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THE DEMISE OF "MITOCHONDRIAL EVE"

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On the first day of 1987, a scientific "discovery" seized the attention of the popular press. The original scientific article that caused all the commotion—"Mitochondrial DNA and Human Evolution"—appeared in the January 1, 1987 issue of *Nature*, and was authored by Rebecca Cann, Mark Stoneking, and Allan C. Wilson (see Cann, et al., 1987). These three scientists announced that they had "proven" that all modern human beings can trace their ancestry back to a single woman who lived 200,000 years ago in Africa. This one woman was nicknamed "Eve" (a.k.a., "mitochondrial Eve")—much to the media's delight. An article in the January 26, 1987 issue of *Time* magazine bore the headline, "Everyone's Genealogical Mother: Biologists Speculate that 'Eve' Lived in Sub-Saharan Africa."

A word of explanation is in order. For decades, evolutionists had been trying to determine the specific geographical origin of humans—whether we all came from one specific locale, or whether there were many small pockets of people placed around the globe. When they set out to determine the specific geographical origin of humans, a curious piece of data came to light. As they considered various human populations, Africans seemed to show much more genetic variation than non-Africans (i.e., Asians, Europeans, Native Americans, Pacific Islanders, et al.). According to molecular biologists, this increased variability is the result of African populations being older, thus, having had more time to accumulate mutations and diverge from one another. This assumption led some researchers to postulate that Africa was the ancient "cradle of civilization" from which all of humanity had emerged.

The genetic material (DNA) in a cell's nucleus controls the functions of the cell, bringing in nutrients from the body and making hormones, proteins, and other chemicals. Outside the nucleus is an area known as the cytoplasmic matrix (generally referred to simply as the cytoplasm), which contains, among other things, tiny bean-shaped organelles known as mitochondria. These often are described as the "energy factories" of the cell.

Mitochondria contain their own DNA, which they use to make certain proteins; the DNA in the nucleus oversees production of the rest of the proteins necessary for life and its functions. However, mitochondrial DNA (mtDNA) was thought to be special for two reasons. First, it is short and relatively simple in comparison to the DNA found within the nucleus, containing only thirty-seven genes instead of the 70,000+ genes located in the nuclear DNA. This makes it relatively easy to analyze. Second, unlike nuclear DNA, which each person inherits in a jumbled form from both parents, mitochondrial DNA was thought to be passed on only through the mother's line (more about this later). Working from the assumption that mtDNA is passed to the progeny only by the mother, Dr. Cann and her coworkers believed that each new cell should contain copies of only the egg's mitochondria. In trying to draw the human family tree, therefore, researchers took a special interest in these minute strands of genetic code. What they **really** were interested in, of course, was the variations in mitochondrial DNA from one group of people to another.

Although our mtDNA should be, in theory at least, the same as our mother's mtDNA, small changes or mutations in the genetic code can, and do, arise. On rare occasions, mutations are serious enough to do harm. More frequently, however, the mutations have no effect on the proper functioning of either the DNA or the mitochondria. In such cases, the mutational changes will be preserved and carried on to succeeding generations.

Theoretically, if scientists could look farther and farther into the past, they would find that the number of women who contributed the modern varieties of mitochondrial DNA gets less and less until, finally, we arrive at one "original" mother. She, then, would be the only woman out of all the women living in her day to have a daughter in every generation till the present. Coming forward in time, we would see that the mtDNA varieties found within her female contemporaries were gradually eliminated as their daughters did not have children, had only sons, or had daughters who did not have daughters. This does not mean, of course, that we would **look like** this alleged ancestral mother; rather, it means only that we would have gotten our mitochondrial DNA from her.

To find this woman, researchers compared the different varieties of mtDNA in the human family. Since mtDNA occurs in fairly small quantities, and since the researchers wanted as large a sample as possible from each person, they decided to use human placentas as their source of the mtDNA. So, Rebecca Cann and her colleagues selected 145 pregnant women and two cell lines representing the five major geographic regions: 20 Africans, 34 Asians, 46 Caucasians, 21 aboriginal Australians, and 26 aboriginal New Guineans (Cann, et al., 1987, 325:32). Only two of the 20 Africans were born in Africa.

After analyzing a portion of the mtDNA in the cells of each placenta, they found that the differences "grouped" the samples by region. In other words, Asians were more like each other than they were like Europeans, people from New Guinea were more like each other than they were like people from Australia, and so on.

Next, they saw two major branches from in their computer-generated tree of recent human evolution. Seven African individuals formed one distinct branch, which started lower on the trunk than the other four. This was because the differences among these individuals were much greater than the differences between other individuals and other groups. More differences mean more mutations, and hence more time to accumulate those changes. If the Africans have more differences, then their lineage must be older than all the others. The second major branch bore the non-African groups and, significantly, a scattering of the remaining thirteen Africans in the sample. To the researchers, the presence of Africans among non-Africans meant an African common ancestor for the non-African branches, which, likewise, meant an African common ancestor for both branches. The nickname "Eve" stuck to this hypothetical common ancestral mother, and later, then, fired the media's imagination.

Having concluded that the African group was the oldest, Dr. Cann and her colleagues wanted to find out just **how** old the group might be. To do this, they used what is known as a "molecular clock" that, in this case, was based on mutations in the mtDNA. The rate at which the clock ticked was determined from the accumulation of changes over a given period of time. If the assumption was made that there was one mutation every 1,000 years, and if scientists found a difference of 10 mutations between us and our ancient hypothetical ancestor, they then could infer that that ancestor lived 10,000 years ago.

The results obtained from analysis of mitochondrial DNA eventually led to what is known in evolutionary circles as the "Out of Africa" theory. This is the idea that the descendants of mitochondrial Eve were the only ones to colonize Africa and the rest of the world, supplanting all other hominid populations in the process.

THE DEMISE OF MITOCHONDRIAL EVE

Things change rapidly in science. What is popular one day, is not the next. Theories come, and theories go. And so it is with mitochondrial Eve. She once was in vogue as "the woman of the moment," so to speak. Now, she has become virtually the "crazy aunt in the attic" that no one wants to admit exists.

But it was not forbidden fruit that caused her demise this time around. The "passing" of one of evolution's most familiar icons is due to new scientific facts that have surfaced since her introduction in 1987. **If** humans received mitochondrial DNA (mtDNA) only from their mothers, then researchers could "map" a family tree using that information. And, **if** the mutations affecting mtDNA had indeed occurred at constant rates, then the mtDNA could serve as a molecular clock for timing evolutionary events and reconstructing the evolutionary history of extant species. It is the "ifs" in these two sentences that are the problem.

Mitochondrial Eve is alleged to have lived in Africa at the beginning of the Upper Pleistocene period (between 100,000 and 200,000 years ago). She has been described as the most-recent common ancestor of all humans on Earth today, with respect to matrilineal descent. The validity of these assertions, however, is dependent upon two critically important assumptions: (1) that mtDNA is, in fact, derived exclusively from the mother; and (2) that the mutation rates associated with mtDNA have remained constant over time. However, **we now know that both of these assumptions are wrong!**

First, let us examine the assumption that mtDNA is derived solely from the mother. In response to a paper that appeared in *Science* in 1999, anthropologist Henry Harpending of the University of Utah lamented: "There is a cottage industry of making gene trees in anthropology and then interpreting them. This paper will invalidate most of that" (as quoted in Strauss, 1999, 286:2436). Just as women thought they were getting their fair shake in science, the tables turned. As one study noted:

> Women have struggled to gain equality in society, but biologists have long thought that females wield absolute power in a sphere far from the public eye: in the mitochondria.... [A] study by Philip Awadalla of the University of Edinburgh and Adam Eyre-Walker and John Maynard Smith of the University of Sussex in Brighton, U.K. finds signs of mixing between maternal and paternal mitochondrial DNA (mtDNA) in humans and chimpanzees. **Because biologists have used mtDNA as a tool to trace human ancestry and relationships, the finding has implications for everything from the identification of bodies to the existence of a "mitochondrial Eve"** 200,000 years ago (Strauss, 286:2436, emp. added).

One year later, researchers made this startling admission:

> Mitochondrial DNA (mtDNA) is generally assumed to be inherited exclusively from the mother…. Several recent papers, however, have suggested that elements of mtDNA may sometimes be inherited from the father. This hypothesis is based on evidence that mtDNA may undergo recombination. If this does occur, maternal mtDNA in the egg must cross over with homologous sequences in a different DNA molecule; paternal mtDNA seems the most likely candidate…. **If mtDNA can recombine, irrespective of the mechanism, there are important implications for mtDNA evolution and for phylogenetic studies that use mtDNA** (Morris and Mightowlers, 2000, 355:1290, emp. added).

In 2002, a study was conducted that concluded:

> Nevertheless, even a single validated example of paternal mtDNA transmission suggests that the interpretation of inheritance patterns in other kindreds thought to have mitochondrial disease should not be based on the dogmatic assumption of absolute maternal inheritance of mtDNA…. The unusual case described by Schwartz and Vissing **is more than a mere curiosity** (Williams, 2002, 347:611, emp. added).

And now we know that these are more than small "fractional" amounts of mtDNA coming from fathers. The August 2002 issue of the *New England Journal of Medicine* contained the results of one study, which concluded:

> Mammalian mitochondrial DNA (mtDNA) is thought to be strictly maternally inherited…. Very small amounts of paternally inherited mtDNA have been detected by the polymerase chain reaction (PCR) in mice after several generations of interspecific backcrosses…. We report the case of a 28-year-old man with mitochondrial myopathy due to a novel 2-bp mtDNA deletion…. We determined that the mtDNA harboring the mutation was paternal in origin and accounted for **90 percent** of the patient's muscle mtDNA (Schwartz and Vissing, 2002, 347:576, emp. added).

Ninety percent! And all this time, evolutionists have been selectively shaping our family tree using what was alleged to be only **maternal** mtDNA!

As scientists have begun to comprehend the fact, and significance, of the "death" of mitochondrial Eve, many have found themselves searching for alternatives that can help them maintain their current beliefs regarding human origins. But this recombination ability in mtDNA makes the entire discussion a moot point. As Strauss noted:

> Such recombination could be a blow for researchers who have used mtDNA to trace human evolutionary history and migrations. They have assumed that the mtDNA descends only through the mother, so they could draw a single evolutionary tree of maternal descent—all the way back to an African "mitochondrial Eve," for example. But "with recombination there is no single tree," notes Harpending... Thus, **"there's not one woman to whom we can trace our mitochondria,"** says Eyre-Walker (1999, 286:2436, emp. added).

Our thoughts on the matter exactly.

We now know that the two key assumptions behind the data used to establish the existence of "mitochondrial Eve" are **not just flawed, but wrong**. The assumption that mitochondrial DNA is passed down only by the mother is completely incorrect (it also can be passed on by the father). And, the mutation rates used so calibrate the so-called "molecular clock" are now known to have been in error. (To use the words of Rodriguez-Trelles and his co-workers, the method contains a "fundamental flaw.")

Rather than merely reconsidering the "Mitochondrial Eve" theory and attempting to revamp it accordingly, evolutionists need to admit, honestly and forthrightly, that "mitochondrial Eve," as it turns out, has existed only in their minds, not in the facts of the real world. Science works by analyzing the data and forming hypotheses based on those data. Science is not supposed to massage the data until they fit a certain preconceived hypothesis. All of the conclusions that have been drawn from research on mitochondrial Eve via the molecular clock must now be discarded as unreliable. A funeral and interment are in order for mitochondrial Eve.

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