edge of spatial pattern within benthic communities. The largest size category, the megafauna, figures more prominently in chapters on vertical zonation by Carney, Haedrich, and Rowe and on geographic patterns of species diversity by Rex. Finally, reviews of physiological adaptations by Somero, Siebenaller, and Hochachka and of parasitism by Campbell are based largely on data from fish, though the general conclusions in both cases are probably applicable to other taxa.

Readers familiar with the deep-sea biological literature will expect, and find, excellent contributions from such a list of authors. On the other hand, those unversed in the problems of sampling this most difficult and inhospitable environment may be shocked to find just how small are the data sets on which so much of our knowledge of two-thirds of the earth's surface is based. Developments in ecological theory and statistics have clearly outstripped the field biologist's ability to collect relevant samples.

It is a reflection on the inordinately long gestation period for books of this kind that many of the chapters in *Deep-Sea Biology* are already quite dated; this may explain why two of them carry rather pointed submission dates of 1977 and 1979. Did the authors insist?

In most cases, and for most readers, the delay in publication is of no great importance, since deep-sea biology is hardly advancing at the rate of cell biochemistry. But in one instance the editor has been particularly unfortunate, for, though the book incorporates the most startling discovery of recent years, that of the hydrothermal vent communities, it almost completely missed a less dramatic but potentially even more significant development. The recent indications that the assumedly stable abyssal environment may be subjected to major seasonal variations in the supply of food threaten one of the basic tenets of the subject and many of the interpretations in this volume that are tacitly based on it.

Nevertheless, the book is a timely, well-written, and valuable source for students, teachers, and research workers, not only providing an almost up-to-date account of what is known but also pointing out the principal areas of ignorance. For an old-fashioned and non-numerate biologist it is heartening to find that the main recurring *cri de coeur* in almost every chapter is for more natural history.

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Fibrinogen and Fibrin

Molecular Biology of Fibrinogen and Fibrin. MICHAEL W. MOSESSON and RUSSELL F. DOOLITTLE, Eds. New York Academy of Sciences, New York, 1983. x, 672 pp., illus. Cloth or paper, $135. Annals of the New York Academy of Sciences, vol. 408. From a conference, June 1982.

For almost half a century fibrinogen has been one of the most intensively studied proteins. Work on fibrinogen got under way not only because of its medical importance as a precursor of intravascular and extravascular fibrin in humans but also because it is present in plasma at high concentrations and is relatively easily isolated through classical salting-out and ethanol-fractionation techniques. The stated purpose of these proceedings is to provide a summary of knowledge about fibrinogen and fibrin that could serve as a definitive source of information for workers in this field. The book achieves this goal, being the most comprehensive of the many monographs on fibrinogen in recent years.

The book is an unqualified tribute to early workers in the field and to their astuteness in predicting essential structural features in the fibrinogen molecule and the essential molecular events in the fibrin self-assembly reaction. The elongated shape of the fibrinogen molecule, the trinodular structure of the protein, the self-assembly of monomeric fibrin molecules following removal of fibrinopeptides in a staggered overlapping arrangement to form intermediate polymers, and subsequently the three-dimensional structure of the fibrin network gel were accurately predicted in the late '40's and the '50's. John Ferry, Harold Scheraga, and Henry Slayter, all instrumental in these early developments, have contributed to this volume their early as well as their most recent data.

By 1982 the complete primary structure of this large protein (molecular weight, 340,000) had been established in the laboratories of Agnes Henschen and Russell Doolittle and the disulfides that link the six different peptide chains of the identical halves of the molecule had been correctly assigned. The elucidation of the complete amino-acid sequence allowed for assignment of different domains in the molecule; the alpha-helical coiled portions of the six peptide chains link the central E domain, comprising the amino terminal portions of the chains, and the two peripheral D domains, comprising the carboxy terminal portions of the chains. Such domains were accurately predicted from electron micrographs by Hall and Slayter in 1959. Several papers present electron-microscope images produced through modern-day techniques, including scanning-transmission electron microscopy capable of visualizing unstained protein molecules, and all of them confirm the trinodular structure of fibrinogen. With better resolution, the outer nodules can now be resolved into two subcomponents. High-resolution micrographs by Erickson and Fowler also beautifully demonstrate that the earliest fibrin protofibrils are assembled in a staggered overlapping arrangement. Examination of proteolytically modified fibrinogen crystals in the electron microscope reveals five nodules; in addition to a central nodule and a nodule at each end, there is a nodule midway between each end and the center. This pair of nodules is thought to represent a major cleavage site for plasmin in the fibrinolytic process.

Detailed studies of the highly orderly degradation of fibrinogen and fibrin by plasmin are treated in another section. The studies have provided additional understanding of the complex structure of these molecules, fully confirming that there are discrete molecular domains. The mapping of the discrete amino-acid sequences that interact during fibrin self-assembly is also covered extensively. Although the sequences representing residues 17 to 19 in the $A\alpha$ chain and residues 374 to 411 in the γ chain seem to be involved in the self-assembly, there is substantial evidence that additional binding sites exist, which await further clarification.

An impressive section of the book deals with the major progress made in the study of fibrinogen biosynthesis and the genotypical expressions of the three fibrinogen chains. Progress was spearheaded through the work of Crabtree and colleagues, Chung and colleagues, and Fuller and colleagues and is discussed in the book by these groups. The exact events that allow three different genes to be coordinately transcribed, the resultant messenger RNA's to be processed, each messenger RNA to be translated, and the nascent peptide to be translocated, proteolytically processed, glycosylated, folded, and covalently cross-linked with five other subunits to make a functional protein are under intense scrutiny. Work on this subject is likely to produce results applicable not only to the regulation of the fibrinogen gene but to gene regulation in general.

Another section of the book deals with the interactions between fibrinogen and

cells and fibrinogen and cell surface proteins such as fibronectin. Hawiger and Niewiarowski discuss impressive data that have emerged from their laboratories concerning the exact amino-acid sequence in the fibrinogen molecule, that is, the carboxy-terminal portion of the γ chain responsible for the binding of fibrinogen to activated platelets, an event that appears essential in normal platelet aggregation. The detailed studies pioneered by Mosher also tell us of the exact domains in fibrinogen and fibronectin that allow these two molecules to attach noncovalently and covalently.

Several years of work in Henschen's laboratory had by 1982 provided information on the discrete amino acid switches in ten cases of dysfibrinogenemia. (At this time, the number of abnormally functioning fibrinogens that have been characterized has doubled.) This information is beginning to pay off in an understanding of the function of normal fibrinogen.

Although much information is needed in the form of high-resoultion x-ray diffraction patterns before we can completely comprehend the three-dimensional structure of fibrinogen and fibrin, comprehension is clearly within our reach. Although work on the genes of the fibrinogen chains has just begun, the impressive progress made so far makes it reasonable to expect that the next few years will provide much clarification concerning the regulation of the fibrinogen genes as well as the genotypical features of the major inherited fibrinogen disorders, the afibrinogenemias and the dysfibrinogenemias. The book provides strong reassurance that we will soon understand the conversion of fibrinogen to fibrin.

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Invertebrate Lineages

Crustacean Phylogeny. FREDERICK R. SCHRAM, Ed. Balkema, Rotterdam, 1983 (U.S. distributors, MBS, Salem, N.H.). xii, 372 pp., illus. $38. Crustacean Issues, 1. Based on a symposium, Dallas, Dec. 1981.

A revival of interest in the phylogeny of Crustacea has occurred in recent decades, stimulated by such developments as Manton's proposal that the Arthropoda are polyphyletic, the discovery of new classes of Crustacea apparently possessing ancestral characters (Cephalocarida and Remipedia), evidence from new fossils, and the availability of cladistic methods for constructing family trees. This revival has produced debate on a number of issues, some of which are considered in this volume. Three authors discuss the validity of Dahl's class Maxillopoda. Grygier argues that it is a natural taxon and enlarges it to include Hansen's Y-larvae and, on the basis of sperm morphology, the Pentostomida. Newman reconstructs the probable developmental stages of the ancestral malacostracan and suggests how the Maxillopoda evolved by pedomorphosis from the 11th of the proposed 14 stages. Boxshall rejects the Maxillopoda and finds within the group three independent lineages whose evolution has been guided by functional adaptations. The largest group of Maxillopoda, the Copepoda, and their diversity are the subject of a rather recondite essay by Marcotte, which includes an introduction to ancient Greek philosophy. The phylogeny of the Ostracoda, sometimes excluded from the Maxillopoda, is treated by McKenzie, Müller, and Gramm, with a good discussion and illustrations of the recently discovered Cambrian phosphatocopids with fully preserved appendages.

Other issues involve the caridoid facies and the carapace. Did the ancestral malacostracan conform to the caridoid facies, and did it have a carapace? Hessler answers yes to both questions in unequivocal terms. Dahl believes that eumalacostracan orders evolved from ancestors that lacked a carapace but had the caridoid escape reaction of suddenly flexing the abdomen and tail fan forward. In his view isopods and amphipods did not lose their carapaces during evolution but never had them.

The Peracarida and its components are considered by three authors. On the basis of the analysis of six characters, Watling abolishes the Peracarida, places the Spelaeogriphacea, Cumacea, Tanaidacea, and Thermosbaenacea in Schram's superorder Brachycarida, transfers the Mysidacea to the Eucarida, and raises the Amphipoda and Isopoda to superfamily rank. Useful papers on the Amphipoda and Tanaidacea are contributed by Bousfield and Sieg, respectively.

Kunze gives arguments for recognizing the Hoplocarida as a subclass of Malacostraca rather than a superorder within the subclass Eumalacostraca. In this she is supported by Dahl and Schram but opposed by Hessler.

Three papers deal with the Decapoda. Felgenhauer and Abele find four independent evolutionary lines of shrimplike forms, Dendrobranchiata, Procarididea, Stenopodidea, and Caridea, but suggest that the last is heterogeneous. Rice reviews the evidence available from zoea larvae for the pathways of evolution in crabs but warns of pitfalls in basing phylogeny on larval characters. Burkenroad, long recognized for his pioneering work on peneid shrimp systematics, finally publishes his key to the taxa of peneids (Dendrobranchiata), a key that has been available in some circles for many years. It is good to finally have this key published, but unfortunately Burkenroad did not update it to include recent advances in peneid taxonomy, especially those of the distinguished peneid specialist Perez Farfante. Burkenroad's curt dismissal of Perez Farfante's important contributions in three footnotes is inexcusable, in my opinion.

This volume will not end debate on any issues of crustacean phylogeny, but Schram has done us a service by making available, conveniently, the pros and cons of many of the issues. I recommend this book to anyone interested in the evolution of Crustacea.

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