man in our generation and in our country has given a better example of that true simplicity and sincerity which are the distinguishing characteristics of the highest type of the scientific life. Those of us who worked with him as students, as assistants, as colleagues, revere his memory not less for the simplicity and sincerity of his personal life than for the work he wrought for astronomy. His career is an illustration of the possibilities open to an American boy, and his life has shed luster upon his country and upon his science.

Henry S. Pritchett

December 2, 1907

THE LIFE AND WORK OF JOSEPH LEIDY[1]

The statue just unveiled, of the late Joseph Leidy, reveals a most admirable portraiture of the greatest naturalist that this country, perhaps that any country, ever produced; for but few equalled, and none ever surpassed, Joseph Leidy in the exactness, variety and the comprehensiveness of his knowledge of natural history. Joseph Leidy, of French-German extraction, was born in this city, September 9, 1823, and died here, April 30, 1891. His whole life may be said to have been devoted to the study of natural history and was as simple, pure and noble as the objects of his lifelong study. Regarding with the spirit of a philosopher the petty incidents and annoyances that go to make up one's daily life, as only unavoidable interruptions to his life work, Leidy pursued the even tenor of his way. Happy in his domestic life, enjoying the society of his friends, generous and charitable, kindly and sympathetic to those with whom he came in daily contact, straightforward and honorable, incapable of deceit or of a mean or ungenerous thought or act, he lived his life beloved by all, and passed away without having made an enemy during his long career. Such having been the life of our distinguished fellow citizen, his eulogist, as might be expected, will have no incidents to relate such as the lives of great generals, statesmen, men of affairs afford. Nevertheless, when perhaps the latter are forgotten, the name and reputation of Joseph Leidy will be preserved in the many and valuable contributions he made to our knowledge of natural history. Well might he have said like Horace "Exegi monumentum aere perennius." Leidy's early education was obtained at private schools. He studied medicine at the University of Pennsylvania, graduating as doctor of medicine in 1844. He at once began the practise of his profession to which he devoted himself for about two years. For some time Dr. Leidy experienced that struggle with hardships and obstacles incidental to the lives of so many young physicians, but it was happily relieved by his election in 1853, at thirty years of age, as professor of anatomy in the University of Pennsylvania. This position he held with the most distinguished success till his death, a period of nearly forty years. While Dr. Leidy was universally recognized as the leading teacher of human anatomy in this country, his text-book being long a classic, he himself viewed anatomy not simply as a means to an end, of practical value to the practitioner of medicine and surgery, but as constituting only a part of the general subject of morphology; that is, of the general structure of plants and animals. As an illustration of the manner in which Leidy studied the human body may be mentioned his treatise on the "Comparative Anatomy of the Liver" which work can still be studied with advantage by the medical student. With the means of a livelihood assured through his professorship at the university,

[1] Address delivered at the unveiling of the Leidy statue, October 30, 1907, City Hall Plaza, Philadelphia.

and leisure to investigate, Dr. Leidy began that series of brilliant researches which made him, during a period of forty years, the most conspicuous ornament of the university and Academy of Natural Sciences, and that at a time when Cope, Meehan, Redfield, Cassin, LeConte, Horn, Tryon and Allen were among the active members at the regular Tuesday meetings of the academy—a galaxy of talent truly. Leidy's researches, communicated principally to the academy, and published in its *Journal* and *Proceedings,* embracing all branches of natural history and numbering over 550 contributions to our knowledge of nature, attracted the attention of this country, Europe and indeed of the whole world. Dr. Leidy's familiarity with all natural objects invariably impressed those brought in contact with him. If some minute infusorian was shown under the microscope, one would have supposed from his observation that he had devoted his life to the study of the Protozoa. A worm being submitted to him for identification his description of its structure would lead to the inference that his specialty was helminthology. One had only to see Dr. Leidy dissect a fly or a snail no bigger than a pin's head to realize that he was an admirable comparative anatomist. His drawings of the structure of insects and mollusks are made use of even at the present day by recent authorities to illustrate their text-books on entomology and conchology. While Dr. Leidy made no claim to being an authority on mineralogy, mineralogists consulted him in connection with their specialty, prominent jewelers in regard to the value of diamonds and other gems. As an illustration of the accuracy of his knowledge in this respect, it may be mentioned that on one occasion, when visiting the Centennial, Dr. Leidy recognized in one of the exhibits a mineral labeled beryl as being really topaz, and of great value. On careful examination by experts it was shown to be topaz and subsequently the specimen was sold for many thousand dollars. The speaker can testify as to his knowledge of botany, having accompanied him on a trip through the Rocky Mountains in company with one of the most critical of botanists, who was amazed at Dr. Leidy's familiarity with the western flora. He rarely if ever was at fault; if, however, he failed to identify a species correctly, with his characteristic honesty he was the first to acknowledge it. Of the innumerable streams and ponds in the neighborhood of Philadelphia visited in company with Dr. Leidy with the object of obtaining infusoria, etc., the speaker can not recall a single instance in which Dr. Leidy did not at once recognize the objects when viewed afterwards under the microscope. His work on the Rhizopoda is a monument to his skill as a microscopist. Some years ago the theory was advanced that catarrh and hay fever were produced by an infusorian animalcule, the *Asthmatos ciliaris.* Dr. Leidy having been requested to express an opinion in regard to the nature of the supposed infusorian at once recognized through his familiarity with this class of animals that the so-called infusorian animalculæ supposed to be the cause of disease were only "incomplete, deformed ciliated epithelial cells. It never crossed my mind that they were anything else than ciliated epithelial cells more or less modified by the condition of the catarrhal affection."[2] Leidy's discovery of the *Trichina* in the pig, explaining how man comes to be infested with that parasite and whereby thousands of lives have been saved, would alone have entitled him to recognition as one of the foremost helminthologists of the day—and which indeed he was considered. As is well known, Leidy was the pioneer in American paleontology.

[2] *American Journal of Medical Sciences,* 1879, p. 86.

Long before it was learned that the bad lands of Nebraska and other parts of the west constituted a veritable mausoleum of mammalian and other vertebrate remains, a fragment of a tooth was submitted to Leidy for examination, who without a moment's hesitation said it was part of a molar of an extinct kind of rhinoceros. The correctness of this determination was questioned when the tooth was brought to the academy, it being almost incredible that a rhinoceros could ever have lived in Nebraska, and further, the academy did not possess at that time the skeleton of a rhinoceros with which to compare the tooth in question. The correctness of Dr. Leidy's opinion was, however, fully sustained soon afterwards by the discovery of several entire molars with a complete skull of the animal. Dr. Leidy told the speaker that the remaining part of the tooth of which he had examined the fragment was found in situ in the skull, and that the broken fragment adapted itself perfectly to it. With the revealing of the extinct life of the west Dr. Leidy, whose almost inexhaustive knowledge of the vertebrate skeleton qualified him, and at that time him alone, to interpret fossil remains, began at the academy that series of epoch-making researches which, in his hands and those of his successors, established on paleontological evidence the doctrine of evolution so that no one competent to appreciate that evidence has since ever doubted its truth. Indeed, considering the circumstances, the few skeletons to be found in museums in this country at that time with which the remains of extinct animals could be compared, Leidy's determination of the tooth just referred to as being that of an extinct rhinoceros was as remarkable and as replete with results as Cuvier's identification of the bones found in the quarries of Mont Martre as being those of an extinct opossum. Indeed as far back as 1853—five years before the appearance of Darwin's "Origin of Species"—Dr. Leidy observed:

> The study of the earth's crust teaches us that very many species of plants and animals became extinct at successive periods, while other races originated to occupy their places. This probably was the result in many cases of a change in exterior conditions incompatible with the life of certain species and favorable to the primitive production of others. Living beings did not exist upon earth prior to their indispensable conditions of action, but wherever these have been brought into operation concomitantly the former originated. Of the life present everywhere with its indispensable conditions and coeval in its origin with them what was the immediate cause? It could not have existed upon earth prior to its essential conditions and is it therefore the result of these? There appear to be but trifling steps from the oscillating particle of organic matter to a Bacterium; from this to a Vibrio; thence to a Monas, and so gradually up to the highest orders of life. The most ancient rocks containing remains of living beings indicate the contemporaneous existence of the more complete as well as the simplest of organic forms; but nevertheless life may have been ushered upon earth through oceans of the lowest types long previously to the deposit of the oldest paleozoic rocks as known to us.

Where, may it be asked, can there be found in the whole range of biological literature a more concise statement in regard to the origin of life, the extinction of species, the survival of the fittest—in a word, of Darwinism?[3] Again, in regard to the descent of man, Leidy suggested:[4]

> That but little change would be necessary to evolve from the jaw and teeth of *Notharctus* that of a modern monkey. That same condition that would lead to the suppression of a first premolar in continuance would reduce the fangs of the other premolars to a single one. This change with a concomitant shortening and increase of depth of the jaw would give the character of a living Cebus. A further reduction of a single premolar would give rise to the condition of the jaw in the old world apes and man.

As a fitting recognition of Dr. Leidy's

[3] Smithsonian Contributions, 1853.

[4] "Extinct Vertebrate Fauna," 1873, p. 90.

services to the Academy of Natural Sciences he was unanimously elected its president in 1881, he having served the institution as chairman of the board of curators continuously for forty years. Both positions he held at the time of his death. That the value of Dr. Leidy's contributions to science have not been over-estimated by his personal friends and admirers is shown by the honors conferred on him by the learned institutions both at home and abroad, and by the marked courtesy and attention paid to him by the most distinguished savants on the occasion of his visits abroad. Among the honors conferred upon Dr. Leidy may be mentioned the LL.D. of Harvard, the medals of the Royal Microscopical and Geological Societies of London, the Cuvier medal of the Academy of Sciences of Paris, membership in all the most important learned societies in this country and in those of England, France, Germany, Russia, Italy, Norway, Sweden, Hungary, Denmark, Spain, Portugal and Brazil. Surely it was a fitting tribute to one so honored at home and abroad as Joseph Leidy that his personality should be embodied in enduring stone in his native city, even though his works were an imperishable monument to his memory.

HENRY C. CHAPMAN
JEFFERSON MEDICAL COLLEGE

THE ARC AND THE SPARK IN RADIO-TELEGRAPHY[1]

THE discovery by Heinrich Hertz between 1887 and 1889 of experimental means for the production of electric waves and Branley's discovery that the conductivity of metallic particles is affected by electric waves form the foundation on which, in 1896, Signor Marconi built up his system of wireless telegraphy.

[1] Evening discourse before the British Association for the Advancement of Science, Leicester, 1907.

Many of the early investigators certainly had glimpses of a future system of being able to transmit messages without connecting wires, for as early as 1892 Sir William Crookes predicted in the *Fortnightly Review* the possibility of telegraphy without wires, posts, cables, or any of our costly appliances, and said, granting a few reasonable postulates, the whole thing comes well within the realms of possible fulfilment.

Two years later Sir Oliver Lodge gave his memorable lecture on the work of Hertz, and carried the matter a step nearer the practical stage.

There will not be time to dwell to-night on the early history of the art and its development. It will be necessary, however, to explain some of the fundamental properties of signaling by means of Hertzian waves in order to be able to bring out clearly the relative advantages and disadvantages of the two rival methods now in practical use for producing Hertzian waves for wireless telegraphy.

The fundamental part of the transmitting apparatus may be said to consist of a long conductor, generally placed vertically, in which an alternating or oscillating current is set up by some suitable means. Such a conductor radiates energy in the form of Hertzian waves at right angles to itself into space, in very much the same way that an ordinary candle sends out light in all directions. This radiation, though it is strictly in the nature of light, is invisible to our eyes, as the frequency is too low.

If we set up any other conductor approximately parallel to the first, there will be produced in this second conductor alternating or oscillating currents having the same frequency as those in the first conductor, and which can be detected by suitable instruments.

The simplest and one of the earliest