Human evolution

Darwin's children

Human evolution has speeded up over the past 80,000 years. That raises awkward questions about the concept of “race”

PROBABLY, more bad science has been conducted on the concept of human race than on any other field of biology. The reason is that an awful lot of research into race has been motivated by preconceived ideas that one lot of people are somehow “better” than another lot, rather than being a disinterested investigation of regional variations in a single species and the evolutionary pressures that have created them.

Contrariwise, even well constructed studies, if they do find racial differences, risk opposition from those who deny that people from different parts of the world could ever differ genetically from one another in important ways. As a result, only the foolish or the daring rush in to add to the carnage. It remains to be seen which category the authors of two papers in this week's Proceedings of the National Academy of Sciences fall into.

One of the papers, written by Andrea Migliano and her colleagues at Cambridge University, looks at a local outcome of human evolution—the short stature often known as pygmyism—and tries to explain the evolutionary circumstances that cause it. The other, by Robert Moyzis of the University of California, Irvine, and his colleagues, asks a broader question: how much evolutionary change has happened since Homo sapiens climbed out of his African cradle and began to colonise the world? The answer is, quite a lot—and the rate of change seems to have speeded up.

Breed early and breed often

The best known pygmies are the Aka, Efe and Mbuti of central Africa. However, by the standard definition—which is that a group's men have an average height below 1.55 metres—there are also pygmies in the Andaman Islands, Malaysia, Thailand, Indonesia, the Philippines, Papua New Guinea, Brazil and

Bolivia.

African pygmies usually live in forests, and the conventional explanation for their stature has been that it makes it easier for them to move through dense vegetation. There are also two competing explanations: that small bodies keep cool more readily than large ones (pygmyism tends to be a tropical phenomenon) or that pygmies live in places with unreliable food supplies, and their size means they can make do with smaller meals.

Dr Migliano and her team reject all these explanations. Some non-African pygmies live outside forests and many live in cool, dry areas. Moreover, some of the world's tallest people, such as the Turkana and Maasai of East Africa, suffer periodic interruptions to their food supply. Instead, the researchers suggest that short stature is not a desirable feature in itself, but is rather a consequence of something else, namely a need to reproduce early.

By adding pre-existing data for African pygmies to new information they have collected about the Aeta and the Batak of the Philippines, they show that at the beginnings of their lives all these pygmy populations follow the same growth curves as taller people, including Turkana and Americans. This demonstrates that pygmyism is not a result of early malnutrition, as another hypothesis has it. At the age of about 12, however, pygmies stop growing. That is also the age at which they become sexually mature—about three years earlier than taller people.

The other part of the argument is that all observed pygmy populations have a short life expectancy. Indeed, this, according to Dr Migliano's hypothesis, is the crucial evolutionary pressure. Of the six groups of pygmies for whom data exist, two have a life expectancy of 24 years and the other four about 16 years.

Exactly why that is so probably varies from place to place (in the case of the Filipino groups, Dr Migliano cites tuberculosis, measles and malaria as the most likely causes), but the actual reasons do not affect the evolutionary argument. This is that a short life exerts pressure to mature early, and thus switch resources from growth to reproduction. A mathematical model used by the team confirms that, given pygmy life expectancies, their growth and reproduction patterns have indeed been optimised by natural selection. The various pygmy groups are thus the products of harsh circumstances.

Local heroes

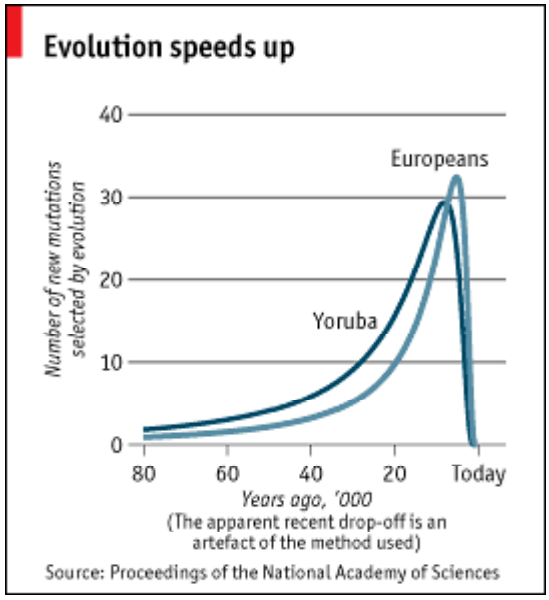
Such alteration of stature is a particularly clear example of what Dr Moyzis's

paper suggests is a wider phenomenon—that Homo sapiens is continuing to undergo local evolution. He and his colleagues reckon they can both estimate the rate of evolution and identify many of the evolving genes, by using a trick with the clumsy name of linkage disequilibrium.

Genes are linked together in cell nuclei on structures called chromosomes. These come in pairs, one from each parent. However, when sperm and egg cells are formed, the maternal and paternal chromosomes swap bits of DNA to create a new mixture. The pieces of DNA swapped are complementary—that is, they contain the same types of gene. But they may contain different versions of the genes in question, and these different versions can have different biological effects.

Over the generations this process of swapping mixes the genes up thoroughly, and an equilibrium emerges. If a new mutation appears, however, it will take quite a while for that thorough mixing to happen. This means recent mutations can be spotted because they are still linked to the same neighbouring bits of DNA as they were when they first appeared. Moreover, the size of these neighbouring blocks gives an indication of how long ago the mutation in question emerged; long blocks suggest a recent mutation because the mixing process has not had time to break them up.

All this has been known for decades, but it is only recently that enough human DNA sequences have become available for the technique to be used to compare people from different parts of the world. And this is what Dr Moyzis and his colleagues have now done.



What they have found is that about 1,800 protein-coding genes, some 7% of

the total known, show signs of having been subject to recent natural selection. By recent, they mean within the past 80,000 years. Moreover, as the chart shows, the rate of change has speeded up over the course of that period. (The sudden fall-off at the end is caused because the linkage-disequilibrium method cannot easily detect very recent mutations, rather than by a sudden reduction in the rate of evolution.) The researchers put this acceleration down to two things. First, the human population has expanded rapidly during that period, which increases the size of the gene pool in which mutations can occur. Second, the environment in which people find themselves has also changed rapidly, creating new contexts in which those mutations might have beneficial effects.

That environmental change itself has two causes. The past 80,000 years is the period in which humanity has spread out of Africa to the rest of the world, and each new place brings its own challenges. It has also been a period of enormous cultural change, and that, too, creates evolutionary pressures. In acknowledgment of these diverse circumstances, the researchers looked in detail at the DNA of four groups of people from around the planet: Yoruba from Africa, Han Chinese and Japanese from Asia, and Europeans.

Various themes emerged. An important one was protection from disease, suspected to be a consequence of the increased risk of infection that living in settlements brings. In this context, for example, various mutations of a gene called G6PD that are thought to offer protection from malaria sprang up independently in different places.

A second theme is response to changes in diet caused by the domestication of plants and animals. One example of this is variation in LCT, a gene involved in the metabolism of lactose, a sugar found in milk. All human babies can metabolise lactose, but only some adults can manage the trick. That fact, and the gene involved, have been known for some time. But Dr Moyzis's team have worked out the details of the evolution of LCT. They suspect that it was responsible for the sudden spread of the Indo-European group of humanity about 4,000 years ago, and also for the more recent spread of the Tutsis in Africa, whose ancestors independently evolved a tolerant version of the gene.

The pressures behind other changes are less obvious. In the past 2,000-3,000 years, for example, Europeans have undergone changes in the gene for a protein that moves potassium ions in and out of nerve cells and taste buds. There have also been European changes in genes linked to cancer and Alzheimer's disease. Chinese, Japanese and Europeans, meanwhile, have all seen changes in a serotonin transporter. Serotonin is one of the brain's

messenger molecules, and is particularly involved in establishing mood.

The finding that may cause most controversy, however, is that in the Asian groups there has been strong selection for one variant of a gene that, in a different form, is responsible for Gaucher's disease. A few years ago two of the paper's other authors, Gregory Cochran and Henry Harpending, suggested that the Gaucher's form of the gene might be connected with the higher than average intelligence notable among Ashkenazi Jews. The unstated inference is that something similar might be true in Asians, too.

The Ashkenazim paper caused quite a stir at the time. It was merely a hypothesis, but it did suggest a programme of research that could be conducted to test the hypothesis. So far, no one—daring or foolish—has tried. Eventually, however, such questions will have to be faced. The paper Dr Moyzis and his colleagues have just published is a ranging shot, but the amount of recent human evolution it has exposed is surprising. Others will no doubt follow, and the genetic meaning of the term “race”, if it has one, will be exposed for all to see.

Human mating

A buyers' market

Men propose; women dispose

WOMEN often complain that dating is like a cattle market, and a paper just published in Biology Letters by Thomas Pollet and Daniel Nettle of Newcastle University, in England, suggests they are right. They have little cause for complaint, however, because the paper also suggests that in this particular market, it is women who are the buyers.

Mr Pollet and Dr Nettle were looking for evidence to support the contention that women choose men of high status and resources, as well as good looks. That may sound common sense, but it was often denied by social scientists until a group of researchers who called themselves evolutionary psychologists started investigating the matter two decades ago. Since then, a series of experiments in laboratories have supported the contention. But as all zoologists know, experiments can only tell you so much. Eventually, you have to look at natural populations.

And that is what Mr Pollet and Dr Nettle have done. They have examined data from the 1910 census of the United States of America and discovered that marriage is, indeed, a market. Moreover, as in any market, a scarcity of buyers means the sellers have to have particularly attractive goods on offer if they are to make the exchange.

The advantage of picking 1910 was that America had not yet settled down, demographically speaking. Though the long-colonised eastern states had a sex ratio of one man to one woman, or thereabouts, in the rest of the country the old adage “go west, young man” had resulted in a surplus of males. Mr Pollet and Dr Nettle were thus able to see just how picky women are, given the chance.

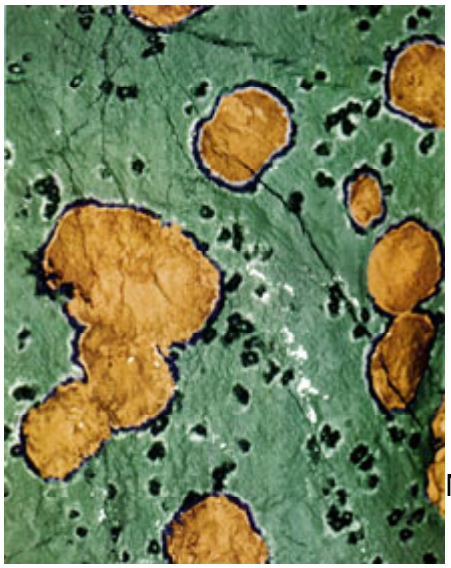
Rather than looking at the whole census, the two researchers relied on a sample of one person in 250. They then assigned the men in the sample a socioeconomic status score between zero and 96, on a scale drawn up in 1950 (which was as close to 1910 as they could get). They showed that in states where the sexes were equal in number, 56% of low status men were married by the age of 30, while 60% of high status men were. Even in this case, then,

there are women who would prefer to remain single rather than marry a deadbeat. When there were 110 men for every 100 women (as, for example, in Arizona), the women got really choosy. In that case only 24% of low-status men were married by 30 compared with 46% of high-status men. As the men went west, then, so did their marriage opportunities.

Extraterrestrials

Lodestones, not life

The building blocks for life emerged on Mars—but not life itself



No sign of aliens after all

FOR a dull lump of greyish rock, ALH 84001 has had an eventful life. The meteorite, which was retrieved from the Allan Hills of Antarctica in 1984, is certainly well travelled. Experts in the field think it came from Mars, having been blasted off the surface of that planet by a collision with an even bigger meteorite. More than that, it contains minerals that some researchers believed, in a flurry of publicity when the rock was properly examined just over a decade ago, must have been made by living things on the Martian surface. The number constituting “some” has been dwindling since then, but there are still a few hold-outs who think ALH 84001 is indeed the first evidence of extraterrestrial aliens—albeit of bacterial dimensions.

The reason why ALH 84001 is so interesting is that it contains organic compounds. Life is thought to have emerged on Earth from a primordial soup of such compounds, which are based on carbon, hydrogen and oxygen, though just how it did so is obscure. When ALH 84001 was analysed, however, some astrobiologists suggested that the conventional explanation might be wrong. Perhaps life had evolved on Mars first and the red planet had then “seeded” its

blue neighbour when rocky projectiles similar to ALH 84001 were blasted off its surface in abundance in an era when the solar system had a lot of loose asteroids flying around.

To test these claims, a group of researchers led by Andrew Steele of the Carnegie Institution in Washington, DC, decided to identify precisely what ALH 84001 contains and then compare the results with those from rocks that definitely formed on Earth. Using a number of different techniques, they discovered that the tiny spheres of carbonate minerals within the meteorite which had caused such a stir were surrounded by an iron-oxide mineral called magnetite.

Some true believers had seen the presence of magnetite in the meteorite as evidence supporting their cause. That was because certain earthly bacteria make small grains of the mineral, in order to navigate their habitats using the Earth's magnetic field, much as human navigators once used lodestone compasses made of magnetite to find their way around. However, most of the magnetite on Earth is not bacterial. Instead, it was ejected in liquid form from volcanoes. If this magnetite cools in an environment rich in water and carbon dioxide (which terrestrial volcanoes usually are), it can act as a catalyst for the formation of organic compounds from the carbon, hydrogen and oxygen atoms in those two raw ingredients.

Dr Steele and his colleagues thus decided to compare ALH 84001 with volcanic rocks collected in Svalbard, the northernmost territory of Norway. These rocks are thought to have formed when volcanoes erupted in freezing, pristine conditions a million years or so ago.

The researchers found that the earthly boulders, too, contained carbonates encircled by magnetite. Writing in a forthcoming issue of Meteoritics and Planetary Science, they conclude that the organic material in ALH 84001 was made not by Martian microbes but, rather, by chemical reactions within the rock.

Such a conclusion may be disappointing to astrobiologists, who seek to study life on other planets, so far without success. But it also offers them hope. If Dr Steele and his colleagues are correct, then volcanic activity in a place other than Earth has produce interesting-looking organic compounds. That means the building blocks of life could form on cold, rocky volcanic planets throughout the universe. And the universe is a very big place..