concretely in his own words what is their significance. This reticence is especially noticeable in the sections devoted to historiography, where the author is too ready to accept the word of someone else that a given historian was "scientific" (which neither Tatishchev nor Karamzin, prominently featured in the book, really were). But one must be grateful to him for having given us a judicious and informative account of a complicated and often obscure story.

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Commemorative Lectures

Clerk Maxwell and Modern Science. Six commemorative lectures. C. Domb, Ed. University of London Press, London, 1963. x + 118 pp. Illus. $4.

James Clerk Maxwell was professor of natural philosophy at King's College, London, from 1860 to 1865, and the six essays in this volume commemorate his tenure there.

Sir John Randall's introductory address, based primarily on the Campbell and Garnett biography and the *Collected Papers*, reviews comprehensively Maxwell's life and work. New to many readers will be the summary of I. B. Hopley's useful study of Maxwell on color and color vision. Maxwell's performance as a teacher is reevaluated; the long-standing assumption that he was a poor lecturer is questioned, and his effort toward making laboratory work part of the physicist's education is stressed. One curious paragraph suggests that it is time to take a "fresh look at the premises and hypotheses" at the basis of electromagnetic theory because considerable confusion concerning electromagnetic theory exists today; presumably this refers neither to the attempts to create non-Maxwellian electrodynamics (Born and Infeld and others), nor to the action-at-a-distance theories (Feynman and Wheeler).

The theorist R. E. Peierls, in an essay entitled "Field theory since Maxwell," begins with passages from Maxwell's 1864 paper on electromagnetic theory. The excerpts indicate that terms referring to the physical model introduced in the previous paper are not to be taken literally, but that energy considerations *are* literal: "All energy is the same as mechanical energy." Peierls, like Randall, speculates on the introduction of displacement current. It would seem reasonable that such speculations should rely only on Maxwell and not on contemporary views. These speculations should not use the basic equations in the symmetrical form common today (due to Heaviside and Hertz); they should use Maxwell's original 20 equations involving the potentials. Peierls convincingly analyzes the change from the 19th-century search for mechanical models of the electromagnetic field to our present disinterest in such models. He then discusses other fields of contemporary physics, the quantization of fields, and the restrictions imposed on measurements of fields (particularly the electromagnetic field) due to quantization, and in so doing summarizes the work of Bohr, Rosenfeld, and Peierls himself. He ends, not surprisingly, by mentioning the troubles encountered in contemporary quantum field theory.

The most interesting paper in the collection may well be C. A. Coulson's "Interatomic forces." Kinetic theory was an early concern of Maxwell; his belief in velocity distributions led him to reject the billiard ball model of molecular collisions and to seek a power law for repulsive force between particles. Underlying this work, and much other work of the period, was the concept of "molecule." Maxwell wondered how a theory could account completely for an unseen world of molecules—"a strangely modern cry to come from an early Victorian," Coulson comments. The passages in which Maxwell reacted to Darwinism are fascinating; his three great papers on electromagnetic theory are roughly concurrent with *The Origin of the Species*, and he shared the interest of his age in evolution. He rejected any evolutionary processes on the molecular level, seeing molecules as eternal and unchangeable, coexistent with nature herself. "No theory of evolution can be formed to account for the similarity of molecules, for evolution necessarily implies continuous change, and the molecule is incapable of growth or decay, of generation or destruction." Coulson concludes with some modern considerations on interatomic forces and shows that Maxwell could not have reached these conclusions without the intellectual equipment of the 20th century.

The last three papers begin with comments on Maxwell, but do not investigate his work directly. Two outline particular areas of science which are based on electromagnetic theory, and the third is concerned with an application of the quantum theory of radiation. Sir Edward Appleton begins his discussion, "Radio and the ionosphere," with the Heaviside-Kennelley layer and proceeds to the experimental studies of the E and F layers by ionospheric sounding devices. E. G. Bowen's interest centers on radio telescopes. He first formulates six requirements for such an instrument, then shows how the Australian 210-foot telescope attempted to meet these requirements, and finally discusses some results obtained with the instrument. R. A. Smith's discussion of masers and lasers takes us even farther from Maxwell, for in this treatment quantum considerations are critical.

One can hopefully view this volume as part of a modest Maxwell "revival." After a long period with little attention, some interest is again being shown. A new biography and other Maxwellian studies now being undertaken may add measurably to our knowledge of the greatest physicist of the 19th century.

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Darwiniana

Charles Darwin. Evolution by natural selection. Gavin de Beer. Doubleday, Garden City, N.Y., 1964. xii + 290 pp. Illus. $4.95.

Darwiniana. Essays and reviews pertaining to Darwinism. Asa Gray. A. Hunter Dupree, Ed. Harvard University Press, Cambridge, Mass., 1963. xxiv + 327 pp. $5.

Ever since the centennial year of Charles Darwin's *Origin of Species* (1859), numerous books and papers have appeared on Darwin and on his life and works. With every new publication, this question arises—Why another? Apparently Sir Gavin de Beer felt that he should answer the question, and he did so by calling attention to what is still happening: (i) In London, 240 participants on a television program were asked what names they associated with evolution. One third of them associated no name at all, an-

other third associated various names including Huxley, Einstein, and even Aristotle, and only the remaining third mentioned Darwin. (ii) One answer on an examination for the General Certificate of Education at Advanced Level was: "Darwin's theory was based on three solid pints [sic]: 1. The struggle for the exits. 2. The survival of the fattest. 3. Maternal selection." Sir Gavin could not decide whether the candidate for the Certificate was an innocent or a humorist.

Actually, Sir Gavin needs no excuse for his small book. It is accurate, clearly written in nontechnical language, and covers the chief events in Darwin's life. It covers both the personal and the scientific events. Sir Gavin describes briefly the pre-Darwinian concept of species—the concept of their assumed stability or instability—and, as part of the background from which evolution emerged, he gives a short account of Darwin's own concept of biology previous to his voyage on the *Beagle*. He thus places Darwin in his proper milieu. He then recounts in sufficient and, at times, amusing detail the events that preceded and those that followed the publication of the *Origin of Species*.

Darwin's proof that organic evolution had occurred was so overwhelmingly important that it diverted attention from his other scientific achievements, including his distinguished contributions to both botany and zoology. He published on variations in plants, animals, and man, on the expression of the emotions in man and animals, on the insect pollination of orchids, and on the effects of self and cross pollination in the flowering plants. He described the insectivorous and climbing plants, and he investigated the movement of plants in detail. He studied the different forms of flowers on plants of the same species. He described the formation of vegetable mould and the building of coral reefs and volcanic islands. Sir Gavin records all of Darwin's contributions but, necessarily, very briefly.

Although Sir Gavin has added little new to our knowledge of Darwin, his book has a value of its own. It would be an ideal gift to any high school student or college undergraduate, who is interested in evolution. It could also be read with profit by any historian of science who is not a professional biologist.

Asa Gray's *Darwiniana* is a collection of essays that was published in 1876, although the essays themselves had appeared earlier. Since its first publication, it has been evaluated many times. This new edition is a John Harvard Library Book, one of a series supported by the Belknap Fund, established to publish "rare, inaccessible or hitherto unpublished source material." The editor, A. Hunter Dupree, is the author of *Asa Gray: 1810–1888* (1959). He is, of course, the one person for the task, and his introduction and footnotes makes this edition by far the most useful. Gray was a correspondent and personal friend of Darwin's, whose preliminary announcement of natural selection in 1858 included a copy of a letter he had written to Gray.

Asa Gray was the first real champion of evolution in America, and, if we care to designate Darwin as Charles the Great, Asa Gray, T. H. Huxley, G. Henslow, J. D. Hooker, and Sir Charles Lyell can rank as the paladins. Gray fought for evolution. He crossed pens with Louis Agassiz, his colleague at Harvard. He debated Charles Hodge of Princeton, and he answered numerous other biologists who found evolution perturbing. His reviews of Darwin's works assured that they would have a fair hearing in America, and he very effectively used his own work on plant geography to overcome the opposition to evolution which many of the older botanists had grown up with.

Some of the leading evolutionists were nonreligious, but Gray himself was religious—in fact, he was a conservative Presbyterian. This was a source of strength for his defense of evolution, since it tended to keep the *odium theologicum* at a minimum. Gray, however, could reach only the literate fraction of his fellow countrymen. The *pagani* remained in opposition to evolution for almost another century, and the Fundamentalists among them have not yet been reached by any intellectual contact.

Gray was a doughty champion, although he did not always agree completely with Darwin and the English evolutionists. He accepted, for example, both teleology and natural selection and, in this, he differed with Darwin and Huxley. Logically, of course, natural selection, as a means, is not incompatible with some teleological end, but the leading evolutionists rejected this view. They recognized clearly that teleology and natural selection are rival hypotheses and that both are not needed to explain how evolution came about, or even to account for the fact that man himself had evolved. With the coming of evolution and the recognition of the role of natural selection, teleology found itself on the way out—at least within the biological fraternity.

Rereading *Darwiniana* does bring back the atmosphere of the early days of evolution. In this well-printed and reasonably priced edition this atmosphere is brought within the breathing range of any who wish to sample it.

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Pictorial Medical History

The World of Asclepios: A History of Medicine in Objects. Erwin H. Ackerknecht. Huber, Bern, Switzerland, 1963. 92 pp. Illus. $12.

A History of Medicine. Jean Starobinski. Hawthorn, New York, 1964. 111 pp. Illus. $5.95.

Both of these books offer new versions of the history of medicine in, or rather with, pictures. Both authors, curiously, teach medical history in Swiss universities. Both works are short on text, the first much more so than the second, and both are multilingual publications: Ackerknecht's is published with parallel German and English texts; Starobinski's, which was written in French, has been translated and published in a German edition as well as in this English edition. This is perhaps due to the high proportion of printing costs that go into the pictures, which are the same for any language.

Both works were printed in Switzerland. The quality of the reproductions is excellent, and some of the colored ones, especially the photographs of objects, are really quite striking. Both authors have used genuine sources rather than the reconstructions of an artist's imagination, a measure of the essential integrity of their purpose. Unfortunately both volumes demonstrate the difficulty of attempting to explain medical history in pictures. Illustrations can be extremely useful as supplements to text in certain cases—for example, to explain the mechanism of objects or as an aid in developing anatomical knowledge—where they elucidate struc-