# Being human: science, culture and fear

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# The science of culture

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I want in this paper to address two aspects of the relationship between science and culture, then to bring them together in the context of the third theme of the conference: fear. We have learned an enormous amount over the past 150 years about how our species came to be, and this has opened up rich avenues of enquiry about how culture came to be; it is a constant source of astonishment to me that this wealth of information and source of new understandings is still, for many people, not a cause for delight and celebration, but rather for fear and denial.

## HOW HUMANS CAME TO BE

There is absolutely no doubt in the minds of professional biologists that all living things are related by common ancestry, or that human beings are:
—animals: we obtain our food by ingesting other organisms;
—chordates: our bodies are supported by a stiffening rod that runs along our dorsal side;
—mammals: we have body hair, and females secrete milk for suckling infants;
—primates: we have dextrous, unwebbed fingers and toes;
—and apes: our tail is reduced to a coccyx, and we have an appendix in the gut.

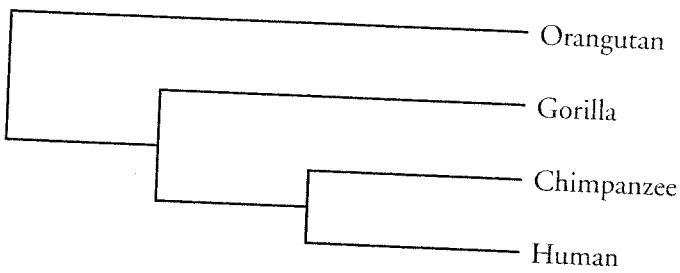
In this paper, what we are interested in is the last bit—us being apes.

When we go back in time and look for fossils documenting our oneness with our closest relatives (the gibbons, orangutans, gorillas and chimpanzees), it is like walking down a long dark corridor, with curtains hiding the view from us. If we start at 20 million years ago, and walk down the corridor, from time to time we pass places where the curtain is pulled back, allowing us a glimpse of the world outside, and we see animals that might be relevant to the tale we want to tell. About 18 million years ago, the curtain is pulled some way back, and we see a lightly forested East African landscape populated by apelike creatures. Some of these, the proconsulids, we can see very well and in great detail, but they are disappointing because, despite their tailless-ness, they are less like real apes than the apes are from each other. The ones that look as if they might be more like real apes can be discerned more dimly, in the background. Then the curtain closes again, and despite brief occasional glimpses of African, European and Asian landscapes, and tantalisingly apelike inhabitants, these are fleeting and often controversial. It is not until we reach 4 million years ago that the curtain is suddenly pulled widely back to reveal African woodlands and a plethora of apes, but already they are bipedal and obviously part of our own special lineage, our side of the split from the chimpanzees. After this, it is the periods when the curtain is in place, hiding the view, that are the rarity, and we see more than we miss. After the 2 million mark, continents other than Africa appear in our view, and as we near the present day the apes become more and more human.

If, then, the fossil record does not document any of the actual common ancestors, how can we know what they looked like, and when they lived?

We know what they must have looked like by reconstructing them, using the method known as cladistic analysis. Our bodies are but sparsely haired, whereas those of the other apes, including our closest relatives the chimpanzees, are more thickly haired, so by the principle of parsimony we can infer that all the common ancestors were well-haired, and that body hair was lost only in the special human line. The same reasoning suggests that the common ancestors walked on all fours, not (or, not habitually) on two legs, that they had short legs, small brains, protruding jaws, and divergent great toes.

To deduce when they live, we use a technique called the Molecular Clock. This makes use of the finding that most changes to DNA, the material of heredity, are neither advantageous nor disadvantageous, but neutral, so an overall regularity in rates of change can be predicted. By counting the DNA differences between pairs of species, we can reconstruct the relative times when their ancestors branched off the evolutionary tree; then, given a few key fossils as calibration, we can calculate the approximate times of each of these nodes. The evolutionary tree of the Great Apes (orangutans, gorillas, chimpanzees and humans) looks like this:




We can test whether a molecular clock exists by using what is called the Relative Rates Test. If the genetic distance of gorillas is the same to both chimpanzees and humans, it means that since their evolutionary separation the ancestors of chimpanzees and humans have gone on changing at the same rate. If the genetic distance of orangutans is the same to all three other apes, it means that ancestral gorillas and ancestral chimpanzee/humans went on evolving at the same rate after their evolutionary separation, too. Is this the case? Table 1 shows that it is (genetic distances are in percent of the total genome):

**Table 1**

| | Orangutan | Gorilla | Chimpanzee | Human |
|---|---|---|---|---|
| Orangutan | x | 3.09 ± 0.11 | 3.12 ± 0.11 | 3.08 ± 0.11 |
| Gorilla | | x | 1.63 ± 0.08 | 1.62 ± 0.08 |
| Chimpanzee | | | x | 1.24 ± 0.07 |
| Human | | | | x |

The figures are taken from Chen & Li (2001). Different DNA segments evolve at slightly different rates, so Chen and Li collected all the data published so far, on the grounds that irregularities are likely to even out over a large enough dataset, and ended up with 53 DNA segments, carefully chosen to avoid actual genes. Genes, because they code for physical and biochemical characteristics concerned with the survival of the organism, are likely to evolve fast if an advantageous mutation occurs, and not to change at all if a disadvantageous one occurs; so Chen and Li chose pseudogenes (DNA segments which used to be genes in the distant past, but were switched off during evolution) and introns (non-coding segments within genes). Recall that the discovery that less than 10% of the total genome actually consists of genes, in most organisms, has been one of the surprises that molecular geneticists sprung on us over the past 20 or 30 years.

When we look at the table, we can see that the relative rates test tells us that evolution in neutral DNA has gone on at the same rate throughout, so a molecular clock is justified. (Some of the mean distances differ slightly, but the differences are not significant when the standard errors are taken into account.)

There is a fossil proto-orangutan, *Sivapithecus*, from the Siwalik Hills in Pakistan, which is about 10–12 million years old. So the orangutan lineage was already separate by then. We don't know precisely how far along the lineage it was, so the noted palaeoprimatologist David Pilbeam gave Chen and Li an estimate for the time when the orangutan and gorilla/chimpanzee/human lineages separated: 12 to 16 million years ago. As there is a molecular clock, we can calculate the other separation dates: the gorilla and chimpanzee/human lineages separated 6.2–8.4 million years ago, and the chimpanzee and human lineages separated 4.6–6.2 million years ago.

Is this consistent with the human fossil record? There are some rather scrappy and controversial sets of fossils from the Tugen Hills in Kenya at about 6 million years old (Senut et al. 2001) and from the Middle Awash region in Ethiopia at 5.2–5.8 million (Haile-Selassie 2001), and these were recently augmented by an absolutely stunning complete skull from Chad, 6–7 million years old (Brunet et al. 2002), which has however proved no less controversial. It seems fair to say that the oldest fossil which most specialists would be prepared to accept as being on the human line is *Ardipithecus ramidus*, also from the Middle Awash, at about 4.4 million years ago (White et al. 1994). *Ardipithecus* looks to me about as primitive as you can get and still be recognisably on the human lineage, so I would be surprised if the human/chimpanzee split is very much older than that. Haile-Selassie's fossil, which he also thinks is *Ardipithecus*, would be just about consistent with that judgement, but the Kenyan and Chadian fossils would probably not be, and would be pushing the boundaries of the Chen and Li dates as well.

Most of what we know about *Ardipithecus* is about its teeth, though there are some parts of the skull and skeleton, and apparently there is a great deal more material now known, and soon to be described.

The 4-million-year-old sites of Kanapoi and Allia Bay, in northern Kenya, have yielded the earliest specimens of what are known as australopithecines. This general term designates "primitive members of the human line", and they are a very diverse lot. Dating from between 4 million and 1 million years ago, we have abundant material of skulls, skeletons and teeth, from South Africa, Malawi, Tanzania, Kenya, Ethiopia and Chad. They had a habitually upright posture and walked bipedally, as shown especially by the shape of the pelvis, femur and ankle; even if we have just a skull, we can still tell that they stood upright, because the foramen magnum (the hole through which the spinal cord enters the skull to join the brainstem) is underneath the skull, indicating that the skull was balanced on top of the spine, rather than at the back of the skull which would indicate that the skull was slung from the front of a nearly horizontal spine like a chimpanzee or gorilla. But they had short legs, a wide, funnel-shaped ribcage, and strong, well-muscled arms, and there is disagreement over whether this means that they were efficient tree-climbers or whether these features were just legacies of their ancestral condition which they had had no reason to throw off yet.

They were a diverse lot. So far, nine species have been identified, in three or four different genera (a genus is a cluster of related species), and one could argue that *Ardipithecus ramidus* is a sort of australopithecine as well. Some of these species were primitive and could have been ancestors of real humans, whereas others were very specialised and could certainly not have been ancestral to anything else. It is important to realise that there would be two or three species in existence at any one time: they were animals like any other, coexisting, competing, each exploiting the environment in its own way. Human evolution was not "onward and upward"; some of them were our ancestors (obviously), but most of them were our maiden aunts, destined for a final quietus, unwept, unsung.

From about 2½ million years ago, we get the first traces of something more like us: *Homo*. Around 2 million years ago there start to be complete skulls and partial skeletons. The earliest had the small teeth and rounded palates of *Homo*, but still had australopithecine-like skeletons, and their brains were only a very little larger than those of the australopithecines; they were typified by a species called *Homo habilis*, and we can refer to them as the habiline grade. They were succeeded rapidly by the much more advanced erectine grade, which for the first time extended the human range outside of Africa; the grade consisted of several species, the best known being *Homo erectus*

of Java. The erectines had much larger brains and shorter muzzles and, for the first time, the beginnings of a protruding nose. The skeleton is best known from a remarkably complete sub-adult individual from Nariokotome in northern Kenya; the rectines had long legs and obviously a fully modern, striding gait, and the small barrel-shaped ribcage of modern humans. They were succeeded by the sapient grade, people like us (*Homo sapiens*).

These four grades—australopithecine, habiline, erectine, sapient—overlapped in time, and graded into each other, so that some specimens are difficult to allocate securely to one rather than another and it is probably not meaningful to try to do so—we are, after all, dealing with the dynamic process known as evolution. The first definite habiline is 2.3 million years old; the last, about 1.5 million. The earliest erectine is 1.8 million, but there are fragmentary remains 2 million years old that may be erectines. The last erectines survived in Java to perhaps as late as 80,000 years ago, by which time the first sapients had long since evolved in Africa and begun to spread out of it.

The first people truly identifiable as *Homo sapiens* were African, and they lived 130,000 years ago; by 110,000 years ago *Homo sapiens* were in Israel, by 67,000 in China, by 63,000 in Australia, and by 40,000 in Europe.

What of our cousins, the Neandertal species, who evolved in Europe some 300,000 years ago and held sole occupany of Europe and Western Asia until they were displaced by modern humans? Do we class them as erectine or sapient, or something different? The question is not really meaningful. They were very different from us, with their stocky build, big noses, back-sloping cheeks, big brows and flat heads; but they were very human, too, with brains as large as ours, burial of the dead, and a nice line in well-made stone artefacts. But about 40,000 years ago modern humans entered Europe, and the Neandertals crumbled before them. Warfare, or just biological competition? We don't know. But we do know now that there was a little interbreeding. Neandertals hung on longest in the Iberian Peninsula, and in Portugal, 25,500 years ago, there was buried a 5-year-old boy whose skeleton suggests very strongly that he was hybrid between a modern and a Neandertal.

## HOW HUMAN CULTURE CAME TO BE

The behaviours and skills we associate with being human, and form the basis of human culture, are actually very old. There is a sense in which they could only have evolved in the Primates, mammals with large brains and dextrous hands, and Primates are already more intelligent, meaning showing more human-style learning and understanding ability, than most other mammals. Dolphins and elephants have their moments, but lacking the dexterity that four fingers and a thumb provide has proved an unsurmountable handicap in the culture department.

Our nearest relatives, the other great apes, in many respects approach us more closely than do monkeys, in mental capacities as well as physical structure. Look at Table 2.

All great apes sit upright and often (though not habitually) stand upright. This at once frees their hands from locomotion and allows them to play other roles. They are not habitually bipedal, however; this is something that had to wait for the human line to separate off, though the full striding gait had to await the erectine phase. Canines began to become seriously reduced in the human line too, although some evidence indicates that other, pre-human apes had independently shortened their own canines. Brain size began to increase only in the habilines, and thenceforth carried on increasing at every stage.

All great apes use tools. Orangutans are extremely good at using, even occasionally making, tools in zoos, and one population is known to use natural objects as tools in the wild. Gorillas, less lively-minded than orangutans, only occasionally use tools. The great toolmaker among nonhumans is the chimpanzee. Wild chimpanzees modify sticks to serve as probes into termite mounds, modify leaf clusters to act as sponges, and perform a great many other tool-making activities; they also use stones to crack nuts, but do not modify the stones. The interesting thing is that not all populations of chimpanzees do all of these things, but there are stone-using populations, termite-probing populations, and so on. There are other ways of doing things that are found in one or a few

**Table 2** Development of human characteristics.

| | Great Apes | Chimp | Aust | Hab | Erect | Sap |
|---|---|---|---|---|---|---|
| **Anatomy** | | | | | | |
| Upright posture | x | x | x | x | x | x |
| Bipedal gait | | | x | x | x | x |
| Shortened canines | | | x | x | x | x |
| Enlarged brain | | | | x | xx | xxx |
| Striding gait | | | | | x | x |
| **Technology** | | | | | | |
| Tool use | x | x | x | x | x | x |
| Tool making | | x | x | x | x | x |
| Stone tool making | | | | x | x | x |
| Fire | | | | | x? | x |
| Hafting | | | | | | x |
| Standing structures | | | | | | x |
| Water transport | | | | | | x |
| **Psychology** | | | | | | |
| Self-awareness | x | x | x | x | x | xx |
| Symbolic communication | x | x | x | x | x | x |
| Mental template | | | | | x | x |
| Language | | | | | | x |
| **Society** | | | | | | |
| Kin-based groups | x | x | x | x | x | x |
| Fission-fusion organisation | | x | x | x | x | x |
| Community territory | | x | x | x | x | x |
| Food sharing | | x | x | x | x | x |
| Activity bases | | | | x | x | x |
| **Culture** | | | | | | |
| Social transmission | ? | x | x | x | x | x |
| Big game hunting | | | | | x? | x |
| Burial | | | | | | x |
| Art | | | | | | x |

Abbreviations: Chimp—chimpanzees; Aust—australopithecines; Hab—habilines; Erect—erectines; Sap—sapients.

populations, different from what is done in other populations. Chimpanzee specialists therefore speak of chimpanzees having very rudimentary cultures, and culture areas (Whiten et al. 1999). This means that they are transmitting cultural information to each other, but it is notable that what they do not do is build upon pre-existing culture to add layers of complexity, which is something that all human societies do.

It may seem curious that chimpanzees are so clever at making tools out of sticks, grass stems and leaves but they do not modify stone, using it just as they find it. There is evidently some sort of conceptual breakthrough here, because in the human fossil record there is no trace of stone tool-making until the habiline stage (though it is possible that one australopithecine species, *Australopithecus garhi*, known from a single 2.5-million-year-old site in Ethiopia, may have made them). What is more, whereas chimpanzees do plan ahead, and select stones to carry to nut-cracking sites from as much as 500 metres away, habilines obtained suitable material for their stone tools from 2–3 km, occasionally as much as 11 km, away (Potts 1988). Presumably

australopithecines were capable of doing (at least?) as much as chimpanzees are, but so far there is no way of recognising their cultural activities in the fossil record.

Hafting of tools is something that is known only for *Homo sapiens*. All modern peoples regularly affix stone or other hard material, onto wood with twine, resin, nails, or slotting techniques, to extend the reach of the business end, or increase leverage or projectile quality. Likewise, only sapients are known to erect standing structures like walls; and only sapients are known to use watercraft. The arrival of the first people in Australia, now dated to over 60,000 years ago (Thorne et al. 1999), is as clear a demonstration of sapient capabilities as one could wish for.

The use of fire is of course universal in modern humans, but claims of fire associated with other grades, such as the erectines at Zhoukoudian in China (so-called Peking Man), are very controversial.

The psychological traits we think of as characteristically human actually have precursors in our closest living relatives. We are self-aware, meaning that we know that we exist in the same sense that others exist, and can ponder the contents of our own minds. Because of language, we can ask others how they think and feel, and when we compare the responses with the way we ourselves think and feel, we understand that they are fundamentally similar to us. This in turn enables us to some extent to see into others' minds, to predict their behaviour, and to change places with them. We have a Theory of Mind. A classic experiment by Gordon Gallup 30 years ago showed that chimpanzees recognise their own reflections in mirrors, while monkeys do not: so chimpanzees, like us, are aware of their own separate existence (Gallup 1970). Subsequent research has shown that all great apes, and some species of gibbons ("Lesser Apes"), can recognise their mirror images, though not all individuals have proved capable of it, in fact the percentage of gorillas who pass the mirror test is rather low, about 30%, compared to nearly 50% of chimpanzees and at least the same percentage of orangutans (Swartz et al. 1999). There is some indication that conditions of rearing and psychological health may affect whether mirror recognition occurs, just as happens in humans. From the fact of the presence of testable self-awareness in all great apes we can deduce that they, too, should have some basic Theory of Mind, and experiments and observations on them show that indeed they do: they recognise their own and others' intentionality, can plan deception, take roles, and swap roles with others (see various papers in Parker et al. 1999).

The ability to learn to communicate with symbols is likewise known in all great apes. There is still a raging controversy over whether it can be said that what nonhuman apes learn can be described as language; this is surely a sterile argument, and the protagonists need to be reminded that what we are dealing with is the dynamic process called evolution. The point is that all great apes have skills in this direction which few or no other animals possess; where one wishes to place the barrier between language and not-language is entirely arbitrary, and adds nothing to our understanding of the matter.

Philosophers like Kant and Descartes laid down the law about the differences between humans and "animals" (minds, souls and so on), and some human chauvinists at the present time still quote them approvingly, as if the 18th Century philosophers had said all there is to say. But the nonhuman great apes have been known to western science and philosophy for a mere 200 years or less, and were unknown to Kant and Descartes, and one should not expect them to fit into hard-and-fast categories established on the basis of comparisons made 300–400 years ago between humans and "animals".

What can we deduce from the fossil record about the development of full human self-awareness? The control of fire implies strongly that awareness and forward planning are well developed, and one could argue the same about artefact hafting; Wynn (1995) has argued that one form of non-hafted stone tool, the handaxe, required a mental template to manufacture. Handaxes appear in the record, in Africa, about 1.5 million years ago, whereas the earlier pebble tool cultures needed no higher cognition than simple striking off of flakes until an adequate edge was achieved. It should be noted that handaxes appeared during the erectine phase, and some erectines (those in eastern Asia, who presumably had migrated out of Africa before handaxe technology arose) persisted in the pebble-tool phase until a few tens of thousands of years ago. As for language, handaxes do

not require grammar-like rules to make (Wynn 1995); it has been argued that the earliest evidence for language is the sea-crossing to Australia, because this needed detailed cooperation to build watercraft (Noble & Davidson 1996).

All Primates, and probably most land vertebrates, if they live in groups at all, live in kin-based groups, from which one or both sexes disperse on reaching maturity and join other groups. Chimpanzees and humans are unusual—unique among the apes, certainly—in having what are called fission-fusion societies, meaning that they live in large communities (from about 20 to 120 strong, in chimpanzees) which split up into small parties whose composition shifts from day to day. Individuals have their preferred companions, with whom they like to associate; these may be close kin, but are often not. Each community occupies a territory, and the adult males patrol the borders, attacking members of the neighbouring community when they discover them. We know of at least one instance of organised warfare between two chimpanzee communities, in which the males of the larger community cooperatively invaded the territory of the smaller one, and attacked and killed its members until the community was extermined (Goodall 1986). One would like to think that chimpanzees were better than us, but in this regard they are our equal in savagery.

A gentler evidence of higher cognition in chimpanzees is their propensity for sharing food; this applies especially to the so-called Pygmy Chimpanzees (Kano 1986). They cooperate in hunting prey, especially colobus monkeys, and share out the spoils according to unwritten rules: females in oestrus get some, and so do more dominant males (Goodall 1986; Boesch & Boesch-Achermann 2000). Which is not to say that there is not also dissention and bad grace in food distribution as well.

Chimpanzees do not return to a home base after the day's activities. We do not know whether australopithecines did or not, but the habilines probably did (Cameron 1993).

We still have a great deal to learn about the evolution of culture, but there can be no denial that culture evolved as humans evolved physically. We can observe increasing evidence of cognitive and cultural development in the archaeological record, and it is of considerable significance, as well, that we do not have to imagine all this cultural complexity emerging from baseline—our closest living relatives are already well beyond the cognitive level of "mere animals".

## THE CULTURE OF DENIAL

How is it, then, that some people, even some who are scientifically trained, do nonetheless, deny not only the evolution of culture but the reality of evolution itself? The answer is of course that denial is religiously based: none of the world's major religions envisages any organisms—let alone human beings—as having evolved, and for some scientists the sacred scriptures take precedence over that part of the corpus of modern science.

John F. Ashton, PhD, proudly promoted the fact that 50 people with scientific training believe in creation, not evolution, which took just six days and happened only six thousand years ago, and edited their testimonials into a book (Ashton 1999). In a book which was presumably designed to show the general public that it is intellectually respectable to deny evolution, it is very noticeable that not one of those 50 was influenced by scientific evidence, but every one started off as a Christian fundamentalist (or "creationist"), or was persuaded into that way of thinking by someone close to them, and tried their hardest to reinterpret science as somehow agreeing with the Christian sacred text—the Bible, specifically the Book of Genesis. Like all exercises in "creation science", that involves a lot of double-think, special pleading, and blatant junking of facts that stubbornly refuse to fit,

But a scientist cannot just ignore the grand sweep of modern science, which insists that the earth is not a mere 6,000 years old, that species did not become existent suddenly in their present form, that there is no evidence of Noah's flood having occurred, that languages did not suddenly arise after the Tower of Babel. And so the egregious phenomenon called "Creation Science" was born. The idea that, when correctly interpreted, modern science does somehow after all support the Book of Genesis with its short timescale, species created each after its own kind, and the rest of

it. To do this, you have to argue that radiometric dating is an illusion, that the deep geological column with its progression of life forms—from invertebrates to fish to reptiles to mammals to humans—is due to Noah's flood, and that transitional fossils are somehow not transitional after all. The main technique is to comb through scientific reports to find anomalous radiometric dates and fossils apparently out of order, highlight them, and refuse to accept standard scientific explanations. A firm favourite is to find some quote from a famous scientist, making him or her appear to have doubts about some evolutionary event, or about evolution itself; "creation science" books and pamphlets are short on original research, but very long indeed on Famous Quotes. And the whole process is made much easier because there is actually a creationist Establishment, whose basic line was laid down by Duane T. Gish, PhD, in his 1979 book, *Evolution? The Fossils say No!* No-one who wants to arm themselves with the so-called "evidence against evolution" can afford to ignore Gish's writings.

The Gish line involves a great deal of sophistry and double-speak. The famous fossil *Archaeopteryx*, intermediate between reptiles and birds in the view of all scientists who have seen and studied it, becomes in Gish's hands a plain old ordinary bird that just happens to have teeth and a long bony tail. A few erroneous potassium-argon dates were published in the early days, when the technique was being refined and was still incompletely understood, therefore radiometric dating doesn't work, therefore the earth is young. Gish went on many lecture tours from the 1970s to the 1990s, and would love to hold public debates with scientists, most of whom had never heard of such claims as he put forward, and were simply floored. Audiences were, on the whole, very impressed, and swallowed the line that scientists had been hoodwinking the public, that they had been promoting evolution because they were all atheists, and that really evolution was all con trick.

A flurry of scientific books refuting the creationists' claims were published, but had little impact; the creationists' books, by Gish and many others, were more simply written, full of bright and breezy language and pictures. In the USA a few states even passed laws mandating equal time in the classroom for "evolution-science" and "creation-science", though each of these was later struck down in the courts. Now the technique is for local school boards to choose anti-evolutionary works as school textbooks.

Not everybody is happy with the standard creationist chat. Interestingly, in Ashton's book highlighting 50 scientific PhDs who believe in a six-day creation, two of his chosen scientists pointedly refused to accept the Gish line, and warned their colleagues that the scientific evidence does not in fact support "six days" or a "young earth" or special creation: Ben Clausen and Elaine Kennedy, both geologists, both creationists, both struggling to reconcile their fundamentalist upbringing with what they know to be true scientifically, and well aware that it is not in fact possible—or, as they would doubtless see it, not *yet* possible but they have every faith that one day the evidence for the 6-day creation will emerge.

Creationism is largely a Christian phenomenon; in fact, creationists like to call themselves just "Christians", as if the Pope, the Archbishop of Canterbury, the Patriarch of Constantinople, and all the many "theistic evolutionist" scientists are somehow not real Christians. Creationism has however recently spawned a Muslim offshoot (Yahya 1999). Interestingly, this has arisen not in a country where Islam is the state religion, but in avowedly secular Turkey, and Harun Yahya's book *The Evolution Deceipt* takes a good deal from Gish's *Evolution: the Fossils Say No!* —the same chatty, pictorial style, the same examples, the same atmosphere of paranoia. There is also a Hare Krishna version, Cremo & Thompson's *Forbidden Archaeology*, which is actually a far more scholarly-appearing work: in over 900 pages it goes through the entire history of archaeology and anthropology, parading for the reader's attention all the supposedly very ancient traces of human activity and other anomalies which, they maintain, have been suppressed by the profession. Hindu cosmology believes in billions of years, and humans were present throughout; but, if a human fossil was associated in the same strata with a dinosaur, it serves a short timescale as well as a long one, so the Christian creationist establishment has happily used *Forbidden Archaeology* as a kind of I-told-you-so text to fill in the gaps that Gish left.

I won't go into creationist arguments and their refutation here, but I will ask the question: why? I think the answer is: fear. The idea of evolution and the millions of years of earth history—"deep time", as it has been called—fills many people with dread. Where, they ask, is the loving God who carefully crafted each species, and formed a world that was just perfect for humanity? Where are the rules we are to live by? Where is life after death, with our reward for being good? What was the purpose of all those aeons when gaudy corals waved in warm sunlit seas, with only trilobites and armoured jawless fish to enjoy them? What was the point of millions of years when dinosaurs stalked each other like robots, with no Man to subdue and dominate them? Which of all these australopithecines and habilines was Adam, and which Eve? If chimpanzees are not just "animals", there are no boundaries, and all is an evolutionary continuum, what is Man, and what is not-Man?

The scientific world-view revolves around hypothesis testing: you make observations, generate a hypothesis to explain them, and test your hypothesis to see if it is consistent with other knowledge. The general public has great difficulty understanding that science is progressive: the creationist just has to say, "oh, so *Homo ergaster* is the ancestor now; last week it was *Homo erectus*", and the audience knowingly nod their heads, not affirming "scientific understanding has progressed", but "scientists keep changing their minds, they don't know what they are talking about". They want certainties in their lives.

The creationist world-view does not test its hypotheses; in fact, if mere science gets in the way, it must be rejected:

> "*But the main reason for insisting on the universal Flood as a fact of history and as the primary vehicle for geological interpretation is that God's Word plainly teaches it! No geologic difficulties, real or imagined, can be allowed to take precedence over the clear statements and necessary inferences of Scripture*" (Morris 1970).

But the creationist certainty comes at a price. In its Judaeo-Christian guise, it means the Book of Genesis. Adam was created first; Eve was created as his helpmeet. No women's lib there: a woman is subordinate to her husband. No gay lib, either: he created Adam and Eve, not Adam and Steve (Ham & Taylor 1989). Noah built a gigantic ark to contain all the animals for a year till the great deluge subsided; so the ancestor of us all had access to ocean-liner technology:

> "*The current status of the races, which varies from stone age to space age, from animal worship and spirit worship to Christianity, is not a result of innocent ignorant people searching for improvement. It is a direct consequence of whether the ancestors of any race worshipped the living God or deliberately rejected him... [Non-Christians, like the Australian Aborigines] are not primitives in need of education and technical aid so that they can understand the Gospel, but spiritual degenerates in need of the gospel of the Creator Christ so they can appreciate education and the relevance of technology*" (Mackay 1984). (I'm sure the Japanese will be glad of that).

We are all responsible for the sins of our fathers, so the descendants of Noah's naughty son Ham are unavoidably cursed:

> "*Sometimes the Hamites, especially the Negroes, have even become actual slaves to the others. Possessed of a genetic character concerned mainly with mundane, practical matters, they have often eventually been displaced by the intellectual and philosophical acumen of the Japhethites and the religious zeal of the Semites.*" (Morris 1976).

But ultimately, in a creationist system, all competing world-views must be banned. A recent "Call to arms for Conservative Christian Science Educators" has a list of mandatory educational principles, among which is:

> "*The Fall in Genesis 3 has affected the human mind. Limited because of its finiteness, the mind is further clouded by the effects of sin and wrong thinking. The teaching of a fully Biblical creationist worldview is thus paramount in attempts to understanding the creation.*" (Deckard 1998).

Let us be clear about what this means. It means that opposing views will not be tolerated. Not only science but the very idea of a multicultural society, in fact culture itself, is subservient to the Christian worldview.

There is a group in Denver, Colorado, called "Biblically Correct Tours", which conducts between 100 and 150 tours of major Colorado attractions every year. Tyson Thorne, one of the tour guides, was interviewed by David Holthouse, who asked him—if you're a true believer, don't you have to accept that your loving God committed genocide? "That's true", says Thorne. "God told the Israelites when they moved into the land to wipe out everybody, to spare no one, not even their cattle. Why did he do that? I don't know. That's God's call. In that case, genocide was obviously the right thing to do, because God commanded it. I'm not willing to set it aside and say, 'Well, that part of the Bible is patently untrue, because a loving God would never do that'. I don't presume to lecture God".

This is that terrible sense of rightness that is Timothy McVeigh, Osama bin Laden, Shoko Asahara. That, not science, is what I fear. For science brings understanding, and understanding is the enemy of fanaticism.

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