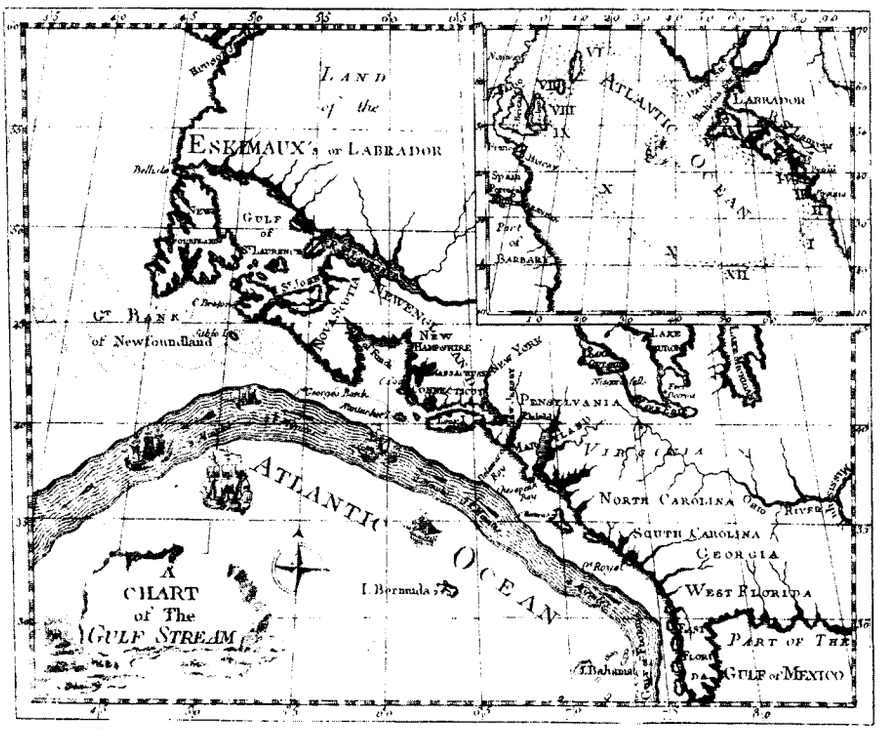

A version of Benjamin Franklin's 1786 chart of the Gulf Stream. "While . . . Franklin was in London as Deputy Postmaster General for the American colonies (1764–1775) he was consulted as to why mail packets sailing from Falmouth, England to New York were taking weeks longer than merchant ships traveling from London to Rhode Island. In October 1768 Franklin discussed this problem with his cousin Timothy Folger, a Nantucket sea captain. . . . Folger sketched the Stream on a chart and added written directions on how to avoid it." The Franklin-Folger chart was first printed in London around 1769–70, and a version of it was included in Franklin's "Maritime Observations," published in 1786. This paper and the chart were reprinted a number of times. "Usually the chart was carefully and accurately copied, but there are some exceptions." The version shown here is one of them. [From P. L. Richardson's paper in *Oceanography: The Past*]

the sea, the collection of papers here is most notable for its diversity. In one thick volume we can find contributions, some of considerable interest if only for their curiosity value, that include a discussion of the social implications of Victorian aquaria, a listing of Chilean naval hydrographers, a paper insisting that Prince Henry the Navigator was really an oceanographer, a Marxist tract on oceanographic expeditions, an account of the medicinal use of sea creatures, histories of international oceanographic conferences, personal apologias, passionate defenses of unpopular scientists of previous centuries, nationalistic claims to serious contributions to marine research, and a few thorough technical discussions of the origin of some particular "marine" idea. Even this list does not encompass the sweep of what has been drawn together here in the name of oceanography.

The book contains a number of contributions (a small fraction of the total) written in honor of the anniversary under celebration. To a great extent, these papers share with many of the others in the book a style and substance one can call "annual report boilerplate." It is the kind of thing that most institutions put into their annual reports—a listing of money raised, names of staff, projects and programs undertaken, all proclaimed as important and lasting. Such accounts are ultimately of some use to historians both as a source of facts and figures and as an indication of what the institution's administrators thought was important at the time. But annual reports do not ordinarily make particularly stimulating or enlightening reading.

The difficulty both individuals and organizations have in attempting open and honest evaluations of their roots and history is well known. What usually results from institutionally sponsored accounts is bowdlerized puffery lacking both the flesh and blood of real human organizations and any substantive intellectual context. A much keener sense of the origins and atmosphere of the early days of the Woods Hole Oceanographic Institution, a fascinating place, can be found in the journalistic account, *On Almost Any Wind*, by Schlee (Cornell University Press, 1978). Otherwise the accounts of the role of Bigelow, Iselin, Lillie, and others in "reviving" American oceanography with the financial help primarily of the Rockefeller Foundation have little to add to previously published material.

In the purely scientific context of oceanography, an opportunity was missed here. The Oceanographic Institution shared in the great transformation of American science that took place during and after World War II. The scientific aspects of the field have been dominated for 30 years by leaders who emerged during that period. Many of them were and are powerful, fascinating personalities, superb scientists by any standards. Many are gone already (Bullard, Ewing) and the rest are nearing retirement; an era soon will have passed. If those who remain had been asked to contribute their personal views of oceanography of the 1930's, '40's, and '50's, with no pretense to "history," corporate or otherwise, we could have had something of lasting value to future historians of the science. With a few notable exceptions, what we have in the present book is "amateur" history, neither unapologetic firsthand memoirs nor careful, documented tracing of ideas.

This is a book to be browsed in; anyone tempted to read it through risks mental indigestion. There are fascinating anecdotes, vignettes, insights, and arguments strewn throughout. But it does not define "the past" of anything recognizable as a coherent subject.

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Physical Aspects

Evolution of Physical Oceanography. Scientific Surveys in Honor of Henry Stommel. BRUCE A. WARREN and CARL WUNSCH, Eds. MIT Press, Cambridge, Mass., 1981. xxxiv, 624 pp., illus. $37.50.

This volume of scientific surveys honoring Henry Stommel on the occasion of his 60th birthday is unusual in several ways. Often such books excite only passing interest. Although they may reflect the scope of the scientific contributions of the person they honor, they may fail to give much feeling for his or her personality and individual style. This book, however, mirrors well the personality and style of Henry Stommel, who has been one of the dominant intellectual

forces in physical oceanography for over 30 years and whose style of inquiry has permeated the subject. As a scientific contribution, the book will be of enduring value to students and practitioners of oceanography.

The book opens with five short essays on Stommel by Arons, Veronis, Montgomery, Deacon, and Fuglister—it takes five essays to give anything like a complete image of this many-faceted, modest, and delightful man. The 18 scientific surveys are contributed by a veritable who's who in oceanography and are grouped into four sections—general ocean circulation, physical processes, techniques of investigation, and ocean and atmosphere. The contributors have taken their task seriously—though the chapters vary considerably in level and depth of technical detail, none is without interest. Papers by Warren, Worthington, and Reid on deep circulations, water mass characteristics, and the mid-depth circulation, respectively, occupy a sixth of the volume and incorporate many new results hitherto scattered. Together they provide a better description of the physical characteristics of the ocean as currently understood than any available hitherto. Fofonoff's account of the Gulf Stream system makes an interesting contrast to Stommel's own book of 20 years ago on the same subject and provides an impressive reminder of the detail achieved in observation during that time. A survey of the dynamics of large-scale ocean circulations by Veronis is more analytical in nature and includes discussion of the interesting recent numerical experiments by Holland and Rhines and others. Leetmaa, McCreary, and Moore survey observation and theory of equatorial currents, and Beardsley and Boicourt give an interesting, though qualitative, overview of estuarine and continental shelf circulations.

The section on physical processes begins at the small scale, with Turner's comprehensive account of small-scale mixing, enlarges to the macro-scale, with Hendershott on long waves and ocean tides and Wunsch on low-frequency (and large-scale) variability, then shrinks again in scale to that of thermal convection. Malkus's contribution on the last topic is both a review and (as is his wont) an original contribution, extending some of his earlier ideas to investigate the amplitude of turbulent convection from stability criteria. In between are a characteristically readable and illuminating discussion of internal waves by Munk and, to remind the physical oceanographer that there are other things in the sea besides water, a short chapter by Steele on some varieties of biological oceanography, emphasizing the variability, both physical and ecological.

Three chapters describe techniques of investigation in physical oceanography. Many of the most striking results in recent years have come as a consequence of ingenious new instruments and careful experimental design; Baker's account in this book can only give a sampling of these. Broecker shows how geochemical tracers have contributed to our appreciation of ocean circulation, and Faller defends the laboratory experiments that have given considerable insight into the dynamics of more complex oceanic systems. Finally, Charnock discusses small-scale air-sea interaction processes with perhaps somewhat less penetration than is found in some other chapters, and Charney and Flierl consider oceanic analogs of large-scale atmospheric motions. There are extensive references and a good index.

In the early '50's, Stommel asked, in a Woods Hole pamphlet, "Why do our ideas about the ocean circulation have such a peculiarly dream-like quality?" This beautifully produced volume is eloquent testimony to the revolution in physical oceanography that has occurred since then, owing in no small part to Stommel's participation, encouragement, imagination, and example. It is a worthy tribute.

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An Ecological Reassessment

Primary Productivity in the Sea. Papers from a symposium. PAUL G. FALKOWSKI, Ed. Plenum, New York, 1980. x, 532 pp., illus. $45.90. Environmental Science Research, vol. 19. Brookhaven Symposia in Biology.

This is a most interesting time for those interested in the ecology of phytoplankton. It is a time of reassessment and reflection in which many of the basic ideas and methods that have been generally accepted for years are being reconsidered; our whole understanding of the dynamics of planktonic ecosystems is at stake. This is well illustrated by the proceedings of last summer's Brookhaven symposium on primary productivity in the sea. Despite the distinctly marine bias indicated by the title, the papers in this timely and important volume have general ecological relevance and will be of interest to all those interested in materials processing in ecosystems as well as to oceanographers and limnologists.

The reassessment of ideas in oceanography has been necessitated by the recent suggestion that oceanic productivity measurements are serious underestimates and that, even in oligotrophic oceans, the growth rate of the phytoplankton is close to the maximum rates observed in culture. The presumed high growth rates in the sea can be supported only by recycling of limiting nutrients. All the evidence seems to point to rapid recycling at small spatial and temporal scales: scales at which there is a nonsteady-state relationship between uptake, growth, and recycling processes. The basic questions addressed by the papers in this book include: How good are our productivity measurements? What are the in situ growth rates of phytoplankton? What can we infer from the observed physiology of natural and cultured populations? What is the magnitude and importance of nutrient recycling in planktonic ecosystems? and What can be learned from realistic models of phytoplankton growth and grazing?

The papers are arranged in a logical order beginning with aspects of light absorption and the quantum efficiency of photosynthesis, proceeding through cellular physiology and nutrient kinetics, and ending with such topics as grazing, nutrient regeneration, and the flux of carbon in the sea. Each of the papers is self-contained and forms a good discussion of the latest developments in its field, but the overall flow is more impressive. As Myers points out in the first paper, phytoplankton are not like small higher plants. They are best thought of as microbes in that they show types of overflow metabolism typical of single-celled organisms. This has led to some real problems of interpretation when steady-state continuous-culture data are extrapolated to the (more variable) real world. Yentsch also addresses this problem in a discussion of the fundamental relationship between laboratory data and an understanding of how the oceans work. For the first time, in my opinion, this book successfully fuses the work of physiologists and field oceanographers so that a new synthesis begins to appear.

What is clearly demonstrated is the critical importance of recycled nutrients. Dugdale, Eppley, and others have stressed the relative importance of "new" versus recycled sources of nutrients in the oceans of the past, but I, as a limnological observer, am impressed by the case that can be made for the magnitude of the recycled flux. Harrison's