The Terminal P-Tr Events

The Great Paleozoic Crisis. Life and Death in the Permian. DOUGLAS H. ERWIN. Columbia University Press, New York, 1993. xii, 327 pp., illus. $55 or £42.50; paper, $26 or £20. Critical Moments in Paleobiology and Earth History Series.

The apparently sudden extinction of the dinosaurs, together with a host of marine taxa, during the terminal Cretaceous (K-T) mass extinction has captured the public's interest and continues to stimulate extensive research on the causes and effects of mass extinction. Yet the K-T pales in comparison to the great Permo-Triassic (P-Tr) mass extinction, 250 million years ago. Approximately 57 percent of the Earth's extant marine families, 83 percent of the marine genera, and perhaps as many as 95 percent of the marine species disappeared at the end of the Permian. By taxonomic measures, the impact of the P-Tr extinction exceeded that of any other known mass extinction by at least a factor of two. These numbers are inexact, but there is no disputing that this was animal life's greatest crisis. (Curiously, plants were rather less affected.) No wonder Erwin has labeled the Permo-Triassic the "Mother of Mass Extinctions." But beyond counts of extinct taxa, the enduring legacy of mass extinctions is the permanent elimination of communities and ecosystems that had persisted for millions of years. The P-Tr extinction did exactly that; the benthic marine communities of the Paleozoic, dominated by brachiopods, bryozoans, and crinoid echinoderms, disappeared and were replaced by the mollusk-dominated communities of the Mesozoic and Cenozoic.

This book is an ambitious attempt to review the broad range of physical and biological events of the late Permian and early Triassic. Erwin examines, evaluates, and synthesizes a tremendous volume of research, much of it new. For example, new correlations based on conodonts greatly improve temporal resolution in marine sections. A large amount of information on boundary sections in China is now available; these data complicate our interpretation of the extinction. Erwin integrates these and other new paleontological data with recent contributions in isotope geochemistry, paleoceanography, tectonics, and other disciplines to produce the first synoptic treatment of late Permian history.

The salient question addressed in Erwin's book, and in most other analyses of mass extinction, is the nature of the mechanism responsible for mass extinction. Too often, our search for simple solutions to complex problems leads only to simplistic hypotheses. There are surely situations where the answer *is* simple; perhaps a rock fell out of the sky 65 million years ago and (indirectly) killed the dinosaurs. But the Earth's physical and biological systems are so complex as to defy comprehension, and the major features of life's history are unlikely to have such simple causes.

Refreshingly, Erwin embraces the complexity of the Permian world in his quest to understand the processes responsible for the P-Tr extinction. It was a dynamic world then: the continents were completing the assembly of the Triassic supercontinent, Pangea; a major glaciation gripped the world in the late Carboniferous and Permian; volcanic eruptions formed the Siberian traps, the most extensive flood basalts of the past 600 million years, in the late Permian; atmospheric concentrations of CO_2 increased rapidly; and sea level dropped by more than 200 meters at the end of the Permian. Each of these events influenced other aspects of the physical and biological world. Erwin carefully examines and weighs these factors and their intimate interrelationships in constructing his interpretation of the extinction's causes.

The Great Paleozoic Crisis might be difficult for the nonspecialist. Erwin's use of time/stratigraphic nomenclature is inconsistent and confusing. The sources of data and the data themselves are sometimes unclear. Different values for the extinction's impact are given throughout the book: 83 percent (p. 16), 70 percent (p. 86), and 78 to 84 percent (p. 88) of the genera, to cite a few examples. More important, one is sometimes left wondering what Erwin really believes. At one point (p. 111) he refers to the putative susceptibility of reef ecosystems to mass extinctions as a "canard," with little empirical support. He reverses himself later (p. 264), without explanation, pronouncing that reefs "are consistently decimated by mass-extinction events" and that "the end-Permian mass extinction was no exception to this rule." Similarly, Paleozoic gastropods (Erwin's specialty) first are described as limited in their ecological range to herbivory, scavenging, and suspension-feeding (p. 20); six pages later they approach modern gastropods in their ecological breadth (p. 26). Perhaps minor individually, these cases are symptomatic of occasionally careless writing or inconsistent thinking that frustrate the reader.

Erwin's book, on the positive side, avoids an overly narrow focus on the paleobiology of the late Permian; he has crafted a thorough and integrated review of a broad range of physical and biological events from that turbulent interval in life's history. *The Great Paleozoic Crisis* is a valuable reference for anyone interested in the phenomenon of mass extinction and will undoubtedly fuel many graduate seminars in the coming year.

Philip W. Signor
Department of Geology and Center for Population Biology, University of California, Davis, CA 95616

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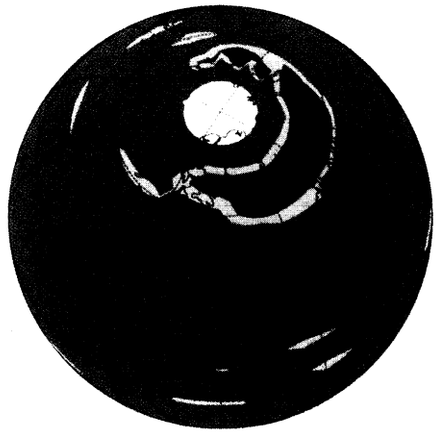
Remote Observations

Atmospheric Remote Sensing by Microwave Radiometry. MICHAEL A. JANSSEN, Ed. Wiley, New York, 1993. xx, 572 pp., illus. $95 or £79. Wiley Series in Remote Sensing.

Microwave radiometry is concerned with the measurement of thermally emitted microwave radiation. Although its wavelength region is the same as that of radar, it is distinct from radar in that a radiometer has no transmitter; it is passive rather than active. In essence, it is applied radio astronomy. Much of the early work in microwave radiometry of the Earth was accomplished within radio astronomy groups.

Microwave radiometry is now used in making operational weather observations



"Enhanced concentration of upper atmospheric chlorine monoxide in northern latitudes, observed on January 6, 1992 by the Microwave Limb Sounder on the Upper Atmosphere Research Satellite . . . The red color indicates ClO in excess of ~1 part per billion by volume. ClO is a chemically active form of chlorine whose abundance is a measure of the rate at which chlorine destroys ozone, and which, at comparable abundances, is linked to the formation of the ozone hole in the southern hemisphere. Its appearance at these levels over populated areas in the north is of major concern." [From the dust jacket of *Atmospheric Remote Sensing by Microwave Radiometry*; courtesy of Joe W. Waters]