mole-rats is no simple feat. In the field, they remain sequestered underground in hard-packed soils breaking through to the surface only rarely to spew out loose soil, thereby creating the volcano-like molehills that are the sole above-ground evidence of their presence. Because they are adapted to a remarkably stable and impregnable environment, captive naked mole-rats are sensitive to the least disturbance, so environmental conditions must be carefully regulated and observations need to be performed surreptitiously in the laboratory. Although Jarvis provides information on capture, transport, housing, and maintenance, naked mole-rats clearly are exotic animals unlikely to become common laboratory subjects. The frontispiece color plate by Jarvis and R. A. Mendez and the numerous photographs help convey to the reader who will never have an opportunity to see a naked mole-rat a sense of the atypical morphology and behavior of these bizarre mammals. Mendez's excellent color photography of naked mole-rats also appears in a popular article by E. Pennisi in *Discover* (March 1986).

Each chapter in the book includes a summary and each can be read as an independent entity and out of sequence, so selective reading is possible. However, because all the citations are collected into a single "literature cited" section that does not include references to the chapters, a reader who obtains a photocopy of a particular chapter will not have access to reference information. Ten of the 15 chapters have multiple authors, and the three editors each contributed to at least three chapters, so the book is a cooperative effort. Although the editors indicate that they "solicited contributions from everyone active in naked mole-rat research," some researchers who have published recently (for example, Lovegrove in *Behavioral Ecology and Sociobiology* in 1991) are not contributors, so this book does not include all points of view on evolution of eusociality in mole-rats.

This book will appeal to a broad selection of biologists because so many aspects of the biology of naked mole-rats, including reproductive physiology, energetics, diet, opportunities for dispersal, systematics, and social organization, are atypical for mammals. Further, the book is full of fascinating scientific trivia that will make it interesting reading for any avid naturalist. Readers will discover that all of the following can be answered by naming the naked mole-rat. What mammal: Is capable of prodigious digging feats with its teeth? Exhibits nipple development by non-breeding adults, including males, in the presence of a pregnant female? Begs for feces from its colony mates? Has females that are often twice the mass of adult males? Exhibits poikilothermy? Is so ugly that it is beautiful?

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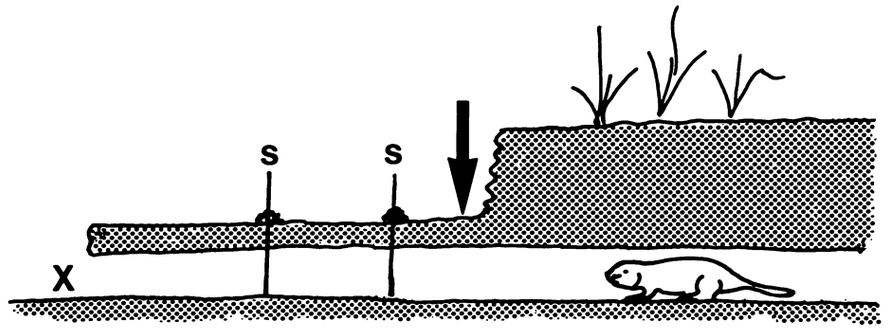
"Acrylic plastic (plexiglass) tunnel systems used to house and observe naked mole-rat colonies at Cornell University; a nest box is in the foreground." [From Lacey and Sherman's chapter in *The Biology of the Naked Mole-Rat*]



"The standard method of capturing naked mole-rats. As the mole-rat approaches the opened portion of the burrow (x) it displaces fine straws (s) inserted into the burrow through its roof. When the straw nearest the opening moves, a hoe is driven smartly down at the point of the arrow." [From the appendix of *The Biology of the Naked Mole-Rat*]

The Earth's Climate

Paleoclimatology. THOMAS J. CROWLEY and GERALD R. NORTH. Clarendon (Oxford University Press), New York, 1991. vii, 339 pp., illus. $59.95. Oxford Monographs on Geology and Geophysics, 18.

When most people think of climate change, their minds turn to thoughts of how weather has changed over the past decade or two. Climatologists usually go one step further when they are asked to evaluate the possibility of global "greenhouse" warming. They turn to the instrumental climate record of the past 100 to 150 years to answer questions such as: Are recent record high temperatures due to civilization's modification of the atmosphere, or are they just due to natural climatic variability? Could natural climatic forcing (for example, by volcanoes or the sun) counteract or reinforce global warming? and How realistic are the climate models that we are using to make assessments of future climatic change? A growing number of scientists, however, are coming to the conclusion that the instrumental record of change is too limited to answer these questions. Scientists across the spectrum of environmental disciplines need an observational base that is significantly longer and more variable than the instrumental record of the past century. The paleoclimatic record addresses this problem by extending our observational baseline back hundreds, thousands, and millions of years into the past.

Paleoclimatology has hit the bookshelves just in time to serve as a valuable resource for global change research and to help train a new generation of interdisciplinary scientists who will routinely use the record of the past as a key to the future. Crowley and North's book is written to be used by advanced students and professionals. All who are interested in how the climate system works and in how it is modeled will be interested in this balanced discussion of data and models. Students with backgrounds in meteorology, climatology, or oceanography will get the most out of the introductory coverage in the first two chapters of models and basic climatology, but such a background is not a strict prerequisite. The bulk

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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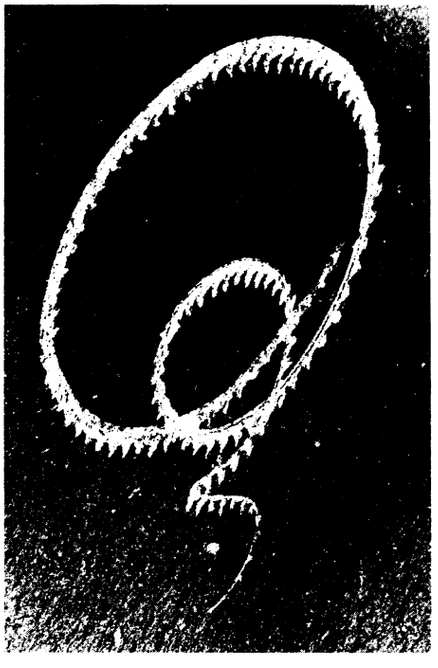
Graptolites Without Fear

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 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*]

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