tions, spontaneous or experimentally induced, the virulence of strains of microorganisms from different populations was occasionally different—the more virulent being the less vegetative—but the effective virulence of strains in any one community proved stable during the entire endemic and epidemic periods of observation. The dosage and host resistance factors, on the contrary, varied significantly with the amount and severity of infection. Expressing these relationships in terms of cause and effect, it appears that infections in these animal populations were controlled by stable virulence and varying dosage and resistance factors. In instances in which a foreign microorganism gained access to a hitherto unexposed population, the inherent virulence, the available dosage and the amount and distribution of non-specific population resistance together determined the extent and severity of the infection. In instances in which a microorganism was already present in the population, variations in population resistance and in available dosage were chiefly responsible for endemic and epidemic prevalences. Fluctuations in population resistance were brought about by immigration, season and diet acting upon the non-specific components, and by the infecting agent stimulating the specific components of resistance. Fluctuations in available dosage resulted from variations in the host resistance and vector factors.

To what extent is this knowledge obtained by experiment consistent with the known facts of human epidemiology? Briefly, there is evidence that the factors related to microbe and host suffice to account for the usual manifestations of cholera, typhoid and the insect and animal-borne infections; there are no data indicating that these factors may not likewise suffice in other human infections. Concerning the operation of these factors, there are grounds supporting the view that infections transmitted by vectors or contracted from foreign hosts, and infections transmitted by water, milk or food are for the most part controlled by a fluctuating dosage factor operating on a population of fluctuating resistance. These diseases, taken together and considered from the tempero-geographical view-point, constitute the great majority of the total number. Added to them are the parasitic and skin infections, whose prevalence appears likewise to be controlled by the host and dosage factors. The remaining group of respiratory diseases transmitted by direct contact, relatively very small but common to this climate, and therefore of great interest, are at present not as well understood. One can but state that the available data do not discredit the view that their prevalence too is controlled by fluctuations in dosage of and resistance to specific agents of relatively fixed virulence.

Further knowledge of the spread of human infections is being obtained by methods similar to those of experimental epidemiology. Opie's studies on the spread of tuberculosis in families, Paul's observations of families with rheumatic disease, the work on the spread of upper respiratory tract pathogens among small groups of individuals, and detailed bacteriological, clinical and sociological investigations of circumscribed communities throw light on the manner and extent of dissemination of the specific agents and the relation of variations in dissemination, that is, in dosage, to variations in amount and severity of the infection in these communities. They give promise to make more clear the rôle of resistance and whether it consists primarily of inherited non-specific factors on the one hand, or of acquired specific factors.

To broaden the scope of experimental epidemiology the studies must be extended from the acute, highly fatal, bacterial diseases of animals to the more chronic ones and to virus infections. This last step is already being taken. Knowledge of many types of infection in many species of hosts will be required for the proper development of epidemiology as a science.

# OBITUARY

## LOUIS AGRICOLA BAUER (1865–1932)

THE death in Washington on April 12, 1932, of Louis Agricola Bauer, the original director and, since 1930, director emeritus of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, removes from science an internationally recognized authority in the field of his especial interest. Almost solely on account of his enthusiasm and organizing ability, the systematic magnetic survey of the whole earth both on land and on the oceans has been accomplished within the past twenty-five years, by which an empirical basis has been established for theoretical discussions of the origin and behavior of the earth's magnetic field which would otherwise have long remained impossible. While the recognition accorded Dr. Bauer rests largely on this monumental achievement in accumulating a vast amount of observational information, he has also been among the foremost in the discussion of not only terrestrial magnetism but of other related geophysical problems, as is evidenced by the long list of titles with which he is accredited.

Born of German-American parentage on January 26, 1865, in Cincinnati, Ohio, Dr. Bauer received there his early training and obtained from the University of Cincinnati the degrees of civil engineer (1888) and

master of science (1894). After a short experience as computer in the Coast and Geodetic Survey under Mendenhall and Schott, his interest in terrestrial magnetism was aroused and he entered the University of Berlin for the purpose of perfecting his theoretical knowledge of that and related subjects. Here he made the acquaintance and came under the influence of the men whose names are inseparably connected with the progress of geophysical science of that period. The subject of his dissertation for the degree of doctor of philosophy obtained in January, 1895, was "Beiträge zur Kenntniss des Wesens der Säkular Variation des Erdmagnetismus."

On his return to America he was appointed docent in mathematical physics at the University of Chicago, and the following year (1896) instructor in geophysics. Then for two years, 1897–1899, he was assistant professor of mathematics and mathematical physics at his alma mater, the University of Cincinnati. In 1899 he was appointed lecturer in terrestrial magnetism at the Johns Hopkins University. During these years his practical interest in terrestrial magnetism was manifested by the work accomplished during the summer months as chief of the Division of Terrestrial Magnetism of the Maryland Geological Survey, during which a detailed survey of the state was made, and when the Division of Terrestrial Magnetism was established at the Coast and Geodetic Survey in 1899 he was made inspector of magnetic work and chief of the division. It was under his direction in this capacity that the five magnetic observatories of the Coast and Geodetic Survey were established and put into permanent operation. At this time also preliminary experiments were made as to methods of securing satisfactory magnetic observations at sea which were to lead to large results a few years later.

Dr. Bauer's theoretical studies had emphasized the hopelessness of attempting to reach a solution of the many fundamental questions involved in the subject of the earth's magnetization until a very much wider distribution of observational results was available. He then conceived the idea of making a magnetic survey of the entire globe, and for the carrying out of this vast project applied for assistance to the newly established Carnegie Institution of Washington. His application was effectively endorsed by the leading geophysicists and magneticians of that time, the more eagerly since the nature of the organization of the institution made it an especially appropriate agency for carrying out an international project of this character. The result was the establishment in 1904 of a new Department of Research in Terrestrial Magnetism, with Dr Bauer as its first director.

During the following 25 years the carrying out of this ambitious project was vigorously prosecuted under the able and zealous leadership of the director. While those land areas were not included in the scope of the operations of the Department of Terrestrial Magnetism where the work was already being done by the governments controlling them, exploratory expeditions were sent to remote regions in Africa, Asia, Australia, South America and the islands of all the seas to make the desired observations. It was early realized that no survey confined to the land areas alone could be satisfactory either for the practical needs of navigation or for the purposes of analysis and discussion. Results of the desired accuracy could not be obtained on vessels of ordinary construction, and so an entirely unique and non-magnetic one, the *Carnegie,* was specially designed and between 1909 and 1929 was sent to all parts of the navigable seas collecting magnetic and oceanographic information not available by any other means yet devised.

While this work was in progress, Dr. Bauer focused attention on the fundamental theory of terrestrial magnetism and published a series of papers dealing with the physical decomposition, analysis and origin of the earth's magnetic field. The last one on "Chief Results of a Preliminary Analysis of the Earth's Magnetic Field for 1922," which appeared in 1923, summarized his latest mathematical analysis as based chiefly on the magnetic data obtained by the Department of Terrestrial Magnetism on land and sea. Fifteen papers, 1892–1923, on the magnetic secular variation dealt with the discussion of the phenomena and the internal and external systems of operating causes; the earth's total magnetic energy was computed by rigorous methods, based for the first time on satisfactory data, for various epochs, 1829–1885, and it was found that there has been a steady diminution in the earth's magnetization—a result confirmed by the analysis for 1922, mentioned above. Dr. Bauer also initiated magnetic and allied observations during eleven solar eclipses, beginning with that of May 28, 1900, he himself making observations during that and three others, to determine possible magnetic effects. Researches dealing with solar activity and terrestrial magnetism were published in twelve leading communications. Others related to correlations between solar activity and atmospheric electricity and the annual variation of atmospheric electricity, and to earth-currents. Space does not permit listing the many other contributions dealing with special problems.

In addition to his extensive contributions to terrestrial magnetism and allied subjects, Dr. Bauer has aided greatly in the development and progress in these fields through the publication of the *International Quarterly Journal of Terrestrial Magnetism and Atmospheric Electricity.* He founded this journal in

1896 and was solely responsible for it until 1927, since which time he has collaborated in its continuation.

In recognition of his services to science, Dr. Bauer was the recipient of many honors. The honorary degree of D.Sc. was conferred on him by the University of Cincinnati and by Brown University. He received the Charles Lagrange prize (Physique du Globe) of the Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, the Georg Neumayer Gold Medal, and the insignia of Commander of the Second Class of the Norwegian Order of St. Olaf, and was appointed Halley Lecturer at the University of Oxford in 1913. He was also an honorary member of Sociedad Cientifica Antonio Alzate of Mexico, and of Royal Cornwall Polytechnic Society of England, and corresponding member of Göttingen Academy of Sciences, Portugal Royal Academy of Sciences, Batavia Academy of Sciences, Société de Géographie de Lisbonne, Russian Academy of Sciences, and Institute of Coimbra, Portugal.

Dr. Bauer served as United States delegate to the Brussels (1919) meeting of the International Research Council and to the Rome (1922), Madrid (1924) and Prague (1927) meetings of the International Union of Geodesy and Geophysics. During 1919 to 1927 he was secretary and director of the Central Bureau and during 1927 to 1930 he was president of the Section of Terrestrial Magnetism and Electricity of the International Union of Geodesy and Geophysics. Dr. Bauer was a member of the International Meteorological Organization since 1928. He also took from 1917 a prominent part in the National Research Council of the United States and in the American Geophysical Union, being chairman of the latter union from 1922 to 1924.

The breadth of his scientific contacts was indicated also by the large number of scientific societies both at home and abroad of which he was a member. Among these were the American Philosophical Society, American Academy of Arts and Sciences, American Physical Society, American Association for the Advancement of Science, American Geographical Society, Washington Academy of Sciences, Philosophical Society of Washington, Deutsche Meteorologische Gesellschaft and Gesellschaft für Erdkunde zu Berlin.

It is not too much to say that the work of Dr. Bauer has had a large directive influence on the development of terrestrial-magnetic investigation during the past forty years and that the activities of the department which he founded have splendidly realized his vision.

Dr Bauer is survived by his widow, Mrs. Adelia Doolittle Bauer; a daughter, Mrs. Dorothea Weeks, of West Chester, Pennsylvania; a sister, Mrs. Caroline Bauer, of Cincinnati, Ohio, and a brother, Dr. W. C. Bauer, dean of the Engineering School, Northwestern University, Evanston, Illinois.

J. A. F.

## WILHELM OSTWALD

WITH the death of Wilhelm Ostwald there passes the last of the great triumvirate which discovered and developed the theory of solutions and the theory of electrolytic dissociation. The younger generation has a different perspective and adds Nernst's name to the list, very properly.

Three of these, van't Hoff, Arrhenius and Nernst, were really great thinkers, and Ostwald was a great protagonist and an inspiring teacher. So far as the effect on the scientific world is concerned Ostwald has been like Abou Ben Adhem. Ostwald has really outlined his own great value to the world in the book entitled "Great Men."

"When the prospective genius has done his great work and has communicated it to the world, one likes to think that he can go quietly to bed and wake up famous the next morning. There are one or two cases in which that is about what has happened, as in the case of Darwin, whose fundamental book was sold out within a few weeks of its appearance. This is a very rare case, however, and belongs rather in a class by itself, because it was a piece of work which had been going on for years and which was written up because of the external reason that Wallace had reached the same general conclusion. Also, the world was to some extent ready for it.

"In the overwhelming majority of cases, the earth continues to revolve at its normal rate even when the most startling thought has been put forward, and very often the work of getting the new idea accepted is scarcely less than that of originating it. In many cases the man who had the idea is not able to get it accepted and this task falls to the lot of another man who may be less clever, but who speaks a language which makes the world conscious of the treasure which had been offered to it in obscure words."

There are plenty of illustrations in modern chemistry of the truth of these words of Ostwald. The theory of stereochemistry was developed independently by van't Hoff in Holland and by LeBel in France; but it is very much of a question whether either of these men could have got the theory accepted in any reasonable time. Nobody will dispute that the work essential to the adoption of the theory was done by Johannes Wislicenus in Germany. The experiments of Pfeffer on osmotic pressure and of Raoult on the lowering of the freezing-point were very interesting; but nobody knew just what they meant. It was van't Hoff who furnished the theoretical explanation which was lacking and who thereby