HERMANN VON HELMHOLTZ.

FOR forty years Helmholtz held the scientific leadership of Europe. One hesitates to assert the preëminence of a man whose modesty was never more apparent than after he had been honored by the scientific societies of the world; but in this instance little doubt exists as to the place of distinction that had been won. Helmholtz did so much, in so many different fields, and so well, that barely now is an idea obtainable of the deep impress he made on these times. His was a versatile genius, hardly less critical than creative. He was mathematician, physicist, physiologist, biologist, mechanician, psychologist, author, professor, experimenter, lecturer, physician, oculist, inventor, all in one — an Admirable Crichton of our specializing day. Old age set no limit to his mental activity, and he who began a grand career of discovery by the microscopic examination of invertebrates and vibriones closed it at seventy-odd studying the movements of the ether, and in friendly touch with the pioneers of psychical research. To run over the record of his successive advances into the realm of unknown nature is to traverse the scientific achievements of the last half-century. In him many old lines of speculation and investigation in natural philosophy met, were swallowed up, or gained redirection. What he did still bettered what was done. We feed to-day on thought and knowledge largely the result of his originality and industry. He sought to plant our feet on everlasting laws, and, amid all the hurlyburly of opposing theories and the crash of traditional systems, wrestled only for the truth. From his masterful German intellect sprang some of those fecund generalizations which, equally with higher concepts in the spiritual world, make all things new. It is possible that, as the years go by, part of what he taught will be swept away, or will form the foundation of a fairer edifice. But he himself would be first to rejoice in a closer fact and a broader horizon. On the contrary, truths of his that we now have no use for, and which lie neglected in his work, may some day come to light again, mammoths embalmed in crystalline ice, to nourish, clothe, and ornament a more advanced race of men. As Agassiz said of Humboldt, so we may say of Helmholtz: "The fertilizing power of a great mind is truly wonderful; but as we travel farther from the source, it is hidden from us by the very abundance and productiveness it has caused."

The unscientific habitude of the epoch when Helmholtz began professional life may be inferred from the fact that although at the end of his studies in the Friedrich-Wilhelm Institute for the education of army surgeons he read a thesis on venal tumors, he had never seen a tumor cut. He was twenty-one years old, and had taken up medicine partly because it was the profession of a well-to-do relative, chiefly because it was a chance to indulge his taste for physics. His father, a teacher of literature in the Potsdam Gymnasium, and his mother, Caroline Penn, of English descent, had surrounded him with influences of refinement, but had little else to give. The "great love of nature" that always possessed him had gone hungry for many boyish years, stayed a bit by such few old school-books on physics as might be happened on in the library of a poor literary professor — as scarce as novels in an Auld Licht manse. Yet to him that fusty lore of phlogiston, treating fire as a distinct element, was more fascinating far than the obligatory Cicero and Vergil. He was not, however, in the slightest degree unscholarly. A relish for the essence of literature marked him through life, and he had a large share of that gift of expression so gracefully exemplified now and again among those who have practised the art of medicine.

Thrown into the Charity Hospital at Berlin as a free patient by an attack of typhus fever, the young student on his recovery drew good out of evil by devoting the enforced savings of this period to the purchase of a cheap microscope. Otherwise he would have had to go without the instrument by means of which he proceeded at once with enthusiasm to the study of the invertebrata and of the processes of putrefaction and fermentation. From this time on, for thirty years, leaving medicine behind, he pursued physiology, while for the last twenty-five years of his life, say from 1868 to 1893, he gave himself up to labors in the domain of physics. Such a division is, of course, arbitrary, and refers rather to special preoccupation than to actual accomplishment. His growth was evolutional. He looked into the conditions of the human organism, into its methods of sustenance, and was led on. The problem of the nature of "vital force" rendered it necessary in one who doubted the presence of that irre-

sponsible, eccentric governor of the bodily functions, to put some underlying agency in its place; and hence, by sequential stages, he reached the great law of the conservation of energy. Dissecting individual members of the body, such as the eye and ear, he must needs acquire a knowledge also of the nature of light and sound. This embarked him upon the study of physics, and it was only natural that a man of his comprehensive capacity should make the next or concurrent expedition into the province of mathematics. He might have stopped short at any point, as many others would have done, and still have been useful and famous. But he felt with Goethe that the finest achievement of a man of thought is "to have fathomed what may be fathomed"—willing "to revere the unfathomable," once convinced that it is beyond his experimental powers or his inductive plummet.

If there is an army surgeon of twenty-six at one of our Indian outposts doing original scientific work in dreary frontier obscurity, the example of Helmholtz may encourage him. The original paper on the "Conservation of Force" was written amid the altogether unfavorable surroundings of grim barracks. Pipeclay and philosophy are not kindly disposed one to the other, and this may be the reason why Helmholtz was notified by "Poggendorff's Annalen" in the usual way, with regret, that the little essay was not suited to its dignified and unventuresome pages. Even in pamphlet form the classic lay unheeded. It is true the Physical Society of Berlin had heard it read; but looking on it more as a flight of fancy than as a summary of what was known, they let its momentous inference slip by. In reality, Helmholtz did not seek so much to convince the physicists as to secure their aid in forcing an obvious truth upon his comrades in medicine and physiology, who still believed in and applied the vitalistic dogmas in utter disregard of the natural forces and sciences. That the body is a converter of energy, like a tree or a steam-engine, and not a thing apart from the rest of creation, a law unto itself, was teaching sorely needed by medical men who thought it bad form to count the pulse with a repeater, and who never measured a patient's temperature.

Graduating theses on the doctrine of the "conservation of energy" mounted up into the thousands long ago; but the magnificent charm of the truth cannot be staled. Let us admit that it simply pushes the perplexities of life back: it is something to have gained a firmer foothold for the human mind amid invasive difficulty and doubt. Nature, we are told by it, possesses a store of energy that cannot in any way be either increased or diminished, and that quantity is as eternal and unalterable as the quantity of matter. If we were to follow a fixed quantity of energy through all its infinite transformations, we would find it ever and ever the same in amount. What grander secret could a man wrest from nature? And does not Clerk Maxwell, one of the great minds of this century, cry, "Excelsior!" by intimating that the supreme duty and glory of the true scientist would be to accomplish the final proof of this? Here is a law that does not contradict any known fact in natural science, but embraces and harmonizes more of those facts than any other law except it be that of gravitation. It reveals motion and matter coöperating before suns or planets were begotten of them. It explains the organization of our solar system, the conditions of being, and the possibilities of living forms yet to be. It teaches that celestial space is not vacuous, but that the light and heat which reach us thrill across it on unbroken telegraphic lines of ether. It shows us meteors carrying life from old worlds to new, pollen-bearers of the universe. It sees the sun stoking itself with dead worlds; ever belting itself tighter for the daily race that is set before it. It suggests the gradual rising of existence through periods of fruition and death into higher perfection on other spheres swinging around, remoter central sources of vivifying sunshine and attraction. And while it thus lifts our thoughts into the empyrean of eternity, it also vouchsafes a simple explanation of evanescent flame and flower, of muscular vigor, of sights, sounds, and odors, and of all that this material world includes of sensation.

That this sublime doctrine should be claimed for other teachers than Helmholtz need not surprise. A truth is of suspicious validity that never has more than one prophet; and with modesty Helmholtz was always prompt to admit that there had been leaders in Israel besides himself—men like Mayer in Germany and Joule in England. But his was the fullest perception, the deepest conviction, the clearest enunciation. His voice rang strong above the choir, and compelled the admiration of a listening world. Moreover, he clinched his rightful authorship of the doctrine by studies from which has developed the most progressive philosophical treatment of vortex motion. Applying mathematics with marvelous power to abstruse problems in hydrodynamics, he has helped to give us a clue to the true theories of gravitation, cohesion, and the ether; for, as Lord Kelvin has with keen insight propounded, atoms of matter may be vortex-rings in a frictionless liquid.

Helmholtz had, long before, convinced people of the tremendous range of his mind, even if some decriers sneered that he was like Talleyrand's doctor, who knew everything, even

PHOTOGRAPHED BY BRADY IN SEPTEMBER, 1893.

ENGRAVED BY T. JOHNSON.

HERMANN VON HELMHOLTZ.

physic. Between the promulgation of the two great principles just referred to, the one physical, the other mathematical, he had invented the wonderful ophthalmoscope for the diagnosis of diseases of the inner part of the eye. He did not hesitate to say that the eye had every possible defect that could be found in an optical instrument, and some peculiar to itself; but even so, it was vastly better to scrutinize with than a mere primeval sensitiveness to light, or the rudimentary enjoyment of casual pigment-spots on the skin. After twoscore years of skilful use of the ophthalmoscope, 35 per cent. of the children in German schools, and 20 per cent. in English, remain shortsighted, whence we may conclude that it came none too soon to prevent the degradation, by modern bad habits, of an organ still imperfect. It would be hard to say how many people owe improved vision, or the salvation of their sight, to the ophthalmoscope and its congener, the ophthalmometer, with whose aid, when the trouble is detected, a remedy can be hit on. Before Helmholtz made these great inventions (which, by the way, he generously left unpatented), no one had ever seen a living retina at its task.

To his investigations and discoveries regarding the eye — that wonderful little motor which converts the energy of the invisible ether-waves into sensations of light and form and color — Helmholtz added others of equal magnitude in the domain of sound. The action of the ear he traced to the harmonic vibration of its membrane, so that here another wave-motor, converting the beats of the air into sounds, came under consideration. From profound studies of acoustic problems he built up a theory of music, and derived much that was new as to the true nature of sound, mapping out, in the scheme of fundamental and secondary notes, what may perhaps be termed its spectrum. The practical developments of his ideas, embodied in his monumental work on the sensations of tone, are regarded as the scientific basis of modern music, and contain the prophecy or germ of such inventions as the telephone and phonograph. His deep conclusion, based upon these and other physiological and physical results with eye and ear,— the "gates of knowledge,"— was that we owe little to transcendental intuition. The impressions of the senses are but arbitrary signs or symbols of the outward things of the world, and their interpretation must be learned through experience.

While all this work was being pushed forward, Helmholtz was quietly and conscientiously performing the duties of one professorship after another. He ceased to be an army surgeon only to become a pedagogue, and it may respectfully be questioned whether the fashion, still prevalent, of requiring a great investigator to earn his daily bread by means of lectures to students is one of the best evidences of civilization. Still, it was not all wasted time, and Helmholtz had the satisfaction of inspiring and guiding many brilliant young men, among whom may be counted several Americans. He moved with growing honor and prestige from chair to chair, until he was called to the presidency of the Berlin Imperial Institute for Physical and Technical Research. In 1877 he became rector of the University of Berlin, and six years later his admirer, Emperor William I., conferred on him a hereditary title. We cannot altogether understand in this country why he and Tennyson and Kelvin should accept a peerage; but as a form of national recognition and reward it may have some advantages over second-rate consulships in out-of-the-way ports. Helmholtz was in no social sense revolutionary, but a sturdy, loyal, conservative Prussian. In fact, extremely little of personal controversy beset any part of his career; and as for the political or religious disputes in which some philosophers embroil themselves, they were altogether foreign to him. He had nothing of the temperament, for example, that led Tyndall to anathematize the very name of Gladstone.

With America the relations of Helmholtz were close and pleasant; and when he came in 1893 to attend the Electrical Congress at Chicago, the recognition he had given to the work of Rowland, Root, and other American scientific men, was promptly repaid by his election to the honorary presidency of that important body, to assist in the further definition of units and laws, which in earlier years he had been foremost in determining. He was an old man, and it has been hinted that he dragged himself abroad because it was the imperial pleasure. But his letters in response to the official invitations, and his conversations while here, betrayed intense expectancy and delight. His strong practicality also cropped out in the use he made of opportunities, such, for example, as securing from the Edison Electric Lighting Company of Chicago a complete set of all its forms, blanks, and rules for account-keeping.

This eminent practicality or hardheadedness marked all his work, finding expression in his standard writings on acoustics and optics, and breathing through all his popular or scientific lectures. He defined his attitude when, in referring to the hypothesis of Kant and Laplace as to the origin of the planetary system, he said: "The question about the end of things is perhaps of greater practical interest than that of the beginning." Even in the moral sciences he insisted upon the value of experimental demonstration, and could not refrain from sharp criticism of Hegelian royal roads of specula-

tion in matters of conduct and culture. He did not believe in the *a priori* construction of any system of philosophy; he could not agree with Kant that at least geometrical axioms were bedrock intuitions beyond any necessity of experimental proof. Even though his beloved Goethe, whose "Faust" was always on his lips, advanced the proposition that colors owe their existence to the blending of light and shade, he flouted the idea mercilessly, and talked of the poet's "egregious failure" in this sphere of natural philosophy. But, after all, if he insisted that, as sheer materialists, we must prove everything, not less did his intellectual processes ever lead upward and onward. If he dissected the eye, he gloried in the rainbow and the sunset; if he analyzed the mechanism of the ear, he reveled in the music of voice and instrument. If he discussed the relation of optics to painting, it was with the wish that he, as one who, in climbing a noble mountain, had himself noted a few good points of view, might help the artist. If he applied to the principle of the conservation of energy the most rigorous inquiry into all that occurs in the long series of natural phenomena, he held no doctrine of pessimism, before which individuality must collapse in nothingness. With fine suggestion, he asked whether our dull mortal senses might not be deaf to the inner meaning of life. For him who fights valiantly the battle of a better, purer day, he taught that no effort is wasted in the final economy of things, but that "in our intelligence, our civic order, and our morality, we are living on the inheritance that our forefathers gained for us, while that which we acquire and add will, in like manner, ennoble the life of posterity."

Thomas Commerford Martin.

THE HORSE-MARKET.

No well-regulated person enters the horse-market, especially in the capacity of buyer, without a certain thrill of excitement. Conventional and tame as life has become, a man cannot yet rid himself of the notion that he ought to be familiar with a horse as well as with a gun and a boat. Hence, to be "done" in a horse trade, though the most common of misfortunes, is felt to carry with it a measure of disgrace. On the other hand, there is always the possibility that you may obtain a steed young, sound, and kind. Such animals certainly exist; and although the jockeys would doubtless prefer to deal exclusively in diseased and vicious horses, a few good nags must occasionally pass through their hands, if only by accident. To buy a Houyhnhnm is, again, much better than to sell him; for he can be bought without moral deterioration on the part of the purchaser, and this is considered by some squeamish persons to be an advantage in the transaction.

In winter the horse-market languishes. Auction sales are slimly attended, and the bidders are chiefly suburban and country dealers looking for bargains. The moral as well as the physical atmosphere is depressing. The auctioneer knows that eloquence would be wasted; the cold eyes and thin lips of the jocks who stand about him in a ring chill his fervor; the damp, piercing air of the sale-stable chokes his voice; the apple-woman shivers behind her basket; coat-collars are turned up; gusts of wind sweep in through the big, open doors; and