soil depletion, lower medical costs due to the use of toxic chemicals) then a simple "dollars-per-bushel" cost comparison will understate the relative efficiency of organic methods vis-à-vis conventional methods (no empirical estimate of nonquantity "outputs" is made). To compare costs per physical unit of output, Oelhaf disaggregates to specific commodities and employs two different estimation techniques. He first argues that, under rather complex and not entirely credible assumptions, farm prices for organic produce should approximate production cost per unit. He mobilizes an intriguing array of original survey data for commodities ranging from organic rice to beef. For most of the observed commodities, organic growers receive 5 to 15 percent more than conventional producers. (Cases where differentials fall outside this range are noted and briefly explained.) The figures are heuristic; there is no claim to a perfect correspondence between observed prices and the true unit cost. (There is no obvious bias in his estimates.)

The second estimation technique is more conventional—direct observation of production costs. Oelhaf supplements the Klepper study (*2*) with his own (rather spotty) sample of U.S. producers of several commodities. However sound the methodology or details of the findings, it is intriguing that cost differentials measured from the production side correspond quite closely to those estimated from market price.

The skeptic might put little credence in these calculations, especially when Oelhaf extrapolates from the minuscule number of existing organic farms to an entire farm economy run on organic principles. (Which specific organic practices are involved in his calculations is unclear.) Certainly Oelhaf is aware of weaknesses in his case. Still, his findings reinforce other information to make a strong case for moving away from chemical-intensive agriculture and toward ecological agriculture. Virtually the entire thrust of U.S. agriculture research and public policy has been toward refinement of technologies grounded in the pesticide-herbicide-fertilizer nexus. The resource commitment to organic methods has been tiny. And yet a sizable and apparently growing number of organic farm operators have been able to compete, with only small price premiums. Meanwhile, the chemical-intensive technology has demonstrably contributed to health and environmental problems that are of increasing social concern. And the rising input costs and diminishing returns of such technology are clearly linked to the sharp rise in food prices of the past decade. There is no need to take the claims of any of the various organic movements as gospel. But perhaps it is time for the scientific and public policy establishments to commit resources to a serious and open-minded investigation of the claims of the movement. This is Oelhaf's concluding message. It is delivered without the self-righteous sermonizing that has limited the credibility of the movement up to now.

Although Oelhaf's policy recommendations (on research priorities, pollution taxes, and so on) make sense, he does not address basic political-economic questions whose answers are crucial for the prospects of conversion toward the organic future he espouses. Among those questions: In view of the power, objectives, and past behavior of the industries (and government agencies) that have shaped and promoted chemical-intensive technology, is it reasonable to expect a transformation of priorities just because it would be in society's long-run interest?

DAVID VAIL

Department of Economics, Bowdoin College, Brunswick, Maine 04011

References

1. R. Wolf, Ed., *Organic Farming* (Rodale Press, Emmaus, Pa., 1977).
2. R. Klepper *et al.*, *Am. J. Agric. Econ.* **59**, 1 (1977).
3. D. Pimentel, *Environment* **15**, 18 (1973).
4. W. Berry, *The Unsettling of America* (Sierra Club Books, San Francisco, 1977), chapter 1.
5. M. Perelman, *Farming for Profit in a Hungry World* (Allanheld, Osmun, Montclair, N.J., 1977); see also U.S. Department of Agriculture, Economic Research Service, ERS No. 542, 1974.
6. J. Hightower, *Hard Tomatoes, Hard Times* (Schenkman, Cambridge, Mass., 1973).

Marine Life Histories

Settlement and Metamorphosis of Marine Invertebrate Larvae. Proceedings of a symposium, Toronto, Dec. 1977. FU-SHIANG CHIA and MARY E. RICE, Eds. Elsevier, New York, 1978. xii, 290 pp., illus. $25.

The settlement of marine invertebrate larvae includes those events that lead to the termination of a pelagic life and the assumption of an attached or sedentary bottom existence. Settlement is a behavioral response initiated through tactile and chemosensory perception by larvae. Metamorphosis, on the other hand, is the morphological and physiological change that adapts the animal to a new way of life—that is, from a pelagic to a benthic existence and not uncommonly also from a herbivorous to an omnivorous or carnivorous diet.

The volume under review is concerned with the phenomena of both settlement and metamorphosis and consists of 20 papers originally read at a symposium held to honor Robert L. Fernald, former director of the University of Washington Friday Harbor Laboratories, on his retirement.

Somewhat over half of the contributions are reviews of recent work, five are reports of research heretofore unpublished, and those remaining combine some new observations with a summary of previous knowledge.

A wide assortment of marine bottom invertebrates are considered, including coelenterates, platyhelminthes, annelids, sipunculans, echiurids, phoronids, gastropod mollusks, bryozoans, cirripedes, echinoderms, enteropneusts, and tunicates. There are, however, some conspicuous omissions; for example, the decapod crustaceans are completely neglected, and the bivalve mollusks are only briefly mentioned. Oddly, notwithstanding the illustration of a lingulid iarva on the cover of the volume, brachiopods also are not considered.

The contributions concerned mainly with metamorphosis are largely or entirely descriptive and deal principally with morphological changes. This is not to suggest that these contributions do not sometimes deal with concepts or make inferences of more general or theoretical interest. Bonar's paper on opisthobranch mollusks, for example, presents an interesting and provocative discussion of developmental patterns, and Zimmer relates his findings on the structure of the preoral coelom in the phoronid actinotroch larva to the preoral body region of other deuterostomes.

There are several general summaries of morphological changes at metamorphosis in circumscribed taxa, such as those by Woollacott and Zimmer on cellularioid bryozoans and by Ruppert on turbellarians, a discussion of the fate of larval structures in echinoderms by Chia and Burke, and finally Cloney's long review and analysis of ascidian metamorphosis. There are also detailed original descriptions of metamorphosis of particular species, such as that of Reed on the ctenostome bryozoan *Bowerbankia gracilis*, Hermans's study on the opheliid polychaete *Armandia brevis*, and Potswald's description of several species of the genus *Spirorbis*. These descriptive papers are abundantly illustrated with either line drawings or electron micrographs. Particularly striking are some of Eckelbarger's scanning electron photomicrographs of whole sabellariid polychaete larvae.

The papers dealing with settlement are necessarily restricted to those species of invertebrates whose larvae are readily reared under laboratory conditions. Much of the experimental work over the last three or four decades has been on polychaetes and barnacles. The present volume indicates the trend toward research with other, previously unstudied forms, particularly coelenterates and opisthobranch mollusks. The review of Chia and Bickell on hydrozoan coelenterates is useful because it considers all aspects of settlement, namely the behavior of the planula larvae prior to attachment, the characteristics of the environment that induces the settlement, and finally possible roles of various sensory receptors in locating surfaces for settlement. Research on settlement up to now has seldom considered experimentally the functioning of the sensory organs, and indeed the present volume reflects the paucity of such investigations.

The most significant advances in the past five years have been made in the work on settlement of opisthobranch gastropods. This research is described by Hadfield and by Switzer-Dunlap. Opisthobranchs perhaps more than other gastropod mollusks are associated with very specific diets. Thus nudibranchs generally feed upon coelenterate or bryozoan prey whereas Anaspidea feed on littoral thallus algae. It is not surprising that these gastropod forms often have very specific settling responses that establish the relationship between them and the organisms on which they feed. The exact sensory mechanisms that may explain such responses are not yet known, but the elegant experiments of Hadfield show that very specific compounds are involved and that such substances are effective in solution rather than associated with a surface, as has been reported for barnacles.

The volume includes original observations and summaries of settlement in a number of other taxa. Rice, in addition to her lucid review on the morphological and behavioral changes at metamorphosis, gives the first published account of settlement by the pelagosphaera larvae of sipunculans. A well-organized and readable account of settlement in echinoderms is given by Strathmann, and Pilger reviews settlement and sex determination in the Echiura. Lewis summarizes substratum selection in "free-living" and symbiotic barnacles. There appears as yet to be no explanation of how the interesting species-specific relationships between barnacles and their cetacean and sea-turtle hosts is established.

This volume is not a comprehensive account as the title may suggest, and it is certainly not a complete "synthesis of existing ideas" as the editors hoped. Rather, it is largely a review of recent research, mostly accomplished within the last ten years; the treatment is not balanced but reflects where current interest lies. As an introduction to the literature the volume is marred by the use of abbreviated reference citations. Overall, its principal usefulness should be in stimulating ideas for further research, both behavioral and ecological, on benthic marine invertebrates. One dares hope that this will be sufficient reward for efforts of the editors and contributors.

RUDOLF S. SCHELTEMA
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543

A Great River

The River Volga and Its Life. PH. D. MORDUKHAI-BOLTOVSKOI, Ed. Junk, The Hague, 1979 (U.S. distributor, Kluwer Boston, Hingham, Mass.). xiv, 474 pp., illus. $70. Monographiae Biologicae, vol. 33.

The Volga is one of the great rivers of the world, and it has probably been the most studied of them from a limnological point of view. Sadly though, much of the work on the Volga has been published in Russian and cannot be read by many of the international scientific community. Now and again, however, the Russians come from behind their wall of cyrillic script and complex syntax and tell us what they have been doing. The last time was in 1928 when A. L. Behning published *Das Leben der Volga* in the series Die Binnengewässer. The present book is a worthy successor that brings us up to date.

The particular importance of the Volga is that it has, particularly in recent decades, been much impounded and altered by humans. But in contrast to other large rivers, such as the Missouri and the Ohio, a great deal was known about its ecology before alteration. Serious biological work began on the Volga in the mid-19th century and has continued with increasing vigor and resources to the present time. Mordukhai-Boltovskoi and his coauthors therefore had a wealth of literature to summarize, and they have done it very much with a view to bringing out just what the effects of humans have been.

The book takes up the various topics one would expect in such a work. Geography, geological history, hydrology, dissolved substances, phytoplankton, pollution, production, zooplankton, benthos, and fish are each the subject of a chapter or more. There are also chapters on the littoral of the reservoirs, some of which are very large lakes, and on fish parasites, which are a popular subject of study in the Soviet Union, and a long annotated list of the species of plants and animals that occur in the river.

The book is a mine of information but is certainly not bedtime reading, for each chapter tends to deal in turn with each reach of the river, discussing their differences, changes brought about by each reservoir, and differences with the past. Many of the chapters produce no particular surprises to a specialist in running water ecology, but they should be informative to others, especially to those concerned with impoundments. There are, however, parts that are of great interest and that are full of new ideas. For instance, Romanenko's chapter on microbiology is particularly interesting and novel, and there is some fascinating discussion of the spreading of invertebrates up and down the river in response to the changes caused by humans.

So this is a useful book and it deserves a wide audience. I have only two criticisms. I could have used a good map of the drainage basin, comparable, say, to the one of Tasmania that accompanied volume 25 of this series. And the English is a bit rough and hard to follow at times. It is not that the grammar is wrong but that the usage is sometimes quaint. The grammatical errors that do occur are regrettably only too common in scientific writing, so perhaps the translator may be forgiven.

H. B. N. HYNES
Department of Biology, University of Waterloo, Waterloo, Ontario NZL 3G1, Canada

Books Received

American Energy Choices before the Year 2000. Papers from a conference, New York, Jan. 1978. Elihu Bergman, Hans A. Bethe, and Robert E. Marshak, Eds. Lexington (Heath), Lexington, Mass., 1978. viii, 152 pp., illus. $14.50.

Analytical Chemistry of Liquid Fuel Sources. Tar Sands, Oil Shale, Coal, and Petroleum. Papers from a symposium, New Orleans, Mar. 1977. Peter C. Uden, Sidney Siggia, and Howard B. Jensen, Eds. American Chemical Society, Washington, D.C., 1978. x, 342 pp., illus. $32. Advances in Chemistry Series, 170.

Angina Pectoris. Vol. 1, 1977. I. E. Katzeff and H. Edwards. Eden Press, St. Albans, Vt., 1978. x, 244 pp. $22. Annual Research Reviews.

Animal Physiology. Adaptation and Environment. Knut Schmidt-Nielsen. Cambridge

(Continued on page 224)