systematically pursued and coordinated with the results of the field searches.

Muhly ends his book with the comment that it is only the beginning of his research. Much work indeed is being accomplished each year by him and his scientist-colleagues. It will be useful for the reader of the book to consult some of the recent progress reports and summaries—for example, J. D. Muhly, "Tin trade routes of the Bronze Age," *Am. Sci.* **61**, No. 4, 404 (1973), and T. A. Wertime, "The beginnings of metallurgy: A new look," *Science* **182**, 875 (1973)—as an introduction to and summary of the modern state of the problems. These articles also offer maps which the book does not provide. They could inspire the reader to give up consecutive reading of *Copper and Tin* in favor of selective consultation, to which the book is and will remain especially suitable and through which its valuable contributions will be best discovered.

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Muscle Pigment

Myoglobin. Biochemical, Physiological, and Clinical Aspects. LAWRENCE J. KAGEN. Columbia University Press, New York, 1973. xiv, 151 pp., illus. $10. Columbia Series in Molecular Biology.

Research on myoglobin has been overshadowed by that on its larger cousin, hemoglobin, but this muscle pigment is coming into its own. The transport of O_2 from intracorpuscular hemoglobin in the capillaries to the cellular sites of its reduction is under intense investigation today, stimulated in part by apparent changes in tissue O_2 partial pressure (pO_2) and O_2 delivery produced by changes in the affinity of hemoglobin for O_2. These results have come both from studies on laboratory animals and from a spectrum of clinical findings. Myoglobin is widely distributed in muscle, which represents some 40 percent of vertebrate body mass, and is assumedly involved with O_2 transport. Therefore its respiratory function should be of great significance in total body metabolism, and yet certain critical knowledge about it is lacking today.

This book, one of the Columbia Series in Molecular Biology edited by Ernest Borek, provides an up-to-date synopsis of our knowledge about myoglobin for the reader with basic knowledge in the field. It is weighted in favor of the interest of the author in an immunological approach to the study of myoglobin. Physical chemistry is presented rather briefly; for example there is no mention of the kinetics of the reaction of oxygen and myoglobin, while the amino acid sequences of myoglobin of various species are dealt with extensively. The book contains a brief history of our knowledge of myoglobin, a discussion of its biochemical aspects, including excellent tabular summaries of the amino acid sequences, and of its physiology, including its distribution in the tissues of a variety of animals, its localization in cells, factors altering its concentration in the tissues, and its synthesis and degradation. These are followed by a discussion of immunological studies and a large chapter on clinical aspects such as genetic variants and conditions characterized by myoglobinemia and myoglobinuria. Important matters of present uncertainty such as the existence of fetal myoglobin and the precise localization of myoglobin in the muscle cell are pointed out and the evidence summarized. I would have preferred that more attention be given to the greater question, that of the function of myoglobin.

The book is clearly written, eminently readable, and conveniently small. It represents a practical compromise between an introductory text and a review *in extenso*. The paper is unglazed, to the reviewer's pleasure. In spite of the small size of the book, the bibliography contains more than 500 references.

The book is recommended for the clinician or basic scientist with an interest in the physiology and pathophysiology of muscle. Even the expert will profit.

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Symbionts

The Lichens. VERNON AHMADJIAN and MASON E. HALE, Eds. Academic Press, New York, 1973. xiv, 698 pp., illus. $35.

Lichen formers make up about half of the some 50,000 species of the Ascomycetes, the largest group of the Fungi. The Ascomycetes that early took up life with algae abandoned their saprophytic origins and invaded the harshest habitats (bare rock, for example), where competition was low or nil, and there they diversified. Most mycologists cannot name to genus the commonest lichens that they see around them, and textbooks of mycology regularly dismiss the lichens with a page of platitudes on symbiosis. For all its merit *The Fungi: An Advanced Treatise,* edited by Ainsworth and Sussman and with volumes appearing since 1965, also overlooks this conspicuous mass of Fungi, and, aware of this, the publishers commissioned the present book on the lichens, which offers a broad yet scrupulously detailed synthesis of an astonishingly diverse literature.

Nineteen chapters deal with every major area of contemporary lichenology: structure and development, physiology and ecology, chemistry of secondary natural products, symbiosis, and systematics. All the chapters are in English, but strangely no mention is made of the fact that some are translations. The lack of any appreciable overlap among the papers points to a careful collation of the contributions of the 23 authors (representing 11 nationalities) by the editors.

The Lichens is filled with outstanding reviews. For example, an article entitled "Sexual reproduction" becomes Letrouit-Galinou's vehicle for discussing the highlights of 25 years' work on the structure of the ascus and ascocarp by Chadefaud's group in the Sorbonne. The large, convoluted, almost exclusively French literature on this subject has never before been summarized in English. Peveling brings order from the many recent fine-structural studies on the individual symbionts and on the nature of their physical contact. Richardson describes the elegant experiments on carbohydrate movement between symbionts carried out by D. C. Smith and his co-workers at Oxford. The fantastic temperature extremes and water stresses that lichens endure and that account for much of their unique ecology are masterfully summarized by Kappen in one of the book's longest and best chapters. But perhaps most telling of all are the chapters that are not there. There is no "Paleontology," for these ancient double organisms left no fossil record; and there is no "Genetics," reminding us that in this vast group still not even so much as one unequivocal chromosome number is known.

Why have the abundant lichens not been even more extensively studied?

Biologists have complained that lichenology is esoteric and that getting into research on lichens is hard. *The Lichens* not only opens the door upon these organisms as research subjects but also points to the most promising directions for future work. For the general reader, this book gives the best available view of the life of the lichen, evolution's *chef d'oeuvre* of symbiosis.

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Quantitative Marine Biology

Biological Oceanographic Processes. TIMOTHY R. PARSONS and MASAYUKI TAKAHASHI. Pergamon, New York, 1973. x, 186 pp., illus. $12.

The classic textbook in oceanography, *The Oceans* by Sverdrup, Johnston, and Fleming (Prentice Hall), was published in 1942, before the postwar explosion of oceanographic research. Since then it has become more and more difficult to comprehend the subject within one book or even to describe one part of the subject in the manner of Sverdrup *et al.* Thus it is necessary for any author to adopt a point of view from which to look at his part of the seas, and the value of any treatment depends on this choice. Parsons and Takahashi consider that the study of pelagic marine organisms now has the kind of quantitative rigor usually associated with the more fundamental or experimental aspects of biology. Gone are the descriptions of oddities to be found in the deep sea. Instead we have a discussion of regularities in biochemical composition and the rates of transformation of energy. Thus this book can be considered not only as a detailed review of certain special aspects of biological oceanography but also as an attempt to show the coming of age of this subject.

The first two chapters deal with the "statics" of plankton. Because of the stance taken, the variety of species of phytoplankton and zooplankton are dealt with perfunctorily, fuller treatment being replaced in part by a description of methods of measuring particle size (an enterprise in which Parsons has played a leading role) and a discussion of the importance of such measurements. The chapter on chemical composition provides a comprehensive review of the literature.

The main part of the book is concerned with the dynamics of plankton growth. The modeling of ecosystems is now in vogue, but such models depend for their realism on the adequacy and accuracy of estimates of rates of change of the components. This book provides a valuable source of information on these building blocks for pelagic ecosystems, the functional relation of phytoplankton growth to nutrients and light, the dependence of zooplankton feeding on particle concentrations, the relative importance of microbial heterotrophic processes, and so on.

The last parts of the book deal with possible applications to questions of estuarine water quality, and fish stock recruitment, as a function of variable food supply. By implication the authors indicate that the potential usefulness of the results lies in the consideration of the details of practical problems.

The book admirably fulfills the aim of providing a source of quantitative expressions of near-surface pelagic phenomena. In parts, particularly the earlier chapters, the compression of information makes for difficult reading, but this will be a valuable reference work for students, engineers, and others requiring information in this field. This is the stated aim of the authors, but beyond this, and especially in the later chapters, the book, by the accumulation of detail, gives an opportunity to evaluate the present status of the subject as a scientific discipline.

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Karyotypes

Cytotaxonomy and Vertebrate Evolution. A. B. CHIARELLI and E. CAPANNA, Eds. Academic Press, New York, 1973. xvi, 784 pp., illus. $41.

This is a book of exceedingly uneven quality. It is clear, from the concluding chapter by Capanna, that the editors had hoped at the outset to be able to read some kind of taxonomic sense into the many accurately documented vertebrate karyotypes which have been published since the late 1950's. It was about this time that several simple but most fruitful technical innovations were introduced to vertebrate karyology, notably the use of spindle-arresting agents and hypotonic treatment before fixation.

In the event, the editors' hopes have manifestly not been realized, so much so that Capanna amusingly refers to the demonstration in 1970 that two closely related species of deer have diploid numbers of 46 and 6 (or 7 in the male) respectively as the "Muntjac Scandal"!

Miller and Bakken's early chapter "Ultrastructure of genetic activity in vertebrate chromosomes" is out of context in a book such as this. Romanini's survey of DNA C-values suffers from abominable translation into English, so poor as to be obscure in many places. Mancino's chapter on lampbrush chromosomes is scarcely more than a list of references. White has provided a balanced review of chromosomal rearrangements. Koulischer has written on chromosome "evolution" in cell cultures, again a subject that is not really relevant to this book.

Chapters by Colombera on karyotypes of lower chordates, by Potter and Robinson on karyotypes of cyclostomes, and by Morescalchi on karyotypes of amphibians are of some limited interest, but information on the fish is restricted to a checklist of chromosome numbers assembled by the editors. Gorman has written a scholarly and valuable chapter on the karyotypes of reptiles, as also have Ray-Chaudhuri on birds, Sharman on monotremes and marsupials, and Matthey on eutherian mammals. Vorontsov has surveyed sex-determining mechanisms in the chordates in rather mundane fashion (he fails to mention the clear-cut evidence for female heterogamety in *Pleurodeles* and *Ambystoma* obtained by Gallien and by Humphrey respectively by breeding from sex-reversed animals, and Lacroix's confirmatory comparison of the lampbrush chromosomes of normal and sex-reversed *Pleurodeles*). Ohno has written a provocative chapter in which he compares sex-determining genes with regulatory genes in the sense of Jacob and Monod.

There is no mention in this book of recent advances in the fine-scale analysis of karyotypes by Giemsa-banding and fluorescence techniques, nor of in situ hybridization revealing the distribution of highly reiterated base sequences in the chromosomes of several vertebrates, including man.

Considered all round, this book is an ill-conceived hotchpotch, and it certainly does not do justice to its title.

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