different patterns of evolution of the mitotic spindle ("closed" versus "open" mitosis) in light of paleontological evidence on the time of occurrence of different taxa.

Perhaps what emerges most strikingly from these essays is the reaffirmation that a very large number of classes and phyla appear in the fossil record within the approximately 70-million-year interval from the late Precambrian (Upper Vendian) through the Lower Cambrian (Tomotian and after). Brasier's summary should be considered together with tabulations presented by Sepkoski in *Paleobiology* (**4**, 223 [1978] and **5**, 222 [1979]) and by various authors in Part A of the *Treatise on Invertebrate Paleontology* (R. A. Robison and C. Teichert, Eds., Geological Society of America, 1979). The change in diversity is spread over millions of years, but still only about 10 percent of Phanerozoic time, and the total effect is astounding. In part on the basis of data in this book, Sepkoski (in preparation) documents that two-thirds of the 90 metazoan classes with a marine fossil record originated in the Vendian–Cambrian interval; for contrast, he finds that during the later half of the Phanerozoic (essentially from the Permian to today) only 5 percent of the classes originated. The sometimes-heard suggestion that there is a long Precambrian fossil record for the metazoa (if we would but be diligent enough to find it) is not substantiated in these most recent summaries.

The desire for a mechanistically acceptable genetic explanation for this enormous radiation in biologic diversity has led some of the contributors (most notably Yochelson) to espouse one form or other of the currently popular developmental macromutation line of thought. Perhaps molecular biology with its recent focus on split genes and insertion sequences (transposons, for example) may yet make the major macroevolutionary question of "how the Cambrian radiation could have occurred" comprehensible from a genetic point of view.

With respect to the theory of classification, only Jeffries uses cladistic procedures to reconstruct phylogenetic relationships, and this he does for the deuterostome wing of the metazoa. (In contrast, the three or four phyla of the arthropod grade of development [Chelicerata, Crustacea, Uniramia, and possibly Trilobita] are not explicitly differentiated in a cladistic fashion.) The cladistic procedure has the advantage of spelling out the basis for a decision on classification at each branch point so that it is immediately clear to others. Whether or not Jeffries's resulting pattern is any more likely to be correct in its linking of "carpoids" with chordates (instead of with echinoderms) of course cannot be resolved by a methodological procedure and remains open to question.

In sum, this is an excellent book to which neontologists and paleontologists engaged in phylogenetic studies should have ready access. The final chapter records some of the discussion from the meeting that gave rise to the book, and the remarks of several persons were worth including. Hessler, for example, ponders whether the arthropod diversity in the Burgess Shale is really any greater than that of a modern crustacean fauna—and hence he questions the tendency to assign these admittedly strange ancient beasts to a high taxonomic rank. A good index closes the book.

THOMAS J. M. SCHOPF
Committee on Evolutionary Biology, University of Chicago, Chicago, Illinois 60637

Mammals in the Age of Dinosaurs

Mesozoic Mammals. The First Two-Thirds of Mammalian History. JASON A. LILLEGRAVEN, ZOFIA KIELAN-JAWOROWSKA, and WILLIAM A. CLEMENS, Eds. University of California Press, Berkeley, 1980. x, 312 pp., illus. Cloth, $35; paper, $9.75.

This beautifully conceived and executed book covers a subject that after a long period of stasis has undergone rapid advances during the 1960's and '70's. The editors and authors literally have left few stones unturned in their search for and summary of available knowledge about Mesozoic mammals. The range of their own background of fieldwork and original scientific contributions to the subject is outstanding. One of the authors, George Gaylord Simpson, published two monographs in 1928 and 1929 that served for many years as the starting point for most students interested in these furred but unspectacular players in a drama dominated by large reptiles. In the last 20 years a flood of information has been published about early and primitive extinct mammals, but the information is widely scattered and many of the publications are already out of print. This mass of data had not been summarized adequately by anyone until Lillegraven and his well-organized coworkers took up the task. They have done it admirably well. The book has a generally lively style, is well illustrated (some reprinted figures have suffered in the process, however), and is almost completely free of typographical errors.

Lillegraven's introduction (chapter 1) lays down important ground rules, which I appreciate although I do not entirely agree with all of them: (i) a cutoff date of 1 January 1978 for inclusion of new information; (ii) no new taxa (this results in a coy circumlocution for a family based upon *Gypsonictops*); (iii) taxonomic chapters have the same format; and (iv) classification remains eclectic and arbitrary rather than phylogenetic. A conscious effort is thus made to avoid new, higher-order taxonomic formulations on the grounds that they might be unfamiliar, unstable, or somehow hinder communication!

The second chapter, entitled "Where, when, and what—a survey of known Mesozoic mammal distribution," offers a thorough review of the provenience of the known specimens of Mesozoic mammals. Its authors are Clemens, Lillegraven, E. H. Lindsay, and Simpson. Profound successes in field exploration have been realized for the Mongolian Cretaceous, the Portuguese Jurassic, and the late Triassic or early Jurassic of a number of areas in Eurasia and Africa, but it is pleasant to note that the vast former gaps in the Mesozoic mammalian fossil record are gradually being filled for other areas of the world as well, as in the case of the late Jurassic and Cretaceous of North America, the early Jurassic of Andhra Pradesh, India, and the latest Cretaceous of the Peruvian Andes. This chapter is highly useful, both as a summary of what we know and as a guide to where future exploration should be concentrated. I only wish that the authors had gone on and told a little of the "who and how" that have been responsible for the "where, when, and what."

In another stage-setting chapter, A. W. Crompton and F. A. Jenkins, Jr., discuss the origin of mammals, at least as the term Mammalia is currently defined. The familiar story of the evolution of the mammalian jaw joint is told and a commitment is made to a model involving parallel or convergent evolution of the three-boned middle ear separately in monotremes and therians.

After these beginnings, separate chap-

ters are devoted to triconodonts (Jenkins and Crompton), docodonts (D. G. Kron), and multituberculates (Clemens and Kielan-Jaworowska). Discussed next are symmetrodonts (M. J. Cassiliano and Clemens), the paraphyletic "eupantotheres" (M. J. Kraus), the origin of the tribosphenic molar and metatherian and eutherian dental formulas (T. M. Bown and Kraus), and theria of metatherian-eutherian grade (Kielan-Jaworowska, J. G. Eaton, and Bown). Regarding this last "group," I would prefer to call them Theria, *incertae sedis*. Discussed next are marsupials (Clemens) and, finally, eutherians (Kielan-Jaworowska, Bown, and Lillegraven).

The book closes with a long and fascinating hypothetical discussion of reproduction in Mesozoic mammals (Lillegraven), followed by a well-researched but possibly oversimplified summary of Mesozoic paleogeography in the light of plate tectonics (Lillegraven, Kraus, and Bown) and a brief comment on living and Tertiary fossil monotremes (Clemens). Although the monotremes are not yet known from the Mesozoic, they must have had a long history throughout that era in spite of some strident claims to the contrary.

Not only is much previous thought summarized in this book, many glimpses are given of work in progress on unpublished discoveries. Thus, in the next few years we can expect publication of new Chinese, Russian, and Mongolian Mesozoic materials from sites recently discovered in northern and eastern Asia, as well as from an early Jurassic site from peninsular India. Mammal-producing late Cretaceous localities have also been found in France and Portugal. Another facet of current exploration is that taxa previously known from poor or incomplete material are becoming represented by much better specimens than before, such as a recently collected partial docodont skeleton from the Jurassic of Scotland, a "eupantothere" skeleton from Portugal, and amphilestid cranial and postcranial material from the early Cretaceous of Montana.

As a final note, it is a pleasure to report that the enormous amount of work that went into organizing, writing, editing, and copy editing this volume was contributed gratis. The authors' proceeds will be donated to a special fund of the Geological Museum of the University of Wyoming for the support of graduate education in vertebrate paleontology.

MALCOLM C. MCKENNA
Department of Vertebrate Paleontology, American Museum of Natural History, New York 10024

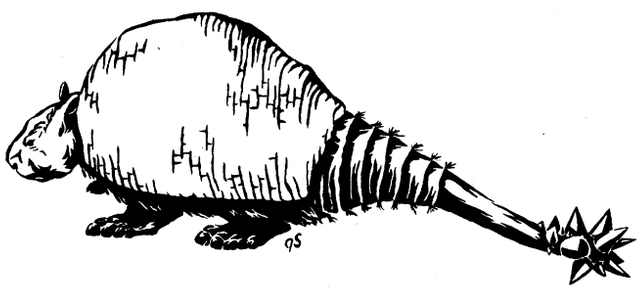
A Fortuitous Experiment

Splendid Isolation. The Curious History of South American Mammals. GEORGE GAYLORD SIMPSON. Yale University Press, New Haven, Conn., 1980. x, 266 pp., illus. $17.50.

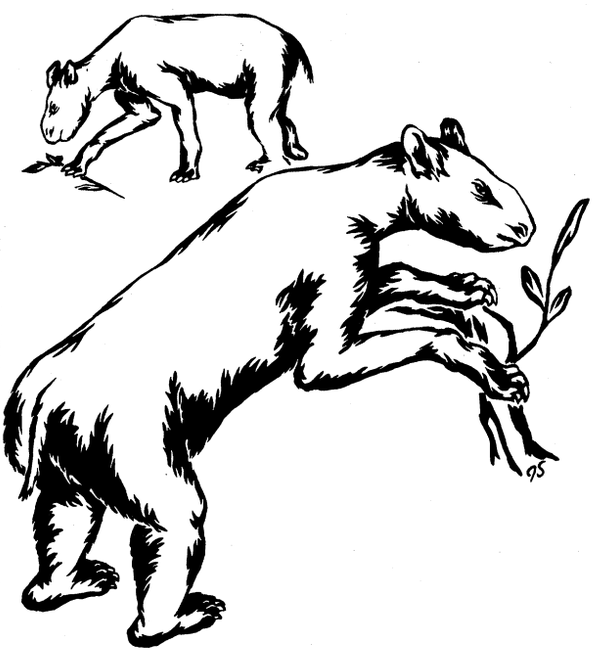
Charles Darwin, in his *Voyage of the Beagle*, was particularly perplexed by the fossil and living mammals of South America. Why, he wondered, were extinct species more numerous than those now living? "This wonderful relationship in the same continent between the dead and the living, will, I do not doubt, hereafter throw more light on the appearance of organic beings on our earth, and their disappearance from it, than any other class of facts." Darwin's prediction has come true, and the observations made during his epic voyage contributed significantly to the development of his theory of organic evolution.

George Gaylord Simpson, doyen of American paleontologists, has devoted a significant part of his career to unraveling the history of South American mammals. He demonstrated that this history "can be considered as an experiment without a laboratory, fortuitously provided by nature." In *Splendid Isolation*, Simpson documents the history, discusses controversial points, highlights interesting and unusual features, identifies problems in our knowledge of the record, and emphasizes those matters that warrant further study. Above all, he clarifies the primary role that South American mammals have had in demonstrating that organic evolution indeed occurred.

During most of the Age of Mammals (65 million years ago to present), South America was, as Australia is today, an island continent. The absence of continuous land connections between South America and any other continent caused evolution there to occur in a closed system and its fauna to evolve in "splendid



"Restoration of *Doedicurus*, a Pleistocene glyptodont, modified from a painting by Horsfall for [W. B.] Scott." The glyptodonts "were the most heavily armored mammals that ever lived. . . . The tail was evidently a formidable weapon of defense. It would seem that between this weapon and their armor they would be immune to attack, yet for unknown reasons they all became extinct." [From *Splendid Isolation*]



"Restorations of the early Miocene (Santacrucian) genus *Homalodotherium*, strange, clawed 'ungulate' of the notoungulate suborder Toxodonta." Although "it borders on fantasy that an animal certainly to be classified among the Ungulata . . . should have claws . . . this is not unique. In a time range overlapping that of the homalodotheres in South America there was a large group of clawed Ungulata called chalicotheres [that] ranged over all the continents other than South America, Australia, and Antarctica." [From *Splendid Isolation*]