Charles Rupert Stockard

February 27, 1879 — April 7, 1939

With the passing of Dr. Stockard on April 7 of the current year Anatomy has lost an inspiring leader, and our medical college one of the oldest and most distinguished members of its active faculty.

Dr. Stockard was born in Washington County, Mississippi, on February 27, 1879. The son of a physician, he showed in his early youth great enthusiasm in the field of Zoology, attested by numerous observations on the nesting habits of birds and a collection of eggs which he fondly kept until his death. He entered the Mississippi Agricultural and Mechanical College, receiving the degrees of bachelor of science in 1899 and master of science in 1901. During the Spanish-American War he was acting professor of Military Science at the above institution, and afterwards he held the same position in Jefferson Military College from 1901 to 1903.

In spite of this early experience, a military career had no appeal for young Stockard. His love of nature reasserted itself and he decided to become a zoologist, entering Columbia University, from which he received the Ph.D. degree in 1906. While at the Columbia department of Zoology he conducted investigations on various subjects, including Botany, and wrote articles on the natural history of the spoon-billed sturgeon—abundant in the lakes of the lower Mississippi area—and the nesting habits of birds in Mississippi. Under the direction of Professor Bashford Dean he studied the development of the thyroid, the lens of the eye, and the mouth and gills of the cyclostome fish *Bdellostoma stouti*. This early work on fish embryology determined the direction of subsequent studies; at the suggestion of Professor T. H. Morgan and following the trend initiated by the German experimental embryologists, particularly Herbst, Stockard undertook a series of important investigations on the influence of external factors on development, selecting the embryos of the minnow *Fundulus* as a favorable object. One of his first papers was on the development of *Fundulus* in solutions of lithium chloride, followed by a study of the artificial production of a single median cyclopean eye by means of sea water solutions of magnesium chloride, and later by an analysis of the influence of external factors, chemical and physical, on the development of the same fish. This work was carried out at the Marine Biological Laboratory at Woods Hole, Massachusetts, where Dr. Stockard spent most of his summers and where his absence will be deeply felt.

Dr. Stockard joined Cornell Medical College in 1906 as assistant in Embryology and Histology, and in 1908 he became instructor in Comparative Morphology. His inquiring mind found a stimulus in the teachings of Professor James Ewing and led to work on tissue growth and regeneration—mostly in the jelly-fish *Cassiopea*—which he

carried out at the marine laboratory of the Carnegie Institution at the Dry Tortugas, Florida. These investigations were aided by the Huntington fund for cancer research.

In 1909 he was appointed assistant professor of Embryology and Experimental Morphology. His attention was once more focussed on the problems of embryonic development and he returned to his early interest in the origin of the lens of the eye. Experiments on this subject had already been performed by several investigators who had destroyed the optic vesicles by mechanical means, but Stockard followed an entirely different approach and showed that certain chemical substances such as magnesium salts, alcohol, chloretone, and other anaesthetic agents generally inhibit the normal outgrowth of the optic vesicles. Under these conditions the lens originates from the ectoderm without any direct stimulus whatever from an optic vesicle. Continuing his work along these lines, he carried out experimental studies on the position of the optic anlage in *Amblystoma* (1913) and of the artificial production of eye abnormalities in the chick embryo (1914). From these investigations he concluded that specific defects are not specific responses to a given chemical substance, as advocated by Herbst, Hertwig, and himself in earlier papers. Congenital defects of the eye he regarded as an index of developmental deficiencies in the whole embryo, an idea expanded later (1923) in the course of experiments on the influence of alcohol on mammalian development.

Dr. Stockard was appointed professor of Anatomy in 1911. That year he went abroad and worked in the Zoological Station at Naples and in the Anatomical Institute at Munich, visiting the most important zoological and anatomical laboratories of the continent. He returned to Germany the following summer to marry Miss Mercedes Müller of Munich.

As a natural consequence of his findings on the effects of alcohol and other narcotics on development, Dr. Stockard attacked the problem of the influence of alcohol on the germ cells and development of embryos in mammals, and the first contribution on this topic appeared 1912. He devised methods whereby guinea pigs were made to inhale alcohol fumes for variable periods, and the effects on the offspring were carefully noted. As often happens in scientific research, one problem led to another which was apparently unrelated but the solution of which was indispensable for the successful continuation of the work. One of these problems arose in the course of the experiments with alcohol when it was realized that the available data on ovulation of the guinea pig were inadequate and often misleading. With the collaboration of Dr. G. N. Papanicolaou, Dr. Stockard undertook a daily examination of the vagina of guinea pigs, preparing smears of the contents which were found to vary according to the stage of the sexual cycle. In this way the existence of a typical oestrous cycle for this animal was firmly established. The influence of this discovery on anatomical research in this country was widespread, judging from the large number

of studies on the same subject in diverse animals which followed. It also led to a painstaking study of the human sexual cycle by Dr. Papanicolaou, published in 1933.

The experiments on the influence of alcohol on the mammalian germ cells did not fill Dr. Stockard's mind to the point of displacing other interests, and once more he returned to the field of experimental Embryology. But this time he was concerned with the origin of the vascular endothelium and the blood cells. The exponents of the monophyletic theory on the origin of blood had been scoring heavily, it seemed, and claimed to have demonstrated that the different types of blood corpuscles spring from a common stem cell. Dr. Stockard sought light on this important problem in a study of blood development in *Fundulus*, but he did not limit himself to observations on normal embryos. He found that treatment of eggs at the two-celled stage with weak solutions of alcohol in sea water neither arrests the formation of the blood nor interferes with the development of the heart, but that the latter is often closed at its posterior end and that this prevents the free circulation of the blood. Nevertheless, the heart which does not contain blood may be fully developed and have a normal endothelial lining. Undoubtedly, the latter does not arise from a cell capable also of producing blood elements. Furthermore, these studies also showed that the origins of the white and red blood corpuscles, respectively, are distinct and that these two different types of cells cannot be considered to have a common origin except in so far as both arise from mesenchyme cells. The latter, however, also give rise to pigmented cells (chromatophores).

The work on the influence of alcohol on the germ cells and development lasted for a period of over thirteen years, with more than one hundred guinea pigs treated from a few months to six years, and records available from over 5,000 animals in the several generations. It aroused immediate interest not only in the medical profession but also among the laity. This was due in large measure to the adoption of the Eighteenth Amendment. Reports on these experiments—with the collaboration of Dr. Papanicolaou—appeared in various publications. While admitting that alcohol exerts a deleterious influence on the individual and causes defects and even the death of some of the offspring *in utero*, Dr. Stockard concluded that "when we consider the welfare of the race or stock rather than that of the individual, it is found that the descendants of those groups of animals which suffered the highest mortalities and thus withstood the most rigorous elimination are superior in quality to the descendants of the groups less severely affected. This individual selection furnishes a great advantage to the later generations." Similar thoughts were expressed later by him (1924) to the discomfort of those who have cherished the idea that alcohol, even when used in moderation, spells the doom of our race.

Aside from their social implications, the alcohol experiments furnished proof that the germ cells themselves may be adversely affected because males that inhaled alcohol fumes gave rise to defective offspring although mated with vigorous untreated females. The effect of this injury of the germ cells is not only shown by the immediate offspring of alcoholized animals but is conveyed through their descendants for several generations.

In breeding such a large number of guinea pigs Dr. Stockard noticed the presence of an extra toe in some of the animals, which he regarded as the atavistic reappearance of a digit lost in the course of evolution. These observations furnished the basis for an interpretation of a similar reappearance of the great toe in the hind limbs of certain dog breeds, and it was found that when the latter are crossed with breeds which lack the great toe, its development in the first generation of hybrids seems to be inherited as a single-factor Mendelian dominant. An interpretation of true polydactyly in the human was also advanced on the basis of the findings in the guinea pig and dog.

The problem of the origin of identical twins in humans and other mammals is also a subject which had engaged Dr. Stockard's attention since his early experiments in the influence of the external factors on development. In 1921 he published an extensive article entitled "Developmental rate and structural expression: An experimental study of twins, 'double monsters' and single deformities, and the interaction among embryonic organs during their origin and development" which shed considerable light on the fundamental processes involved.

The idea that constitutional differences in humans may depend upon definite hereditary patterns of the endocrine complex of the individual held a preeminent place in Dr. Stockard's mind during the latter half of his fruitful career. His early views on this subject were largely speculative, but he was a man of great mental resourcefulness and he was determined to test their validity in the same experimental fashion that he had applied to his studies on development. The existence of wide dissimilarities in the modern breeds of dogs led him to select this animal for the experiments, especially since certain extreme human types are duplicated in the dog. With the aid of the Rockefeller Foundation he acquired a farm in Westchester County and began to assemble dogs of various breeds. At the beginning the experiment was beset with unforeseen difficulties. To raise dogs in the pure air of the country with enough space to roam about sounds like an easy matter. But even under these ideal conditions confinement in adjoining, though spacious, runs, on the one hand, and the susceptibility of some of the breeds to disease, on the other, led to problems which had little to do with the aim of the investigation. Distemper, parasitic worms, mange, and unsuspected dietary deficiencies were some of the obstacles that had to be surmounted. Dr. Stockard, however, was not a man who could be easily defeated and he immediately began to cast about for remedies and

when none existed he applied himself to discover them. This accounts for his brief excursions into the realm of veterinary medicine, especially his contributions to the treatment of distemper (translated into Norwegian by O. L. Mohr) and the transmission of immunity to this disease. Within a few years the problems of disease and diet in the dog colony had been conquered. Considering that at times there were nearly 400 dogs in adjoining kennels and with an almost negligible mortality this was no mean achievement.

An experiment of the scope of Dr. Stockard's, involving crosses between different breeds; rearing of young with pronounced disharmonies in some cases; studies on the inheritance of morphological characteristics; observations on behavior and instincts; and histological examinations of the endocrine glands, requires considerable time and patience. In the course of the last twelve years a wealth of data had been slowly accumulating. Some of the results have already been reported in various publications. At his death Dr. Stockard left an extensive manuscript covering the diverse aspects of his work. It is expected that it will be published in the near future. Had he been granted a few more years of life he could have experienced the satisfaction of having accomplished a task with the thoroughness which was so characteristic of his scientific undertakings.

Besides being a leader in scientific research Dr. Stockard was a born teacher. He had the gift of clarity and the ability to impart knowledge. He was always popular as a lecturer because he could simplify the abstruse and digest it for his hearers. Among the many lectures that he gave the following deserve special mention: Harvey Lecture, 1921; DeLamar Lectures, Johns Hopkins, 1925; Harrington Lectures, University of Buffalo, 1926; Beaumont Foundation, Detroit, 1927; Lane Lectures, Stanford University, 1930; Potter Memorial Lecture, Jefferson Medical College, Philadelphia, 1934; and the Joseph Collins Lectures at the Academy of Medicine, New York, 1937. The subject of the Lane Lectures was expanded into a volume under the title *The Physical Basis of Personality* (New York, W. W. Norton, 1931), translated into German as *Die Körperliche Grundlage der Persönlichkeit* (Jena, G. Fischer, 1932). He contributed chapters to several books. His remarkable capacity for work made it possible for him to attend to numerous duties not related directly to teaching and research. He was at one time secretary–treasurer of the American Association of Anatomists, managing editor of the *American Journal of Anatomy*, coeditor of the *Journal of Experimental Zoology* and the *American Anatomical Memoirs*, trustee of the Marine Biological Laboratory, Woods Hole, Massachusetts, the Long Island Biological Association and the Bermuda Biological Station, and for a number of years member and then president of the board of scientific directors of the Rockefeller Institute for Medical Research, a position which he occupied at the time of his death.

During a visit to Germany in 1922 he received the M.D. degree from the University of Würzburg. Previously, in 1920, the University of Cincinnati had conferred on him the degree of doctor of science. He was president of the American Association of Anatomists (1928-30) and the American Society of Zoologists (1925), section vice-president of the American Association for the Advancement of Science; member of the Harvey Society (honorary), the American Philosophical Society, the National Academy of Sciences, the New York Academy of Medicine and the Institut International d'Embryologie of Utrecht, Holland, and others.

The friendliness of his manner, his keen sense of humor, and his frankness were duly appreciated by those who were associated with him. His influence on research in his own department is attested by the seventeen volumes of collected studies issued since 1910. Yet he did not believe in research as a duty. He preferred to speak of it as an "opportunity." This wholesome point of view explains his own attainments as an investigator, because only love of research for its own sake can lend the patience and courage required to overcome difficulties and bring the task to a successful termination. A man of his scientific stature can be substituted but not replaced.