and Ecology of Zooplankton Communities that the old metabolic model lives on, like Mr. Hyde transcending his creator's hopes and expectations. Despite this, very little new is contributed to solving the problems of vertical migration. Yes, vertical migration is consistent with metabolic advantage—also with escape from predators, with maximum exploitation of phytoplankton growth, and with maximum reproductive output. But the difficulty of testing each relationship, so that we are left with one general, unifying unfalsifiable hypothesis, is very great. Such a chimera-like problem suffers from too much truth and frustrating ungraspability. This results in recourse to probabilistic "best guess" verification, as is evident in this book. I am interested in the remarkable paradigmatic quality of McLaren's first paper, which is still generating more research and rhetoric than the one intended to replace it, the more intellectually demanding paper on demography.

The other major paradigm (dare I repeat Kuhnian terminology?) dominating this book is the Brooks-Dodson hypothesis of 1965. Their claim that the size structure of zooplankton communities is the result of fish selecting large prey or that it results from competition for food among grazing zooplankton when large predators are absent has also had a remarkably stimulating effect on research. This volume summarizes well, albeit in piecemeal fashion, the complexities of competition and size-selective predation in freshwater plankton communities, showing, in particular, the intricacies of predation by invertebrates and prey responses to them, factors not included in the original model. By contrast, work on vertical migration has bogged down in hazy ideas and apparently untestable hypotheses.

The problem of filter-feeding is also a major presence in this volume. For years we assumed, on the basis of a few observations, that grazing zooplankton fed mechanically by pumping water through a screen of fixed size that could be combed by limbs passing food to the mouth. A great deal of experimental work in the 1960's and 1970's enabled feeding rates to be quantified, on the hypothesis that water was pumped mechanically through a filter and that the structural properties of the filter could account for the sizes of the particles captured, in particular the fact that zooplankters appeared to "select" particles of slightly larger than average size. Recently we have seen that copepods show highly varied feeding responses based on the abundance, size, texture, and chemical composition of their food particles. It seems likely that copepods detect particles before direct contact is made, that some particles may be rejected once captured, and that the panoply of feeding responses is mediated by chemo- and mechanoreceptors all over the anterior part of the body. As the five papers in this volume indicate directly or through references to recent work, if the idea of passive filter-feeding is not dead, reports of its demise are not greatly exaggerated.

Evolution and Ecology of Zooplankton Communities is a valuable contribution to the literature of aquatic biology. Though it slights the marine environment, good problems in ecology are not directly related to salinity. This book reviews large amounts of earlier literature, presents new data and experimental work, and makes available in one sourcebook many advances in plankton research. In general the contributions are well written and well illustrated. The editing is excellent. I spotted no more than a dozen very small typographical errors, surely a proud accomplishment in so long a book. Its general format is that of *Limnology and Oceanography*, but because speculation, controversy, and theory have been the heart of the symposium the outcome is far more vivid and interesting than the average contents of that austere journal. Those exciting little aquatic animals living at low Reynolds numbers deserve no less.

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Atmospheric Phenomena

Ball Lightning and Bead Lightning. Extreme Forms of Atmospheric Electricity. JAMES DALE BARRY. Plenum, New York, 1980. x, 298 pp., illus. $29.50.

This most recent addition to the literature on lightning reviews the known physical aspects of two unusual forms of atmospheric luminous phenomena. Through an analysis of the available literature, Barry summarizes the characteristics of ball and bead lightning and encourages the reader to improve his or her understanding of these phenomena. The book includes a large collection of photographs of bead and ball lightning.

Although we are assured at the outset that "lightning terms such as stroke, stepped leaders, dart leaders, and ionization channels will be used in subsequent chapters," Barry does not always follow this rule. Instead he introduces new terms such as secondary discharge, main discharge, and discharge velocity (p. 119), dart stroke (p. 122), and flashless discharges (p. 196). The continuity of his discussion would have been enhanced if he had followed the definitions he presents in the introductory chapter and used standard scientific terminology.

Bead and ball lightning are not treated equally in the book. Only chapter 2, 17 pages long, deals with bead lightning; the remainder of the book covers ball lightning—its characteristics, photographic evidence of it, skepticism concerning it, and its simulation in the laboratory. The short treatment of bead lightning is justified, however. I have seen bead lightning every three or four years during a series of summer thunderstorm studies that now span 20 years. In addition, my colleagues have photographed bead lightning several times, and reliable theories explaining the observed phenomenon have been published in the reviewed literature. Barry suggests correctly in the preface to the book that bead lightning is apparently an accepted scientific fact. Ball lightning is another matter and deserves the attention he devotes to it.

The characteristics of ball lightning are presented in an interesting way—by analyzing 13 cases reported in the literature. One result of this analysis is table 4.1, which is a compilation of the data available on the energy density of ball lightning. It is a useful table for comparisons. I had not realized, for example, that the energy estimates range over ten orders of magnitude with a mean roughly centered on 1 joule per cubic centimeter. Barry concludes that ball lightning is a "single form" having the possibility of either silent or explosive decay.

Several other tables will be useful to researchers of ball lightning. Table 5.1 contains references to all discussions of ball lightning that include photographs, and tables 6.2 and 6.3 contain references to photographs of what has been thought to be natural ball lightning and photographs of artificially produced ball lightning. The latter resulted from laboratory studies, some by Barry, that demonstrated the formation of a luminous ball in an enriched mixture of hydrocarbons. We are led to the reasonable conclusion that a hydrocarbon gas oxidation mechanism could be responsible for one type of ball lightning.

The possibility of obtaining a photograph of ball lightning is an intriguing one, attracting wide interest among researchers. Barry presents approximately 24 "ball lightning photographs" and labels most of them false. Three photo-

graphs pass Barry's test for ball lightning, and I invite you to pick those three before reading Barry's explanation in the text. You may conclude, as I have, that obtaining the first photograph of ball lightning remains one of the greatest challenges to the amateur, professional, or scientific photographer.

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Cognition

The Nature of Thought. Essays in Honor of D. O. Hebb. PETER W. JUSCZYK and RAYMOND M. KLEIN, Eds. Erlbaum, Hillsdale, N.Y., 1980. xx, 256 pp., illus. $24.95.

As the authors of this collection acknowledge, Hebb's *Organization of Behavior*, published in 1949, gave a sense of new direction in experimental and physiological psychology. Its centerpiece was the proposal of redundant, spatially distributed cell assemblies to explain the flexibility of mental operations, our abilities in learning to perceive the world, and the brain's resistance to damage.

This collection includes both the bringing up to date (by Goddard) of Hebb's neuronal concepts in terms of recent findings concerning synaptic potentiation and a description by Nadel of the discovery of neural bases of cognitive maps, one of the most interesting recent developments in physiological psychology.

The main part of the book, however, is on human cognitive psychology, with chapters on the language of thought (by Jusczyk and Earhard), on the psychology of structural simplicity (by Krueger and Osherson), and on the information processing approach (by Simon, Bever *et al.*, Paivio, and Posner).

It was some ten years after the publication of Hebb's book, influential though it was, that this other and stronger current of cognitive psychology began to flow. Perhaps the most provocative essay in this collection is by Neisser, whose *Cognitive Psychology* in 1967 marked the swelling of this current in the mainstream of academic psychology. In a way Neisser in his chapter "The limits of cognition" has reversed his former allegiance and sides here with the early Hebb, in spirit if not in detail.

A major preoccupation of the information processing approach to cognition is to inquire what are *the* specific characteristics of the recognition of letters, *the* capacity of memory, *the* speed of this piece of processing, *the* limits of that mental performance, and so on, as if the brain were a machine with fixed characteristics.

In his chapter, Neisser now doubts the correctness of this assumption of measurable fixity. He shows with some apposite demonstrations that human capacity is flexible rather than having rigid limits.

Posner's position in his chapter is directly opposed to Neisser's. He argues for mental chronometry as "the effort to observe the time course of information flow in the nervous system," by measuring reaction times and the like. Neisser has the more convincing case here. The effort to capture some essence of cognition in measurements such as reaction times that assume fixed mechanisms of processing is a direction taken because of seductive qualities of what can be experimented upon rather than because of what is characteristic of mental life.

With this in mind it is appropriate that Hebb's own essay here culminates in some speculations on creativity in terms of the simultaneous activation of cell assemblies (or, as I should prefer to say, of cues capable of addressing schemata). Though experiments might be more difficult, demonstrations are possible as Hebb shows; and it is more likely that here is to be found something closer to the nature of thought.

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Computer Work Remembered

A History of Computing in the Twentieth Century. A Collection of Essays. Papers from a conference, Los Alamos, N.M., June 1976. N. METROPOLIS, J. HOWLETT, and GIAN-CARLO ROTA, Eds. Academic Press, New York, 1980. xx, 660 pp., illus. $29.50.

Despite the impact computers have had on society, accounts of their development have been lacking. Many of the pioneers of computing are approaching advanced age, and the present volume is the result of a timely attempt to record their recollections and perspectives on past developments.

The book includes over 30 papers that focus on most of the major computer and programming developments in the United States and abroad from 1935 to 1955. There is appropriate attention to British, German, Japanese, and even Russian work, and, although several American computing projects such as Harvard's Mark I and Eckert and Mauchly's UNIVAC are not specifically included, overall the book has a fair cross-section of topics.

In addition to the papers by the computing pioneers, there are papers by historians like Henry S. Tropp and Kenneth O. May describing historiographic problems associated with writing contemporary history; Brian Randell and Simon Lavington, although not historians, have researched various aspects of British computing history and have also contributed historical papers. Several papers that were not presented at the conference that gave rise to the book, including one on programming in the U.S.S.R., have been added. Despite significant contributions by women during the period covered, particularly in programming, there is not one female-authored paper. The book concludes with an annotated bibliography by Randell that supplements his excellent bibliography that appears in *The Origins of Digital Computers* (second edition, Springer-Verlag, 1975). The lack of an index to the book is a serious deficiency.

As a collection the essays are rather disjointed. They are grouped into several units—The Human Side, The Languages, The Machines, and The Places—but with the exception of the unit on languages the groupings seem somewhat arbitrary. Papers on ENIAC, for example, are included under The Places, and one entitled "Early programming developments in Cambridge" is included under The Machines.

Some of the contributors set out to provide as unbiased accounts as they can. Others are more polemical. Most of the pioneers tend to focus on the priority issues that were the subject of bitter disputes at the time of the events and that remain controversial. For example, J. Presper Eckert, the coinventor of numerous "firsts" in electronic computing, including the ENIAC and the UNIVAC, focuses on his contribution to the stored-program concept: "My best computer idea, today briefly called 'stored program,' became to us an 'obvious idea,' and one that we started to take for granted. It was obvious that computer instructions could be conveyed in a numerical code" (p. 531). In this paper, Eckert argues against those who credit John von Neumann with this concept.

Similarly, Maurice Wilkes attempts to establish his priority regarding the devel-