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BOOK REVIEW

DeSalle's and Tattersall's Human Origins: A Companion to The Museum of Natural History's Hall of Human Origins and More

***Human Origins: What Bones and Genomes Tell Us about Ourselves*, by Rob DeSalle and Ian Tattersall. College Station: Texas A & M University Press, 2008. Pp. 216. H/b $ 29.95**

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This book was written to complement the recently reworked Hall of Human Origins at the American Museum of Natural History in New York City. The authors also wanted it to stand alone as an introduction to the latest discoveries in human evolution by presenting new developments and information on paleontology and genomics in understanding human evolution. In so doing the authors attempt to answer philosophical or epistimological questions about how anthropology and evolutionary biology proceed in order to best answer questions about human evolution. How do we know what we know? Why do we want to understand our evolutionary past? How do we establish the validity of our answers? What tools are needed for understanding paleontological, genomic, and evolutionary processes? The authors do an excellent job of answering these questions. In fact, the book easily could be used as an introductory text for a college course in biological anthropology or human evolution. It is up to date, clearly and engagingly written, and well illustrated.

The book is around 200 pages and is divided into nine chapters and an epilogue. In Chapter 1, DeSalle and Tattersall give a broad introduction and history of the question of human origins. In Chapters 2–4, they outline the tools used in paleontology, genomics, and evolutionary biology to discover and examine the evidence. The authors put humans in their place in history in Chapter 5 and, in the sixth chapter, they examine human evolution. Chapter 7 contains a description of the genomics of modern human variation and the history of early modern human migrations over the earth. In Chapters 8 and 9, the two characteristics that make modern humans unique among the animal kingdom, the human brain and language are discussed. The epilogue is a philosophical look at where we might be going in the future.

In the first chapter, DeSalle and Tattersall explore how humans have approached the questions of their origins both through historical times and cross-culturally. In doing so, they clarify which approaches to the question of human origins are scientific and which are not and introduce what they consider to be the three components of the toolbox of human origins: paleoanthropology, genomics, and evolutionary process. In comparing various creation myths and theories of human origins, the authors ask how can we know what is true? They explain that we never know whether we have the best possible explanation for a phenomenon but that what good science tries to do is to find the best possible explanation *given current evidence and technology.* Scientists attempt to disprove and to continuously test theories by natural observation. "Through knowing what does not exist or what is not real (and those things or statements that are falsified), we are able to describe the natural world more accurately" (p. 20). This is why religious creation myths and intelligent design are not science—they are unfalsifiable. They cannot be tested and must be accepted as faith. This is fine, the authors stress, but it is not science. DeSalle and Tattersall end the first chapter with a discussion of how understanding human origins and evolution and evolutionary principles are a necessity in solving such modern world problems as

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disease, bioterrorism, and the energy crisis. "Origins are at the heart of understanding evolution and ultimately, we believe, at the heart of understanding the human condition" (p. 31).

Once having identified the three major tools for the study and understanding of our origins, paleoanthropology, genomics, and evolutionary theory, in the next three chapters (2–4), DeSalle and Tattersall describe each of these avenues of research. In Chapter 2, they give a brief history of modern paleoanthropology and emphasize the multidisciplinary approach begun by Louis and Mary Leakey in their work in East Africa. They describe the work of the paleontologist and his collaborators both in the field and in the laboratory. Besides painstaking, difficult, and detailed analysis of the human fossils, paleontologists, and their fellow scientists attempt to understand the environment in which they lived, the time period they lived, their animal competitors, the relationships among them, and their behavior. The authors describe the work involved and collaborations necessary to glean these things and some of the relatively new techniques used to reach their conclusions (GIS, geochemical dating techniques, MRI, phylogenetic analysis, etc.). This is a clearly written and concise summary of the field.

In Chapter 3, DeSalle and Tattersall provide an explanation of the genome and its importance in understanding human evolution. They describe the makeup of the genome and how it functions, and how scientists map the chemicals that make up the genome (the approximately 25,000 genes in the human genome), and why this is important. As the authors state: "Genomes are a great starting point for understanding life… How organisms are put together, how they work in a molecular genetic sense, and how they react to the environment are critical to our understanding of human origins…The footprints of divergence and the history of how we evolved and are evolving are also hidden in the sequence of the bases in our genomes." (pp. 66–67).

In Chapter 4, the authors discuss evolution and human origins. Of course humans are subject to the processes of evolution, and without understanding these processes we cannot understand human origins. Thus, they describe modern approaches to evolutionary biology and how they are integrated with paleontology and genomics, how each of these fields of research compliment one another. In this chapter, the processes of evolution and speciation are clearly described. There is an interesting discussion of the differences between the causes of a speciation event and the future events that are subsequently caused by that speciation. The earliest humans differed from their chimp-like ancestors, but after this early divergence, both chimpanzees and humans went on separate evolutionary paths colored by these initial differences.

DeSalle and Tattersall next outline the place of *Homo sapiens* in the tree of life (Chapter 5). In this chapter, they describe patterns of divergence and evolutionary trees and how humans fit into the hierarchy of life on earth. The tree of life represents ancestor-descendent relationships, and the authors present an excellent figure (Figure 41) depicting this tree in a circular rather than the typical linear, up-and-down figure. Thus, all major taxa of living organisms are depicted as equal rather than the typical top-down rankings of the sixteenth century *Scala Naturae*. The authors discuss the new systematics, developed in the 1960s, in which rather than classifying organisms by the consensus of a committee of experts, a more testable perspective began to be employed. This involved (1) classifying organisms together if they were more similar to each other than they were to other organisms, and (2) if a particular characteristic was confined to a pair of species it was taken as evidence of their relationship and the result of inheritance from a common ancestor. The process also involved a philosophical feature called parsimony. "A decision about which phylogenetic tree is the best explanation for the data is typically based on choosing the one with the fewest character changes. The process by which we make evolutionary trees is call phylogenetics" (p. 84). There is a nice, simple illustration of how this is done using both morphological and hypothetical gene sequences and a cat, dog, and lizard as examples. There is an explanation of how the gene bank now is used to assist in systematics. The authors also provide a test for readers to hone their abilities to read and interpret evolutionary trees, this time using a fish, cat, dog, lizard, and a human. In the remainder of the chapter, the phylogenetic analysis of the tree of life that has been worked out over the last decade is described. As the authors explain: "We are now ready to clamber around the tree of life. There are many routes to take. The way we have chosen in this book is to bounce around the tree of life toward our own branch, in order to find out where in this convoluted, branching, crowded tree we sit." (p. 100)

After a nice review of the evolution of life up to our closest ancestors, the great apes, DeSalle and Tattersall are ready to tell us the human evolution story (Chapter 6). They provide an up-to-date outline of this adventure beginning with the first hominid fossils appearing around 7 million years ago up to the emergence of modern humans (*H. sapiens*). Some highlights are as follows. The idea that bipedalism was an exaptation (or preadaptation) is counterintuitive but the best explanation for this defining human behavior. By this is meant that the earliest ancestors of hominids were morphologically adapted for upright posture when they came to the ground, as are many other primates—Malagasy sifaka, spider monkeys, gibbons, and, to a great extent, the great apes. "And once it started moving on two legs while on the ground, it would have

possessed *all* of the advantages—and disadvantages—that this new style of terrestrial locomotion conferred" (p. 115). Even though our earliest ancestors were bipedal on the ground, their morphology indicates that they also were considerably agile in the trees and their ecology was likely an "edge habitat" with a mixture of open areas and forests. Our earliest ancestors were mainly frugivores–omnivores, and rather than being mainly hunters, they were likely prey to many predator species (see also Hart and Sussman 2009).

Even though they had small, ape-like brains, we should not feel too superior since one of the earliest genus of hominids, *Australopithecus*, for example, lasted from 4+ million years ago to 1.4 million years ago, approximately 3 million years. *H. sapiens* has only been around for 200,000 years or so. Tools appear around 2.5 million years ago and involve a number of advances in the thought processes of early humans, "clearly an epochal event in hominid history" (p. 119). And one of the important points made by the authors, both in regard to tool-making and later in the book to language, is that the toolmakers "were not physically any different from their non-tool-making predecessors…Any invention, even one as significant as this, has ultimately to be made by an individual, and to be somehow based on knowledge already there: and in appearance the individual concerned can hardly differ significantly from his or her own parents or offspring. Innovations always occur *within species*, simply because there is no place else for them to appear" (pp. 119–120).

In the remainder of this chapter, the authors outline events such as: the appearance of the first "hand axe" (again decoupled from any major morphological shift at about 1.6+ MYA); that of essentially modern bodies and hominids outside of Africa (around 1.8 MYA); hominids reaching Europe around 800,000 years ago and the first appearance of fire around the same time in Israel; and the first hunting weapon is found at 400,000 years ago. Neanderthal man appears in Europe at 200,000 years ago, and they were highly adaptable, living in very harsh climates, making beautiful (but monotonous) tools, probably meat eaters with warm clothing, and they buried their dead, but there is no indication from the fossil record that they developed sophisticated symbolic thought, the hallmark of *H. sapiens*. Humans that are morphologically modern first appear in Africa around 200,000 years ago, and they enter Europe at around 40,000 years ago, replacing Neanderthals within 10,000 years of their appearance in Europe. Again, the earliest *H. sapiens* were not behaving significantly differently from their predecessors. "Modern behaviors" do not begin to appear until around 75,000 years ago (such as engravings and body ornaments). "It would, of course, be unrealistic to expect that the expression of this capacity of ours (as opposed to the underlying capacity itself) should have sprung into existence full-blown. After all, even today, we are still discovering new ways to deploy our intellectual potential" (p. 132). The expression of modern behaviors, however, seems to have exploded around 45,000 years ago. In one last point, the authors suggest that from genomic information, it appears that *H. sapiens* did not interbreed with Neanderthals and that it is likely that there was not just one movement out of Africa but movements back and forth, or to and from Africa, both in early and later modern *H. sapiens* history.

By studying the mitochondrial genome, and the X and Y chromosomes, we can trace female and male lineages throughout modern human history, including patterns of migrations of populations over the last 60,000 years. This is the subject of Chapter 7. After explaining how these genetic tools allow us to understand the movements of human populations around the earth, the authors outline this history. The first thing that genomes allow us to do is figure out times of divergence (separation) of certain populations. By measuring different rates of mutation, geneticists are able to develop molecular clocks, and another method enables calculation of times of the most recent common ancestor of a particular population (using coalescence methods). Referring to the illuminating study of population geneticist Alan Templeton (2002), the authors describe the two major migrations of humans out of Africa at 80,000 and 55,000 years ago, respectively. The later humans did not interbreed with the earlier ones. However, a major finding of Templeton's was that the recent pattern of human movement and breeding indicates a large and widespread *Homo sapiens* that has continually interbred and moved back and forth across the globe. Two things that these more detailed studies teach us is that, first, we can get a very fine-grained view of human movement for specific geographic regions. DeSalle and Tattersall outline these specific migration routes. Secondly, by looking at some of the patterns in mitochondrial DNA and the Y chromosome, and especially the X chromosome, the relationships of humans from different areas began to look not like a straight line but like a web. "This view nicely explains why there is more variation within human geographic groups then between them, and why any two randomly chosen individuals will differ at only 0.1% of their DNA sequence positions" (p. 165). As Templeton emphasizes in a 1998 study, given these data, we can no longer support the concept that humans can be divided into genetically distinct biological races. Race is not a biological reality among human populations, and because of continuous admixture over the last 60,000+ years, human races never existed biologically.

The factors in the fossil record and in the genome that underlie the uniqueness of humans are examined in the next two chapters. What are the factors that make us specifically human and different from all other organisms? As the

authors state: "It is a pretty good bet that we are the only species on this planet that cares what the answers to such questions are—or can even ask them. And this, of course, is part of what makes us unique" (p. 187). All of our unique behaviors are related to the human brain, the subject of Chapter 8. There is an excellent, clearly written discussion of the evolution and function of the brain in living organisms, starting with structures that lead to sensitivity in one celled-organisms and intercellular connectivity in plants and sponges. There also is an equally well-written description of the techniques used in the study of brain function and of those techniques used for getting a genomic view of the brain (which genes are expressed during brain function) in relation to our senses; taste, smell, hearing, touch, and sight. Genomic studies of these senses indicate that changes in the genetics of the latter three senses were important in the evolution of the unique human brain, especially in our unique talents of complex tool-making, art, music, and language. Finally, recent genomic studies, using a technique called macroarray, indicate that, even though differences in particular genes related to brain function are not great in comparing chimpanzees to humans, differences in regulation and expression of these genes are radically different, with much higher levels of expression in humans, referred to as "up-regulation."

"To the best of our knowledge, we human beings are most profoundly set off from the rest of Nature in being symbolic creatures" (p. 191). This is the subject of Chapter 9, symbolic thought and language. It was not the big brain that led to *H. sapiens*, unique place in human evolution, "it was symbolic thought, as substantiated by the archaeological evidence of symbolic behaviors. It was this that changed the rules of the evolutionary game" (p. 193). The authors here re-emphasize that "modern behavior" lagged behind modern anatomy by tens of thousands of years. What evidence exists for what the authors are calling modern behavior? When does this first appear in the fossil record? It is around 40,000 years ago, with appearance of Cro-Magnons that the authors believe we have clear evidence of "the appearance of a *qualitative different* kind of intelligence" (p. 194). These humans, DeSalle and Tattersall claim (and I agree), were symbolic: "They bequeathed us items that were *overtly symbolic*: clear proclamations of symbolism and symbolic thought processes" (p. 194). This included not only cleverly made, complex tools of stone, bone, and antler, but, also, such things as: astonishing symbolic cave art; exquisite small, both symbolic and realistic, animal and human figurines; systems of notation; and musical instruments. The authors believe, and again I agree, that the stimulus for this late and rapid emergence of behaviors that imply symbolic thought was "the invention of language, combined with a brain and vocal tract that were already enabled for it. Language, after all, is the ultimate symbolic activity, and symbolic thought is almost inconceivable without it" (p. 200).

In the Epilogue, DeSalle and Tattersall emphasize that, although we arrived very late in the history of earth and have only been here for a very short time, we will have, and have had, an enormous impact on our and the earth's past and future. In the near future paleontology and genomic studies will lead to more discoveries and greater understanding of our history and biology. Some of these advances in our knowledge will bring about many ethical questions, of which the authors provide some interesting examples. However, the "modern" human behaviors of symbolic thought and culture, which we have inherited and which stem from our uniquely organized brain, are our most amazing attributes and will lead us to greater understanding of our cognitive abilities and of the world around us. Though I might add, these same capacities and the technologies we develop with them, might well lead us to our own premature extinction.

This is an exceptional book. I would suggest it as an upper-level high school or a college textbook for courses in the introduction to human evolution, and to a popular audience. I also encourage students and readers to visit the Hall of Human Origins at the American Museum of Natural History.

References

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