and temporal kinetics is considerably greater than the time of survival of single channels in patches. (iii) Single-channel records taken with a cell attached may differ drastically from those taken in excised patches.

Although it has been difficult up to now to show much relationship between microscopic and macroscopic currents, the single-channel data open up a whole new array of previously unexpected detail, both in multiple time-constant kinetics with several kinds of bursting and in multivalued channel conductances. It appears that this situation might be analogous to that encountered earlier with atomic spectra (with fine and hyperfine structure), for which the necessary resolution and consolidation were provided by Bohr.

In contrast to the frequently observed lack of coherence in a volume generated from a meeting, this book is a rather tightly integrated mix of "how to" (for example, recipes for making pipettes and cell suspensions), richly detailed descriptions of methods for data analysis (including computer programs for filtering and detection), and scholarly analyses of electronic circuits and the underlying theoretical basis for the interpretation of the channel kinetics. The 1981 article by Hamill *et al.* is reprinted in an appendix.

The book should remain a landmark in the field of membrane biophysics. I appraise it as a "must" book for anyone who is now using or intends to begin research employing patch clamps.

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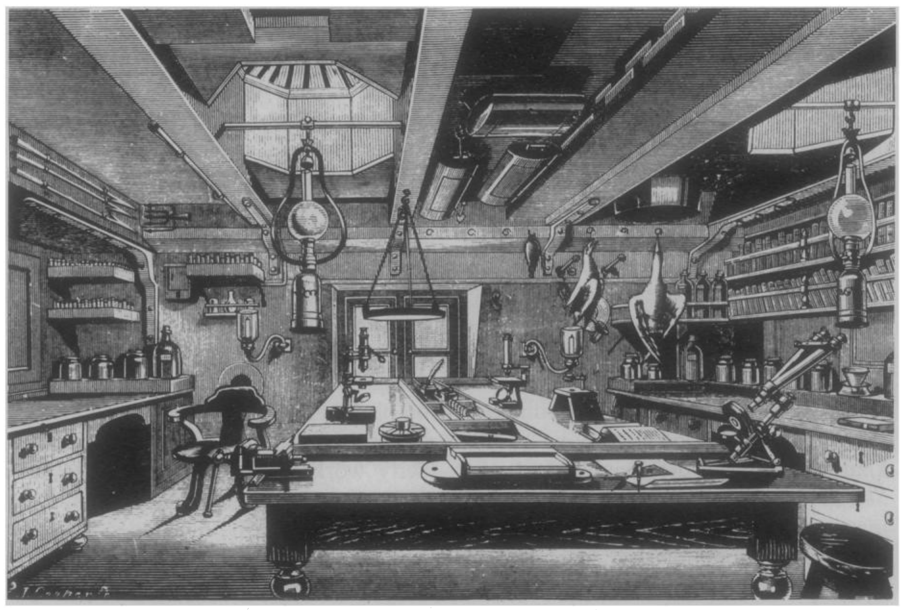
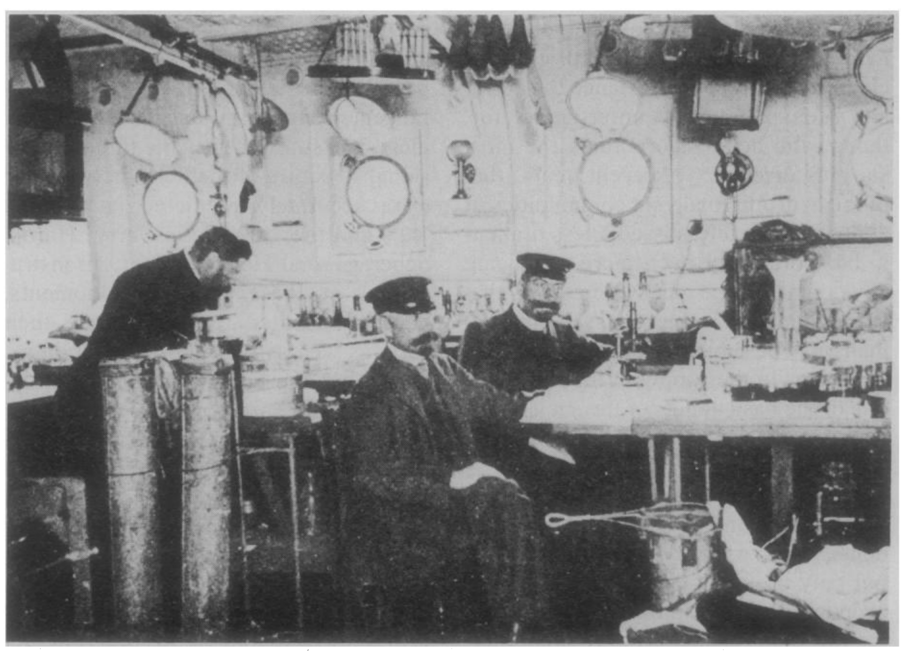
The Benthic Fauna

Deep-Sea Biology. GILBERT T. ROWE, Ed. Wiley-Interscience, New York, 1983. xii, 560 pp., illus. $69.95. The Sea, vol. 8.

Deep-Sea Biology had its genesis in 1977, inspired partly by the discovery of the remarkable communities associated with the Galápagos hydrothermal vents. The editor's aim was to reflect recent progress in this and other broad areas of deep-sea biology, but not to attempt to cover all aspects of the subject. Consequently, acknowledged leaders in selected fields were invited to review their own areas, and in doing so several of them have also tried to identify the most challenging and fruitful topics for future research.

Despite an excellent résumé of the history of deep-sea biology in general by Mills and a chapter by Vinogradov and Tseitlin devoted to mid-water life, the book is essentially concerned with the benthos, that is the organisms living in, on, or very close to the floor of the deep ocean. Three of the four rather arbitrary size categories into which the benthic fauna is usually divided are each dealt with in separate chapters: the bacteria by Jannasch and Wirsen, the nanobenthos and meiobenthos by Thiel, and the macrobenthos by Rowe, in each case with a review of modern techniques and a summary of results. These same size categories are the ultimate subject of a chapter on sediment community metabolism by Smith and Hinga, and the meiofauna and macrofauna provide most of the examples used by Jumars and Eckman to illustrate and summarize current knowl-





"Contrasting styles in sea-going biological laboratories." (Top) "The 'natural history work room' of H.M.S. *Challenger*, 1982 to 1876." (Bottom) "Laboratory of *Princess Alice II* during cruise in summer 1904. The personnel are, from left to right, L. Tinayre (artist), P. Portier (bacteriologist), and Jules Richard (scientific director). During this cruise in the Mediterranean and tropical eastern Atlantic, Portier, using sterilized reversing bottles, showed that the open sea had relatively few bacteria and that none could be grown from sediment samples collected at abyssal depths (a result at variance with earlier studies) although there were always bacteria associated with deep water animals." [From E. Mills's paper in *Deep-Sea Biology*; originals (respectively) from C. W. Thomson, *The Voyage of the Challenger: The Atlantic* (Harper, New York, 1878), courtesy of Institut Océanographique, Monaco)] 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 Aα 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