

## EVOLUTION

### Of Whale Knuckles and Placental Trees

Christian de Muizon

Cetaceans are probably the most extraordinary mammals. They are highly adapted to life in water and strictly dependent on their aquatic environment. As a consequence, their anatomy and physiology have been strongly modified and do not resemble those of other mammals. Because cetaceans are so drastically transformed from their terrestrial ancestors, their affinities with other mammals have long been debated. Although researchers agreed that cetaceans had their origin in some group of land mammals that lived during the early Tertiary, there was

no consensus on the identity of the group that subsequently evolved into whales and dolphins. Whales have been seen as closely related to seals, creodonts (hyaenodonts), ungulates, and mesonychid condylarths (large carnivorous to omnivorous archaic ungulates). In the absence of a better candidate, the mesonychids were on the verge of becoming accepted when molecular biologists claimed that cetaceans were most closely related to artiodactyls (even-toed ungulates)—specifically to hippos. A few years later, paleontologists discovered postcranial remains of early Eocene cetaceans that demonstrated the presence of a double-pulleyed astragalus (like the sheep ankle bones that the Romans used to play at knucklebones), a characteristic of all artiodactyls and exclusively found in that order. This discovery, among the most important paleontological finds of the past hundred years, led to an immediate consensus on cetacean ancestry. It also demonstrated a remarkable complementarity of two different approaches to the study of the evolution and phylogeny of mammals.

Such interplay between anatomical and paleontological studies, on the one hand, and molecular investigations, on the other, forms a central theme of *The Rise of Placental Mammals*, edited by Kenneth Rose and David Archibald. The

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volume grew out of a symposium (at the 2002 meeting of the Society of Vertebrate Paleontology) commemorating the centenary of George Gaylord Simpson's birth. The authors offer an extremely useful consideration of current thoughts on the early evolution and phylogenetic relationships of the 18 extant placental orders.

The volume begins with the editors' introduction and a short chapter that recounts Simpson's contributions to the study of placental mammals. These are followed by two chapters that provide broad morphological and molecular perspectives on the clade's origin and diversification. John Wible, Guillermo Rougier, and Michael Novacek use dental, cranial, and postcranial anatomical data to characterize placentals, more basal eutherians, and more distant outgroups. They also discuss relations among Cretaceous eutherians and possible relations to extant placental clades. Mark Springer, William Murphy, Eduardo Eizirik, and Stephen O'Brien

#### The Rise of Placental Mammals Origins and Relationships of the Major Extant Clades

Kenneth D. Rose and J. David Archibald, Eds.

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**Accepted group.** The monophyly of paenungulates—comprising three extant orders, here represented by African elephant (*Loxodonta africana*), rock hyrax (*Procapra capensis*), and West Indian manatee (*Trichechus manatus*)—is now commonly accepted, while debates continue over Afrotheria.

review the molecular evidence for superordinal clades. Whereas Wible *et al.* place the origin and diversification of the extant orders after the Cretaceous-Tertiary boundary, Springer *et al.* find support for a Cretaceous interordinal radiation.

Each of the remaining 11 chapters appraises phylogenetic relationships within an order or superordinal clade through a careful examination of the morphological and molecular data. The authors provide thorough discussions of the fossil relatives of the extant orders. Because only anatomical data can be used to compare fossil and recent taxa, the considerations of morphological characters are especially detailed and abundant. The phylogenetic conclusions drawn from morphology and molecules do not always agree so well as in the case of the cetaceans. Nor do the authors always express their personal interpretation of conflicting results. But at least the reader is provided with the data and references, which offer an excellent starting point for more detailed research on the evolution of individual orders. The volume's clear and well-organized presentation demonstrates the editors' success in the difficult task of coordinating a work that covers several highly debated issues.

One such issue, an important problem in recent debates on mammalian systematics that is addressed in several chapters, is the supraordinal taxon Afrotheria: a major group, possibly a clade, of mammals originally endemic to Africa. This taxon was first proposed on the basis of molecular data (*1*) but is not fully corroborated by morphological characters. Molecular phylogenies of placental mammals place the Afrotheria in a basal position; they diverge before the Xenarthra (sloths, anteaters, and armadillos), which have generally been considered the basal group. Afrotheria comprises seven orders of extant African mammals: proboscideans, sirenians (manatees and dugongs), hyracoids (dassies), tubulidentates (aardvarks), macroscelids (elephant shrews), chrysochlorids (golden moles), and tenrecs. That the first three of these orders form a monophyletic group, the paenungulates, is now commonly accepted. Although morphological data leave the phylogenetic position of aardvarks and elephant shrews unclear, "most of the morphological hypotheses are not in conflict with the molecular analyses." On the basis of morphological features, the tenrecs and golden moles are not obviously related to the other Afrotheria; however, a total-evidence tree (using 196 morphological characters, 19

nuclear genes, and 3 mitochondrial genes) presented by Robert Asher includes them in the Afrotheria. Although the paenungulates are relatively well documented in the fossil record, that is apparently not the case for the four remaining afrotherian orders. This lack of knowledge of the early members of these orders may explain why their molecular affinities are so difficult to corroborate with morphological data; it certainly demonstrates the desirability of finding early Tertiary fossils from these groups. Whether or not the Afrotheria represent a clade, Rose and Archibald's volume clearly sets the problem posed by the group and indicates its importance for mammalian paleontology.

Among the other important phylogenetic questions discussed in the book are the rela-

tionship between the Xenarthra and the pangolins, and their affinities with other placentals; the relationship between paenungulates and perissodactyles; the relationships of primates to tupaiids ("tree shrews") and dermopterans ("flying lemurs"), and their affinities with bats; the complex problem of identifying the phylogenetic positions of the various groups traditionally placed in the "insectivores"; and the links between Cretaceous placentals and the extant orders.

*The Rise of Placental Mammals* addresses most current issues in placental phylogeny and systematics. The contributors provide the pros and cons of conflicting interpretations of the data. Although the authors do not always clearly state their personal points of view, the presentation of the arguments allows readers

to reach their own conclusions. The volume should be welcome bedside reading for all mammal systematicists and anyone interested in the evolution of mammals. It complements a recent comprehensive examination of Mesozoic mammals (2), and I look forward to similar volumes covering other mammals such as marsupials, monotremes, and the many higher taxa known exclusively from Cenozoic fossils (2).

#### References

1. M. J. Stanhope *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **95**, 9967 (1998).
2. Z. Kielan-Jaworowska, R. L. Cifelli, Z.-X. Luo, *Mammals from the Age of Dinosaurs: Origins, Evolution, and Structure* (Columbia Univ. Press, New York, 2004).

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## EVOLUTION AND RELIGION

### Seeing Similarities

Sahotra Sarkar

In this timely book, Michael Ruse interprets the last 200 years of conflict between biology and religion as a struggle between evolutionism and creationism. Evolutionism is not merely an endorsement of the scientific theory of evolution. It consists of "the whole metaphysical or ideological picture built around or on evolution," including a belief in progress and attempts to reduce cultural and ethical values to evolutionary biology. As such, it constitutes a "secular religion." Thus, for Ruse (a philosopher of science at Florida State University), the debate over creationism is more a conflict between two religions than one between religion and science.

The book covers the period from the end of the Enlightenment (roughly the end of the 18th century) to the present. Religious history and that of evolutionary ideas receive equal time. Ruse's account of religion is restricted to Christianity and almost entirely limited to Britain and the United States. He sees the origins of the conflict over evolution in a crisis of religious faith induced by the Enlightenment's emphasis on reason and science and its rejection of text-based established religions. The Enlightenment offered a vision of progress based on human effort. The emerging pre-Darwinian views of evolution (such as those of Erasmus Darwin, Jean-Baptiste de Lamarck, and Robert Chambers), although hardly professional science, co-opted this vision in their accounts of organic change.

Charles Darwin, in contrast, attempted to convert evolution into science by elaborating a material mechanism for it—natural selection. Darwin was at best ambivalent about the ideology of progress. (Alfred Russel Wallace was

more convinced of its reality—strangely, he receives scant attention in Ruse's story.) Moreover, natural selection acting on blind variation was antithetical to the idea of progress with its implied directionality. In spite of Darwin's efforts, Ruse argues, evolution

did not become established as a professional science in the 19th century or even during the first two decades of the 20th. Instead, it remained popular science. Given the generally accepted ideology of progress, natural selection was often abandoned in favor of directional mechanisms of organic change. According to Ruse, during this period, almost all of those who endorsed evolution also endorsed evolutionism. The social Darwinism of the late 19th century only exemplifies the worst excesses of such an evolutionism.

Religious belief also underwent significant changes during this period. Established denominations of Christianity were often reluctant to feud with science. They rejected evolutionism but typically tried to forge an interpretation of evolution that could co-exist with nonliteral interpretations of biblical texts. However, the older sects (such as Presbyterianism, Congregationalism, and Quakerism) gradually saw their constituencies shift to evangelicals and fundamentalists, particularly in the United States after the American Revolution disrupted the

established social order. Among fundamentalists, any thought of evolution was anathema because it conflicted with their literal interpretation of Genesis. In the mid-20th century, "young Earth" creationism, which still holds that Earth is less than 10,000 years old, emerged from fundamentalism. It continues to have its devoted adherents but has largely become intellectually irrelevant in the United States since a Supreme Court decision specifically precluded the introduction of religion in science classes.

On Ruse's account, evolution became a professional science following the modern synthesis of the late 1920s and 1930s. Ruse argues, though not very convincingly, that the architects of the synthesis continued to uphold an ideology of progress and endorse evolutionism. He ignores the fact that, with the exception of R. A. Fisher, these architects largely rejected attempts to deploy evolution in the political arena. (Some, such as J. B. S. Haldane, whom Ruse ignores, often explicitly rejected progress.) Ruse's sketch of contemporary evolutionary theory is also idiosyncratic, with sociobiology presented as that theory's most significant achievement. Because the sociobiologists W. D. Hamilton and Edward O. Wilson are the heroes of this story, Ruse claims that contemporary evolutionary biology endorses evolutionism and not merely evolution.

The final chapters of *The Evolution-Creation Struggle* turn all too briefly to the contemporary debates over creationism. Ruse offers a short and cogent critique of intelligent design that concentrates on its failure to spawn any serious scientific research. But the book ends with an unfortunate whimper: we are told that we should try to understand the other side; we are not told how Ruse's understanding of that side will help us prevent the reintroduction of religion in our science classes.

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