

MITOCHONDRIAL EVE

by Greg Egan

===

© Greg Egan, 1999

First published in /Interzone/ #92, February 1995

www.fictionwise.com

===

Thanks to Caroline Oakley, Anthony Cheetham, John Douglas, Peter Robinson, Kate Messenger, Philip Patterson, Tony Gardner, Russ Galen, David Pringle, Lee Montgomerie, Gardner Dozois, Sheila Williams, and Bill Congreve.

===

With hindsight, I can date the beginning of my involvement in the Ancestor Wars precisely: /Saturday, June 2, 2007/. That was the night Lena dragged me along to the Children of Eve to be mitotyped. We'd been out to dinner, it was almost midnight, but the sequencing bureau was open 24 hours.

"Don't you want to discover your place in the human family?" she asked, fixing her green eyes on me, smiling but earnest. "Don't you want to find out exactly where you belong on the Great Tree?"

The honest answer would have been: /What sane person could possibly care?/ We'd only known each other for five or six weeks, though; I wasn't yet comfortable enough with our relationship to be so blunt.

"It's very late," I said cautiously. "And you know I have to work tomorrow." I was still fighting my way up through post-doctoral qualifications in physics, supporting myself by tutoring undergraduates and doing all the tedious menial tasks which tenured academics demanded of their slaves. Lena was a communications engineer - and at 25, the same age as I was, she'd had real paid jobs for almost four years.

"You always have to work. Come on, Paul! It'll take fifteen minutes."

Arguing the point would have taken twice as long. So I told myself that it could do no harm, and I followed her north through the gleaming city streets.

It was a mild winter night; the rain had stopped, the air was still. The Children owned a sleek, imposing building in the heart of Sydney, prime real estate, an ostentatious display of the movement's wealth. ONE WORLD, ONE FAMILY proclaimed the luminous sign above the entrance. There were bureaus in over a hundred cities (although Eve took on various 'culturally appropriate' names in different places, from Sakti in parts of India, to Ele'ele in Samoa) and I'd heard that the Children were working on street-corner vending-machine sequencers, to recruit members even more widely.

In the foyer, a holographic bust of Mitochondrial Eve herself, mounted on a marble pedestal, gazed proudly over our heads. The artist had rendered our hypothetical ten-thousand-times-great grandmother as a strikingly beautiful

woman. A subjective judgement, certainly - but her lean, symmetrical features, her radiant health, her purposeful stare, didn't really strike me as amenable to subtleties of interpretation. The aesthetic buttons being pushed were labelled, unmistakably: /warrior/, /queen/, /goddess/. And I had to admit that I felt a certain bizarre, involuntary swelling of pride at the sight of her... as if her regal bearing and fierce eyes somehow 'ennobled' me and all her descendants... as if the 'character' of the entire species, our potential for virtue, somehow depended on having at least one ancestor who could have starred in a Leni Riefenstahl documentary.

This Eve was black, of course, having lived in sub-Saharan Africa some 200,000 years ago - but almost everything else about her was guesswork. I'd heard palaeontologists quibble about the too-modern features, not really compatible with any of the sparse fossil evidence for her contemporaries' appearance. Still, if the Children had chosen as their symbol of universal humanity a few fissured brown skull fragments from the Omo River in Ethiopia, the movement would surely have vanished without a trace. And perhaps it was simply mean-spirited of me to think of their Eve's beauty as a sign of fascism. The Children had already persuaded over two million people to acknowledge, explicitly, a common ancestry which transcended their own superficial differences in appearance; this all-inclusive ethos seemed to undercut any argument linking their obsession with /pedigree/ to anything unsavoury.

I turned to Lena. "You know the Mormons baptised her posthumously, last year?"

She shrugged the appropriation off lightly. "Who cares? This Eve belongs to everyone, equally. Every culture, every religion, every philosophy. Anyone can claim her as their own; it doesn't diminish her at all." She regarded the bust admiringly, almost reverently.

I thought: /She sat through four hours of Marx Brothers films with me last week - bored witless, but uncomplaining. So I can do this for her, can't I?/ It seemed like a simple matter of give and take - and it wasn't as if I was being pressured into an embarrassing haircut, or a tattoo.

We walked through into the sequencing lounge.

We were alone, but a disembodied voice broke through the ambience of endangered amphibians and asked us to wait. The room was plushly carpeted, with a circular sofa in the middle. Artwork from around the world decorated the walls, from an uncredited Arnhem Land dot painting to a Francis Bacon print. The explanatory text below was a worry: dire Jungian psychobabble about 'universal primal imagery' and 'the collective unconscious'. I groaned aloud - but when Lena asked what was wrong, I just shook my head innocently.

A man in white trousers and a short white tunic emerged from a camouflaged door, wheeling a trolley packed with impressively minimalist equipment, reminiscent of expensive Scandinavian audio gear. He greeted us both as 'cousin', and I struggled to keep a straight face. The badge on his tunic bore his name, Cousin André, a small reflection hologram of Eve, and a sequence of letters and numbers which identified his mitotype. Lena took charge, explaining that she was a member, and she'd brought me along to be sequenced.

After paying the fee - a hundred dollars, blowing my recreation budget for the next three months - I let Cousin André prick my thumb and squeeze a drop of blood onto a white absorbent pad, which he fed into one of the machines on the trolley. A sequence of delicate whirring sounds ensued, conveying a reassuring sense of precision engineering at work. Which was odd, because I'd

seen ads for similar devices in /Nature/ which boasted of no moving parts at all.

While we waited for the results, the room dimmed and a large hologram appeared, projected from the wall in front of us: a micrograph of a single living cell. /From my own blood?/ More likely, not from anyone's - just a convincing photorealistic animation.

"Every cell in your body," Cousin André explained, "contains hundreds or thousands of mitochondria: tiny power plants which extract energy from carbohydrates." The image zoomed in on a translucent organelle, rod-shaped with rounded ends - rather like a drug capsule. "The majority of the DNA in any cell is in the nucleus, and comes from both parents - but there's also DNA in the mitochondria, inherited from the mother alone. So it's easier to use mitochondrial DNA to trace your ancestry."

He didn't elaborate, but I'd heard the theory in full several times, starting with high school biology. Thanks to recombination - the random interchange of stretches of DNA between paired chromosomes, in the lead-up to the creation of sperm or ova - every chromosome carried genes from tens of thousands of different ancestors, stitched together seamlessly. From a palaeogenetic perspective, analysing nuclear DNA was like trying to make sense of 'fossils' which had been forged by cementing together assorted bone fragments from ten thousand different individuals.

Mitochondrial DNA came, not in paired chromosomes, but in tiny loops called plasmids. There were hundreds of plasmids in every cell, but they were all identical, and they all derived from the ovum alone. Mutations aside - one every 4,000 years or so - your mitochondrial DNA was exactly the same as that of your mother, your maternal grandmother, great-grandmother, and so on. It was also exactly the same as that of your siblings, your maternal first cousins, second cousins, third cousins... until different mutations striking the plasmid on its way down through something like 200 generations finally imposed some variation. But with 16,000 DNA base pairs in the plasmid, even the 50 or so point mutations since Eve herself didn't amount to much.

The hologram dissolved from the micrograph into a multicoloured diagram of branching lines, a giant family tree starting from a single apex labelled with the ubiquitous image of Eve. Each fork in the tree marked a mutation, splitting Eve's inheritance into two slightly different versions. At the bottom, the tips of the hundreds of branches showed a variety of faces, some men, some women - individuals or composites, I couldn't say, but each one presumably represented a different group of (roughly) 200th maternal cousins, all sharing a mitotype: their own modest variation on the common 200,000-year-old theme.

"And here you are," said Cousin André. A stylised magnifying glass materialised in the foreground of the hologram, enlarging one of the tiny faces at the bottom of the tree. The uncanny resemblance to my own features was almost certainly due to a snapshot taken by a hidden camera; mitochondrial DNA had no effect whatsoever on appearance.

Lena reached into the hologram and began to trace my descent with one fingertip. "You're a Child of Eve, Paul. You know who you are, now. And no-one can ever take that away from you." I stared at the luminous tree, and felt a chill at the base of my spine - though it had more to do with the Children's proprietary claim over the entire species than any kind of awe in the presence of my ancestors.

Eve had been nothing special, no watershed in evolution; she was simply

defined as the most recent common ancestor, by an unbroken female line, of every single living human. And no doubt she'd had thousands of female contemporaries, but time and chance - the random death of daughterless women, catastrophes of disease and climate - had eliminated every mitochondrial trace of them. There was no need to assume that her mitotype had conferred any special advantages (most variation was in junk DNA, anyway); statistical fluctuations alone meant that one maternal lineage would replace all the others, eventually.

Eve's existence was a logical necessity: some human (or hominid) of one era or another had to fit the bill. It was only the timing which was contentious.

The timing, and its implications.

A world globe some two metres wide appeared beside the Great Tree; it had a distinctive Earth-from-space look, with heavy white cumulus swirling over the oceans, but the sky above the continents was uniformly cloudless. The Tree quivered and began to rearrange itself, converting its original rectilinear form into something much more misshapen and organic - but flexing its geometry without altering any of the relationships it embodied. Then it draped itself over the surface of the globe. Lines of descent became migratory routes. Between eastern Africa and the Levant, the tracks were tightly bunched and parallel, like the lanes of some Palaeolithic freeway; elsewhere, less constrained by the geography, they radiated out in all directions.

A recent Eve favoured the 'Out of Africa' hypothesis: modern /Homo sapiens/ had evolved from the earlier /Homo erectus/ in one place only, and had then migrated throughout the world, out-competing and replacing the local /Homo erectus/ everywhere they went - and developing localised racial characteristics only within the last 200,000 years. The single birthplace of the species was most likely Africa, because Africans showed the greatest (and hence oldest) mitochondrial variation; all other groups seemed to have diversified more recently from relatively small 'founder' populations.

There were rival theories, of course. More than a million years before /Homo sapiens/ even existed, /Homo erectus/ itself had spread as far as Java, acquiring its own regional differences in appearance - and /Homo erectus/ fossils in Asia and Europe seemed to share at least some of the distinguishing characteristics of living Asians and Europeans. But 'Out of Africa' put that down to convergent evolution, not ancestry. If /Homo erectus/ had turned into /Homo sapiens/ independently in several places, then the mitochondrial difference between, say, modern Ethiopians and Javanese should have been five or ten times as great, marking their long separation since a much earlier Eve. And even if the scattered /Homo erectus/ communities had not been totally isolated, but had interbred with successive waves of migrants over the past one or two million years - hybridising with them to create modern humans, and yet somehow retaining their distinctive differences - then distinct mitochondrial lineages much older than 200,000 years probably should have survived, too.

One route on the globe flashed brighter than the rest. Cousin André explained, "This is the path your own ancestors took. They left Ethiopia - or maybe Kenya or Tanzania - heading north, about 150,000 years ago. They spread slowly up through Sudan, Egypt, Israel, Palestine, Syria and Turkey while the interglacial stretched on. By the start of the last Ice Age, the eastern shore of the Black Sea was their home..." As he spoke, tiny pairs of footprints materialised along the route.

He traced the hypothetical migration through the Caucasus Mountains, and all the way to northern Europe - where the limits of the technique finally cut the

story dead: some four millennia ago (give or take three), when my Germanic two-hundredish-great grandmother had given birth to a daughter with a single change in her mitochondrial junk DNA: the last recorded tick of the molecular clock.

Cousin André wasn't finished with me, though. "As your ancestors moved into Europe, their relative genetic isolation, and the demands of the local climate, gradually led them to acquire the characteristics which are known as Caucasian. But the same route was travelled many times, by wave after wave of migrants, sometimes separated by thousands of years. And though, at every step along the way, the new travellers interbred with those who'd gone before, and came to resemble them... dozens of separate maternal lines can still be traced back along the route - and then down through history again, along different paths."

My very closest maternal cousins, he explained - those with exactly the same mitotype - were, not surprisingly, mostly Caucasians. And expanding the circle to include up to 30 base pair differences brought in about 5 per cent of all Caucasians - the 5 per cent with whom I shared a common maternal ancestor who'd lived some 120,000 years ago, probably in the Levant.

But a number of that woman's own cousins had apparently headed east, not north. Eventually, their descendants had made it all the way across Asia, down through Indochina, and then south through the archipelagos, travelling across land bridges exposed by the low ocean levels of the Ice Age, or making short sea voyages from island to island. They'd stopped just short of Australia.

So I was more closely related, maternally, to a small group of New Guinean highlanders than I was to 95 per cent of Caucasians. The magnifying glass reappeared beside the globe, and showed me the face of one of my living 6000th cousins. The two of us were about as dissimilar to the naked eye as any two people on Earth; of the handful of nuclear genes which coded for attributes like pigmentation and facial bone structure, one set had been favoured in frozen northern Europe, and another in this equatorial jungle. But enough mitochondrial evidence had survived in both places to reveal that the local homogenisation of appearance was just a veneer, a recent gloss over an ancient network of invisible family connections.

Lena turned to me triumphantly. "You see? All the old myths about race, culture, and kinship - instantly refuted! These people's immediate ancestors lived in isolation for thousands of years, and didn't set eyes on a single white face until the twentieth century. Yet they're nearer to you than I am!"

I nodded, smiling, trying to share her enthusiasm. It /was/ fascinating to see the whole naïve concept of 'race' turned inside out like this - and I had to admire the Children's sheer audacity at claiming to be able to map hundred-thousand-year-old relationships with such precision. But I couldn't honestly say that my life had been transformed by the revelation that certain white total strangers were more distant cousins to me than certain black ones. Maybe there were die-hard racists who would have been shaken to the core by news like this... but it was hard to imagine them rushing along to the Children of Eve to be mitotyped.

The far end of the trolley beeped, and ejected a badge just like Cousin André's. He offered it to me; when I hesitated, Lena took it and pinned it proudly to my shirt.

Out on the street, Lena announced soberly, "Eve is going to change the world. We're lucky; we'll live to see it happen. We've had a century of people being

slaughtered for belonging to the wrong kinship groups - but soon, /everyone/ will understand that there are older, deeper blood ties which confound all their shallow historical prejudices."

/You mean... like the Biblical Eve confounded all the prejudices of fundamentalist Christians? Or like the image of the Earth from space put an end to war and pollution?/ I tried diplomatic silence; Lena regarded me with consternation, as if she couldn't quite believe that I could harbour any doubts after my own unexpected /blood ties/ had been revealed.

I said, "Do you remember the Rwandan massacres?"

"Of course."

"Weren't they more to do with a class system - which the Belgian colonists exacerbated for the sake of administrative convenience - than anything you could describe as enmity between /kinship groups/? And in the Balkans -"

Lena cut me off. "Look, sure, any incident you can point to will have a convoluted history. I'm not denying that. But it doesn't mean that the solution has to be impossibly complicated, too. And if everyone involved had known what we know, had /felt/ what we've felt -" she closed her eyes and smiled radiantly, an expression of pure contentment and tranquillity "- that deep sense of belonging, through Eve, to a single family which encompasses all of humanity... do you honestly imagine that they could have turned on each other like that?"

I should have protested, in tones of bewilderment: /What 'deep sense of belonging'? I felt nothing. And the only thing the Children of Eve are doing is preaching to the converted./

What was the worst that could have happened? If we'd broken up, right there and then, over /the political significance of palaeogenetics/, then the relationship was obviously doomed from the start. And however much I hated confrontation, it was a fine line between tact and dishonesty, between accommodating our differences and concealing them.

And yet. The issue seemed far too arcane to be worth fighting over - and though Lena clearly held some passionate views on it, I couldn't really see the topic arising again if I kept my big mouth shut, just this once.

I said, "Maybe you're right." I slipped an arm around her, and she turned and kissed me. It began to rain again, heavily, the downpour strangely calm in the still air. We ended up back at Lena's flat, saying very little for the rest of the night.

I was a coward and a fool, of course - but I had no way of knowing, then, just how much it would cost me.

-

A few weeks later, I found myself showing Lena around the basement of the UNSW physics department, where my own research equipment was crammed into one corner. It was late at night (again), and we were alone in the building; variously coloured fluorescent display screens hovered in the darkness, like distant icons for the other post-doctoral projects in some chilly academic cyberspace.

I couldn't find the chair I'd bought for myself (despite security measures escalating from a simple name tag to increasingly sophisticated computerised

alarms, it was always being borrowed), so we stood on the cold bare concrete beside the apparatus, lit by a single fading ceiling panel, and I conjured up sequences of zeros and ones which echoed the strangeness of the quantum world.

The infamous Einstein-Podolsky-Rosen correlation - the entanglement of two microscopic particles into a single quantum system - had been investigated experimentally for over twenty years, but it had only recently become possible to explore the effect with anything more complicated than pairs of photons or electrons. I was working with hydrogen atoms, produced when a single hydrogen molecule was dissociated with a pulse from an ultraviolet laser. Certain measurements carried out on the separated atoms showed statistical correlations which only made sense if a single wave function encompassing the two responded to the measurement process instantaneously - regardless of how far apart the individual atoms had travelled since their tangible molecular bonds were broken: metres, kilometres, light-years.

The phenomenon seemed to mock the whole concept of distance - but my own work had recently helped to dispel any notion that EPR might lead to a faster-than-light signalling device. The theory had always been clear on that point, though some people had hoped that a flaw in the equations would provide a loophole.

I explained to Lena, "Take two machines stocked with EPR-correlated atoms, one on Earth and one on Mars, both capable of, say, measuring orbital angular momentum either vertically or horizontally. The results of the measurements would always be random... but the machine on Mars could be made to emit data which either did, or didn't, mimic precisely the random data coming out of the machine on Earth at the very same time. And that mimicry could be switched on and off - instantaneously - by altering the type of measurements being made on Earth."

"Like having two coins which are guaranteed to fall the same way as each other," she suggested, "so long as they're both being thrown right-handed. But if you start throwing the coin on Earth with your left hand, the correlation vanishes."

"Yeah - that's a perfect analogy." I realised belatedly that she'd probably heard this all before - quantum mechanics and information theory were the foundations of her own field, after all - but she was listening politely, so I continued. "But even when the coins are magically agreeing on every single toss... they're both still giving equal numbers of heads and tails, at random. So there's no way of encoding any message into the data. You can't even tell, from Mars, when the correlation starts and stops - not unless the data from Earth gets sent along for comparison, by some conventional means like a radio transmission - defeating the whole point of the exercise. EPR itself communicates nothing."

Lena contemplated this thoughtfully, though she was clearly unsurprised by the verdict.

She said, "It communicates nothing between separated atoms - but if you bring them together, instead, it can still tell you what they've done in the past. You do a control experiment, don't you? You make the same measurements on atoms which were never paired?"

"Yeah, of course." I pointed to the third and fourth columns of data on the screen; the process itself was going on silently as we spoke, inside an evacuated chamber in a small grey box concealed behind all the electronics. "The results are completely uncorrelated."

"So, basically, this machine can tell you whether or not two atoms have been bonded together?"

"Not individually; any individual match could just be chance. But given enough atoms with a common history - yes." Lena was smiling conspiratorially. I said, "What?"

"Just... humour me for a moment. What's the next stage? Heavier atoms?"

"Yes, but there's more. I'll split a hydrogen molecule, let the two separate hydrogen atoms combine with two fluorine atoms - any old ones, not correlated - then split both hydrogen fluoride molecules and make measurements on /the fluorine atoms/... to see if I can pick up an indirect correlation between them: a second-order effect inherited from the original hydrogen molecule."

The truth was, I had little hope of getting funded to take the work that far. The basic experimental facts of EPR had been settled now, so there wasn't much of a case for pushing the measurement technology any further.

"In theory," Lena asked innocently, "could you do the same with something much larger? Like... DNA?"

I laughed. "No."

"I don't mean: could you do it, here, a week from tomorrow? But - if two strands of DNA had been bonded together... would there be any correlation at all?"

I balked at the idea, but confessed, "There might be. I can't give you the answer off the top of my head; I'd have to borrow some software from the biochemists, and model the interaction precisely."

Lena nodded, satisfied. "I think you should do that."

"/Why?/ I'll never be able to try it, for real."

"Not with this junkyard-grade equipment."

I snorted. "So tell me who's going to pay for something better?"

Lena glanced around the grim basement, as if she wanted to record a mental snapshot of the low point of my career - before everything changed completely. "Who'd finance research into a means of detecting the quantum fingerprint of DNA bonding? Who'd pay for a chance of computing - not to the nearest few millennia, but to the nearest /cell division/ - how long ago two mitochondrial plasmids were in contact?"

I was scandalised. /This/ was the idealist who believed that the Children of Eve were the last great hope for world peace?

I said, "They'd never fall for it."

Lena stared at me blankly for a second, then shook her head, amused. "I'm not talking about pulling a confidence trick - begging for a research grant on false pretences."

"Well, good. But -?"

"I'm talking about taking the money - and doing a job that has to be done. Sequencing technology has been pushed as far as it can go - but our opponents

still keep finding things to quibble about: the mitochondrial mutation rate, the method of choosing branch points for the most probable tree, the details of lineage loss and survival. Even the palaeogeneticists who are on our side keep changing their minds about everything. Eve's age goes up and down like the Hubble constant."

"It can't be that bad, surely."

Lena seized my arm; her excitement was electric, I felt it flow into me. Or maybe she'd just pinched a nerve.

"/This/ could transform the whole field. No more guesswork, no more conjecture, no more assumptions - just a single, indisputable family tree, stretching back 200,000 years."

"It may not even be possible -"

"But you'll find out? You'll look into it?"

I hesitated - but I couldn't think of a single good reason to refuse. "Yes."

Lena smiled. "With /quantum palaeogenetics/... you'll have the power to bring Eve to life for the world in a way that no-one has ever done before."

-

Six months later, the funds ran out for my work at the university: the research, the tutoring, everything. Lena offered to support me for three months while I put together a proposal to submit to the Children. We were already living together, already sharing expenses; somehow, that made it much easier to rationalise. And it was a bad time of year to be looking for work, I was going to be unemployed anyway...

As it turned out, computer modelling suggested that a measurable correlation between segments of DNA could be picked out against the statistical noise - given enough plasmids to work with: more like a few litres of blood per person than a single drop. But I could already see that the technical problems would take years of work to assess properly, let alone overcome. Writing it all up was good practice for future corporate grant applications - but I never seriously expected anything to come of it.

Lena came with me to the meeting with William Sachs, the Children's West Pacific Research Director. He was in his late fifties, and /very/ conservatively dressed, from the classic Benetton AIDS ISN'T NICE T-shirt to the Mambo World Peace surfing dove motif board shorts. A slightly younger version smiled down from a framed cover of /Wired/; he'd been guru of the month in April 2005.

"The university physics department will be contracted to provide overall supervision," I explained nervously. "There'll be independent audits of the scientific quality of the work every six months, so there's no possibility of the research running off the rails."

"The EPR correlation," mused Sachs, "proves that all life is bound together holistically into a grand unified meta-organism, doesn't it?"

"No." Lena kicked me hard under the desk.

But Sachs didn't seem to have heard me. "You'll be listening in to Gaia's own theta rhythm. The secret harmony which underlies everything: synchronicity,

morphic resonance, transmigration..." He sighed dreamily. "I /adore/ quantum mechanics. You know my Tai Chi master wrote a book about it? /Schrödinger's Lotus/ - you must have read it. What a mind-fuck! And he's working on a sequel, /Heisenberg's Mandala/ -"

Lena intervened before I could open my mouth again. "Maybe... later generations will be able to trace the correlation as far as other species. But in the foreseeable future, even reaching as far as Eve will be a major technical challenge."

Cousin William seemed to come back down to Earth. He picked up the printed copy of the application and turned to the budget details at the end, which were mostly Lena's work.

"Five million dollars is a lot of money."

"Over ten years," Lena said smoothly. "And don't forget that there's a 125 per cent tax deduction on R&D expenditure this financial year. By the time you factor in the notional patent rights -"

"You really believe the spinoffs will be valued this highly?"

"Just look at Teflon."

"I'll have to take this to the board."

-

When the good news came through by email, a fortnight later, I was almost physically sick.

I turned to Lena. "What have I done? What if I spend ten years on this, and it all comes to nothing?"

She frowned, puzzled. "There are no guarantees of success - but you've made that clear, you haven't been dishonest. Every great endeavour is plagued with uncertainties - but the Children have decided to accept the risks."

In fact, I hadn't been agonising over the morality of relieving rich idiots with a global motherhood fixation of large sums of money - and quite possibly having nothing to give them in return. I was more worried about what it would mean for my career if the research turned out to be a cul-de-sac, and produced no results worth publishing.

Lena said, "It's all going to work out perfectly. I have faith in you, Paul."

And that was the worst of it. She did.

We loved each other - and we were, both, using each other. But I was the one who kept on lying about what was soon to become the most important thing in our lives.

-

In the winter of 2010, Lena took three months off work to travel to Nigeria in the name of technology transfer. Her official rôle was to advise the new government on the modernisation of the communications infrastructure - but she was also training a few hundred local operators for the Children's latest low cost sequencer. My EPR technique was still in its infancy - barely able to distinguish identical twins from total strangers - but the original

mitochondrial DNA analysers had become extremely small, rugged and cheap.

Africa had proved highly resistant to the Children in the past, but it seemed that the movement had finally gained a foothold. Every time Lena called me from Lagos - her eyes shining with missionary zeal - I went and checked the Great Tree, trying to decide whether its scrambling of traditional notions of familial proximity would render the ex-combatants in the recent civil war more, or less, fraternal toward each other if the sequencing fad really took off. The factions were already so ethnically mixed, though, that it was impossible to come to a definite verdict; so far as I could tell, the war had been fought between alliances shaped as much by certain 21st-century acts of political patronage as by any invocation of ancient tribal loyalties.

Near the end of her stay, Lena called me in the early hours of the morning (my time), so angry she was almost in tears. "I'm flying straight to London, Paul. I'll be there in three hours."

I squinted at the bright screen, dazed by the tropical sunshine behind her. "Why? What's happened?" I had visions of the Children undermining the fragile cease-fire, igniting some unspeakable ethnic holocaust - then flying out to have their wounds tended by the best microsurgeons in the world, while the country descended into chaos behind them.

Lena reached off-camera and hit a button, pasting a section of a news report into a corner of the transmission. The headline read: Y-CHROMOSOME ADAM STRIKES BACK! The picture below showed a near-naked, muscular, blond white man (curiously devoid of body hair - rather like Michelangelo's /David/ in a bison-skin loin-cloth) aiming a spear at the reader with suitably balletic grace.

I groaned softly. It had only been a matter of time. In the cell divisions leading up to sperm production, most of the DNA of the Y chromosome underwent recombination with the X chromosome - but part of it remained aloof, unscrambled, passed down the purely paternal line with the same fidelity as mitochondrial DNA passed from mother to daughter. In fact, with more fidelity: mutations in nuclear DNA were much less frequent, which made it a much less useful molecular clock.

"They claim they've found a single male ancestor for all northern Europeans - just 20,000 years ago! And they're presenting this /bullshit/ at a palaeogenetics conference in Cambridge tomorrow!" I scanned the article as Lena wailed; the news report was all tabloid hype, it was difficult to tell what the researchers were actually asserting. But a number of right wing groups who'd long been opposed to the Children of Eve had embraced the results with obvious glee.

I said, "So why do you have to be there?"

"To defend Eve, of course! We can't let them get away with this!"

My head was throbbing. "If it's bad science, let the experts refute it. It's not your problem."

Lena was silent for a while, then protested bitterly, "You /know/ male lineages are lost faster than female ones. Thanks to polygyny, a single paternal line can dominate a population in far fewer generations than a maternal line."

"So the claim might be right? There might have been a single, recent 'northern European Adam'?"

"Maybe," Lena admitted begrudgingly. "But... /so what/? What's that supposed to prove? They haven't even /tried/ to look for an Adam who's a father to the whole species!"

I wanted to reply: Of course it proves nothing, changes nothing. /No sane person could possibly care./ But... who made /kinship/ such a big issue in the first place? Who did their best to propagate the notion that everything that matters depends on /family ties/?

It was far too late, though. Turning against the Children would have been sheer hypocrisy; I'd taken their money, I'd played along.

And I couldn't abandon Lena. If my love for her went no further than the things we agreed on, then that wasn't love at all.

I said numbly, "I should make the 3 o'clock flight to London. I'll meet you at the conference."

-

The tenth annual World Palaeogenetics Forum was being held in a pyramid-shaped building in an astroturfed science park, far from the university campus. The placard-waving crowd made it easy to spot. HANDS OFF EVE! DIE, NAZI SCUM! NEANDERTHALS OUT! (/What?/) As the taxi drove away, my jet-lag caught up with me and my knees almost buckled. My aim was to find Lena as rapidly as possible and get us both out of harm's way. Eve could look after herself.

She was there, of course, gazing with serene dignity from a dozen T-shirts and banners. But the Children - and their marketing consultants - had recently been 'fine-tuning' her image, and this was the first chance I'd had to see the results of all their focus groups and consumer feedback workshops. The new Eve was slightly paler, her nose a little thinner, her eyes narrower. The changes were subtle, but they were clearly aimed at making her look more 'pan-racial' - more like some far-future common descendant, bearing traces of every modern human population, than a common ancestor who'd lived in one specific place: Africa.

And in spite of all my cynicism, this redesign made me queasier than any of the other cheap stunts the Children had pulled. It was as if they'd decided, after all, that they couldn't really imagine a world where everyone would accept an African Eve - but they were so committed to the idea that they were willing to keep bending the truth, for the sake of broadening her appeal, until... /what/? They gave her, not just a different name, but a different face in every country?

I made it into the lobby, merely spat on by two or three picketers. Inside, things were much quieter, but the academic palaeogeneticists were darting about furtively, avoiding eye contact. One poor woman had been cornered by a news crew; as I passed, the interviewer was insisting heatedly, "But you must admit that violating the origin myths of indigenous Amazonians is a crime against humanity." The outer wall of the pyramid was tinted blue, but more or less transparent, and I could see another crowd of demonstrators pressed against one of the panels, peering in. Plain-clothes security guards whispered into their wrist-phones, clearly afraid for their Masarini suits.

I'd tried to call Lena a dozen times since the airport, but some bottleneck in the Cambridge footprint had kept me on hold. She'd pulled strings and got us both listed on the attendance database - the only reason I'd been allowed through the front door - but that only proved that being inside the building

was no guarantee of non-partisanship.

Suddenly, I heard shouting and grunting from nearby, then a chorus of cheers and the sound of heavy sheet plastic popping out of its frame. News reports had mentioned both pro-Eve demonstrators, and pro-Adam - the latter allegedly much more violent. I panicked and bolted down the nearest corridor - almost colliding with a wiry young man heading in the opposite direction. He was tall, white, blond, blue-eyed, radiating Teutonic menace... and part of me wanted to scream in outrage: I'd been reduced, against my will, to pure imbecilic racism.

Still, he was carrying a pool cue.

But as I backed away warily, his sleeveless T-shirt began flashing up the words: THE GODDESS IS AFOOT!

"So what are you?" he sneered. "A Son of Adam?"

I shook my head slowly. /What am I/? I'm a /Homo sapiens/, you moron. Can't you recognise your own species?

I said, "I'm a researcher with the Children of Eve." At faculty cocktail parties, I was always 'an independent palaeogenetics research physicist', but this didn't seem the time to split hairs.

"Yeah?" He grimaced with what I took at first to be disbelief, and advanced threateningly. "So /you're/ one of the fucking patriarchal, materialistic bastards who's trying to reify the Archetype of the Earth Mother and rein in her boundless spiritual powers?"

That left me too stupefied to see what was coming. He jabbed me hard in the solar plexus with the pool cue; I fell to my knees, gasping with pain. I could hear the sound of boots in the lobby, and hoarsely chanted slogans.

The Goddess-worshipper grabbed me by one shoulder and wrenched me to my feet, grinning. "No hard feelings, though. We're still on the same side, here - aren't we? So let's go beat up some Nazis!"

I tried to pull free, but it was already too late; the Sons of Adam had found us.

-

Lena came to visit me in hospital. "I knew you should have stayed in Sydney."

My jaw was wired; I couldn't answer back.

"You have to look after yourself; your work's more important than ever, now. Other groups will find their own Adams - and the whole unifying message of Eve will be swamped by the tribalism inherent in the idea of recent male ancestors. We can't let a few promiscuous Cro-Magnon men ruin everything."

"Gmm mmm mmmn."

"We have mitochondrial sequencing... they have Y-chromosome sequencing. Sure, our molecular clock is already more accurate... but we need a spectacular advantage, something anyone can grasp. Mutation rates, mitotypes: it's all too abstract for the person in the street. If we can construct exact family trees with EPR - starting with people's known relatives... but extending that same sense of precise kinship across 10,000 generations, all the way back to

Eve - then /that/ will give us an immediacy, a credibility, that will leave the Sons of Adam for dead."

She stroked my brow tenderly. "You can win the Ancestor Wars for us, Paul. I know you can."

"Mmm nnn," I conceded.

I'd been ready to denounce both sides, resign from the EPR project - and even walk away from Lena, if it came to that.

Maybe it was more pride than love, more weakness than commitment, more inertia than loyalty. Whatever the reason, though, I couldn't do it. I couldn't leave her.

The only way forward was to try to finish what I'd started. To give the Children their watertight, absolute proof.

-

While the rival ancestor cults picketed and fire-bombed each other, rivers of blood flowed through my apparatus. The Children had supplied me with two-liter samples from no fewer than 50,000 members, worldwide; my lab would have put the most garish Hammer Horror film set to shame.

Trillions of plasmids were analysed. Electrons in a certain low-energy hybrid orbital - a quantum mixture of two different-shaped charge distributions, potentially stable for thousands of years - were induced by finely-tuned laser pulses to collapse into one particular state. And though every collapse was random, the orbital I'd chosen was - very slightly - correlated across paired strands of DNA. Quadrillions of measurements were accumulated, and compared. With enough plasmids measured for each individual, the faint signature of any shared ancestry could rise up through the statistical noise.

The mutations behind the Children's Great Tree no longer mattered; in fact, I was looking at stretches of the plasmid most likely to have stayed unblemished all the way back to Eve, since it was the intimate chemical contact of flawless DNA replication which gave the only real chance of a correlation. And as the glitches in the process were ironed-out, and the data mounted up, results finally began to emerge.

The blood donors included many close family groups; I analysed the data blind, then passed the results to one of my research assistants, to be checked against the known relationships. Early in June 2013, I scored 100 per cent on sibling detection in a thousand samples; a few weeks later, I was doing the same on first and second cousins.

Soon, we hit the limits of the recorded genealogy; to provide another means of cross-checking, I started analysing nuclear genes as well. Even distant cousins were likely to have at least some genes from a common ancestor - and EPR could date that ancestor precisely.

News of the project spread, and I was deluged with crank mail and death threats. The lab was fortified; the Children hired bodyguards for everyone involved in the work, and their families.

The quantity of information just kept growing, but the Children - horrified by the thought that the Adams might out-do them with rival technology - kept voting me more and more money. I upgraded our supercomputers, twice. And though mitochondria alone could lead me to Eve, for book-keeping purposes I

found myself tracing the nuclear genes of hundreds of thousands of ancestors, male and female.

In the spring of 2016, the database reached a kind of critical mass. We hadn't sampled more than the tiniest fraction of the world's population - but once it was possible to reach back just a few dozen generations, all the apparently separate lineages began to join up. Autosomal nuclear genes zig-zagged heedlessly between the purely-maternal tree of the Eves and the purely-paternal tree of the Adams, filling in the gaps... until I found myself with genetic profiles of virtually everyone who'd been alive on the planet in the early ninth century (and left descendants down to the present). I had no names for any of these people, or even definite geographical locations - but I knew the place of every one of them on my own Great Tree, precisely.

I had a snapshot of the genetic diversity of the entire human species. From that point on there was no stopping the cascade, and I pursued the correlations back through the millennia.

-

By 2017, Lena's worst predictions had all come true. Dozens of different Adams had been proclaimed around the world - and the trend was to look for the common paternal lineage of smaller and smaller populations, converging on ever more recent ancestors. Many were now supposedly historical figures; rival Greek and Macedonian groups were fighting it out over who had the right to call themselves the Sons of Alexander the Great. Y-chromosomal ethnic classification had become government policy in three eastern European republics - and, allegedly, corporate policy in certain multinationals.

The smaller the populations analysed, of course - unless they were massively in-bred - the less likely it was that everyone targeted really would share a single Adam. So the first male ancestor to be identified became 'the father of his people'... and anyone else became a kind of gene-polluting barbarian rapist, whose hideous taint could still be detected. And weeded out.

Every night, I lay awake into the early hours, trying to understand how I could have ended up at the centre of so much conflict over something so idiotic. I still couldn't bring myself to confess my true feelings to Lena, so I'd pace the house with the lights out, or lock myself in my study with the bullet-proof shutters closed and sort through the latest batch of hate mail, paper and electronic, hunting for evidence that anything I might discover about Eve would have the slightest positive effect on anyone who wasn't already a fanatical supporter of the Children. Hunting for some sign that there was hope of ever doing more than preaching to the converted.

I never did find the encouragement I was looking for - but there was one postcard which cheered me up, slightly. It was from the High Priest of the Church of the Sacred UFO, in Kansas City.

[[[

Dear Earth-dweller:

Please use your BRAIN! As anyone KNOWS in this SCIENTIFIC age, the origin of the races is now WELL UNDERSTOOD! Africans travelled here after the DELUGE from Mercury, Asians from Venus, Caucasians from Mars, and the people of the Pacific islands from assorted asteroids. If you don't have the NECESSARY OCCULT SKILLS to project rays from the continents to the ASTRAL PLANE to verify this, a simple analysis of TEMPERAMENT and APPEARANCE should make this obvious even to YOU!

But please don't put WORDS into MY mouth! Just because we're all from different PLANETS doesn't mean we can't still be FRIENDS.

]]]

-

Lena was deeply troubled. "But how can you hold a media conference tomorrow, when Cousin William hasn't even seen the final results?" It was Sunday, January 28th, 2018. We'd said goodnight to the bodyguards and gone to bed in the reinforced concrete bunker the Children had installed for us after a nasty incident in one of the Baltic states.

I said, "I'm an independent researcher. I'm free to publish data at any time. That's what it says in the contract. Any advances in the measurement technology have to go through the Children's lawyers - but not the palaeogenetic results."

Lena tried another tack. "But if this work hasn't been peer-reviewed -"

"It has. The paper's already been accepted by /Nature/; it will be published the day after the conference. In fact," I smiled innocently, "I'm really only doing it as a favour to the editor. She's hoping it will boost sales for the issue."

Lena fell silent. I'd told her less and less about the work over the preceding six months; I'd let her assume that technical problems were holding up progress.

Finally she said, "Won't you at least say if it's good news - or bad?"

I couldn't look her in the eye, but I shook my head. "Nothing that happened 200,000 years ago is any kind of news at all."

-

I'd hired a public auditorium for the media conference - far from the Children's office tower - paying for it myself, and arranging for independent security. Sachs and his fellow directors were not impressed, but short of kidnapping me there was little they could do to shut me up. There'd never been any suggestion of fabricating the results they wanted - but there'd always been an unspoken assumption that only /the right data/ would ever be released with this much fanfare - and the Children would have ample opportunity to put their own spin on it, first.

Behind the podium, my hands were shaking. Over two thousand journalists from across the planet had turned up - and many of them were wearing symbols of allegiance to one ancestor or another.

I cleared my throat and began. The EPR technique had become common knowledge; there was no need to explain it again. I said, simply, "I'd like to show you what I've discovered about the origins of /Homo sapiens/."

The lights went down and a giant hologram, some thirty metres high, appeared behind me. It was, I announced, a family tree - not a rough history of genes or mutations, but an exact generation-by-generation diagram of both female and male parentage for the entire human population - from the ninth century, back. A dense thicket in the shape of an inverted funnel. The audience remained silent, but there was an air of impatience; this tangle of a billion tiny

lines was indecipherable - it told them absolutely nothing. But I waited, letting the impenetrable diagram rotate once, slowly.

"The Y-chromosome mutational clock," I said, "is wrong. I've traced the paternal ancestries of groups with similar Y-types back hundreds of thousands of years - and they never converge on any one man." A murmur of discontent began; I boosted the amplifier volume and drowned it out. "/Why not?/ How can there be so little mutational diversity, if the DNA doesn't all spring from a single, recent source?" A second hologram appeared, a double-helix, a schematic of the Y-typing region. "Because mutations happen, again and again, at /exactly the same sites/. Make two, or three - or fifty - copying errors in the same location, and it still only looks like it's one step away from the original." The double helix hologram was divided and copied, divided and copied; the accumulated differences in each generation were highlighted. "The proof-reading enzymes in our cells must have specific blind spots, specific weaknesses - like words that are easy to misspell. And there's still a chance of purely random errors, at any site at all - but only on a time scale of millions of years.

"All the Y-chromosome Adams," I said, "are fantasy. There are no individual fathers to any race, or tribe, or nation. Living northern Europeans, for a start, have over a thousand distinct paternal lineages dating to the late Ice Age - and those thousand ancestors, in turn, are the descendants of over two hundred different male African migrants." Colours flashed up in the grey maze of the Tree, briefly highlighting the lineages.

A dozen journalists sprang to their feet and started shouting abuse. I waited for the security guards to escort them from the building.

I looked out across the crowd, searching for Lena, but I couldn't find her. I said, "The same is true of mitochondrial DNA. The mutations overwrite themselves; the molecular clock is wrong. There was no Eve 200,000 years ago." An uproar began, but I kept talking. "/Homo erectus/ spread out of Africa - dozens of times, over two million years, the new migrants always interbreeding with the old ones, never replacing them." A globe appeared, the entire Old World so heavily decorated with crisscrossing paths that it was impossible to glimpse a single square kilometre of ground. "/Homo sapiens/ arose everywhere, at once - maintained as one species, worldwide, partly because of migrant gene flow - and partly thanks to the parallel mutations which invalidate all the clocks: mutations taking place in a random order, but biased toward the same sites." A hologram showed four stretches of DNA, accumulating mutations; at first, the four strands grew increasingly dissimilar, as the sparse random scatter struck them differently - but as more and more of the same vulnerable sites were hit, they all came to bear virtually the same scars.

"So modern racial differences are up to two million years old - inherited from the first /Homo erectus/ migrants - but all of the subsequent evolution has marched in parallel, everywhere... because /Homo erectus/ never really had much choice. In a mere two million years, different climates could favour different genes for some superficial local adaptations - but everything leading to /Homo sapiens/ was already latent in every migrant's DNA before they left Africa."

There was a momentary hush from the Eve supporters - maybe because no-one could decide any more whether the picture I was painting was /unifying/ or /divisive/. The truth was just too gloriously messy and complicated to serve any political purpose at all.

I continued. "But if there was ever an Adam or an Eve, they were long before

/Homo sapiens/, long before /Homo erectus/. Maybe they were..
/Australopithecus/ -?" I displayed two stooped, hairy, ape-like figures.
People started throwing their video cameras. I hit a button under the podium,
raising a giant perspex shield in front of the stage.

"Burn all your /symbols/!" I shouted. "Male and female, tribal and global.
Give up your Fatherlands and your Earth Mothers - it's Childhood's End!
Desecrate your ancestors, screw your cousins - just do what you think is right
/because it's right/."

The shield cracked. I ran for the stage exit.

The security guards had all vanished - but Lena was sitting in our
armor-plated Volvo in the basement car park, with the engine running. She
wound down the mirrored side window.

"I watched your little performance on the net." She gazed at me calmly, but
there was rage and pain in her eyes. I had no adrenaline left, no strength,
no pride; I fell to my knees beside the car.

"I love you. Forgive me."

"Get in," she said. "You've got a lot of explaining to do."

===