Alan Rutherford

A Brief History of Everyone Who Ever Lived

The Human Story Told Through Our Genes

New York: The Experiment, 2017
401 pages

Genes, Ancestry, and Prehistoric Sexual Politics

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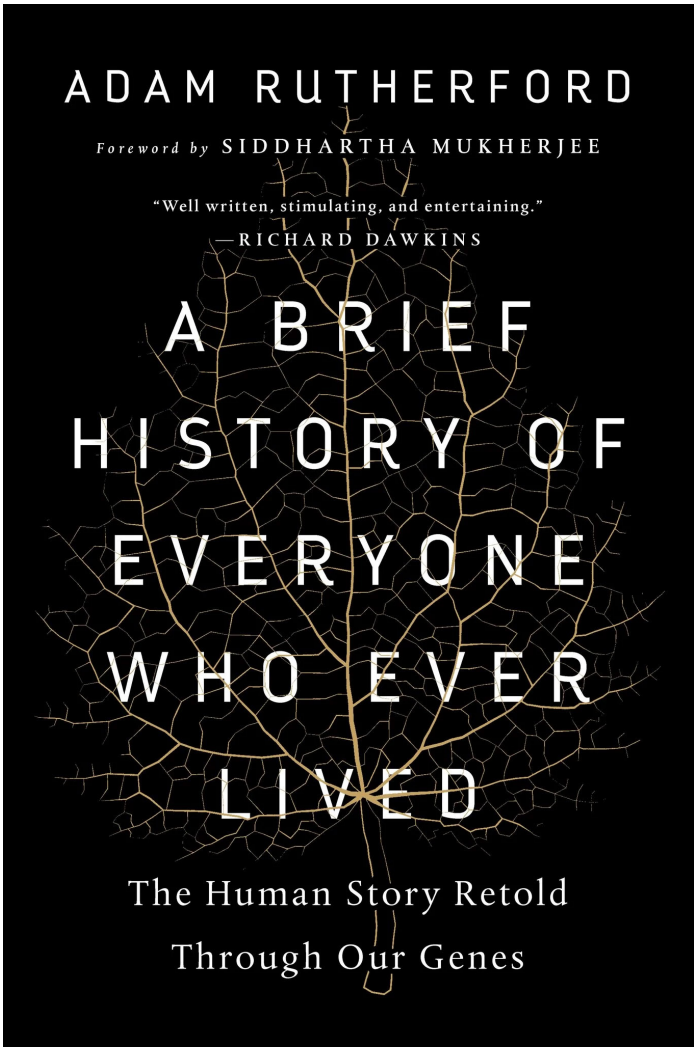

In the past dozen years all the sciences relevant to Big History have advanced, with striking discoveries in astronomy, geology, biology, and anthropology. Since the ponderous sequencing of the human genome, completed in 2001, genetics has rushed ahead even faster. Referring to the rapidity of sequencing today, the growing data bank of genetic analyses, and the astonishing success of sequencing 50,000-year old DNA from Neanderthals and Denisovans, Adam Rutherford—a former editor of the British journal *Nature* who is fully aware of the progress of genetics—describes the growth of genetic science and data as "breathtaking." Accordingly, he has authored *A Brief History of Everyone Who Has Ever Lived,* a chapter in the Grand Narrative begging to be brought up to date. Working strictly with what we have learned from genetics, Rutherford lays out the history of modern humans over the past 100,000 years, thus building on the background of a century of fossil discoveries. The result is an invigorating read, difficult at times, but enlightening in its clarification of mistaken assumptions about genetics in popular thinking.

We can imagine several roads to our evolutionary past. We can start with morphology, the gradation between earlier and later creatures that first led biologists to the idea of evolution. A version of this might be tracing the skeleton from mammals through amphibians, reptiles and fish to its first appearance as a notochord in *Pikaia* more that 500 million years ago. Adam Rutherford outlines the much longer route through "apes and monkeys . . . ratty mammals . . . wading sea creatures . . . worms and weedy sea plants" to our most ancient ancestor "locked in a rock at the bottom of the oceans, inside the hot bubbling tumult of a hydrothermal vent." The unifying thread of this four-billion-year narrative is genes, more precisely, the DNA that assures a kind of immortality to the stream of life. Early segments of that journey have been explored by others—Matt Ridley, Lynn Margulis, Frank Ryan. Rutherford has

his hands full unpacking the most recent episode in the history of *Homo sapiens*.

Genealogy as it is popularly practiced follows limited and tenuous data. People identify themselves by regional or national origins: they have an English background or Mexican heritage. Genealogical hobbyists in search of long-term continuity are tracking surnames, a linguistic activity dependent on reliable recording of paternal identity—and paternal continuity gets the most attention. But, Rutherford points out the oversimplification: we have two parents, four grandparents, eight great-parents, doubling with each generation. Thirty generations back, around the year 1450, our 500 million ancestors equal the world's population at the time, which has already verged on the impossible; forty generations back, about the time of William the Conqueror in the eleventh century, the mathematics of forty doublings indicates our ancestors must number more than 2 trillion, twenty times the estimated 100 billion *Homo sapiens* who have ever lived. Clearly, this is impossible: every ancestor must appear on multiple ancestral lines. Our imaginary family tree cannot capture this complexity. "Pedigrees begin to fold in on themselves a few generations back, and become less arboreal, and more a mesh or weblike. You can be, and in fact are descended from the same individual many times over." An English background or Mexican heritage disappears in a vast prehistoric web, a modern version of Indra's net, illustrated in the interlaced background of Rutherford's book cover. Genetic pathways leap borders and mountains and the barriers of oceans. Idealized pedigrees disappear into the history of all previous human life. We are virtually descended from everyone. Take your pick: Charlemagne, Cicero, Cleopatra. They are your ancestors. This is not a paternizing fantasy but a statistical certainty.

Rutherford's *Brief History* attempts to bring order to this tangled web. The ponderous sequencing of the human genome completed in 2001, which he meticulously explains, took years to accomplish; the result was what he calls "the most wondrous map ever produced by humankind." Today we have a data base of hundreds of fully sequenced and thousands of partially sequenced human genomes—the result of the National Geographic Genome Project which provides a genomic map for anyone who sends in a saliva swab. Other companies now provide the same service, though some imply more precise details of geography and region than genetics can deliver. The most unanticipated development has been the sequencing of DNA from prehistoric bones and teeth of Neanderthals and Denisovans who died up to 50,000 years ago. It is precisely this penetration of genetic analysis deep into the past that makes possible his brief history of everyone who ever lived.

One's genome consists of a roughly equal mix of parental DNA; so does the genome of everyone who ever lived. Rutherford provides a full account of the process of gene copying and transfer, with apt analogies for clarification. Through genetic mixing at every generation—analogous to the reshuffling of a deck of cards—unlimited variation in offspring is possible, accounting for the observed differences in siblings, and in fact the uniqueness of the estimated 107 billion humans who have ever lived. During the amalgamation of genes at the moment of conception, chunks of neutral or beneficial genes may be preserved while detrimental gene combinations may limit, damage, and over time reduce the efficacy of offspring, one result being a line of descendants that eventually goes extinct. Like letters, words, and language that preserve our stories through time, DNA preserves our ancestral story, the only caveat being occasional mistakes at conception where letters are miscopied, words are altered, or chunks of language are lost. These changes constitute mutational variations that become the drivers of evolutionary change.

Rutherford's analysis brings clarity to ideas and long-standing misconceptions—the thorny problem of race, for instance. *Homo sapiens* originated in Africa and have lived there for as much as 300,000 years—time to develop widespread genetic diversity. The few hundred *Homo sapiens* who migrated out of Africa

200,000 years later carried a fraction of that genetic richness, after which mutation and selection developed differences across all non-African populations, often quite superficial: variable facial features, hair texture, body proportions, eye color, and eventually skin pigmentation—the latter being the feature that has signified status, class, and caste from Europe to India in historic times. The fact is that there is far more diverse genetic variation in the African genome; there is more variation between Africans than between Africans and non-Africans, including light skinned Europeans. Genetically, alleged differences attributed to race have no scientific validity. Race is a myth; as Ashley Montague put it long ago, "man's most dangerous myth."

An added footnote: genes operate with a limited four-part "alphabet" (A, C, G, T); dark skin in Africa is related to a specifically positioned "G," which remained in place in out-of-Africa migrants for a long time, so that "we can say with confidence that the Africans who populated southern Europe 50,000 years ago were dark skinned." The light skin of Europeans occurred with an "A" substituted for the "G," which analysis of prehistoric DNA shows did not occur until around 8,000 years ago. Simple arithmetic shows that Europeans were dark-skinned for 84% of their occupied history, a perspective that renders white Eurocentric assumptions of superiority ludicrous.

In a revealing account of genome sequencing, Rutherford unpacks the hazards of genetic research among Native Americans. In Europe and Asia, hominid remains may be 40,000+ years old, found in cave debris among animal remains, and beyond claims from the living. In the Americas, the remains of a 12,600-year-old Montana toddler designated Anzick-1, carefully buried with stone tools and red ochre looks too much like an ancestral burial of today's Native Americans, and Kennewick Man, discovered on the banks of the Columbia River where he had been carefully buried 8,600 years ago, was claimed as "The Ancient One" by the five Federated Tribes of the Colville Reservation, who regard the ground as sacred. Scientists unaccustomed to resistance, with assumptions that prehistoric genomes were an open field for investigation, found themselves in a twenty-year quagmire. The American land was taken from Native Americans who now tend to see genetic study as further colonial predation: DNA is considcred part of the spiritual person. These, along with incidents of a cavalier approach to scientific research on Native American DNA samples has resulted in a tenuous and sometimes hostile relation between tribal traditions and genetic research, reminding us that genetic study of identifiable ancestors cannot be undertaken without full disclosure.

Within the last dozen years we have identified prehistoric Asians known as Denisovans, their name taken from a cave in Siberia where a finger bone and molar were recovered. We know nothing more about them than the sequencing of their DNA can tell is, but this tells us that they interbred with modern humans. Additionally, the popular press has made us aware that we carry the DNA of Neanderthals. Given their size as larger than *Homo sapiens*, hints that they may not have developed speech, along with their portrayal as primitive and undeveloped, Neanderthals have been regarded as a dead-end brutish line that went extinct at least 30,000 years ago. As such, it was thought, they would not have been attractive partners for our more discriminating, rational, and creative species. We have had to adjust these views in light of evidence that Neanderthals sewed, made clothes and jewelry, had the physical structure basic to speech, and perhaps left rock art in European caves. Still, the presence of Neanderthal DNA in our own has been attributed to a chance dalliance somewhere in the dark forests and distant mists of time past.

Rutherford clarifies the situation by noting that humans are "horny and mobile." The introgression of Neanderthal genes into our own was far more widespread than a single dalliance. DNA sequencing of prehistoric remains chronicle at least three introgressions. Romanian bones indicate a meeting of Neanderthals and *Homo sapiens* around 40,000 years ago, but Croatian Neanderthal bones tell us

that interbreeding occurred also 60,000 years ago, the time when modern humans were entering Europe. Even more striking, the DNA of a female Neanderthal from the Altai Mountains of Siberia who died roughly 50,000 years ago carries modern DNA acquired by one of her ancestors 50,000 years earlier—100,000 years ago. Conceivably, this introgression may have occurred much closer to Africa when the earliest waves of modern humans were crossing into the Arabian Peninsula or traversing the Eastern Mediterranean region.

As Rutherford notes, separation of modern humansfrom Neanderthals occurred approximately 500,000 to 650,000 years ago—not long enough to preclude successful interbreeding. The world was clearly "a whole lot more cosmopolitan in the millennia before we came to be the last representatives of the genus *Homo*." The widespread occurrence of Neanderthal remnants in modern humans—3 to 4 percent—indicates repeated and widespread intermating. Whenever these groups met, widespread sexual dalliance occurred. Rutherford adopts a creative image from the beat poet Edward Sanders: "clusterfuck: Whenever humans met—sapiens, Neanderthal, Denisovan—they had sex." And, in an interesting corollary, the proportional association of Neanderthal DNA with X and Y chromosomes indicates that "the first encounters we had with them that resulted in procreation were male Neanderthals with female *Homo sapiens*."

Rutherford has delivered a fascinating history. Along the way he clears away some genetic ideas that have surfaced that amount to questionable science—the alleged height gene, addiction gene, transsexual gene, obesity gene, gay gene—all a return to a form of primitive analysis not much different from "fate." He makes clear that genetics seen as a foundation for determinism is no better than phrenology, teacup reading, or astrology. Genetics may be virtually absolute in establishing paternity or the identity of a murderer, but its predictive power for character is limited. The presence of a gene associated with Altzeimer's or any other disease does not mean a person will contract it. Genetics is most useful in unraveling the past. "The genome is a history book, and we will not cease from exploring it." Certainly: as one more chapter in the grand narrative of the past, the human genome is the richest of territories.