynamic principles the most important cause was to be sought in the structural idiosyncrasies of the patient rather than in the invading bacteria which he regarded, at the most, as "liberating causes."

Jordan had, by this time, become thoroughly convinced of the importance of bacteriology as a separate science rather than a branch of some other biological science, and felt strongly that bacteriologists should have a society of their own. He was not alone in this, of course, but he and H. W. Conn of Wesleyan University were the only ones who campaigned actively for the organization of such a society. Their efforts were so successful that the first meeting of the Society of American Bacteriologists was held in New Haven in 1899 with a program arranged by A. C. Abbott. Jordan was very active in the Society for a number of years, holding the office of president in 1905, but in later years his active participation declined. His part in the organization of the Society was, perhaps, as typical of the man as any other single project. He felt that such a Society was actively needed and he spared no effort and inconvenience to get it under way. He actively supported it in its early struggling days, but when it became clear that the Society had developed into a healthy, strong organization, he characteristically left it to be conducted by the younger men, but always retained a warm personal interest in it.

Meanwhile the work at Chicago was developing rapidly. Jordan was made associate professor in 1899, the last year bacteriology stayed in the Department of Zoology. Davenport had become a member of the staff and took over the course in general biology so Jordan's teaching time could be devoted entirely

to bacteriology. He made use of this additional time by offering a course in public hygiene and found it necessary to have Davies help him with the general course. Smith again gave the course on water and water supplies. Jordan's own experimental work continued with an extensive study of *Bacillus pyocyaneus* and its pigments and another study of the production of fluorescent pigments by bacteria. His broad, general biological view of bacteriology is evident not only in his papers on bacteria, but even more in the variety of aspects of bacteriology and preventive medicine which interested him. In 1898 he read a paper before the Chicago Medical Examiners Association on the supposed inheritance of bacterial diseases and in 1899 published a study of the death rate from diphtheria in the large cities of the United States. It was clear to him from the beginning that preventive medicine and hygiene depended not only on purely bacteriological and immunological studies but also on the general biological aspects of host and parasite populations, the mechanisms involved in the transmission of infective agents and many other factors.

In 1900 bacteriological work was removed from the Department of Zoology and incorporated in a new Department of Pathology and Bacteriology, of which Ludvig Hektoen was in charge. The change was with respect to administration, for the laboratories continued to be housed in the Hull Biological Laboratories. Bacteriological work had expanded to such an extent that the entire fourth floor of the Hull Laboratories was occupied. The change, of course, included a change in the staff with whom Jordan was associated. Smith and Davies no longer worked in the bacteriological laboratories and Jordan's associates in the new department included H. Gideon Wells and William Buchanan Wherry in addition to Hektoen. Wherry was an assistant in bacteriology. Very much the same work in bacteriology was offered—courses in general and pathogenic bacteriology, elementary technic, public hygiene and research. Ernest E. Irons, Howard Taylor Ricketts and Mary Hefferan came to the department the following year, and Wilfred Hamilton Manwaring in 1903.

During these years a situation developed in Chicago which was, in a sense, made to order for Jordan with his training and experience. For many years the city of Chicago had been discharging its sewage into the Chicago River and, as the population increased and the volume of sewage grew, the water intakes were moved farther and farther out into the lake to escape sewage contamination. By the late eighties, the situation had become critical. Typhoid fever was common in the city, a serious epidemic occurred in 1890-'91, and minor epidemics were frequent. In a report of an investigation of the quality of public school water supplies conducted by Jordan in collaboration with F. R. Zeit and J. H. Long of Northwestern University, he wrote ". . . Through most of the time during the period covered by our examinations the water has not been in a safe sanitary condition. . . . It should be added that its condition now is probably not worse than has been the case many times in the last fifteen years. . . . The real source of the difficulty is in the quality of the general public water supply. . . ." The contaminated water supply assumed somewhat greater importance to the city at this time because of the approaching World's Fair It was so bad that the *Lancet* went to the length of appointing a commission to study the sanitary aspects of Chicago city water with the object of providing unbiased information for Englishmen who might come to the Exposition. Needless to say, the report of the commission was not flattering. Meanwhile the city had taken action and had organized the Sanitary District of Chicago under a general law enacted by the State Legislature in 1889. The remedy applied through the agency of the District was the cutting of the Drainage Canal from Bridgeport to Lockport and thereby reversing the flow of the Chicago river. Sewage was, therefore, no longer discharged into the Lake but drained into the Mississippi River by way of the Illinois and Desplaines Rivers. The remedy was efficacious as far as Chicago's water supply was concerned but resulted in a suit between St. Louis and Chicago in which the former charged that the sewage which eventually found its way into the Mississippi River resulted in contamination of the St. Louis water supply.

Jordan was intimately associated with this sewage disposal scheme from its beginning and carried on extensive bacteriological examinations of the water of the Illinois River at various points both before and after the Canal was opened. His investigations were the first controlled and extensive examinations of the question of self-purification of streams and provided a solid foundation of fact upon which all later work has been based. Briefly, he found that the enormous numbers of colon bacilli present in Chicago sewage disappeared completely in less than one hundred and fifty miles of flow and that the bacterial flora of the Illinois River at Grafton, where it empties into the Mississippi, was not altered by the opening of the Drainage Canal. His testimony on this point before the Supreme Court of the United States was the decisive factor in its decision in favor of the city of Chicago. Jordan's keen mind was nowhere displayed to better advantage than on the witness stand before the Court. Aside from the legal implications of his work, he had established the fact of self-purification of streams, a tremendously important addition to knowledge of sanitation and one upon which innumerable sewage disposal systems have since been based. It was not alone the scientific interests of the matter that motivated his work. He remarked on another occasion that "It is one of the vital offices of a university to contribute to the well-being of the community in which it is placed." His contributions to the sewage disposal of the city were, in effect, a partial discharge of the obligation he felt, and he continued to discharge this obligation further in following years through his association with the public health activities of the city. The present high standard of public health in Chicago is due, in large part, to his influence and advice.

Since the translation of Hueppe's text of bacteriology had failed to satisfy the need for an adequate text in English, Jordan filled the gap by writing one of his own. The idea had undoubtedly been germinating for some time, and in 1902 he entered into an agreement with the W. B. Saunders Company for the publication of a text which he would write. His book, "General Bacteriology," was a carefully considered and carefully written volume, one which he took six years to write—the

first edition appeared in 1908. His facility for writing beautiful English stood him in good stead and the immediate and continued success of his text is no doubt attributable to its well written, orderly and accurate presentation, as well as to the need it filled. For many years Jordan's "General Bacteriology" was, by all odds, the most widely used text in this country and had gone through eleven editions at the time of his death. Through the agency of this volume, Jordan may be said to have exerted a strong and wide influence on the development of American bacteriology and it was one of his important contributions to the field.

The John McCormick Institute for Infectious Diseases had been founded in 1902 by Mr. and Mrs. Harold F. McCormick. Ludvig Hektoen was director of the Institute and in 1905 Jordan was placed in charge of the Serum Division. At the time antitoxic sera were prohibitively high in price and altogether beyond the reach of the general public. The situation appeared unreasonable and Jordan was moved to undertake the production of diphtheria antitoxin under the auspices of the Institute so that such sera might be made available generally. His mind, of course, went beyond the immediate issue, the therapeutic use of antitoxin in the individual case, to the more general public health aspects of diphtheria control. He personally purchased a farm outside the city in Barrington, Illinois, and there the Institute kept horses for the production of antitoxin. Paul Gustav Heinemann, who had come to the department as a fellow in 1904, gradually took over the actual supervision of the work at Barrington, thereby relieving Jordan of much of the detail. Only native serum was produced at the beginning, but in 1907 the Gibson method of refining and concentrating antitoxin was adopted and a few years later the Banzhaf method, one utilizing plasma instead of serum, took the place of the Gibson method. A modification of the latter method was worked out and a more efficient method of bleeding the horses developed. Better serum than that available commercially was produced under Jordan's direction, and the improved methods were published to make them available to others. At first antitoxin was distributed through the Illinois State Board of Health but later, when more

became available, the Serum Division changed its policy so that physicians and druggists could obtain antiserum directly from the Institute or from the City of Chicago Department of Health. The costs were borne by the Institute and the antitoxin was purchased from the Institute, Jordan contributing his time and the use of the farm. It is difficult to estimate the benefit conferred by the serum work as carried out by the Institute. Not only were indigent sufferers from the dread disease relieved but, further, the products of the large manufacturing concerns were materially improved and reduced in cost. The Serum Division was discontinued in 1917 after its purposes had been accomplished.

Jordan was made full professor in 1906. For a period of several years, roughly from 1905 to 1914, his interests went further into the field of public health. His work with water-borne disease took the form of specific investigations of outbreaks of typhoid fever in Milwaukee, Detroit, Des Moines, St. Charles, Winnipeg, Quincy, Rockford and other municipalities. His papers reporting these investigations are models of what an epidemiological investigation should be, and he was invariably able to put his finger on the weak link in the sanitary chain. The detailed bacteriological studies in connection with these epidemics completed the picture of the mechanisms involved in the transmission of the disease. The study of the Rockford epidemic was one of the most interesting of these, for here Jordan found definite evidence that the contamination of the water supply with sewage sometimes resulted in a preliminary gastro-enteritis of relatively short incubation period which preceded the actual infections. As a result of these and other pieces of work, he came to be regarded as one of the foremost authorities in the country on water-borne disease and at the request of the United States Public Health Service, he set up bacteriological standards for drinking water supplied to the public by common carriers in interstate commerce.

He became more and more interested in milk and milk-borne disease, incidentally tracing three outbreaks of typhoid fever to contaminated milk supplies. He was very active in the campaign for pasteurized milk in Chicago. One of his earliest pieces of

work in this connection (1904) was a pointed analysis of the Chicago milk market, carried out while he was a member of the Health and Sanitation Committee of the Civic Federation of Chicago. As a member of the Committee on Regulations for the Pasteurization of Milk, he was, in large measure, responsible for the organization and drafting of a code of uniform and effective practice. Further, he took an active part in creating an informed public opinion on the desirability of pasteurization of milk supplies through articles such as "The Campaign for Pure Milk," published in Christendom, "The Household Milk Supply," a publication of the Domestic Science Department of the University, "The Case for Pasteurization," in the Journal of the American Medical Association, and similar informative writings which reached the medical profession and various portions of the general public. His own enthusiasm was, of course, for the adoption of effective public health measures based upon a solid foundation of scientific fact, and he realized that the hope of achieving such goals lay in the education of the public at large.

In spite of the fact that many of his activities were directed toward specific goals, Jordan never became narrow in his interests. In the midst of studies of typhoid fever epidemics, milk-borne disease and other investigations, he found time for articles such as "The Sphere of Bacteriology," "The School and the Germ Carrier," "Profitable and Fruitless Lines of Endeavor in Public Health Work," "School Diseases," "Disease Carriers Among School Children," and others. In 1912 he began the series of annual studies on typhoid fever in the large cities of the United States which appeared anonymously in the Journal of the American Medical Association.

Meanwhile his experimental work continued along various lines. His interest in insect-borne disease is apparent from two pieces of work on anopheline mosquitoes, one a note on the occurrence and habitat of *A. punctipennis* and *A. maculipennis*, and the other a study on the binomics of *Anopheles*. From the beginning of his work and throughout his life, Jordan was greatly interested in what is often called "pure" bacteriology. He carried on active experimental work of this kind in addition to his public health activities. Work on bacterial

enzymes, on the effect of bile on the colon bacillus, and similar studies may be considered to be in this category. Perhaps one of the most interesting evidences of the breadth of his scientific thinking during this period is a paper on bacterial variation read before the National Academy of Sciences. The strict monomorphism of Koch and his school had, for a time, subdued pleomorphism with the exception of that exhibited by the so-called involution forms. Bacterial variation did not come into its own until the early twenties with the work of de Kruif and Arkwright, and yet in 1914 Jordan perceived the importance of the problem and discussed it at length. His peculiarly analytical mind, which solved complex epidemiological problems in what seemed to many an almost uncanny fashion, is evident through all his work. His early study of a thermostable hemolytic substance present in sterile nutrient broth, an attempt to assay the significance of such variables in studies on bacterial hemolysins, was thoroughly characteristic of the man. Those who worked with him knew of his constant, almost fanatical, demand for control experiments. During this period Jordan became much interested in milk-sickness and carried on extensive experimental work in collaboration with Norman McLeod Harris in an attempt to find a bacterial etiology. These attempts were unsuccessful and it was later shown that the toxic qualities of milk from cows with trembles were a result of poisoning of the animals by white snakeroot.

In 1909-'10 he spent a sabbatical year at Freiburg. During the year he did little or no experimental work but spent his time studying the sanitary organization of the larger German cities, such as Frankfort, Berlin and others. Germany was, of course, much further advanced than the United States in this respect, and Jordan was particularly interested in the methods used in training sanitarians and the organization of instruction in hygiene. The information he gained was put to good use when he returned to America.

For some time Jordan had felt that the scope of bacteriology was so broad that its possibilities, particularly with regard to hygiene and preventive medicine, could not be realized in a Department of Pathology and Bacteriology. The rapidly grow-

ing importance of preventive medicine convinced him that instruction in this field should be made available in medical schools, and the medical school at the University in particular, and further that an opportunity should be provided for the training of health officers and experts in the field. His efforts and enthusiasm bore fruit in the creation, in 1912, of the new Department of Hygiene and Bacteriology with Jordan as head of the Department. The change was, again, one of administration, for the laboratories continued to occupy the fourth floor of the Hull Biological Laboratories. The first year the staff included, in addition to Jordan, Harris who had been in the old department since 1902, Heinemann, and Wherry, who had left but returned as a visiting professor. Wherry gave a course in parasitology, the first in the University, and Jordan expanded his own teaching to include a course on vital statistics and epidemiology. The introduction of parasitology into the Department was an innovation in the field of bacteriology. The protozoan and helminth infections and the role of insects in the transmission of disease had, of course, been known for many years, but Jordan was one of the few who perceived the essential similarity and common ground between the two fields. In later years it has been more generally realized that parasitic and bacterial infections have much in common, not only in modes of transmission, but also in the defensive mechanisms of the host against the infective organism which, in many cases, appear to be identical. Jordan hoped, from these beginnings, to develop a school of hygiene and public health that would function side by side with investigative work of a fundamental nature. This ambition was never quite realized, owing to a variety of circumstances, but the plan served as a stimulus for the development of such work in American universities.

By 1915 the Howard Taylor Ricketts Laboratory had been built by the University to serve as temporary quarters for the Departments of Pathology and of Hygiene and Bacteriology, and after twenty-three years bacteriological work at the University was physically separated from the Department of Zoology, where it had originated. The new laboratory was named in honor of Ricketts, a member of the faculty of the Department

of Pathology and Bacteriology who had died in 1910 of typhus fever during an investigation of that disease in Mexico.

During these years Jordan's interests had become even broader and included the field of food poisoning. The transition from the water- and milk-borne enteric diseases to gastro-enteritis resulting from the ingestion of foods was not a difficult one. The expansion of his interests in this direction was undoubtedly facilitated by his contacts with the large meat packing concerns in Chicago. He had been asked by one of these companies to investigate a stubborn outbreak of typhoid fever in a subsidiary plant in South America. He solved the problem in his usual competent fashion and at the same time developed a marked interest in the problems of food preservation and food poisoning which confronted the packing industry. This interest soon took concrete form in the shape of several publications in the general field of the bacteriology of foods, food-borne infections, and food-poisoning. He began at this time his association with the packing industry as an advisor and consultant, an association which lasted until his death. The step took courage on his part for, at the time, it was generally felt that industrial connections were not altogether desirable for one engaged in academic work. The opportunity to contribute further, although indirectly, to public health was not to be denied and the sanitary improvements resulting from close cooperation between industry and the research laboratory have amply sustained his feeling.

About this time Jordan started an extended investigation into the differentiation and biological characteristics of bacteria of the typhoid-paratyphoid group. The morphological, physiological and immunological similarities of these organisms made differentiation of the species from one another a difficult matter and a possible solution lay in a detailed and careful study of the entire group. The results of this work were embodied in a series of papers extending over a period of years, the last paper appearing in 1925. As a result of this investigation and a number of others, he became the foremost authority on these organisms in America.

When the United States entered the World War in 1917 two sanitary needs were apparent at once; a supply of trained tech-

nicians for laboratory diagnosis, and organization and supervision of the laboratories at the training camps in this country. The problem which arose was the control, not of enteric infections as in previous wars, but of respiratory infections, such as pneumonia and epidemic influenza and of meningococcus meningitis. The last was of greatest importance in the early days, the influenza control came later. Jordan, in common with the other bacteriologists of the country, rose to the occasion and bent every effort toward the control of these diseases in the army camps. His work took two forms; one, the most obvious, was the training of technicians for work in the army laboratories. The University laboratories were used to a great extent for this purpose, the courses of training being arranged and taught under Jordan's direction. The other work he undertook was in the capacity of director of the Red Cross car "Lister." Four of these cars, equipped for field laboratory work, were built by the Pullman Company and operated by the Sanitary Service of the American Red Cross. Jordan made a series of trips in the "Lister" to army camps in various parts of the country. When the laboratory of a given camp required organization or instruction in diagnostic methods or when an epidemic appeared to be getting out of hand, the car was called and whatever measures necessary were taken. The "Lister" operated only a few months before being turned over to the army along with the "Reed" and "Metchnikoff." One car, the "Pasteur," was retained by the Red Cross and Jordan accepted the directorship of this car after the others had been transferred. The essential weaknesses in the organization for control of disease in the army camps were apparent at once to Jordan, and he made many pointed and valuable suggestions which were perhaps of considerably more importance than the actual work of laboratory organization and instruction in diagnostic procedures.

The influenza pandemic of 1918-'19 was of great concern, not only to the army but to the civilian population as well. The problems confronting the bacteriologists were difficult ones, particularly since Pfeiffer's bacillus, thought to have been established as the causative agent of influenza many years before, was found to bear only an uncertain relation to the disease. As

a member of the Respiratory Commission, Jordan undertook a systematic investigation of the bacteriology of the disease, an investigation in which not only he but other members of his department took an active part and which extended over a period of several years. Other members of the Commission made similar investigations and by frequent consultation and pooling of information it was hoped that some light might be thrown on the etiology of the disease. The venture was not successful, however, and in 1927 Jordan wrote an extended review entitled "Epidemic Influenza" which was published in book form by the American Medical Association and which did much to clarify the chaotic mass of information which had accumulated about the disease in the course of years. His serious consideration of certain experimental evidence suggesting a virus etiology is of particular interest in view of the recent work in which a filterable virus has been shown to be the cause of at least some kinds of influenza.

After the brief disorganization of the war period, the department settled down to continued development under Jordan's guidance. An additional laboratory, Ricketts Laboratory South, had been built and a few years later, when the Department of Pathology moved to new quarters in Billings Hospital, the Department of Hygiene and Bacteriology occupied both buildings. The work in parasitology, begun with Wherry in 1913, took more definite form with the addition of William Hay Taliaferro to the staff in 1924. Taliaferro initiated and maintained active research in the field which in its fundamentals drew closer to bacteriology.

Not long afterwards, research on virus diseases was initiated in the department—at first confined to poliomyelitis but later, with the addition of N. Paul Hudson to the staff, extended to include a variety of studies on other diseases of virus etiology.

Jordan's own work on the paratyphoid-enteritidis group and his epidemiological work went on unchanged. He undertook an annual report on diphtheria mortality in the large cities in the United States, a companion to the annual typhoid report, which was likewise published anonymously in the Journal of the American Medical Association. He prepared standard methods of

bacteriological analysis of milk for the American Public Health Association and published papers on the bacterial content of stored normal and typhoid feces and the interconvertibility of "rough" and "smooth" bacterial types. His experimental work turned to studies on food poisoning and food-borne infection and the relation of the paratyphoid bacilli to these problems. He had, by this time, become accepted as the first American authority on food poisoning and shared international honors only with Savage of England. The food poisoning investigations took a new and promising turn with Dack's discovery of a filterable substance produced by staphylococci which, on feeding to human beings, produced the typical clinical picture of food poisoning. The importance of this observation was obvious to Jordan and the phenomenon was subjected to an intensive investigation. Jordan's observation that certain monkeys were susceptible to the action of the toxic substance was soon confirmed by the other workers in the laboratory and put the study of the toxic substance on a solid experimental foundation. He later found that a variety of bacteria, including the presumably innocuous colon bacillus, could produce similar toxic material under suitable conditions of cultivation. This finding was of some interest in that it was in complete accord with epidemiological studies. Savage had previously postulated the existence of such toxic substances on theoretical grounds, an hypothesis with which Jordan did not agree until their existence could be shown experimentally. The earlier portions of this work were summarized, in a general review of food poisoning in book form entitled "Food Poisoning and Food-Borne Infection," published in 1931. The volume was, in effect, a second edition of an earlier book, "Food Poisoning," published in 1917. Characteristically, in neither of these did Jordan regard food poisoning as a purely bacteriological problem but presented, in addition, a complete and concise summary of food poisoning resulting from contamination of food with toxic chemical substances.

In the last few years of his life, Jordan took his vacations in the winter and spent them in Puerto Rico, Panama and Jamaica. At no time did he stop working, for in Puerto Rico he was visiting professor in the School of Tropical Medicine, in the

Canal Zone he worked in the Gorgas Memorial Laboratories—it was here that he discovered the susceptibility of monkeys to the staphylococcus toxic substance. In Jamaica he became interested in an affection peculiar to that island and certain other parts of the world which was called "vomiting sickness," and by a judicious combination of epidemiological and experimental work, disclosed significant facts relating to its etiology. While at these places he gathered information regarding the general sanitary situation which he presented to the Rockefeller Foundation in the form of informal reports—he had been a member of the International Health Division for some years and then a member of the Board of Scientific Directors of the Foundation.

Jordan was appointed Andrew McLeish Distinguished Service Professor of Bacteriology in 1931 and was retired in 1933 at the age of 67. He continued to work as actively as ever after retirement but was not well during the last year of his life, his illness the result of a coronary occlusion. During the latter part of the summer of 1936 he and Mrs. Jordan went to Shelburne, Vermont, for rest and recuperation in the New England that was always dear to him. Here his condition became suddenly worse and he was removed to the hospital in Lewiston, Maine, where he died.

He had lived a full and active life and the honors that had come his way were many. He had been president of a number of organizations, including the Society of American Bacteriologists, the Epidemiological Society, the Chicago Pathological Society and the Institute of Medicine. He served as a member of the Board of Scientific Directors of the International Health Division of the Rockefeller Foundation, on the Medical Fellowship Board of the National Research Council, as a trustee of the McCormick Institute, a member of the Committee on Foods of the American Medical Association, as a consultant to the United States Public Health Service, as consulting bacteriologist to the Stream Pollution Laboratories of the Service and in many other capacities. A Fellow of the American Public Health Association, he was the recipient of its Sedgwick Medal in 1934. He was on the editorial boards of a number of scientific journals, was editor of the Journal of Preventive Medicine and joint

editor, with Hektoen, of the Journal of Infectious Diseases. He gave several endowed lectures, including the Gordon Bell Memorial Lectures, the Harvey Lectures and the Cutter Lectures. He was made an honorary Doctor of Science by the University of Cincinnati in 1921 and was elected a member of the National Academy of Sciences in 1936.

His students made up a very important part of his life. He knew no greater joy than that of developing to the best of his abilities the talents of promising young men and women and he followed their subsequent careers with keen personal interest. They, in turn, felt his warm and steady support and did not hesitate to call upon him for advice and encouragement in later years. He is said to have remarked upon one occasion that if he had done no productive research, he would still feel that his students alone would have made life well worth living.

Jordan's contributions to bacteriology, public health and preventive medicine in America can hardly be over-estimated. The leading American authority in the fields of his greatest interest, his influence was great and many of his contributions were of the subtle kind that escape general notice. His scientific acumen and the uncompromising probity with which he dealt with the problems he handled left a permanent impress on bacteriological thinking.

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