more attention has been given to this aspect of the problem in recent years.

For both human and aquatic populations the greatest uncertainty in assessment of the possible effects of the prolonged, very low-level exposures that typically follow from environmental contamination arises from the extended extrapolations that must often be made from experimental results obtained at high doses and dose rates.

This difficulty is neatly underlined by the first of the 30 papers that make up this volume. Templeton has assembled the available information concerning the dose rates to aquatic organisms from the transuranic radionuclides in contaminated environments and finds that they are comparable to those to be expected from the natural background. In laboratory studies of the response of developing fish embryos to the α-radiation from uranium-232 and plutonium-238 no damaging effects were noted until the estimated dose rates were many orders of magnitude greater. This does not necessarily mean that there are no detrimental effects in contaminated environments; it may mean that the criteria of effect are either inappropriate or insufficiently sensitive.

There are, however, some welcome signs that the dose rates employed in laboratory experiments are moving down toward values that might be termed environmentally relevant, that is $\lesssim$ 1 rad per day. Hyodo-Taguchi describes effects on the spermatogonial cell population, gonadosomatic index, and fecundity of fish at dose rates below 10 rads per day from both accumulated tritium and an external cesium-137 γ-ray source. Higuchi *et al.* report finding the fecundity of brine shrimp to be affected at a dose rate of 27 rads per day from accumulated tritium at the lowest concentration used. Several other papers describing the effects of both short- and long-term irradiation provide additional evidence that damage to the developing and mature gonad and the consequences for fertility and fecundity may be the most significant effect for populations of aquatic organisms in contaminated environments.

A natural extension of these studies that is of particular interest is the continuing field investigation at the Oak Ridge National Laboratory of a natural population of mosquito fish in a contaminated lake. It has been concluded that radiation-induced recessive lethal mutations in the population are responsible for the increased production of nonviable embryos relative to controls (Blaylock and Frank). Schröder reports studies of the mutagenic effects of parental irradiation on quantitative traits in fish that are under polygenic control. He presents evidence for a greater radiosensitivity than has been found for the qualitative traits determined by specific loci. If confirmed, these results will be of significance in a wider context than contaminated aquatic environments.

The many typographical errors, which may be more than a nuisance to readers for whom English is not the mother tongue, detract from an otherwise well-produced book.

Perhaps inevitably in a collection of this nature, the quality of the papers is variable, but there is sufficient material of interest to make the book a worthwhile acquisition for those professionally concerned with the effects of radiation in aquatic environments.

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The book review editor is attempting to make a collection of writings about the reviewing of scholarly books, and particularly scientific ones. Any references readers can provide to such writings would be appreciated.

Carbon Dioxide

Biophysics and Physiology of Carbon Dioxide. Papers from a symposium, Regensburg, Germany, Apr. 1979. C. BAUER, G. GROS, and H. BARTELS, Eds. Springer-Verlag, New York, 1980. xiv, 456 pp., illus. $43.70. Proceedings in Life Sciences.

This volume, which contains the 51 papers (but not the ensuing discussions) presented at a symposium, provides an excellent representative cross section of current investigations of and ideas about the molecule that Roughton once spoke of as the "junior partner of oxygen."

The book begins with a review of the physical properties of CO_2 and its reaction with water and a description of the pressure-jump technique for studying the kinetics of such reactions. This is followed by discussions of mechanisms involved in and the importance of carbonic anhydrase to the facilitated transport of CO_2 and H^+ in various artificial systems and presentation of evidence that facilitated diffusion does indeed occur in muscle. It appears that facilitated diffusion is mainly translational, with HCO_3^- and mobile buffers as carriers for CO_2 and H^+ respectively, and that carbonic anhydrase is essential to the process.

The second section of the book is devoted mainly to the chemistry and physiological significance of the carbamate reaction of CO_2 with hemoglobin and other biomolecules. The reaction occurs not only with proteins but also with the peptides—angiotensin, bradykinin, and glucagon—and it is suggested that this reaction may play a regulatory role in the hormonal activity of these substances.

About three-quarters of the book deals with carbonic anhydrase—its structure, its chemistry, and its physiology. The several isozymes of carbonic anhydrase are being studied by x-ray diffraction, nuclear magnetic resonance, and amino acid sequencing. Some of the studies have been enhanced by the fact that the Zn^{2+} of this metalloenzyme can be replaced by a number of other divalent metal ions, which are spectroscopically or magnetically useful. Only with Co^{2+}, however, is enzymatic activity largely retained, although some activity remains with Cd^{2+} and Mn^{2+}.

Questions remain about the active site and exact mechanism of the catalytic hydration of CO_2, but the basic steps include binding by the enzyme of CO_2 and H_2O, breaking the O–H bond in water, formation of an O–C bond, dissociation of HCO_3^-, and dissociation of H^+. That the rate of the last step is dependent on buffer concentration can be demonstrated by measuring the exchange of ^{18}O between CO_2 and H_2O. This exchange reaction is also used to study carbonic anhydrase activity within red blood cells. Although both the hydration and dehydration reactions are rapid when catalyzed by carbonic anhydrase, they probably never come to complete equilibrium during the normal residence time in a mammalian capillary. Factors suggested to account for this delay are the time required for Cl^--HCO_3 exchange between red cells and plasma, the lack of carbonic anhydrase in plasma, and the time required for carbamino reaction.

Carbonic anhydrase has been demonstrated to exist not only in red cells, where it was originally discovered, but in a wide variety of tissues, such as lung, striated muscle, renal tubules, brain, osteoclasts, and chorioallantoic membrane. Histochemical methods for the localization of carbonic anhydrase include cobalt precipitation, autoradiography with ^3H acetazolamide, and immunocytochemistry. Most of what we know

about the physiological functions of carbonic anhydrase has been deduced from experiments in which its activity was reduced or abolished by specific inhibitors such as acetazolamide. The physiological significance of carbonic anhydrase differs somewhat in different tissues, but the general statement can be made that carbonic anhydrase is important in any situation where the formation or dissolution of HCO_3^- is a potentially rate-limiting step in the transfer of HCO_3^- (and often of other ions as well) across cell membranes.

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