the "P" position, and the Conodonti (revised), distinguished by six- or seven-element apparatuses with a variety of pectiniform elements in the "P" position. Some seven orders and 42 families are included. This section is not intended for the unanointed or even the casual conodont student. This is stuff for the conodontophile, the best of feasting at the High Table.

Although details of generic apparatuses are the book's strength, both theoretical and applied interpretations of conodonts are discussed. An appendix of stratigraphic range charts for 562 of the most important of more than 5000 species defines 156 biozones and substantiates an earlier claim that conodonts have the longest range of stratigraphic utility of any group of organisms.

What were the evolutionary dynamics of a 300-million-year period during which conodonts were among the most widespread and prominent of marine animals? Why are conodonts extinct while other less vigorous or interesting phyla survive? *The Conodonta* doesn't provide all of the answers because so much is still unknown, but what is known confirms that, as Stephen Jay Gould wrote in *Natural History* in July 1983.

> We should . . . care about conodonts, even if we have never correlated a rock or tend to look askance at inch-long worms with faint tail fins and bilobed heads. For their age, their taxonomic uniqueness, and demise record the nature of history.

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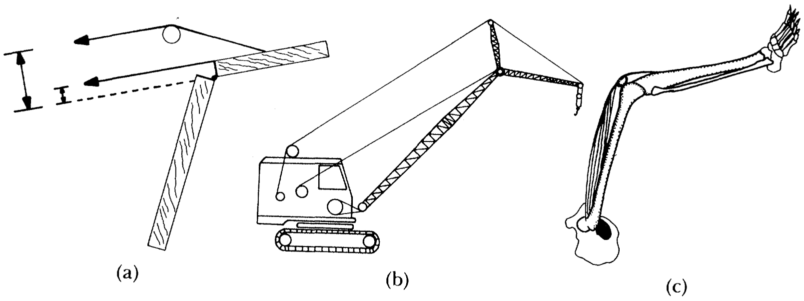
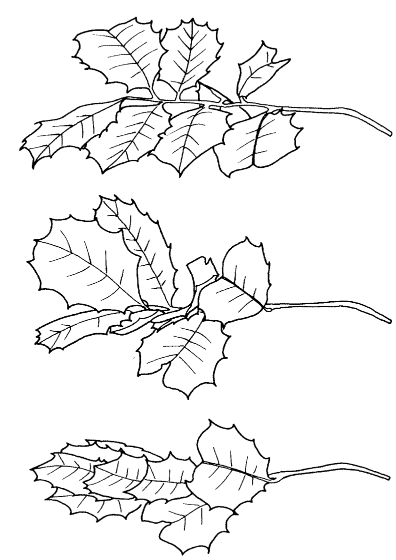
A Broader Biophysics

Life's Devices. The Physical World of Animals and Plants. STEVEN VOGEL. Princeton University Press, Princeton, NJ, 1989. xii, 367 pp., illus. $49.50; paper, $17.95.

The physical world of mass, linear dimensions, time, and temperature—and combinations thereof—was here first. Plants and animals had to live with laws of physics that preceded them. Evolutionary fitness involved selection of the proper materials and structures and "the tuning of design to the details of the mechanical characteristics of the environment." An appreciation of physics, though fundamental to the understanding of life, is missing from the perspectives of many biologists and most nonscientists. It is time for some biologically relevant physics, but how does one find it? Fashions in science funnel the majority of practitioners into the study of a small subset of the appropriate phenomena. Biophysics is literally the application of the concepts of physics to the study of life, but use of "biophysics" as a key word leads to disappointment if one has something other than electron microscopes, ionizing radiation, ultracentrifugation, or nucleic acids in mind. In *Life's Devices*, Steven Vogel addresses this need and restores a broader biophysics—or "comparative biomechanics" (as distinguished from plain "biomechanics," which Vogel observes "has been preempted by an incorrigibly anthropocentric branch of medical or athletic science").



"The uses of a jib. In (a) the moment arm (two-ended arrows) of a force is increased by running a cable over a pulley instead of pulling directly on the hinged member. The force is exerted in the same direction but is much more effective when its line of action is further from the hinge. (b) An articulated crane runs the support cable for its outer, hinged member over a jib for just this reason. (c) In a human leg the tendon of the muscle that extends (straightens) the lower leg runs over an extra bone, the kneecap." [From *Life's Devices*]



"A branch and leaves of holly in a wind tunnel at three different speeds," 0, 10, and 20 meters per second. "The wind here blows from the right. Notice how the leaves bend over and, at the highest speed, reduce their exposed surface area by pressing against each other and against the branch." [From *Life's Devices*]

"Man can learn nothing unless he proceeds from the known to the unknown," wrote Claude Bernard. This principle seems to have guided Vogel, who made effective use of everyday experience in writing this book for adult nonscientists in a graduate program in liberal studies at Duke, trying, in his words, "to exclude as few people as possible from the intuitive satisfactions of the . . . topic." It is obvious that he enjoys the subject and sharing it. Each chapter is a feast, seasoned with humor that underscores the enjoyment. Though tempted to quote a pun or two, I leave them for you to read, for they are best in context.

A core of four chapters on the physics of gases and liquids and four on solid materials and structures is preceded by clear treatments of necessary conceptual tools and semantics of physics: quantities, dimensions, and units, conservation laws, the consequences of size and shape, gradients and summations. Vogel finishes with chapters on motility, "staying put and getting away," and energy and philosophical afterthoughts. There are two appendixes (notes on numbers, problems, and demonstrations).

I became hopelessly confused in only one section, that on non-saggy beams and chains (pp. 227–229). Physics is fun, but I, for one, would "get the picture" more easily if it appeared with the discussion. I counted 11 figures one page-flip past the discussion I was trying to visualize. Why not have dispersed the blank space from the last page of the chapter to enhance figure alignment? This criticism would apply to many books, but it is especially troublesome when reading physics.

This broader biophysics belongs in the biology curriculum. Whether it is offered by a physics or biology department, *Life's Devices* is an excellent textbook. For the tenured biologist, it is a fine refresher, a warm-up for specialized reading, and a pedagogical model for teaching science to nonmajors. There is more to life than *our* narrow subset of appropriate phenomena.

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