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JOSEPH HENRY[1]

JOSEPH HENRY was an international figure. The city of Albany, as his birthplace and the scene of his early discoveries, may rightfully assert a claim on Henry; Princeton, the site of his later triumphs in the study of electricity, justly claims a share of his renown; and Washington, where he devoted the last thirty years of his life to the organization and development of the scientific interests of the nation, has a deep sense of proprietorship in him. Yet, like all really great men, Henry belongs to the nation, and the nation has in many ways manifested her pride in his achievements. An impressive memorial service was held in his honor in 1878 in the United States House of Representatives. Five years later his monument in bronze was erected in the Smithsonian grounds by authority of Congress. Still later his statue was placed in the rotunda of the Library of Congress beside that of Newton, the two symbolizing scientific achievement of the highest order. And in 1924 a bust of Henry was placed in the Hall of Fame in New York City, thus according him a place among America's immortals. International recognition of his pioneer work was accorded him through the action of the International Congress of Electricians at Chicago in 1893, in adopting the name "henry" as the standard unit of inductive resistance.

In considering the life of this great American, we must remember that his half century of productive activity was divided into two distinct periods. The first included the two decades in which his brilliant researches in electro-magnetics brought him world-wide and permanent renown. The succeeding thirty years were devoted to a task for which he is not so well known to technicians, but which in the long run of years has proved to be of at least equal value to his epoch-making discoveries—the task of the organizer and administrator.

Henry's famous discoveries in the field of electro-magnetics, in the course of which he transformed the feeble and inefficient apparatus of Sturgeon into a powerful electromagnet capable of lifting a weight of 3,500 pounds, are perhaps too well known to need recounting. This remarkable advancement was due to his discovery of the necessary law of proportion between the electro-motive force in the battery and the resistance in the magnet, and his two distinct types of magnets, which he named the "intensity

[1] Address delivered on October 16 at the sixty-first convocation of the University of the State of New York.

magnet" and the "quantity magnet," ushered in a new epoch in electrical science.

While at first Henry devoted his efforts to studying the magnetizing effect of the electric current, his attention was later directed to the related electric phenomenon-induced electric currents. Even before Morse made use of the electro-magnet in telegraphy, this subject of induced currents had been experimented with by Henry both in Albany and at Princeton. Two fundamental and important properties of the electric current were announced by him as a result of these later researches—one, that the discharge of electricity from a Leyden jar was oscillatory, and the other, that these discharges could influence electrical apparatus located at a distance as great as two hundred feet without the aid of any connecting medium other than the ether, and this despite the interference of such non-conductors as floors and walls of buildings. He found also that when using lightning as his source of electric discharge, rather than the Leyden jar, his electrical apparatus was similarly affected, although in the latter experiment the distance was as much as eight miles. To Henry these observations were sufficiently significant to be recorded, and for hypotheses to be advanced concerning them. The science of electricity, however, had not advanced sufficiently at that time, nor at the time of his death, to make practical applications of these observations, but we know to-day that he had discovered a property of the ether which is essential to radio telegraphy and telephony. A distinguished president of the General Electric Company, upon this same occasion nine years ago, thus summed up the result of Henry's researches:[2] "I may say at once, without fear of successful contradiction, that the entire electrical industry is not only founded upon, but is a direct outgrowth of the work of Henry."

The second period of Henry's activity, covering the last thirty years of his life, represents the formative period of scientific effort in America, and during this critical time Joseph Henry was recognized as the leader in directing the national organization of science. In retrospect, the group of men that led in the development of scientific activities in America during this period were pioneers and outstanding figures in the history of science and education: Louis Agassiz, the naturalist; James Hall, geologist; James D. Dana, geologist and mineralogist; Silliman, chemist; Henry, the physicist; J. Lawrence Smith, chemist; Benjamin Pierce, the mathematician; Benjamin A. Gould, astronomer; Asa Gray, botanist; and many others of greater or less degree of productivity and influence. In this group Henry was the natural leader, with a vision that penetrated far into the future, and an initiative that led him to organize and administer effectively every trust placed in his charge. Men instinctively trusted and looked to him for suggestion and advice, and as we study his portrait this is readily understood. His face radiates intelligence, integrity and kindness, associated with great firmness and stability—qualities that led those about him to admire and accept his leadership.

In the year 1846, Henry came to the parting of the ways—it became necessary for him to make a momentous decision. The Smithsonian Institution had in that year been established by Act of Congress on the lines laid down by Henry, and the Board of Regents, having sought Henry's advice in planning the organization of the new institution, chose him as the first secretary, thus confirming his judgment as to the future development of the Smithsonian. His choice lay between a lifetime in the field which he loved and which held the most brilliant promise and the career of a scientific administrator in which there would be little opportunity for personal researches. Henry's greatness of soul is clearly shown in his cheerful willingness to abandon his own scientific career for the sake of providing opportunity for future researches and the diffusion of knowledge.

Having accepted the secretaryship of the Smithsonian, he entered at once upon the duties with his characteristic zeal and ability. The plan of organization which he drew up was a masterpiece of clear exposition, and the outline presented for the future operations of the institution was so fundamentally sound that it has not been necessary to change it in any essential point to the present day. He laid the foundations for the United States National Museum and the International Exchange Service of governmental and scientific publications, which have since become great national enterprises. He personally organized the great system of meteorological observations with its army of volunteer observers and its daily telegraphic reports, which formed the beginnings of the present United States Weather Bureau. He took a particular interest in the meteorological phase of the work of the institution, the "Instructions for Meteorological Observers" having been written by his own hand, the instruments used by the observers being tested by him, and in fact the entire administration of this extensive project being carried on by him personally. His aid and encouragement in the early surveys of the great west led eventually to the establishment of the United States Geological Survey and the Bureau of American Ethnology.

Joseph Henry's great success as a scientific admin-

[2] "The debt of electrical engineering to the work of Joseph Henry in Albany," by Dr. E. W. Rice, Jr. An address delivered at the fifty-second convocation of the University of the State of New York, October 20, 1916.

istrator came in large measure from his versatility and his broad viewpoint regarding matters of science. During his administration of the Smithsonian there arose the bitter controversies over the question of man's origin aroused by Darwin's announcement of his theory of evolution—a controversy which we have recently seen revived in this country. Henry believed that controversy was unfortunate and unprofitable, of little avail in settling a problem, and that the scientific method—through research to discover the facts and prove or disprove a contention by them—was the true means by which to arrive at the truth and a satisfying conclusion.

Professor Henry was a Scotch Presbyterian and a devoutly religious man, also qualified by tradition, training and mental ability to form an opinion as to whether there was a real conflict between the conceptions of the scientist and those of the religionist as to the processes of creation and the origin of man. In some reminiscences of Henry by Professor Henry C. Cameron[3] he quotes Henry as saying: "We explain a fact when we refer it to a law. We explain a law when we refer it to the will of God." Professor Cameron wrote that Henry could say, "There are two books from which I collected my divinity; besides that written one of God, another of his servant, nature—that universal and public manuscript that lies expansed unto the eyes of all"—also "that the person who thought that there could be any real conflict between science and religion must be very young in science or very ignorant of religion."

Professor Henry wrote very little on subjects outside of his special field of research and nothing has been found in print on his views of organic evolution, but he did talk freely with his associates, and one of them, Dr. W. B. Taylor, of the Smithsonian staff, states in his memorial of Henry:[4]

From the very first, he accepted the problem as a purely philosophical one; employing that much abused term in no restricted sense. With no more reserve in the expression of his views, than the avoidance of unprofitable controversies (though no one—more than he—enjoyed the calm and purely intellectual discussion of an unsettled question by its real *experts*), he yet found no occasion to write upon the subject. The unpublished opinions, however, of one so wise and eminent, can not be a matter of indifference to the student of nature; and their exposition can not but assist to enlighten our estimate of the mental stature of the man, and of his breadth of apprehension and toleration.

Whatever may be the ultimate fate of the theory of natural selection (he remarked in the freedom of oral intercourse with several naturalists), it at least marks an epoch—the first elevation of natural history (so-called) to the really scientific stage: it is based on induction, and correlates a large range of apparently disconnected observations, gathered from the regions of paleontology or geological successions of organisms, their geographical distribution, climatic adaptations and remarkable readjustments, their comparative anatomy, and even the occurrence of abnormal variations, and of rudimentary structures—seemingly so uselessly displayed as mere simulations of a "type." It forms a good (working hypothesis) for directing the investigations of the botanist and zoologist.[5] Natural selection indeed—no less than artificial (he was accustomed to say), is to a limited extent a fact of observation; and the practical question is to determine approximately its reach of application, and its sufficiency as an actual agency, to embrace larger series of organic changes lying beyond the scope of direct human experience. It is for the rising generation of conscientious zoologists and botanists to attack this problem, and to ascertain if practicable its limitations or modifications.

These broad and fearless views, entertained and expressed as early as 1860 or 1861, exhibiting neither the zealous confidence of the votary nor the jealous anxiety of the antagonist, received scarcely any modification during his subsequent years. Nor did it ever seem to occur to him that any reconstruction of his religious faith was involved in the solution of the problem. So much religious faith indeed was exercised by him in every scientific judgment that he regarded the teachings of science but as revelations of the divine mode of government in the natural world: to be diligently sought for and submissively accepted; with the constant recognition however of our human limitations and the relativity of human knowledge.[6]

From the very beginning of his connection with the Smithsonian, he emphasized the fact that Smithson, by the wording of his bequest, had intended the

[3] Smithsonian Misc. Coll., 356, 1881, p. 171.

[4] Smithsonian Misc. Coll., 356, 1881, pp. 342, 343.

[5] "In the investigation of nature, we provisionally adopt hypotheses as antecedent probabilities, which we seek to prove or disprove by subsequent observation and experiment; and it is in this way that science is most rapidly and securely advanced." (Agricult. Report, 1856, p. 456.)

[6] "With reference to the intimations of the comparative antiquity of man, Henry quoted with sympathetic approbation the sentiment so well expressed by the Bishop of London in a Lecture at Edinburgh, that 'the man of science should go on honestly, patiently, diffidently, observing and storing up his observations, and carrying his reasonings unflinchingly to their legitimate conclusions, convinced that it would be treason to the majesty at once of science and of religion, if he sought to help either by swerving over so little from the straight line of truth.' (Smithsonian Report for 1868, p. 33.)"

benefits from it to be not restricted to any locality or any country, but to be available to all mankind. Moreover, in Smithson's will, there was no restriction in favor of any particular branch of knowledge, and Henry insisted that all researches which had for their purpose the increase of existing knowledge should receive due consideration. This broad-minded policy resulted in keeping the activities of the institution well diversified, practically all the branches of science sharing in its attention, and this ideal has been followed to the present time.

Henry served without compensation as chairman of the Lighthouse Board of the United States from 1871 until the time of his death and in addition to administering the work of this important body in improving our national lighthouse system, he personally made a number of valuable researches in the field of fog-signalling and on the illuminants for use by lighthouses, with the result that great advances were made in methods of the protection of shipping. During the trying days of the Civil War, when every available agency was called into service for the preservation of the Union, Henry was one of a commission appointed by President Lincoln to examine and report upon various investigations and experiments intended to facilitate the operations of war and to improve the art of navigation. From the valuable results of this commission arose the National Academy of Sciences with its national charter, with Henry as one of the prime movers. He was its second president, and held that office until his death. He directed the mobilization of scientific effort during the Civil War and a half century later the National Academicians organized, under its charter, the National Research Council for the purpose of mobilizing the scientific and technical men for service to the government in its time of need. He also took a leading part in the organization of the American Association for the Advancement of Science and the Philosophical Society of Washington.

Who can estimate the influence of such a career upon the progress of science in America? Entering upon the field just as this country was beginning to take a serious part in the world's scientific advance, Henry did more than any other one man to shape the progress of this initial effort and direct it into channels which have resulted in placing America among the forefront of the nations in the march of science.

I have often thought, when in the rooms in the Smithsonian Institution where Henry lived and worked, of the wonderful progress of his beloved science since he passed on, fifty years ago. He made his first contributions to fundamental research in electro-magnetics, and then for the cause of the advancement of science undertook the organization and development of a scientific institution in accordance with a plan that was very largely if not wholly his own creation. With great singleness of purpose and a superb devotion to duty he gave all that was in him to the interests of science in America. A man of vision, initiative and power, modest, thorough and sincere, he won the respect not only of the scientific men of his time but also of the great leaders of political, social and educational thought. The founder of many of the present great governmental scientific agencies, adviser and counsellor in the formation of others and the leading spirit in the organization of many of the scientific societies of to-day, Henry may well be called the organizer of American science. This work alone entitled him to a place among America's immortals: add to it his brilliant researches and fundamental discoveries in the field of electricity, and we are led to say of Joseph Henry, with one of his biographers, "there is no greater name in American science."

Charles D. Walcott
Smithsonian Institution

THE SIGNIFICANCE OF HEXYLRESORCINOL AND ITS HOMOLOGUES IN RELATION TO THE PROBLEM OF INTERNAL ANTISEPSIS[1]

Biological Aspects of Internal Antisepsis

"Chemotherapy," in the sense of complete disinfection of the blood stream and tissues by means of some substance more toxic to any invading microorganism than to the host, is a conception which may be traced directly to Ehrlich's first efforts to divert the trend of medical thought from a more or less intelligent empiricism to the interpretation of biological processes and pharmacodynamic effects in terms of chemical reactivity.

It is unfortunate that a term so broad as this should have come to be generally employed in the very restricted sense of the treatment of specific general infections by chemical means. The administration of iron in anemia, or morphia to relieve pain, or even of sodium bicarbonate to relieve gastric hyperacidity are all examples of "chemotherapy" in the real meaning of the word, although in the latter in-

[1] From the Department of Bacteriology, School of Hygiene and Public Health, The Johns Hopkins University. Read before the symposium on "Chemistry in the field of micro-biology," at the annual meeting of the American Chemical Society, Baltimore, Maryland, April, 1925.