obvious insights into the foraging strategies of hunter-gatherers. The volume's most important contribution is the evaluation of general ecological models in a human context. Most of these models were developed in the context of animal ecology, but they also seem to provide a useful perspective for understanding subsistence behavior in humans. Yet the editors' claim that the volume emphasizes "adapting, rather than simply adopting, models and approaches developed in evolutionary ecology" is somewhat misleading. Of the papers in this book, only Moore's is principally concerned with building rather than evaluating theory. Most of the authors adopt ecological models without modification, and discord between predictions and observations is resolved via ad hoc interpretations more often than by any attempt to extend existing models or to develop new ones. This problem is also apparent in the biological literature and is certainly not unique to the papers in this book. Nonetheless, the discrepancies between data and predictions often point to assumptions that are inappropriate in the human context, and incorporation of these insights into new general models would be a welcome next step.

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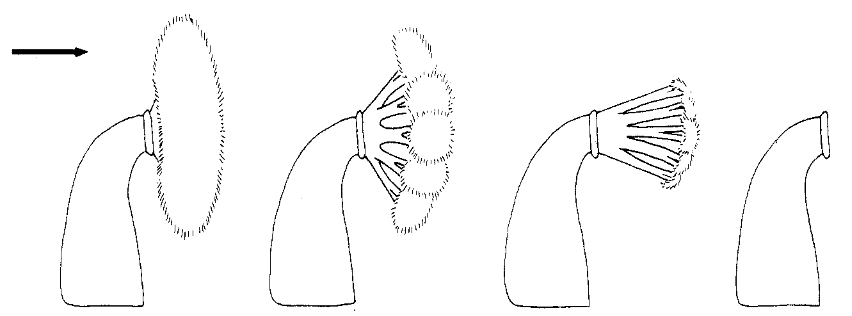


Changes in the shape of a large sea anemone, *Metridium*, exposed to currents of increasing speed. In low-speed currents (far left), the anemone extends into the flow, bends just beneath the oral disk, and extends its tentacles for filter feeding. As the current gets faster, the oral disk separates into lobes and is eventually retracted in strong currents (far right). The changes in shape reduce the rate of increase in drag that would otherwise be proportional to the square of the current speed. [From *Life in Moving Fluids*]

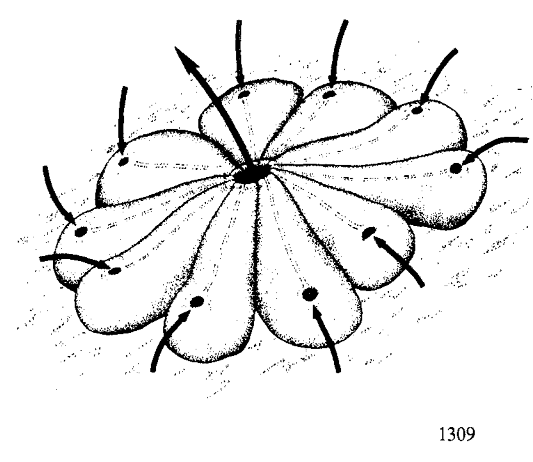
Organisms and Flow

Life in Moving Fluids. The Physical Biology of Flow. STEVEN VOGEL. Illustrated by Sally A. Schrohenloher. Willard Grant Press, Boston, 1981. xvi, 352 pp. $23.50.

Steven Vogel's book has grown out of many years of experience with organisms and flow. The book evolved as a course textbook, but it should be required reading for students of biology at all levels of career development. Flow, whether natural or induced, in the aquatic medium or in air, is important in some facet of the lives of all organisms, and Vogel demonstrates that fluid mechanics offers a viable and rewarding way to understand a multitude of biological adaptations.

The book emphasizes essentially open systems, of flow around or through organisms. Flow in closed systems receives limited treatment, and non-Newtonian fluids (such as mucus) and fluid with inclusions (such as blood) are outside the scope. Concepts of fluid mechanics are carefully developed, and each step is artfully illustrated with biological applications. For example, definitions and properties of fluids are used to illustrate how temperature-viscosity relationships influence the shape of water fleas. Laws of continuity and conservation and energy concepts are related to numbers of arteries, veins, and capillaries in humans, to the ventilation of sponges, worm holes, and prairie dog burrows, to the movement of sap in trees, and to the air bubbles that surround submerged beetles. Drag and its consequences for organisms of various sizes are discussed in detail. Aspects relevant to swimmers and fliers have been well reviewed elsewhere. Here, sessile organisms (ranging from forest trees to intertidal algae and hydroids) receive equal treatment for the first time. The discussion of life in boundary layers (that region of flow where solids and fluids meet) will be especially welcome to benthic ecologists. More discussion of the transport of gases and nutrients through boundary layers would have been welcome, especially in the context of tradeoffs with drag for aquatic organisms. Vogel also explains how the boundary layer can be a barrier to dispersal, for example of spores, and how some organisms overcome the problem. Lift forces and their exploitation by flying and gliding organisms are shown with reference to seeds, sand dollars, insects, birds, and mammals. Fish, which swim using lift forces, receive relatively little attention. Fish swimming has been treated at a rate in excess of one review per year for several years, but Vogel's iconoclastic approach could have brought a new and valuable perspective to the subject. Induced flows are important in small animals and many filter feeders. These are described as part of the discussion of flow dominated by viscosity, which includes ideas on seed and spore dispersal and how interstitial fauna can manipulate their habitat. Flow in pipes is put in the context of the life of trees and worms. Finally, Vogel has done great service to experimental biologists by describing methods and including an invaluable list of suppliers.

Vogel's underlying philosophy is clearly stated in the preface. It is one advocating an approach to biological problems by way not of elaborate mathematics but of "insight into the operative physical processes." This has been the common approach for most biologists who have backed into fluid mechanics to tackle some specific problem; most become too fascinated to wish to back out again. However, the applications rest on advances in fluid mechanics by workers



Flow patterns through a colony of sea squirts, or ascidians (*Botryllus*), to show the combination of incurrent flow into a single relatively high-speed excurrent, effluent jet. This flow pattern ensures that colonies will not reingest water from which they have already removed food and oxygen and which contains their own excretions. [From *Life in Moving Fluids*] who are at best secondarily interested in biological phenomena. There are a few of a new breed of students of biomechanics trained in both biology and fluid mechanics. I believe these will make the major advances in biofluid mechanics.

Vogel's style is conversational, and together with his puns and sometimes obscure classical allusions it may be irritating to some readers. Yet the overall approach is successful. It is simply not possible to read the book without itching to adjourn to the laboratory to try out ideas that come to mind under Vogel's stimulation. Whether he likes it or not, Vogel is an evangelist.

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Biomineralization

Silicon and Siliceous Structures in Biological Systems. Papers from a meeting, Richmond, Va., Dec. 1978. TRACY L. SIMPSON and BENJAMIN E. VOLCANI, Eds. Springer-Verlag, New York, 1981. xvi, 588 pp., illus. $98.90.

Silica deposits, in the form of amorphous to poorly crystalline opal, are widely distributed in the biological world. The involvement of silica in biomineralization has been documented in both animal and plant protists and in higher animals and plants. Because of this wide phylogenetic distribution, the literature on siliceous organisms is scattered. Simpson and Volcani have done a great service in attempting to bring together in this volume a sampling of recent assessments of most of the known occurrences of biogenic silica.

There are chapters dealing with silicified algal groups, especially the diatoms and chrysophytes, and with protozoans, especially the radiolarians, choanoflagellates, and rhizopod amebas. Among the higher organisms there are chapters devoted to silica in higher plants and in the sponges, including the coralline sponges. Most of the authors have concerned themselves with the fine structure and deposition of silica, but a few deal with physiological aspects, especially the effects of germanium as a metabolic analog for silicon. Except for the occurrence of opal known in mollusks (patellacean gastropods), the biological coverage is reasonably complete.

Papers authored by the two editors and their collaborators account for about one-third of the book. A chapter on cell wall formation in diatoms is noteworthy because it describes a variety of unpublished results from Volcani's laboratory, such data being otherwise generally unavailable. Only the paper by Riedel and Sanfilippo on radiolarian evolution seems out of place. It is an interesting account of radiolarian morphogenesis through time, but its relationship with silica is clearly subordinate. It is a paper for paleontologists, especially those concerned with the nature of evolutionary change as discerned from the fossil record. It should have been published elsewhere (and I hope that it will be).

Although there are very few typographical errors, there are a disturbing number of substantive errors and sources of confusion. The most frequent error and source of potential confusion concerns the use of the term "silicon." Where "silica" would better have been used silicon is variously described as dissolved, soluble, polymerized, or amorphous. Silicon granules, flakes, and capsules are discussed. Silicon is even referred to as an anion in one place and silica as an element in another. Quartz is parenthetically listed as obsidian flakes and blue glass, neither being correct. An introductory chapter on the chemistry of silica and the mineralogy of siliceous deposits would have been a very useful addition to the book.

Phytoflagellates are discussed under the heading of algal groups by several authors, but appear under Protozoa in another case, serving to confuse anyone attempting to sort out a phylogenetic history of silica deposition. The unfortunate impression is created in the introduction that the coralline sponges are newly discovered, when in fact they have been known since the turn of the century. It is suggested that diatoms must have developed the ability to capture silicic acid from very dilute solutions because concentrations in natural water are so low. Most geochemists would reverse this argument to state that natural water concentrations are low because diatoms (and other organisms) so effectively sequester silica.

The status of research on the process of silica biomineralization may be compared with that of research on calcification. Siliceous structures lack the complication imposed by the crystallography of the carbonate and phosphate minerals, but the morphological complexities are similar. Volcani concludes that "the mechanism of silicification is largely *terra incognita* about which there are far more questions and speculations than answers." A similar statement applies to calcification. Thus, this book should be of interest to anyone investigating biomineralization and may provide some insights to those concerned with calcareous structures in biological systems. For anyone interested in silica deposition or siliceous organisms it is a useful compendium, but one that needs careful reading in one or two chapters to avoid the errors.

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Muscle Structure

The Structural Basis of Muscular Contraction. JOHN SQUIRE. Plenum, New York, 1981. xviii, 698 pp., illus. $65.

Since the 1972 Cold Spring Harbor Symposium on Muscle Contraction, the published proceedings of which became a standard work of reference, many reviews and monographs dealing with muscular and nonmuscular motility have appeared. There has, however, been a dearth of major single-author books dealing with muscle, *Machina Carnis*, the monumental, essentially historical, book by Dorothy Needham being an exception. On this score alone the present volume is a most welcome addition to the literature on muscle.

Squire deals primarily with muscle structure as revealed by electron microscopy and x-ray diffraction. Throughout the book, however, structural information is presented and discussed with an eye to major issues that are of interest to muscle physiologists, biophysicists, and biochemists. Thus muscle structure at the molecular level is looked upon as a means of answering questions concerning the conversion of chemical energy from adenosine triphosphate (ATP) into mechanical work, the changes in myosin crossbridge configuration, including its relation to the actin filament, as adenosine diphosphate and phosphate are released, and the finer details of the control by calcium of the actin-myosin interaction.

The introductory chapter reviews the fundamentals of muscle physiology and provides a bird's eye view of muscle structure, including an account of the sliding filament model. The ideas that independent force generators reside in the crossbridges formed by myosin attachments to actin and that ATP hydrolysis serves as the immediate source of energy are introduced, and the chapter is