ventral side, the first step in forming a digestive cavity by invagination. Jägersten's model ancestral metazoan, "*Bilaterogastraea*," thus emphasized (and provided adaptive significance for) the basic morphogenetic process of invagination, which the older theories had failed to account for. However, it also required that the primitive coelenterate that resulted be bilaterally symmetrical, benthic but not sessile, and with oral surface oriented downward.

I have expounded Jägersten's theory in some detail here because his book assumes the validity of the Bilaterogastraea theory and its consequences, although it devotes but a sentence (on p. 216) to review of it and does not defend it at all. The reader is merely referred to the author's earlier papers, although an understanding of them is required to appreciate some of the arguments presented in the book.

Much of the book documents the ubiquity of the "pelago-benthic" life cycle (consisting of pelagic larva and benthic, nonsessile adult) among the animal phyla to support the argument that this type of life cycle "dates back to the common ancestral forms of all metazoans" and that "the pelagic larval type has thus persisted in ontogeny without interruption since its first appearance." The main extension of theory is thus that *Bilaterogastraea* and most of its descendants retained a pelagic, distributive, primary larval phase in the life history, and that entirely benthic and entirely planktonic life cycles with direct development are derived or secondary phenomena.

Here Jägersten is on fairly firm ground. (Its stability does not depend on acceptance of the Bilaterogastraea theory.) He cites cases from a number of phyla of larval forms with benthic, direct embryogenesis showing distinct vestiges of adaptations to pelagic life. Benthic adult adaptations appearing in pelagic larval stages (the molluscan foot, for example) are considered accelerations that may fit the metamorphosing larva more rapidly for the adult habitat. Jägersten coins the term "adultation" for this precocial incorporation of adult characters in larvae and notes correctly that it should not be taken as evidence that the larvae resemble ancestral adults.

Jägersten's attributions of adaptive significance of larval features occasionally lead (as does the Bilaterogastraea theory) into brambly phylogenetic thickets. Two confusions mar some of the arguments: the author sometimes seems too ready to equate generality of a condition with primitiveness, and he does not provide clear recognition of the principle that from the finite genetic reservoir of an evolving line natural selection constantly effects compromises between conflicting selective pressures.

Science fiction, according to a current dictionary, is "fiction in which scientific discoveries and developments form an element of plot or background." Books such as this one, avidly propounding a particular theory of early metazoan evolution, belong to this genre. The early evolution of the animal phyla and the determination of their major features occurred gradually, perhaps over hundreds of millions of years and 2 or 3 billion years ago. The true phylogenetic relationships remain uncertain. Scientific discoveries and developments are largely restricted to comparative analyses of extant organisms, and the rest is speculation. However, the ratio of information to fiction continues to increase, and speculative syntheses stimulate improvements in the generalizations from observable facts by which we explain order and pattern in nature.

ALAN J. KOHN
Department of Zoology,
University of Washington, Seattle

Mechanisms and Perturbations

The Changing Chemistry of the Oceans. Proceedings of a symposium, Lerum and Göteborg, Sweden, Aug. 1971. DAVID DYRSSEN and DANIEL JAGNER, Eds. Almqvist and Wiksell, Stockholm, and Wiley-Interscience, New York, 1972. 366 pp., illus. $21.50. Nobel Symposium 20.

The assertion implicit in the title of this Nobel symposium volume is plausible, but very far from demonstrated. The editors and authors of this intelligently organized series of papers and discussions refrained, therefore, from presenting the usual disconnected string of horror stories one has come to expect from "environmentalists" and have rather directed their energies at trying to identify and understand the mechanisms controlling the composition of seawater and at posing the question What would it *take* to change the chemistry of the oceans? The one exception, a laconic account by Jun Ui of "A few coastal pollution problems in Japan," gains much of its very powerful impact from this context.

It is a common attitude that the environment is "given" or static, that if one dumps mercury or injects CO_2 or SO_2 or whatever into it it will change to some new state. This concept finds expression in "base-line studies" made to characterize a particular system at time zero before an unnatural event—dredging, spraying, clear-cutting—takes place. The results of these studies are indistinguishable from legal briefs and indeed are rarely used or referred to unless something goes wrong. Seldom is a conscious effort made to understand the mechanisms controlling the "base-line" values. The approach is empirical, not predictive.

It is a distinguishing feature of this symposium that little space is expended on such efforts. Indeed, L. Machta in updating the greatest and most elaborate base-line study of them all—the monitoring of atmospheric CO_2 levels—shows how inadequate short time series measurements are in the characterization of any species actively involved in the geochemical processes in the terrestrial environment.

The symposium was organized as a rather interesting mix of reviews and research papers. Most of the major perturbations that man knows he is in the process of inflicting on the environment are well discussed. Thus, in addition to the CO_2 system, the cycles of organic carbon (Sorokin, Skopintsev), sediments (Goldberg), phosphorus (Stumm), and sulfur (Berner) are given detailed treatment. A great deal of current information is assembled in the process, making the volume a valuable resource. Useful discussions of the large-scale oceanic circulation (Veronis), of the natural fluctuations of oceanic and atmospheric conditions (Namias), and of the factors controlling marine ecosystems (Steele) provide a context within which to place the measurements.

The research reports are a mixed bag. Those on manganese nodules and the trace element cycle (Lal) and N_2O (Hahn) contain much new information and are of considerable interest. Those on mercury (Jernelov) and DDT (Bowen) are rather short on numbers although they gain from the current importance of their topics. Large quantities of new data on marine aerosols are presented (Chesselet); they are not thoroughly discussed in relation to previous measurements, however, so the significance of the very peculiar reported enrichments of potassium and of the postulated presence of gaseous chlorine will be missed by the uninitiated.

Of the model papers, that on systems

analysis (Odum) I found more than usually impenetrable, and the discussion of steady states and chemical stability (Pytkowicz) is very preliminary: the CO_2 juggernaut (Machta) rolls on.

What would it take to change the chemistry of the oceans? This collection of papers gives a very valuable summary of the current status of our attempts to answer this question. It is interesting to note that little attention is paid to estuarine processes, which probably account for a large part of the action.

JOHN M. EDMOND
Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, Cambridge

Biological Assessment

The Panamic Biota. Some Observations Prior to a Sea-Level Canal. A symposium, Washington, D.C., March 1970. MEREDITH L. JONES, Ed. Biological Society of Washington, Washington, D.C., 1972. viii, 270 pp., illus. Paper. Bulletin of the Biological Society of Washington, No. 2.

In his introduction Meredith Jones states that the primary objective of this symposium is to summarize knowledge of the Panamic biota. Approximately half the 24 contributors attempt to do this for different aspects of the biota. They generally conclude that the reptiles and amphibians, birds, mammals, corals, and some echinoderms are reasonably well known and that the mollusks decapods, fishes, and terrestrial flora are poorly understood. These are, of course, relative evaluations since the various authors are not necessarily applying equivalent criteria to their systematic specialty and some are reviewing much larger taxa than others. For example, Neal Weber does not attempt to estimate the numbers of insects in Panama whereas Alexander Wetmore can place the number of bird species at 865 (10 percent of all the world species) with a reasonable degree of precision.

Sylvia Earle (marine plants), James Porter (corals), Lawrence Abele (decapods), and Richard Chesher (echinoderms) provide the most complete and useful summaries of their groups. Some authors compare the Atlantic and Pacific affinities of their groups and some provide estimates of what the final numbers of species described from Panama will be. As a working document this symposium would have been more valuable if all the authors had adhered to a uniform policy of presenting numbers of known species, estimates of total species, and Atlantic-Pacific comparisons when relevant. Many groups of organisms are not covered in this volume, presumably because no expert was available or there just wasn't enough information to be worth summarizing.

In addition to papers on the flora and fauna there are a succinct historical review of the isthmus, the canal, and the Panama–United States treaty situation; two papers on the physical characteristics of the proposed sea-level canal; and two excellent ecological reviews—of the coastal zones by Peter Glynn, and of the human ecology of the indigenous populations of eastern Panama by Reina Torres de Arauz. Although a few of the papers are trivial, most of the authors adequately assess the current knowledge in their fields. Several authors depart from their charge and speculate on the biological implications of a sea-level canal. In this regard the symposium might have profited by including a population geneticist and a theoretical ecologist. The views of a parasitologist would also seem worthwhile in broadly establishing possible biological interactions. Two papers represent background reports of recent study groups (William Newman) and surveys (Gilbert Voss) of the isthmian region. These make poignant reading as the authors describe their frustrations in attempting to obtain recognition for their institutions or committee report. Newman provides a fascinating discussion of the trials and tribulations of the National Academy committee report, which he and other members of the committee (CERIC) felt was largely neglected by the Atlantic-Pacific Interoceanic Canal Study Commission (see P. M. Boffey, *Science* **171**, 355–58 [1971]).

The participants almost unanimously call for more collections and more research in the isthmian region to overcome the relatively poor state of our knowledge for most groups of isthmian organisms. This situation could have been at least partially remedied had a small part of the Canal Study Commission's $22-million appropriation been spent on a more detailed biological survey. Biologists have often been criticized for their lack of agreement on the implications of the proposed sea-level canal. These scientists are not expected to make the decision on whether or not a canal should be built, but it is they who are best able to evaluate the ecological costs. This can be done intelligently, however, only if adequate long-term support for their research is available. No one expected the engineers to recommend a site for a new canal without rather lavish funding for accumulation of new data pertaining to their assignment; it is unfair to expect precision from biologists with much less complete data. Perhaps biologists involved in funding studies of national environmental issues are not yet up to situations complicated by international overtones and the lack of pork-barrel considerations.

IRA RUBINOFF
Smithsonian Tropical Research Institute, Balboa, Canal Zone

Books Received

Advances in Cancer Research. Vol. 16. George Klein, Sidney Weinhouse, and Alexander Haddow, Eds. Academic Press, New York, 1972. x, 366 pp., illus. $19.50.

Advances in Lipid Research. Vol. 10. Rodolfo Paoletti and David Kritchevsky, Eds. Academic Press, New York, 1972. xviii, 386 pp., illus. $23.50.

Biological Boundaries of Learning. Martin E. P. Seligman and Joanne L. Hager. Appleton-Century-Crofts, New York, 1972. xiv, 480 pp., illus. $12.95. Century Psychology Series.

Cardiovascular Fluid Dynamics. Vol. 1. D. H. Bergel, Ed. Academic Press, New York, 1972. xxii, 366 pp., illus. $20.

Cell Surface Alteration as a Result of Malignant Transformation, II. Papers by Jaro Ankerst and others. MSS Information Corp., New York, 1972. 240 pp., illus. $15.

The Death-Life Law of Nature. Raymond Westbury Maxwell, Jr. Published by the author, Box 13897, Baden Station, St. Louis, Mo. 63147. xii, 400 pp.

Design in the Built Environment. R. Fraser Reekie. Crane Russak, New York, 1972. xii, 142 pp., illus. $10.50.

Dynamics of Learning. Nathaniel Cantor. Agathon, New York, 1973 (distributed by Schocken, New York). xx, 296 pp. $7.50.

The Earth and Human Affairs. National Academy of Sciences Committee on Geological Sciences. Canfield (Harper and Row), New York, 1972. xiv, 142 pp., illus. Cloth, $3.95; paper, $1.95.

Echocardiography. Harvey Feigenbaum with the assistance of Sonia Chang. Lea and Febiger, Philadelphia, 1972. xiv, 240 pp., illus. $11.

Fish Nutrition. John E. Halver, Ed. Academic Press, New York, 1972. xii, 714 pp., illus. $32.50.

FORTRAN for Engineering Physics. Electricity, Magnetism, and Light. Alan B. Grossberg. McGraw-Hill, New York, 1972. viii, 246 pp., illus. Paper, $4.50.

Generalized Functions and Fourier

(Continued on page 834)