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HENRY PICKERING BOWDITCH, PHYSIOLOGIST[1]

By Dr. WALTER B. CANNON

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SIXTY-EIGHT years ago a young chemist, Charles W. Eliot, was the new president of Harvard University. Almost from the first he undertook the hard task of revolutionizing medical education. In his report for the academic year 1870–71, he wrote that the corporation and overseers had "changed the title of the Parkman Professor of Anatomy and Physiology in the Medical School. Physiology having been made a separate branch of instruction, and an assistant professor having been appointed to teach it, the Parkman Professor will hereafter teach anatomy only." The change, it was explained, was made with the assent of Oliver Wendell Holmes, for twenty-four years the incumbent of the combined chair. And later in the report President Eliot added, "The appointment of an Assistant Professor of Physiology and the equipment of a physiological laboratory has put that department of instruction upon a much better footing than before."

The comment is justifiable that no great change was required to bring about a considerable improvement. The literary Parkman professor had lavished his flowery adjectives on bodily structure, and had paid only incidental tribute to bodily function. He was, indeed, impressed by the revelations of the microscope, which, he declared, has "cleared up many uncertainties concerning the mechanism of special functions." Unfortunately, however, nature had been reluctant. "If any prying observer," he wrote, "ventured to spy through his magnifying tubes into the mysteries of her glands and canals and fluids, she covered up her work in blinding mists and bewildering halos, as the deities of old concealed their favored heroes in the moment of danger." But progress was recognized. "Science has at length sifted the turbid light of her lenses, and blanched their delusive rainbows."

Though there is evidence that Dr. Holmes in his lec-

[1] An address given at the celebration of the fiftieth anniversary of the founding of the American Physiological Society, Baltimore, April 1, 1938.

tures gave only cursory attention to physiological phenomena, he was probably more considerate than his predecessor, J. C. Warren, who let physiology take its chances with anatomy and surgery. Even Warren did not have the multiple tasks of Dunglison, at Virginia, who taught not only anatomy and physiology, but also materia medica, pharmacy and medical history. That bewildering array reached well beyond Holmes's range; nevertheless, Holmes, impressed by the diversity of his teaching duties, once declared that he occupied not a chair but a settee. It is probable that he was dissatisfied with this situation well before 1871, for in 1865 J. S. Lombard was appointed lecturer in physiology and held recitations twice a week in a summer course. He was succeeded in 1870 by William T. Lusk, father of Graham Lusk, who for a year gave the first physiological course at the Harvard Medical School that was accompanied by experimental demonstrations.

The conditions at Harvard were not unique. Instruction in physiology was usually a subsidiary activity, incidental to other teaching. The professor might be concerned primarily with any other aspect of medicine—with anatomy, pathological histology, diseases of children, psychiatry or gynecology, merely to mention a few actual instances of associated subjects. On the side, the professor lectured about bodily processes. There was one exception, in the career of J. C. Dalton, who, beginning in 1852, was the first American to devote full time to physiological teaching and research. He was, however, a lone worker, combining physiological and anatomical studies, an excellent expositor of his subjects, but not a leader of others towards new developments.

Into this realm of biology, almost uncultivated in the United States, Henry P. Bowditch entered in 1871. The year before, while stimulated by the fresh ideas and industry of Ludwig's laboratory at Leipzig, he had written: "The patient, methodical and faithful way in which the phenomena of life are investigated by the German physiologists not only inspires great confidence in their results but encourages one in the hope that the day is not far distant when physiology will take its proper place as the only true foundation of medical science." Imbued with this ardent faith he bought the apparatus to outfit a laboratory for physiological investigation (this personal gift was the "equipment" referred to by President Eliot), and installed it in two renovated rooms in the attic of the old medical building near the Massachusetts General Hospital. There he set to work as an assistant professor. No professor of physiology was over him, and when he was asked whom he was assisting, he replied, simply, "I'm assisting myself." That was the literal truth; at the time he had no helper.

Dr. Bowditch's description of physiological processes, well illustrated by exhibited proofs, was something new and strange. William James, who had received the Harvard degree in medicine four years previously, wrote to his brother, Henry, in November, 1872: "I go into the Medical School (*i.e.*, from Cambridge to Boston) nearly every morning to hear Bowditch lecture." It happened that a Mr. Weitbrecht, who taught me physics in the St. Paul High School, nearly a half century ago, had had a year of medicine at Harvard; he told me that his outstanding experience was hearing Dr. Bowditch's lectures in the 70's. They were stimulating, enthralling, he declared, full of the enthusiasm and vigor and interest of the young physiologist.

The two laboratory rooms in the attic soon became crowded with disciples. There they first experienced the thrill of discovery and were started on scholarly careers. Their interests embraced almost all phases of modern experimental medicine. Researches were undertaken in general biology, pharmacology, experimental surgery and pathology, physiological psychology as well as in the field of physiology proper. Among the men who worked with Bowditch in the early years of his professorship were Minot, the embryologist; J. C. Warren, the surgeon; Stanley Hall and William James, psychologists; Ott, the pharmacologist; Putnam, the neurologist; and J. W. Warren and W. P. Lombard (happily still with us), physiologists. As the man who suggested the research which led me to become devoted to physiological study I am glad to express my obligation to Bowditch.

During the first twelve years of his service to the Harvard Medical School Dr. Bowditch published almost twice as many scientific contributions as during the remaining twenty-three years. The lessened productivity in the last two thirds of his academic life was the consequence, I believe, of his acceptance of the deanship of the school, in 1883. He had excellent administrative ability. The tasks of administration, however, take away from an investigator one of the most important conditions for his success—his free *time*. An administrator's attention must be given to critical decisions, and gradually scientific interests become crowded aside—a consequence which is minimized by American university authorities. As dean, Dr. Bowditch established a number of valuable innovations; prominent among them was a highly creditable spoiling of the tradition expressed in the phrase that the faculty of the Harvard Medical School was a "Back Bay dining club." This he did by importing two outlanders—W. T. Councilman from Johns Hopkins, as professor of pathology, and W. H. Howell, from the same university, by way of Michigan, as associate professor of physiology. After he resigned from the deanship, however, Bowditch did not return to active work in the laboratory, but became more and more immersed in public and general university affairs.

Though Dr. Bowditch's scientific papers were not numerous, some of them have proved to have wide significance. His first published research, concerned with the properties of cardiac muscle, has become a classic in physiology because it reported, in the brief compass of twenty pages, two fundamental observations, the "staircase" phenomenon and the "all-or-none" law. The bearings of these phenomena on the processes in skeletal muscle fibers and the nerve trunk have been repeatedly recognized in the last twenty years. Bowditch himself was deeply interested in the functioning of the nervous system. He was one of the first to bring evidence of the indefatigability of the nerve trunk in its normal environment. And his study, with Warren, on the conditions which affect the knee jerk not only revealed temporal relations of excitatory and inhibitory impulses within the system, but also led the way to many other investigations, notably those of Lombard, in which the patellar reflex was the index of central states.

There is time merely to mention some additional researches by Bowditch alone or in collaboration with his students—the energy of ciliary motion, circumstances affecting the action of vasomotor nerves, the influence of anesthetics on vasomotor reflexes, illusions of motion, and the accuracy of judgment of positions in space. Besides these physiological and psychological studies, however, there was, at different periods, time-consuming attention to the phenomena of growth in children. Hall, himself a pioneer in the field, has referred to Bowditch as "the father of child study." As early as 1872 he had called attention to the greater increase of height of girls than of boys from about the twelfth to the fourteenth year. This phenomenon was subsequently confirmed by his own and other more extensive measurements and has since been recognized as a typical difference between the sexes. His report, issued in 1877, indicated six new lines of study in anthropometry; and in a review of his earlier data, published in 1891, he emphasized the importance of repeated measurement of the same children during the years of rapid growth, in order to allow accurate conclusions to be drawn regarding variability and relative size at various stages of adolescent development.

A characteristic of Dr. Bowditch, highly valuable to him as a physiologist, was his ingenuity. While in Ludwig's laboratory, in 1869, he devised the first apparatus (a simple use of the metronome) to mark time on the then newly invented kymograph; "It was real fun," he wrote to his mother, "to see how delighted the Professor (Ludwig) was with it." While in Leipzig he also designed the so-called "Bowditch clock," with arrangements for stimulating or for registering time at any desired brief intervals. Another neat idea was his scheme for weakening the strength of induced currents in the induction coil by turning the secondary instead of withdrawing it remotely along the axis of the primary. A new form of plethysmograph, a new apparatus for artificial respiration, a novel animal holder, a cannula for observing the vocal cords, a special arrangement of non-polarizable electrodes, and an extraordinarily comfortable lounging-chair, thoughtfully contrived, were other evidences of his inventiveness.

All physiologists should regard with gratitude Dr. Bowditch's labors in defense of freedom of research. The principles which he laid down in 1896 have been prominent in all the conflicts with the antivivisectionists since then. In brief they are (1) that the experimenters are no less humane than their critics and know much better than their critics the importance of the experimental method and whatever discomfort to animals it may involve; (2) that abuse of animals in research institutions has not been shown to exist; (3) that the governing bodies of such institutions have both the will and the power to stop abuses should they arise; and (4) that existing law furnishes sufficient protection against cruelty in the laboratory as well as against cruelty elsewhere. For many years, when the struggle to prevent the imposition of restrictive measures was centered in Massachusetts and was critical, Dr. Bowditch appeared at the legislative hearings, and because of his sterling character and high standing in the community his testimony convinced the legislators that the charges of the antivivisectionists were baseless and their efforts a danger to public welfare. His methods of defense of animal experimentation established precedents which have proved valuable in many subsequent conflicts.

Dr. Bowditch had numerous associations with physiologists in this country and abroad. He cooperated in the founding of both the International Physiological Congresses and the American Physiological Society. Of our society he was the second president. In 1877, when Michael Foster started the English *Journal of Physiology,* Bowditch was consulted and agreed to serve as one of the editors. In the late 90's, when the activities of the American physiologists appeared to warrant a means of publication here, he gave support and encouragement to W. T. Porter in establishing the *American Journal of Physiology.* Throughout his academic career he served on important commissions and committees, both professional and non-professional. The present buildings of the Harvard Medical School are a monument to the efforts of Dr. Bowditch and his life-long friend, John Collins Warren.

I first knew Dr. Bowditch when he was about 56 years old. His grayish hair and beard made him seem elderly; his erect carriage, however, and a peculiar springy walk gave the impression of strength and vigor. For twenty-five years he had been meeting

new medical students annually and giving them instruction. In my day his lectures had become routine, but they were admirably illustrated with well-prepared demonstrations. His manner with students was kindly though dignified, and his judgments were generous. For some years he had not been active in research. But when, in October, 1896, we started plans to use the recently discovered x-rays to study the process of swallowing, he paid close attention to them and gave the enterprise wholehearted support.

In the following years of association with him I became well acquainted with his rare qualities as a man. He was eminently single-minded. He seldom spoke of the past—the prospects ahead were more important. He was a natural leader, tempered by courtesy, fairness and good will. His friends were many and there was mutual devotion between him and them. His conversation was not witty, but he had a delightful sense of humor. I well recall his hearty laugh as he told of an overheard conversation between one of his little daughters and a neighbor's child. The visitor expressed surprise that Dr. Bowditch, a doctor, had no patients; the daughter explained, "Oh, my father isn't that kind of doctor; he is the kind of doctor who doesn't know anything!"

He had a life full of achievement. As a young man, in 1861, he left his studies to enter the Union Army. Though wounded while leading a charge he returned to the fighting forces and served to the end of the war. At the start of his professional career he brought back to the United States ideas and inspiration which he had received from Ludwig and the enthusiastic group in Leipzig. He established here the first physiological laboratory to which students were welcomed. In stimulating his students to carry on investigations he began a movement which has now spread almost everywhere in our land. He touched many aspects of research himself. He was intimately concerned with many new developments in modern physiology. He preserved extraordinary health and activity until he was well over sixty years of age; then a slowly progressive disease—paralysis agitans—crept upon him, and he had to endure the gradual loss of all his powers. As he waited for the end his friend from early manhood, William James, wrote to him. "I admit that the form of your tragedy beats that of most of us, but youth is a stuff that won't endure in any one, and to have had it, as you and I have had it, is a good deal gained." He had had it, to be sure, and had used it in admirable ways, leaving a lasting example of service to worthy causes as his legacy to American biologists.

SILAS WEIR MITCHELL, 1829–1914[1]

By Professor A. J. CARLSON
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DR. S. WEIR MITCHELL was born in Philadelphia on February 16, 1829. His parents were of Quaker stock. His father, Dr. John K. Mitchell, was a noted Philadelphia physician, a professor in the Jefferson Medical College, and ahead of his time in scientific and literary attainments.

Silas Weir was imaginative as a child, perhaps an early index of his prolific pen in the production of works of fiction in later years. Once he was put to bed on bread and water for 24 hours, for saying and sticking to it, that he had seen "pink elephants walking down Chestnut Street."

But his bent towards the more serious things of science also was early in evidence. He writes, in his fragmentary autobiography: "One of my greatest joys was to go with my father to his chemical laboratory in Locust Street, where he conducted experiments and gave lectures in a spring course."

In 1844 at the age of 15, Silas Weir entered the University of Pennsylvania, which he described as "a small affair with some good men." As a college freshman he was twice reprimanded for disorder, and once warned for deficiency in scholarship. He had not learned to work hard, his health was not the best, and he was much given to day dreaming. Young Weir's father urged his son to go into business, or at least cease dreaming and make up his mind as to his future work. Weir decided on medicine, to his father's disgust. His father said: "You have no appreciation of the life. You are wanting in nearly all the qualities that go to make success in medicine. You have brains enough, but no industry." It seems that even an able father may not know his own abler son.

Young Weir entered Jefferson Medical College. He writes thus concerning his first year as a freshman medic:

> I had to learn to work, to concentrate attention. It came hard. I used to go over and over some confounded bone, and fall asleep. The more abominable those dry bones became, the more I worked. After six months of this I began to hear Dunglinson's lectures on physiology. This was very interesting. Although neither he nor anyone else taught physiology with experiments or illustra-

[1] Address at the fiftieth anniversary meeting of the American Physiological Society, Baltimore, Md., April 1, 1938.