WHO KILLED THE 
Men of England?

The written record of history meets genomics, evolution, demography, and molecular archaeology.

by Jonathan Shaw

illustrations by John Walker
There are no signs of a massacre—no mass graves, no piles of bones. Yet more than a million men vanished without a trace. They left no descendants. Historians know that something dramatic happened in England just as the Roman empire was collapsing. When the Anglo-Saxons first arrived in that northern outpost in the fourth century A.D.—whether as immigrants or invaders is debated—they encountered an existing Romano-Celtic population estimated at between 2 million and 3.7 million people. Latin and Celtic were the dominant languages. Yet the ensuing cultural transformation was so complete, says Goelet professor of medieval history Michael McCormick, that by the eighth century, English civilization considered itself completely Anglo-Saxon, spoke only Anglo-Saxon, and thought that everyone had “come over on the Mayflower, as it were.” This extraordinary change has had ramifications down to the present, and is why so many people speak English rather than Latin or Celtic today. But how English culture was completely remade, the historical record does not say.

Then, in 2002, scientists found a genetic signature in the DNA of living British men that hinted at an untold story of Anglo-Saxon conquest. The researchers were sampling Y-chromosomes, the sex chromosome passed down only in males, from men living in market towns named in the Domesday Book of 1086. Working along an east-west transect through central England and Wales, the scientists discovered that the mix of Y-chromosomes characteristic of men in the English towns was very different from that of men in the Welsh towns: Wales was the primary Celtic holdout in Western Britannia during the ascendance of the Anglo-Saxons. Using computer analysis, the researchers explored how such a pattern could have arisen and concluded that a massive replacement of the native fourth-century male Britons had taken place. Between 50 percent and 100 percent of indigenous English men today, the researchers estimate, are descended from Anglo-Saxons who arrived on England’s eastern coast 16 centuries ago. So what happened? Mass killing, or “population replacement,” is one possible explanation. Mass migration of Anglo-Saxons, so that they swamped the native gene pool, is another.

Yet no archaeological or historical evidence from the fifth and sixth centuries hints at the immense scale of violence or migration that would be necessary to explain this genetic legacy. The science hinted at an untold story.

Not only in this instance, but across entire fields of inquiry, the traditional boundaries between history and prehistory have been melting away as the study of the human past based on the written record increasingly incorporates the material record of the natural and physical sciences. Recognizing this shift, and seeking to establish fruitful collaborations, a group of Harvard and MIT scholars have begun working together as part of a new initiative for the study of the human past. Organized by McCormick, who studies the fall of the Roman empire, the aim is to bring to-
together researchers from the physical, life, and computer sciences and the humanities to explore the kinds of new data that will advance our understanding of human history.

In the Anglo-Saxon example, genomic archaeology—a new approach to genetics, demography, and mathematical simulation that uses genomic data from living people to illuminate major events in the past—eventually led to an explanation of how the males in Roman England might have been wiped out. Another study has traced the geographic spread of a gene variant that allows adults to digest the sugar in milk; possessing that allele appears to have conferred a tremendous evolutionary advantage during the last 10,000 years. Isotopic studies of human bone have revealed prehistoric dietary shifts, and shown that Neanderthals were more like us than previously imagined. Reconstructions of ancient mammalian DNA have led to new, climate-related theories about the extinction of megafauna (such as wooly mammoths) in which humans appear less to blame than previously supposed. And innovative technologies allow the identification of hearths and buildings in layers of soil, revealing the presence of entire villages at sites long thought to have been abandoned. The study of the human past, in other words, has entered a new phase in which science has begun to tell stories that were once the sole domain of humanists.

"Historians have always been looking for deep background conditions as they try to figure out the shaping forces of human history," says Adams University Professor emeritus Bernard Bailyn, who has been following McCormick's progress since the initiative began in 2004. "But Mike and his colleagues are taking this onto a much higher plane, probing deeper elements like medical histories, genetic transformations, ecological shifts over centuries, and the persistence, transformation, and disappearance of distinctive ethnic and physiological strains that can't be traced by usual historical evidence." Because this kind of inquiry is at an early stage, Bailyn adds, "What difference it is going to make in the next generation's textbooks, we don't know yet." But McCormick's imaginative quest, he says, by drawing on the expertise of scientists and social scientists as well as of historians, "has already had the very good effect of bringing people together in interdisciplinary and interfaculty collaborations at a level we haven't had before in history."

**Sexual Apartheid in the Ruins of an Empire**

An exemplar of this new approach is geneticist Mark Thomas of University College London, whom McCormick invited to speak at Harvard as part of the initiative in December 2007. Thomas was among the scientists who first identified the suggestive pattern of Y-chromosome distribution among British men in 2002; he had been seeking a plausible explanation for the data ever since. As he recounted in a lecture titled, "No Sex Please, We're English: Genes, Anglo-Saxon Apartheid, and the Early Medieval Settlement of Britain," Thomas had found that genetically, not one of the English towns he sampled was significantly different from the others. Welsh towns, on the other hand, were significantly different from each other and from the English towns. Most importantly, he found that inhabitants of the Dutch province of Friesland were indistinguishable genetically from the English town-dwellers. Friesland is one of the known embarkation points of the Anglo-Saxons—and the language spoken there is the closest living relative to English. ("Listening to a Frisian speak," says Thomas, "is like listening to somebody speak English with a frog in their mouth.")

In an attempt to explain the remarkable similarity between Frisian and English towns, Thomas and colleagues constructed a population simulation model on a computer. He tested many theories: common ancestry dating back to the Neolithic age; background migration over centuries and even millennia; and a mass-migration event that, he calculated, would have had to involve at least 50 percent replacement—the movement, in other words, of a million people. But most archaeologists and historians who understand the economic capacity of the era, he noted, "find such massive contributions to the English gene pool to be completely unacceptable. And maybe they are right. They know more than we do about these things."

"But still, the genetic data are quite robust," Thomas pointed out. "This is where the idea of an apartheid-like social structure comes in." He has advanced a theory that a sexually biased, ethnically driven reproductive pattern, in which Anglo-Saxon males fathered children with Anglo-Saxon females and possibly Celtic...
females, while the reproductive activities of Romano-Celtic males were more restricted, is the most plausible explanation for the demographic, archaeological, and genetic patterns seen today.

There is some support for this in ancient English laws, which indicate that Britons and Anglo-Saxons were legally and economically different even in the seventh century, long after the initial migration. Thomas cited wergild (blood money) payments as one example: “Killing an Anglo-Saxon was a costly business, but killing a native Briton was quite cheap.” This points to differences in economic status. And differences in wealth “almost always result in differences in reproductive output,” he said. “Sometimes two- and three-fold differences.” To the extent Anglo-Saxons were able to have and support more children, this could lead to a gradual replacement of the indigenous Y-chromosome over many generations. Simulating such an advantage, and choosing an arbitrary figure of 10 percent migration, Thomas found that the Y chromosomes of native Britons could have been replaced in the general population in as few as five generations.

The findings were at odds with traditional interpretations of the evidence, both the notion of “barbarian invasion” espoused by Romance-language-speaking historians and the idea of a “Great Migration,” as Germanic-speaking scholars called it. In historical studies, says McCormick, the prevailing view in the 1960s of the Germanic invasions in general was that the barbarians “came, they burned, they conquered, they killed off most of the Romans, and this dramatic new civilization appeared.” But by the 1970s, he continues, scholars began to realize there never was a homogenous “nation” of Germans in northern Europe, just small tribes that coalesced along the Roman frontier in what were political and cultural, rather than biological, federations, as their very names suggest: Alemanii, meaning “all men”; Goths, meaning “good guys.”

The Romans, scholars believed, provided a common enemy, and that unified the disparate Germanic tribes. This line of reasoning led historians to a further thought: maybe the Anglo-Saxon identity was similarly socially constructed, and not biological after all. In Latin and Greek sources, for example, a Byzantine ambassador describes running into a man on the street with long hair, wearing fur, who greets him in Greek. “A barbarian who speaks Greek!” exclaims the ambassador. “No,” says the man, “I was a Roman merchant before I was captured by the Huns.” Enslaved at first, he had used booty captured in battle to buy his freedom; he had remarried, and now considered his life among the Huns far superior to his former life as a Roman: “Now I fight Romans.”

More recent historical scholarship, therefore, has increasingly emphasized discovering the extent to which the barbarian migrations were really a process of ethnogenesis—the creation of new ethnic identities, as the merchant’s story illustrates. “There is lots of evidence for it,” McCormick says. “But now you have Mark Thomas telling us that you could actually study mating patterns. That is utterly unanticipated.” The work raises a host of new questions: What was women’s role in the barbarian settlements? Were Anglo-Saxon men mating with Celtic women? Or were there women in those invading boats, and if so, how many? What happened to the Romano-Celtic men? Were they killed?

“Thomas is asking really smart questions with amazing new tools,” says McCormick. “I never would have dreamed that we would have a shot at this. Mark showed not only that we have a shot at it, but he has some pretty darn good answers, until proven otherwise, which is the way science works.” The implications are profound: “Suddenly, we have all these genuine historical observations that need to be taken on board by historians and archaeologists and they raise a whole series of new questions, focusing particularly on...what is going on at the intimate level of this new civilization that is being born in the ruins of the Roman empire. The history of Europe will never be the same.”

Genetic Group Dynamics

How can such genetic evidence be put into historical context? The answer lies in further use of the new research tools. In the case of the Anglo-Saxon problem, scientists will have to study women’s remains, looking at their bones or checking the oxygen or strontium signatures in the enamel of their teeth to determine where they were born; or use isotopic analysis to learn whether certain groups of people were eating better foods than others.

But the genes themselves have even more to tell us, says David Reich, professor of genetics at Harvard Medical School. The Y-chromosome can be a particularly revealing signature of the past when compared to other kinds of genetic data. Among African Americans in the United States, for example, Y-chromosomes are about 33 percent European, he says, though the proportion varies from city to city. But those same African Americans’ mitochondrial DNA, which comes from the female line, is only about 6 percent European. And that, says Reich, “tells you about the history of this country, in which men contributed about three-fourths of the European ancestry that is present in the African-American population data. The data speak to a history in which white male slaveowners exploited women of African descent—a fact that is well documented in the historical record. That there is evidence of this in genetic data should be no surprise.”

An even more remarkable history, says Reich, is told in the genes of the men and women living in Medellín, Colombia. Most Americans associate Medellín with the drug cartels of that isolated region. But the remoteness has also preserved a genetic legacy that can be traced to the conquistadores. As described in a paper by Andrés Ruiz-Linares of University College London, the Y-chromosomes of men in Medellín are 95 percent European, while the mitochondrial DNA of the women is 95 percent Native American. Spanish men and Native American women created a new population—confirming the recorded history of the region.

Even more can be gleaned when we look at the X chromosomes of a population like this, says Reich. That is because men carry just one X-chromosome, and women carry two, so women contribute two-thirds of the X-chromosomes in a given population. If the pattern of European Y-chromosome and Native American mitochondrial DNA in Medellín had been established in a single generation, one would expect the X-chromosomes to be one-third European in origin, contributed by men, and two-thirds Native American, contributed by women. But in fact, X-chromosomes in Medellín are mostly European, revealing that there were subsequent waves of European male immigration into the population over several generations: fresh shiploads of conquistadores coupling with a mixed population of women. This sort of analysis could be brought to bear on the question of Anglo-Saxon migrations, as well, he believes, and would at least suggest whether the Anglo-Saxons arrived all at once or during a longer period of time.

The pattern of sexual exploitation by a dominant group seen in the preceding examples is not at all unusual in the human ge-
Seeing through Stone Walls
But genetic forays into history do face limitations. They provide robust observations for which there are diverse explanations. “It is like finding a stone wall in an excavation,” Reich explains. “It could mean the population was defending itself, or it could be a facility for storing grain. You really need to contextualize the genetics with other types of information—linguistics, history, archaeology, fossils, geology—because without this, your genetic data are sort of floating in mid-air.”

Fortunately, the science of the human past has progressed in these other areas no less than in the field of genetics. Innovations in archaeological analysis have had a profound impact on our understanding of Europe’s dark ages. After the fall of the Roman empire, “you get this layer called ‘dark earth’ in the archaeological stratigraphy, he says. “People thought the empire fell and the cities turned into garden plots. That is how dark earth was understood up until about five years ago,” when researchers including Henri Galinié, a Frenchman trained in Britain who visited Harvard last year, began making important new discoveries. The initiative sponsored lecture series has also covered diverse topics: how x-ray fluorescence identifies the Indian and Sri Lankan sources of late Roman and Merovingian jewels; how new environmental evidence explains the development of French towns; and how biological archaeological materials illuminate the economic history of the North Sea region. McCormick has done extraordinary work weaving seemingly exotic threads like these into new insights, partly from necessity.

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“...People thought the empire fell and the cities turned into garden plots...”

“...the most fun day in the last two years was my first contact with Mike”

“...we were learning...amazing stuff...”

“...the average human height at the time decreased something like six inches in around 50 years...”

“...the movements of people...”
discoveries in Tours, France. “In the Roman excavations,” says McCormick, “there were pots and stone buildings and columns.” But then suddenly you get a layer of nothing but dark, humus-looking soil. What actually happened, Galìnè and others have found, is that people shifted to organic building materials. “They had thatched roofs and wooden houses, they didn’t have Roman garbage removal, and they just dumped the ashes and charcoal from their hearths out in the road and all of that compacted. It is extremely rich, extremely dense,” but only from a molecular point of view, McCormick says. “We thought the towns of France were abandoned, but now we discover that they are there, filled with wooden structures. When you get that kind of a complex and macroscopically invisible archaeological layer, you start calling in the scientists. It is one example of the extraordinary things that are happening with the interaction among scientists, archaeologists, and historians.”

At another site, in Flanders, McCormick and two colleagues identified a Carolingian royal farm from the eighth and ninth centuries. Four teams from four different universities—30 people from 13 different countries speaking 10 different languages—used remote-sensing techniques (ground-penetrating radar, geomagnetic perspection, and electroresistivity) to identify subterranean structures. Then they took corings based on those results. At the same time, Steve Weiner of the Weizmann Institute in Israel, an expert in biomineralization, analyzed phytoliths—tiny silica crystals found in wood and grasses—at the site. Phytoliths accumulate in hearths when wood is burned, and “phyrotechnology is one of the hallmarks of human behavior,” he says. Phytoliths also become concentrated in the dung of animals like cows when they eat grass; when the dung is used to plaster walls, this can reveal the presence of structures. Furthermore, crystals record how they were formed or deformed, enabling researchers to distinguish plants used for fuel from those used for other purposes. “Steve has been working on wonderful quantitative approaches to phytoliths that allow him to distinguish hearths from dung used to plaster walls,” says McCormick. “This aids in the identification of structures and building materials that are completely invisible to the naked eye.” At the same time, Clay professor of scientific archaeology Noreen Tuross was experimenting with techniques for identifying molecular disorder in layers of earth below hearths, in places where plows, for example, had destroyed the hearth itself.

**Milk and Culture**

This new approach to history at Harvard broadened further last fall, when McCormick, Reich, and Welch professor of computer sciences Stuart Shieber organized a symposium on the science of the human past that covered topics beyond McCormick’s scholarly focus on the dark ages of Europe.

At the symposium, Tuross spoke about our closest relatives, the extinct Neanderthals. Recent research has shown that these humans were much more like us than was once thought. (Reich and Nick Patterson believe that Neanderthals were genetically so similar to modern humans that they should not be considered a separate species—sex would have yielded fertile offspring.) They used tools, probably had language, and controlled fire. They were large-brained; some were red-headed. They were probably highly intelligent: after all, they survived 100,000 years of the last glacial age in Europe. Still, one stereotype of Neanderthals persists: that they were almost exclusively meat eaters.

Tuross is an expert in isotope analysis, which allows her to gauge an animal’s trophic level—where on the food chain it has been feeding. The idea that Neanderthals were uber-predators is based on evidence from a cave in Croatia in which Neanderthal remains showed higher nitrogen isotope levels than even the bones of the top animal predators of the time. But Tuross was skeptical of these results. If Neanderthals were exclusively carnivorous, she reasoned, this would make them very different from other humans, who are omnivorous to the point that “only raccoons come anywhere near.” The fact that scientists actually haven’t studied how the nitrogen isotope measured in the Croatian analysis concentrates in meat eaters also gave her pause: the use of novel analytical techniques carries the risk of misinterpretation.

Tuross decided to conduct her own study of Neanderthals, using bones collected decades ago from Shanidar Cave in Northern Iraq. Her own isotopic analysis suggests that, far from feeding at the top of the food chain, the

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Shanidar Neanderthals, at least, had a varied diet.

Reconstructing the full story of Neanderthals is important because it may give scientists new insights into functionally important changes on the human family tree. Why did we survive when Neanderthals did not? Could their genes have been swamped by those of modern humans, as in the Anglo-Saxon domination? With new tools, scientists might answer those questions. But the biologically important differences, cautions Patterson, may be factors such as pathogen resistance, rather than some defining trait of modern human behavior such as language.

Mark Thomas offered an example of such a nuanced difference when he returned to Cambridge for the symposium a year after his first visit and spoke about his modeling of the spread in Europe of a variant of the lactase gene that enables adults to digest the sugar in milk. The variant arose around the same time as dairying began in Europe and spread rapidly, suggesting that possessing it conferred tremendous advantages for survival. In fact, this lactase allele is the most strongly selected part of the genome in the last 20,000 years among Europeans. Why would the ability to drink milk confer such an advantage? There may be more than one reason, Thomas suggests. Milk provides calories, protein and fat, calcium, vitamin D, and a steady supply of uncontaminated fluids. It may have allowed more economic use of the land. Having cows may also have conferred prestige, leading to sexual selection of dairy farmers.

When Thomas modeled the spread of the gene across a 9,000-year time span, he found that the simulation that best matched modern conditions suggested that the gene arose in central Europe 7,500 years ago, and that its spread paralleled that of the Linearbandkeramik culture, so named because of the characteristic linear bands they used to decorate their pottery. The Linearbandkeramik people were central and northern Europe’s first farmers, and the ability to digest milk, which probably arose in this culture as a random mutation, may have been an important factor in their subsequent diffusion throughout the continent. (Archaeologists have found in this culture the first evidence of a decline in the importance of sheep and goats relative to cows.) “The spread of the gene was shaped by selection and by an underlying demographic process, the spread of farming,” he says. These combined factors may even explain why Europeans are genetically so homogenous for variants of the lactase gene, compared to other milk-drinkers throughout the world.

“The lactase allele is not really part of my research agenda,” says McCormick, “but this is important,” he stresses. It illustrates concisely the changes in what is considered historical evidence. “In the nineteenth century, only written records were historical evidence. Now, atomic disorder is historical evidence; genes are historical evidence. The epistemological distinction between history and pre-history has become blurred, if not dissolved. The writing of new history will use the same kind of material evidence that prehistorians use, alongside the written record.” McCormick is fired with enthusiasm for the future of his discipline. “It is exciting. I jump up every morning. But it is also challenging. Division and department boundaries are real. Even with a generally supportive attitude, it is difficult [to raise funds, to admit students who are excellent in more than one discipline, and so on]. This is a whole new way of studying the past. It is a unique intellectual opportunity and practically all the pieces are in place. This should happen here—it will happen, whether we are part of it or not.”

Intellectual barriers are falling as scholars realize that “there is no big break in the evolution of the human organism,” he continues. “You and I still view the world through the experiences of our childhood. It is real and it is history, relevant to us as human beings as well as to societies and civilizations. The transmitted experience of our parents’ youth and their parents’ youth recedes to a point where we can no longer perceive the thread, but it is there.... Our ancestors came from Africa, and that is the fact, not insignificant for us to know as citizens of the Earth, and that should be reflected in the way history is written and understood.”

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