companies would pursue the option. Intransigent resistance to unions has been more evident in computerized clerical and service work than in factories where unions have already been recognized.

Bruins's theme is the battle to preserve social hierarchies in defiance of new technologies that have undermined their reasons for existence. He makes the argument by examining the response of the U.S. Navy's officer corps to innovations in the armament and propulsion of vessels. Line officers were warriors, whose historic task had been to assault enemy sailing vessels with close bombardment and hand-to-hand combat. Steam turbines and 16-inch guns placed many trained specialists on the ships, but the line officers kept the influence of such men marginal and blocked their access to promotions as late as World War II. For enlisted men the impact of new fighting ships was different. Above all, native-born Americans were trained to replace the global pool of seafarers on which sailing ships had traditionally relied.

Although it is neither necessary nor desirable that all authors in a collective volume agree with one another, differences of opinion emerge on some rather fundamental questions in these essays without being explicitly addressed. First, there is the problem of defining "technology." Although the editors employ a very narrow conception based on "the way we transform and use energy" (p. 1), other authors expand the notion to embrace the mode of production in all its aspects. Second, although most of the essays implicitly accept technological determinism, only Chandler's functional adaptation theory makes the causal relationship explicit, and Hammack and Bruins repudiate the idea that changes in technology lead irresistibly to determinate changes in other aspects of human life and thought. No one raises the question of what determines choices among alternative available technologies.

Finally, although no author in the collection opposes the belief that the onward march of innovation has made life unequivocally better today than it was for our ancestors, several authors (especially Scheiber) express deep anxiety over the ecological future of the planet. Moreover, Vatter's generally optimistic account of economic development since 1870 poses two ominous questions: whether a "technosuperstructure" tied to educational credentials has rigidified racial inequality and whether the recent surge in capital-saving innovations has so diminished opportunities for productive investment of accumulated wealth as to generate an economic crisis that neither relocation of industry nor military spending can prevent. If this book stimulates its readers to fresh thinking on these vexed questions, it will have made an important contribution to debates over public policy.

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Ancient and Modern Reefs

The Evolution of Reef Communities. J. A. FAGERSTROM. Wiley-Interscience, New York, 1987. xviii, 600 pp., illus. $74.95.

This volume crosses disciplinary boundaries to amalgamate data on reefs from a broad spectrum of the biological and geological literature. Fagerstrom notes that the book aims to "integrate the broad scope of research on modern (Holocene) and ancient reefs with consideration of the major environmental factors and processes that influence their success or failure." It is successful in doing this, with abundant, up-to-date information that is woven into a lively and readable narrative.

The book is divided into three sections of unequal length that deal with the reef phenomenon, the ecology and geological history of major reef-building organisms, and the ecology and geological history of pre-Cenozoic reef communities. Part 1 treats chemical, physical, and biological definitions, factors controlling reef growth and distribution, and processes such as sedimentation, binding, and early cementation. Fagerstrom develops the ecological concepts of communities and guilds as they pertain to reef development in present and past geological time. This recognition that guilds of various species perform particular functions within the reef community provides the author with a framework for much of his analysis of modern and ancient reefs and the reader with a means to relate changing components of reef communities through time. The guilds recognized in this volume are constructors, bafflers, binders, destroyers, and dwellers. This first section, constituting well over half the volume, thus deals rather exhaustively with a large number of topics. For example, Fagerstrom presents almost eight full pages on the relationship between scleractinian corals and their symbionts the zooxanthellae. Here biochemistry, zoology, ecology, and paleobiology all enter the discussion; that they are intelligently summarized is one of the strengths of the work. The fourth chapter, which treats the simultaneous processes in play during a reef's existence, focuses on five processes (construction, destruction, sediment transport, sediment deposition, and binding), thus breaking an extremely complex topic into manageable portions.

Part 2 (the shortest section) presents the autecology and geological history of the major reef-building groups, the algae (including cyanobacteria), sponges, corals, and two groups important in the geological past, the highly specialized brachiopods of the late Paleozoic (Richthofeniacea) and the somewhat analogous specialized bivalves of the late Mesozoic reef communities (Hippuritacea, or rudists). This part of the book will be of special usefulness to biologists and sedimentologists wishing information on extinct reef organisms. It may be disturbing to some specialists to see the prokaryotic cyanobacteria lumped with all photosynthesizers as algae with little discussion of other possibilities. Fagerstrom also describes the morphology and history of the Cambrian reef-building Archaeocyatha in the chapter on the Porifera, without noting the problematical taxonomic position of the former group. These arguing points seem minor in the face of the very large amount of biological and paleontological information in this section of the book.

Part 3 provides much of the raison d'être of the book, presenting the history of reef communities and their changing guild composition through Phanerozoic time up to the Cenozoic Era. Precambrian reef-community structure was dealt with in part 2, and much of part 1 was concerned with the development of models for sedimentary, biological, and post-depositional modification of modern and fossil Cenozoic reefs. This section summarizes the salient paleobiological data on fossil reefs in a chapter each on early Paleozoic (Cambrian and Early Ordovician), Middle Paleozoic (Middle Ordovician to Late Devonian), Late Paleozoic (Late Devonian to Late Permian), and Mesozoic reef communities. The organization of each chapter proceeds through a series of examples of well-documented individual occurrences of fossil reefs, a discussion of evolutionary (and extinction) events, and a summary of changes in community composition, trophic structure, and guild structure within each of these segments of geological history. This sequence of chapters provides a clear synthesis of the geological history of reef communities and illustrates the interplay between organic evolution, extinction, and radiation of new reef organisms to wherever opportunities existed. In the last chapter, Fagerstrom presents his conclusions: reef communities have evolved over time and reefs are defined by the presence of constructing organisms, topographic prominence, and faunal diversity.

The greatest attraction of *The Evolution of Reef Communities* is the synthesis of data and opinions from numerous disciplines into a very readable dissertation on virtually all aspects of the reef phenomenon. The long list of bibliographic references includes nearly 400 published during the 1980s and several published as recently as 1986. Unfortunately, however, the book has numerous spelling errors, and some of the photographic reproductions are not of sufficient quality to warrant their inclusion. The placement of all the photographic figures at the end of the book is awkward. Necessary locality and geological information is not in captions but rather in a separate register (requiring an extra inserted finger for the curious). These editorial shortcomings detract from a useful book.

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Functional Neuroanatomy

Arthropod Brain. Its Evolution, Development, Structure, and Functions. AYODHYA P. GUPTA, Ed. Wiley-Interscience, New York, 1987. xiv, 588 pp., illus. $64.95.

The wonder of the cellular architecture of the insect brain was first pointed out by Ramon y Cajal, after he had examined his silver preparations of the honeybee. Since that time brains of arthropods, especially of insects, have been subjected to the collective scrutiny of comparative neurobiologists and anatomists. This is due as much to the endlessly fascinating behaviors of these creatures as to the considerable impact of insects upon the health and economies of human societies. It is noteworthy when a book on the arthropod brain appears, because there have been so few. The modern standards start with Bullock and Horridge's 1966 classic, *Structure and Function in the Nervous System of Invertebrates*, which provided taxonomic breadth, a ground plan of the arthropod brain, and a lexicon. Nine years later, N. J. Strausfeld published his brilliant and somewhat idiosyncratic *Atlas of an Insect Brain*, which focused on the brain of the housefly. Of course, review chapters in the various generic *Advances in . . .* volumes have appeared over the years and filled some gaps in coverage, but nothing approaching Bullock and Horridge in comprehensiveness or Strausfeld in detail is available (at least in English). This is all the more unfortunate now that the widespread application of technical advances permitting visualization of single neurons has given rise to the standard of the "identified neuron" in physiologically and anatomically interconnected networks. If Bullock and Horridge gave us the layout of the "forest" of the arthropod brain, modern techniques allow us to map it out tree by tree, and it is fair to state that modern insect neuroanatomy is functional neuroanatomy. How successfully does *Arthropod Brain* convey this state of affairs?

Insects get about two-thirds of the coverage, but there are chapters on crustaceans, spiders, millipedes, mites, and ticks, as well as the evolutionarily central onychophorans—the annelid-arthropod "link." Since the time of Cajal's studies, the optic projections in the insect brain have been the subject of enormous efforts by anatomists, and this book is remarkably restrained in its single-chapter discussion of this important topic—perhaps too restrained. The mushroom bodies (MBs) get three chapters, which should please behavioral neurobiologists, because this region of the brain certainly appears to be an important integrative center in the control of behavior. In particular, Gupta advances the argument that large, well-elaborated MBs represent a relatively advanced evolutionary condition among arthropods. It is interesting that over the years honeybees, crickets, and cockroaches—all of which have large MBs—have served as the mainstays for physiological investigations of brain in relation to behavior. In this volume, Erber and co-workers contribute a cogent review of the functional role of the MBs in insects, pointing out that MB neurons receive multimodal inputs and presenting evidence for the role of the MBs in complex olfactory learning. Olfaction and vision have always been favorite subjects for entomological physiologists and anatomists. The olfactory pathways in the lepidopteran brain are capably reviewed by Christensen and Hildebrand, who draw upon their own pacesetting work in *Manduca*. Vision, as noted earlier, is treated lightly in this volume, but this is certainly forgivable given the many books and review articles already available on this subject.

Neurobiology at all levels is being driven by new techniques, and we live in a New Age of neuroanatomy. This book reflects its time. Immunocytochemical markers, especially for neurotransmitters (or biosynthetic enzymes leading to their production), have been applied to produce chemical maps of the arthropod brain, although with less spectacular effect than has been accomplished in the mammalian brain. Nonetheless, the ability to correlate structure and function at the level of identified neurons makes the immunocytochemical maps that are reported in this book, for the bee brain for example, an undeniably important advance in functional neuroanatomy. Several chapters on the ultrastructure of the arthropod brain are included, and here I sadly report that the quality of the electron micrographs is very uneven, and sometimes poor. The book does not dwell on techniques per se, nor should it; two chapters at the end deal briefly with techniques, but they are redundant; their inclusion is puzzling in light of the availability of two excellent books on insect neuroanatomical techniques, edited by Strausfeld and published by Springer-Verlag.

Is the book authoritative? Certainly some important contributors to the field are among the authors, but some of the major names are conspicuously missing. But this is perhaps compensated by the inclusion of the younger generation of functional neuroanatomists, who combine physiological and anatomical approaches to the problem of sensory-motor integration.

Overall, this is a valuable addition to the literature of comparative neuroanatomy. The emphasis on insects is not misplaced; this group has always served as important research material for investigations of the development of the nervous system, and with the infusion of molecular biology techniques, especially applied to *Drosophila*, it is all the more important to have reference volumes on the insect brain. This book, with its focus on the use of new technologies to probe the structure of one of life's marvelous "living crystals," is surely welcome, for, as Floyd Bloom said in another context, "the gain in the brain is mainly in the stain."

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Complex Dynamical Objects

Structure and Dynamics of Elliptical Galaxies. TIM DE ZEEUW, Ed. Reidel, Dordrecht, 1987 (U.S. distributor, Kluwer, Norwell, MA). xvi, 579 pp., illus. $89. International Astronomical Union Symposium no. 127. From a symposium, Princeton, NJ, May 1986.

Elliptical galaxies were once thought to be among the simplest dynamical objects held together by self-gravitation. They have a bright center that appears nearly stellar. Luminosity fades away smoothly in all directions with no detectable outer boundary. Contours of equal brightness (isophotal contours) are very nearly elliptical in shape, circular in some objects, flattened as much as 3:1 in others. Apart from the bright center

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