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.

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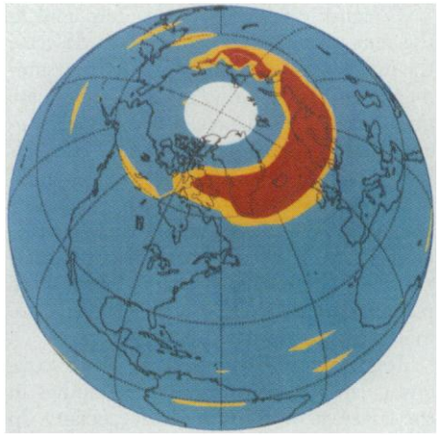
Remote Observations

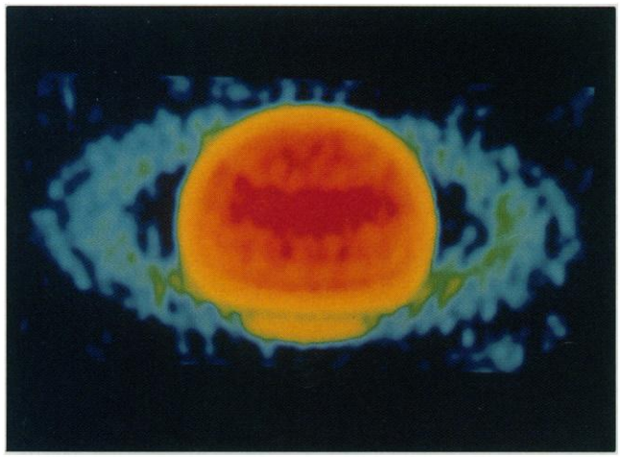
Atmospheric Remote Sensing by Microwave Radiometry. MICHAEL A. JANSSEN, Ed. Wiley, New York, 1993. xx, 572 pp., illus. $95 or £79. Wiley Series in Remote Sensing.

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]



"Image of Saturn at 6 cm wavelength made at the National Radio Astronomy Observatory's Very Large Array in New Mexico. The banded structure is due to variations of ammonia concentration in the subcloud Saturn atmosphere that are related to the general circulation at deep levels. . . . The rings are inherently faint at microwave frequencies but are readily identified in the image." [From the dust jacket of *Atmospheric Remote Sensing by Microwave Radiometry*; courtesy of Arie W. Grossman and Duane O. Muhleman]

both from the ground and from satellites. It is also employed extensively from various platforms for a wide range of scientific investigations. *Atmospheric Remote Sensing by Microwave Radiometry* is a detailed treatment of remote sensing by microwave techniques of the atmospheres of Earth and other planets.

Weighting functions are widely used in the remote sensing community to describe the information content of passive measurements of temperature profiles. They are often misused in measurements of constituent profiles. Westwater's chapter, "Ground-based microwave remote sensing of meteorological variables," contains a general discussion of weighting functions that provides a common theoretical basis for both applications. This chapter should be required reading for anyone involved in passive remote sensing in any spectral region.

It is inevitable that in a book of this scope any given reader will find shortcomings in the coverage of his or her own specialty. In this spirit I wish that Gasiewski, in his chapter "Microwave radiative transfer in hydrometeors," had illustrated his concepts with an example in a portion of the spectrum commonly used for rainfall measurements, which would have provided a better background for the discussions of the measurement of rainfall from satellites that appear further on in the book. Also, in Grody's chapter "Remote sensing of the atmosphere from satellites using microwave radiometry" I was disappointed by the absence of any discussion of the measurement of precipitable water. It was clear from his treatment of the measurement of water vapor profiles that he had not read Westwater's discussion of weighting functions.

Like many multiauthored compilations, the book suffers from some redundancy among the chapters, although the various authors' different approaches to the common themes can be interesting and instructive. All the chapters have substantial depth, but some are more accessible than others. Rosenkrantz's contribution ("Absorption of microwaves by atmospheric gases") will be almost impossible reading for anyone without some background in quantum mechanics.

This book belongs on the desk of anyone working (or planning to work) in the atmospheric applications of microwave radiometry. Those working in other branches of remote sensing will find many of the ideas presented here useful as well. Those merely curious about the field will find it rather slow going.

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Reprints of Books Previously Reviewed

Breaking the Maya Code. Michael D. Coe. Thames and Hudson, New York, 1993 (distributor, Norton, New York). Paper, $14.95. *Reviewed* **257**, 1773 (1992).

Chandra. A Biography of S. Chandrasekhar. Kameshwar C. Wali. University of Chicago Press, Chicago, 1993. Paper, $16.95 or £13.50. *Reviewed* **251**, 455 (1991).

Complexity. The Emerging Science at the Edge of Order and Chaos. M. Mitchell Waldrop. Simon and Schuster, New York, 1993. Paper, $12. *Reviewed* **259**, 387 (1993).

The Diversity of Life. Edward O. Wilson. Norton, New York, 1993. Paper, $14.95. *Reviewed* **259**, 1774 (1993).

The Mismeasure of Man. Stephen Jay Gould. Norton, New York, 1993. Paper, $9.95. *Reviewed* **215**, 656 (1982).

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Books Received

Action and Reaction. Paul Theerman and Adele F. Seeff, Eds. University of Delaware Press, Newark, 1993 (distributor, Associated University Presses, Cranbury, NJ). 324 pp., illus. $39.50. From a symposium, College Park, MD, April 1987.

Ad Infinitum. . . The Ghost in Turing's Machine. Taking God Out of Mathematics and Putting the Body Back In. An Essay in Corporeal Semiotics. Brian Rotman. Stanford University Press, Stanford, CA, 1993. xviii, 203 pp. $39.50; paper, $12.95.

The Adaptive Decision Maker. John W. Payne, James R. Bettman, and Eric J. Johnson. Cambridge University Press, New York, 1993. xiv, 330 pp., illus. $59.95; paper, $19.95.

The Biology of the Autistic Syndromes. Christopher Gillberg and Mary Coleman. 2nd ed. Keith, London, 1993 (U.S. distributor, Cambridge University Press, New York). viii, 317 pp., illus. $64.95. Clinics in Developmental Medicine, no. 126.

Bird Migration. Thomas Alerstam. Astrid Ulfstrand, illustrator. Cambridge University Press, New York, 1993. viii, 420 pp. Paper, $34.95. Translated from the Swedish edition (1982) by David A. Christie. Reprint, 1990 ed.

Brain Development and Cognition. A Reader. Mark H. Johnson, Ed. Blackwell, Cambridge, MA, 1993. xii, 734 pp., illus. $64.95; paper, $26.95.

C/Math Toolchest for Engineering and Scientific Applications. Charles P. Bernardin. PTR Prentice Hall, Englewood Cliffs, NJ, 1993. viii, 484 pp., illus., + diskette. Paper, $65.

Cahuachi in the Ancient Nasca World. Helaine Silverman. University of Iowa Press, Iowa City, 1993. xvi, 371 pp., illus. $59.95.

Captive Seawater Fishes. Science and Technology. Stephen Spotte. Wiley, New York, 1992. xxiv, 942 pp., illus., + plates. $97.95. Wiley-Interscience Publication.

Chemical Physics of Intercalation II. Patrick Bernier *et al.*, Eds. Plenum, New York, 1993. x, 403 pp., illus. $115. NATO Advanced Science Institutes Series B, vol. 305. From an institute, Chateau de Bonas, France, June 1992.

Children and Disasters. Conway F. Saylor, Ed. Plenum, New York, 1993. xxii, 237 pp. $39.50. Issues in Clinical Child Psychology.

The Chromosome. J. S. Heslop-Harrison and R. B. Flavell. Bios Scientific, Oxford, U.K., 1993 (U.S. distributor, Books International, McLean, VA). xx, 281 pp., illus. $99 or P49.50. John Innes Review. Based on a symposium, Sept. 1992.

Civilizing Mission. Exact Sciences and French Overseas Expansion, 1830–1940. Lewis Pyenson. Johns Hopkins University Press, Baltimore, MD, 1993. xxii, 377 pp., illus. $45.

Clean Production Strategies. Developing Preventive Environmental Management in the Industrial Economy. Tim Jackson, Ed. Lewis, Boca Raton, FL, 1993. xxiv, 415 pp., illus. $60.

Combat Stress Reaction. The Enduring Toll of War. Zahava Solomon. Plenum, New York, 1993. xvi, 284 pp., illus. $35. Plenum Series on Stress and Coping.

Desmopressin in Bleeding Disorders. G. Mariani, P. M. Mannucci, and M. Cattaneo, Eds. Plenum, New York, 1993. x, 361 pp., illus. $105. NATO Advanced Science Institutes Series A, vol. 242. From a workshop, Il Ciocco, Tuscany, Italy, April 1992.

Diagnostic Molecular Microbiology. Principles and Applications. David H. Persing *et al.*, Eds. American Society for Microbiology, Washington, DC, 1993. xxii, 641 pp., illus. Spiral bound, $59.

Dietary Lipids and Insulin Action. I. Klimes *et al.*, Eds. New York Academy of Sciences, New York, 1993. xiv, 388 pp., illus. Paper, $110. Annals of the New York Academy of Sciences, vol. 683. From a symposium, Smolenice Castle, Slovak Republic, Sept. 1992.

Electrodynamics of High-Temperature Superconductors. Alan M. Portis. World Scientific, River Edge, NJ, 1993. viii, 247 pp., illus. $68; paper, $28. Lecture Notes in Physics, vol. 48.

Evolutionary Ethics. Matthew H. Nitecki and Doris V. Nitecki, Eds. State University of New York Press, Albany, 1993. x, 368 pp., illus. $16.95. SUNY Series in Philosophy and Biology. From a symposium, Chicago, May 1990.

The Evolutionary Tales. Rhyme and Reason on Creation/Evolution with Apologies to Chaucer and Darwin. Ronald L. Ecker. North Bridge, Palatka, FL, 1993. xii, 212 pp. Paper, $10.