Cell

Human History, Human Genomes

Who We Are and How We Got Here: Ancient DNA and the New Science of the Human Past

Author: David Reich
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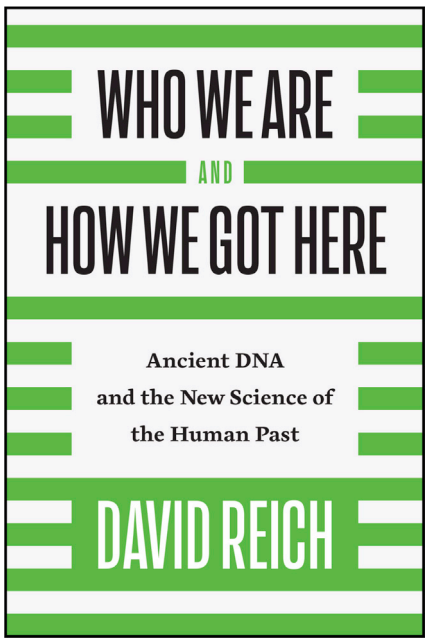
David Reich's *Who We Are and How We Got There* is an expansive analysis of the new field of ancient DNA. Broadly, the field of ancient DNA takes advantage of the rapid technological advances in many different areas of science and technology. For example, it capitalizes on recent progress in next-generation sequencing coupled with careful statistics to interpret slight variations in genotype. It also makes use of innovative technologies to extract DNA from bones and other ancient remains. Notwithstanding the wide range of applicable areas of study, Reich ably ties together the widely disparate topics to describe this research on humanity's ancestry.

Ancient DNA is a triumph for genomics, demonstrating its substantial influence far beyond genetics' traditional subject matter, branching out into archeology, linguistics, and even history. Manifesting this, Reich compares the pan-scientific impact of the development of ancient DNA to that of carbon dating or the microscope.

The book is divided into three main parts that are further subdivided into manageable chapters. Globally, it takes great pains to make the subject digestible to those who might only have a minimal scientific background. To wit, "Part I, the Deep History of Our Species" opens with a chapter on basic genetic concepts and a straightforward introduction to the growing use of genetic information to explore the origins of the human species. This opening serves to outline how genetics can be used to understand how our species split off from other coexisting hominids and to also provide a primer on the statistics of population genetics.

Reich discusses how we ascertain population structure from DNA sequencing. He starts out with the more traditional ascertainment of ancestry, based on subsets of genomic material such as the mitochondrial genome or the Y chromosome. While this has allowed for the determination of various aspects of relatedness, particularly placing the Neanderthals into a distinct lineage, this research has always been fundamentally limited by the amount of data and variants one can get from the relatively small genomic region. Now, with the advent of cheap and fast whole-genome sequencing, the potential for ancient DNA analysis has grown substantially.

Reich does a great job of weaving technical facts with a personal narrative that includes accounts of his lab's research and the various personalities in the field. That said, relating technical information is always tricky in terms of gauging the right background material for a given audience. A specialist may have appreciated more information on how one determines the significance of the four-population test or on exactly how one knows whether the ancient DNA extracted is not contaminated with contemporary variants. Conversely, a non-specialist may want more detail, for instance, on exactly how next-generation sequencing works or on what is meant by selection in relation to evolution, particularly negative and positive selection. Notwithstanding that, Reich's figures and captions do a great job of providing a pictorial narration necessary to understand ancient DNA; they are one of the best parts of the book.



Moreover, Reich could have further engaged his readership by analyzing whether the massive growth in ancient DNA was due to a single seminal discovery or the accruing of various different technologies that happened to come together at the right time. Here the scientist might be more interested in understanding the particular technologies in more depth, while the lay reader might be interested in a comparative analysis between other fast-growing fields and the triggers for their growth.

Throughout this first section and much of the balance of the book, Reich discusses a number of controversies in the field, noting how the "genetic record forced our hand. Instead of confirming scientists' expectations, it has produced surprises." Then, the second part of the book aims to describe in greater detail how emerging DNA extraction and analysis technologies have helped mold and change our understanding of the human lineage. One of the important outcomes was the positing of what Reich calls "ghost populations", a topic he introduces at the outset of the second section. These are ancient populations that cannot directly be sequenced but whose past existence is evident from their contributions to later populations.

Even after providing us with so much new information culled from the genetic record, Reich cautions against relying too much on fitting genetics to historical dates, as these dates will necessarily shift as the science advances. Nevertheless, he does point out examples where the genetics would seem to contradict the understanding of archeologists—for instance, in the mass migration of pre-European steppe populations into Europe. Another case where the field of ancient DNA provided novel results was in the relationship between the structure of Indian society and its underlying genealogy. In particular, Reich points out how

DNA analysis has manifested just how much of society in the Indian subcontinent is made up of numerous small, not significantly interbreeding populations. This has created many past population bottlenecks and, importantly, relates to current incidence of rare diseases.

Summarizing his entrance into other areas of research, Reich notes that while geneticists rarely have the necessary formal training in archeology, anthropology, or linguistics and are thus prone to make some errors, they should not be ignored, as they have much to add to the research. Specifically, he says that a "great lesson of the asncient DNA revolution is that its findings almost always provide accounts of human migrations that are very different from preexisting models."

A good example here is the Native American lineage, where ancient DNA provides evidence for a more complex peopling of North American than the traditional "Clovis-first" model. A related point involves the ethics of the study of Native American populations themselves–particularly, the collection of DNA from a small subset of the population with the aim of making inferences about the broader community. Reich questions his moral responsibilities here in light of the impossible task of obtaining consent from all potentially affected parties. The issue of community consent is discussed in some detail. This is an important area; as Reich notes, the lack of clarity on this issue can chill genetic population research.

The third part of the book, "Disruptive Genome," attempts to put ancient DNA research in a contemporary social context, looking, for example, at social justice issues such as the inequalities among races. Reich argues that while challenging to grapple with, differences between populations should not be ignored: they have practical, medical applications—for example, as Reich describes, in the area of prostate cancer.

One of the interesting issues that is tackled in the third section is the applicability of ancient DNA research to near-history: how we can move from using DNA to reconstruct the far past, greater than 4,000 years ago, to reconstructing near-current events? Here, one needs to analyze the actual relatedness between people sequenced, providing a detailed history of peoples. To this end, Reich provides an interesting case study concerning Thomas Jefferson. Ancient DNA sequencing has strongly corroborated the suspected relationship between Jefferson and his slave Sally Hemings. However, as one moves closer to the current time, the study of cryptic relatedness raises non-trivial privacy concerns.

Near the end of the book, Reich discusses the degree to which one could focus on personal histories using current genetic technologies—for example, through studying your own particular population group, via examining your own personal ancestry, or even through a longitudinal DNA self-study. Reich suggests that one ought to be cautious in this self-reflection. This is probably a good idea: scientists may lose their ability to be unbiased observers, while lay readers may find themselves swamped with unwieldy and uninterpretable amounts of information.

Overall, this is an informative book that tackles a timely new field and interesting topics. It's not without its controversies, but altogether, we recommend reading it and coming to your own conclusions.

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