Four papers survey the empirical evidence of the diversity of life through Phanerozoic time, the past 570 million years of abundant life. Marine animals are dealt with by Sepkoski and Hulver, terrestrial vertebrates by Padian and Clemens, vascular land plants by Niklas, Tiffney, and Knoll, and marine invertebrates by Signor. These authors all comment on the main problem of these kinds of studies, which is the incompleteness of the fossil record. The land vertebrate record is particularly weak, and this is illustrated by the apparent fact that the dinosaurs died out completely not once but dozens of times during their history. Padian and Clemens note that a strict reading of the fossil record shows a total extinction of dinosaur genera every five million years or so, at the end of each geological stage.

Signor surveys the possibilities for applying correction factors to take account of the patchiness of the fossil record. It has been argued that our knowledge of fossil distributions depends on at least three factors: the volume of sedimentary rocks laid down during each time period, the area of these rocks that is now exposed, and the degree of research attention that has been devoted to them (so-called "paleontological interest units" may be calculated). Signor finds that broad correction factors for these biases may be applied to the fossil record of marine invertebrates and that when they have all been allowed for there appears to have been a rising trend in species diversity through time, with a particularly great increase during the Cenozoic, the last 66 million years.

Several papers look at ecological aspects of the diversity of life and seek to explain how major groups replace each other through time and why the overall diversity of life has increased. In the case of marine invertebrates during the Paleozoic (570 to 245 million years ago), Sepkoski and Miller find that each successive fauna appears first in an onshore location and later extends to offshore environments. This study relies on the assumption that there exist major "communities" (in the paleontological sense) that maintain their integrity for tens or hundreds of millions of years as species and genera come and go. Richard Bambach finds that major increases in diversity of marine animals are related to the "discovery" and utilization of empty ecospace (opportunistic adaptive radiation), and certain major adaptive zones may remain empty for a long time after a group becomes extinct and before an ecologically equivalent group evolves. The idea of empty ecospace is very important, and it may suggest that the history of life is not dominated by high levels of competitive interaction in which resources are all hotly contested and adaptive radiations are driven by wholesale improvements in competitive ability. The hard-to-define idea of "progress" in evolution again comes into question.

Progress and competition in macroevolution form part of the equilibrium viewpoint, that the diversity of life tends to increase to a certain level, a kind of global carrying capacity, and a dynamic equilibrium will be established. A new equilibrium level can be attained only if the biosphere is perturbed in a major way. In a theoretical paper, Kitchell and Carr develop a non-equilibrium mathematical model to describe the patterns of diversity and replacement of Phanerozoic marine animals. This stochastic approach offers a workable alternative to the equilibrium (deterministic) approach to global diversity of Sepkoski and others. Just as many ecologists now argue that equilibrium modeling of ecosystems may have limited validity because ecosystems rarely, or never, reach equilibrium, so Kitchell and Carr argue that the diversity of the biosphere is in a state of "continual disequilibrium" because of perturbations (extinction events) and major evolutionary innovations.

In contrast to the global approach of the papers just described, a few tackle particular aspects. For example, David Jablonski attempts a test of the popular theory that many mass extinctions were caused by global marine regressions. He examines modern marine faunas and finds that, even if all species on the continental shelf were wiped out, there would be a reduction in numbers of families of only 13%, much less than the magnitude of the end-Permian (245 million years ago) mass extinction event (52% reduction). Ward and Signor look at the relatively well known fossil record of ammonites and attempt to find regular patterns of diversification. However, the different families expand and contract through time with a great variety of patterns, and there is no single easy explanation.

James Valentine, the editor of this book, published seminal papers on Phanerozoic diversity patterns in the late 1960's and 1970's. Great strides in our understanding have been made since then, but there are still major problems: how good is the fossil record? what is the "shape" of the history of life? are the patterns caused by equilibrium or non-equilibrium processes? The questions could not be larger, but they are all the more exciting for that.

M. J. BENTON
Department of Geology, Queen's University of Belfast, Belfast BT7 1NN, Northern Ireland

Marine Mammals

Fur Seals. Maternal Strategies on Land and at Sea. ROGER L. GENTRY and GERALD L. KOOYMAN, Eds. Princeton University Press, Princeton, NJ, 1986. xviii, 292 pp., illus. $40; paper, $14.50.

This multi-authored volume describes an approach for extending traditional land-based studies of seals by using an ingenious instrument known as a time-depth recorder to obtain information from free-ranging animals at sea. This approach is employed to provide a more complete description of maternal behavior in five species of fur seals and one sea lion experiencing varying degrees of environmental uncertainty. For each species, observations of females and their pups on land are supplemented with diving records from the females' excursions offshore to obtain food. For one species, the approach was extended by using isotopic tracer methods to estimate some components of energy budgets of females and pups during the nursing period. The results are collated and compared in the final chapter to investigate how maternal strategies in otariid seals vary with environmental predictability.

Small sample sizes plague research on marine mammals and are a particular problem when the techniques required to obtain data are costly. In this case, expense limited the number of time-depth recorders employed, and the tendency of such instruments to break down reduced sample sizes even further, in some cases to three or fewer animals. Though the authors carefully detail such limitations in the data they present, it remains for the reader to remember them, particularly in the final chapter, where small databases tend to get lost sight of in interspecific comparisons.

This work is not without some more avoidable problems. There are annoying inconsistencies, both within and between chapters, and probabilities associated with statistical tests are presented in an often flawed manner. The term "attendance behavior," defined in the preface, is subsequently used in so many different contexts that its intended meaning becomes obscured. In several chapters, estimates of feeding success of female otariids during foraging trips at sea are based on questionable assumptions about food requirements or intake. Equally questionable is the use of yearly mean sea surface temperature as an index of environmental uncertainty. The editors compare the "most extreme environments (subpolar and tropical) inhabited by otariids" in fig. 1.1 and conclude (p. 5) that "the sites differed most in the rapidity of [annual temperature] change around the overall mean." Yet, this pattern disappears when the two graphs in fig. 1.1 are plotted

on identical scales; there is in fact no significant difference in annual temperature change between their subpolar and tropical sites (t test, $p > .05$).

The final chapter of the volume is one of the few attempts in the literature to apply the comparative approach to the study of seals and to integrate aspects of their behavior, physiology, and ecology; it is valuable for these reasons. Still, it contains more compilation than synthesis, including unnecessary repetition of figures from earlier chapters.

Given the recent interest in the ecological implications of body size in mammals generally, it is unfortunate that the authors did not pursue this matter further, especially given that the two species of otariid seals living in the most unpredictable (in terms of annual productivity) environment studied are smaller than close relatives living in more predictable environments. It might also have been more interesting to attempt to explain differences in population density than differences in absolute abundance of the species considered. Finally, in a book on maternal strategies that attempts to integrate observation and theory, failure to discuss observed differences in maternal investment in individual sons and daughters in relation to recent theories of parental investment is an opportunity missed.

Seal biology, as evidenced by this work, still shows all the traits of a young science; it remains largely inductive in approach and descriptive in nature, with new understanding emerging more through serendipity than design and reference to theory often merely a post hoc exercise. Yet it is clear that this monograph, and the pioneering approach it describes, which has already yielded some valuable and unexpected results, will provide further stimulus for using pinnipeds as vehicles for testing hypotheses generated by ecological and evolutionary theories, thereby bringing more field studies of these fascinating yet elusive mammals into the mainstream of modern biology.

D. M. LAVIGNE
Department of Zoology, University of Guelph, Guelph, Ontario N1G 2W1, Canada

Some Other Books of Interest

Hormones, Receptors and Cellular Interactions in Plants. C. M. CHADWICK and D. R. GARROD, Eds. Cambridge University Press, New York, 1986. xii, 375 pp., illus. $69.50. Intercellular and Intracellular Communication, 1.

Noting that the study of ligand-receptor interactions is less well advanced for plant than for animal systems, Chadwick and Garrod have compiled a volume the aim of which is "to take a broad look at the current status of [such] interactions in a variety of higher and lower plant systems" in the hope of providing "a cross-fertilization of ideas and a stimulus to research." The work opens with chapters on auxin, ethylene, and gibberellin receptors (Libbenga *et al.*, Hall, and Stoddart), which are followed by a discussion of cyclic AMP in higher plants (Newton and Brown). Receptors in slime molds are the subject of the next two chapters (Newell, Chadwick *et al.*). Further chapters deal with the plasma membrane of higher plant protoplasts (Fowke), yeast mating (Ballou and Pierce), pollen-stigma interactions as studied in *Brassica oleracea* (Dickinson and Roberts), host-pathogen interactions (Ralton *et al.*), attachment of *Rhizobium* to legume root hairs (Dazzo), and functions of plant lectins (Holden and Yeoman). Each chapter has its own reference list, and the book includes a subject index.

The volume inaugurates a series to be published under the general editorship of B. Cinader. The second volume will be devoted to receptors in tumor biology.—K.L.

Wetlands. WILLIAM J. MITSCH and JAMES G. GOSSELINK. Van Nostrand Reinhold, New York, 1986. xvi, 539 pp., illus. $44.50.

In this volume the authors have set out to fill a need for "a comprehensive reference [for] scientists, engineers, and planners involved in the management of wetlands and . . . a textbook for students and professors for newly evolving courses on wetland ecology." The book is intended for an audience with some background in ecology and emphasizes, though does not limit itself to, North American wetlands. The opening section gives some history of wetland use, outlines the distinguishing features of wetlands, defines the various types, and describes their status and distribution in the United States. Part 2, entitled The Wetland Environment, contains chapters on hydrology, geochemistry, biological adaptations, and ecosystem development. Parts 3 and 4 are devoted to particular types of wetland ecosystems—tidal salt and freshwater marshes, mangrove wetlands, inland freshwater marshes, northern peatlands and bogs, southern deepwater swamps, and riparian wetlands. Part 5 takes up such practical issues as the valuation of wetlands, strategies of and laws bearing on wetland management, and classification and inventorying of wetlands. A list of nearly 700 references and a 21-page index conclude the volume.

—K.L.

Books Received

Applied Classical Electrodynamics. Vol. 2, Nonlinear Optics. F. A. Hopf and G. I. Stegeman. Wiley-Interscience, New York, 1986. x, 187 pp., illus. $27.50. Wiley Series in Pure and Applied Optics.

Are Australian Ecosystems Different? J. R. Dodson and M. Westoby, Eds. The Ecological Society of Australia [no place], 1985 (distributor, Blackwell Scientific, Carlton, Australia). iv, 250 pp., illus. Paper, $A25. Proceedings of the Ecological Society of Australia, vol. 14. From a symposium, Sydney, Aug. 1984.

Assessing the Nuclear Age. Selections from the *Bulletin of the Atomic Scientists*. Len Ackland and Steven McGuire, Eds. Educational Foundation for Nuclear Science, Chicago, 1986 (distributor, University of Chicago Press, Chicago). xviii, 382 pp., illus. $29.95; paper, $12.95.

Authority, Liberty, and Automatic Machinery in Early Modern Europe. Otto Mayr. Johns Hopkins University Press, Baltimore, 1986. xviii, 265 pp., illus. $30. Johns Hopkins Studies in the History of Technology.

Averting Catastrophe. Strategies for Regulating Risky Technologies. John G. Morone and Edward J. Woodhouse. University of California Press, Berkeley, 1986. x, 215 pp., illus. $17.95.

Basic Mechanisms of the Epilepsies. Molecular and Cellular Approaches. Antonio V. Delgado-Escueta *et al.*, Eds. Raven, New York, 1986. xxiv, 1096 pp., illus. $98.50. Advances in Neurology, vol. 44. Based on meetings, San Diego, CA, Dec. 1983, and Santa Ynez Mountains, CA, Dec. 1982.

Basic Toxicology. Fundamentals, Target Organs, and Risk Assessment. Frank C. Lu. Hemisphere, New York, 1985. xvi, 276 pp., illus. $49.95.

Biochemistry and Biology of Plasma Lipoproteins. Angelo M. Scanu and Arthur A. Spector, Eds. Dekker, New York, 1986. xii, 514 pp., illus. $107.50. The Biochemistry of Disease, vol. 11.

Chemotherapy of Malaria. R. H. Black *et al.* L. J. Bruce-Chwatt, Ed. 2nd ed. World Health Organization, Geneva, 1986 (U.S. distributor, WHO Publications Center, Albany, NY). vi, 262 pp., illus. Paper, SwF 44. World Health Organization Monograph Series, no. 27.

Clinical Trials. Design, Conduct, and Analysis. Curtis L. Meinert in collaboration with Susan Tonascia. Oxford University Press, New York, 1986. xxvi, 469 pp., illus. $75. Monographs in Epidemiology and Biostatistics, vol. 8. Intended as "a general reference for practitioners of clinical trials," with "the main focus on trials involving uncrossed treatments and a clinical event as the outcome measure."

The Development of Social Welfare. John W. Landon. Human Sciences Press, New York, 1986. 210 pp. $24.95.

Developmental Behavioral Pharmacology. Vol. 5. Norman A. Krasnegor, David B. Gray, and Travis Thompson, Eds. Erlbaum, Hillsdale, NJ, 1986. xiv, 310 pp., illus. $36. Advances in Behavioral Pharmacology. Based on a conference, Leesburg, VA, Aug. 1983.

Disordered Systems and Biological Organization. E. Bienenstock, F. Fogelman Soulié, and G. Weisbuch, Eds. Springer-Verlag, New York, 1986. xxii, 405 pp., illus. $72.50. NATO Advanced Science Institutes Series F, vol. 20. From a workshop, Les Houches, France, Feb. 1985.

Education's Smoking Gun. How Teachers Colleges Have Destroyed Education in America. Reginald G. Damerell. Freundlich, New York, 1985 (distributor, Scribner, New York). viii, 312 pp., illus. $17.95.

Elastic Energy Methods of Design Analysis. Ralph J. Harker. Elsevier, New York, 1986. xxii, 441 pp., illus. $42.50.

Electromagnetic Surface Excitations. R. F. Wallis and G. I. Stegeman, Eds. Springer-Verlag, New York, 1986. x, 305 pp., illus. $45. Springer Series on Wave Phenomena, 3. From a summer school, Erice, Italy, July 1985.

Immunology and Epidemiology. G. W. Hoffmann and T. Hraba, Eds. Springer-Verlag, New York, 1986. viii, 242 pp., illus. Paper, $20.50. Lecture Notes in Biomathematics, vol. 65. From a conference, Mogilany, Poland, Feb. 1985.

Induced Circular Dichroism in Biopolymer-Dye Systems. M. Hatano. S. Okamura, Ed. Springer-Verlag, New York, 1986. xiv, 135 pp., illus. $49. Advances in Polymer Science, 77.

Integral Methods in Science and Engineering. Fred R. Payne *et al.*, Eds. Hemisphere (Harper and Row), New York, 1986. x, 653 pp., illus. $95.50. From a conference, Arlington, TX, March 1985.