THE REVOLUTION IN HUMAN EVOLUTION

The 10,000 Year Explosion:
How Civilization Accelerated Human Evolution
Gregory Cochran and Henry Harpending
New York: Basic Books, 2009

Reviewed by F. Roger Devlin

Greg Cochran was a physicist doing optics research with applications in defense. When the Cold War ended, all the fun went out of it for him, and he quit in order to pursue his own scientific interests. Now that rarest of birds, a scientist without any permanent institutional affiliation, he investigates whatever questions strike his fancy regardless of academic departmental divisions. For example, he has proposed pathogenic explanations for various diseases previously thought to have other causes.

Becoming interested in evolutionary anthropology, he joined Steve Sailer's invitation-only Human Biodiversity Internet discussion group. There he met anthropologist Henry Harpending, a much-published Professor of Anthropology at the University of Utah. Harpending had done fieldwork among the !Kung (Bushmen) and Herero in Botswana and Namibia, concentrating on sexual and economic strategizing and the resulting family patterns. Dissatisfied with the state of his discipline, Harpending sought to combine its traditional methods with the mathematical modeling used by demographers and geneticists. A number of scientific papers have by now resulted from Cochran's and Harpending's collaboration, including a celebrated "Natural History of Ashkenazi Intelligence."[1]

The book under review is Cochran's and Harpending's presentation for the intelligent layman of their research and theorizing about genetic change within modern human populations: in other words, it is about the process of human evolution as it can be detected within the cosmic blink-of-an-eye of the past few millennia.

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[1] Also co-written by Jason Hardy: *Journal of Biosocial Science* 38 (5) (2006): 659–93.

RECENT HUMAN EVOLUTION

Paleoanthropologists have traditionally spoken of humans "attaining behavioral modernity" around 40,000 years ago. Behavioral modernity denotes a complex of behaviors including new tool-making technologies, art (e.g., cave paintings), personal decoration, and ritualized burials. Human genetic change since this transition point has long been considered negligible, and anthropologists commonly speak of cultural evolution taking over from biological evolution. "Culture freed the human race from the pressures of natural selection: We made clothes rather than growing fur and built better weapons rather than becoming stronger" (p. 2). Stephen Jay Gould thought even 100,000 years too short a time span in which to detect evolutionary differences, and concluded that "everything we call culture and civilization we've built with the same body and brain" (pp. 1, 5). Some biologists even claimed that human evolution had stopped completely.

Cochran and Harpending do not dispute the importance of cultural change, nor do they attempt to reduce every cultural innovation to a corresponding genetic change. But they demonstrate that significant human evolution has occurred since the advent of agriculture just 10,000 years—400 human generations—ago. Indeed, they believe human evolution has recently accelerated on the order of one-hundredfold over earlier primate evolution.

Like Darwin in *The Origin of Species*, they begin by directing the reader's attention to the dramatic effects of artificial selection upon plants and animals. It is hard to believe, for example, that corn (maize) is a close relative of the Mesoamerican wild grass teosinte, but genetic evidence leaves no room for doubt. The wild and cultivated varieties are thought to have separated just 7000 years ago.

Dogs were domesticated from wolves about 15,000 years ago, and now come in more shapes and sizes than any other mammal. The majority of today's breeds are not more than two centuries old. The most interesting changes brought about by domestication have been behavioral rather than physical.

> There are breeds like the Irish setter that point, and breeds like the Border collie that live to herd other animals. Both [are] elaborations of behaviors we see in wolves. Dogs are much more playful than wolves, and this can probably be understood as retention of juvenile behavior. Many of the ways in which dogs

> interact with humans can be understood as a new application of behavioral adaptations designed for a pack. [Thus,] if some wolves are genetically inclined to try to become pack leaders, others are probably natural followers, and dogs likely have higher frequencies of such "sidekick" characteristics: the owner takes on the role of leader of the pack. There is no complex behavioral adaptation in dogs without a recognizable precursor in wolves. (pp. 10–13)

An extreme example of rapid change is Russian scientist Dmitri Belyaev's fox-breeding program. Selecting exclusively for tameness over a period of just forty years (ten fox-generations), he succeeded in producing friendly foxes which enjoyed human contact.

These outcomes of breeding upon animals are not, indeed, comparable to what evolutionists call "complex adaptation," viz., the evolution of major morphological features such as wings or eyes. Such structures involve the coordinated operation of many genes. But neither are the results of artificial selection negligible. Differences in even a single gene can sometimes have important consequences, and such a gene can spread rapidly under a human breeder's guidance.

Natural selection can have similar results—not in forty years, of course, but within a few millennia, which is still a brief spell in biological terms. For example, the creosote bush was brought from South America to North America at the end of the last ice age 11,500 years ago (migratory birds probably carried the seeds). Since that time, some insects native to North America have so adapted themselves to it that they cannot feed upon anything else; others have evolved camouflage as creosote sticks and leaves.

Could natural selection have brought about comparably significant adaptations in our own species over the course of thousands rather than millions of years? A thousand years is only about forty human generations, after all.

The answer will depend on how constant our environment has been. Once an organism becomes well-adapted to a particular environment, evolutionary change can slow to a snail's pace. On the other hand, if a favorable mutation helps adapt an organism to a new environment, it can spread almost as rapidly as in a consciously directed breeding program.

Now, humans have clearly not had a static environment in the 40,000 or 50,000 years since we wandered out of Africa. Firstly, we had to adapt to the colder and otherwise variegated regions of Eurasia. Secondly, we adopted a settled agricultural way of life beginning around 10,000 years ago. More recently, we have even determined our own environments to a great extent.

Plenty of random genetic mutations have occurred among the three billion bases of the human genome during this same period. A few which might not have mattered to hunter-gatherers on the African savannah (and so would have gotten lost during the early phase of *Homo sapiens'* existence) turned out to be useful in the new Eurasian environments; these would have been likely to spread among local populations.

There is good evidence this has occurred. A simple example is lactose tolerance, which is caused by a single gene. Most human beings (in common with our earliest ancestors) lose the ability to digest milk after the age of weaning. But for Eurasians with domesticated cattle, the randomly-occurring lactose tolerance variation was valuable and so was preserved and spread. Once a sizeable number of people carried the gene, "a new kind of pastoralism became possible, one in which people kept cattle primarily for their milk rather than for their flesh. This change is very significant, because dairying is much more efficient than raising cattle for slaughter: it produces about five times as many calories per acre" (p. 181).

Thus, lactose tolerance increases the carrying capacity of the land for the group which has acquired it and gives them an advantage in competition with others. A lactose tolerant tribe is likely either to conquer or gradually to displace its nearby rivals. Cochran and Harpending speculate this might have been the critical advantage which permitted the Indo-European expansion. (Competing theories include higher intelligence and horsemanship.)

Today, the rate of lactose tolerance in parts of Scandinavia has reached 95 percent. And now that other human groups are herding cattle instead of merely hunting them, lactose tolerance is appearing among them as well: sometimes through the same genetic variant Europeans have (the Fulani and Hausa in West Africa), sometimes through different ones (the Tutsi in East Africa and some Arabs).

How do we know lactose tolerance is a recent mutation?

When a new gene gets passed on to the next generation, it does not normally go by itself: a large chunk of the chromosome where it is located goes with it. A chromosome typically gets broken into just two, three, or four pieces in a single human generation, and within each piece the offspring inherits the same pattern of genetic variants which the parent had: this is called a "shared haplotype."

Over the generations, breaks will randomly occur at other points along the chromosome until all the genes get shuffled. But this takes a very long time, and until then a gene will be linked with whatever other genes happen to be nearest to it. As a rough rule: the longer the shared haplotype, the younger the mutation. The shared haplotype around the European lactose tolerance mutation is over one million bases long.

And lactose tolerance is just one example. Hundreds of such variants with long shared haplotypes have been discovered in recent years. They include a number of the gross morphological differences commonly used to distinguish the races, such as fair skin and eyes among Europeans and the epicanthic eye fold among East Asians. Most of the variants are not so clearly visible. Their average age is 5000–5500 years among Eurasians and 8500 years among Africans.

On this basis it is possible to estimate the current rate of human genetic change and compare it with that of earlier primate evolution:

> Since we have sequenced the chimpanzee genome, we know the size of the genetic difference between chimps and humans. Since we also have decent estimates of the length of time since the two species split, we know the long-term rate of genetic change. The rate of change over the past few thousand years is far greater than this long-term rate over the past few million years, on the order of 100 times greater. (p. 23)

With men as with dogs, the most interesting genetic changes to study are those that involve behavior. Since the first appearance of tool making (by *Homo habilis*) on the African savannah more than two million years ago, the most radical change in hominid behavior occurred in the Upper Paleolithic, or last phase of the Old Stone Age, between 40,000 and 30,000 years ago—the "attainment of behavioral modernity" mentioned above. Innovations which date from this period include fortified dwelling places, dramatically improved tools and weapons made from new materials or from materials available only hundreds of miles away (indicating trading networks), painting, sculpture, and jewelry, all with noticeable regional variations in style. These changes have been called the "human revolution," the "cultural explosion," or the "big bang" of anthropology.

It is noteworthy that this transition did *not* coincide with the first development of anatomically modern humans (*Homo sapiens*) in Africa between 200,000 and 100,000 years ago. "In archeological artifacts from as recently as 100,000 years ago, it's hard to see any real difference in the material culture of Neanderthals and the material culture of Africans" (p. 53).

There must have been some genetic change, a "gateway mutation" (p. 23) (or set of mutations) in *Homo sapiens* around 40,000 years ago which made it all suddenly possible. What could this genetic change have been? Where did it come from, and why?

At around this time, modern humans were migrating into Europe, where they encountered the Neanderthals: "There were big differences between *Homo sapiens* and *Homo neanderthalensis* in way of life, with Neanderthals being high-risk, highly cooperative hunters, rather like wolves, while anatomically modern humans in Africa probably had a mixed diet and were more like modern hunter-gatherers" (pp. 54–55).

It is extremely probable that a certain amount of interbreeding occurred. The two lineages were separated by only half a million years, and no primates are known to have established reproductive isolation in so short a time. Bonobos (pygmy chimpanzees) branched off from common chimpanzees 800,000 years ago, but the two subspecies are still able to have fertile offspring with one another. Most mammalian species retain the ability to interbreed far longer.

The simplest hypothesis concerning the "human revolution" seems to be that it happened because modern humans acquiring new genetic variants directly from Neanderthals: "there is no faster way of acquiring new and useful genes" (p. 36).

Modern humans were certainly on balance the better adapted of the two species; after all, we are here and the Neanderthals are not. Late Neanderthal sites have, indeed, turned up where some of the Upper Paleolithic innovations are copied with greater or lesser success. But Neanderthals never developed them independently; they seem to have lacked the "spark" which had made them possible.

On the other hand, *Homo sapiens* had also been around at least 60,000 years already and had never produced such innovations before they encountered Neanderthals. It seems there was some special synergy between a few of the Neanderthal genetic variants and the preexisting *Homo sapiens* genome: "It would take only a very limited amount of interbreeding for modern humans to have picked up almost every Neanderthal allele [genetic variation] with any significant advantage.

The alleles most obviously worth stealing would be those that implemented adaptations to local conditions in Europe" (p. 53).

Some anthropologists also claim to have detected Neanderthal admixture in early modern human skeletons from Europe, but no consensus yet exists on this point.

For the benefit of those concerned about the effects of Neanderthal ancestry upon the nobility of their lineage, incidentally, the authors include a demonstration that we are also descended from viruses! A virus is a loose strand of DNA or RNA which enters living cells and begins copying itself. Occasionally a virus will enter human sperm or egg cells and copy itself into the human genome. Many identifiable traces of such viral DNA have turned up, a few of which even perform valuable functions. How's that for adding polish to your family escutcheon?

THE AGRICULTURAL REVOLUTION

Since the attainment of behavioral modernity, the most important change in the human way of life has been the development of agriculture. Farming produces between ten and one hundred times as many calories per acre as foraging. This resulted in a population explosion. Before agriculture, there may have been about 6 million human beings on the earth; during the last 10,000 years BC, their number is estimated to have grown between 40 and 170 times.

> Farming appeared first in the Fertile Crescent of Southwest Asia. By 9500 BC, we see the first signs of domesticated plants: first wheat and barley, then legumes such as peas and lentils. From there farming spread in all directions, showing up in Egypt and western India by 7000 BC and gradually moving into Europe. Around 7000 BC, rice and foxtail millet were domesticated in China. In sub-Saharan Africa, agriculture appeared around 2000 BC. (p. 68)

Mesoamerican Indians domesticated maize around 5000 BC, but North American Indians in the Illinois and Ohio River valleys adopted maize agriculture only 1000 years ago. Australian Aborigines never domesticated plants at all (pp. 7, 79). "The sedentary lifestyle of farming allowed a vast elaboration of material culture. Food, shelter, and artifacts no longer had to be portable. Births could be spaced closer together, since mothers didn't have to continually carry small children. Food was now storable, unlike the typical products of foraging, and storable food could be stolen. For the first time, humans could begin to accumulate wealth" (p. 70).

Humans had been adapting to foraging for a very long time, so the transition to a settled way of life must have been difficult. The average standard of living did *not* rise because of agriculture; population growth kept up with or even surpassed the vast increase in available nourishment. Early farmers were on the whole less well-nourished than the hunter-gatherers who preceded them:

> The carbohydrate fraction of their diet almost tripled, while the amount of protein tanked. Protein quality decreased as well. Hunter-gatherers would rarely have suffered vitamin deficiency diseases such as beri-beri, pellagra, rickets, or scurvy, but farmers sometimes did. There are numerous signs of pathology in the bones of early agriculturalists. Average height dropped by almost five inches. In the Americas, the introduction of maize led to widespread tooth decay and anemia due to iron deficiency.
>
> Many researchers have written about the health problems stemming from the advent of agriculture. Our point is that, over millennia, populations *responded* to these new pressures. People who had genetic variants that helped them deal with the new diet had more surviving children, and those variants spread: farmers began to adapt to an agricultural diet. (pp. 76–77)

The process of adaptation probably began with changes in the frequency of existing genetic variants; but as population soared, new mutations became more common.

Lactose tolerance, discussed above, was one important adaptation; it is thought to have originated about the same time as cattle were first domesticated, around 6000 BC. Fair skin may have originated among Europeans in response to shortages of vitamin D: fresh meat has plenty of vitamin D, so hunters had likely never had this problem (p. 78). Late adoption of agriculture may explain why the Picts of ancient Scotland are described by Roman authors as dark-skinned (p. 92). Other new genetic changes protected farmers against alcoholism: "Booze inevitably accompanies farming" (p. 82).

Most of the more recent adaptations involve just a few specific genetic functions: changes in metabolism and digestion, in defenses against infectious diseases, in reproduction, in DNA repair, or in the central nervous system (pp. 75–76). Hundreds of adaptations seem to have become common in the past 10,000 years.

> Populations that have never farmed or that haven't farmed for long, such as the Australian Aborigines and many Amerindians, have characteristic health problems today when exposed to Western diets. The most severe such problem currently is a high incidence of type 2 diabetes. The prevalence of diabetes among the Navajo is about two and a half times higher than it is in their European-descended neighbors, and about four times more common among Australian Aborigines than in other Australians. (p. 80)

Besides changing our diets, the adoption of agriculture brought about a host of new challenges: crowding, the accumulation of garbage, difficulties with human waste disposal, and increased numbers of rats and mice as well as livestock near places of human habitation. All of these led to infectious diseases, some newly common, others new altogether. These diseases acted as a selective pressure to produce genetic changes. The authors list nine separate mutations, for example, which protect against falciparum malaria (the most common and dangerous form of malaria); different mutations are common in different regions.

The most interesting genetic changes, as the authors say, are those that change minds rather than bodies. Agriculture selects for personality traits that make men successful rather than colorful: traits such as patience, self-control, and the ability to defer gratification: "Food is often shortest just before sowing, and those earlier farmers had to abstain from eating the seed grain when they and their families were hungriest. This is something that classic hunter-gatherers just didn't do. Efforts to teach Bushmen to become herders frequently fail when they eat all their goats" (p. 114).

For similar reasons, "conventional solutions to the problem of slow modernization among peoples with shallow experience of farming are highly problematic." The cause of differences between "developed" and "undeveloped" societies may well be "biological changes that are the product of natural selection acting over millennia" (p. 122).

Agriculture also leads to private property and stinginess. Hunter-gatherers usually shared resources with the tribe, largely because there wasn't much else to do with them: "Try eating a whole giraffe before the meat goes bad" (p. 115). But farmers could increase their reproductive success by being miserly.

Hunters are often lazy as long as their stomachs are full, and this makes sense since it conserves their energy. But farmers can almost always find things to do to increase their fitness: piling up enduring assets, building barns or irrigation works, trading for more land or livestock. Evolution seems to be selecting for men who enjoy keeping busy.

There is also evidence that humans have recently been selected for endurance rather than short bursts of strength, probably another adaptation to settled agriculture.

Finally, agricultural surpluses allowed for the emergence of nonproductive elites. These elites had powerful reasons to want to keep the peace in their domains: it was necessary to secure their own position and revenue. In effect, they began "taming" the farmers living under them:

> There are parallels between the process of domestication in animals and the changes that have occurred in humans [in the past 10,000 years]. In both humans and domesticated animals, we see a reduction in brain size, broader skulls, changes in hair color or coat color, and smaller teeth. With reasonable amounts of gene flow between [elite and peasant] classes, populations as a whole [and not just the elites] should have become tamer. If your ancestors were farmers for a long time, you're descended from people who decided it was better to live on their knees than die on their feet. (pp. 112, 110)

EVOLUTION WITHIN THE PERIOD OF RECORDED HISTORY

One of the authors' boldest speculations concerns a possible genetic basis for the explosion of innovation over the past few centuries commonly known as the scientific and industrial revolutions. Certainly genetics will never explain particular scientific or technological achievements: no use digging up Copernicus' bones in search of a gene to "explain" the heliocentric hypothesis. Genes could only be "responsible for" scientific progress in the sense of providing it with a necessary, not a sufficient, condition. But it is entirely likely that the first anatomically modern men lacked some of the native as well as cultural equipment for carrying out scientific research.

"Some argue that gradual genetic changes could not be responsible for such rapid social changes. We believe, however, that these arguments are mistaken" (p. 122). There often exist fairly precise points along a quantitative continuum where certain qualitative differences or even new processes suddenly emerge. The authors use the example of a "phase transition": the temperature at which a solid melts or a liquid vaporizes. Another well-known example is the "critical mass" of material necessary to sustain a fission reaction.

What would have been the analogous genetic point at which the rapid development of science became possible? "We think there was no direct selection favoring creativity itself, and that creative individuals are accidental by-products of selection for other traits, traits that really did pay off in everyday life, such as low time preference and the ability to make complex mental models" (p. 126).

Slight differences in the average distribution of these or similar traits can result in massive increases in the number of outliers at the upper end of the bell-curve. Such slight differences in average distributions could well have come about over the course of a few centuries.

Let me offer an example of my own. Many students of classical antiquity have wondered why scientific achievement was so limited in the highly civilized Hellenistic and Roman ages in comparison to the modern era. Archimedes (d. 212 BC), e.g., is now widely considered the greatest scientific mind of antiquity, but he was best known to the men of his own day as a designer of siege engines. His mathematical works were collected and commented upon only in the sixth century AD. Another one thousand years later, rather suddenly in the sixteenth century, he was rediscovered by a number of scientific men interested in carrying on and extending his researches. Intellectual historians have speculated on the reason for this lag. Was it something to do with Christianity? Was it a change in the social structure? Cochran and Harpending might suggest that the genetic outliers—scientifically gifted men—had simply become frequent enough after seventeen further centuries of genetic change to form a research community worthy of a singular ancient prodigy.

ASHKENAZI INTELLIGENCE

The 10,000 Year Explosion concludes with an example of significant genetic change that occurred within a single millennium: the evolution of intelligence in Ashkenazi Jews. "A fair amount of classical commentary on the Jews has been preserved," the authors point out, "and there is no sign that anyone then had the impression that Jews were unusually intelligent" (p. 193). But today the Ashkenazim are estimated to have an average IQ of 112, about three-quarters of a standard deviation above the European mean (p. 191).

They also suffer from an unusual set of serious genetic diseases at frequencies vastly exceeding the gentile populations which surround them. The authors studied 21 of these disorders and believe that some or all of them are genetically linked to high intelligence.

"[E]ver since [torsion dystonia] was first recognized, observers have commented on the unusual intelligence of the patients who suffer from it" (p. 221). Seven studies also indicate high IQ in patients with nonclassic congenital adrenal hyperplasia, a condition with a gene frequency of almost 20 percent among Ashkenazim. The authors themselves discovered that Israelis being treated for Gaucher's disease are eleven times as likely as the average Israeli Ashkenazi to be engineers or scientists.

Most of the genetic mutations at the root of typical Ashkenazi diseases involve just two biological subsystems: DNA repair and sphingolipid storage disorders. "Imagine a fat biochemistry textbook where each page describes a different function: most of the Ashkenazi diseases would be described on just two of those pages" (p. 214).

Sphingolipid mutations in particular seem like the kind that might increase intelligence: "In each there is a buildup of some particular sphingolipid, a class of modified fat molecules that play a role in signal transmission and are especially common in neural tissues. Researchers have determined that elevated levels of those sphingolipids cause the growth of more connections among neurons" (p. 220).

Tay-Sachs and Niemann-Pick diseases, for example, are sphingolipid disorders that cause a marked increase in the growth of dendrites, the fine branches that connect neurons; they are the only known disease alleles that cause increased neural connections.

It is rare for any population to suffer high frequencies of dangerous mutations like these: the more dangerous the mutation, the more strongly natural selection tends to work against it. But there are two cases in which they may become common: genetic drift in a population bottleneck or natural selection in favor of some positive trait with which they happened to be linked.

A population bottleneck is an event that drastically reduces the numbers in a breeding pool. For example, Pingelap is a Pacific island that was devastated by a Typhoon around 1775, leaving about twenty survivors. Today, almost 10 percent of the islanders suffer a form of severe color blindness. Color blindness just happened to be a trait found among the survivors, and spread as the island population replenished itself.

But the effects of a population bottleneck are random; there is nothing in the bottleneck hypothesis that would account for the concentration of Ashkenazi genetic disorders in just two functional areas. "We looked at twenty-one genetic diseases among the Ashkenazi and calculated the probability of finding four that affected sphingolipid metabolism, assuming randomness, in a given population. That probability was very low, less than 1 in 100,000. That can't be a coincidence" (p. 215).

And several other genetic results which would be expected from a bottleneck, such as a decrease in overall genetic variety, are not found among the Ashkenazim.

This leaves us with the hypothesis of natural selection in favor of some positive trait (such as intelligence) with which the harmful Ashkenazi alleles happened to be linked. Another circumstance favoring this hypothesis is the pattern of "heterozygote advantage" in these diseases. There are certain alleles which are beneficial to carriers of a single copy ("heterozygotes") but harmful to those with two. The sickle-cell mutation among Africans is the best known example: a single sickle-cell gene protects against falciparum malaria, while two produce the dangerous condition known as sickle-cell anemia. There are many examples of heterozygote advantage, not all of them defenses against infection. Such alleles are usually signs of strong, recent selection; over a longer time, mutations with fewer side effects tend to occur and win out (p. 217).

Natural selection for intelligence required an unusual pattern of social organization to endure over many generations: one in which fertility was linked to success at cognitively demanding occupations and marriage outside the group was strongly discouraged. As the authors demonstrate, Ashkenazi history fulfilled these unusual requirements over a period of eight or nine centuries.

Early Ashkenazi history is unclear. The most plausible hypothesis seems to be that the male ancestors of the Ashkenazim were brought to Italy as slaves following either the Great Revolt of AD 66–73 or the Bar Kochba Revolt of AD 132–135. After regaining their freedom, many of these men would have had to take wives from the local gentile population. About 40 percent of Ashkenazi ancestry is European, mostly from the maternal line. Once a Jewish community had been reestablished, however, strong controls were instituted against intermarriage: not less than 50 percent of Ashkenazi ancestry is Middle

Eastern. "Even 2 percent mixing per generation over the past 2,000 years would have caused the Ashkenazim to become 80 percent European." The evidence indicates a rate of interbreeding less than 1 percent (Kevin MacDonald has estimated it at about 0.5 percent). This is important, because, "selective pressures cannot change a population that freely mixes with its neighbors. Intermarriage quickly dilutes the effect of beneficial alleles within a population, since the introduction of alleles from outside easily swamps the effects of selection within the group" (pp. 194, 219).

These ancient Jewish communities gradually migrated to Northern France and Germany. When they first appear in the historical record in Carolingian times

> they are long-distance merchants who trade with the Muslim world. This is the beginning of a unique occupation pattern; there were no other European groups—or other Jewish groups, for that matter—who were noted for this. When the security required for long-distance travel no longer existed, the Ashkenazim increasingly specialized in one occupation, finance. The majority seem to have been moneylenders by 1100. (p. 195–7)

Serious persecution began in 1096, and gradually Jews were expelled from most of Western Europe. But they were welcomed in the Polish-Lithuanian Commonwealth because of their unusual skills.

> For 800 to 900 years, from roughly 800 to 1650 or 1700, the great majority of Ashkenazi Jews had managerial and financial jobs, jobs of high complexity. It would have been impossible (back then) for the majority of any territorial ethnic group to have such jobs because agricultural productivity would have been too low. (p. 199)

Genetic selection for success at intellectually demanding tasks such as scholarship, finance, and trade required that an impermeable ethnic group occupy a specialized economic niche over a period of centuries. Ashkenazi Jews uniquely fulfill this unusual requirement. But could natural selection have brought about the results we see? The authors show that it could have:

> Assume that parents of each generation averaged a single IQ

> point higher than the rest of the Ashkenazi population. In other words, let's suppose there was a modest tendency (mediated through economic success) for intelligent parents to have more surviving children—a tendency that certainly would not have been noticed at the time. If we assume a heritability of 30 percent for IQ, a very conservative assumption, then the average IQ of the Ashkenazi population would have increased by about a third of a point per generation. Over forty generations, roughly 1000 years, Ashkenazi IQ would have increased by 12 points. (p. 223)

STEPPING ON TOES

Although Cochran and Harpending are primarily scientists whose aim is to understand the world better, they also realize their work flies in the face of the egalitarian doctrines which still control public policy. The official experts on "third world development" will not be pleased to learn that the objects of their benevolence have to farm for several thousand years before they can become capable of modernization. Some Jews have evidently not felt flattered by the authors' "odious" theory of superior Ashkenazi intelligence. And they compound their offence by citing Kevin MacDonald.

Let us conclude with the gauntlet they throw down to the ideologues:

> It's time to address that old chestnut that biological differences among human populations are "superficial," only skin-deep. It's not true: We're seeing genetically caused differences in all kinds of functions, and every such difference was important enough to cause a significant increase in fitness (number of offspring)—otherwise it wouldn't have reached high frequency in just a few millennia. . . . Evolution has taken a different course in different populations. Over time, we have become more and more unlike one another as differences between populations have accumulated. (pp. 90, 10)

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