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.

P. A. JORDAN
School of Forestry, Yale University, New Haven, Connecticut

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.

MAX S. MATHESON
Chemistry Division, Argonne National Laboratory, Argonne, Illinois

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

compares natural and laboratory-produced lignins and their structures. Chapters on ultraviolet, infrared, and paramagnetic resonance spectra follow in part 4. Lignin reactions, including solvolysis, halogenation/nitration, oxidation, reduction/hydrogenolysis, and high energy breakdown, are dealt with in the next six chapters. Lignin reactions in the technologically important sulfite and alkaline pulping processes are described next. The physical chemistry of the lignin macromolecule and its modified forms is then well covered. The two final parts deal with microbiological breakdown of lignin and utilization of lignins, first as a source of chemicals and then as unchanged polymers. Expectedly, the contributions vary widely in length and quality, but all provoke enthusiasm and thought. Only the section on biological deterioration of lignin is rather weak, perhaps reflecting inadequate input from or consultation with biologically oriented workers in the field.

Many may find $35 excessive for a book reproduced photomechanically from typescript, with unesthetic line-end irregularities and some minor typographical errors, but the formulas and figures are clean and generally understandable, and, on deliberation, the price seems reasonable recompense for the marathon effort invested in producing the first text on lignin that is suitable for educating newcomers to the field.

JOHN M. HARKIN
Division of Wood Chemistry Research, U.S. Forest Products Laboratory, Madison, Wisconsin

Ostracoda

Colloque sur la Paléoécologie des Ostracodes. Colloquium on the Paleoecology of Ostracodes. Pau, France, July 1970. H. J. Oertli, Ed. Société Nationale des Pétroles d'Aquitaine, Pau, 1971. 954 pp., illus. 150 F. Bulletin du Centre de Recherches Pau-SNPA, supplement to vol. 5.

Compared to other microscopic organisms, Ostracoda have outstanding potential for providing information concerning salinity, temperature, currents, and other aqueous conditions in the past. These little crustaceans have some advantages over the one-celled Foraminifera, which already have been found valuable for interpreting paleoecology: ostracods thrive in fresh and brackish water where forams cannot survive, and they were abundant and diverse in the Paleozoic, at which time forams were represented mostly by irregular agglutinated types.

Each ostracod of the distant past is assumed to have lived in an environment much like that in which its descendants flourish. Interpretation involves two factors. First, the relationship of the fossil to the living ostracod must be firmly established by taxonomy. Second, the ecology of living ostracods must be known in detail. Extinct taxa pose a special challenge, but even they can be compared against morphologically (and presumably functionally) similar living forms.

Research on Ostracoda has accelerated in recent years. Over half the genera were founded in the last two decades. In the early 1960's the ostracod volumes in the American *Treatise on Invertebrate Paleontology* and the Russian *Osnovy Paleontologii* appeared in quick succession, contributing greatly to taxonomy. Colloquiums held in Naples (1963) and Hull (1967) emphasized the ecology of Recent ostracods. The time was right for an attack on the more difficult problem of ostracod paleoecology. At a colloquium called in Pau, France, in 1970, 84 ostracodologists met for formal presentation of papers and subsequent discussion. More than half were from France, the United States, and Britain, but others came from as far as Israel, Japan, Yugoslavia, and Gabon. The results are impressive.

The 53 published papers (in French or English) cover Ostracoda geologically from Devonian to Recent times and geographically from western Canada to the Kouznetsk Basin. Most either analyze in detail the fauna in a local area or report on geographic distributions of faunas of a particular age. As might have been expected, a few contributions fail to fit the theme of paleoecology: two about classification and one about morphology. Of the numerous new concepts in the interpretation and utility of fossil ostracod occurrences, a few of the highlights can be mentioned here. T. I. Kilenyi discusses various methods of distinguishing the biocoenosis, citing ambiguities arising from postmortem displacement. Vladimir Pokorný uses diversity of the fossil ostracod community to identify transgressive and regressive movements of the sea. H. J. Oertli interprets environments of deposition based solely upon the preservation of ostracods; this is an intriguing approach, independent of taxonomy. Kaesler and Taylor investigate the possibilities of cluster analysis, and Jacobzone and Carbonnel apply Jaccard's coefficient to correlation of Miocene faunas. Articles of more than local interest include K. G. McKenzie on the paleozoogeography of freshwater Ostracoda, D. Ter Keurs on assemblages in transgressive/regressive sequence, and F. Adamczak on ostracod assemblages in Middle Devonian rocks.

The progress made at the colloquium fulfilled all expectations, probed new insights, and suggested lines for future research. Although ostracod paleoecology is still in the exploratory stage, it promises to be a major means of understanding the geologic past.

ROBERT V. KESLING
Museum of Paleontology, University of Michigan, Ann Arbor,

Respiration

Comparative Physiology of Respiratory Mechanisms. JOHAN B. STEEN. Academic Press, New York, 1971. x, 182 pp., illus. $10.

An objective of the comparative physiologist is to describe the means by which different organisms solve similar basic physiological problems. The solutions achieved by the animals depend on many factors, including their size and complexity and the nature of the habitat in which they live. In this book the problem at issue is respiratory gas exchange, and solutions to it are described and discussed for animals ranging from Protozoa to man.

The main themes of the book concern the diffusion of gases (oxygen and carbon dioxide) across the (respiratory) interface of the animal and its environment and the transport of these gases between this region and the tissues. For the general reader an introductory chapter is provided which discusses the basic principles of these processes. The largest part of the book is organized according to the respiratory medium involved—aquatic, aerial, or transitional. Later chapters provide brief discussions of specialized topics such as respiratory adaptations to altitude and diving, gas exchange of the placenta and the bird egg, and swimbladder function. Throughout the book, the author chooses examples of the phenomena he deals with and examines them quantitatively.

This book might be considered a