

of the book covers the record of past climatic change, beginning with the recent record of change and marching back over longer and longer time periods in the earth's history. Crowley and North review much of what we know and don't know about climatic change on time scales of decades, centuries, and longer. This is a solid source book with an extensive, up-to-date bibliography.

Without doubt, those who wish to anticipate future climatic change will be well served if they read *Paleoclimatology*. Future trace-gas-induced change could be significantly larger than any change of the last 10,000 years, and the paleoclimatic record may provide the best clues as to how the earth's climate system responds to large changes in climatic forcing. Crowley and North survey the patterns of past change with possible future change in mind. The record of the past may allow us to unravel the patterns and causes of natural decadal- to century-scale climatic variability, but this natural change may be swamped by human-induced climatic change in the future. Crowley and North demonstrate that the trace-gas-forced change of the future will likely be without past analogs. This fact means that we will have to rely on models of the climate system to assess the temporal and spatial patterns of future change. As the authors point out, however, the paleoclimatic record has a big role to play in improving and testing these models.

The paleoclimatic record is rife with hints that the climate system may be more sensitive to perturbations than the instrumental record would suggest. The dominant component of climatic variance over the past million years is concentrated in a frequency band centered on about 1 cycle per 10^5 years. This component manifests itself as the quasi-periodic comings and goings of the ice ages and has been linked statistically to the small changes in insolation induced by predictable changes in the eccentricity of the earth's orbit. But, as Crowley and North emphasize, we do not yet know how such a small perturbation in forcing could have such a large impact on the climate system. Contrast this observation with paleoclimatic evidence that variations in solar output as small as 0.20% may have generated significant variability in the climatic system. Again, this represents a level of radiative forcing to which our present generation of climate models is relatively insensitive. Other evidence suggests that the climate system can jump, in a matter of centuries and without large changes in forcing, between significantly different stable modes.

The greenhouse debate centers on the sensitivity of the climate system to future trace-gas forcing. Climate models suggest

that the response to a doubling of atmospheric trace gases could be a global mean surface air warming of 1.5 to 4.5°C. The paleoclimate record will be needed to improve estimates of climate sensitivity. Like a good teacher, the paleoclimate record may convince us to look more carefully at those large changes of the past that are not well understood. Like a good textbook, *Paleoclimatology* will serve as a useful guide to those changes.

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Graptolites Without Fear

Graptolites. Writing in the Rocks. DOUGLAS PALMER and BARRIE RICKARDS, Eds. Boydell Press, Rochester, NY, 1991. xvi, 182 pp., illus., + plates. \$79. Fossils Illustrated, vol. 1.

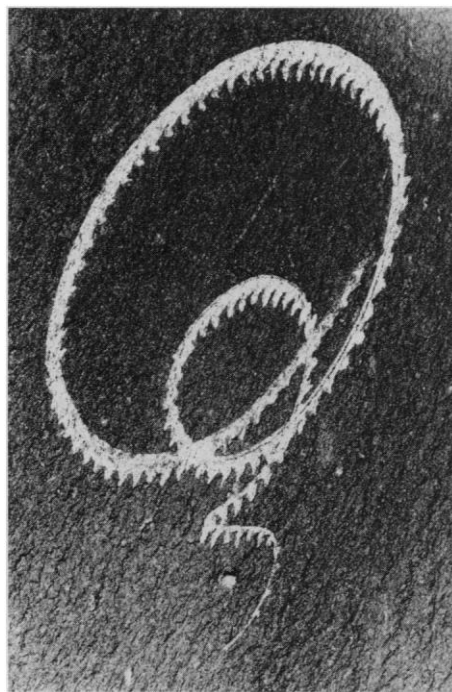
The premise of this first volume of a projected new series, Fossils Illustrated, is that graptolites are misunderstood. Apparently, the problem is not so much that graptolites are difficult to understand as it is that those who have studied this extinct

group of organisms have not explained the morphology and ecology of the fossils in an understandable manner for either amateurs or professionals. This theme carries through the entire volume, accompanied by chapter titles as contemporary as today's TV talk shows. The informality of "How did they live?," "What was their sex life like?," and "What other organisms did they live with?" will perk the interest of many, although the chapters concerning preservation, classification, evolution, and geologic occurrence will be of greater interest to the stratigraphic paleontologist.

The product of "BIG G" (the British and Irish Graptolite Group), *Graptolites* is an attempt to popularize graptolite study worldwide but particularly in the United Kingdom. The volume includes 14 chapters authored and coauthored by 14 specialists and 8 appendixes written by many of the same. The appendixes deal with problems of where to collect graptolites and where to find help for identification and give a brief biographical sketch of 8 early graptolite workers. This section includes directions to specific localities, an item that probably will irritate professionals and delight amateurs. Chapter 11 explains collection and preparation of specimens in the field and is entertaining with such practical instructions as "Boots and wellingtons will be necessary"—good advice for those in the United Kingdom, but of much less value for those working in Nevada. Most of the book is written for the amateur or at least the non-graptolite paleontologist, but chapter 5, concerning paleoenvironmental adaptations, and appendix 3, concerning classification to the subfamily level, are a little more professionally oriented. A glossary and 138 absolutely gorgeous illustrations of a variety of graptolite species and their structures complete the book.

This volume is pleasant reading and a good review of graptolites. It will not add much that is new to the paleontologic literature, but it succeeds in demonstrating that graptolites are understandable, even interesting fossils, and all of this in spite of an almost complete lack of knowledge concerning the soft parts that engineered these extinct Paleozoic structures. Predation or competition with the early jawed fishes is suggested as a cause for their extinction, but this idea is based more on the appearance of the more mobile, biting vertebrates at approximately the same time as the extinction of graptolites than it is on substantive evidence. The idea is not seriously considered. Similarly, a previous report of graptolites that survived into the Permian of China is dismissed.

The 138 illustrations (labeled "plates" but



The helical growth spiral of *Monograptus proteus*, Llandovery, Silurian, Germany. The spirally coiled colony is flattened on the bedding plane as a silvery chlorite film on black shale and is also stretched in a direction from top right to bottom left as a result of the compression of the rock during folding by forces operating normal to that direction. [From *Graptolites: Writing in the Rocks*]

referred to as "figures" in the text) demonstrate most of the important graptolite morphology and are the real strength of the book. Such features as details of the prosicula, metasicula, and crossing canals and other structures rarely preserved on most specimens are shown in splendid scanning electron micrographs. The book includes almost everything that is important for a general understanding of graptolites and with its fine illustrations will be useful for those who are instructing students or who are just collecting fossils.

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Approachable Immunology

Cellular and Molecular Immunology. ABUL K. ABBAS, ANDREW R. LICHTMAN, and JORDAN S. POBER. Saunders, Philadelphia, PA, 1991, xii, 417 pp., illus. Paper, \$26.95. Supplementary slide set, \$250.

The major challenge facing the immune system is similar to that faced by the writer of a textbook on the subject: a constantly changing environment. The last 10 years have seen an explosion in our knowledge of the workings of the immune system, with many of the mysteries of the complex cellular and molecular interactions finally beginning to be elucidated. This explosion of information has made it difficult to find an introductory textbook on immunology that is both up-to-date and of high quality. The publication of this book has solved that problem, at least for the near future.

The key attribute of this book is the clarity and conciseness with which it presents this complex and abstruse field. Text and figures are well coordinated, and the figures are outstanding, presenting the information clearly and simply but still conveying the essence of the experiments.

The text, comprising 19 chapters, is divided into four sections: Introduction to Immunology; Lymphocyte Specificity and Activation; Effector Mechanisms of Immune Responses; and Immunity in Defense and Disease. Each chapter has four to six subsections, including a summary and about a dozen key references. Informational boxes are included to provide important or noteworthy background information on diverse aspects of immunological research that are crucial for understanding modern immunology but that fall between the cracks in many courses. A sampling of the topics found in these boxes are CD-molecule nomenclature, hybridomas, transgenic mice, cytokine re-

ceptor families, and immunity to malaria. Another nice teaching aid is the availability of a moderately priced slide set of the figures from the book.

Aimed primarily at medical students, this comprehensive, balanced, and approachable presentation will provide both medical students and Ph.D. candidates with an excellent foundation in immunology. The book is not so comprehensive as to scare them off, but there is enough substance to convey an understanding and appreciation of the immune system. An essential but often missing component of immunology textbooks is the clear establishment of the connection between the immune system and clinical medicine. Section 4, which focuses on the role of the immune system in defense against pathogens and on diseases caused by abnormalities in the immune system, firmly establishes this link.

How does this book compare to those already in use? In my opinion, it is the best available textbook of immunology for medical and research-oriented graduate students. The popular *Essential Immunology* by Roitt, the seventh edition of which was published in 1991, is also thoroughly illustrated, but it is less comprehensive and is better suited for undergraduates. On the other hand, the excellent *Fundamental Immunology*, edited by William Paul, is very comprehensive, with each of the chapters written by a leading expert, but is more suitable for advanced students. *Molecular and Cellular Immunology* fills a gap between these two extremes. It is a scholarly work that gives substantive accounting of current immunology in a way that is ideally suited for a medical graduate student's first exposure to the subject.

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