BOOK REVIEWS

Evolutionary Transformations

Early Vertebrates. PHILIPPE JANVIER. Clarendon (Oxford University Press), New York, 1996. xiv, 393 pp., illus. $135 or £75. ISBN 0-19-854047-7. Oxford Monographs on Geology and Geophysics, 33.

Interest in the major features of vertebrate evolution has never been greater. Developmental biologists have begun, through comparative studies of gene expression and tissue development, to understand the genetic bases of major vertebrate traits such as segmentation of the axial skeleton and musculature, as well as the segmental design of the head. Molecular evolutionists continue to reconstruct the broad outlines of vertebrate evolution, to assess the congruence of these reconstructions with phylogenetic patterns derived from morphological data, and to consider patterns of gene homology and evolution from arthropods to mammals. And paleontologists have continued making discoveries of new taxa with novel anatomical features. Fossils of particular relevance for our understanding of basic vertebrate design are those that represent early stages of vertebrate evolution, from nearly 500 million years ago (with the first vertebrate fossils found in the early Ordovician) into the Permian 250 million years later. During this time span, all major features of vertebrate design (such as jaws, sensory systems, segmental organization of the body, brain, spinal cord, and head, and the structure of the internal and external skeleton) were established. Furthermore, clades originating during this time represent all major groups of vertebrates with extant representatives (sharks, ray-finned fishes, coelacanths, lungfishes, and tetrapods), as well as an enormous diversity of extinct taxa.

And yet there has been no accessible synthesis of recent paleontological discoveries of early vertebrates and the wealth of anatomical detail that these new fossil discoveries reveal about the origin of vertebrate life. Janvier's well-written overview of the pattern of early vertebrate evolution is thus a welcome synthesis, presenting a complete survey of early vertebrate fossils, their anatomy, and their phylogenetic relationships as currently understood. A potentially confusing array of early vertebrate taxa is presented clearly and logically with a great deal of phylogenetic and anatomical information. After a general introduction to the rise of vertebrate diversity and the origin of major extant clades, Janvier presents his survey of early vertebrates, which constitutes the bulk of the book. For each major clade, he presents external morphology, internal anatomy, taxonomic diversity and phylogenetic relationships, and stratigraphic and geographic data. The evidence supporting each phylogeny is presented as a nested series of shared derived traits (rather than as a complete taxon-by-character data matrix). The last section of the book discusses alternative interpretations of both early vertebrate phylogeny and selected anatomical features.

I found two features of this book particularly useful. First, there is an abundance of illustrations, both of taxa and of anatomical features. The reconstructions of individual taxa and of the collections of species found in individual fossil localities are outstanding and provide a clear visual representation of early vertebrate diversity. Furthermore, a great deal of anatomical detail is presented for each clade, and the illustrations of these anatomical features are essential for understanding the characteristics used for phylogenetic reconstruction. For many readers, the extensive discussions of anatomy will be excessive, and they can be skipped if a general appreciation of early vertebrate life is all that is desired. But anatomical features are the primary data, and I suspect that many vertebrate biologists will find these discussions a useful summary of an even more extensive, complex, and detailed primary literature that is inaccessible to all but the most anatomically knowledgeable.

Second, Janvier successfully mixes detailed description of clades with summaries of the major characteristics of more inclusive monophyletic levels such as Gnathostomata (jawed vertebrates). This means that one can read the book selectively, focusing on those sections that detail significant vertebrate innovations and the origins of major clades.

It is striking how much information is now available on early vertebrates. Thanks to new preparation techniques and discoveries of well-preserved material, the origin of many fundamental vertebrate traits is now accessible. As neontologists investigate basic features of vertebrate design such as the genetic basis of segmental organization, the development of the head, and the structure and function of the axial skeleton, they would do well to recall the early history of key vertebrate traits so well described in this book.

George V. Lauder
Department of Ecology and Evolutionary Biology, University of California, Irvine, CA 92612, USA

Trunk Lines

The Proboscidea. Evolution and Palaeoecology of Elephants and Their Relatives. JEHESKEL SHOSHANI and PASCAL TASSY, Eds. Oxford University Press, New York, 1996. xxx, 472 pp., illus. $175 or £95. ISBN 0-19-854652-1.

Proboscideans, spectacularly trunked and tusked mammals, encompass the two living African and Asian elephants, plus fossil relatives. The extinct relatives already include the less familiar mammoths, mastodons, gomphotheres, deinotheres, barytheres, moeritheres, and numidotheres. Perhaps even the elephants, at least in the wild, are soon to join them as just a grand memory. Possessing a useful hide, ivory tusks, and edible meat has not been fortunate for elephants, but their fascination and usefulness may save at least the Indian elephant in domestication or in ever smaller preserves. The Proboscidea have a long and well-documented history, partly because of their generally large size, which makes their fossil remains relatively conspicuous. Few museums have large collections of them, but the group is now well sampled in Africa, Eurasia, and the Americas. Known proboscideans are arrayed in about 38 fossil and two living genera, but this number may drop as methods of classification change.

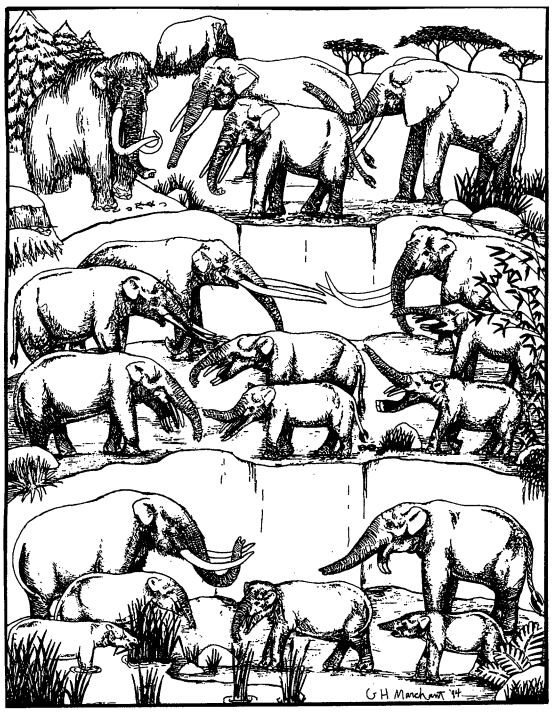
Africa was the earliest well-documented proboscidean homeland, as far back as the Paleocene 60 million years ago, but the early African proboscideans are closely related to *Anthracobune* of Asia and their common ancestor with *Anthracobune* was therefore not necessarily restricted to Africa. Early semiaquatic proboscideans are also related to Tethyan ocean-dwelling desmostylians and sirenians and to hyraxes on land. During the Eocene and Oligocene, proboscideans continued in African isolation, represented by animals like *Moeritherium* and by the more elephant-like *Phiomia* and *Palaeomastodon*. These latter animals had tusks in the lower jaw as well as in the

skull and had already acquired the hallmark proboscis. In the early Miocene the proboscideans escaped their African confinement and spread to Asia and then Europe. Later in the Miocene they arrived in North America from Asia across the same Bering "bridge" that was later to serve for human expansion to the Americas. In the late Cenozoic proboscideans ranged from the tropics to the tundra. About 3 million years ago they spread to South America before being struck down in both Americas by the planet's most virulent destroyers, humans.

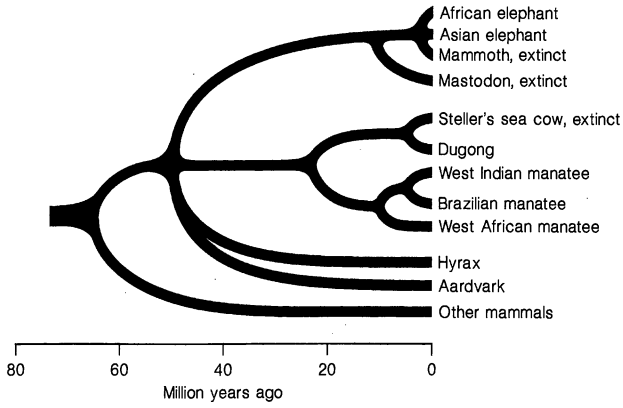
The history of proboscideans has been worked out in great detail primarily because proboscidean dentitions preserve a complexly changing but variable dental pattern and because the skull has undergone many changes as well. Postcranial changes have been a bit more conservative. The dental changes occurred rapidly and have led to an over-split taxonomy with too many genera and species, not always well founded. The same nomenclatural overkill has happened as well in the taxonomy of certain other mammals with complex teeth, notably fossil beavers and various other rodents, but also fossil horses and their allies.

With this book, the history of study of proboscideans enters a new and welcome phase, but two other phases have gone before. The earliest of them extends from antiquity to the death of Henry Fairfield Osborn more than 60 years ago. Osborn's two monumental but idiosyncratic tomes, published posthumously in 1936 and 1942, summed up everything but the barytheres and (then unknown) numidotheres. An enormous amount of information was there, but it was not well organized. Osborn's methodology and evolutionary philosophy were flawed, and the work was intimidating to other investigators. Few researchers possess his two-part monograph (or can afford to). For some time after Osborn the study of elephant relatives languished, but it was later rejuvenated by Heinz Tobien, Vincent Maglio, Jeheskel Shoshani, Pascal Tassy, and others. Since Osborn, a veritable explosion of knowledge about proboscideans has occurred. Progress has been partially summarized several times, but the present multi-authored volume edited by two of the greatest students of the subject is a landmark comparable to Osborn's. Far better organized, Shoshani and Tassy's book deals with the history of research, proboscidean anatomy, complexities of dental descriptive nomenclature, and cladistic analyses of proboscidean relationships and then with a series of subjects like dwarf mammoths, sexual dimorphism, extinction of various lineages, and biogeography. Cladograms are backed up by character matrices, and a successful attempt has been made to ensure that the volume is maximally useful. There are tables of synonymy, several kinds of index, and an extensive bibliography. Lovers of pithy footnotes by the ream will be well rewarded. The book is also well illustrated. The third phase of proboscidean research can now begin on a much sounder base than heretofore. This book is a landmark in the study of the biology and paleobiology of the Emperor of Beasts.

Malcolm C. McKenna
Department of Vertebrate Paleontology, American Museum of Natural History, New York, NY 10024, USA



A depiction of "how the Proboscidea may have undergone three major radiation events, starting from the bottom. Depicted at the centre front of each stage are species that form the spine of these radiation events": *Palaeomastodon*, *Gomphotherium*, and *Primelephas* respectively. "*Moeritherium*, in the first radiation, is depicted standing in water; gomphotheres and stegodons in the second radiation are shown in varied habitats; *Mammuthus*, in the third radiation, stands in snow-covered tundra, *Elephas* is in front of Elephant Rock in Sri Lanka at the centre back, and *Loxodonta* is in front of an acacia tree in East Africa." [From *The Proboscidea*; Gary H. Marchant]



"An immunological phylogeny of paenungulate taxa with three extinct forms—*Mammuthus* (woolly mammoth), *Mammut americanum* (American mastodon), and *Hydrodamalis gigas* (Steller's sea cow). From geological evidence, it is assumed that this group diverged from other mammals about 60–65 million years ago." [From *The Proboscidea*; after Lowenstein, 1985]

■

Browsings

Fly Pushing. The Theory and Practice of *Drosophila* Genetics. Ralph J. Greenspan. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1997. x, 155 pp., illus. $35. ISBN 0-87969-492-0.

Covers "the basics of doing a cross," the isolation of new variants, mapping, synthesizing of specific genotypes, and analysis of mutations for potential drosophilists having little more than an elementary knowledge of genetics.

Modern Mathematics in the Light of the Fields Medals. Michael Monastyrsky. Peters, Wellesley, MA, 1997. xvi, 160 pp. $35. ISBN 1-56881-065-2.

A revised English version of a 1991 Russian work giving an account of "mathematical progress" centered on the work of Fields medalists in topology, complex analyis, algebraic geometry, number theory, and other areas, with reflections on the award and its history.

New World Primates. Ecology, Evolution, and Behavior. Warren G. Kinzey, Ed. Aldine de Gruyter, Hawthorne, NY, 1997. xviii, 436 pp., illus. $62.95. ISBN 0-01185-2; paper, $31.95, ISBN 0-202-01186-0.

Nine papers (mostly updated versions of 1988 symposium presentations) on topics including fossil platyrrhines and catarrhines, color vision polymorphisms, vocal communication, mating systems, and "the human niche in Amazonia," followed by a synopsis of 16 monkey genera prepared by the late editor.