

Prehistoric Geography and Genetic Change in Evolving Humans

Alexander (1979:261 ff.) posed a question—not necessarily novel at the time-- that has nevertheless become more prominent since in the effort to understand how humans evolved:

" ... students of human evolution sometimes implicitly or explicitly assume that the human species and its cultural capacity and accoutrements evolved independently or in parallel in different parts of the world. Coon (1963) probably is the most explicit exponent of this view, which seems strange to biologists (and perhaps also to most social scientists) because of the exceedingly remote likelihood that the process of genetic change by mutation and selection could produce the same sets of genetic units independently in different localities. Rarely, however, have the alternatives to this biologically unlikely scenario been discussed. At another extreme the human species could have evolved in one locality and spread, replacing the existing forms (by definition in this model belonging to distinct species) without interbreeding with them. In this scenario all of the differences among modern human populations of different geographic origins would have resulted from divergences after the initial spread of the newly evolved human species.

"A model somewhere between these two extremes would have each major step in the transition from a prehuman species to a human one occurring in one locality but with the subsequent spread of the new form taking place with not only extensive dispersal but much interbreeding as it spread. This hypothesis, which seems to more parsimonious partly because of its flexibility, could include many successive waves of dispersing populations, sometimes interbreeding a great deal, sometimes little or not at all with the displaced forms. It could include a continuous genetic compatibility throughout the entire history of evolution from a prehuman or nonhuman ancestor to *Homo sapiens sapiens*, even if actual interbreeding did not always occur with contact and displacement. It could also mean that some sets of genes involved in the physical differences among human populations could have existed throughout human evolution, even though attributes like the capacity for culture and other aspects of our behavioral background were maintaining a much higher degree of uniformity across the globe. This last suggestion is not inconsistent with biological evolutionary theory, since it is quite possible that there has been a greater uniformity of the selective environment in regard to mental attributes than in regard to physical ones. Human mental attributes depend upon the social environment and are characterized by the development of a remarkably distinctive plasticity associated with neoteny and long juvenile life. On the other hand many physical attributes, such as skin color and various aspects of body build, have obviously been selected differently in different climates and do not necessarily involve great plasticity."

One reason this question has become more acute recently is that molecular genetic studies have led some investigators to postulate that modern humans are all descended from a relatively small population that existed in Africa about 200,000 years ago. This "Garden of Eden" model, which corresponds to the second one described above, has seemed to many to imply that modern humans derived all of their geographic differences from the last 200,000

years of evolution. If all mitochondrial DNA derives from a single woman who lived 200,000 years ago in Central Africa, then, say these people, ancient geographic differences among *Homo erectus* populations--- suggested by some physical anthropologists who have studied fossil remains (e.g. Milford Wolpoff; but not all, e.g. Chris Stringer) to parallel modern differences among Oriental, African, and European populations -- are unlikely to have played a role in modern differences among human populations with different geographic origins.

Because *Homo erectus* fossils indicate a distribution throughout the warmer parts of the Old World, from southern Africa north into Europe and eastward to China, for perhaps a million and a half years, the Garden of Eden model also implies that the modern humans that expanded outward from Africa 200,000 years ago completely displaced at least the female lines of mitochondrial DNA in other locales. This suggestion in turn has to some implied that the different forms were not conspecific, or could not interbreed, and thus seems to eliminate the "Shifting Balance" model favored by Alexander (1979) [who authored this model? Wolpoff?]. This implication seems at first demanded merely by the requirement of complete extinction of invaded lines (at least in the sense of female descendant lines), since nowhere on earth within recorded history has any endemic human population been eradicated without genetic contribution to the invading population.

How can the apparent contradictions be resolved? Do the molecular data really indicate what their reporters have assumed, or are they in fact compatible with a less radical model of human evolution

[Is this correct?: If one traces human ancestry backward, sooner or later a single individual of each sex will be identifiable as ancestral to all living humans. Any two such ancestors (i.e. of the two sexes) may have lived at the same time, but there is no particular reason to expect that to be the case. Moreover, universal ancestors of either sex may appear at different levels in the family trees of different individuals. The more intense the pressure of selection (the greater the differential in reproduction among different groups or families or individuals), the more recently universal ancestors are likely to have lived.]

First, tracing mitochondrial DNA, necessarily through uninterrupted female lines, does not necessarily describe either what proportions of the nuclear genetic materials in modern forms are attributable to any single ancestral female, or where those genetic materials may have originated. Thus, members of continuously female lines descended from a female who lived in Africa 200,000 years ago may have been parts of groups that progressed into the Orient or Europe and, by mating with males from those regions, absorbed significant proportions of the genetic materials characterizing the people of those regions and unlike those that characterized their ancestors in Africa. In this fashion *Homo erectus* features predating the common female ancestor in Africa could in fact retain their geographic distribution in modern humans. The problem in expecting this description to be accurate is that it requires that the mitochondrial DNA of the invading African line completely replace that of the resident populations, while allowing survival of local nuclear genes. It implies, in other words, that selection has either

been more intense or less geographically variant on mitochondrial genes than on nuclear genes. Perhaps it is not unlikely that there might have been changes in mitochondrial DNA that represented widespread or universal improvement, if mitochondrial DNA functions in a systemic way -- that is, if it is less frequently than (much or most) nuclear DNA involved in changes in the phenotype that directly affect the organism's success in particular external environments.

Ironically, it is a basic assumption of the students of phylogenies traced through mitochondrial DNA that it be selectively neutral. This assumption seems not to be based on any particular evidence, however, rather being made primarily because it is convenient if the data are to be used in dating phylogenetic events. If students of the fossil record who believe that racial differences are ancient (e.g., Milford Wolpoff, biological anthropologist from The University of Michigan), are correct, as contrasted with those who deny that such ancient differences are reflected in modern humans from these different regions (e.g., Chris Stringer, archaeologist from the British Museum), then the very argument of the molecular geneticists that a single female ancestor lived in Africa 200,000 years ago tends to negate their own assumption of neutrality in mitochondrial DNA. In a double irony, the resulting new model in turn removes the reason used to generate the 200,000 year date that caused much of the original controversy.

If the above argument is correct, it also implies that there is no particular reason to associate the mitochondrial DNA of a woman who lived in Africa 200,000 (or any particular number of) years ago with something thought of as "anatomically modern" humans. In other words, the nuclear genes of the woman in question could have been entirely those of anatomically ancient humans, or modern humans, or any combination. Independent evidence would have to be marshalled to answer this question. If there is no such evidence, then the change in mitochondrial DNA represented in the African female ancestor could have been no more than one of the minor (or major) genetic changes that, according to the "intermediate" model described by Alexander (1979) may have been flowing among the various populations that were slowly becoming "anatomically modern" as a result of the spread of changes from many different localities rather than a single one.

This hypothesis, then, postulates that if mitochondrial DNA changes independently of nuclear genes, and if the different forms of mitochondrial DNA have had adaptively different effects on their bearers, then the seeming incompatibility between models of human evolution devised by molecular biologists, under the label "Garden of Eden" models, and those devised by archaeological and biological anthropologists, under the label "Shifting Balance" models, may be eliminated.

[Note: This note was written as a result of listening to arguments in a Cambridge symposium in February 1987 on Origins and Dispersal of Modern Humans," reading the accounts of the symposium in *Science* magazine, reading some papers by molecular biologists, and listening to the tape put together by the BBC about the symposium. It is very incomplete, and may be wrong, and I need to re-read the mitochondrial DNA arguments before I know it is correct enough to be passed out widely. Presumably, this particular argument will be prominent in the

two volumes from the symposium, titled *The Human Revolution*, edited by Paul Mellars and Chris Stringer, and scheduled to be published simultaneously by the University of Edinburgh Press and the University of Chicago Press in the fall of 1988. I am not sure when the alternatives posed in *Darwinism and Human Affairs* were first elaborated, and I don't know what is the most appropriate reading to enable one to learn more on this topic.]

edited by D. Lahti, 9/5/2021