

The death of Eve

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By Graeme O'Neill

A new analysis of modern human DNA has blown a hole in the theory that we all trace our origins back to a common African matriarch. As Graeme O'Neill finds, we might be better off if we see a briar patch where our family tree once stood.

A death in the family is a sombre occasion, but Australian National University anthropologist Alan Thorne must have been tempted to break out the champagne this week as a DNA study pronounced the last rites over "African Eve", the supposed matriarch of modern humankind. Geneticists from the University of California made international headlines in 1987 when they announced a new type of "archaeology with genes" had traced the origins of modern humans to a hypothetical female who lived in East Africa some 200,000 years ago. Almost overnight, "African Eve" became the dominant theoretical model for modern human origins.

But a new analysis of modern human DNA, published in this week's *Nature*, gives a very different account of the origins of modern humans and breathes new life into some old skeletons that Eve's proponents banished to the family closet.

Washington University biologist Alan Templeton presents the results of a much broader-based analysis of human DNA that strongly supports Alan Thorne's 25-year-old thesis that modern humans evolved more or less simultaneously from archaic populations in Africa, Europe, Eurasia and South-East Asia.

According to the "regional continuity" hypothesis of Thorne and long-time collaborator Professor Milford Wolpoff, of the University of Michigan, far-flung human populations in Africa, Europe and Asia have been exchanging genes for at least a million years, a process that proceeds apace today. In his paper, *Out of Africa, Again and Again*, Templeton reaffirms Africa's dominant role in shaping the human gene pool.

But he presents evidence for not one, but at least two major expansions out of Africa since an original *Homo erectus* diaspora nearly two million years ago established regional populations of archaic humans in distant regions of the Old World. Templeton's new analysis undermines the central pillar of the "Eve" hypothesis: that her new-wave descendants completely replaced earlier human populations when they came into contact without interbreeding with them.

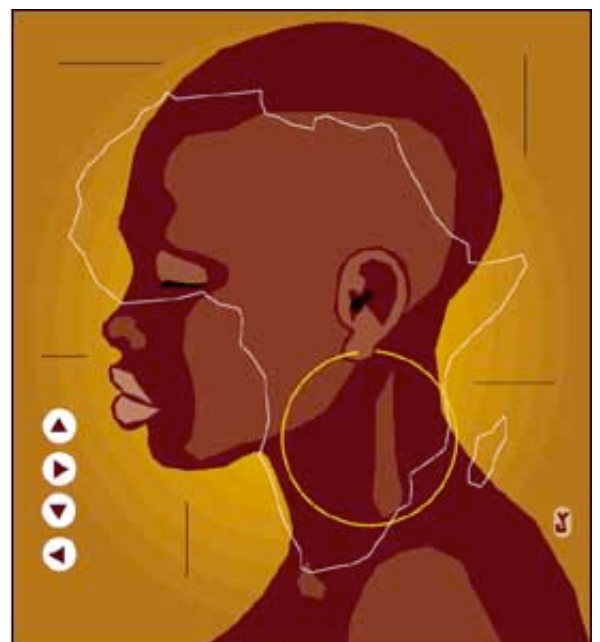
"These early people supposedly went extinct because nobody wanted to have sex with them," says Thorne. "It just misses the basic point about human behaviour – whether we're black, white or brown, humans are into gene flow."

Templeton says gene flow has occurred by two mechanisms that Thorne described 25 years ago: the slow diffusion of genes over great distance, through tenuous contact at the edges of widely separated human populations, and at least two major population expansion events that resulted in interbreeding, not replacement. Templeton's conclusions present the most serious challenge yet to the "Eve" model of modern human origins.

When the late professor Alan Wilson and colleagues Dr Rebecca Cann and Dr Mark Stoneking published the first DNA-based family tree of modern humans in *Nature* in 1987, their analysis was based solely on human mitochondrial DNA (mtDNA). They ignored a potentially far more informative evolutionary history imprinted upon the 35,000-odd genes of the cell nucleus. Mitochondria are tiny structures that power cells. They carry a set of genes on a small loop of DNA that has a unique, maternal mode of inheritance. Children inherit a unique mix of their mother's and father's nuclear genes, but carry their mother's mtDNA signature; paternal mtDNA is lost at conception.

Mitochondrial genes are passed down through the female line, unmixed and unchanged except by occasional mutation – they are inherited, in effect, as one huge gene. Similarly, fathers bequeath the few genes on the male Y-chromosome *en bloc* to sons. Last year, a study of the Y-chromosomes of a globally representative sample of 1062 males pointed to a recent African origin for modern humans.

Too recent, in fact. "African Adam", putative patriarch of modern mankind, lived about 50,000 years too late to do any begetting with Eve. "African Adam" offered a cautionary tale about the risks of drawing sweeping conclusions about modern human origins from one-dimensional



Thorne and Wolpoff have long argued that a more thorough analysis of human nuclear genes would support their regional continuity hypothesis. Templeton has now delivered. In theory, almost every gene in the nucleus can tell its own evolutionary tale. Human family trees based on other genes or segments of chromosomes have proliferated in the past decade – eight of them figure in Templeton's latest analysis, which also incorporates the mtDNA and Y-chromosome "trees".

Ninety per cent of these analyses point to an African origin for modern humans – but not necessarily a *recent* African origin. One of the genes Templeton selected for analysis, the beta-globin gene, yields a family tree rooted in south-eastern China more than half a million years ago. If it came from Peking Man's descendants, it would refute the proposition that Eve's descendants extirpated resident human populations as they swept through the Old World.

While not dependent on the human fossil record, Templeton's conclusions are in reassuring accord with it. Fossils show that human cranial capacity increased quite slowly until about 700,000 years ago but increased substantially throughout the Old World between about 500,000 and 400,000 years ago. Templeton's genetic evidence places the first new wave of African emigres at about 600,000 years, some 1.1 million years after *H. erectus* left Africa.

About 130,000 years ago humans in Africa begin to exhibit modern anatomical features such as high, rounded skulls, small brow ridges, a vertical forehead and face, and a noticeable chin. By 90,000 years ago – coincident with Templeton's "second wave" 95,000 years ago – these features began appearing outside Africa. Thorne and his supporters have long contended the modern human family tree is more like a briar thicket, tangled in root and branch, and much older and broader than the "African Eve" theory allows.

They believe humans are a rare example of something biologists call "reticulate evolution". Normally populations of a species that become geographically separated diverge and become new species. But continuing gene flow where the branches touch has maintained humans as a single, anatomically diverse species – in genetic terms, what goes around, comes around.

On fossil, DNA and modern anatomical evidence, Thorne and his supporters argue that modern humans evolved in multiple centres throughout the Old World, from populations founded by the original *H. erectus* diaspora. Thorne first aired his ideas at a human evolution conference in Europe in 1977 in a paper titled *Centre and Edge*. Wolpoff, in the audience, was intrigued.

He offered an explanation for an apparent paradox in the relatively recent human fossil record. In widely separated regions of the Old World, early humans developed distinctive features as they adapted to local environments. Then, almost synchronously, they began to exhibit the "modern" anatomical traits that Templeton describes. Thorne believes the explanation lies in a dynamic balance between two mechanisms.

Intense selection pressure for increased brain capacity, intelligence, memory and language would cause "hot" new variants of genes influencing these traits to diffuse rapidly through the Old World via contact around the edges of populations. But at their centres, these populations had sufficient genetic mass to retain other, locally adaptive features. As they converged towards modernity, they developed distinctive physical traits that are still evident in the world's modern people.

The first popular article on Thorne's ideas, published in *The Bulletin* in November 1982, described how spectacular fossil discoveries in Australia in the late 1960s and 1970s convinced him that Australian Aborigines represented a fusion of two ancient human lineages from Asia.

Striking anatomical similarities convinced Thorne that his "gracile" race, typified by a slender, thin-skulled male skeleton, LM3, discovered at Lake Mungo in 1974, had come out of China – which makes LM3 a descendant of "Peking Man". Thorne's "robust" race, heavily boned with a massive skull and large brow ridges, is typified by skeletons he found at Kow Swamp in north-western Victoria in the early 1970s. They bear striking resemblance to the extinct Solo people of Java – the modern heirs of "Java Man".

In 2000, new dating techniques revealed the LM3 skeleton from Lake Mungo was at least 50,000 years old and last year ANU researcher Dr Greg Adcock announced that ancient DNA recovered from LM3's bones had yielded an mtDNA signature pre-dating Eve's. The discovery challenged Eve's proponents to explain how a pre-Eve mtDNA found its way into an anatomically modern human much younger than Eve.

Professor Chris Stringer, of the British Museum, the chief advocate of a recent, African origin for humans, concedes that the Templeton paper marks a "significant advance in discussions of the genetics from opponents of the classic Out of Africa models". However, he argues that the "old" nuclear gene variants that Templeton believes originated outside Africa could just as easily have arisen in Africa and been exported by Eve's descendants in recent times.

Templeton has come down on Thorne's side. If he is right, the descendants of Peking Man, Java Man and Europe's Neanderthals were not obliterated as Eve's thoroughly modern African *wunderkinder* spread around the globe. They survived to make their own contributions to the modern human gene pool: they live in suburbia, drive BMWs and Toyotas, wear business suits and communicate by mobile phone – they are we.