Book Reviews

Treatise on Invertebrate Paleontology

Brachiopoda, relatively sparse elements in Recent marine biotas, are among the more important groups of fossil animals studied by paleontologists. In the past 150 years, dozens of scientists have devoted a large number of monographs to documenting the morphology, taxonomy, and phylogenetic development of this phylum. The remains of shelled animals provide an essential key to relative chronologies and to paleogeographic and paleoecologic reconstructions of the past 600 million years of earth history. For almost two-thirds of that time, from 600 to 225 million years B.P., brachiopods dominated the shelly faunas. Consequently, a comprehensive understanding of brachiopods is essential to any reasonable elaboration of earth history during the Paleozoic Era.

Publication of the two volumes **Brachiopoda**, vols. 1 and 2 (Geological Society of America and University of Kansas Press, Lawrence, 1965. 959 pp., $19.50), by Alwyn Williams and others, as Part H of the *Treatise on Invertebrate Paleontology*, brings this unparalleled project of synthesizing biologic data on all the invertebrate phyla to the point at which it is almost three-quarters completed. Perhaps this is a time for taking stock of the amazing products of this effort that has involved the work of some 200 paleontologists for more than 15 years.

The *Treatise on Invertebrate Paleontology* was conceived and has been executed largely through the efforts of Raymond C. Moore, the general editor who has worked for more than a decade to bring the project so near completion. Four societies (the Paleontological Society, the Society of Economic Paleontologists and Mineralogists, the Palaeontographical Society, and the Palaeontological Association), the University of Kansas Press, and the Geological Society of America have sponsored and made possible regular publication of these volumes as they have been completed.

Originally planned as a compilation of existing information at the generic level, the project has undergone gradual metamorphism until the latest volumes contain a large amount of new research. The first volume completed, Part G, *Bryozoa* (1953), compiled by R. S. Bassler, adequately fulfilled the original purpose of the *Treatise*. However, the last two contributions, Parts C and H on foraminifera and brachiopods, respectively, show what far-reaching changes have been made during the past 12 years.

Brachiopods are divided into two major classes on the basis of shell composition, among other characters. The Inarticulata have predominantly chitinophosphatic shells; the Articulata are invariably calcareous. Brachiopods have resisted comprehensive analysis during the more than 150 years since they were studied seriously by Cuvier in the early 1800's. Because much of the research was directed to the study of fossil shells, zoological studies were relatively rare until the past decade or so. Consequently, a major contribution in these volumes is a summary of the physiology, functional morphology, and life habits of living brachiopods. Much of this is new material by the two principal contributors, Alwyn Williams who has done a great deal of original research in the deposition of shell material in articulate brachiopods and A. J. Rowell who has contributed a completely fresh look at the taxonomy of the inarticulates.

A great deal of new information is included in these volumes, but Williams emphasizes the extent to which brachiopod anatomy and ecology have been neglected in modern biological studies. Other than Williams and Rowell, only three scientists have contributed significantly, in modern times, to our knowledge of the anatomy of recent brachiopods. S. H. Chuang and R. T. Payne have examined inarticulates in some detail, and Daphne Atkins has published on the growth and feeding mechanisms of selected articulates. In the section on ecology only 25 modern ecological studies are cited, and many of these deal with secondary interpretations based on fossil shells. The ecological conclusions are largely based on M. J. S. Rudwick's unpublished studies. Now that modern biology seems to be more and more dominated by cellular and molecular research, it is significant that the study of whole animals, their ecologic and biogeographic implications, and the importance of ontogenetic and phylogenetic development in systematics, is falling by default into the province of paleontology.

The chapter on morphology is generally excellent. All aspects of shell form and structure are exhaustively examined and profusely illustrated with many original figures. Any student of brachiopods or any morphologist who studies this part of the volume carefully will be richly rewarded. Especially significant are the discussions of musculature, shell growth, and structure.

One aspect of this section is unfortunate—certain opinions are stated as accepted fact. Some unsolved problems in brachiopod structure and anatomy are presented in such a positive way that the reader may be lured into unqualified acceptance. The nature and extent of the lophophore attachment to the shell floor, the origin and significance of endopunctae, and the function of the brachial ridges in productoid brachiopods are among the subjects of continuing research and discussion.

The phylogenetic interpretations are less satisfactory, especially the suggested evolutionary relationships among the major groups of brachiopods. In addition, the coverage of these groups in the systematic treatment of the genera is quite variable in quality. Perhaps such a result is inevitable in a volume to which so many have contributed, but the editorial quality, particularly in the second volume, is somewhat below that of other recently published parts of the *Treatise*.The quality of many of the photographs is poor, and the accuracy of some of the drawings is questionable.

The new classification of brachiopods will raise many questions in the minds of specialists on the phylum. Williams and Rowell have taken an eclectic approach, apparently assuming that by throwing all possible variables into the equation, an answer certainly would be forthcoming. They have, indeed, produced an answer to the classification muddle, but parts of the answer appear nonsensical. The major subdivisions into 11 orders, 5 among the inarticulates and 6 for the articulates, seem reasonable for they reflect the main

kinds of brachiopods recognized by most paleontologists. It is at the subordinal and superfamily levels that many difficulties appear. Few paleontologists would now insist on a monothetic Beecher-type classification, but some will dispute the revisions made by Williams and Rowell. Despite the apparent finality of this work, major classifications will continue to be advanced on combinations of internal and external characteristics that are considered by various specialists to have phylogenetic and evolutionary significance.

A few examples among the articulates indicate the extent of the difficulties. It has long been recognized that brachiopod shell structures fall into three broad categories: endopunctate, pseudopunctate, and impunctate. The apparently random inclusion of punctate genera in the section on Spirifers is most confusing. Punctate forms, usually with a spondylium in the pedicle valve, are classed as Superfamily Suessiacea, while the punctate syringothyrid forms are included as a family in the Spiriferacea. The Spiriferinacea are predominantly punctate forms which, however, include both the impunctate *Odontospirifer, Spiriferinaella,* and *Spiriferinoides* and the clearly unrelated genus *Dimegelasma.* No argument based on phylogeny or evolutionary change can justify such a hodgepodge. Similar confusion exists among the extremely variable genera included in the superfamily Reticulariacea. Among the strophomenaceans a complete reorganization of families and subfamilies on the basis of internal characters of the brachial valve, coupled with consideration of shell structures, probably would have greater phylogenetic significance than the classification given in the *Treatise.*

Despite these weaknesses in classification and organization, which are largely matters of opinion among specialists, the editor, the authors, and their collaborators have assembled most of the significant biological information on this important animal phylum. These volumes will be a standard reference source for student, teacher, and specialist alike for many years to come.

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Biological Organization: The Case for Evolution

It is no longer a fashionable exercise to prove the "case for evolution." Those textbooks that marshal the evidence from comparative anatomy, embryology, and paleontology in a solid phalanx of Victorian assurance are rapidly becoming extinct. They are being replaced by others that accept the fact of evolution as common knowledge and concern themselves with ways and means.

Bruce Wallace, in **Chromosomes, Giant Molecules, and Evolution** (Norton, New York, 1966. 171 pp., $1.95), contends that we are deluding ourselves. He believes that the recent flurry of antievolutionary sentiment (see *Science,* 11 Feb., p. 632) is the opening gun of a new campaign, and he would like to see his book become the weapon to win the allegiance of intelligent uncommitted laymen, especially teachers in public schools, clergymen, and parents.

The strategy for the demonstration of evolution is familiar, although the illustrations from genetics and molecular biology are a refreshing change from ear bones and aortic arches. Essentially the method is to show (i) that the structures of biological materials (here these are giant chromosomes, amino-acid sequences in proteins, and base sequences in DNA) are complex and precise; (ii) that different species possess very similar structures; (iii) that differences of structure within and between species are of the same kind; and (iv) that it is almost inconceivable that such similar structures could have independent origins.

The case built up by Wallace is a clear, concise, and logically unassailable one. The facts are well presented in a novel format that consists of a short text followed by 39 figures, each with a detailed explanation. My principal reservation concerns the varying standard of depth. The terms mitosis and meiosis are deliberately avoided for the sake of simplicity, but the structural formulas for 20 amino acids appear very early in the argument. Some of the examples, such as the diagram of chromosome changes in *Datura,* are quite complex. They will certainly tax the perseverance of the nonbiologist.

Another audience, however, may well be reached by this book. Undergraduate and beginning graduate students in biology should find that it provides a useful introduction to some very exciting material. It forges connecting links between at least three levels in the hierarchy of biological organization—the biochemical, the cytological, and the populational. Let us hope, therefore, that its principal use will be in the classroom rather than as ammunition in an ideological war.

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Ecological Genetics

In an age when any but the narrowest specialist finds more books published in his field than he can possibly read, the appearance of still another volume of symposium proceedings is likely to engender a feeling of resignation in a prospective reviewer. However, **The Genetics of Colonizing Species: Proceedings of the First International Union of Biological Sciences Symposium on General Biology** (Academic Press, New York, 1965. 458 pp., $24), edited by H. G. Baker and G. L. Stebbins, proved a pleasant exception from run-of-the-mill symposia proceedings, and I read the volume from cover to cover with great interest and considerable profit.

A reading of this volume is well worth the effort for a biologist interested in evolutionary problems. As I see it, the book's particular merits are threefold: (i) Much of the material is new, and it is clearly presented by outstanding authorities in the field. Much credit should go to the editors and to Professor C. H. Waddington, who selected the speakers. (ii) The problems of colonizing species are viewed rather broadly—not only over a wide taxonomic spectrum but also from the viewpoints of the several relevant disciplines, genetics, ecology, cytology, and behavior. (iii) The import of the contributions goes considerably beyond the confines of the symposium title. Much fundamental evolutionary theory is discussed using colonizing species as examples. This aspect of the book makes it of considerable value to evolutionists in general.

The subject matter of the symposium was concerned with the genetical and ecological consequences of the accidental or deliberate introductions of animals or plants into parts of the world