new courses. It is safe to say that while he must already be regarded as the most eminent meteorologist of our country, the true measure of his eminence will be better recognized when those who follow the science that he enlarged come to appreciate more fully what he did for it.

W. M. D.

PROFESSOR JOSEPH LEIDY: HIS LABORS IN THE FIELD OF VERTEBRATE ANATOMY.[1]

WE hear it said that at no time have the conditions for intellectual attainment been so favorable as in the days of Athenian supremacy. This may be true for communities, but not for individuals. Surely the atmosphere of Philadelphia from 1823 to 1891 favored greatness in science, else there is no connection between the man and his environment. Is it not a truth that it only needs the man to come forward to claim favoring conditions, to insist upon them as his own, to have another like Joseph Leidy to be bred among us? A man to whom questions of birth and of patronage were as nothing; one with a common school education and without the subsequent advantages of training under distinguished masters; one to whom all things required for his well-being appeared to come like the beneficent forces of nature until we are apt to lose sight of the will and of the steadfast purpose that directed them. He was never

"limited and vexed
By a divided and delusive aim,"

but, fixed and invariable in his methods, he completed a unique career.

He dedicated himself early to anatomy, and it is about this science as a central stem that all his labors cluster.

Signs of immaturity are evident in the early labors of most men. But this was not the case with Leidy. His first paper, entitled, "Notes on the White Pond in New Jersey" (Proc. Phil. Acad. Nat. Sci., 1847) exhibited the same clear observation and lucidity of statement which characterize his subsequent writings. The earliest of his anatomical papers ("On the Fossil Horse of America," Proc. Phil. Acad. Nat. Sci., 1847, 262) was in no respect inferior to any of his numerous records in the literature of paleontology of North America. The word growth used in respect to him is inappropriate. In the best sense of the word he never grew. Rather, like Bichat, he simply unfolded the native resources which lay innate within him.

For his graduating thesis in medicine he treated of the eye in vertebrate animals. This essay has not been published. In his twenty-second year, namely, July 29, 1845, he was elected a member of the academy, and from this date to that of his election to the chair of anatomy in the University of Pennsylvania, eight years later, his communications were in the main devoted to the structure and properties of the vertebrates. In this interval his industry was great, for he was actively engaged at the same time in teaching, and in assisting Professor W. E. Hoone in his anatomical work, and Professor George B. Wood in dissecting and mounting pathological specimens. He described the retention of the intermaxillary suture in the skull of a New Hollander (Proc. Phil. Acad. Nat. Sci., 1847), also one on the same bodies in the boa constrictor resembling the Pacinian corpuscles (Proc. Phil. Acad. Nat. Sci., 1848, 27). He wrote a paper on the existence of the intermaxillary bone in the embryo of the human subject of the tenth week (Proc. Phil. Acad. Nat. Sci., 1848, 45).

[1] Read at a special meeting of the Philadelphia Academy of Natural Sciences, May 5, 1891, by Harrison Allen, M.D.

Remarkable instances of preservation of organized animal matter were reported by him in 1847 (Proc. Phil. Acad. Nat. Sci., 313) on the films and cartilaginous structures in the extinct genera *Basilosaurus* and *Megalonyx*, the former a reptile of the eocene and the latter a mammal of the pliocene age. The vertebræ of *Basilosaurus* retained tissue which when burnt gave out animal odor. Fibrous membranes taken from one of the bones of *Megalonyx* exhibited many of the characteristics of recent membrane; in the articular cartilages the corpuscles were well preserved and distinct. It was held that under favoring conditions the cartilaginous and fibrous tissue might be preserved for an indefinite period.

In 1848 (Proc. Phil. Acad. Sci., 116) Dr. Leidy read remarks on the development of the Purkinjean corpuscles in bone; on the intimate structure of articular cartilage, and on the arrangement of aveolar sheath of muscular fascicute and its relation to tendon.

Cartilage was found to possess numbers of fine, transparent filaments, nearly uniform in thickness, having an average measurement of $\frac{1}{25000}$ of an inch. Hunter had claimed this fibrilation, but without the aid of the microscope it cannot be demonstrated. This cannot be said to be a prior claim. Professor George A. Piersol has kindly informed me that Dr. Leidy was the first to make the announcement of a fact now accepted. Kolliker was inclined to regard the appearance as pathological. The fibrillar nature of the matrix of all dense connective tissue, including cartilage and bone, is now universally recognized. The comments upon the arrangement of the aveolar sheath of muscular fascicute were to the effect that "the filaments of fibrous tissue cross each other diagonally around the muscular fascicute, forming a double spiral extensive sheath. When the filaments reach the rounded extremities of the fascicute they become straight and in this manner conjoin with the tendinous filaments originating at the extremities of the muscular fibres. The importance of this arrangement can be readily understood, from the diagonally crossing of the aveolar filaments, comparatively inelastic in themselves, the sheath is rendered elastic, thus permitting the muscle fibres freely to move without their action being interfered with."

Dr. Leidy was in the habit of introducing these comments in his lectures when speaking of the function of fibres depending upon their position to each other rather than upon differences in composition.

In 1849 (Am. Journ. of the Med. Sci.) Dr. Leidy announced a plan of the construction of the liver. He assumed that the follicul form of the liver in insects represented the plan of the primitive liver of the human embryo. The subsequent changes which lead up to the complex system of interlacing of tubules with their linings of biliary cells was the result of the blind end of the follicle undergoing subdivision by branching, each of the branches being lined with the cells and the mouths of the now open tubules, freely communicating with each other. This scheme was the most philosophical of any hypothesis previously proposed to account for the intricacy of the minute anatomy of the liver; it was accepted at once by the scientific world, and is itself an answer to the criticism sometimes made upon Dr. Leidy's labors, that they are purely descriptive. The evolution of the system of glands appended to the alimentary canal was distinctly set forth by Leidy in this paper. Since the relations of the liver as a blood-making and an excretory organ have been better defined, other hypotheses than that of Leidy have been proposed to elucidate its morphology.

But the latest expressions on the subject show an evidence of the reindorsement of the original statements.

In 1850 (Proc. Phil. Acad. Nat. Sci., 201) Dr. Leidy performed some experiments upon the transplantation of cancer. Taking several fragments of a cancerous tumor from a human subject he inserted them beneath the skin of living frogs. After an interval of five months had elapsed the frogs were killed and the localities in which the sections had been inserted were examined. In all but one instance they were found to be living and united to the host by vascular attachments. The characteristic cancer cells, however, had in great part disappeared. Dr. Leidy believed that similar experiments on warm-blooded animals might increase the number of viable cancerous elements. The transplantation of tissue from one animal to another was not novel, but the facts of these experiments proved that cancer might be inoculable, — a statement which was novel, and has been disputed since. The observation was in the line of most important research, and the recent experiments embracing the successful transfer of the human hypertrophied thyroid body from the neck to the abdomen of the same individual have been essayed with important practical results. They again demonstrate that Dr. Leidy's mind was not one limited merely to the line of description. At the time of these experiments Dr. Leidy was conducting a course of physiological instructions to medical students. No doubt remains that had he chosen physiology as a branch of research that he would have been signally successful.

In 1852, Dr. Leidy created from the species *Hippopotamus liberiensis*, Morton, a new genus, *Chœrodes*, which was founded upon the skeleton of a young individual. In the *Journal of the Philadelphia Academy* for 1850–54 this form was renamed *Chœropsis*, since *Chœrodes* was found to be previously assigned to a genus of insects. Abundant material of the adult has since been received in Paris and made the basis of an elaborate memoir by Alphonse Milne-Edwards, who has confirmed Leidy's diagnosis in every particular.

Opinions have differed widely as to the nature of dental caries. One set of observers claimed that it was due to vital or general conditions affecting the economy; another insisted that the disease was due to forces acting entirely from without. Since the bacteriological method of research has been introduced into medicine this difference of opinion no longer exists, for all agree that the statement last made is the correct one. Dr. Leidy in 1870 (Proc. Phil. Acad. Nat. Sci., 133) demonstrated in the subject of an old man that a single tooth remaining in the lower jaw was free from caries owing to the fact that it was imbedded in the bone. He thus demonstrated that caries was caused by extraneous conditions, for the disease was controlled by vital states of the individual, it was unreasonable to infer that they would not long before have attacked and destroyed the tooth that had so long remained in the jaw. This fertile suggestion anticipated the discovery of the bacillar origin of dental caries made by one of his pupils, Professor Miller of Berlin, several years afterward. The announcement of a new species of fossil horse and of a new species of Pæbrotherium, in 1847, brought to Dr. Leidy a reputation for acumen in the study of fragments of skeletons, and the study of the treasures of fossil remains in all sections of our country soon controlled his energies. While this work is strictly anatomical, its relations are in the main with geology; it is so vast in quantity that no attempt can be made here to discuss it, even if your speaker were competent to do so. This much can be said in dwelling upon his qualifications as an anatomist, so far as I know, there is but one instance of his having made an error in statement.[1] Attempts to protect from error often go with timidity, if they are not due to it. But in Leidy's case it was not over caution that saved him from error, but too correct primal impressions of the objects he studied. His powers of application were amazing, and the correctness of his conclusions was due to swiftly drawn deductions from the existing premises, and not to surmises or to feats of the imagination. In illustration of his ability may be mentioned his discovery of *Uineatherium*, — this genus he established upon a few fragments. Entire skeletons were afterward discovered, and two observers, independent of one another, endeavored to found distinct genera upon them. But all later writers have claimed that *Uineatherium* was indubitably founded on the fragments described by Leidy.

Exceptional ability in drawing just inferences from imperfect material signalized Leidy's labors in other directions. He delighted in this kind of work, and numbers of short communications were made by him on abnormalities. Among these may be mentioned the note on the dissection of a male hog, showing arrest of development in the organ of generation (Proc. Phil. Acad. Nat. Sci., 1870, 65); on "polydoctylism" in the horse (Proc. Phil. Acad. Nat. Sci., 1871, 112) and an account of a buffalo fish with congenital narrowing of the mouth (Proc. Phil. Acad. Nat. Sci., 1875, 125).

He was the first authority in the country on questions of disputed identifications. On one occasion a number of alleged fossil bones were sent him for examination, which proved to be inorganic concretions. On another a specimen which a zealous physician thought to be a new genus of parasite from the human intestine proved to be the fragment of imperfectly digested orange pulp. On yet another, a number of bones were sent to him by a physician who obtained them from a woman who claimed to have been pregnant. They were shown to be the bones of an embryo hog.

Dr. Leidy's communications on human anatomy have not been numerous, but they all exhibit the same closeness of observation, and cautious yet far-reaching conclusions.

In 1849, Dr. Leidy redescribed and placed on better foundation the thyreo epiglottideum muscle. In 18— he studied the development of the human temporal bone and described for the first time the attic or upper chamber of the middle ear. The term "attic" has come into general use with aurists. He also entered into a critical revision of the component parts of the petrosa, and corrected several errors into which no less authority than Huxley had fallen. His well-known work on human anatomy appeared in 1860. It was prepared especially for the use of his students at the university. The most noteworthy feature in this work was an attempt to anglicize anatomical nomenclature. In the second edition, which appeared in 1889, the same intent to reform nomenclature is apparent. This department of pedagogy, while of English origin, has had its most earnest exponents in America, and Dr. Leidy's labors in the field will hold always an honorable position. In his teaching, Dr. Leidy held to the existence of a vocal membrane in the larynx, rather than a vocal cord. His demonstration of the temporal muscle was original and clearly demonstrated the existence of two layers arising in an undifferentiated mass at the posterior part of the temporal fossa.

[1] He identified a fragment of the mandible of Bathygrathus as belonging to the maxilla. Owen invited his attention to it. Leidy said of this, "It was an egregious blunder, I cannot understand how I could have made it." A frank confession of a venial error.

From a man of Dr. Leidy's industry we may expect to hear of many plans entertained but subsequently abandoned, of many discoveries actually his own with which his name is not associated. At one time he contemplated writing a work on comparative anatomy, but was deterred from so doing when, upon inquiry of the publishers, he learned how small was the demand for writings of this kind. We cannot but regret that he did not entertain the subscription plan for reimbursement. For no one can doubt the fact that his admirers would have eagerly provided the means for publication had his wishes been more generally known. Respecting his unrecorded discoveries no one can speak with authority. On one subject he has himself spoken, namely, that the discovery of the tactile corpuscle on the nerves of the finger is his own. He occasionally referred to this as an instance of the dangers of procrastination in not placing upon record original observations the moment the facts became clearly defined in the mind of the investigator. He also frequently alluded to his having observed the amæboid movement in the white corpuscles. But he interpreted them to be pathological and hesitated in recording his discovery. This he used to say was one of the greatest mistakes of his life. But no discoveries of this kind were possible at the stage of microscope technique which Leidy commanded; were our knowledge of this property of the white blood corpuscle lost to us it would be exceedingly difficult to re-establish it without the use of the warm stage.

Such is a brief epitome of the labors of Joseph Leidy in the anatomy of vertebrates. It is a theme for a volume. But the man is greater than his works. All who knew Dr. Leidy are witnesses to the impression of strength in reserve he at all times made. It can be said of him as has been said of Haller by Francis Horner: "I never rise from an account of such a man without a sort of thrilling palpitation about me which I know not whether I should call admiration, ambition, or despair."

LETTERS TO THE EDITOR.

*** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Work and Energy.

IN many of the standard text-books and treatises on mechanics there is a lack of definiteness in the elementary treatment of the subjects of work and energy that often proves troublesome to the student. To illustrate this, let us place side by side the definitions of work and energy given in the "Syllabus of Elementary Dynamics" prepared by the Association for the Improvement of Geometrical Teaching.

(*a*) When the particle (or point of a body) to which a force is applied moves in the line in which the force acts, the force is said to do work, or to have work done against it, according as the motion is in the sense of the force or in the opposite sense.

(*b*) Energy is a general term for the capability of doing work, which from any cause a mass, or different masses in their relation to one another, may possess.

These definitions are in substantial agreement with those most often given, and are the only explicit statements usually found as to the meaning of work and energy.

A careful reading shows, however, that there is in definition (*b*) an implicit suggestion of something not definitely stated, and concerning which a definite statement is very much needed. According to the definition, energy is possessed by masses (i.e., by bodies); or, in other words, a body may do work. But what is meant by a body doing work? In most text-books the student will search in vain for a definite answer to this question.

Another question is suggested by the definition of work above quoted. It is clearly stated when work is done by a force and when work is done against a force. But in the latter case, what is it that does the work?

These two questions are sure to present themselves to the thoughtful student. If the definition of work were so stated as to furnish explicit answers to them, the acquirement of correct notions would be much facilitated.

A source of confusion slightly different from that above mentioned is found in certain books. Work is defined as if always done by forces; while energy is defined simply as capacity for doing work. The inference might naturally be drawn that energy is possessed by forces. But the student who draws this logical conclusion will be perplexed by finding that, in what follows, energy is always referred to as belonging to bodies instead of forces.

As an improved statement of the fundamental definitions of work and energy, the following may be suggested:

1. A force does work upon the body to which it is applied when the point of application moves (or has a component of motion) in the direction toward which the force acts.

2. A body does work against a force applied to it when the point of application moves (or has a component of motion) in the direction opposite to that toward which the force acts.

3. A body possesses energy when its condition is such that it can do work against applied forces.

Definitions (1) and (3) are not substantially different from definitions commonly given. Definition (2) is usually not given explicitly, though always implied in the development of the theory of energy.

It is quite possible that these definitions may admit of improvement. They must, of course, be accompanied by quantitative statements as to how work and energy are to be computed. But it is believed that the clear development of the subject is much facilitated if explicit definitions similar to these are given at the outset.

No attempt is here made to criticise all the various methods of treating the subject of work. Other forms of definition than the one above considered are found in various books. In most cases, however, they lead to the same difficulty above mentioned.

A treatment practically identical with that here suggested is adopted in McGregor's "Kinematics and Dynamics"—a book possessing many other admirable features—and possibly in other works. It certainly is not adopted by some of the best known English writers.

L. M. HOSKINS.

Madison, Wis., Nov. 9.

AMONG THE PUBLISHERS.

EVER since the announcement made last winter that the author of "Robert Elsmere" had a new novel under way, expectation has been eager to know when it would appear. Mrs. Ward, like George Eliot, has once more taught us that fiction, far from being merely a superficial representation of passing situations and emotions, may grapple with the greatest problems and teach men noble truths. It is with pleasure, therefore, that we publish the fact that Mrs. Ward's new book is to appear very soon from the press of Messrs. Macmillan & Co., New York, and that it is to be called "The History of David Grieve." It is understood that the book will trace the career of a disciple of the Elsmerian doctrines in his work among the poor of London.

—There lives an Indian people on the Carribbean coasts of Nicaragua and parts of Honduras, which is largely mixed with African and Indian elements, foreign to them, on the littoral tracts, but farther inside is of purer race. This people is known to the whites as Moskitos, or as they want to be called, *Misskitos*; their language was but imperfectly studied, probably because the tribes inspired their visitors with contempt on account of their subserviency to English interests. Only the missionaries of the Herrenhut denomination spent time enough for mastering entirely the intricacies of this tropical language, and from their writings,