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the Kidney (Baltimore, 1929); "Urine Formation in the Amphibian Kidney," in *American Journal of the Medical Sciences*, **190** (1935), 727–746, with Arthur M. Walker; and "Processes of Urine Formation," in *Proceedings of the Royal Society of London*, **B126** (1938), 398–432. Among the relevant individual articles and groups of papers on his kidney work are three papers by Richards and Oscar Plant in *American Journal of Physiology*, **59** (1922), 144–202, which report the effect of changes in renal blood pressure on urine output; "Observations on the Composition of Glomerular Urine . . . ," *ibid.*, **71** (1924), 209–227, with J. T. Wearn, the first detailed publication of their qualitative analysis of glomerular fluid; eight articles from Richards' laboratory in *Journal of Biological Chemistry*, **101** (1933), 179–267, **107** (1934), 661–672, **110** (1935), 749–761, and **116** (1936), 735–747, on quantitative studies of glomerular fluid; and six papers by Richards and his colleagues in *American Journal of Physiology*, **118** (1937), 111–173, which discuss their investigation of renal tubule fluid.

Richards summarized the work of the Committee on Medical Research in the foreward to Edwin C. Andrus *et al.*, eds., *Advances in Military Medicine*, 2 vols. (Boston, 1948), I, xli–liv.

The most comprehensive source on Richards' professional career and personal life is the extensive collection of his personal papers in the University of Pennsylvania Archives (a total of 42 boxes). Additional documents on Richards' service to the Committee on Medical Research are in the papers of the Office of Scientific Research and Development, Record Group 227, National Archives, Washington, D.C.

II. Secondary Literature. The best biography of Richards is Carl F. Schmidt, "Alfred Newton Richards," in *Biographical Memoirs. National Academy of Sciences*, **42** (1971), 271–318. The collection of articles in Isaac Starr, ed., "Alfred Newton Richards, Scientist and Man," in *Annals of Internal Medicine*, **71**, supp. 8, no. 5, pt. 2 (1969), covers many areas of Richards' life and work, including his years as head of the Committee on Medical Research and his kidney research. David Y. Cooper, "Alfred N. Richards and the Discovery of the Mechanism of Urine Formation," in *Transactions and Studies of the College of Physicians of Philadelphia*, **6** (1984), 63–73, discusses Richards' kidney research in depth.

John Patrick Swann

RIDDLE, OSCAR (*b.* Cincinnati, Indiana, 27 September 1877; *d.* Plant City, Florida, 29 November 1968), *physiology, endocrinology.*

Oscar Riddle spent his research career studying birds to explore questions of evolution and the nongenetic physiology of reproduction and determination of sex. Best known for his isolation of the hormone prolactin, he also devoted considerable time to matters of science education and free public information about evolution.

The son of Jonathan Riddle and Amanda Emiline Carmichael, Riddle was born in a log house in Greene County, Indiana. His father was a farmer; his maternal grandfather ran a general store and flour mill in Cincinnati, Indiana. Unfortunately, when Jonathan Riddle died in 1882, he left his wife with nine children and few resources. The family managed only because the children contributed to the family economy. Oscar helped to haul drinking water from the nearby spring, store milk and vegetables, clear land, and do general farming. When he was nine and ten, Oscar worked on a farm two miles away to supplement the family income. He experienced a typical midwestern farmer's education, walking to a one-room cabin for a short school season; he later walked two miles to the village school. By age fourteen, Riddle was supporting himself and had acquired through his outdoor work a curiosity about the material world around him, including fossils. He had also begun to question religious dogma about the Flood.

According to Riddle's memoirs, a local lecture presented by a college classmate of his older brother's affected the course of Oscar's life. The young fellow was studying zoology at Indiana with Carl H. Eigenmann, who examined blind cave fish to explore questions of evolution and adaptation. The student took a collection of Eigenmann's fishes to Cincinnati and discussed evolution. Riddle was enthralled, for "nothing in a long life has equaled the release, thrill, and resolution obtained from this message, so simply delivered by a young man from a neighboring farm" (Corner, p. 430). Riddle attended high school in Bloomfield, then began at Indiana University in 1896. There he chose biology, spending his summers at the Turkey Lake biological field station.

In 1899 Eigenmann recommended Riddle for a position with the U.S. Fish Commission, collecting fish in Puerto Rico. Riddle gathered specimens there but also taught biology at the new Model and Training School in San Juan. As his Spanish improved, he received other teaching assignments throughout Puerto Rico. In 1901 he traveled to Trinidad and to the Orinoco River in Venezuela for collecting and observing. He returned to Indiana, then traveled with Eigenmann in 1902 to collect blind fish in western Cuba. After receiving his B.A. from Indiana University in 1902, Riddle rejected job offers in business and enrolled as a graduate student at the University of Chicago.

At Chicago, Riddle found Jacques Loeb's physiological ideas particularly intriguing. Unfortunately, Loeb left for California that year. In 1903, to help

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put his sister through college, Riddle took a position teaching physiology at Central High School in St. Louis, where he remained for five half-years, through 1906. The half-years allowed him to attend the Marine Biological Laboratory's summer session in physiology in 1903 and to hold an assistantship at Indiana for the summer of 1904 and for a longer period in 1905. In 1906 he reenrolled at Chicago, with an assistantship in zoology. As a result of personality conflicts with the physiologist G. N. Stewart, Riddle decided to concentrate instead on zoology under Charles Otis Whitman, with a minor in biochemistry under Albert Prescott Matthews.

Riddle joined in Whitman's work on pigeons and evolution. Whitman suggested that for his dissertation Riddle examine the causes of barring, the appearance of alternating light and dark bars on the feathers of pigeons and other birds. When Riddle took up the study that had become so important a part of Whitman's own career and life, Whitman virtually embraced him as a son. Thus, when Riddle completed his Ph.D. in 1907, he stayed at Chicago in joint positions in teaching, as associate in zoology and embryology, and in research, as assistant in experimental therapeutics.

In mid 1910 Riddle traveled to Europe, with Whitman's promise that he would be made assistant professor in biology upon his return. He spent several weeks in Berlin, visited Paul Ehrlich in Frankfurt, then went on to the Naples Zoological Station. Unfortunately, Whitman died unexpectedly on 6 December 1910, after caring for his pigeons during a cold spell. Riddle decided to return early to Chicago after Whitman's successor, Frank Rattray Lillie, informed Riddle that he would not be reappointed for the next year because of internal opposition. With fears about his livelihood and about the fate of Whitman's extensive unpublished, somewhat disorganized research results, and that of the research pigeons, Riddle left Naples. His decision to publish Whitman's work required a formidable commitment of time and energy. The decision determined the course of Riddle's own lifework.

Matthews obtained a six-month research appointment for Riddle in his Laboratory of Experimental Therapeutics, and Riddle acquired some money to maintain the pigeon colony still at Whitman's home. In 1912 came his first and only important move, to a position as research associate with the Carnegie Institution of Washington, which also promised to publish Whitman's papers and to maintain the pigeon colony. In 1913 Riddle moved to the Station for Experimental Evolution at Cold Spring Harbor, New York, where he continued his research even after his official retirement in 1945. He married Leona Lewis there in 1937.

At the laboratory Riddle pursued many problems of physiology and reproduction in pigeons and doves. Yet his biographer George Corner reports that Riddle's research life was not particularly happy there. The first laboratory director, Charles Benedict Davenport, did not really approve of Riddle's loyalty to Whitman's non-Mendelian and descriptive approach, which Davenport likely regarded as old-fashioned. Riddle did rather dogmatically follow Whitman's lead in his emphasis on attacking the general problems of life rather than focusing narrowly on one or another analytical problem. Thus he emphasized the way in which barring results from metabolic, and hence nongenetic changes rather than from inheritance. In fact, many of Riddle's specific conclusions have been shown to be inadequate or incorrect. His most significant research contribution was his isolation of prolactin, the pituitary hormone that stimulates the mammary gland to produce milk.

Riddle had already been among the first to use extracts of other glands, including insulin, thyroxin, adrenalin, and pituitary extract, in his explorations of pigeon metabolism. After reading a report that extracts of the anterior lobe of the pituitary gland of rabbits could stimulate milk secretion, he set out to isolate the substance responsible. By 1932, R. W. Bates, S. W. Dykshorn, and Riddle had obtained a substance that did produce lactation, but the substance remained in an impure form. They called it prolactin, continued their work, and identified prolactin as a protein. Riddle then found that the crop milk which pigeons produce is also induced by a pituitary hormone. He quickly identified it as prolactin and obtained it in a reasonably pure form. Using Riddle's correlation of crop growth and lactation, others purified the hormone further and eventually prepared it in a useful crystalline form.

Riddle had few assistants, a small laboratory, and no students because he remained at a research laboratory throughout his career. Yet perhaps his most important contribution to science lay in his public lobbying for freethinking in education, beginning with his first publication in 1906. Specifically, he became concerned that evolution be taught in high schools and colleges. His nonteaching position secured him from the attacks of antievolutionists. After a public address in 1936 attacking high schools for their backwardness in rejecting evolutionary ideas and embracing religious dogma, he received considerable criticism. This led him to publish in 1954 the rather poorly received *Unleashing of Evolutionary Thought* and a series of much more effective

articles. As an outspoken advocate of scientific, and opponent of religious, thinking, Riddle received in 1958 the Humanist of the Year Award from the American Humanist Society and a citation from the National Association of Biology Teachers, which he had founded in 1930. He served as president of the American Rationalist Federation in 1959 and 1960. The American Philosophical Society, the American Association for the Advancement of Science, and the National Academy of Sciences also elected him as member.

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II. Secondary Literature. The best biography is by George Corner in *Biographical Memoirs. National Academy of Sciences*, **45** (1974), 427–465.

Jane Maienschein

RIDEAL, ERIC KEIGHTLEY (*b.* Sydenham, England, 11 April 1890; *d.* London, England, 25 September 1974), *physical chemistry.*

Rideal was the first of four children born to a London consulting chemist, Samuel Rideal, and his Irish wife, Elizabeth Keightley. As a financially successful and leading public analyst, author of many textbooks on water and sewage purification, and a deviser of the Rideal-Walker quantitative test for disinfectant activity (1903), Samuel Rideal could afford to give his children an excellent education. After attending Farnham Grammar School in Surrey, Rideal boarded at Oundle School in Northamptonshire, a boys' secondary school that, under its brilliant headmaster, F. W. Sanderson, was unusual among English public schools for its obligatory engineering and workshop practice as part of the curriculum.

In 1907 Rideal entered Trinity Hall, Cambridge, on an open scholarship in natural science. There, although he studied formally in Sir William Pope's chemistry department, with its very strong emphasis upon inorganic and organic chemistry, it was the physics classes in the Cavendish Laboratory that excited his interest in the physical chemistry then being systematized by Wilhelm Ostwald and Walther Nernst in Germany and by James Walker in Great Britain. An even greater formative influence on Rideal at Cambridge was the stimulating lectures of the physiologist William Bate Hardy, whose interest in osmosis was to prompt Rideal's lifelong passion for surface chemistry, which he always viewed as the boundary discipline between mechanical and biological systems.

Rideal graduated with first-class honors in chemistry in 1910. Then, like most British chemists before World War I, he spent two years studying in Germany—first, at his father's suggestion, with the electrochemist A. Fischer at the Technical University in Aachen, and then with Kekulé's pupil Richard Anschütz at the University of Bonn. He obtained his doctorate, with a dissertation on the electrochemistry of uranium salts, from Bonn in June 1912.

On returning to London in 1912, Rideal spent his first two years doing electrochemical consulting in his father's office suite. He was testing water supplies in Ecuador when war broke out in Europe in 1914. After serving with the Royal Engineers in Belgium, he contracted dysentery in 1916 and spent the remainder of the war in the department of munitions inventions. Here he spent most of his time developing a catalyst for the industrial production of ammonia that used the synthetic laboratory method Fritz Haber had described in 1905. Rideal's co-worker on this project was Hugh Stott Taylor, with whom he published *Catalysis in Theory and Practice* in 1919. For his work during the war period, he was awarded the M.B.E.; he also found time to produce, with (and for) his father, four textbooks on industrial chemistry.

As visiting professor of chemistry at the University of Illinois, Urbana, from 1919 to 1920, Rideal had the opportunity to become friends with such leading American physical chemists as Gilbert N. Lewis, Richard C. Tolman, and Irving Langmuir; the influence of the latter's work proved particularly stimulating. Rideal returned to England in 1920 to take up the Humphrey Owen Jones lectureship at