Book Reviews

The Ethical Animal. C. H. Waddington. Allen and Unwin, London, 1960. 230 pp. 25s.

This is a notable book on an important subject, written by an outstanding scientist and thinker. What it is about is concisely stated on page 23: "It is the thesis of this book that the framework within which one can carry on a rational discussion of different systems of ethics, and make comparisons of their various merits and demerits, is to be found in a consideration of animal and human evolution." This idea is not quite new; it was stated previously in Waddington's well-known *Science and Ethics* (1942). Rather closely related but not identical ideas were advanced by Chauncey Leake; they have been made popular in numerous writings by Julian Huxley. The book under review is, nevertheless, the first in which the argument is developed fully, explicitly, and with admirable clarity, so that its strong and weak points can be clearly identified and subjected to analysis and criticism.

Of the 16 chapters into which the book is divided, four are the crucial ones (chapters 2, 12, 13, and 14). Waddington takes as his point of departure this fact: "For every human being there are some propositions which he considers to be ethical, that is to say, to relate to goodness and badness or duty and obligation." Waddington does not attempt to define goodness in terms of other concepts, such as pleasurableness, desirability, and so forth. He considers, instead, the ontogeny of the concept of the good, that is, the developmental processes which lead to its formation in a human individual. He suggests that there is an early developmental stage at which an infant becomes an "authority-acceptor" and an "ethicizing being," and he supports this suggestion by referring to the work of psychologists and psychoanalysts who have studied the development of the human personality. Waddington then argues very cogently that the capacity to accept authority and to acquire ethical beliefs is established in human biological evolution as an essential adaptation for transmitting from one generation to another the store of information which constitutes human culture. But as so often happens in evolution, a highly adaptive functional system has some features which by themselves are unadaptive: "Some development of 'authority-bearing systems' is, as we have said, necessary to mold the baby into an information-acceptor," and yet "the processes which the human species has evolved for bringing about this result are of a kind which will almost inevitably lead to an over-development of authority." As a consequence, "we tend to demand of our ethical beliefs a degree of certainty which we would never look for in any other doctrines. They should, we feel, be universal in scope, absolute in character and unassailable in validity." To me, an essential, and an attractive, feature of Waddington's theory is the emphasis he places on the fact that it is the ability to "ethicize," and not the contents of the ethical beliefs, that is a product of adaptation in the process of biological evolution. The theory thus avoids the pitfall of supposing that there exist genes for transmitting this or that ethical tendency or belief, a supposition at variance with our present ideas about the role of genes in development and in evolution.

Criterion of Biological Wisdom

Waddington's attempt to find an evolutionary criterion for evaluating ethical beliefs is very ingenious. The basic argument here is that the biological "function of ethicizing is to make possible human evolution in the sociogenetic mode." However, "To say that something has a function is not merely to assign causal efficacy to it, but implies further that the causal network of which it is a part has as a whole some general character. A particular example of the activity can then be judged by how well it brings about the realization of that character." Here, then, Waddington sees a criterion for criticizing the validity of ethical systems. Provided that we discover the general character of human evolution and, indeed, of the evolution of life as a whole, "We have then to inquire, of any particular ethical belief which comes to our attention, how effective it is in mediating this empirically ascertained course of evolutionary change." This is what the author calls the criterion of biological wisdom. *Wisdom* used in this metaphorical sense (parallel to Cannon's "wisdom of the body" or "homeostasis") is not necessarily the same as *wisdom* in philosophical discourse or in everyday life. This is probably the Achilles' heel of the theory; I find myself unable to accept the conclusion drawn by Waddington: "One could, therefore, not question the wisdom of evolutionary advance since this is a matter of definition." Nor is the problem of the general direction of biological and of human evolution an easy one. Waddington argues: "Biological wisdom consists in the encouragement of the forward progress (anagenesis) both of the mechanism of the socio-genetic evolutionary system, and of the changes in the grade of human organization which that system brings about. . . . The general anagenesis of evolution is towards what may crudely be called richness of experience." He wisely refrains from an "attempt to work out, even in broad outline, the nature of the conclusions to which the application of the evolutionary criteria would lead."

Waddington is well aware that a biologist writing about ethics is likely to find himself in a position "like a baby sitting in the bath water, called upon to parry the attacks of well-meaning philosophers anxious to resolve semantic puzzles by emptying me, along with a lot of other alleged rubbish, down the sink." He defies these well-meaning efforts and shows that he is at least aware of the objections raised against "scientific" ethics by philosophers from Hume (who pointed out that one cannot logically pass from "is" to "ought") to the modern logical positivists (dealt with in a chapter entitled "Squaring the Vienna circle"). In another chapter, "Understanding and believing," Waddington takes up matters of *wisdom* in its more usual sense and concludes: "The authority of science gives its sanction to one of the greatest creations of the human mind—the attitude of logical thought continually checked by the empirical appeal to experiment—but it needs, in my view, to be supplemented

by the ideal of the creative artist—an ideal which expresses itself in thought precesses which move in a different dimension to those of logic and experiment." One can only hope that this wisdom can be squared with the *wisdom* of the evolutionary process.

The theory presented in *The Ethical Animal* will not, as Waddington is well aware, be accepted unanimously by everybody, or even by all biologists. It is nevertheless a significant contribution to the discussion of a momentous issue. By changing what he knows about the world, man changes the world he knows; by changing the world, he changes himself. Are these changes in accord with biological and other wisdom?

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Geological Survey Research 1960. Professional Paper No. 400, part A and part B. U.S. Geological Survey, Washington, D.C., 1960 (order from Supt. of Documents, GPO, Washington 25). Part A, 142 pp., illus., $1; part B, 523 pp., illus., $4.25.

The United States Geological Survey is currently engaged in so many activities and projects, spanning the full range of the geological sciences, that publication of results has tended to lag behind the completion of many investigations. This book has been prepared to make available a digest of important new ideas and new discoveries, both published and unpublished, made by survey personnel during the 12 months that ended 30 June 1960. This presentation is an experimental one, and only the work of the Geological Division is included.

The arrangement of material is dictated by what the Geological Division considers to be its major objectives: increasing our knowledge in economic geology, regional geology, and geologic principles and processes. Pages A1–A26 are devoted to economic problems, by district and region, together with commodity and topical studies. Many persons outside geology will consider this to be the most important phase of the survey's work, because the economic studies help in solving problems connected with the construction of highways and dams and, while developing information in the search for new deposits of minerals and fuels, provide the nation with a continuing appraisal of its known and potential mineral and fuel resources. It should be noted, however, that without the supporting regional studies (pages A26–A54) and those that deal mainly with principles and processes (pages A54–A73), the specific economic studies would soon become sterile.

All reports and articles by survey personnel, actually published or otherwise released to the public during fiscal 1960, are listed alphabetically by author in the bibliography (pages A107–A127). Not every title that will eventually bear dates between July 1959 and June 1960 could be included, since publication in periodicals is commonly delayed several months. The inclusion of journal articles and survey open-file reports with standard survey publications will greatly aid geologists and others searching the recent literature. The "Subject classification of publications" (pages A127–A136), together with the very detailed table of contents, makes the lack of a general index less inconvenient.

The list of investigations now in progress, which gives the name and headquarters of those in charge of each investigation (pages A77–A105), alone makes the publication worth the price. Too often in the past, even after extensive inquiry, have workers outside the survey started a research project only to find that it duplicated a survey project which was well under way. The only illustrations in part A are four index maps.

The second part of this professional paper is bound separately and consists of 232 papers, generally of less than 1000 words each. Some of the papers are primarily announcements of new discoveries or observations on problems of limited scope, and for many, this will probably be the final report. Others are progress reports on more extensive investigations which have been under way for some time. It is expected that these conclusions will, in large part, be included in much longer reports to be published when the projects are complete.

Most authors are represented by one paper, but some have as many as seven. The papers, well-illustrated by line drawings and a few photographs, are arranged, as to subject matter, in the same order as those in part A. The volume has a comprehensive index, by subject and author, referring to article number rather than to page.

I hope that the publication will be continued and that it will be expanded to include the work of other survey divisions.

Obviously few, if any, will read the entire book but almost every geologist will enjoy and benefit by browsing, not only in his own field of interest but also in the many others presented. There is a wealth of material for the teacher and the research geologist, as well as for those more concerned with practical application of the science.

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Analysis and Design of Feedback Control Systems (formerly *Servomechanism Analysis*). George J. Thaler and Robert G. Brown. McGraw-Hill, New York, ed. 2, 1960. xiii + 648 pp. Illus. $14.50.

The first industrial revolution provided abundant power for operating machinery, but this power had to be controlled by human beings. In the present industrial revolution, more and more of the control functions are being taken over by the machines themselves. This is done by using the principle of feedback. A standard is set up for the variable to be controlled in an industrial process. This standard is continuously compared with the actual value of the variable, and an error signal is obtained, which is then used to actuate machinery in such a way that the error is reduced.

The present volume is intended for use by electrical engineering students who are taking the analysis and design of such apparatus at the senior or graduate level. The authors first provide an introduction to the subject and some of the basic working tools. They then deal with the analysis of linear control systems: how to evaluate their performance—the speed of response, stability, overshoot, steady-state error, and so forth. They continue with the design and construction of control systems for given specifications. Finally they go on to more advanced aspects of the subject and discuss Mitrovic's method, sampled data control systems, and the analysis and design of nonlinear control systems, including relay servomechanisms. There are five appendixes, giving, in addition to some useful tables, descriptions of physical components