
Published in 2002, Evolution is an ambitious attempt by British science-fiction writer Stephen Baxter to chart the whole of mankind’s career, from earliest primate origins to final extinction, 500 million years from now. Inevitably there are those who will draw comparisons with Olaf Stapledon’s Last and First Men, but these are misplaced. Evolution concerns itself primarily with the anatomical and social development of humanity rather than the cultural and philosophical considerations of Stapledon’s classic work. The book is – in common with all Baxter’s work – firmly based on hard science and the pre-human and human primates featured are described in some detail, though Baxter points out that it is not intended as a textbook.

Evolution draws extensively on current theories about primate social dynamics and the origins of modern human behaviour, for example Steven Mithen’s “cognitive fluidity” (Mithen, 1996) and Robin Dunbar’s compelling theory connecting grooming with the origins of language (Dunbar, 1996). The book also appears to be influenced by works as diverse as Richard Fortey’s 1997 highly acclaimed Life: An Unauthorised Biography and Brian Aldiss’s 1962 Hugo-winning novel Hothouse.

Evolution has three parts, covering pre-human primates, humans (Homo ergaster through to H. sapiens), and post-humans (following the fall of modern man). Through this runs a narrative thread following 34-year old palaeontologist Joan Useb and her companions in the year 2031, as civilization unravels following a massive eruption of the Rabaul caldera in Papua New Guinea.

Prologue
The book opens with heavily-pregnant Joan en route by private jet to a biodiversity conference in Darwin, Australia. She is accompanied by primatologist Alyce Sigurdardottir, genetic programmer Alison Scott and the latter’s two genetically-enhanced daughters. The skies around the aircraft are full of smoke from seasonal forest fires in Indonesia and the eastern coast of Australia, which now burn for months each year. There is also concern aboard about Rabaul, which has been causing earthquakes for the last two weeks.

Joan recalls a childhood field-trip to Hell Creek, Montana with her mother (also a palaeontologist) and her discovery of a tooth of an early primate known as Purgatorius. The book then jumps back 65 million years to follow the story of the tooth’s owner, a mouse-sized female called Purga. She is living in the last days of Cretaceous Period, shortly before the Chixulub impact event that brought about the extinction of the dinosaurs.

Part One: Ancestors
Chapter 1: Dinosaur Dreams
The night sky is dominated by a comet, which is becoming steadily brighter as it approaches Earth on a collision course. I assume this is done for dramatic effect, as the object responsible for the Chixulub impact crater was an asteroid, not a comet. A comet would not have produced the anomalously high levels of iridium associated with the impact that led Luis and Walter Alvarez their 1980 theory of a
meteorite impact being responsible for the dinosaurs’ demise. Recent work (Bottke, Vokrouhlicky and Nesvorny, 2008) suggests the impactor was part of a much larger body that was broken up by a collision 160 million years ago, again ruling out a comet.


Like most of the characters that feature in the first part of the book, Purga’s life is largely about the Three Fs – feeding, fighting and reproduction. She has more than her fair share of problems with the last of these – three of her mates are killed (only one as a result of the impact) and she loses two of her three litters. Fortunately for her – and indeed every subsequent species of primate, including Homo sapiens – one of Purga’s offspring survives to maturity.

This episode differs from subsequent tales in that the story is presented from multiple points of view, ranging from that of a moth eaten by Purga to an “air whale” – a pterosaur with a hundred-metre wingspan living in the stratosphere and feeding on the aerial “plankton” of small insects swept up into the upper atmosphere. The “air whale” is Baxter’s dramatic conceptualisation of the hypothetical creature capable of exploit this niche, originally proposed by Richard Fortey (Fortey, 1997).

Chapter 2: The Hunters of Pangaea
Purga’s story is also broken by an interlude entitled The Hunters of Pangaea, set eighty million years earlier and featuring the orniths, a species of intelligent dinosaur that existed for only a few thousand years and, like the air whale, left no trace in the fossil record. “Hunters” also appeared separately as a stand-alone short story.

Chapter 3: The Devil’s Tail
Purga is described as being nocturnal, in line with the then-current thinking that ancestral primates were nocturnal. However a recent study (Tan, Yoder, Yamasita & Li, 2005) rejects nocturnality – or at least exclusive nocturnality. The nocturnal view rests largely on the fact that the majority of living prosimians are nocturnal, and the large orbits of many fossil forms, suggesting that they were also.

The study considered the gene sequences of opsins in primates. Opsins are light-sensitive proteins found in retinal photoreceptor cells. Trichromatic or colour vision requires three types of opsin, sensitive to short, medium and long wavelengths. However colour vision is not particularly useful for nocturnal animals, and has been found that in nocturnal animals either the genes coding for short wavelengths or those coding for medium/long-wave opsins rapidly pick up deleterious mutations, rendering the opsins themselves non-functional and giving the animal only monochromatic (“black-and-white”) vision. Because the “bad” opsin genes do not in such cases affect the organism’s survival, there is no Darwinian natural selection acting to eliminate them.

For any species, this mutation would be expected to occur at the same rate across successive generations, and on the nocturnal picture the opsin genes in all nocturnal primates would be expected to have undergone similar degrees of deleterious mutations, reflecting similar times of divergence from the last common diurnal ancestor (presumed not to be a primate).

However this prediction was not borne out by the study, which showed considerable variation in the degree of genetic defects found across a range of prosimians, indicating different time periods of deleterious mutation for different lineages, and suggesting different diurnal ancestry for each. This in turn implies that the common primate ancestor of all of these lineages must have been diurnal, unless each lineage independently went through a phase of diurnality, before reverting to nocturnality, which seems unlikely.
The assertion that every human alive today is a direct descendant of Purga is a good story but bad science. Even if we assume that Purgatorius is on the direct line of evolution leading to Homo sapiens (and while it is sufficiently generalised in its anatomy to have given rise to later Eocene primates, there is no strong evidence suggesting it actually did so), speciation events require founder populations, not founder individuals. The evolution of Homo sapiens (and indeed all other species) was never contingent on the success or failure of a particular individual to breed.

Chapter 4: The Empty Forest
The story moves on to that of another prosimian, a squirrel-sized female plesiadapid called Plesi, living in Texas two million years after the Chixulub impact, before picking up the engaging tale of a young male notharctus called – wait for it – Noth.

Chapter 5: The Time of Long Shadows
The lemur-like notharctus live on Ellesmere Island, in the Canadian Arctic Archipelago. It is 51 million years before the present. Unlike earlier primates, the notharctus have taken to group living. Noth and his younger sister get cut off from their troop and after several days wondering, are adopted by another. They hibernate through the winter with their new companions, then the mating season gets underway and young Noth has just 48 hours to lose his virginity. He defeats his arch-rival (called simply Rival), then bites off a bit more than he can chew when he challenges a solitary male called Solo, who has just bitten off a testicle from the troop’s alpha male, the Emperor. Fortunately notharctus seem have much a lower pain threshold in that particular part of their anatomy than humans – the Emperor rapidly recovers and together with Noth and several other males, puts Solo to flight.

At the – um – climax of the story, Noth gets to mate with Big, one of the troop’s senior females, but not before Rival has mated with Noth’s sister. Noth, however, bears Rival no ill will. It has to be said that Noth and his companions are the most likable characters in this entire saga, and notably their story provides the one conventionally happy ending in an otherwise bleak tale. The science is not however absent, and we learn much about the more powerful brains and complex social dynamics of the notharctus. Nor is the ending entirely positive – we learn that the notharctus are eventually driven out by competition with what will eventually prove to be mankind’s nemesis – the rodents.

Chapter 6: The Crossing
The scene now shifts to West Africa, 32 million years ago, to tell the tale of a group of anthros – monkey-like simians, which are swept out to sea by a flash flood. They survive the immediate peril by clinging to a raft of matted vegetation, but then have to endure weeks of thirst and starvation, during which many of them die. At length, however, the raft drifts ashore and the survivors find themselves in South America, the progenitors of the New World monkeys that live there to this day.

As implausible as it sounds, on a timescale of many million years it would only need to happen once, and there really is no other way of explaining the presence of the New World monkeys in South America without any fossil evidence of them ever having lived in North America.

Chapter 7: The Last Burrow
The next chapter is a short speculative piece set 15 million year ago in a small shrinking strip of tundra in Antarctica where small lemming-like primates compete with cold-adapted dinosaurs which survived the Cretaceous–Tertiary extinction event, and are now buried below many miles of sheet ice.

Chapter 8: Fragments
The final chapter of the book’s first part centres on an alpha male ape, with the appropriate name of Capo, who belongs to an unnamed (and as yet undiscovered) species of ape, living in a forest near the coast of North Africa 5 million years ago. They resemble chimpanzees, though the latter have yet to evolve. Their society is male dominated, like that of chimpanzees, but they copulate using the missionary position, a trait shared with bonobos and humans, whereas chimps use the doggy position (de Waal & Lanting, 1997).

Capo – the progenitor of mankind, the ancestor of Socrates, Newton and Napoleon – is the troop’s capo di tutti capi and lets nobody forget it. He has a habit of beginning his day by shitting on his subordinates, thereby starting a management practice that is still widespread five million years later. Unfortunately for Capo his territory is shrinking. As the Earth continues its long-term cooling, so the forest patch occupied by his troop is slowly dying off. The change has become significant over Capo’s 40 year life, and now the forest patch has become too small to support the troop. By a leap of instinct, Capo realises he must lead the troop to a new territory.

Roughly half the troop elects to remain behind, though Capo is relieved when his favourite female Leaf joins the migration. As Capo leads his diminished band to the edge of the forest, those remaining behind waste no time in battling to establish the new hierarchy. The apes make their way across open savannah and a salt pan. Overnight they are attacked by hyenas, and one of the younger males is taken. Next day, they reach the apparent safety of a new patch of forest, but by now Capo’s authority over the group is breaking down, with two young males – Finger and Frond – looking to depose him.

Worse is to follow. It turns out that the forest is already occupied by apes of the same species as Capo, who are in no mood to welcome immigrants. Heavily outnumbered, Capo’s troop begin posturing and displaying but the locals do not back down. Capo realises that he has no choice but to retreat and lead the troop onwards, though he now realises that any other forest they come across is likely to be similarly occupied.

Finger refuses to accept the retreat and after attacking Capo he launches himself at the other group. He is rapidly overpowered and killed. Capo’s band retreats, but only when Frond signals a retreat. One of the younger females defects – she will be grudgingly accepted by the others, provided she becomes pregnant quickly. The group are not pursued, but Capo realises his days as boss are over. He climbs into a tree, and is comforted by Leaf.

Meanwhile Frond cracks open a thigh bone from the corpse of a gomphothere (an extinct relative of present-day elephants) and finds he can eat the bone marrow. To make a living out on the open savannah is very difficult, but enough of the troop and their descendants will survive to lead to the evolution of the first humans….

The main problem with this story is that it is difficult to believe that an ape, confined all his life to a single patch of forest, would be able to formulate the concept of the existence of other patches of forest beyond his own. It is one thing to be aware of the resources needed to stay alive, and where they may be found within a particular environment; entirely another to postulate the existence of similar environments elsewhere.

Interlude
The conclusion of this first part of the novel is followed by a brief interlude in Joan Useb and her companions arrive at Darwin Airport. Earthquakes from Rabaul are making themselves felt as is the presence of anti-globalization protestors. The group are bottled up in the airport, waiting for the authorities to disperse the protestors. A delegate named Ian Maughan introduces himself to Joan. They
discuss a self-replicating probe nicknamed “Johnnie” (after mathematician and computer scientist John von Neumann) that has landed on Mars. Meanwhile, Alison Scott has unveiled her latest genetic creation – a recreated australopithecine.

Part 2: Humans
Chapter 9: The Walkers

The story proper then resumes with an episode set 1.5 million years ago, in Kenya. “Far” (this is the nearest thing she has to a name) is a pre-pubescent female hominid of a type that will one day be labelled Homo ergaster, though Baxter suggests that what we have found is merely the tip of the iceberg and there were many different human species living all across the Old World at this time. (Until recently, the term Homo erectus was used for humans of this era; however the current tendency is to reserve this term for Eurasian populations [the first to be discovered] and class the African populations as Homo ergaster. Whether the physical differences, albeit greater than those found in modern humans, warrant the use of two species is debatable, and some authorities (e.g. Conroy, 1997) continue to class both populations as H. erectus.)

Far enjoys running, in fact as both a sprint and middle-distance runner she could outstrip any athlete living today, male or female. She can run 100 metres in 6 or 7 seconds and a mile in three minutes! Her performance in long-distance events isn’t given, but I suspect she’d have left Paula Radcliffe trailing in her wake.

Although horses, greyhounds and indeed many other mammals could comfortably outperform even Olympic athletes in track events, could earlier types of human? The pelvic region in Homo sapiens is basically a design compromise between two conflicting needs – bipedal motion versus a birth-canal capable of allowing the passage of a large-brained infant. A part-way solution is that H. sapiens births are to all intents and purposes premature births, taking place while the head is still of a just about manageable size. The down side of this, of course, is that a new-born H. sapiens requires more postnatal care than the infants of any other species.

Even then, the locomotion capabilities of H. sapiens are still compromised, and it is likely that the earliest fully-bipedal humans such as H. ergaster, which were smaller-brained than ourselves, were probably more efficient bipeds. Enhanced middle and long-distance running abilities would have given them an edge when hunting; conversely when the tables were turned, sprinting abilities would have helped them to escape predators.

Far also packs a punch that would have had Mohammad Ali on the ropes. While sheltering from a bushfire, she is attacked from behind, stunned and dragged partially conscious into forest by a hungry australopithecine, but as she is about to be carved up for dinner she revives and punches him hard enough to do considerable facial damage.

A modern-day chimp, though weighing in at around half the size of a modern-day human, possesses far greater upper body strength. There is nothing mysterious about this – compare the thickness of the upper arm with that of the thigh in a human, and it is obvious that strength has been concentrated in the lower body at the expense of the upper. In a tree-climber such as a chimp, strength is more evenly distributed. The same would have applied, albeit to a lesser extent, to australopithicines and the earliest humans such as Homo habilis, which retained vestiges of the arboreal habit. But would the same apply to a fully-evolved biped like H. ergaster? The answer, probably, is yes. H. ergaster/erectus, while less robust than the stocky Neanderthals, still had a more powerful all-round physique than a present-day human.
We don't know about their hand–to–eye co-ordination, but there is no reason to suppose it was inferior to ours. So given a good tennis coach, and combined with her enhanced speed and strength, we can speculate that Far would probably run rings round Roger Federer or Rafael Nadal. But with her smaller brain, she'd probably be less effective at team sports and a Homo ergaster football team probably wouldn't beat anybody, apart of course from the current England side.

Far's story contains an interesting take on the two major issues concerning Mode II or Acheulian tool technology. Mode II tools superseded the more primitive Mode I or Oldowan tools made by the earliest humans and possibly by some of the later australopithecines. Mode II tools are characterised by teardrop–shaped hand–axes, the first examples of which were found at Saint–Acheul in Northern France in the mid–19th Century (hence “Acheulian”). The oldest known Acheulian tools are dated to 1.65 million years ago and come from West Turkana in northern Kenya (Scarre, 2005). The Acheulian hand–axe tradition endured with little change for over a million years.

But one major puzzle about these often beautifully–crafted hand–axes is that they are often too large to be useful (see, for example, the fine example in the Natural History Museum in Kensington). Also, they often appear to have been discarded soon after manufacture, with no sign of wear, suggesting that they were never used.

One theory (Kohn & Mithen, 1999) proposes that the axes were made to impress prospective mates. When a female saw a large, symmetrical axe, she might conclude that its maker possessed the right attributes to father successful offspring. The axe, having served its purpose (or not) would then be discarded. This – like the elaborate bower of the male bower bird – would be an example of the extended phenotype of a species playing a role in sexual selection (Dawkins, 1982).

Another issue with the hand–axes is that while they are ubiquitous in Africa and western Eurasia, they are not found east of Northern India. This was first noted by American archaeologist Hallam Movius in 1948. The “Movius Line” has stood the test of time and two theories have been proposed to explain it. One is that the ancestors of those living east of the Movius Line left Africa before the hand–axes were invented. The other possibility is that the migrants from Africa passed through a region lacking suitable materials to make the axes, and by the time they emerged from it, the tradition had been forgotten.

Baxter describes Far's ancestors a few generations back as having originated from east of the Movius Line, but having migrated back to Africa. Far, cut off from her own people, is adopted by another group and when a male suitor named Axe presents her with a hand–axe, she does not understand its significance, although she is attracted to its maker.

In the chapter's most speculative development, Far deceives Axe into thinking she is older than she actually is by using a piece of ochre to simulate menstruation. The “sham menstruation” hypothesis (Knight, Power & Watts, 1995; Power & Aiello, 1997) proposes the use of ochre to feign menstruation by early modern humans (Homo sapiens). But while pigment usage by early modern humans is well–attested and is taken as evidence of symbolic behaviour, such usage by earlier human species is less so. Recent work (Soressi & d’Errico, 2007) does however suggest Neanderthals may have made use of pigment for symbolic purposes, but the Neanderthal brain was comparable in size to that of a modern human, much larger than those of Far's people.
western Asia will never become known to science. As a boy, Pebble was forced to flee when outsiders invaded their settlement, killing most of the inhabitants, including Pebble’s father. Kin groups are identified by ochre makings scrawled on their faces, hands and arms. Pebble’s group wear vertical lines, the invaders wear a cross-hatch design. These body markings are the beginning of art, but also of nations and of war.

Chimps have a keener sense of smell than humans; Capo and his band were repelled by locals who could pick up subtle differences in their scent. If early humans had a poorer sense of smell, they would need something else to establish a group identity. The use of pigment by Neanderthals, as noted above, is a possibility though its use in this particular context is pure speculation.

Pebble’s people then establish friendly trading relations with a group of anatomically modern humans and one perennial question is answered in the affirmative when Pebble starts having sex with Harpoon, one of the moderns, and in due course she falls pregnant and produces fertile offspring. Later, the Neanderthals and moderns find a way of crossing to an offshore island, using logs as swimming aids, and they exterminate the local population of late Homo erectus people, stranded there millennia earlier as sea levels rose.

There is little doubt in my mind that modern humans did on occasions have sex with Neanderthals. Even in the wild, closely-related species will on occasion mate, for example horses and donkeys, lions and tigers, and whales and dolphins. While the fruit of such unions are generally infertile, they are usually viable. Given that modern humans will have sex with sheep, it seems inconceivable that at some stage they did not have sex with Neanderthals. Whether this resulted in fertile offspring, and whether any Neanderthal DNA exists in the current human genome remains contentious, though genetic studies have failed to find evidence, and it seems that Neanderthals diverged from modern humans as long as 800,000 years ago.

No evidence has yet come to light of the widespread warfare and genocide described in this chapter. Some claim such behaviour has always been a part of the human condition, for example Nicholas Wade, who bases his claim on the behaviour of chimpanzees and some contemporary hunter-gatherer tribes (Wade, 2007). But while some hunter-gatherer societies are warlike, such as the Yanomamo of the Amazon rainforest, other indigenous people are not.

Though more mentally-adept than the Neanderthals, Harpoon’s people are described as not yet being behaviourally modern. Anthropologists define modern human behaviour as the use of abstract thought, symbolic behaviour (such as art and creative expression), use of syntactically-complex language and the ability to plan ahead.

The following are generally accepted as evidence of modern human behaviour:

Finely made tools.
Fishing.
Evidence of long-distance trade among groups.
Use of pigment and jewellery for decoration or self-ornamentation.
Figurative art, such as cave paintings, petroglyphs and figurines.
Burial of the dead.
Systematic use of space in living-areas, with particular areas reserved for particular functions, e.g. food storage.

The first anatomically-modern humans may have lived as long as 195,000 years ago (Omo Kibish 1 and 2,
Ethiopia) or at least 154,000–160,000 years ago (Herto Bouri, Ethiopia), rather earlier than the 132,000 years suggested by Baxter. According to many authorities (e.g. Mithen, 1996; Klein & Edgar, 2002), modern human behaviour did not arise until much later in a “big bang” of human consciousness, but this is disputed by others (e.g. Oppenheimer, 2003), who claim there was no “big bang” and knowledge, skills and culture were gradually acquired over hundreds of millennia.

Baxter takes a middle view, with the use of ochre going back 1.5 million years, and anatomically but not-quite-behaviourally modern humans engaging in trade. The final cognitive breakthrough occurs in the next chapter, set 60,000 years ago in the Sahara.

Chapter 11: Mother’s People
The protagonist in this chapter is a 30-year-old woman referred to as Mother though she still doesn’t really yet have a name. As a result of a chance mutation, Mother has the mental organisation of a modern human, or what Steven Mithen, Professor of Archaeology at Reading University has described as cognitive fluidity. Mithen believes that the human brain originally had separate cognitive “domains” for different functions, such as social interaction, tool-making, food and resource gathering (“natural history”), etc, drawing on the work of Jerry Fodor, Annette Karmiloff-Smith, Michael Tomasello, Howard Gardiner, Leda Cosmides and John Tooby. Modern human behaviour came about when the barriers between these domains broke down, allowing them to interact with each other. Art, religion and language all arise from the synergistic interactions between the various domains. The idea of initially separate domains interacting may have been inspired in part by Julian Jaynes’ controversial theory about “bicameral minds”, proposed in 1976. (See Mithen, 1996; Fodor, 1983; Karmiloff-Smith, 1992; Tomasello, 1999; Gardiner, 1983 & 1999; Jaynes, 1976).

Mother understands the concept of cause and effect, and is capable of abstract thought. This enables her to invent the spear-thrower (atlatl) – a crucial invention because her people are starving to death. But Mother’s enhanced mental powers come at a cost; many of her ideas come to her when she is having crippling migraine attacks. These do, however, form the basis of shamanistic rituals and hence the world’s first religion. That cave art may be associated with such practices was first proposed by eminent French prehistorian Jean Clottes and South African anthropologist David Lewis-Williams. The latter also suggested that some African rock art may be derived from migraine aura (Lewis-Williams, 2002).

Unfortunately Mother begins to suffer from paranoid schizophrenia following the death of her son, and after murdering her aunt in the irrational belief that she killed her son, she instigates the practice of human sacrifice to bring rain. Fortunately only two sacrificial victims are required before the rains come; she was quite prepared to work her way through the entire tribe. Other influences are more benign: her cognitive skills gradually work their way through the tribe and the first true syntax-rich language develops.

Some years later, Mother develops cancer. Her condition rapidly worsens and she is eventually smothered by one of her acolytes, Sapling, in the world’s first mercy killing. Sapling calls her Ja-ahn – “Mother” in the new language; thus Mother becomes the first person in human history to have an actual name.

Chapter 12: The Raft Continent
In the next few stories, set in Australia 52–47,000 years ago, we meet a series of Ja-ahn’s descendants, all bearing mutated versions of her name. (The ultimate implication, though, that this is the origin of the name “Joan” is a little suspect. “Joan” is actually of Hebrew origin, meaning “the Lord is gracious”). Baxter does not describe the first migration of modern humans from Africa, skipping on eight thousand years, to the story of one of Ja-ahn’s descendants, a young man called Ejan. Following a failed attempt by
three of his brothers, Ejan and his sister Rocha make the first voyage to Australia, crossing the then narrow straits from Indonesia. Over the next five thousand years, humans colonise Australia, but their depredations soon kill off all the continent’s megafauna, such as giant kangaroos, which survive only as cave paintings. Painted over with later images, they are dismissed as childish doodling by people who have already forgotten what has been lost.

Chapter 13: Last Contact
Jahna is another of Ja-ahn’s descendants, living in Western France at the height of the last Ice Age, 31,000 years ago. Her people co-exist with Neanderthals, but despise them and have reduced them to slavery. Only one Neanderthal, known as the Old Man, continues to live in freedom. He looks after Jana and her brother when they are cut off from a hunting party in a snowstorm – but when Jahna’s father eventually finds them, he kills the sleeping Neanderthal by repeatedly smashing him over the head with a rock.

Chapter 14: The Swarming People
The action of final chapter to be set in prehistoric times takes place in Anatolia, Turkey, 9,600 years ago and describes the interaction between Mesolithic hunter-gatherers and Neolithic farmers. The story is based around Colin Renfrew’s theory that the Indo-European languages (Latin, Greek, Sanskrit and their descendants) were spread by farmers, originally living in Anatolia, who spread across Eurasia taking their language with them (Renfrew, 1987). See also this article on Indo-European origins.

Juna – the latest incumbent of the “Ja-ahn” name – is a young woman living with a group of hunter-gatherers. She is pregnant and concerned that her child will be killed on birth. Her tribe – in common with others described earlier – practice infanticide when times are hard. A possible way out presents itself when Juna’s people begin trading with a man called Cahl, who brings them beer. Nobody knows how to make beer: Cahl’s mysterious people keep the secret to themselves.

But Cahl has a fetish about pregnant women and Juna persuades him to take her with him back to his people, where – it is said – no babies have to be killed. Cahl’s people live in a town – one of the first in the world – called Keer. They practice a primitive form of agriculture – but it is enough to feed everybody, including Juna’s soon-to-be-born baby. But conditions in Keer are squalid and disease is rife. Juna is put to work in the fields where she befriends a woman called Gwerei and learns the language of her people, the language now known as proto-Indo-European. By night, she is used sexually by the repulsive Cahl.

As the months go by she learns that Keer is but a satellite of a larger town, Cata Huuk (sic), whose ruler is known as the Potus. While a passable cognate for “potentate”, I assume this is a humorous play on the acronym POTUS for President of the United States. The reason for Baxter’s spelling of Catal Hoyuk – the Neolithic settlement on which the story is based – is unclear; I have not seen it spelled that way elsewhere. Possibly the idea is that Cata Huuk was the original name (similar to Londinium for London), but this is certainly incorrect. “Catal Hoyuk” means “Fork Mound” in present-day Turkish, and Turkish is not an Indo-European language.

The Potus’ youngest son Keram is tasked with collecting tribute from Keer and other outlier towns. On one such visit, while Cahl is trying to ingratiate himself, Juna emerges from Cahl’s hut and begs Keram to take her and her unborn baby to Cata Huuk where, she claims, she was originally born but abducted as a child by the people of Keer. Although dubious about her story, and over the enraged protests of Cahl, Keram takes Juna with him, together with the tribute. Juna is puzzled that the people of Keer – who are hardly well off – don’t get beer in return. (I could comfortably retire on the money I’ve handed over to HM Revenue & Customs over the last few decades, and I’m still waiting for them to buy me a pint!)
At Cata Huuk, the Potus takes a liking to Juna, and allows Keram to marry her. Her son is born and she has another child with him. The society of Cata Huuk is rigid and hierarchical. The Potus, his family and the priesthood are the first people ever to live without having to work for food. This new way of life has more in common with the chimpanzee colonies of the forest than it does with the hunter-gather lifestyle of the Upper Palaeolithic.

For four years, all is well, but then Cata Huuk is sacked by outsiders, and Juna, Keram and their children are forced to flee. As they make their way to the coast, they pass through Juna’s old home, now a rough shanty town. Juna has a brief re-union with her sister. Most of the inhabitants have died from measles – one of many diseases that have flourished in the new urban societies, to which the hunter-gatherer people have no immunity.

Catal Hoyuk, though often described as one of the world’s first cities, is probably better described as a large village (see, for example, Hodder, 2006). Contrary to Baxter’s description, society appears to have been fairly egalitarian. There is no evidence of a civic centre or the type of organization one would expect in the kind of state-level society described. At the time of the events described, states with the stratified societies we know so well today were still some millennia in the future.

Regardless of whether the Anatolian farmers spoke proto-Indo-European, they spread out in what Italian geneticist Luigi Luca Cavalli-Sforza described in the 1980s as a “wave of advance”, leaving a genetic imprint in present day European populations (Cavalli-Sforza, 2000). However later work by Bryan Sykes at Oxford suggested that a strong Palaeolithic/Mesolithic component remained (Sykes, 2001). This can be explained by the farmers gradually moving out generation by generation from their homeland, but with significant intermarriage with local Mesolithic hunter-gatherers (Bellwood & Renfrew, 2002). In some places almost certainly the Mesolithic people took up farming on their own. This probably explains the existence today of isolated languages such as Basque, which may have been related to the languages originally spoken by Mesolithic hunter-gatherers. Though there were undoubtedly exceptions, it seems likely that relations between hunter-gatherers and incoming farmers were amicable, as each would have had something the other needed. The hunter-gatherers would know the lie of the land, having lived there for generations. In exchange for this knowledge, the farmers would be able to offer them food – and possibly even beer!

Chapter 15: The Dying Light
The next chapter, set in Rome in AD 482, deals with intrigue in the years after the fall of the Roman Empire in the West. Athalaric and his mentor, the elderly Honorius, are what would later become known as antiquarians. They are shown dinosaur bones and the skulls of Homo erectus and a Neanderthal. They speculate quite accurately on what these remains might mean. But Honorius is murdered after turning down the opportunity to become Pope, and such investigations would have to wait for another 1300 years.

Chapter 16: An Entangled Bank
The second section ends as we once again pick up the story of Joan Useb and her companions. The conference goes ahead, but is hijacked by terrorists led by a young man named Elisha, who releases smallpox into the air and is about to rape one of Alison Scott’s genetically-enhanced daughters when the police storm the building and kill most of the terrorists. The remainder, including Elisha, commit suicide. Joan goes into labour and simultaneously Rabaul blows up.

Joan delivers her baby safely and the conference delegates are vaccinated against smallpox, but the Rabaul eruption is sufficient to push Earth’s already-stressed eco-system over the edge, although it isn’t even the biggest eruption in human history. Wars break out across the globe. Mankind’s complex
Part 3: Descendants
Chapter 17: A Long Shadow

The final part of the book is set in the distant future, long after the fall of Mankind. Homo sapiens is almost – but in the first chapter – not quite extinct. Royal Navy flyer Lt. Robert Wayne Snow – “Snowy” – awakes from suspended animation to see the face of senior pilot Ahmed supervising his revivification. There is no sign of his CO, Robert “Barking” Madd, telling Snowy at once that something has gone wrong. When asked how he is, he nevertheless jokes that any landing you walk away from is a good one.

Snowy and his colleagues have been placed in a suspended animation chamber known as the Pit, and buried at an undisclosed location. They are part of a UN Protection Force, the idea being that if the UK or its allies are invaded, they will be thawed out and spring out of the ground, ready to fight. But the Pit appears to be leaning at an angle from the vertical, and much of the instrumentation is dead. Worse still, it soon turns out that all but five of the twenty-strong contingent is dead. Other than Snowy and Ahmed, the only survivors are the group’s resident genius Sidewise, a young pilot called Bonner and the only surviving woman, Moon (whose actual name is June – the final descendant of Ja-ahn??!). There has been no “tally” or wake-up call, no orders, no clue as to what is going on. The Pit’s clock only goes up to fifty years, and its hands have jammed against the end of their dials...

As the senior ranking survivor, Ahmed takes charge. They emerge from the Pit to find themselves in the middle of a forest. Maps, supposedly stored outside the Pit, are nowhere to be found. Taking weapons and equipment from the Pit, they strike off north. After some hours, they get clear of the forest, only to discover the last pitiful remnants of human civilization – the crumbled remains of a dam, a ruined church, the dimly-recognisable street layout of a town, with nothing surviving above waist height. We never learn how long the group were in suspended animation, or even where they are, but Sidewise guesses that at least a thousand years have passed.

Looking at the night sky, Sidewise locates Jupiter, Saturn and Venus, but he can’t find Mars and speculates something has happened to it. He is correct – it has been dismantled by the von Neumann machines, the robotic descendants of humanity.

As the weeks pass, the morale of the group deteriorates. The fauna appears drastically changed, with rodents the size of wolves in the ascendant. Escaped budgerigars seem to be thriving, but not cats. Sidewise – obviously no cat-lover – claims that cats weren’t so tough, just a pain in the arse. Finally Snowy encounters a human female, but she lacks the power of speech. Sidewise dubs the female Weena (the “old literary reference” is actually from “The Time Machine” by H.G. Wells). The pair discovers a colony of small, hairy ape-like people, descended in all probability from feral children who lived in sewers during the collapse of civilization. Without culture and learning, the power of speech was soon lost. With no need for energy-expensive big brains, these too were lost.

Ahmed still dreams of rebuilding civilization, despite the group containing – as Sidewise puts it – just one womb. This remark infuriates Moon, who feels increasingly threatened, especially by the sex-starved Bonner. Things finally unravel as Ahmed falls ill, Moon disappears, and the now barely rational Bonner goes after her. Snowy and Sidewise decide to leave and go their separate ways. Sidewise admits he was having sex with Moon. Snowy spends the remainder of his life following the ape-people.

It seems doubtful that language would be lost, even if civilization collapsed. If Noam Chomsky is correct, the capacity for language is intrinsic to the human brain. This is borne out by the rapid emergence of creoles – fully-featured languages – from the lingua franca known as pidgins that develop when people
speaking different languages come into contact. Any group of humans capable of surviving for 1000 years would need language, and if they had only a rudimentary pidgin to begin with, it would soon expand into a proper language – as indeed described by Baxter in Chapter 12.

Long before the rise of civilization, primates gained a survival advantage by having ever bigger brains. Primates’ key strategy was to be smarter than the competition, and this would not change in a world after civilization had collapsed. Humans living in a post-apocalyptic world would need all their wits to survive. Possibly Baxter intends a metaphor in this and subsequent chapters – a social commentary on “dumbing down” (The effete Eloi and brutish Morlochs from “The Time Machine” were also intended as social commentary).

This chapter does have some dubious plot-devices. Putting a group of military personnel into suspended animation is a good way of getting them into the future, but makes little sense from a military point of view. In the absence of command-and-control facilities, scattered groups of twenty men and women armed only with Walther PPK semi-automatic pistols would be a pretty ineffective deterrent against invasion.

That the Pit’s clock would only be good for fifty years seems implausible. A Casio G-Shock’s calendar will run up to AD 2100 and it would have been trivial to provide a digital calendar that could record the passage of time for millennia. And why on earth leave the maps outside?

When Sidewise cannot find Mars in the night sky, he assumes it has been destroyed. But at any given time it is unusual for more than one or two of the customarily naked-eye planets to be on view. Typically at least one will be below the horizon, or will only be up during the daytime. Even to be able to see Venus, Jupiter and Saturn at the same time is actually quite uncommon.

Chapter 18: The Kingdom of the Rats
In east Africa, 30 million years from now, the rodents have consolidated their grip on Earth. Elephant-sized post-humans, with Big Brother contestant-sized brains, are farmed for their meat by rodents. Other monkey-sized post-humans live in the trees, as their pre-human ancestors once did. Detritus from Mankind’s tenure of Earth still litters the ground – glass from car windscreens, bottles, etc. At the end of this chapter, the asteroid Eros collides with Earth, but the light of its approach does not register as a threat in the dim consciousness of any of the planet’s current denizens.

Chapter 19: A Far Distant Futurity
The book’s final chapter, like its first, is set in Montana, now part of the supercontinent of New Pangaea, some 500 million years from now. The Sun is beginning to leave the main sequence and Earth is now a desert of salt and sandstone. Small monkey-like people now live in a symbiotic relationship with borametz trees, rather like the Fisher folk of Brian Aldiss’ Hothouse. Earth is visited by descendants of the von Neumann machines that dismantled Mars. Eventually, as the Sun heats up, bacteria inhabiting rock hurled into space by meteorite impacts is all that remains of life on Earth. Some of these bacteria eventually reach other planets, where life begins anew.

Epilogue
18 years after the Rabaul eruption, Joan Useb and her daughter Lucy are living on Bartolome Island in the Galapagos, looking after feral children left behind when the islands were evacuated during the post-Rabaul wars. She realises, though, that Homo sapiens day is done....


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