BOOKS: PALEONTOLOGY

Mammals on the European Stage

Tim Flannery

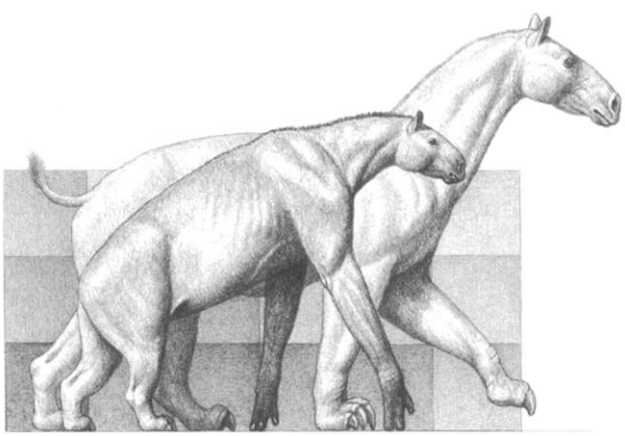
The prehistory of Europe's mammals that Jordi Agustí and Mauricio Antón describe in *Mammoths, Sabertooths, and Hominids* commences with the asteroid impact that wiped out the dinosaurs 65 million years ago and allowed the mammals to inherit the earth. Europe was then a very different place: a tropical island archipelago connected by high-latitude land bridges to North America but separated by seaways from Africa and Asia. As the authors make clear, even at that remote time the continent was a land of revolutions.

The earliest stages in the evolutionary saga of Europe's Cenozoic mammals remain largely mysterious; only a handful of fossils of multituberculates (distant relatives of Australia's egg-laying platypus) have been recovered thus far. The sparse remains are sufficient, however, to determine that the continent's multituberculates had already experienced extensive evolution in isolation. Soon they were joined by other mammals, among them marsupials and primitive placentals, which arrived over land connections with North America.

Through the 10 million years following this infusion, Europe's mammals again evolved in relative isolation. Then a rapid warming brought radical change, for it opened Europe's polar portals with North America to a wide array of invaders. Soon Europe was flooded by immigrants, among them the hippo-like *Coryphodon*, meat-eating creodonts, and the first representatives of some modern orders of mammals.

A remarkable fossil deposit found at Messel, Germany, gives us a unique insight into what Europe was like under the greenhouse conditions of 55 million years ago. The fossils were preserved at the bottom of an ancient deoxygenated lake that may even have belched poison gas, adding to its fossil horde by killing creatures that paused to drink. Preservation of the Messel fossils is so good that impressions of fur and body outlines are frequently found, as are stomach contents ("last meals"); even bacteria in body cavities and impressions of color patterns have been retained. Thus we know that Europe's ancient horse relatives ate fruit, and some of its ancestral bats consumed moths. The deposit leaves the overall impression that middle-Eocene Germany resembled present-day Sumatra.

Between 34 and 33 million years ago, another vast climatic-driven revolution began to reshape Europe's mammals when the mean global temperature plummeted by 5°C. By this time, North America and Europe had begun to drift apart, severing the polar portals, while Asia had begun to nudge closer. The chill brought a lowering of the world's oceans as ice was locked up at the poles, and for the first time a direct land connection between eastern Europe and Asia was established. The impact of these changes was so profound that the Swiss paleontologist Hans Stehlin referred to it as "le grande coupure," the great cut. The ultimate cause of all of this change seems to have lain half a globe away, in the errant continent Australia: Its drift northward had finally severed its epicontinental connections with Antarctica. For the first time, deep ocean water could circulate uninterruptedly around the isolated southern landmass, establishing the frigid bottom waters of the world's oceans. Many of the mammal lineages represented at Messel were driven to extinction at this time. Europe was inherited by more hardy immigrants from Asia, among them Europe's first rhinoceroses, the pig-like entelodonts (some of which had skulls a meter long), and relatives of the true pigs.



Chalicotherids compared. The two subfamilies of these clawed herbivores differed in form and habitats. Genera such as *Ancylotherium* (background) retained more typical perissodactyl proportions, lived in open areas, and browsed like goats. Those such as *Chalicotherium* developed very long forelimbs, favored woodland, and probably held their bodies in static, upright postures as they pulled down branches.

CREDIT: MAURICIO ANTÓN/COURTESY COLUMBIA UNIVERSITY PRESS

By 25 million years ago, global temperatures had warmed, and in the following 10 million years shifting continental crust again brought revolution. This time the culprit was the Arabian Plate, which pivoted in such a way as to open a land bridge between Europe and Africa. Across this bridge came trooping early kinds of elephant-like creatures as well as members of our own group, the anthropoid apes.

Mammoths, Sabertooths, and Hominids
65 Million Years of Mammalian Evolution in Europe
by Jordi Agustí and Mauricio Antón
Columbia University Press, New York, 2002. 325 pp. $39.50, £27.50. ISBN 0-231-11640-3.

The European history of this anthropoid lineage is particularly interesting, for it fills many details left blank by the gap in the African fossil record between 13 and 6 million years ago. Indeed, it has been argued that Europe played a key role in hominoid evolution during this period. One of the most surprising finds is that bipedalism may have arisen directly from a brachiating lineage of apes, akin in lifestyle to the gibbons. If so, then the quadrupedalism of the common chimp and gorilla must represent reversions.

Over the past 25 million years, climate change and tectonic events have repeatedly transformed Europe—at times drying the Mediterranean basin to a vast wasteland of salt, at others swathing the north of the continent in ice. And since 1.8 million years ago, a member of our own genus, *Homo*, has been part of the European fauna.

Although Agustí and Antón's book is full of interesting matter, it suffers from being an uncomfortable hybrid between an academic and a popular work. Agustí, the director of the Institut de Paleontologia M. Crusafont in Barcelona, Spain, has long studied the fossil mammalian faunas of Europe. His text frequently relies on a vocabulary accessible only to fellow specialists. Thankfully, this shortcoming is alleviated by scientific illustrator Antón's dozens of drawings of skeletons and reconstructions of the creatures and environments under discussion. These sketches and paintings are a vital aid in assisting the nonexpert reader to see the big picture through the dense maze of Latin names and jargon. Inadequate referencing and the inclusion of a number of disputable assertions are also lamentable. For example, Agustí reports that a land bridge once con-

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nected Borneo with Australia and that all mammals except marsupials "traversed [the Cretaceous-Tertiary boundary] without major variations"—a supposition hardly supported by the excellent fossil record of North America. It is also somewhat misleading to state that the didelphoid family "has only one representative: the opossum," because this belies the considerable ecological diversity among its 80-odd living species. Such errors, though, largely concern the book's periphery.

These imperfections will not lead astray the informed reader. Many of those who delve into *Mammoths, Sabertooths, and Hominids* will certainly benefit from such a comprehensive and detailed account of how Europe's mammals have changed over the last 65 million years. For European faunas, there really is no resource like it.

BOOKS: ZOOLOGY

Mammals of the Sea in Science and Culture

Ronald J. Schusterman

An encyclopedia is a set of cross-referenced articles, usually arranged alphabetically, intended to cover all aspects of knowledge dealing with a circumscribed subject matter. The focal subject of *Encyclopedia of Marine Mammals* comprises the order Cetacea (whales, dolphins, and porpoises), the order Sirenia (dugongs and manatees), and several members of the order Carnivora: polar bear, marine otters, and the pinnipeds (true seals, sea lions and fur seals, and walruses). Editors William F. Perrin, Bernd Würsig, and J. G. M. Thewissen have produced a grand compilation of 283 essays by 253 expert authors, who discuss topics from "Abundance Estimation" through "White-Beaked Dolphin." The essays vary in length, style, and, to some extent, objectivity; nevertheless, all are quite readable and some are original, eloquent, and even moving.

Encyclopedia of Marine Mammals
William F. Perrin, Bernd Würsig, and J. G. M. Thewissen, Eds.
Academic Press, San Diego, 2002. 1452 pp. $139.95, £90. ISBN 0-12-551340-2.

On the whole, the volume's format provides a generally effective and efficient mode for transmitting information from the vast literature reviewed by the authors. Human impacts, research methodology, physiology, ecology, and evolution are among the aspects considered in focused and cohesive essays.

Much of the material on the behavior and physiology of marine mammals has been gleaned through the use of new telemetry devices, which researchers are using to obtain a window into the underwater world of their subjects. When, in the 1960s, Gerald Kooyman developed the first underwater data loggers for pinnipeds, little was known about the diving, foraging, traveling, and migration patterns of marine mammals. Today, creative applications of digital technology allow scientists to collect detailed information about the activities and environments of free-ranging animals. For example, researchers can attach miniaturized "crittercams" and hydrophones to individual mammals in order to better understand what they see, say, and hear below the surface of the sea.

Hanging together. After the breeding season in the Channel Islands of California, male California sea lions (*Zalophus californianus*) of all ages aggregate in large numbers at Año Nuevo Island, 500 km to the north. Benefits of group living include thermoregulation, enhanced detection of predators, and improved foraging ability.

CREDIT: COLLEEN REICHMUTH KASTAK/LONG MARINE LABORATORY, UNIVERSITY OF CALIFORNIA SANTA CRUZ

In several essays, contributors address topics related to conservation, endangered species, and environmental threats; these accounts make it clear that their authors are rightfully concerned about human degradation of marine mammal habitats. Authors also point out that no matter how impressive conservation efforts may appear, the steps are often only palliative. In the context of global politics and economics, many governments are failing to protect and regulate marine habitats when doing so would conflict with the demands of free enterprise. The conservation theme is also highlighted by various accounts that describe changes in species abundance. For example, James Estes and his colleagues note that the precarious decline of sea otters in the Aleutian archipelago has resulted in concomitant changes in sea urchin density, grazing intensity, and kelp density in subtidal areas. The otter decline itself may be related to a shift in prey preference by killer whales, whose former diet of Steller's sea lions and harbor seals has declined (perhaps as a result of global climate changes and other human impacts). In a volume filled with concise facts and figures, these big-picture stories are invaluable.

With regard to the always contentious topic of the evolutionary history of marine mammals, the authors summarize some remarkable molecular and fossil findings about the origins of whales. Although there are several competing hypotheses about phylogenic relationships among cetaceans and various extant ungulate taxa, recent fossil evidence for the origin of aquatic locomotion in primitive whales suggests close ties between cetaceans and even-toed ungulates. Indeed, this morphological evidence and molecular data indicate hippopotamuses may actually be the closest living relatives of whales, with whom they share several aquatic specializations, including underwater sonic signaling.

Many of the shorter essays describe interesting and obscure facets of marine mammal biology and culture that even the most seasoned reader will savor. One such article delightfully explains the mysterious origins and unusual characteristics of ambergris, a fragrant, lumpy, and legendary substance now known to be formed in the intestines of sperm whales. Another samples folklore and mythology from the times of the ancient Greeks to contemporary beliefs about these animals serving as personal patrons or tribal totems—in other words, as sources of wisdom, strength, and inspiration.

It is traditional for reviewers of encyclopedia to identify errors of omission, as the constraints on length inevitably produce gaps in coverage. The otherwise readable and original essay on pop culture emphasizes cetaceans but omits any significant references to pinnipeds, despite their overlapping presence with people in coastal areas around the world. For example, the ongoing invasion of California sea lions at San Francisco's Pier 39 vastly affects local

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