Book Reviews

Darwin Today

Charles Darwin. The founder of the theory of evolution and natural selection. Gerhard Wichler. Pergamon Press, New York, 1961. xvii + 228 pp.

One would have thought that the year 1959 would bring us a definitive biography of Darwin. This was not to be. There were numerous symposium volumes and collections of essays which contributed signally to our understanding of Darwin and of the evolutionary theory. We witnessed the publication of a number of important contributions to the history of evolutionary thinking, among which Eiseley's *Darwin's Century* is outstanding. Yet, all attempts at Darwin biographies fell far short of their aim. Some of them are colorless compilations, while others are vicious denigrations which concentrate their efforts on proving that Darwin had no originality and that all that was good in the *Origin of Species* had been plagiarized from earlier authors. Perhaps it is just as well that no one tried to write the definitive biography. Not only has evolutionary research made such rapid advances in recent years that many questions now appear in a very different light from that of only a few decades before, but the Darwin centennial also led to the rediscovery of the Darwin notebooks, the contents of which are more revealing than anyone had dared to hope. The sources of his information and inspiration, the chronology and maturation of his ideas, his scientific method, all this appears in a new light. No one should attempt a biography of Darwin until the critical analysis of the notebook material has been completed.

Philosophical Misconceptions

He who wants to inform himself on Darwin, in the meantime, will find an objective and concise summary of Darwin's life and of his role in the history of evolutionary thought, in Gerhard Wichler's *Charles Darwin*. This is an ambitious volume. In part 1, the history of the theory of evolution from 1600 to 1859 is presented. Wichler quite rightly does not carry the history back to the ancients, because their impact on the development of evolutionary thought has been remarkably small, some classicists and historians notwithstanding. If anything, their influence has been inhibitory. Aristotle's failure, in the discussion of final causes, to make a clear distinction between causes for the development of the individual and for the development of nature as a whole (which is the proper subject of evolution), has bedeviled students of evolution until Darwin's day and up to the present. So has the futile endeavor of the metaphysical idealists to reconcile observed change with Plato's concept of the essentially unchangeable *eidos*. The history of the emancipation of our thinking from these philosophical misconceptions has not yet been written. It awaits an author who understands both philosophy and evolutionary theory. Wichler gives us a very brief glimpse. Not only is it quite impossible to cover the whole history of evolutionary thought in the 66 pages which he devotes to it, but there are numerous aspects of this history on which a great deal more original work needs to be done. For instance, what are the sources of historical thinking, a type of thinking which is so conspicuously undeveloped among the ancient and medieval philosophers, and what are the sources of thinking in terms of populations? Have the numerous books and papers on the evolution of "form" without evolution of the "essence" been a boon or a hindrance to evolutionary thinking?

Wichler's basic thesis, confirmed again and again by modern research, is that evolutionary thinking in the century before Darwin was quite widespread but that the major publications on the subject were so speculative and deductive (as well as factually ill-informed) that they did more to discredit the subject than to help it. This Darwin knew only too well, which was the main reason why he collected facts for so many years (more than 20) after the basic formulation of his theory and why he hesitated to publish until virtually forced into it by circumstances.

Part 2 of Wichler's work is a 30-page essay on the development of Darwin's thought on the subject of evolution and, in particular, on the theory of natural selection. Part 3 (104 pages) is somewhat heterogeneous; it contains a survey of Darwin's whole literary output in biology, a description of his family (ancestors and children), his life, his chief characteristics, his relations with Wallace, Hooker, Huxley, Gray, Lyell, and other friends, as well as a bibliography of his books.

The author's encyclopedic approach has enabled him to bring the reader in contact with an enormous amount of subject matter, but this very approach in so small a volume has prevented him from achieving anything more than a cursory survey. There is little in it that could be considered novel or original. The translation (from the original German) appears to be well done, though there are a few slips (like *sea rose* for *water lily*). Much of the recent English and American literature on Buffon, Lamarck, and Darwin was apparently unknown to the author, but this is compensated for by the fact that he quotes and discusses a considerable number of European, mostly German, authors whose writings are neglected by the English-speaking world. What gives the volume its special value is that it is singularly free of the various prejudices which mar other recent Darwin biographies. It can be well recommended to anyone who wants a concise, objective introduction to Darwin's life and the history of the evolutionary theory.

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Rocks' Longevity

The World of Geology. L. Don Leet and Florence J. Leet, Eds. McGraw-Hill, New York, 1961. viii + 262 pp. Illus. Cloth, $4.25; paper, $2.75.

This small book appears to be for the "lay" reader who is intelligent and inquiring but who is not necessarily the possessor of a university education, and its short chapters are units that can be read enjoyably at intervals. This achievement results from the compilers' careful adaption of works by many

authors, most of them now active but also including Louis Agassiz, the late R. A. Daly, Percy E. Raymond, and S. J. Shand. Somewhat less than half of the book is the work of Harvard men, and most of the small but adequate photographs have been supplied from the Harvard collections.

Following the introduction—a quick review of the history and of various fields of earth science—each of the 19 chapters, with one exception, is adapted from a single work and is prefaced by a page or two of information about its subject and author. Most of the earth sciences are considered, but a specific list of subjects and authors is not repeated here: it is enough to say that each author is authoritative in his field, and that the prose, supplemented by photographs and diagrams, is clear and often dramatic.

I made no point of detecting errors, since these must be attributable to the original sources, not to the present volume, but I did note a minor inconsistency. The Leets (flatly) and Simpson, Whipple, and Colbert (in qualified terms) agreed that no rocks were known which are older than 3000 million years; yet on page 43 there is a photograph of algae from Ontario ". . . which existed 3500 million years ago. . . ."

It is to be hoped that the editors or others will compile a companion volume that will: Present opposing authors on half a dozen controversial issues; present a few new lines of such research as paleotemperature, paleomagnetic, and high-pressure studies; take its illustrative examples largely from abroad.

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On Innovation and Imitation

Productivity and Technical Change. Cambridge University, Department of Applied Economics, Monograph No. 6. W. E. G. Salter. Cambridge University Press, New York, 1960. xi + 198 pp. $4.50.

To understand the process of economic growth, it is necessary to analyze developments not only in the economy as a whole but also in its component parts.

If, as Salter has done, one takes the time and the trouble to study the records of individual industries, he will be struck by two facts. First, the rise in labor productivity—that is, the upward trend in physical output per worker or per worker-hour that characterizes a growing economy—is a general phenomenon. Second, however, industries differ greatly in the rate at which labor productivity rises.

Rise in labor productivity is widespread because technical change and capital accumulation affect production in all sectors of the economy. Technical advance of almost every kind, sooner or later and in one way or another, leads to improvements in the methods, equipment, and materials used in every industry; thus technical advance increases (or tends to increase) output per man directly, and by also increasing output per machine and per unit of materials, it increases output per man indirectly. Technical progress in the capital equipment industries lowers the cost of equipment relative to the cost of labor, induces substitution of capital for labor wherever equipment is used, and thereby strengthens the tendency for output to increase in relation to labor input. Technical progress has a like effect in the industries producing fuels and other materials and supplies. Technical progress in the transport and communication industries serves to enlarge the scale of markets; and this makes possible the finer "division of labor," domestic and international, that helps raise productivity. As for saving, it proceeds at a sufficiently high rate to cause wealth to rise more rapidly than the labor force; in this way, capital accumulation joins in lowering the cost of using capital equipment, especially long-lived equipment, relative to the cost of labor, and thus reinforces the general tendency to substitute capital for labor. The increase in population and in per capita real income brought about by technical progress and savings also widens markets and creates economies of large-scale production. Rising income, in addition, finances the investments in education that help push up labor productivity everywhere.

Labor productivity rises at disparate rates in different industries because technical change varies in its impact on individual industries. Variation among industries also occurs in the ease with which capital may be substituted for labor and in the size of the economies brought about by a given increase in volume of production. Further, rates of increase in demand that occur in response to increase in income also vary, both systematically and randomly, from one class of product to another; this, too, causes industrial variation in the economies brought about by larger output. It also causes variation in the rate of investment, which determines the speed with which technical advance can be embodied in new and better equipment, and thus in the rate of increase of labor productivity.

The above summarizes part of Salter's study of trends in British and American industries. While it is possible that I have read more into what Salter has to say than he intended, it is certain that I have omitted findings that are important and interesting. For Salter concerned himself also with the relations between changes in productivity and changes in prices and in wages and with the role these relationships play in the process of adjustment of industry and employment to technical change and capital accumulation. His results extend or—always important in scientific work—confirm findings of previous studies.

Economists may be spurred by Salter's model of economic change to quarrel and perhaps to improve. For example, Salter sees the diffusion of technical change within an industry as resulting from the replacement of old plants with new ones. Replacement occurs when the direct costs (per unit of output) of manning, supplying, and maintaining old plants come to exceed the total costs of new plants—that is, their direct costs plus depreciation and interest charges. The model implies that an industry is homogeneous in all respects except vintage of plant and correlated technical level. However, in a study of the spread of hybrid corn over the United States [summarized in an earlier issue of *Science* **132**, 275 (1960)], Zvi Griliches emphasized the heterogeneity of the corn producing areas and the problem of adapting the innovation to the varying circumstances of each area. Salter's model may be appropriate for manufacturing and Griliches' for agriculture; in any case, the general applicability of Salter's model seems doubtful.

A related assumption, to which exception might be taken, is that investment is the prime vehicle of technical change. But Salter is well aware that other factors play a role in the application of technical advance. He would acknowledge that investment is a necessary but not a sufficient condition, that the rate of innovation may not in fact