

Anthro Notes

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MODERN HUMAN ORIGINS -- WHAT'S NEW WITH WHAT'S OLD

In a lecture at George Washington University this September, Richard Leakey argued that one of the most controversial and least well-understood events in human evolution occurs toward the end of the story. Where, when, and why did modern humans like ourselves first appear, and how did they come to occupy most of the earth?

Study of this stage of evolution is not new; in fact, it began more than 160 years ago with the first discovery of Neandertal fossils in Belgium in 1830. As early as 1868, the co-existence of extinct animals such as mammoths with anatomically modern but very robust humans was documented at the site of Cro-Magnon, in southern France.

Why don't we know more after all this time about an event so close to our own era? And why are the arguments over this event so bitter?

WHAT'S SO MODERN ABOUT MODERN HUMANS?

Anatomically modern humans are distinguished from their predecessors by their relatively "gracile" (less robust or less muscular) skeletons and smaller teeth. Males, in particular, became smaller and overlapped the female size range to a greater extent than previously. Although brain size did not increase in moderns from the preceding "archaic" stage, the braincase itself became taller, less elongated from front-to-back, and more sharply flexed at its base, where it joins the face. In essence, the face became almost completely situated under the braincase, rather than sticking out in front of it as in earlier human ancestors and other primates. Smaller teeth also left the chin sticking out in front, and reduced the need for heavy browridges to take up some of the stress of chewing. (If



THE "CANDELABRA" VS. THE "HATRACK" THEORY

you put your fingers on your remnant "browridges" over the outer corner of your eyes and clench your teeth, you can feel the chewing stress transmitted to the browridge area). Archaic Homo sapiens, with modern-size brains but big brow-ridges, large faces, and large teeth, occupied Europe, Asia and Africa before the appearance of modern Homo sapiens. The term "Neandertals" refers in some theories to one relatively isolated, cold-adapted population of these "archaics." In other theories, Neandertals refers to all later "archaics," ca. 130,000 to 40,000 B.P. (before present).

CANDELABRAS AND HATRACKS

Throughout this century, two basic variants of the story have vied for acceptance by the scientific community. The "candelabra" view recognizes only one major branching of the human line. After the initial dispersal of humans to the three major Old World continents, beginning as early as 1.1 million years ago with the species Homo erectus, the populations of each region evolved in parallel fashion into modern humans. Some migration or gene flow between the regions assured that new characteristics appearing in one region would eventually spread to all. In this theory, most of the immediate ancestors of the modern humans of Africa are found in Africa, while the immediate ancestors of the Chinese are found in China and so forth.

According to this view, the immediate ancestors of Europeans are their predecessors on that continent--namely the Neandertals. The current version of the "candelabra" theory is referred to as "multi-regional evolution" (MRE), because it allows more migration from region to region than earlier versions.

In a contrasting view, known as the "hatrack" theory, a single main stem or center pole leads to modern humans, with branches at intervals through time representing evolutionary dead ends. According to this theory, the Neandertals of

western Europe are one such dead end; the "Peking Man" or Homo erectus fossils of east Asia are another. Until recently, the central stem was always given a European or Near Eastern identity, through such fossils as "Piltdown" (a now-discredited forgery), Swanscombe (a large English skullcap without a face, dating to a period just before the earliest Neandertals), or the Skhul fossils from Israel. The central role of Europe in human evolution was attributed by some to the influence of a colder climate, a limited growing season, and more reliance on both hunting and food storage, all of which would have promoted intelligence and growth of the brain.

In the current version of the "hatrack" theory, however, the central stem is African, and all the earlier fossils of other continents constitute the dead ends of human evolution. Since, in this view, all anatomically modern humans derive from recent African ancestors, the modern theory is called the "out-of-Africa" hypothesis.

How can two such disparate views continue to co-exist? Why does not the data exclusively support one or the other? And why has the "hatrack" school shifted its focus from Europe to Africa? Three new D's--new dates, new data (fossil and archaeological) and new DNA studies--have combined to create a heightened level of argument over modern human origins.

DATING THE DATA

By 35,000 years ago, the shift to modern humans was virtually complete throughout Europe, Asia, Africa and even Australia. The most accurate dating technique for the later periods of archaeology, radiocarbon, gives good results back to about 35,000, but not much older. Some dates of 38 to 40,000 are acceptable, but dates in the 40,000 or older range are decidedly dubious. Most of the story of modern human origins lies beyond 40,000 years ago. Until recently, there were no reliable ways to determine the age of anything between 40,000 and 200,000 years ago.

Recently, however, a range of new techniques have come into general use for exactly the period when modern humans must have emerged, between 200,000 and 40,000 years ago. These techniques include: 1) measuring the accumulation of "radiation damage" from soil radiation in buried crystalline materials such as flints or quartz sands (thermoluminescence), 2) measuring the decay of uranium which soaks into buried bones and teeth from groundwater (uranium series), or radiation damage in the crystals of tooth enamel (electron spin resonance), and 3) studying the decay of the proteins encapsulated in hard tissues of fossil animals such as mollusc shells, bones, teeth, and ostrich eggshells (amino acid racemization).

Unlike radiocarbon, none of these techniques is entirely independent of the burial environment. Thermoluminescence and electron spin resonance dates can be thrown off by inaccurate measurement of the soil radiation or by heating or re-exposure of the sample before the archaeologist finds it. Protein decay rates are dependent on temperature, which is difficult to estimate for 40,000 to 200,000 years ago. And the uranium which soaks into bones and teeth can also wash out again. Using two different techniques to date the same site can help avoid these problems, at least when the two sets of results agree.

The effect of the new dating techniques has been to make many sites and fossils in Africa earlier than was previously thought. The European dates did not change quite as much, because the ebb and flow of ice ages had provided a chronology that tied most of the sites together, even in the absence of exact numbers.

Once the chronology of Africa was based on its own internal sequence of dates, comparative faunal extinctions, and climate changes, it became obvious that the earliest fossils in Africa with "chins" and small teeth were much older than the Cro-Magnons of Europe. In a paper given last spring on ostrich eggshell dates, I and my

colleagues suggested that several of the most important early African sites with modern humans (Klasies River Mouth and Border Cave) date to as much as 105,000 years ago or older. Modern human teeth at Mumba shelter in Tanzania were dated to ca. 130,000 years by uranium series.

Meanwhile new dates for Zhoukoudian (Peking Man sites), and other sites from China and Java suggest that east Asia was occupied exclusively by the more primitive species Homo erectus until about 300,000 years ago. The new Chinese fossils announced this year that supposedly represent a transition between erectus and sapiens do not show that this transition happened in China first, as several newspaper reports seemed to suggest. That the earliest modern humans were African seems quite well-established, although very few sites have been dated thus far.

In Europe, the principal effects of the new dates have been twofold. One is to demonstrate the great antiquity in Europe of the Neandertal-type long face, big nose, and flattened bulge at the back of the head. The oldest fossil now referred to as Neandertal (Le Biache, France) was discovered in 1976 and is about 190,000 years old, while older fossils (for example, Arago in the Pyrenees) with some Neandertal characteristics, date to the 300,000s or older. Secondly, newer, more precise radiocarbon dates from the end of Neandertal times, show that, in particular areas, the transition from Neandertal to Cro-Magnon was quite abrupt. A Neandertal from St. Cesaire in France, found in 1979, is about 35,000 years old, while the Cro-Magnon fossils probably date to at least 34,000, based on comparisons with the Pataud site next door. Such an abrupt transition does not leave enough time for evolution to have occurred in place. In addition, the oldest modern human fossils and archaeological sites of the Aurignacian culture of Cro-magnon are found in eastern Europe just before 40,000 years ago, while Neandertals still lived in the west, just what one would expect if modern humans invaded Europe from

Africa via the Near East. And in the Near East itself, modern humans from Qafzeh, in Israel, excavated in the 1960s, have been dated to ca. 92,000 years ago by thermoluminescence on burned flints, and a similar antiquity was suggested for at least some of these fossils by our work on ostrich eggshells.

One problem in the Near East remains the chronological relationship of the Qafzeh modern humans to Neandertals. What might explain Neandertal dominance of this region after a brief period of modern human occupation at 92,000 years? One possible answer lies in the tiny bones of birds, rodents and insectivores found with the human fossils. Earlier modern humans are accompanied by tropical African birds, mice, voles and so on, while later Neandertals are accompanied by cold-adapted animals from Eurasia.

If Neandertals were the cold-adapted archaics, and the earliest modern humans were tropical, this shifting pattern implies that the distribution of the two populations was originally limited by ecological considerations, and that the Near East represented a boundary zone that shifted as the world's climate changed. By 40,000 years ago, when modern humans returned to dominate the region, they seem to have invented a way to get around this ecological limitation. The animals found at the post-40,000 year-old modern human sites remain primarily cold-adapted.

THE 'AFRICAN EVE' HYPOTHESIS

That humans were "modern" in appearance in the tropics long before these characteristics appear in Europe seems confirmed by the new dates and data. But what is the relationship of the first modern humans in Africa to the later ones who occupied Europe after 35,000 years ago? This relationship is the hottest part of the current controversy.

In 1987, geneticist Rebecca Cann and colleagues proposed that a recent migration out of Africa within the last 200,000 years

had totally replaced all other human populations. None of the "archaic" East Asians, or the Neandertals of Europe had left any descendants at all. All modern humans share a recent African ancestor. The data used to support this hypothesis did not come from the fossil record, or from the dating lab, but from analysis of genetic differences among people living today.

The most common and abundant genetic material (DNA), which occurs in the nucleus of the cell, changes too slowly to measure recently evolved differences--even comparing humans to chimpanzees reveals a less than 1% difference between the two species. But mitochondria, small organelles within cells that are important in converting food to energy, contain a more rapidly changing form of DNA. Since sperm consist almost entirely of nuclear DNA and lack mitochondria, your mitochondria derive entirely from your mother via the ovum. A family tree of human genetic similarities, based on mitochondrial DNA (mtDNA), reflects only female ancestry, hence the "Eve" in the hypothesis.

This last common ancestor of all humans is thought to have been African because Africans are more variable in their DNA than the peoples of other continents, which suggests that they have been in place the longest. Furthermore, some genetic variants are unique to Africa, while all the variants on other continents are found in Africa as well. If Neandertals from Europe or Homo erectus from China contributed to our ancestry, where is their unique DNA?

What about "Adam"? A similar study was done on the genetics of the Y-chromosome, which appears to determine maleness but little else. Family trees based on similarities in genetic make-up of the Y-chromosome reflect only male ancestry, since women do not have one. The same pattern was observed--greater variability and unique patterns in African populations, but no unique patterns outside that continent. The

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most variable DNA in both studies belonged to the small isolated populations of hunter-gatherers in the Kalahari Desert (!Kung) and Zaire forest basin (Mbuti, Aka, Efe) respectively.

At first, the major debate was over possible errors or omissions in the sample (use of African-Americans instead of Africans, assuming little admixture in the maternal line) and the timing of the dispersal from Africa. Using the degree of differentiation developed within Australia and New Guinea (first colonized ca. 50-40,000 years ago), or among the populations of the Americas as a guide, it was estimated that human mtDNA diversifies from a common ancestor at a rate of 2-4% per million years. Since the total amount of difference observed in modern populations was only about 0.57%, this implies a time scale of 140-290,000 years since all humans last shared a common ancestor.

More recently, the family tree itself has been questioned on statistical grounds. Given enough time and repeated tries, the computer program used to generate the published family tree can also generate alternative trees in which Africa plays a diminished role. The genetic basis for total replacement of all previous human populations by the descendants of "African Eve" appears to be in doubt, although this does not negate the importance of the early fossil evidence from Africa.

ANCIENT AFRICANS, WHOSE ANCESTORS?

What was the relationship between the Neandertals or other archaics of regions outside Africa and their successors? Is there any evidence of population movement from Africa to Europe or east Asia? Did the invaders interbreed with the older populations of these areas, or did they simply wipe them out? Much of the argument hinges on current analyses of the fossils themselves. Three issues are central:

1) who were the Neandertals (and what "explains" their robust body form), 2) are there any intermediate fossils between Neandertals (or archaics) and modern humans, and 3) are there regional continuities in facial shape or teeth that continue across the transition from archaic/Neandertal to modern.

Up through the early 1970s, many scholars tended to lump Neandertals with other archaics as having modern brains and large primitive faces (and teeth). Western European Neandertals, whose faces were longer and more projecting, and whose elongated heads appeared to have an "occipital bun" of bone at the back, were simply more extreme than others. It was widely suggested that "if you gave a Neandertal a shave and a haircut [and a shopping trip to J.C. Penny], you wouldn't recognize him on the New York subway."

In the 1970's Erik Trinkaus began a lengthy study of Neandertals from a new perspective--below the neck. His study suggested very strongly that all Neandertals, including those from the Near East but not the archaics from tropical environments and east Asia, shared a common and very unusual "post-cranial" form. Their bones, even the fingers and toes, were extremely thick and bore heavy markings for the muscle attachments that could not be duplicated in modern samples of skeletons. The joint surfaces were sometimes twice as large as the modern human average. Discovery of a pelvis from Kebara, in Israel, suggested that the way the body was carried was quite different, as the spinal column was more deeply indented into the back than in ourselves. Yet, from the same site, a hyoid bone, which attaches to the voice box, suggested that the movement of the throat, tongue, and voice box in producing speech was similar to ours, despite the greater distance in Neandertals between the neck and the back of the throat.

In addition, Neandertals, like other cold-adapted animals, had very large deep chests and short lower arms and legs, to better

conserve body heat. New studies of the face suggested that the very long projecting face and huge, broad nose were distinctive; other large-faced archaics from Africa or East Asia had shorter, flatter faces, with more angulated cheek bones. The distinctions of Neandertals from other archaics appeared quite striking, and resulted in most scholars excluding fossils formerly grouped as "Neandertaloids" from this category. Neandertal morphology was peculiar: you would definitely notice it even on the N.Y. subway!

Are there any transitional fossils? In Africa, several fossils are intermediate between archaics and moderns. Even the early moderns themselves at Klasies River Mouth, for example, are described by Trinkaus as more robust in their limbs than Cro-Magnons of Europe. In Europe, the argument is very heated. Those who argue for interbreeding between Cro-Magnons and Neandertals (Wolpoff and Smith), or even for an indigenous evolution from Neandertals to Cro-Magnons (Brace), point to the less extreme characteristics of some later Neandertals, or to the presence of significant brow ridges and rugged large faces along with definite chins at modern human sites in central Europe.

Transitional or even archaic Homo sapiens fossils from Asia are quite rare; most of the best specimens from China have not been well-published in an accessible format. Regional continuities in Asia, however, are striking to proponents of the multiregional evolution theory (Wolpoff, Wu, Thorne, and Pope). If the earliest modern Asians came from Africa, why do the earliest ones we find already have the flat upper faces, and dental characteristics of Asians today? Why are the earlier archaic Asians also flat-faced? "Out of Africa" theorists (Stringer) argue that the flat faces and other features are either primitive features retained in that population, or simply adaptations to the cold dry Asian climate that are favored each time a new human population reaches the area.

REVOLUTION OR EVOLUTION?

In his recent book, *The Last Chimpanzee*, Jared Diamond argues that modern humans became fully modern in their behavior rather suddenly about 40,000 years ago. This "great leap forward" or "human revolution" is largely based on the perspective from Europe, where major changes in technology (blade and bone tools); economic strategies (ambush hunting, fishing); size of social networks; and symbolic activities (art) occurred over a few thousand years as the Cro-Magnons replaced the Neandertals.

The recovery of new sites, fossils and data dating to between 250,000 and 40,000 has accelerated since the 1960's. Even with the limited exploration of Africa to date, it seems that, like modern human facial shape, some of the modern behaviors of the "human revolution" appear well before 40,000 years ago in Africa. While the later Neandertals ran down their prey and stabbed it with sharpened sticks or an occasional stone-tipped spear, central and eastern Africans hafted small delicate stone points onto spear- or even arrow-shafts; made stone blades, backed triangles or crescents, barbed bone points, and other bone tools; engaged in regular fishing and ambush hunting; ground their food (and some pigments) with grindstones; scratched designs on ostrich eggshell fragments; and traded precious raw materials such as obsidian over more than 500 miles. Like the later Neandertals, the early modern humans also buried their dead with grave goods.

By 50-40,000 years ago, new data show that Africans wore beads of ostrich eggshell, and engaged in organized mining of precious raw materials. Elsewhere, modern humans had used boats to reach Australia, New Guinea, and New Caledonia, where rock art has been dated to 32,000 years ago. Outside of Europe, the "great leap forward" began earlier and was more like a slow jog, with occasional detours and backward movements.

BUT WERE THE CRO-MAGNONS AFRICAN?

Although modern humans appear to have developed earlier in Africa, physical anthropology and archaeology do not demonstrate migration of modern humans to Europe. Despite earlier claims for the fossils from Grimaldi, Italy, African characteristics such as nose shape and width, wide distance between the eyes, and forward projection of the mouth, do not occur in the early Europeans. Grimaldi itself is not only not "African" but is considerably later in time than the earliest modern Europeans--new dates suggest an age of less than 28,000 years. According to recent dates on archaeological sites, the Aurignacian culture of the Cro-magnons appears first in central and southeastern Europe, just before 40,000 BP, spreading to near Barcelona, Spain by ca. 38,000 and finally to France and Germany by 34,000. Southern Spain, near the straits of Gibraltar, is one of the last areas to make the transition from the Mousterian culture of Neandertals--archaeology does not suggest an invasion via this route. The big blades, thick scrapers, and bone points of the Aurignacian are quite unlike anything from the preceding Mousterian culture of Neandertals, so it was assumed that it came into Europe from outside. Yet there is nothing "outside" in this time range, either in the Near East or in north Africa, from which the Aurignacian can be derived. In much of Africa and the Near East, at ca. 40,000, the stone industries were characterized by finely-made small blades, many with narrow points created by blunting or battering the sides, or by small points with a tang or projection for hafting. The Aurignacian does show up in the Near East, but recent dates suggest that this is only after it is well-established in Europe, at about 34,000. The Near East may have been a migration corridor, but it was open in both directions.



CHEWING STRESS AND BROWRIDGES

CAN THIS CONTROVERSY BE RESOLVED?

The controversy over modern human origins is particularly heated because it concerns ourselves and our most recent history. The argument has been widely featured in the public media: *Time*, *Newsweek*, *The New York Times*, and at least two television specials on PBS. Unlike the controversy over earlier phases of human evolution, many of the voices expressed in these pieces are the voices of non-scientists, who argue that up to now, Eurocentric bias has suppressed recognition of our "true" heritage. While the discoveries of the past two decades have gone far towards demonstrating the priority of continents other than Europe in the evolution of modern humans, the data also suggest that this was not a simple event of evolution followed by migration in one direction. Replacement of earlier populations may not have been total. More and better dates and data, particularly from regions such as western Asia, Turkey and the Balkans, as well as Africa, may go far towards clarifying the complex interactions involved in this transition.

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Excellent discussions on this topic can be found in recent journals:

Discover - September '92.

Scientific American - April '92, October '91, December '90.

Science - February, 7, April 3, May 29, June 12, 1922; August 23, 1991; March 11, 1988.

U.S. News and World Report - September 16, '91.

A bibliography on human evolution is available from the Anthropology Outreach and Public Information Office, NHB MRC 112, Smithsonian Institution, Washington, DC 20560.

Alison S. Brooks