reflects the major dilemma of the archeologists. They have been traveling with physicists and chemists for two decades now, and many have adopted the computers, the equations, and the jargon of their comrades—in fact, several of the most jargonesque papers in these volumes were prepared by archeologists who have forsaken archeology to become scientists and now write with the faith of the true believer.

The computers, equations, and jargon have their place in archeology. They lead to the objective study of objects. Archeologists always have counted and measured things they do not understand and will continue to do so, and these are just additional ways of carrying out this task. But if the end purpose of archeology is the study of subjects rather than objects, then does the objective study of subjectivity come any closer to reality than the subjective study of subjectivity? Being scientific is very popular in archeology at the moment, but I would doubt that any amount of doing science, or even publishing in a journal of that name, will ever completely remove archeology from the humanities.

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A Real Predicament

Environment, Resources, Pollution and Society. WILLIAM W. MURDOCH, Ed. Sinauer, Stamford, Conn., 1971. viii, 440 pp., illus. Paper, $5.95.

Within the past four years there have appeared probably more books treating man and his environment from the holistic and ecological viewpoint than appeared during the three decades prior to 1968. The sudden demand seems to reflect man's awakening to a real predicament which may have resulted in part from the previous dearth of such material. This collection of papers by 20 authors plus its editor, ecologist William W. Murdoch, covers the topic in greater depth, breadth, and objectivity than do the majority of similar books today.

Murdoch recommends *Environment: Resources, Pollution and Society* for "undergraduates taking courses that deal with the interaction between man and the environment, particularly interdisciplinary courses." As a source of information and ideas, the book will serve well, but as a text it does not, in my judgment, suffice. There is lacking the consistency of exposition, analysis, and interpretation which the uninitiated student requires for organizing his or her own approach to such a mass of facts and concepts. Consistency, of course, is not to be expected from among 21 authors representing the wide diversity of disciplines these do. A number of the authors do provide detailed basic expositions of their branches of science. While a number of them proceed from ecological concepts, others do not. Murdoch attempts to identify his unifying theme in the introductory chapter, "Ecological systems," reviewing the state and direction of ecology as a science, and in the summarizing final chapter, "Environment and the equilibrium population," which is a stimulating and innovative essay that extends well beyond summarization.

Murdoch's *Environment* provides a wealth of facts and ideas on man's environmental interactions: contributors include experts in economics, the law, political science, and urban sociology as well as in the biological and earth sciences. Generally, most of the major potential crises (such as pollution) or major ecological limits (depleted resources) are covered. Because the intended scope is so broad, however, most readers doubtless will identify some aspect that is either omitted or underemphasized. I find that terrestrial-ecosystem productivity and diversity are not treated adequately. Brown and Finsterbusch cover the man-food relationship in an excellent, thought-provoking statement, but choose to treat economic aspects in more detail than agronomic ones. There is no single overview of the factors that affect the capacity of land to produce food and fiber, or of the bases for diversity in this capacity, or of how man alters and can destroy this productivity. This deficiency may in part reflect the fact that the contribution (by M. Clawson) on land resources, the one disappointing paper in the volume, fails to identify productivity and diversity as primary criteria for assessing land. An excellent model of how ecosystem productivity and economics can be integrated is given by G. J. Paulik in his lucid analysis of marine fisheries. Issues in epidemiology and public health are not included. The crucial matter of human behavior as it relates to environment is not given the deserved distinction of a separate chapter. Many papers are slanted toward analysis of Western or "developed-country" situations; yet our environmental dilemmas are basically global.

Material is organized in a sequence starting with ecological concepts, then moving to the current state of things, to specific problems, and, finally, to how we put things right; but individual authors generally chose to venture beyond these boundaries. Thus Nathan Keyfitz (demographer) compares trends in population growth and birth-control efforts around the world, diagnosing these in ways more sophisticated and probably more realistic than have certain ecologists of late. Then he cleverly discusses alternative strategies for achieving a stable population, though at the last minute blenching from the consequences of not achieving this goal. Biogeologist Preston Cloud, in predicting trends in world mineral supplies, dissects the supposedly objective rationale of many economic and political spokesmen whose conclusions are considerably more optimistic than his.

Current environmental insults and hazards are well catalogued in the chapters on pollution: air (R. J. Hickey), fresh water (W. T. Edmondson), marine (F. MacIntyre and R. W. Holmes), ionizing radiation (E. Cook), and pesticides (R. L. Rudd). As with most compendia of pollution these days, the sum picture ought to alarm any thinking person. However, just how dangerous each effect is and what is the probability of occurrence for each possible degradation or catastrophe are not always clear. Although such evaluation will generally be inexact and requires considerable quantitative analysis, it is crucial to the advocates and managers who are fighting environmental battles in today's arena, where partial successes and compromises are the usual outcome.

In the final section there are several essays of notable depth and innovation. K. E. Boulding (economist) provides a novel analysis of relationships between types of human interaction (his classification) and environmental deterioration. It is refreshing to see an economist identify "bads" as negative equivalents of "goods" and treat future stability as a major economic responsibility. R. B. Smock (sociologist), in arguing that the prime function of human aggregations such as cities is enhancement of learning and cooperation, suggests that cities may be the best foci for solving environmental ills. And V. J. Yannacone (lawyer) argues that only

through the courts can there be real progress in reversing environmental degradation. Murdoch, as an ecologist, carefully weighs the complex of behavioral and economic factors standing between contemporary man and the steady state. He comes up with several noteworthy conclusions: in America the corporation as an institutional form will more likely impede than complement efforts to solve environmental problems; otherwise, the structure of political and economic systems is not as relevant to solving environmental problems as is the level of environmental awareness in the populace; and, in modeling economic and social strategies, the game ought to be optimization rather than identification of limits within which to maximize.

Overall, Murdoch's conclusions convey cautious optimism, but in no way underrate the implications of current population growth, pollution, and diminution of resources. It is commendable, in a moral sense or to be constructive, not to end on a note of despair. One should ask, however, what other prognosis could come out of the information in this book. Consider the sum result from combining trends in population and birth control (Keyfitz) with trends in resources (Cloud, Brown and Finsterbusch, Hubbert, and Paulik) and the implications of pollution (Hickey, MacIntyre and Holmes, and Rudd), then weighing this all in light of man's history of political responses. From this picture a disinterested ecologist will first recognize a species' population in irruptive growth at the same time that the carrying capacity of its environment is undergoing an accelerated decline (not merely a per capita decline). Such may lead him to predict that a precipitous downward adjustment will occur followed by marked instability for some time. Given the degree of ingenuity with which this species exploits and manipulates its environment, and given its flexible behavior, the ecologist will predict neither when nor how the adjustment will occur. The most frustrating aspect of analyzing man's present dilemma is that while we are now capable of predicting with high probability one or more of a series of unpleasant events, we cannot yet identify which of the events will occur first or where or when.

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Irradiated Water

The Radiation Chemistry of Water. IVAN G. DRAGANIĆ and ZORICA D. DRAGANIĆ. Academic Press, New York, 1971. xii, 244 pp., illus. $14. Physical Chemistry, vol. 26.

In 1961 Allen's excellent book *The Radiation Chemistry of Water and Aqueous Solutions* was published. *The Radiation Chemistry of Water* by the Draganić team is a timely successor. Pulse radiolysis was introduced only two years before Allen's book appeared, but since then radiation chemical research has been dominated by pulse radiolytic investigations into the chemical behavior of short-lived species. The organization and shift in emphasis in the Draganić work appropriately reflect this. The authors have felicitously organized the presentation around well-chosen major topics, one for each of eight chapters. The subject coverage is thorough for a book of only 244 pages which attempts to deal with "radiation-induced changes in water and, to the extent necessary to explain the behavior of irradiated water, changes in aqueous solutions."

The initial, historical, chapter conveys a feeling for the problems encountered and solved in arriving at our present knowledge of aqueous radiation chemistry. (The book as a whole describes many of the principal questions currently under active investigation.) Next the authors consider the interaction of ionizing radiation with water, as derived from radiation physics, and the probable pathways of formation of active species, presumably in nonhomogeneous spatial distributions. Much knowledge gained through pulse radiolysis research is correlated in two chapters on the primary products of water radiolysis: on the reducing species—the hydrated electron, the hydrogen atom, and molecular hydrogen—and on the oxidizing species—the hydroxyl radical and hydrogen peroxide. Listed are some of the hundreds of rate constants measured for these transients by pulse radiolysis. The yields (radicals per 100 electron volts absorbed energy) of primary products, a topic of great interest in the 1950's and a major research interest of the authors, is covered in chapter 5. Perhaps their interest is justified, since with the newly developed picosecond pulse radiolysis techniques one enters the temporal and spatial domains in which these yields arise. Work on the diffusion-kinetic theoretical model, which explains with some success the observed primary radical and molecular yields, is described in chapter 6. Essential experimental radiation chemical methods and measurements are found in the last two chapters.

Finally, why a book on the radiation chemistry of water? The authors note the practical importance of aqueous radiation chemistry for nuclear reactors and in the medical use of x-rays. They also emphasize, but not sufficiently, the contributions radiation chemistry has made to the general field of chemical kinetics, first with competition studies and then with direct measurements of rate constants by pulse radiolysis.

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Wood Chemistry

Lignins. Occurrence, Formation, Structure, and Reactions. K. V. SARKANEN and C. H. LUDWIG, Eds. Wiley-Interscience, New York, 1971. xxx, 916 pp., illus. $35.

The appearance of this long-awaited book marks a milestone in the progress of lignin science. The age of pioneering is over. For the first time the subject has been broached in such a manner as to make it teachable material rather than the traditional obscure alchemy into which the famulus could be initiated only by prolonged contact with the aged and wise magister.

In contrast to its predecessors, which have been either largely uncritical synoptic organizations of all the published literature or subjective reports covering mainly the output of a single school, this treatise on lignin sifts and weighs knowledge accumulated from over a century of thought on nature's most enigmatic polymer and presents a workable, logical text. The senior editor, who is emerging as a leading educator in wood chemistry at the increasingly active College of Forestry at the University of Washington, has succeeded in impressing on his collaborators his own broadminded, didactic approach.

The volume is well organized into nine parts comprising 19 chapters. After a short introduction in which terms and concepts are defined, the occurrence and formation of lignins in plants and their differentiation and distribution are described. The next part