

NATIONAL ACADEMY OF SCIENCES

CHARLES SEDGWICK MINOT
1852—1914

A Biographical Memoir by
EDWARD S. MORSE

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Biographical Memoir

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NATIONAL ACADEMY OF SCIENCES
OF THE UNITED STATES OF AMERICA

BIOGRAPHICAL MEMOIRS
PART OF VOLUME IX

BIOGRAPHICAL MEMOIR

OF

CHARLES SEDGWICK MINOT

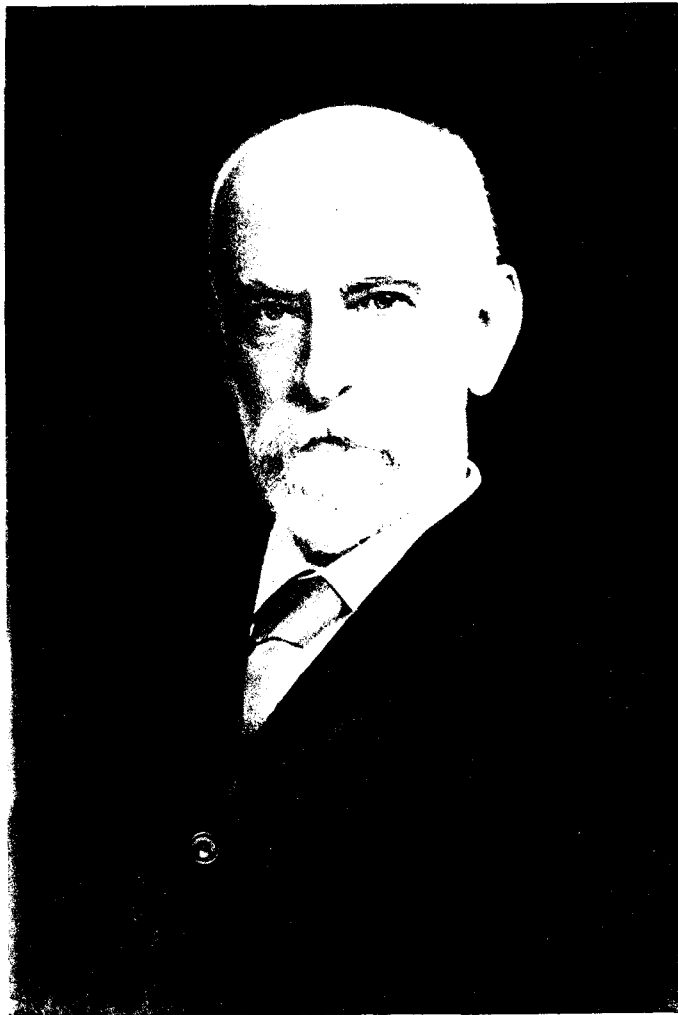
1852-1914

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PRESENTED TO THE ACADEMY AT THE ANNUAL MEETING, 1919

CITY OF WASHINGTON
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To get a true grasp of the character and ability of this man and to appreciate the attainments of this indefatigable worker, one may read the many encomiums and memorial addresses by eminent anatomists and educators, or read his published contributions to science, of which there are a great number. In an address before the American Association of Anatomists, Dr. Frederic T. Lewis declared that Dr. Minot was "by common consent the leading American anatomist." Dr. Lewis, in this address, gives a brief review of his genealogy. On both sides he finds talented men and women, distinguished for their scholarship, occupying high places in public service.

Dr. Minot represented the fifth generation from Jonathan Edwards, whom the historian Fiske regarded as "one of the wonders of the world, probably, the greatest intelligence that the western world has yet seen." If one compares the portrait of Dr. Minot with that of Jonathan Edwards, certain resemblances are recognized. "Holmes describes Edwards as possessing a high forehead, a calm, steady eye, and a small, rather prim, mouth; no reference is made to the rather long, well-modeled nose, which is much like that of his descendant; . . . but whether or not this facial resemblance is objective, these two relatives are alike in possessing the inquiring, analytical mind of the naturalist."

Rev. Theodore Dwight Woolsey, past president of Yale University, read an address on Jonathan Edwards at the 200th anniversary of Edwards' birth, and says of him: "His intense devotion to theological problems on such questions as The Nature of Virtue, The End for which God Created the World, Original Sin, etc., suggests the devotion of Dr. Minot to problems in some respects of a like nature, such as Is Man the Highest Animal? Death and Individuality,

Researches on Growth and Death, Organization and Death.” Dr. Woolsey termed Edwards’ essays as scientific theology. Dr. Lewis says Dr. Minot’s early papers on insects may be compared with Edwards’ remarkable paper on Balloon Spiders, believed to have been written when he was not more than twelve years old. He gives a brief extract of this paper, which is rigidly correct, and says: “These beautifully accurate observations and experiments, recorded with sketches, amply justified Dr. Packard’s opinion that in another age and under other training Edwards might have been a naturalist of a high order.”

Dr. Minot’s father owned a large estate in West Roxbury. For four miles toward Dedham the woods were almost continuous and hardly a house was seen. His father says, “My children’s love of nature was developed by their mother’s tastes.” Henry, who was younger than Charles, did not care to shoot or collect birds, but he studied them with great avidity, and at seventeen had completed his well-known book, entitled “Land Birds and Game Birds of New England.”

Dr. Councilman, in his memoir of Dr. Minot, describing the region he roamed over, forest and dale, much of it included in the Metropolitan Park system, says: “In such surroundings the boy grew up and early acquired the love of nature, the capacity of seeing, and the scientific curiosity to find out the meaning of things he saw, which distinguished the life of the man. He was a member of a large and well-known family, with inherited wealth and distinguished in useful service.” Dr. John Bremer’s memoir in the *Harvard Graduates’ Magazine* says his scientific attainments were fittingly acknowledged by honorary degrees at home and abroad and by the presidency of several scientific societies. Perhaps his crowning pleasure was when he was chosen as the exchange professor from Harvard to the University of Berlin.

Dr. Councilman says “He was in all respects an admirable teacher; as a lecturer, simple and clear, often enlivening his subjects by shafts of clean humor, and in the laboratory stimulating, always insisting that the students should cultivate the faculties of independent observation and judgment.

His laboratory was always orderly, giving one entering it the impression given by a well-ordered household."

Mr. Bremer says: "It was Dr. Minot's firm conviction that every hard worker, but especially every scientific investigator, should have a most engrossing hobby to supply a forcible restraint to his brain activity. His own hobby was his garden at Readville, where he turned his attention to growing rare varieties of peonies with great success. It was his delight to invite his neighbors on a certain day in spring to see with him the result of his care and skill."

Though we had been friends for nearly fifty years, I shall always remember my first meeting him. He introduced the subject of brachiopods by some inquiry and in our conversation expressed the conviction that I was right in my contention regarding the annelidian affinities of these creatures. He seemed so sure in offering these opinions and appeared so young that I was led to question him about the subject and found that he had a comprehensive view of the anatomy and embryology of the mollusks and annelids and appreciated the homologies I had made. It was very agreeable to me, for my views had been stubbornly condemned by malacologists.

At our Naturalists' Club dinners he was always bright and witty, with good stories, though preserving a self-respecting attitude. His story of a feline encounter rendered into English was inimitable. In addressing meetings as presiding officer or in communicating scientific papers, his attitude was one of seriousness and dignity. His words were carefully selected and one realized how keenly his mind was concentrated on the subject. He held his head fixed, though his eyes would glance aside at times. He was always courteous in his manner, though often absorbed in thought. His walk was alert and in a straight line; his attitude was always that of a thoughtful student.

Always a great reader, he began September first, 1870, at the age of eighteen, to record the titles of books read by him in monthly periods. These books were by the best authorities in literature, science, art and romance, classical and modern. This record ceased for a time in September,

1883, with 348 titles, many of these representing two and three volumes. It is an interesting fact that when he began the reading of German books their titles were always recorded in German script. He began a new list in February, 1885, and ended in June, 1891, with a record of 145 titles. His first three books recorded were "Das Abentener des Neujahrsnach," by Zschokke; "William Tell," by Schiller, and "The Luck of Roaring Camp," by Bret Harte. His last three books recorded in June, 1891, were "Histoire de Charles XII," by Voltaire; "Twenty Years After," by Alexander Dumas, and "Portraits Littéraires," three volumes, by Ste. Beuve.

His first communication, published when he was sixteen years old, was his discovery that a butterfly, *Chrysophanus americana*, had three broods, the first one appearing early in May and the third the last of August. The insects of the first brood differ from those of the other two in wanting the row of red spots on the under side of the secondaries. His second paper, published in 1869, was upon the discovery of the male, never before seen, of a certain species of butterfly. In this paper he adds that from an examination of twenty specimens of *Hesperia* regarded as two distinct species he was convinced that they belonged to the same species. Within five months he described three new species of Geometridæ.

His notes on the flight of New England butterflies are interesting as showing his keenness of observation. He actually classifies them by their flight, making three main divisions: in one the flight was sweeping, long sailing; in another, not sailing and shorter than the first group, more or less undulating. In a third group the flight was jerky, generally short. Then he detects certain groups when disturbed return after a short interval to the same spot.

In his Lowell lectures on the "Problem of Life, Growth, and Death," afterwards published in six consecutive numbers of the *Popular Science Monthly*, one derives many items of interest outside the orderly development of the subject. Thus, in the briefest and clearest manner, though somewhat satirical at times, we have a sketch of the various ideas held regarding life units, beginning with Darwin's theory of pan-

genesis, which is the only one, Minot says, that seems to him "intellectually entirely respectable." With Darwin's gemmules we have in turn a rapid survey of the physiological units of Herbert Spencer, Haeckel's Plastidules, to which, he says, Haeckel gave the charming alliterative title of "perigenesis of the plastidules," and adds: "The rhythm of it must appeal to you all, though the hypothesis had better be forgotten." So in turn is given Nageli's *Idioplasmata-Theilchen*; Weisner's Plasomes; Whitman's idiosomes, Haacke's gemmules; Allmann's granuli; Nussbaum's theory of geminal continuity, which Weismann elaborated into the smallest of life units, a group of these being determinants, which grouped together formed ids, and these in turn formed idants. Minot says, with sly humor, "If you want to accept any theory of life units, I advise you to accept that of Weismann, for it offers a large range for the imagination and has a much more formidable number of terms than any other."

Dr. Minot originated a number of technical terms in his papers on anatomy and embryology, and in his presidential address before the American Association of Anatomists he gave in a foot-note a brief list of new terms he has introduced in the address which he modestly recommends for adoption. These are cytogenic glands, cytomorphosis, false glands, lymphæum, mesepatium, phrenic area, and trophoderm.

In his studies Dr. Minot often found himself at variance with other investigators and he criticised fearlessly, even the highest authorities, and his objections were often framed in emphatic words. The exalted reputation of the author in no way modified the emphasis of his criticism. Huxley, Haeckel, Weismann, and others were combatted thus in an address before the New York Pathological Society on the Embryological Basis of Pathology. When Roux advanced the mosaic hypothesis, he said: "It is fortunate for our comprehension of pathological processes that we are already able to say that Roux's theory is erroneous."

Some of his protests bordered on the dogmatic, and from Dr. Lewis's memoirs we quote the following: "In taking leave of psychical research, Dr. Minot published a character-

istic statement which involved him in amusing consequences. He said: "The failure of psychical research should teach us a profound lesson—the lesson that literary training sets limit to the faculties. The leaders of the Psychical Society are literary men." To which Mr. Andrew Lang spicily replied, in an article in the *London News*, entitled "On a certain condescension in scientific men, showing that literary training is not alone in limiting the faculties."

At one time he was interested in psychical research and became a member of the American branch of the English Psychical Society. Some years ago *London Nature* published a series of simple diagrams which were supposed to sustain the theory of thought transference. The experiments consisted in one resting his hand on the head of another person, at the same time concentrating his thought on some simple design. The recipient, with pencil in hand and thought in abeyance, draws a figure on paper. The percentages of similarities were so great in a large number of cases that it was believed that here, at least, were evidences of thought transference. Dr. Minot immediately became interested in the subject and issued five hundred postal cards asking the recipient to draw ten simple figures and return. These were widely distributed, and when these designs were finally tabulated it was found that there was an enormous preponderance of a few figures, such as circles, squares, crosses, etc. From the results of these experiments, embracing five hundred observations, Dr. Minot says: "The general conclusion is unavoidable, that none of the experiments heretofore published afford conclusive evidence of thought transference."

In a report on the prevalence of superstition, Dr. Minot sent out five hundred circulars requesting an answer to four questions relating to—1st, sitting down thirteen at table; 2d, beginning a voyage on Friday; 3d, seeing the new moon over the left shoulder; 4th, occupying a haunted house. The answers were tabulated as to sex, age, etc., and it was found that one in ten men and two in ten women were superstitious.

In all his essays one is impressed with his insistence on the necessity of absolute accuracy in statement. Personal

experiences are agreeably introduced which enliven the pages otherwise intensely technical. The last time he met the Swiss naturalist Kolliker, who, he adds parenthetically, was a leader in microscopical research for sixty-five years, was at the International Congress at Rome, in 1894. He says: "It was most impressive to see all the members of the congress spontaneously rise to their feet when the handsome old man unexpectedly entered the meeting."

His tributes to the memory of Bowditch, Leidy, and others are models of appreciative delineation. The salient characteristics of their lives are defined, the important discoveries are clearly mentioned, and particularly the humanity and gentleness of their characters are described with a loving and sympathetic touch, a reflection of his own sweet nature.

It is a rare event when one finds in biological papers the use of algebraic formulæ; yet, in a paper on "Growth as a function of cells," Dr. Minot uses these formulæ with the freedom of a mathematician. The titles of some of Dr. Minot's communications were somewhat startling.

At the Cincinnati meeting of the American Association for the Advancement of Science, he asked the question in a title, "Is Man the Highest Animal?" and proceeded to show that structurally many mammals surpassed man in complexity of structure. In other words, if an intelligence in Mars should land on the earth and discover the skeletons of man in the forest, applying our categories of classification, he would be forced to place man low down in the mammalian scale, though wondering at the large brain-case. The data that Dr. Minot arrayed in support of his thesis aroused a keen and somewhat bitter discussion, as evolution was considered at that time a heresy.

Louis Agassiz always urged his special students never to work up a subject without abundant material for study, and, above all, to find out what other investigators had done on the subject before publishing. A reference to Dr. Minot's publications indicates that he followed implicitly this dictum of Agassiz. The frequent references, quotations, and foot-notes show how intimately he had mastered the literature of

the subject. He must have been a great reader of scientific memoirs, judging from the numerous citations in his works, and one marvels how he found the time to read the general works of Lecky, Carlyle, Huxley, Darwin, Tyndall, Lubbock, Tylor, and others as well as the works of the principal novelists.

Mrs. Minot told me that Dr. Minot not only read at night, but attending the symphony concerts, he always had a book with him, and at pauses, or at the performing of a work he was not interested in, he would open the book. He was always frank at admitting his incompetence or unfamiliarity with the subject upon which he was writing. Thus, in his article on the "Study of Zoölogy in Germany," after giving an interesting description of German methods, he says: "There are, of course, grave defects connected with the system, but these the author cannot enter into, not being qualified."

In his memoirs on "Senescence and Regeneration," in the *Journal of Physiology*, Vol. XII, No. 2, abounding in plates, tables, and curves, Dr. Minot selected the growth of guinea-pigs for statistical study. "Various considerations led to the selection of this animal. It bears confinement well, is robust and but little liable to disease, breeds readily, is easily managed and fed, and gentle when handled. Its maintenance is much less costly than a larger animal—an important consideration, as one hundred were kept for several years." (The investigation was abruptly brought to an end by the ravages of a dog, who got entrance to their bins and killed 96 in one night.) In a foot-note he adds that "during one winter they consumed upward of 18 barrels of carrots, three tons of hay, 26 bushels of oats and some other food." Illustrating his kindness of heart, he says, "Guinea-pigs are so unintelligent that I have been unable to feel any interest except scientific in them, which has also perhaps been advantageous."*

*I can appreciate his feelings, for many years ago I was interested in the development of the auricular bones of the cat, and secured several litters of kittens to experiment upon. I sacrificed a kitten every week, and on the fourth week I had become so fond of them that it was difficult to make a selection, and they were trooping through the house like cavalry, and finally had to be disposed of in one fell swoop.

In his vice-president's address before the American Association for the Advancement of Science (Indianapolis meeting, p. 271), "On Certain Phenomena of Growing Old," he calls attention to the law of variation in the physical world, and as an illustration collects in a given area a large number of pebbles on a beach and, measuring each pebble, gives the mathematical curve alike on both sides, each beach varying, of course, yet the curve being of the same nature, and this holds good in all; and he says: "All physical variations which are produced by the common action of a large and varying number of causes existing in an infinite number of degrees presents this same peculiarity in the distribution of the variations." Then he gives curves representing the age of students entering Harvard during a period of twenty years. By studying the changes in cell-growth he shows that with increasing age the cell increases its protoplasmic contents. Seventeen years after this address he gave a course of six Lowell lectures on the subject. At the same meeting (p. 341) he presented a paper on the morphology of the blood corpuscles, showing that they arose from cells.

In his presidential address before the American Society of Naturalists (*Popular Science Monthly*, May, 1895) he discourses on "The Work of the Naturalists of the World" and emphasizes the dignity and importance of the naturalist's work. In this address aphorisms abound, as in many of his writings. A most interesting and valuable collection could be made which would form a volume by itself. Here are a few from this address: "Some persons advocate restriction of the right to vote, but to me restriction of the right to be a candidate offers a practical solution of the problem." "We do not admit that scientific work requires a peculiar mind, but only the cultivation of those fundamental faculties of observation and induction which every one should possess and use." "We are handicapped by the college tradition of four years' education to fit a man for anything in general and nothing in particular."

In his experiences as a student and teacher he associated with men of the highest distinction. At the Massachusetts

Institute of Technology, from which he was graduated the youngest member of his class, he came under the influence of the late Edward C. Pickering, the distinguished astronomer, who at that time was professor of physics. He worked for a time with Louis Agassiz at Cambridge, and later at Agassiz's summer school at Penekese. He had the unrivaled privilege of associating with Henry P. Bowditch in his physiological laboratory at Harvard. "Dr. Minot enjoyed Dr. Bowditch's sympathy, interest, and appreciation, to which he responded with life-long respect and admiration. They published a joint paper in 1874."

Abroad he worked in Carl Ludwig's laboratory. In later years he referred to Professor Ludwig as the greatest teacher of the art of scientific research that he had ever known. He studied at Leipzig in the laboratory of the distinguished Rudolph Leuckart, the founder of the modern classification of animals. He then went to Paris, in the spring of 1875, and pursued his work under Prof. Leon Ranvier. After three years' work with these great men, he returned home. At Seal Harbor he enjoyed long walks with Dr. Charles W. Eliot, an education by itself. With Professor Sargent, in similar jaunts, he doubtless discussed the question of athletic training.

In 1883 he was appointed instructor in histology and embryology in the Harvard Medical School. He was later promoted to full professorship, when was published his renowned work upon "Human Embryology." This remarkable work was published by William Wood & Company in 1892. A German edition appeared in 1894. It was dedicated to Carl Ludwig, professor of physiology at the University of Leipzig. The work consisted of 815 pages, illustrated by 463 figures, many of the most intricate character and mostly from his own preparations. Of this work Dr. His, the leading anatomist of Germany, expresses the opinion that "Minot's work at present is the fullest embryology of man which we possess, and it will retain its value as a bibliographical treasure-house even after its contents in any parts have been superseded."

Recently the request has been made for permission to publish a Chinese translation of certain portions of it.

In the short preface of this *magnum opus* he says: "In making my compilation I have drawn constantly from the embryological manuals of Kolliker, Oskar Hertwig, Balfour, and Duval; from the researches of W. His, and from the writings, especially the "Entwicklungsgeschichte der Unke," of Alexander Goette. His modesty is shown in the preface by saying: "The reader will find, nevertheless, imperfections of which I am conscious, and perhaps errors for which I must be responsible. There is probably not a page which might not be corrected with facts already recorded by investigators; certainly not a page which would not be improved by further revision."

While connected with the Harvard Medical School he published a paper in the *Harvard Graduates' Magazine* entitled "On Unsymmetrical Organization," in which he tabulated the appropriations made to the different departments of Harvard University and showed that while one-fifth of the student body was medical, only one-eighteenth of the appropriations went to the Medical School.

Dr. Minot's "Government Report on the Cotton Worm," in conjunction with Edward Burgess, and his "Government Report on the Locust and Cricket," illustrated by a number of plates, indicate his great ability as a draftsman.

The *Philadelphia Medical Journal* published a contribution of Dr. Minot on the unit system of laboratory construction in which he points out the advantages of a unit system of rooms, tables, lighting and all the appliances for study and research.

In *The Microscope* for 1888 he published a paper entitled "The Mounting of Serial Sections," in which he describes his experiences in the difficult technique of staining, cutting, and mounting ribbons of sections for microscopical work. He invented a new form of microtome which was manufactured and extensively used. His mechanical ability aided him greatly in his delicate work with the microscope.

The great collection of sections of vertebrate embryos and tissues in the Harvard Medical School is almost encyclopedic in character and an illustration of Dr. Minot's nicety and precision which marked all his endeavors. The collection consists of thousands of vertebrate embryos, mostly those of man, cut in three different sections—longitudinal, transverse, and frontal—and classified and numbered with the minutest accuracy, and forms a lasting monument to his untiring patience and skill. The cases in which the slides are arranged, methods of numbering, cataloging, and other details were all devised by Dr. Minot. Superadded to his attainments in science, Dr. Minot's accomplishments were varied in other directions. He showed great skill as a draftsman, and his anatomical drawings made under the microscope were clear and accurate. He was also talented as a water-color artist, and some of his landscapes might be mistaken for those of a professional. His skill in establishing new varieties of peonies was marked, and he won the highest prizes from the Massachusetts Horticultural Society year after year.

That his achievements were promptly recognized is attested by the many honorary degrees he received from home and foreign universities. From Yale he received the degree of Doctor of Laws, in 1899; from Oxford, Doctor of Science, in 1902; from Toronto University, Doctor of Laws, in 1904, and from St. Andrews, Doctor of Laws, in 1911.

Dr. Lewis, in his memoir of Dr. Minot, says: "In his exchange professorship with Germany, in 1912-13, he represented not only Harvard University, but the anatomists of America, and he took no less pleasure in presenting the work of his colleagues than in describing his own researches." In this exchange he lectured at the universities of Berlin and Jena.

On June 1, 1889, Dr. Minot was married to Miss Lucy Fossdick, of Groton, Massachusetts. Refined and cultivated, she formed a fitting companion for this busy naturalist. She keenly appreciated the varied works of her husband and aided him in many ways. At her summer residence in Readville she has kept up the wonderful garden of peonies which Dr.

Minot started, and friends and neighbors are freely invited to enjoy its beauties.

In the preparation of this brief memoir I am indebted to Mrs. Minot, who placed in my hands a complete collection of her husband's writings. I have also been aided by the memoirs of Dr. Minot, by Dr. Frederic T. Lewis, *Boston Medical and Surgical Journal*, Vol. CLXXI, p. 911, and the *Anatomical Record*, Vol. 10, No. 3; Prof. Henry H. Donaldson, *Proceedings of the Boston Society of Natural History*, Vol. 35, No. 2, and *Science*, N. S., Vol. XL, p. 926; Dr. Charles W. Eliot, *Proceedings of the Boston Society of Natural History*, Vol. 35, No. 2; Dr. W. T. Councilman, *Proceedings of the American Academy of Arts and Sciences*, Vol. 53, No. 10, and Dr. J. L. Bremer, the *Harvard Graduates' Magazine*, Vol. XXIII, No. XCI.

A glance at Dr. Minot's extensive bibliography, compiled by Dr. Frederic T. Lewis, shows the depth and dignity of many of his titles. The range of subjects dealt with in his various memoirs, presidential addresses, and communications include anatomy, physiology, zoölogy, histology, pathology, embryology, morphology, psychology, toxonomy, and microscopical technique, besides articles on general subjects, and his crowning work, "Human Embryology."

Dr. Frederic T. Lewis, in his address on Dr. Minot before the American Association of Anatomists, gives a very full bibliography of Dr. Minot, and this I have used. Dr. Lewis has sent me four additional titles and I have added a note from the *Proceedings of the Boston Society of Natural History*, which carries the record back to 1868.

A CHRONOLOGICAL LIST OF PROFESSOR MINOT'S
PUBLICATIONS

- 1868 Note of three broods of *Chrysophanus americanus*. Proc. Boston Soc. Nat. Hist., vol. 12, p. 98.
- 1869 Description of the male of *Hesperia metea*, Scudder. Proc. Boston Soc. Nat. Hist., vol. 12, pp. 319-320.
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- 1870 Notes on the flight of N. E. butterflies. Proc. Boston Soc. Nat. Hist., vol. 14, pp. 55-56.
- 1872 Notes on *Limochores bimacula*, Scudder. Canadian Entomologist, vol. 4, p. 150.
- 1874 The influence of anæsthetics on the vaso-motor centers. (With Henry P. Bowditch.) Boston Med. and Surg. Journ., vol. 90, pp. 493-498. 4 plates.
- 1876 Recherches histologiques sur les trachés de l'*Hydrophilus piceus*. Arch. de Physiol. norm. et path., 2e série, T. 3, pp. 1-10. Pl. vi-vii.
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- 1878 Experiments on tetanus. *Journ. Anat. and Phys.*, vol. 12, pp. 297-339. Pl. iii-vi.
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- 1879 Growth as a function of cells. *Proc. Boston Soc. Nat. Hist.*, vol. 20, pp. 190-201.
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 On the conditions to be filled by a theory of life. (Abstract.) *Proc. Amer. Assoc. Adv. Sci.*, vol. 28 (1880), pp. 411-415.
- 1880 A sketch of comparative embryology. I. History of the genoblasts and the theory of sex. II. The fertilization of the ovum. III. Segmentation and the formation of the gastrula. IV. The embryology of sponges. V. The general principles of development. *Amer. Naturalist*, vol. 13, pp. 96-108; 242-249; 479-485; 871-880.
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- 1881 A grave defect in our medical education. *Boston Med. and Surg. Journ.*, vol. 105, pp. 565-567.
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