

ports, and, in systems considered, from bacterial flagella to dolphins and ornithopters. They include physical and mathematical models as well as reports of kinematic, biomechanical, and hydrodynamic investigations. And, as might be expected, they show a concomitant diversity in degree of relevance to what some might perceive as biophysical reality. At some points the living world seems to serve as a stimulus for the genesis of physical theory rather than as the target of its application.

The diversity of backgrounds of the contributors exacerbates many of the deficiencies common in the printed output of symposia. The papers speak many languages. The participants reportedly had problems communicating, and few readers will totally escape bafflement. The biologically trained will wonder about Stokeslets and vortex sheets, the physically adept about the shapes and proclivities of the beasts lurking beneath the Latin binomials. But most readers will find the general lectures of interest and value, in particular that of Brokaw and Gibbons on the mechanics of cilia and flagella, those of Blake and Sleigh on ciliary hydrodynamics, of Lighthill, of Weis-Fogh, and of Tucker on flight, and of Bone and of Newman and Wu on fish swimming. Each has clarity, simplicity, and perspective, together with a well-selected bibliography. The bibliographies (which include titles of all papers) should prove quite useful, since the literature germane to the field is terribly scattered and uneven.

I am struck by the natural division of the volumes between cellular phenomena (volume 1) and vertebrates and insects (volume 2). If these papers reflect current concerns, then an enormous void exists, one filled in nature by a vast diversity of actively swimming aquatic invertebrates, some (squid, for example) large but most of sizes and speeds in between those of the fashionable animals. According to one report here, a copepod can accelerate to 200 body-lengths per second, probably the present record for any swimmer. Clearly there are some accomplished and sophisticated organisms still escaping serious scrutiny.

The principal weaknesses of these volumes are matters of editing and production. Occasional statements that appear unreasonable go unchallenged, a disservice in an area where misinformation often becomes widely accepted. Inadequacies in figure legends and the axes of graphs are frequent. The subject index is too abbreviated to be particularly helpful. Errors of spelling and citation abound. More stringent guidelines for

format and for uniformity of symbols and units would have been useful. And it might have been of interest to provide some information on the background of the participants. Finally, is it now impossible to get for \$80 a book with proper superscripts and subscripts for formulas, with a clear separation of figure legends from text, and without the unhandy bulk of a two-volume typewritten manuscript?

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## Land Snail Biology

**Pulmonates.** Vol. 1, Functional Anatomy and Physiology. VERA FRETTER and J. PEAKE, Eds. Academic Press, New York, 1975. xxx, 418 pp., illus. \$35.

The Pulmonata are the subclass of the Gastropoda that includes all the non-operculate land snails and slugs and a few families of freshwater, brackish-water, and marine snails and limpets, nearly all of which respire at least in part with a "lung." The land snails are of physiological interest because they are the only mollusks that have successfully forsaken aquatic habitats. This book, a sequel to *Physiology of the Mollusca*, edited by K. M. Wilbur and C. M. Yonge (two volumes, Academic Press, 1964 and 1966), is a quite well integrated series of eight up-to-date review articles on this and other aspects of the biology of the Pulmonata. (By contrast, the projected contents of volume 2—on systematics, evolution, zoogeography, ecology, and economic problems—are highly heterogeneous.)

It has long been known that the Pulmonata are derived from a marine group or groups, but there have been conflicting opinions about whether they came from the Opisthobranchia or directly from the more primitive Prosobranchia. In the introduction, Fretter favors a prosobranch (mesogastropod) origin. She states that terrestrial pulmonates probably came from the sea via estuarine and freshwater habitats (where the primitive pulmonates still live). In the chapter on water relationships, J. Machin cautions against using physiological data to ascertain whether this is so. Anomalously, F. Ghiretti and A. Ghiretti-Magaldi state that freshwater pulmonates "show various degrees of readaptation to aquatic life."

Although rich in species, pulmonates have a much narrower range of morphological diversity than the other two gas-

tropod subclasses. Instead, they have had to evolve special physiological and behavioral adaptations to live progressively farther from the sea—even under extreme desert conditions. Pulmonate "lungs" contain varying proportions of water and air. Except when in deep water, the freshwater groups mainly have air. Thus in this respect they are preadapted to become terrestrial. In his review, Machin demonstrates how physiologically well-adapted some of the pulmonates have become to a terrestrial life insofar as the conservation of water is concerned. In their brief review on respiration, Ghiretti and Ghiretti-Magaldi reveal how surprisingly little is yet known about this subject. C. J. Duncan reviews the structure and function of the complex hermaphroditic reproductive system. Some of the marine species still have planktonic larvae; in the terrestrial pulmonates larval characters have had to be suppressed.

The other chapters review attributes and processes common to most animals. The greatest advances in knowledge are demonstrated in the chapters on the nervous system and endocrinology. The remaining chapters are on locomotion, the alimentary canal, and embryological development. Most major aspects of the functional morphology and physiology of pulmonates are skillfully considered or are mentioned somewhere in the book. There are references (regrettably lacking article titles) at the end of each chapter, and the volume concludes with systematic and subject indexes (the fact-filled introduction was not indexed and should have been).

This is the best book on scientific malacology to be published in several years. It will be of interest not only to malacologists, physiologists, endocrinologists, and embryologists but to biologists interested in ecophysiological adaptations.

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## How Roots Work

**The Development and Function of Roots.** Papers from a symposium, Petersham, Mass., Apr. 1974. J. G. TORREY and D. T. CLARKSON, Eds. Academic Press, New York, 1975. x, 618 pp., illus. \$32.25.

This collection of papers presented at the third Cabot symposium is an outstanding book. The first of its three parts deals with the organization and structure