hope that the shorter word of Aristotle may find favor with Mr. Willey.

BURT G. WILDER.

ITHACA, N. Y., November 18, 1898.

POST-GLACIAL CONNECTICUT.

TO THE EDITOR OF SCIENCE: A note in your issue of the 28th ult. makes my 'Postglacial Connecticut at Turner's Falls,' in the Chicago *Journal of Geology* (July–August), 'invoke the agency of ice' to cut the abandoned gorges at the Bird Track Quarry and Poag's Hole. This is just only in so far as it is true that had there been no glacier there would be no postglacial superposed gorge. The gorge, like all those of its class, was cut by the river and a clear photograph is reproduced, showing the visible water wear on these rocks in a region where all others are beautifully rounded by glaciation.

MARK S. W. JEFFERSON.

BROCKTON, MASS., November 11, 1898.

SCIENTIFIC LITERATURE.

Handbuch der physiologischen Optik. H. VON HELMHOLTZ. Hamburg und Leipzig, Leopold Voss. 1896. Second Revised Edition. Pp. xix+1334. M. 51; Bound, M. 54.

The phenomena of vision are so far-reaching and at the same time so organically related that they may almost be regarded as the subject-matter of a separate science. It is neither possible to include them under physics, under physiology or under psychology, nor to distribute them among these sciences. The photochemistry of the retina, the anatomical and histological data, and the comparative and evolutionary relations, add still further to the range of the subject. On vision is based one of the more important departments of medicine; for ophthalmology can in most cases not only offer a correct diagnosis, but also a cure. Probably a majority of the whole population needs its services, and if we add the hygiene of the eye, including the proper lighting of schools, the proper printing of books, etc., there is no one to whom the scientific study of vision is not of practical importance. The phenomena of vision are further factors in the production and appreciation of the great plastic arts — painting, sculpture and architecture. Finally, the world in which we live is before all the world we see.

If there be a science of vision, von Helmholtz should be honored as its founder, and it should date from the completion of the *Physiologische Optik* in 1867. It is true, the doctrine of special creations belongs to the past. Like other departments of knowledge, vision has had a long history and a gradual development. von Helmholtz found at hand not only the greater part of the materials for his structure, but also many of the designs. From the side of physics he had the series of contributions from Kepler, Descartes, Newton, Lambert, Young, Brewster; from physiology there were Haller, Priestley, J. Müller, Plateau, Volkmann, Purkinje; from philosophy Berkeley; from art da Vinci and Goethe—to mention but a few of many names. Contemporary with von Helmholtz worked Aubert, Hering, Listing, von Graefe, Brücke, Vierordt, Donders, von Bezold and many more. But of them all von Helmholtz alone saw the range and unity of the subject, and prepared one of the few books that make an epoch. So well was his work performed that it has scarcely had a successor—only Aubert's *Grundzüge der physiologischen Optik* deserves to be mentioned—and it remained for von Helmholtz himself, in old age, with energies diverted to other channels, to write a new edition of his great work.

To give in a review an account of the contents of a book extending to 1,300 pages, written with great conciseness and covering a range of subjects so wide, is evidently infeasible. Still less possible would it be to enter into critical discussion—an article might be written on each of a hundred topics. This notice must be confined chiefly to the new edition, and the eulogy appropriate to the first edition must be tempered with criticism.

Publication of this edition was begun in 1888. In the course of about a year three parts were issued, treating of the anatomy and dioptics of the eye. About forty pages are here added in addition to substitutions for material omitted, and thorough revisions throughout. The pages in the new edition are, however, somewhat smaller than in the old. This Section concludes with the description of von Helmholtz's great

invention, the ophthalmoscope. The parts then began to appear more slowly, at intervals of about two years, until the death of von Helmholtz in 1894. The eighth part had then been completed, extending the work to page 645. The part on sensations of light runs from page 231 to page 575, being enlarged by more than one hundred pages. Much new material, especially work on intensity done in von Helmholtz's laboratory, is here added. The final part, on perceptions and judgments, mostly edited by Professor König after the death of von Helmholtz, has scarcely been altered. Professor König states that it was not the author's intention to make many changes in this part, even had he been able to continue the revision. The work concludes with an index of the literature, containing 7,833 titles, compiled by Professor König.

It seems ungracious to do other than accept this new edition of a master work with sincere thankfulness. Even though it may not as completely represent contemporary knowledge of the sense of sight as did the first edition, thirty years ago, ought we not to be truly grateful to the author for his elaborate revision? Grateful we should doubtless be and appreciative of the heroic effort of von Helmholtz. But we owe truth to the dead, and I must state my own view to be that little or nothing, or worse than nothing, has been accomplished by this revision. It has happened in cases other than this that a classic work making a remarkable contribution to science has ultimately become an obstacle to to the advance of science. Kant creates a work on epistemology that alters the entire groundwork of metaphysics. After a hundred years we find the cry prevalent in Germany 'back to Kant,' and back they go, not only to the *Critique* as representing the best thought of the eighteenth century, but as though all its trivialities were of contemporary importance.

The *Physiologische Optik*, the publication of which was begun in 1856 and completed in 1867, is one of the few classics in the history of science. It summarized the existing state of knowledge with rare completeness and lucidity, and made remarkable original contributions to the advancement of knowledge. But a work of such magnitude and genius actually prevents the preparation of new books truly reflecting the present conditions and conflicting claims of facts and theories. The physicist, the physiologist, even the psychologist, is apt to regard the gospel according to Helmholtz as infallible. This is the inevitable, against which even the gods do not contend. But the publication of a new edition dated 1896 tends needlessly to prop up the Procrustean bed, confining the growing members. Since 1860 the doctrine of evolution has been established; since 1860 modern psychology has been developed. The '1896' on the title-page is harmful to science; unfair to von Helmholtz himself.

Even the title of the book is an anachronism. Physiological optics correctly describes only that part concerned with the eye as an optical instrument. Optics is a department of physics and no longer includes the psychological phenomena of vision. When von Helmholtz himself prepared a little later a work on the sense of hearing, in many ways a companion volume to that on vision, he did not call it *Physiologische Akoustik*, but *Tonempfindungen*. The literature on vision prior to 1867 is small compared with that subsequent. Thus on the perception of color 163 titles are given in Professor König's bibliography as published earlier than 1867, and 1034 between that and 1894. The newer literature is scarcely incorporated, and in so far as this is attempted a false perspective is given by devoting many pages to work done by Professor König, Dr. Brodhun and others in von Helmholtz's laboratory, while work of equal importance done elsewhere is ignored. The injustice done, for example, to Hering, is very great. In various points of conflict von Helmholtz replies to Hering, but in such an inadequate fashion as to show either carelessness or a complete lack of appreciation of the value of evidence. The possibility that he might be wrong or that progress had been made seems scarcely to occur to him.

I may note two of these points of difference between Hering and von Helmholtz—the perception of color and the perception of space—to illustrate the tenacity with which von Helmholtz clung to his early views in spite of accumulating evidence against them. The Young-Helmholtz theory of color-vision is well known, being, in fact, imposed annually as ascertained

truth on thousands of students in their introductory courses of physics and physiology. When von Helmholtz elaborated the hypothesis it was of great value in coordinating the then known phenomena and in giving a basis for further research. But forty years have brought many changes, and if the hypothesis were now proposed anew by an unknown man it would not find a single adherent. No modern student of organic evolution can conceive how the three-fiber mechanism could develop from a unicellular organism already sensitive to light. No psychologist can conceive how three kinds of fibers make us see three primary colors as white light; they would more probably lead us to see white light as three colors, I should suppose. All the newer phenomena—the spectrum of faint light, color-blindness, contrast, after-images, the variations in the field of vision, etc.—not only do not support the hypothesis, but must be subjugated to it by unlikely subsidiary hypotheses. The phenomena of space perception are too complex to enter into here, but the 'empiristic' theory, of which von Helmholtz was properly proud in the sixties, seems now, after the writings of James, Ward, Stumpf and others, particularly naïve.

With some reluctance I must state that not only are the theories of the *Physiologische Optik* in large measure outgrown, but that in many cases the observations cannot be verified. In subjects in which I have myself worked—after-images, the discrimination of intensity, conflict of the fields of vision and others—new methods have given different and probably more correct results. This is the natural course of science. The work of a great investigator, if vital, must be the ladder by which we climb, but which we afterwards discard. The *Physiologische Optik* is still a great storehouse of facts and observations of contemporary importance, but we should regard it as closed thirty years ago.

The bibliography compiled by Professor König is an extremely useful piece of work, but I see no adequate reason for appending it to the *Physiologische Optik*. It may be delusive in leading the thoughtless to suppose that von Helmholtz had considered all these works; it makes the book needlessly bulky and expensive; it is compiled chiefly at second hand, with many omissions and numberless minor errors.* Such an index should be published separately, and, if possible, revised and brought up to date every few years.

The criticisms that I have ventured to make apply only to the revision of the *Physiologische Optik*. If the first edition had been reprinted without alteration there would be nothing to express but admiration for a work of genius almost unrivalled in the history of science, and for a man of genius whose intellect was so profound and so far-reaching that of his contemporaries only Darwin stands beside him.

J. McKeen Cattell.

Columbia University.

Elementary Botany. By Geo. F. Atkinson. New York, Henry Holt & Co. 1898. 12mo. Pp. xxiii+444.

This latest and best of elementary text-books of botany is a thoroughly commendable work, and reflects high credit upon the author and upon the publishers. In pleasing contrast to the larger number of books with similar titles and kindred scope it is fresh, accurate, comprehensive and readable. It must have a heavy sale as soon as teachers of botany become acquainted with its merits, for in no other American elementary botany now before the public is the subject-matter so thoroughly covered and the illustration so illuminating and suggestive.

The text has been classified by its author under three captions, physiology, morphology and ecology, in the order given, a modification of the ordinary arrangement. In the first

*Thus, in regard to American writers eighteen references are given to Professor Le Conte, but his book on 'Sight' is not included. A comparatively unimportant article by an American author is quoted three times, probably by accident. We find 'Bowditsch' four lines after the name has been correctly given. My own name is given twice within five lines spelled incorrectly in two different ways. Mrs. Franklin's name occurs four times, each time differently. Professor Le Conte Stevens' name occurs five times in four different ways, never quite correctly. One of Professor Stevens' articles is said to be in the 'Amer. Journ. of Sc. Vol. XXIII.,' and the continuation of the article in the next number of the same journal is said to be in 'Sill. Journ. XXIII.' Indeed, I have noted sixteen different ways in which *The American Journal of Science* is referred to.