

a history of medicine in pictures

by George A. Bender

painting by Robert A. Thom

Walter B. Cannon: Physiologic Investigator

IT WAS a young student in his first year at Harvard Medical College in 1896 who gave to medicine fundamental research that has been the basis of gastrointestinal diagnostic procedures ever since. Walter Bradford Cannon devised means of employing the newly developed Röntgen ray, or x-ray, to study digestive processes uninhibited by surgical or mechanical intervention. Countless persons, having undergone the temporary discomfort of swallowing a contrast meal containing radiopaque barium sulfate while standing between x-ray apparatus and a fluorescent screen, owe votes of thanks to Dr. Cannon for lives lengthened because of information gained by their physicians from gastrointestinal fluoroscopy. This ingenious young man, whose active career was to parallel the years during which American medical science was gaining increasing international respect, was to become one of the world's great physiologists, and one of his nation's outstanding contributors to science.

Dr. Cannon, who spent a lifetime in research laboratories and in teaching, in his later years expressed his belief that: "Phenomena, no matter how mysterious they may appear to be, have a natural explanation and will yield their secrets to the persistent, ingenious, and cautious efforts of the investigator." His lifework well bore out the truth of a statement by nineteenth-century



physicist Joseph Henry: "The seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them."

Walter Bradford Cannon was born October 19, 1871, in Prairie du Chien, Wisconsin, the son of Colbert H. Cannon and Sarah Denio Cannon. His father was a railroad man, eventually becoming superintendent of transportation for the Great Northern Railroad system. His mother died of pneumonia when Walter was ten years old. On her deathbed, she admonished her son: "Walter, be good to the world." It was a legacy he neither forgot nor neglected.

Perhaps, as Cannon has hinted in his writings, the young man's choice of his life's work was influenced by the fact that the place of his birth was near to the site of Fort Crawford, where, fifty years earlier, Dr. William Beaumont had conducted his continuing studies of digestive processes through a fistulous "window" in the abdomen of his patient, Alexis St. Martin. However, it was a woman teacher in a St. Paul high school who advised Cannon to study in the East. So, in 1892, with a cash capital of \$180, he entered Harvard College in Cambridge, Massachusetts. From then on, through four years of college and four years of Harvard Medical School in Boston, the young man paid his way with his own earnings. During his last year in medical school, he was invited to conduct courses in comparative anatomy at Harvard College and Radcliffe College. When, in June, 1900, Cannon received his degree in medicine, he accepted an instructorship in physiology at Harvard Medical School. A year after, he married his St. Paul sweetheart, Cornelia James. In 1902, he was named assistant professor; and in 1906, Dr. Cannon was appointed successor to Henry Pickering Bowditch, as George Higginson Professor of Physiology at Harvard—a position which he held for thirty-six years, until his resignation in August, 1942. Dr. Bowditch, who had held the post for thirty-five years, was the first full Professor of Physiology in the United States, and had himself been a student of Carl Ludwig, of Leipzig. Dr. Cannon, with a great deal of affection for his former mentor, often called himself professionally the "son" of Dr. Bowditch, and the "grandson" of Dr. Ludwig. Indeed, the contributions which Dr. Cannon made to advancement of the science of physiology would have earned deep paternal respect from his predecessors.

Professor Bowditch, recognizing potential talent when Walter Cannon volunteered to undertake a research project in addition to his first year medical studies, suggested that he might find a way to utilize the Röntgen ray as a means of studying the process of digestion in animals. Cannon set to work, devising an apparatus in which an animal could be placed above an aperture in a lead-shielded table, under which an x-ray tube was focused. Among his first experiments, Cannon watched the course of a button down a dog's esophagus, and an opaque bolus being swallowed by a goose. While he employed many types of animals, Cannon soon found that cats were most adaptable to his studies. In the main, he employed bismuth subnitrate as a readily dispersible substance opaque to x-rays. Among others, he also tested bismuth oxychloride, and barium sulfate. By mixing these tasteless salts of heavy metals with animals'

natural food, for hours at a time Cannon was able to observe natural activities of digestive organs as shadows coursing across a glowing fluorescent screen.

"For centuries, priests and butchers who watched entrails of their sacrificed victims knew as much as physicians about the mechanical factors of digestion," Dr. Cannon wrote. However, traumatic or surgical wounds profoundly alter digestive processes—and as the nineteenth century neared its close, this vital bodily function was little understood either by physicians or laymen.

With his homemade apparatus and skillfully formulated contrast meals, Cannon found that he could observe movements of the alimentary tract without interfering with the animal to any disturbing degree. "By use of the x-rays," Cannon was able to report, "the rate of passage of food through the oesophagus, the speed of gastric peristalsis and rhythm, the oscillating contractions of the small intestine, the peculiar anti-peristalsis of the large intestine, the rapidity of discharge of gastric contents into the duodenum, the time required for material to be carried to the colon, and all the influences external and internal that affect these processes, can be observed continuously for as long a time as the animal remains in a state of peace and contentment..." His first report, "The Movements of the Stomach Studied by Means of the Röntgen Rays," was published in the *American Journal of Physiology* in 1898.

With the instinct of a true investigator, Cannon was able to turn one of the early difficulties which he encountered into a bypath of original investigation no less significant than that of his research on digestion. He observed that any change of emotional state in the animal, such as anxiety, distress, or rage, was accompanied by total cessation of movements of the stomach. Additional attention to the effects of emotions on digestive organs led to exploration of the autonomic nervous system which controls these move-

ments. Dr. Cannon became no less a master of this branch of physiology than was he in the physiology of digestion. His findings were published from time to time in professional journals, then summed up in book form in *The Mechanical Factors of Digestion*, published in 1911. Four years later, Dr. Cannon's classic book, *Bodily Changes in Pain, Hunger, Fear and Rage*, was published. In the same year, 1915, he also was able to produce hyperthyroidism experimentally.

Dr. Cannon pursued the dual roles of researcher and teacher throughout his life. As a teacher, he possessed in high degree the characteristics which stimulated students to think for themselves and to embark upon original research. In research activities, as Professor Ralph B. Perry has said, "He was a good prospector—he knew how to locate the veins of rich scientific ore. But he (also) knew how to refine the gold." Though Dr. Cannon did not practice medicine, his strictly scientific code was governed by the code of the physician—his efforts were directed toward cure or relief of human ills.

The demands of World War I interrupted Dr. Cannon's work. He went to Europe with a Harvard medical unit whose duty it became to study and to combat shock. Results of these studies and research stemming therefrom saved lives of many persons wounded in military or in civil pursuits. Twenty-five years later, during World War II, Dr. Cannon was called upon to serve as chairman of the Committee on Shock and Transfusions of the National Research Council.

Following World War I, Dr. Cannon resumed both research and teaching. He was one of the pioneers in study of the autonomic nervous system, isolating at terminals of nerves a chemical product, sympathin, and pointing out its role as mediator of impulses between nerve and muscle. His observations also convinced him that the living body always strives toward a harmonious equilibrium—a state which Dr. Cannon called "homeostasis"

the picture While a first year student at Harvard Medical School, Boston, in 1896, Walter Bradford Cannon (1871-1945) employed newly discovered x-rays to study activities of digestive organs in animals. Preferring cats, Cannon induced them to eat radiopaque meals, and followed food through alimentary organs with the aid of a fluoroscopic screen. Basic studies of digestion, and of effects of emotions on it, led to new understandings of food utilization, of transmission of nerve impulses, and of actions of endocrine glands. Second Professor of Physiology at Harvard, Dr. Cannon earned world-wide respect as a researcher, as a teacher, and as an ambassador of scientific good will.

Acknowledgment of helpful assistance in historical research basic to preparation of the text and of the picture, Walter B. Cannon: Physiologic Investigator, is extended to Erwin H. Ackerknecht, M.D., Professor and Director of the Institute of the History of Medicine and Biology, University of Zurich, Switzerland; to C. Sidney Burwell, M.D., Special Consultant to the Dean of the Faculty of Medicine, and to Eugene M. Landis, M.D., George Higginson Professor of Physiology, Harvard Medical School, Boston, Massachusetts; to Carl Johnson, Vice President, Advertising and Public Relations, and to H. E. Carnes, M.D., Parke, Davis & Company, Detroit, Michigan.
Printed in U.S.A.
Text and illustration © 1963, Parke, Davis & Company

in his book, *Wisdom of the Body*, and in other writings. This concept paralleled the *milieu interne* (internal environment) idea advanced earlier by Claude Bernard.

The function of adrenal glands and effects of their secretions on the body, especially under conditions of stress or excitement, also were revealed by Dr. Cannon's research. He studied other organs of internal secretion, and especially the genetic, nervous, and psychic problems of sex. He did not hesitate to follow direction of his curiosity toward questions outside physiologic fields. In 1914, he described physical apparatus for determining coagulation time of blood.

Dr. Cannon's interests were not limited by Harvard's campus or by national boundaries. He accepted exchange professorships, in 1929, at the Sorbonne, in Paris, France; and in 1935, at Union Medical College in Peiping, China. More than fifty foreign students, from seventeen different countries, came to his laboratories for advanced study. Leading physiologists of the world were numbered among his friends, and he took an active part in numerous national and international organizations. He was elected to the National Academy of Sciences in 1914, and served as chairman of its Division of Foreign Relations for many years. He also served as chairman of the Committee on Physiology of the National Research Council from its inception in 1916 until his death. As chairman of the American Medical Association's Committee on Protection of Medical Research he did the profession outstanding service in opposing efforts of antivivisectionists to cripple research. At one time he even served on a committee, along with magician Harry Houdini, seeking evidence of supernatural power. His friendship for Pavlov led to acceptance of presidency of the American-Soviet Medical Society upon its organization. He was capable of deep and loyal friendships, readily moved to sympathy and indignation by suffering and injustice. His organization of medical assistance to Spanish loyalists, and to United China Relief, was motivated not by political considerations but by great sympathy for suffering peoples.

Dr. Cannon was a scientific investigator from start to finish. He spent just fifty years at Harvard, as student, instructor, and professor. Although at times he carried a great burden of administrative work, he always kept research projects going, and managed to instill both wisdom and idealism in his students. Dr. Aub states that the advances in clinical research which have characterized this century are due in no small part to his initial inspiration.

Boyhood in Wisconsin and Minnesota had given Dr. Cannon a great love for athletics and for outdoor life. Proof of prowess of Dr. Cannon and his wife at mountain climbing may be found in Montana, where a mountain peak which they were first to scale bears their name. Their family, consisting of a son and four daughters, enjoyed much affection and quiet happiness together. Dr. Cannon was of a simple, straightforward, friendly disposition. His final book, *The Way of an Investigator*, written after his retirement in 1942, is both autobiographical and delightfully discursive on a life of research and scientific discovery.

When, as a young man, Dr. Cannon conducted his extensive studies with x-rays, the dangers attendant with their use were not realized. Fortunately, he had partially shielded his apparatus with lead sheets. However, during the last years of his life, he suffered intensely from acute dermatitis suspected as having been caused by radiation. His life was ended by a malignant lymphoma. He was nearly seventy-four years of age when death came to him, October 1, 1945.

REFERENCES

- Ackerknecht, E. H., unpublished monograph.
Ackerknecht, E. H., *A Short History of Medicine*. New York, Ronald Press Co., 1955.
Alvarez, W. C., *Dr. Walter B. Cannon Passes*. Gastroenterology, Vol. 5, No. 5, Nov., 1945.
Cannon, Walter B., *The Mechanical Factors of Digestion*. London, Edward Arnold, 1911.
Cannon, Walter B., *Bodily Changes in Pain, Hunger, Fear and Rage*. New York, D. Appleton & Co., 1915.
Cannon, Walter B., *The Way of an Investigator*. New York, W. W. Norton & Co., 1945.
Cannon, Walter Bradford, *A Memorial Exercise*. Harvard Medical School, 1945.
Dale, Sir Henry H., *Prof. W. B. Cannon*. Nature, Vol. 158, No. 4003, July 20, 1946.
Spillman, Ramsay, *Walter Bradford Cannon*. The American Journal of Roentgenology and Radium Therapy, Vol. 55, No. 1, Jan., 1946.