had encountered the infection but simply failed to contract the disease because of their resistance (pp. 118–119).

Here as elsewhere McKeown is reluctant to admit that various efforts aimed at improving health and prolonging life, independent of nutrition, could have had much effect. His arguments are impressive, but the question remains open. He claims that medical treatment, public health measures, and individual hygiene were almost completely ineffective in the early phase of population growth. What remains in doubt is whether the small effectiveness they had could not have brought about what was, after all, a very moderate and slow decline of mortality.

Much of the controversy about medical treatment has been concerned with smallpox. McKeown grants with reluctance that mass vaccination accounted for the elimination of smallpox but seems to say that it was not a very important disease anyway. "Since the mid-nineteenth century the decrease has been associated with only 1.6 per cent of the reduction of the death rate from all causes." This hardly seems adequate as an assessment of the role of what was long the most feared of the childhood diseases. Jenner was widely hailed as a benefactor of mankind for his discovery of vaccination, and no other medical innovation spread so quickly to the most remote parts of the world. It is probable that by mid-century the prevalence of smallpox had already been considerably reduced. McKeown also rejects summarily the possibility that inoculation played a role in the 18th century. No doubt the procedure was a dangerous one by today's standards, but it received the support of the best scientific minds of the time and may have saved many lives in the enlightened upper classes.

The role of public health and the effectiveness of efforts to improve environmental sanitation remain the large unknown in the picture. It will not do to assign as the date for the beginning of the public health movement the time when national public health statutes were first passed. There had long before been sustained efforts on the part of municipalities to regulate the disposition of garbage, street cleanliness, burial, industrial pollution, and so on and to impose such measures as quarantines and building codes. The importance of clean and abundant water, of sewerage, of open spaces in cities was recognized. It is hard to make a general assessment of these measures, but they must have encountered some success here and there. But there was no general understanding of disease transmission. And the accumulation of large numbers in cities may have resulted in a deterioration of sanitary conditions. McKeown believes on the whole that exposure to water- and food-borne diseases worsened before 1850.

With respect to personal hygiene and domestic services, it is certain that standards of cleanliness improved, bathing became more frequent, and cotton clothing that could be washed frequently came into general use. According to McKeown, it is unlikely that such developments contributed significantly to the decline of mortality except possibly in the case of typhus, which was borne by body lice, "for it is the condition of the water and food which determines the risks of infection" (p. 124). Even here, it is perhaps notable that the practice of filtering water was spreading. And typhus, though its importance is difficult to assess because it was almost eliminated by the time for which statistics become available, accounted for severe epidemics and was not a negligible disease.

This reviewer does not understand why McKeown believes that the disappearance of another vector-borne disease, the plague, had no effect on the beginning of the modern rise of population. The last major plague epidemic in Western Europe occurred in 1720 and the last in England in 1679. This disease has been invoked by historians as one of the reasons for the stagnation of population numbers from the 14th to the 17th century. According to figures quoted in this book, the three most severe epidemics of the 17th century in London would have been sufficient to reduce population growth by an average of half a percent per year—hardly a trivial amount. To explain the early phase of the modern decline of mortality a reduction of the exceptional mortality of epidemics (including typhus and bubonic plague) remains a contender. Here, too, McKeown's resistance to explanations that hinge on human efforts to improve the urban environment is apparent. He seems to attribute the disappearance of the plague to a factor other than direct human intervention, "the interruption of land trade routes" from Asia, an explanation he quotes from J. F. D. Shrewsbury. But that author credits mostly another factor, namely the near-elimination of the black rat in British cities as a result of the improvement of building materials and the storage of food. The foremost historian of the plague, J. N. Biraben, attributes its disappearance to the success of quarantine measures.

No single factor can explain the modern rise of population, as McKeown would be the first to admit. An accurate apportionment of the factors responsible is still out of reach. The present work presents a bold and provocative thesis, clearly stated. Other researchers will inevitably be stimulated to challenge it. This is a major service rendered to a field that is still shrouded in ignorance.

ETIENNE VAN DE WALLE
Population Studies Center, University of Pennsylvania, Philadelphia 19104

Fossil Arthropods

Evolution and Morphology of the Trilobita, Trilobitoidea and Merostomata. Proceedings of a NATO Advanced Study Institute, Oslo, July 1973. ANDERS MARTINSSON, Ed. Universitetsforlaget, Oslo, 1975 (U.S. distributor, Columbia University Press, New York). 468 pp., illus. + plates. Paper, $51. Fossils and Strata, No. 4.

This book stems from a conference organized by David L. Bruton of the Paleontologisk Museum in Oslo that brought together 60 paleontologists and zoologists from 13 countries to discuss current research on fossil arthropods. A valuable cross section of current paleobiological research on fossil arthropods, the book will be of interest to zoologists and paleobiologists and, to a lesser degree, to stratigraphic paleontologists.

Remains of Paleozoic arthropods are abundant, but soft tissues and appendages are only rarely preserved. Consequently, knowledge of early arthropod anatomy relies heavily on the study of the diverse and exquisitely preserved trilobites and nontrilobite arthropods of the Middle Cambrian Burgess Shale and a few other deposits that yielded soft parts. Separate articles by H. B. Whittington and C. P. Hughes present a comprehensive reevaluation of the anatomy of some Burgess Shale arthropods. These studies are part of a larger research program on the Burgess fauna organized by Whittington at Cambridge University. J. L. Cisne summarizes some results of a stereoradiographic study of *Triarthrus*, a trilobite with preserved soft tissues and appendages, from the Ordovician. Whittington's and Cisne's anatomical studies revise previous views of primitive arthropod affinities by showing similarities between some trilobites and cephalocarid crustaceans. R. R. Hessler and W. A. Newman develop a comprehensive argument for the diphyletic origin of arthropods, incorporating the new data on trilobite anatomy. Their interpretation supports the view put forth earlier by O. W. Tiegs

and S. M. Manton that the Crustacea were derived from the Trilobitomorpha and that the principal division within the Arthropoda is between a terrestrial lineage (Onychophora–Myriapoda–Insecta) and a marine lineage (Trilobitomorpha–Crustacea–Chelicerata).

Paleozoogeographic and paleoecologic studies of trilobites have been stimulated in part by developments in global plate tectonics. Given the changing positions of continents with time, the paleontologist has the fundamental problem of distinguishing among ancient marine faunas that are geographically widespread because the original preferred habitat was widespread, those that are geographically widespread now because their original habitat was fragmented and displaced by tectonic processes, and those that lived close together originally but were separated by environmental barriers, for example when warm and cold ocean currents were juxtaposed. R. J. Ross, Jr., attempts an explanation of patterns of distribution of early Paleozoic trilobites with reference to oceanic surface currents and inferred positions of continental blocks. Such "best fit" models may stimulate new hypotheses, but they are difficult to test because the variables that can affect faunal distributional patterns are difficult or impossible to isolate and evaluate separately. A different approach is taken by R. A. Fortey in an analysis of Early Ordovician trilobite communities of Spitsbergen. Relative abundance and taxonomic associations of trilobites are related to an environmental gradient from shallow to deep water. Trilobites in the various communities had different potentials for geographic dispersal and phyletic longevity. Fortey's results show the value of meticulous attention to taxonomic, taphonomic, and sedimentologic data. Similarly detailed work is greatly needed in other parts of the world and would undoubtedly lead to a clearer understanding of paleozoogeographic patterns and community evolution in a world of changing geography.

R. A. Robison applies modern ecological theory to interpretation of some Middle Cambrian pelagic agnostoid trilobites. Detailed morphologic and taxonomic studies suggest that some agnostoids conform to an allopatric model of speciation. Competition among secondarily sympatric species led to segregation by depth and character displacement with respect to size. In turn, these factors may account for increased species diversity during Middle Cambrian time.

In one of the more stimulating articles, D. C. Fisher reports an experimental study of the functional morphology of the living xiphosuran *Limulus* and a Jurassic relative, *Mesolimulus*. Fisher has experimentally examined the hydrodynamic and mechanical properties of the form of the prosoma in *Limulus* and has related them quantitatively to swimming and burrowing efficiency. Armed with these data, he builds a convincing argument for swimming and burrowing behavior in *Mesolimulus* and discovers the relative importance of swimming and burrowing in the two genera. The significance of Fisher's paper goes beyond its importance to the study of xiphosurans. His clever application of hydrodynamic principles and experimental methods to gain quantitative information on behavior of a fossil form is a model of analytical strategy that could benefit most functional morphologists.

Unfortunately, the book is marred by defects of production. Some photographs are washed out, several photographic plates are transposed between papers, and in my copy one article has four blank pages. Apparently the most serious flaw is the omission of charts from the text-figures in the article by J. H. Stitt, an oversight that eliminates the basic data upon which Stitt's interpretations are based.

In spite of these flaws, the book has great scientific merit, and no biological or paleontological library should be without it.

MICHAEL E. TAYLOR
Paleontology and Stratigraphy Branch, U.S. Geological Survey, Washington, D.C. 20560

Books Received and Book Order Service

Books Received and the Book Order Service will be combined in issues in which there is a Reader's Service Card. To order any of the Book Order Service books, circle the corresponding number on the Reader's Service Card (pages 626A and 690A); the participating publisher(s) will ship the title(s) ordered and send you a bill.

Advances in Photochemistry. Vol. 10. James N. Pitts, Jr., George S. Hammond, and Klaus Gollnick, Eds. Interscience (Wiley), New York, 1977. xii, 476 pp., illus. $29.50. *To order this book, circle No. 441 on Readers' Service Card.*

Advances in Picture Reconstruction. Theory and Applications. Z. H. Cho, Ed. Pergamon, New York, 1977. viii pp. + pp. 239–372, illus. Paper, $15. *Computers in Biology and Medicine*, vol. 6, No. 4. *To order this book, circle No. 442 on Readers' Service Card.*

Amyloidosis. Proceedings of a symposium, Helsinki, Aug. 1974. Otto Wegelius and Amos Pasternack, Eds. Academic Press, New York, 1977. xvi, 606 pp., illus. $32.25. *To order this book, circle No. 443 on Readers' Service Card.*

Chemical Control of Insect Behavior. Theory and Application. H. H. Shorey and John J. McKelvey, Jr., Eds. Wiley-Interscience, New York, 1977. xiv, 414 pp., illus. $19.50. *To order this book, circle No. 444 on Readers' Service Card.*

Chemical Pharmacology of the Synapse. D. J. Triggle and C. R. Triggle. Academic Press, New York, 1976. x, 654 pp., illus. $43.75. *To order this book, circle No. 445 on Readers' Service Card.*

Computer Software Engineering. Proceedings of a symposium, New York, Apr. 1976. Polytechnic Press, Brooklyn, N.Y., 1977 (distributor, Halsted [Wiley], New York). xx, 584 pp., illus. $32. Microwave Research Institute Symposia Series, vol. 24. *To order this book, circle No. 446 on Readers' Service Card.*

Dynamics of Polymeric Liquids. Vol. 1, Fluid Mechanics. R. Byron Bird, Robert C. Armstrong, and Ole Hassager. Wiley, New York, 1977. xvi, 470 pp., illus. + appendices. $29.95. *To order this book, circle No. 447 on Readers' Service Card.*

Foams. Proceedings of a symposium, Uxbridge, Middlesex, England, Sept. 1975. R. J. Akers, Ed. Academic Press, New York, 1976. x, 302 pp., illus. $23.50. *To order this book, circle No. 448 on Readers' Service Card.*

Fossil Algae. Recent Results and Developments. Papers from a symposium, Erlangen, West Germany, Oct. 1975. Erik Flügel, Ed. Springer-Verlag, New York, 1977. xiv, 376 pp., illus. $36.10. *To order this book, circle No. 449 on Readers' Service Card.*

The Future of Science. 1975 Nobel Conference. St. Peter, Minn., Oct. 1975. Timothy C. L. Robinson, Ed. Wiley-Interscience, New York, 1977. xxiv, 146 pp. $12.95. *To order this book, circle No. 450 on Readers' Service Card.*

Human Histology, Cytology and Microanatomy. Helmut Leonhardt. Translated from the German edition (Stuttgart, 1974), by D. P. Winstanley. Year Book Medical Publishers, Chicago, and Thieme, Stuttgart, 1977. xii, 442 pp., illus. Paper, $11.95. Thieme Flexibooks.

Ichthyology. Karl F. Lagler, John E. Bardach, Robert R. Miller, and Dora R. May Passino. Illustrated by William L. Brudon. Wiley, New York, ed. 2, 1977. xviii, 506 pp. $18.95. *To order this book, circle No. 451 on Readers' Service Card.*

Large-Scale Models for Policy Evaluation. Peter W. House and John McLeod. Wiley-Interscience, New York, 1977. xxiv, 326 pp., illus. $18.95. Wiley Series on Systems Engineering and Analysis. *To order this book, circle No. 452 on Readers' Service Card.*

Mathematical Models for Surface Water Hydrology. Proceedings of a workshop, Pisa, Dec. 1974. Tito A. Ciriani, Ugo Maione, and James R. Wallis, Eds. Wiley-Interscience, New York, 1977. xvi, 424 pp., illus. $27.50. *To order this book, circle No. 453 on Readers' Service Card.*

MDH-Flows and Turbulence. Proceedings of a seminar, Beersheva, Israel, Mar. 1975. H. Branover, Ed. Halsted (Wiley), New York, and Israel Universities Press, Jerusalem, 1977. xii, 162 pp., illus. $25. *To order this book, circle No. 454 on Readers' Service Card.*

Nuclear Cardiology. Principles and Methods. Aldo N. Serafini, Albert J. Gilson, and William M. Smoak, Eds. Plenum, New York,

(Continued on page 698)