tween the first and third of the above definitions. This approach has the same strengths and weaknesses in principle as the purely analytic approach, with the important distinction that limitations in ability to handle data are much less for a computer than for a mathematician.

Perhaps the central and most difficult problem facing ecology is precise prediction of the behavior of field populations. Papers by Stark and by Paulik and Greenough present examples of this kind of problem. The magnitude and multidimensionality of the problems are fascinating. The data used vary from infrared photographic records to x-rays of tree bark. The difficulties are those of econometrics added to those of meteorology with a few biological problems thrown in. The scope of these investigations, and their apparent feasibility, is more surprising than the fact that firm, precise predictions have not yet been forthcoming.

One serious difficulty in ecological research is that the volume of data that must be collected and processed is stupendous. This is particularly true in situations in which the behavior of organisms is important. Hamilton, Savage, and Kavanau are each concerned with automatic systems for recording and reducing behavioral data.

Kavanau has placed mice in what is essentially a computer-environment-control system in which the computer is informed of the behavior of the mice and the mice can, in turn, control the computer so as to modify their own environment in a variety of ways. The behavior revealed by this arrangement makes the mice seem much more exciting than any animals that ever occupied a Skinner box or desperately leaped from an electrified platform. I am fascinated and delighted by any study which can unequivocally conclude that "mice of the genus *Peromyscus* tend to react to the arbitrary imposition of a regime by opposition to it. . . ." Not only is this a promising foretaste of new problems that will be approachable only through highly automated data processing, but somehow it lends hope to the world.

Both Hamilton and Mott are concerned with the statistical problems of data reduction. Hamilton deals with the problem of behavioral data from individual organisms, whereas Mott develops the variance components in data from growing populations.

Holling's general approach is that of a very close feedback relation between experimental data and computer simulation, with the experimenter being guided in his future experimentation by the discrepancies between the simulated and the actual systems. He has been developing some fascinating results in the theory of predator-prey interaction by this technique. Pimentel reviews a series of ecological situations to emphasize the complexity of the problems involved, without attempting a detailed analysis of any one problem. Watt terminates the book with a vision of highly automated future research in ecology, somewhat reminiscent of a technocrat's Utopia.

The quality of each contribution is high. From the standpoint of an expert on computing techniques or a person looking for new insights into the analysis of highly complex problems I think the book may be a little disappointing. This is not a surprise, nor is it a denigration of the book. Some insight is provided into the very beginnings of what will be a major area of intellectual concern 20 years from now. The courage to face this now, on the part of both Watt and his publisher, should be commended.

It should be pointed out that in one sense this is not a book at all, but rather another instance of a commercial publisher's exploiting the slowness and rigid editorial policies of scientific journals. It is a comment on the scientific establishment that work in so many new and as yet uncrystallized areas is first published commercially.

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A Zoological Puzzle

So Excellent a Fishe. A Natural History of Sea Turtles. ARCHIE CARR. Published for the American Museum of Natural History by Natural History Press, Garden City, N.Y., 1967. xii + 248 pp., illus. $5.95.

Anyone who has read Archie Carr's *The Windward Road,* published in 1956, will compare Carr's new book with it. The two are basically on the same topic. The difference between them is indicated by their subtitles. That of *The Windward Road* was "Adventures of a Naturalist on Remote Caribbean Shores." That of *So Excellent a Fishe* is "A Natural History of Sea Turtles." The first book is, by comparison, lush in language, vivid with the color of places and people, but lean in information because the information was still to be obtained. The new book deals with the same places, the same people (with, however, many additions to the dramatis personae), and the same problems; but the problems now are in closer focus, and the lush scenery is in the scarcely noticed periphery. Carr's writing skill is undiminished, although those who enter the present book with the previous book in mind may suffer some disappointment until they are caught by a narrative skill that is as good at the exposition of a problem in biology as at the recounting of an incident in travel.

The problem which Carr's adventure in *The Windward Road* centered about was the "riddle of the ridley": Where did the ridley (Kemp's turtle, *Lepidochelys kempi*) breed? The solution came with the discovery of a film of the fantastic "arribada"—the nearly incredible mass egg-laying by perhaps 40,000 ridleys on a beach near Tampico, Mexico. This was the climax of a long, plodding search by Carr and the discovery of rare individual nestings.

Carr's horizon has widened now. He is heavily involved in the problems of sensory physiology in sea turtles. The difficulties are severe, since these are animals that are invisible (except for the most random contacts) during much or most of their life cycle. It is true that, if you have judged time and place correctly, the very first moments of the sea turtle's life are accessible—the moments when the hatchlings scramble in communal panic out of the buried nest (the phrase is not Carr's but it describes the way in which they stimulate and so aid each other to get out of the sand that traps them), the moments also when these hatchlings begin by some sense still ill understood to find their way to the sea. (Carr's co-workers have done great service here testing the hatchlings with colored spectacles, with colored lights, and with polarized light.) The mystery begins with the hatchlings at sea. Where they go and how they live is not known to Carr or to anyone. That they may go very far is well established; from Ascension Island to the Brazilian coast is one frequent trip that Carr discusses. The return migration some years later is even more of a mystery. How do they find their isolated mainland beaches or their islands? How does the individual turtle find these remote places, and how did the turtles in an evolutionary sense learn to find them? Carr ranges uneasily

through the ideas of imprinting, celestial navigation, chemical gradients, Coriolis force, and continental drift without finding a solution he is comfortable with. He is sure only that random wandering is "the most preposterous theory of all."

As in *The Windward Road*, Carr's climax is a lament for the disappearing species of sea turtles. His title in this latest book derives from a statement of dismay expressed by the Bermuda Assembly in 1620 at the decay even then of "so excellent a fishe." He is very pessimistic now about the prospects for sea turtles unless much more is done. He hopes that a technology of sea-turtle husbandry may be worked out, and he has begun an Operation Green Turtle for this very purpose.

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Ore-Forming Fluids

Geochemistry of Hydrothermal Ore Deposits. HUBERT LLOYD BARNES, Ed. Holt, Rinehart and Winston, New York, 1967. xvi + 670 pp., illus. $19.50.

A very large proportion of the world's metallic wealth has been extracted from mineral deposits precipitated from hot aqueous solutions that rose through the earth's crust in a variety of geologic environments. The depths and petrological nature of the sources of the solutions generally are not known. Many hydrothermal mineral deposits are associated in time and space with igneous activity and crustal disturbances, and a genetic relationship logically can be inferred. However, a wide variety of apparently hydrothermal deposits show no obvious relationship to igneous processes, and their origins have been a subject of extensive and prolonged dispute.

The 19 contributors to this carefully edited book have attempted with moderate to considerable success to inform their readers of some of the problems posed by hydrothermal ore deposits, the current status of methods and results of investigations, and the kinds of conclusions that may be reached concerning the origins and natural histories of these deposits. The problems faced and enumerated by the contributors, all well-known specialists, range from the simple to the very complex, and suggest to the reviewer the kinds of problems that might be encountered by a team of modern scientific investigators attempting to unravel the secrets and duplicate the experiments of an ancient, somewhat deranged alchemist who left behind some of the chemicals and solutions that he used and created, a few fragmentary scribbled notations on faded parchment, and an assortment of battered, corroded pieces of laboratory ware.

As might be expected, the presentations vary in depth and skill of approach, and portions of some treatments are elaborations of the ordinary or belaborings of the abstruse.

The starting point of all investigations of ore deposits must be the deposits themselves. In spite of their worldwide distribution, their very diverse geologic environments, and times of origin extending through much of geologic history, it has long been known that hydrothermal deposits, wherever they are found, have many characteristics in common. There is a general order in which ore and gangue minerals are deposited from the cooling solutions, and chemical interactions between the solutions and the rock they invade leave a relatively small number of distinctive types of alteration mineral assemblages and consistent, repetitive patterns of alterations.

By drawing on studies of actual ore deposits and laboratory investigations of many kinds and of various degrees of elegance, and by bringing together fragmentary data relating to the chemistry of aqueous solutions at high temperatures and pressures, the contributors have attempted, as far as is possible, to make a quantitative evaluation of the composition, density, temperature, and pressure of the ore-forming fluids and the kinds and rates of changes of these variables during a typical epoch of ore-deposition; but admittedly, and like the ancient alchemist, they can report only that considerable and spectacular progress has been made and that much more investigation will be required before a detailed, incontrovertible characterization of ore-forming fluids becomes possible.

The book probably was not intended to be nor will it serve well as a textbook for classroom instruction. Rather it will and should be considered as an important, authoritative reference for students of the genesis of hydrothermal mineral deposits.

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Plant Pathology

The Biochemistry and Physiology of Infectious Plant Disease. ROBERT N. GOODMAN, ZOLTÁN KIRÁLY, and MILTON ZAITLIN. Van Nostrand, Princeton, N.J., 1967. x + 354 pp., illus. $12.50.

In a discussion of plant diseases today, the student of pathology is immediately aware of the need for an understanding of the biochemical and physiological mechanisms of pathogenesis. Such information is effectively presented for the student in this book by Goodman, Király, and Zaitlin. The authors' stated purpose is to familiarize advanced undergraduate and graduate students with current research on and concepts of biochemical and physiological changes in the host as induced by the plant pathogen.

The subject matter is presented in a reasonable manner, beginning with the infection process and covering photosynthesis, respiration, cell wall composition and metabolism, nitrogen, phenol and growth-regulator metabolism, vascular transport, and toxins. All but two chapters ("The infection process" and "Toxins") present the biochemistry and physiology of the healthy plant in a condensed form, followed by individual consideration of host-induced alterations initiated by viral, bacterial, and fungal pathogens. About equal attention is given to each of the pathogens. The collating of material from three authors has been very well executed, so that transition from sections dealing with metabolism in the healthy plant to those concerned with the altered condition in the diseased plant is smooth.

The authors have succeeded in preparing a text that will fill the need of the graduate student and, for that matter, one that may also serve the established researcher. Certain important aspects of host-parasite relations have been ignored; for example, wound barrier formation and the effects of chilling on the biochemistry and susceptibility of tissues. Some discussions of cited material are handled by the authors in a conventional manner, with editorial comments; in others, references are given and the subject is terminated without any additional comment. Perhaps the most serious fault of the text is created by the general approach of the authors in including the sections on general biochemistry at the beginning of each chapter. It is unlikely that this elementary biochemical treatment of the healthy plant will be