pursuit we shall discover the unfolding of beauty, we shall stimulate the aspiration for knowledge, we shall ever widen human understanding.

Mr. Edison has given a long life to such service. Every American owes a debt to him. It is not alone a debt for great benefactions he has brought to mankind, but also a debt for the honor he has brought to our country. Mr. Edison by his own genius and effort rose from modest beginnings to membership among the leaders of men. His life gives renewed confidence that our institutions hold open the door of opportunity to all those who would enter.

Our civilization is much like a garden. It is to be appraised by the quality of its blooms. In degree as we fertilize its soil with liberty, as we maintain diligence in cultivation and guardianship against destructive forces, do we then produce those blossoms, the fragrance of whose lives stimulates renewed endeavor, gives to us the courage to renewed effort and confidence of the future.

DR. WILLIAM BEAUMONT, AN APPRECIATION[1]

By WALTER R. STEINER, M.D.
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IT is indeed a privilege to be able to come here to give some words of appreciation in memory of the physician whom you honor to-day—one who by his study of the physiology of digestion has been proved to be a pathfinder in our present knowledge of this subject. He has blazed a trail which has now become a broad highway, and it is greatly to his credit that he did so without any previous scientific training, for he was without college or medical school degrees or preliminary hospital experience. In spite of this, however, his name even now looms up large amongst the most distinguished men in our profession. In 1900 a monument was erected to him by the Upper Peninsular and Michigan State Medical Societies at Fort Mackinac where Beaumont performed his initial experiments upon digestion, but he did not obtain his proper honors until Osler told about him in an inimitable fashion "and brought him out of the obscurity into which we practical moderns had been allowing him to drift." Since then his manuscripts and papers have been presented by his family to Washington University at St. Louis, where, housed in a special room, they are well exhibited and permanently preserved. A boulder with a suitably inscribed bronze tablet was erected in 1926 by the Beaumont Club on the green in Lebanon, the town of his birth, and at the meeting of the Thirteenth International Congress of Physiologists in Boston his book, reprinted for that special occasion, was distributed to the members of the congress as representing our country's foremost contribution to physiology. Surely a prophet is not without honor even in his own country, despite the adage to the contrary, for to-day you are to dedicate a tablet to him here in this town where he conducted two of his four series of experiments.

[1] An address delivered at the unveiling of a tablet to Beaumont at Plattsburgh on August 24, 1929, upon the termination of the summer course in cardio-nephritis at the Physicians Hospital of Plattsburgh, New York.

Our knowledge of the digestive processes before his illuminating study was vague and unsatisfactory. Two views chiefly prevailed—the mechanical and the chemical. The former considered the grinding or pressing force of the muscular coats of the stomach as largely sufficient to accomplish the required and subsequently obtained digestion, while the second view explained the change taking place in the stomach as chiefly, if not wholly, of a chemical nature, resulting from the process of fermentation. Unable to solve the exact nature of digestion, which had stretched the pia mater of so many distinguished physicians, William Hunter, of London, finally remarked, in the century of Beaumont's birth: "Some physiologists will have it that the stomach is a mill, others that it is a fermenting vat, others again that it is a stew pan, but in my view of the matter, it is neither a mill, a fermenting vat, nor a stew pan but a stomach, gentlemen, a stomach."

Before the new era, however, which Beaumont was about to usher in, there were some honest seekers after the truth, and foremost among them we find Benjamin Richardson Young, of Hagerstown, Maryland, a young man like Beaumont and also an American. It had been long known that the gastric juice was acid in reaction, but it remained for Young to take the fundamental step in demonstrating its acidity and in proving its solvent, anti-putrefactive properties. This he did in a thesis which he presented at the University of Pennsylvania for the degree of M.D. in 1803. In the experiments there recorded he introduced a calculus into a frog's stomach and noted its gradual dissolution. He also put beans, peas, wheat and bread into a frog's stomach and found that in thirty hours the beans, peas and wheat were not acted upon, but the bread bag was empty. However, if the cereals were crushed they were readily digested. Vinous, acetous and putrefactive fermentations were then successively investigated with the re-

sult that he showed that the acid in the stomach did not come from any of these varieties. He proved also that trituration and putrefaction were not essentially concerned. Unfortunately, he concluded that the acid was phosphoric and not hydrochloric. He experimented both upon animals and man, securing pure gastric juice to use *in vitro*. Finally he showed that the acid gastric juice checked putrefaction. He explained the process of digestion as follows: "Aliment is dissolved by the gastric menstruum; it then passes into the duodenum and meets with bile and pancreatic liquor; after being united with these, a heterogeneous mass is formed called chyme, and from this the lacteals secrete chyle." Returning to Hagerstown, Maryland, after graduation he was taken by his father into partnership for the practice of medicine, but unfortunately died of tuberculosis about eleven months later.

Three years after Young's birth, there was born in Lebanon, Connecticut, in 1785, William Beaumont, fifth in descent from one of the same name who probably came to Massachusetts in 1635 and migrated with John Winthrop, Jr., to Connecticut. At any rate, he appears in Saybrook in 1640. Our Beaumont was the third son of Samuel Beaumont, being born in a town where Connecticut's distinguished Revolutionary War governor, Brother Jonathan Trumbull, resided, as well as William Williams, a signer of the Declaration of Independence. The town had passed through stirring times during the Revolution, for here Washington and Trumbull had had frequent conferences upon important matters of state, and here De-Lauzun's Cavalry, the French Legion of Horse, was stationed for seven months during 1780 and 1781.

Little is known of Beaumont's boyhood other than the statement that courage and fearlessness were even then his predominating qualities and that defective hearing first developed after he had taken a dare and stood nearer a cannon that was being fired than any of the playmates. He seems to have industriously tilled the soil and assiduously attended church until the winter of 1806–07, when growing tired of these activities he set out northward with a horse, a cutter, a barrel of cider and $100 of hard-earned money. Finally he arrived at the village Champlain, New York, in the spring of 1807 and began teaching school in that town. While thus teaching school and tending store, he began to study medicine with Dr. Seth Pomeroy, and in the fall of 1810, after three years of such study, crossed Lake Champlain to St. Albans to be instructed further by Dr. Benjamin Chandler.

On the second of June, 1812, he secured a license from the Third Medical Society of the State of Vermont, and on September 13, entered the army as surgeon's mate, receiving his commission on December 2, 1812. On account of the inactivity of the division of the army to which he was assigned, he began the private practice of medicine in Plattsburgh on January, 1813, and continued in this practice until February 13 of that year when he again resumed his army career. His efficient work here is worthy of note and his bravery under fire in the battle of Plattsburgh was highly commented upon, along with that of the other surgeon's mates, by Hospital Surgeon James Mann. Soon after the war of 1812 he resigned from the army and entered partnership with Dr. George Senter, announcing to the public in the Plattsburgh *Republican,* December 15, 1815, that they had commenced business in the line of their profession (physic and surgery). They also state that they have opened a store containing a general assortment of drugs, medicines, groceries, dye woods, etc., which they calculate to sell on liberal terms for cash or approved credit. In a postscript to this advertisement it is stated that medicines, etc., will be put up with accuracy and care. This partnership, however, was dissolved a few months later as Dr. Senter had to go south, and the firm became Beaumont and Wheelock. The same newspaper then records the fact that these two have received and offer for sale at the lowest prices a large and well-selected assortment of groceries, consisting of Madeira, Port, London Particular and Sherry, Wines, Cognac and French Brandy—Jamaica, St. Croix and New England Rum—Pierpont ginger, Plug and Paper Tobacco, Pipes, Codfish, Shad, Mackerel, Chocolates, Spanish Segars, Window glass, Snuff, Starch, Powder, Shot Almonds, etc. Also in addition to their former stock they had a large assortment of Drugs and Medicine, Dye Woods, etc., etc. (September 6, 1816). This business, however, was probably not very appealing to Beaumont, and the firm sold out in about a year to Springer and Woodward. Beaumont then confined himself to the practice of medicine, which evidently soon became quite lucrative as his case records show. But the charm of army life was more enticing to him; his friend, Joseph Lovell, had lately been appointed surgeon-general, and the medical corps of the army had been completely reorganized. He consequently accepted the appointment of post surgeon on March 18, 1820, to take rank from December 4, 1819. He was then ordered to Fort Mackinac, Michigan, and two years later married Mrs. Deborah Platt, of Plattsburgh.

On June 6, 1822, the great opportunity came which subsequently made him famous, for on that day a gun was accidently discharged in the retail store of the American Fur Company, and immediately a French Canadian, Alexis St. Martin, fell to the floor with a

perforated gun shot wound in the upper abdomen. Dr. Beaumont was at once sent for and arrived shortly. He found the patient had just been placed on a cot and the helpers were taking off some of his clothing. The wound seemed to be a mortal one, but Beaumont extracted part of the shot and pieces of clothing, remarking as he dressed the wound, "The man can't live thirty-six hours." But he did survive in spite of the permanent hole in his stomach, and was taken to the fort hospital as soon as he could be moved so that Dr. Beaumont could give him better attention. Two years later the county refused any further assistance to St. Martin and Beaumont took him into his own family from "mere motives of charity and a disposition to save life or at least to make him comfortable." Straightway he improved continually in health so that by June 1, 1824, he was able to perform "any kind of labor from the whittling of a stick to the chopping of logs." This kind treatment of St. Martin was performed when Beaumont's salary was $40 a month with two to four rations daily to supply his needs as well as his family's and St. Martin's. In the fall of that year Beaumont sent a report of this case to Surgeon-General Lovell so that he could correct and publish it in some reputable journal, if he saw fit. In 1825 this article appeared in the Medical Recorder, but unfortunately Joseph Lovell's name was appended to it as its author and the error was not corrected until later in that year.

Experimental work upon the patient apparently was not considered until three years after the accident. Four series of experiments were subsequently conducted, the first being communicated to the Michigan Medical Society in 1827. Unfortunately, St. Martin disappeared shortly thereafter and a two-year search was required to discover him. Then a two-year further study follows, and again from November, 1832, to March, 1833, additional research was done upon him. These three studies finally appeared in the fall of 1833 in book form under the title of "Experiments and Observations on the Gastric Juice and the Physiology of Digestion." In this book of 280 pages, 238 experiments are noted, which are so exact that with the exception of pepsin but little has been added since. The first experiments (four in number) were made at Plattsburgh, although he had previously begun experiments in a desultory way at both Fort Mackinac and Fort Niagara, while the second (fifty-six in number) were conducted at Fort Crawford, Prairie du Chien, Wisconsin. The third (116 in number) were recorded in Washington, and finally the fourth (sixty-two in all) from July 9 to November 1, 1833, were performed in Plattsburgh, following the completion of the manuscript of his book. This series is published at the end of the volume.

This book was printed at Plattsburgh by Frederick P. Allen, and reissued the following year by Lilly, Waite and Company of Boston. Four years later an English edition was published by Sir Andrew Combe, of Edinborough, and in 1834 a German edition had appeared. A second edition was also published in Burlington, Vermont, in 1847 by Dr. Samuel Beaumont, William Beaumont's cousin. This edition was a reprint of the first with a good many minor corrections. In the preface Beaumont writes: "I submit a body of facts which can not be invalidated. My opinions may be doubted, denied or approved, according as they conflict or agree with the opinions of each individual who may read them; but their worth will be best determined by the foundation on which they rest —the incontrovertible facts." He recognized that the secretions of gastric juice and mucus in the stomach were essentially dissimilar in their physical and chemical properties; that the agent of chymification was the gastric juice; that this gastric juice was a clear, transparent, odorless, salty and perceptibly acid liquid, capable of being kept pure for months and perhaps years and of checking the process of putrefaction; it possessed the property of coagulating albumen in an eminent degree: its secretion was not free in the stomach but was excited by food or other irritants; its acidity was due to hydrochloric acid and it possessed also some other active chemical principles; it became intimately mixed and blended with the food by the muscular activity of the stomach, the ultimate principles of aliment being always the same. He realized that the quantity of food consumed was generally more than the system required and that if such excess was persevered in functional abberration and finally disease of the coats of the stomach would ensue. Nutriment as well as bulk were required in a diet, and oily substances retarded digestion, but the digestion of such substances was facilitated in the intestines by bile which was not ordinarily found in the stomach. From three to three and a half hours were usually required for the digestion of a meal. Stimulating condiments and ardent spirits were conducive to disease of the stomach. Chyme when expelled from the stomach into the intestines became chyle which then was acted upon by the bile and pancreatic fluid. Finally, Beaumont declared that no other liquid produced the same effects on food as gastric juice.

In the course of his study he sent specimens of the gastric juice to Professor Robley Dunglism, of the University of Virginia, and Professor Benjamin Silliman, of Yale, two of the foremost scientists in this country, hoping that they might throw some light on some of his observations and render him some assistance. The latter indeed, desiring to aid him, sent

a sample to Professor Jacob Berzelius, the famous Swedish chemist, at Stockholm, but none of their answers were especially illuminating. In spite of this disappointment he showed in his book an extensive knowledge of the literature of the physiology of digestion, and by his researches he is clearly a pioneer. The most important of his findings have been corroborated by Pavlov and others. Small matter is it that he failed to realize that contractions were associated with the pangs of hunger or that the seat of hunger was in the nervous system. He did not discover the existence of reflex or psychic secretion, or that of a continuous and constant secretion, or comprehend the function of saliva in digestion. He also missed the storage function of the stomach, but he paved the way for these and other findings by subsequent investigators.

His remaining years are soon recorded. He resigned from the army in 1839, as Lovell's successor. Dr. Thomas Lawson, not discerning properly the importance of Beaumont's investigations, had ordered him sent to Florida. The acceptance of this post was obviously impossible, so Beaumont, resigning from the army, settled in St. Louis. Here he soon acquired an extensive practice and was busily engaged therein until an accident hastened his death, which occurred on April 25, 1853. His remains rest in the Bellefontaine Cemetery in St. Louis, but his fame belongs to the world.

The following estimate of him was written by one who knew him well:

> He was gifted with strong natural powers, which, working upon an extensive experience in life, resulted in a species of natural sagacity, which, as I suppose, was something peculiar in him, and not to be attained by any course of study. His temperament was ardent, but never got the better of his instructed and disciplined judgment, and whenever or however employed, he ever adopted the most judicious means of attaining ends that were always honorable. In the sick-room he was a model of patience and kindness; his intuitive perceptions, guiding a pure benevolence, never failed to inspire confidence, and thus he belonged to that class of physicians whose very presence afford nature a sensible relief.

May this appropriately inscribed tablet recall to coming generations in Plattsburgh the memory of this most distinguished man, for here he entered the army, here he began the practice of medicine among its inhabitants, here he married his wife and here he conducted two of his now world-famous series of experiments upon the physiology of digestion.

TEN YEARS OF STATISTICAL STUDIES OF MARINE PHYTOPLANKTON AT THE SCRIPPS INSTITUTION OF OCEANOGRAPHY

By Professor WINFRED EMORY ALLEN
SCRIPPS INSTITUTION OF OCEANOGRAPHY

INTRODUCTORY

THIS work was begun in July, 1919, at the invitation and recommendation of Dr. W. E. Ritter, at that time director of the Scripps Institution for Biological Research which later became the Scripps Institution of Oceanography of the University of California. My preliminary survey of possibilities in the summers of 1917 and 1918 had indicated that diatoms and dinoflagellates constituted material fairly favorable for statistical studies, and that arrangements for handling this material effectively could be made more satisfactorily than for any other organisms in the ocean plankton. My original assumption was that the work should be carried with a continuity as high as practicable over a period of at least ten years.

PURPOSES

The fundamental purpose in mind at the beginning of these investigations was to obtain definite series of records of distribution in time and space of diatoms and dinoflagellates as major groups of microplankton organisms. Incidental to the accumulation of such records and consequent to appropriate stages in that accumulation an indefinite number of dependent and interdependent aims was recognized. As examples of these a few may be mentioned as follows:

To determine relative prominence of constituent organisms in general or in particular localities.
To estimate ranges of productivity of particular localities or depth levels or time periods.
To characterize fluctuations in character of populations.
To identify observable causes of specific prominence.
To identify normal trends and periodic series in natural history of the oceanic complex.
To determine observable interrelationships of organisms and their environment.
To determine observable influences involved in stabilizing or destabilizing such interrelationships.
To identify indicators of environmental influences.
To identify food chains.
To identify injurious species of diatoms and dinoflagellates.