

CHAPTER 1

What We Have to Explain

The story of human evolution has fascinated us like no other: we seem to have an insatiable curiosity about who we are and where we have come from. Conventionally, this story has always been told in terms of the bones and stones that make up the archaeological record – for the very good reason that this is often all we have to go on with any certainty. For the last half century, archaeologists have been loath to stray far from the ‘hard evidence’ lest they be accused of being speculative. Yet the stones and the bones skirt around what is perhaps the real story of human evolution, namely the social and the cognitive changes that, step by slow and uncertain step, gave rise to modern humans. It is here that the really big questions lie: What is it to be human (as opposed to being an ape)? And how did we come to be that way?

We *are* great apes, since we share with this family most of our biological, genetic and ecological traits. By current consensus, the rest of this family consists of two species of chimpanzees (members of the genus, or biological family, *Pan*), two (maybe four) species of gorillas (genus *Gorilla*) and two (maybe three) species of orang utans (genus *Pongo*). Of these, only the orangs live outside Africa: they are now confined exclusively to the southeast Asian islands of Borneo

and Sumatra, although until the end of the last Ice Age some 10,000 years ago, they were widespread in Indo-China and the southern parts of the Chinese mainland.

Until about 1980, the conventional view of our relationship with the great apes was that we undoubtedly belonged to the great ape family, but we and our ancestor species formed a separate subfamily from the other apes. This is because we differ from them in a number of very tangible ways: we walk upright while they walk on all fours, they have large brains by primate standards but ours are so much larger still, we have culture but they merely behave. This picture suggested an early division in the ape ancestry between the lineage leading to modern humans and the one leading to all the other great apes. Since the orang utan lineage can be documented in the fossil record back to around 16 million years ago, it followed that our common ancestor with the apes must have been at least this old.

However, the story changed dramatically during the 1980s when it became possible to look at the genetic (as opposed to purely anatomical) similarities between different species. It soon became apparent that humans are in fact genetically more closely related to the chimpanzees than either of us is to any of the other great apes, though the gorillas come a close second. It is the orang utan – isolated in Asia some 16 million years ago – that is the odd one out. The several species of living African apes (humans, gorillas and chimpanzees) form a single lineage that didn't split up until a much more modest 6–8 million years ago (Fig. 1.1). We belong not to a separate subfamily within the great apes family, but to the subfamily of African great apes. Because

we share a common ancestor with the chimpanzees, it makes the chimpanzees (as opposed to some kind of generic early Miocene great ape) the proper comparison for the human lineage, and in many ways the best model for early members of the human lineage (the australopithecines and their immediate predecessors).

So to set the story into context, let me briefly recap the evolutionary history of the African great ape family and our place within it. With this as our background, I will then sketch out five major evolutionary phases that characterize our lineage after its separation from the other African great apes. These phases, or transitions, will be the framework around which I will construct my story of human evolution.

The story so far

The living great apes (including the orang) are the descendants of a dramatic flowering of ape species during the early Miocene era beginning 20 million or so years ago, first in Africa and later in Europe and Asia (Fig.1. 1). Around 10 million years ago, a progressive drying of the climate dramatically reduced the great tropical forests that had been home to this rich diversity of apes during the Miocene. Dozens of species of apes died out, and were replaced by the much more adaptable monkeys who, until then, had been bit-part players on the African and Asian primate scene. One African ape lineage, however, survived and became the common ancestor of the living African great apes. Then, around 8 million years ago, what was to become the gorilla lineage split off. Some 2 million years later, the lineage that eventually

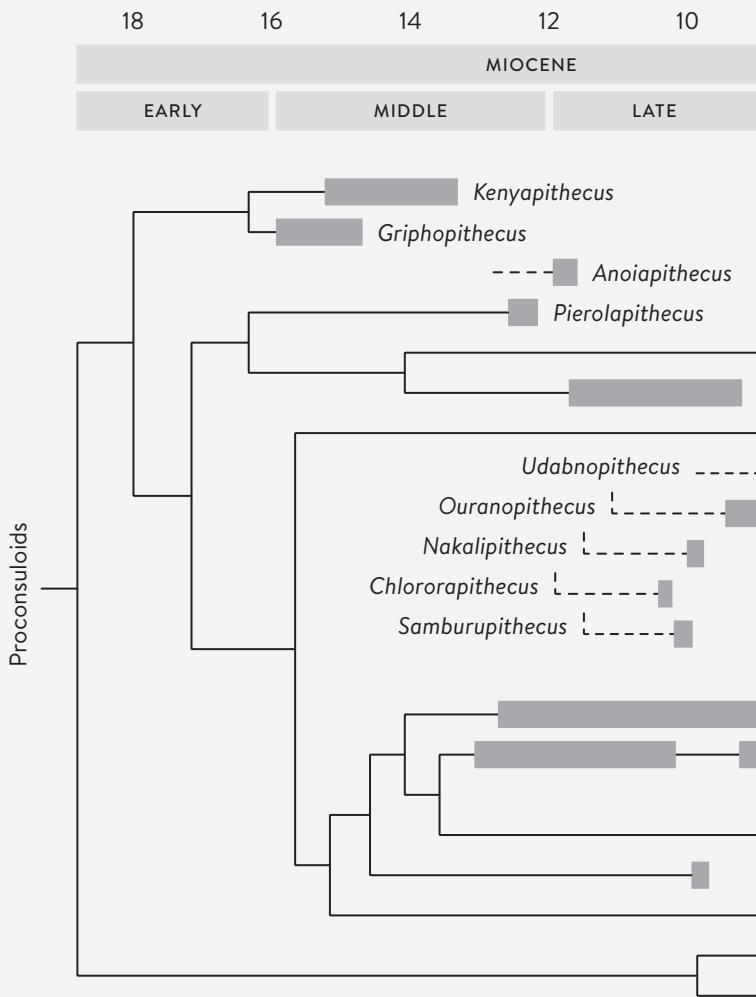
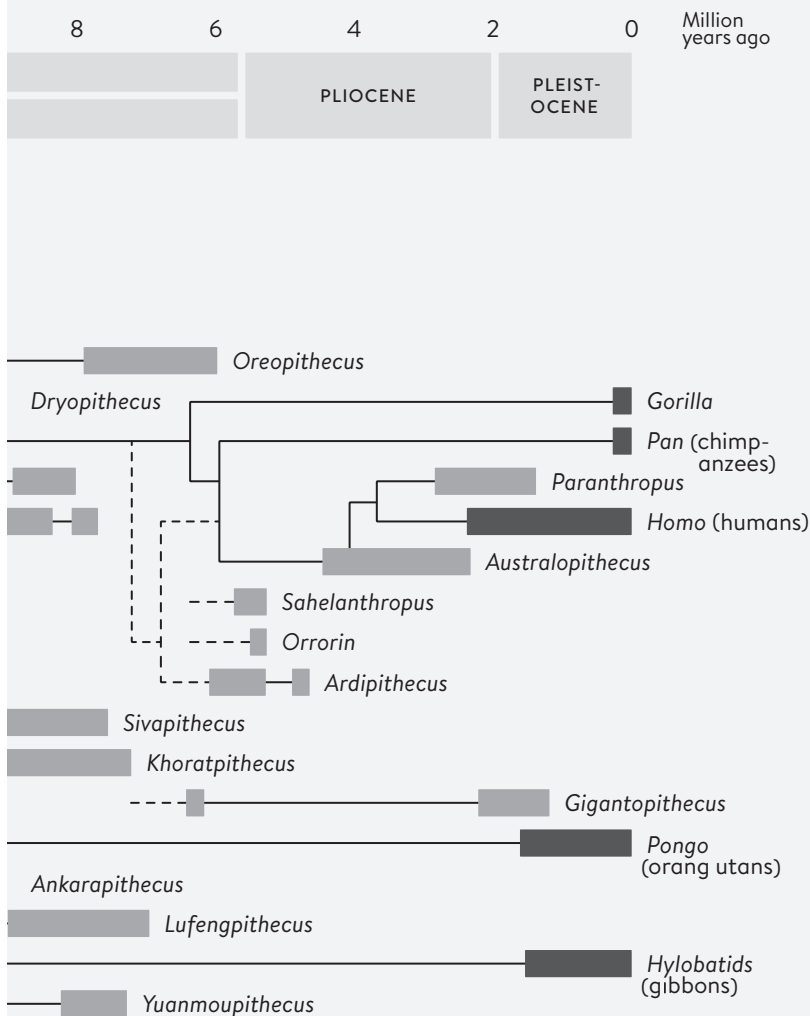


Figure 1.1

The family tree of the ape family, plotted against the geological periods when they lived. The Miocene had a very rich ape community in Africa and Eurasia (the Proconsuloids and their descendants), but most of these died out as the great tropical forests contracted



towards the end of the Miocene. Dark boxes indicate living genera, light grey boxes extinct ones. Dotted lines indicate relationships that are uncertain (such as the position of the earliest hominins, *Sahelanthropus*, *Orrorin* and *Ardipithecus*, in relation to the human family).

After Harrison (2010).

gave rise to modern humans diverged from the human-chimpanzee ancestor (usually known as the Last Common Ancestor, or LCA) and set off on its own evolutionary trajectory. Much later still, around 2 million years ago – at about the same time as the genus *Homo* made its first appearance in eastern Africa – the chimpanzee lineage split into two, giving rise to the common chimpanzee and the bonobo (or pygmy chimpanzee). Conventionally, taxonomists now refer to the great ape family (including humans) as *hominids*, while all members of the lineage leading to modern humans that arose after the split with the LCA are referred to as *hominins*. The older literature used the terms *hominoids* and *hominids*, respectively, but I shall follow the current terminology.

Meanwhile, from its humble origins around 6 million years ago, our lineage – at this stage still just jobbing great apes with no particular pretensions – began to invade a more terrestrial environment in the woodlands around the edges of the remnants of the great Miocene forests in central Africa. Although apes sometimes travel on the ground, they are all, by nature, arboreal species, adapted to shinning up giant forest trees and clambering (or, occasionally, swinging) around in the branches high above the forest floor. What has come to define our lineage – bipedalism – was adopted early on after we parted company with the chimpanzees, presumably in order to facilitate travel on the ground in more open habitats where large forest trees were less common.

We humans are bipedal apes, and palaeoanthropologists use the anatomical signs of bipedalism to identify our earliest ancestors. Currently, the earliest putative fossil hominin is *Sahelanthropus tchadensis*, although there are doubts as to

whether it really is a hominin or ‘just another ape’. The find – a near-complete skull found in what is now the Djurab desert on the southern edge of the Sahara in Chad, West Africa – is remarkable both for its age (it is dated to around 7 million years ago, so very close to the LCA) and for the fact that it was found many thousands of kilometres from the nearest other finds of early hominins in East Africa, and almost as far north of the nearest contemporary ape populations in West Africa (indicating that the forests and woodlands once extended much further northwards into what is now Sahara desert). While some palaeoanthropologists have argued that it is just an ape, others have insisted that the position of its foramen magnum (the hole in the skull through which the spinal cord passes) indicates a bipedal stance, thereby entitling it to be classified as a hominin. Inevitably, perhaps, specimens that date close to the split between apes and hominins are likely to be ambiguous, and so will be difficult to place with any certainty.

The next earliest known hominin fossil is *Orrorin tugenensis*. It dates to around 6 million years ago and was found in the Tugen Hills in Kenya, East Africa. In contrast to *Sahelanthropus*, *Orrorin* consists mainly of limb bones, a jaw and several teeth. The angles of the thigh bone and hip joint¹ suggest fairly uncontroversially that *Orrorin* was bipedal, although it was clearly still a competent climber. In this respect, *Orrorin* seems to bear many similarities to the australopithecines, who became abundant in eastern and southern Africa about a million years later, making it a plausible candidate to be a very early member of the hominin family. Then, from around 4.5 million years ago, the number of fossil finds increases

dramatically, reflecting a period when the hominin lineage repeatedly split into ever greater numbers of new species. The australopithecines proper had arrived. At times, there may have been as many as half a dozen australopithecine species alive at the same time, albeit mostly in different parts of Africa (Fig. 1.2).

The australopithecines were extremely successful, radiating over much of sub-Saharan Africa. Yet despite the fanfare associated with their discovery and early recognition as ancestral members of our lineage, they remain little more than bipedal apes. The australopithecines did not differ from the modern chimpanzees in terms of brain size. Like them, they were probably frugivores (fruit-eaters) who may have taken a little meat when they could get it. It is possible that they developed stone tools during the later stages (mostly associated with *Homo habilis* ('handy man'), now considered to be a late transitional australopith), but at best these tools were quite primitive – much like the hammer stones used by chimpanzees today in West Africa.

The next million and a half years from about 1.8 million years ago are dominated by a single species, *Homo erectus*, perhaps the longest lived of all the hominin species. Strictly speaking, it is what biologists call a *chronospecies*, a species that changes through time – not too surprising given its remarkable longevity. It has an earlier phase (*Homo ergaster* and allies) more or less confined to Africa and a later, larger-brained phase (*Homo erectus* in the strict sense) mainly confined to Eurasia. This phase of hominin evolution marks the first expansion out of Africa and into Eurasia (perhaps around 1.5 million years ago, or even earlier), and the

appearance of the first *worked* tools (the Acheulian handaxes, named after the first ones found in 1859 at Saint-Acheul in northern France). What is remarkable about this period is its seeming stability. For close on a million and a half years, there is only a modest increase in brain size, and even less change in the shape and style of its stone tools. This phase is probably unique in hominin history for its stability.

Then, sometime around 500,000 years ago, a new hominin species emerges out of the African *ergaster/erectus* stock, eventually taking shape as the first archaic humans, *Homo heidelbergensis*. They mark the beginning of a dramatic explosion in brain size and in the diversity of the material culture. Once again, there are some intermediate populations that form a bridge between *H.ergaster* and *H. heidelbergensis*, but the details are of marginal significance. Meanwhile, the *ergaster* populations disappeared from Africa and Europe as they were replaced by archaic humans. In eastern Asia, however, *erectus* populations survived until as late as 60,000 years ago, and in some diminutive forms (the so-called hobbit, *Homo floresiensis*) on the islands of the Indonesian archipelago until as recently as 12,000 years ago – a mere yesterday in geological time scales.

Of more importance is the fact that archaic humans effected a second major wave of invasions into Europe and western Asia, invasions that eventually gave rise to the archetypal European specialists, the Neanderthals (*Homo neanderthalensis*). Neanderthals developed a particular body form that was especially well adapted to high latitude habitats, and in particular the cold climates that began to engulf Europe and northern Asia as the Ice Age gathered momentum. Their

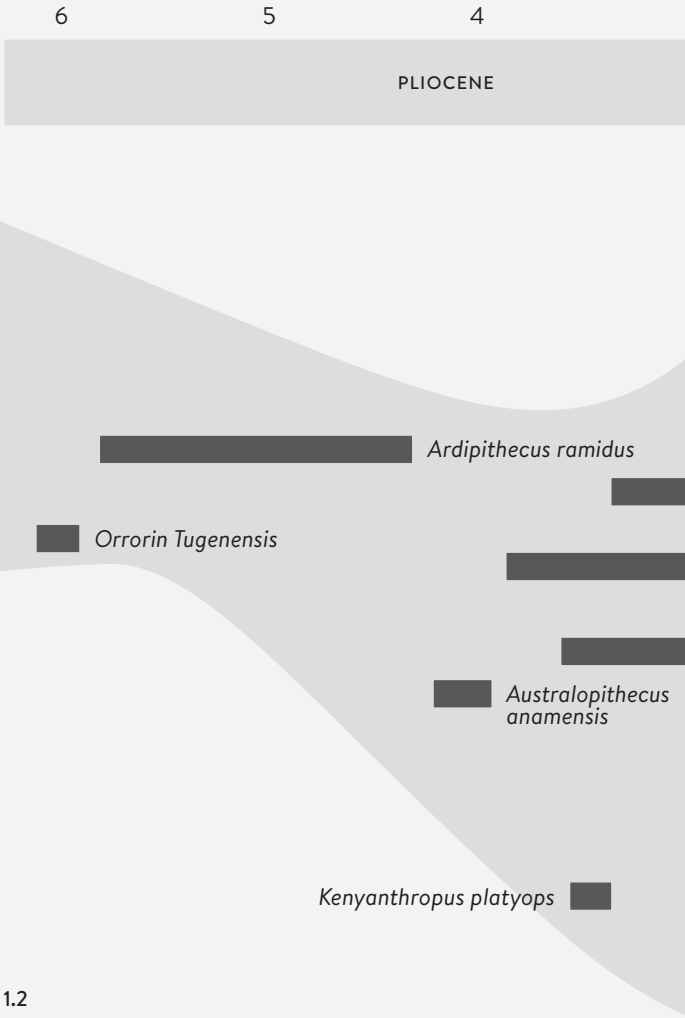


Figure 1.2

Six million years of human evolution, showing the main species and their time spans. Throughout much of our history, there have been several species of hominins alive at the same time. The earliest species were all members of the australopithecine family, which split around 2 million years ago (MYA) into the robust australopithecines and the lineage that led to modern humans.

2

1

0

Million
years ago

PLEISTOCENE

P. boisei (East Africa)

Paranthropus aethiopicus

P. robustus (South Africa)

A. africanus (South Africa)

Australopithecus afarensis (East Africa)

A. garhi

A. bahrelghazali

Homo neanderthalensis

Homo (?) habilis

Homo heidelbergensis

Homo sapiens

? *Homo antecessor* (Europe)
? *Homo ergaster* (Africa)

Homo (?) rudolfensis

Homo erectus
(Asia)

short-limbed, rather heavy build is not unlike that of contemporary arctic specialists like the Inuit (or Eskimo) – designed to minimize heat loss from the extremities. But the Inuit and their Siberian allies are very recent newcomers to these kinds of habitats, whereas the Neanderthals took this strategy to its limits in the 250,000 years or so that they spent in Ice Age Eurasia.

Meanwhile, around 200,000 years ago, populations of archaic humans further south in Africa began to undergo another transformation, giving rise to our own species, anatomically modern humans (AMH) or, to give us our proper scientific name, *Homo sapiens*. Anatomically modern humans differ from their archaic cousins by being more gracile (lightly built) and in having undergone a further increase in brain size. Modern genetics allows us to estimate the length of time over which a lineage has evolved using what has become known colloquially as the *molecular clock*. The molecular clock uses the number of differences in the DNA sequences of two populations or species, combined with the natural rate of mutation, to calculate how long the two lineages have been separated. The focus is on those parts of the genome that are protected from natural selection, so that the clock works only on the steady rate at which DNA naturally mutates. This is important, because those parts of our DNA that directly determine bodily traits can undergo much faster genetic change under the filter provided by natural selection. Using mitochondrial DNA (mtDNA),² the genetic evidence suggests that the origins of AMH lay in a relatively small population of about 5,000 breeding females who lived around 200,000 years ago. This doesn't mean that the entire

population at the time consisted of only 5,000 females, but rather that only these 5,000 females have contributed to the genetic make-up of all humans alive today.

What produced this new development is not clear. Conventional wisdom points to climate change as the main driver of speciation (the process whereby new species emerge out of ancestral populations), and the origins of *Homo sapiens* may be no different. However, our species seems to have spread very quickly through Africa, quite rapidly replacing the archaic human populations. How and why they replaced archaics so quickly is rather a mystery, especially given the fact that archaics had successfully occupied Africa (and Europe) for at least 300,000 years by the time modern humans appeared.

Then, around 100,000 years ago, one lineage of modern humans in northeastern Africa began to undergo rapid demographic expansion, and by 70,000 years ago had bridged out of Africa across the Red Sea to colonize the southern coastline of Asia, eventually reaching Australia by 40,000 years ago at latest.³ Reaching Australia was itself a major achievement, because to do so it was necessary to cross a 90km stretch of deep, open sea between the islands of the Sunda Shelf (modern Indonesia and Borneo) and the those of the Sahul Shelf (New Guinea, then connected to mainland Australia):⁴ they presumably must have had boats of very significant size. Anatomically modern humans mark an important transition in our story because with them comes culture in a way that had never happened before. The period from about 50,000 years ago marks a veritable sea change in the quality and quantity of weapons, tools, jewellery and artwork of a

kind and quality never seen before, not to mention tents, lamps and a host of more substantial gear, including boats.

Modern humans came into contact with Neanderthals for the first time in the Levant as they passed through from Africa on their way to Asia. Indeed, it was probably the presence of the Neanderthals in the Levant that prevented modern humans from entering Europe at this point, forcing them to travel eastwards into Asia along the southern coast of the Arabian peninsula. It is very likely that they came into contact with the remnants of *Homo erectus* populations in eastern Asia. It is even more certain that they came into contact with another archaic human species, the Denisovans, in Asia, since it seems they interbred with them. The Denisovans are known only from a handful of bones from a single cave in the Altai Mountains of southern Siberia dated to 41,000 years ago – a cave that was also occupied at different times by Neanderthals and modern humans. Genetic sequencing of the Denisovan genome suggests that they share a common early ancestry with the Neanderthals, and may represent the end point of an early eastwards expansion of the archaic human populations that predated the Neanderthals.

Meanwhile, back in Europe, the archaic human populations gradually became more adapted to the cold northern climate and evolved into the Neanderthals. The Neanderthals remained the undisputed masters of Europe from around 250,000 years ago until 40,000 years ago, when modern humans appeared, like all subsequent historical invaders, on Europe's eastern fringes out of the Russian steppes, perhaps reaching western Europe only around 32,000 years ago. The two species co-existed until about 28,000 years ago, when

the last of the Neanderthal populations died out in the Iberian peninsula. The Neanderthals are perhaps the iconic mystery of human evolution. Because they are so close to us both genetically and in time, and died out only relatively recently, we have always had a fascination for them. Why did they go extinct, when they were obviously so well adapted to life in northern climates and had survived in Europe for a great deal longer than our species, anatomically modern humans, has existed? I will return to this question later in the book.

Why we are not just great apes

First, let me return to the central question of this book: we share with the other great apes a long history, a largely common genetic heritage, a similar physiology, advanced cognitive abilities that permit cultural learning and exchange, and a gathering and hunting way of life. And yet we are not just great apes. There are some radical differences. The least interesting of these, although the ones that almost everyone has focussed on, are the anatomical differences, and in particular our upright bipedal stance. In fact, most of these traits are just bits of early remodelling to allow a mode of travel that became a route out of certain extinction as the Miocene climate deteriorated and the tropical forests retreated. Much of the rest of the debate has hinged around instrumental behaviours like tool-making and tool use. But in reality these are cognitively relatively small beer – even crows make and use tools, with a brain that is a fraction the size of a chimpanzee’s. The substantive difference lies in our cognition, and what we can do *inside our minds*. It is this that

has given us Culture with a capital 'C', culture that produces literature and art.

Over the last two decades, a great deal of research has been done – and even more ink spilled in learned journals – arguing the case for culture in animals, and especially in the great apes. The field has even coined a name for itself: panthropology, the anthropology of *Pan*, the chimpanzee.⁵ It should come as no surprise that behaviours and cognitive abilities that characterize modern humans are also found in some form in our nearest relatives. That is in the nature of evolutionary processes: traits seldom arise completely *de novo* out of the blue. In most cases, they arise as adaptations of existing traits, which become exaggerated or radically modified under the influence of novel selection pressures. We shall examine some of these later. For the moment, the important point to establish is that, yes, humans and chimpanzees share the ability to transmit behavioural patterns socially by cultural learning, and, yes, we can reasonably argue for culture in chimpanzees and other great apes, but the reality is that what apes do with their cultural abilities simply pales into insignificance by comparison with what humans do. This is not to belittle what monkeys and apes do, but rather to identify the substantive issue that seems to get overlooked in all the brouhaha and excitement: humans somehow raised the whole game by a great deal more than just a couple of notches. How did they do this, and why?

There are probably two key aspects of culture that stand out as being uniquely human. One is religion and the other is story-telling. There is no other living species, whether ape or crow, that do either of these. They are entirely and genuinely

unique to humans. We know they must be unique to humans because both require language for their performance and transmission, and only humans have language of sufficient quality to allow that. What is important about both is that they require us to live in a virtual world, the virtual world of our minds. In both cases, we have to be able to imagine that another world exists that is different to, and separate from, the world we experience on an everyday basis. We have to be able to detach ourselves from the physical world, and mentally step back from it. Only when we can do this are we able to wonder whether the world has to be the way it is and why, or imagine other parallel worlds that might exist, whether these are the fictional worlds of story-telling or para-fictional⁶ spirit worlds. These peculiar forms of cognitive activity are not trivial evolutionary by-products, but capacities that play – and have played – a fundamental role in human evolution. We shall see why in later chapters.

There are, in addition, some other aspects of human culture that will prove to be important. One of these is the social performance of music. To be sure, many other species can be said to produce music, including songbirds and whales, to name but the best known. But only humans seem to engage in music as a *social* activity. For birds, music seems to be mainly a mate advertising display. Humans use music as a mechanism for community bonding in a way that seems to be quite unique. In modern societies, we may often sit listening politely to music in concert halls, but in traditional societies music-making, song and dance are almost indistinguishable and play a crucially important role. This is something we will also need to account for.

What underpins all this cultural activity is, of course, our big brains, and this might ultimately be said to be what distinguishes us from the other great apes. To provide us with a framework for the book, the brain volumes of all the main fossil hominin species are plotted in Fig. 1.3.⁷ Seen on the grand scale of the last 6 million years, hominin brain size has been on a steady upswing in which brains trebled in size from their ape-like beginnings among the australopithecines to the brains of modern humans. This seems to suggest that there has been continuous upwards pressure for bigger and bigger brains over time. However, this does not necessarily mean that the selection pressure for larger brains has been increasing steadily over time. In fact, the continuous increase over geological time is an illusion, created by pooling specimens from the different species together. Separating the species out gives a pattern that is more suggestive of punctuated equilibria: each new species generates something more akin to a rapid increase or phase shift in brain size when it first appears, and then brain size stabilizes across time.

In the chapters that follow, I will identify five major transitions or phase changes in the course of human evolution that we need to explain and which will provide the road map for our journey. Each is based on a major change in brain size or ecological circumstance. The first of these is the transition from apes into the australopithecines and involves mainly an ecological and anatomical transition with no evidence for any significant change in brain volume or cognition. After this, there are three phases of brain evolution, starting around 2 million years ago. The first is a significant jump in brain size with the appearance of the genus *Homo* around

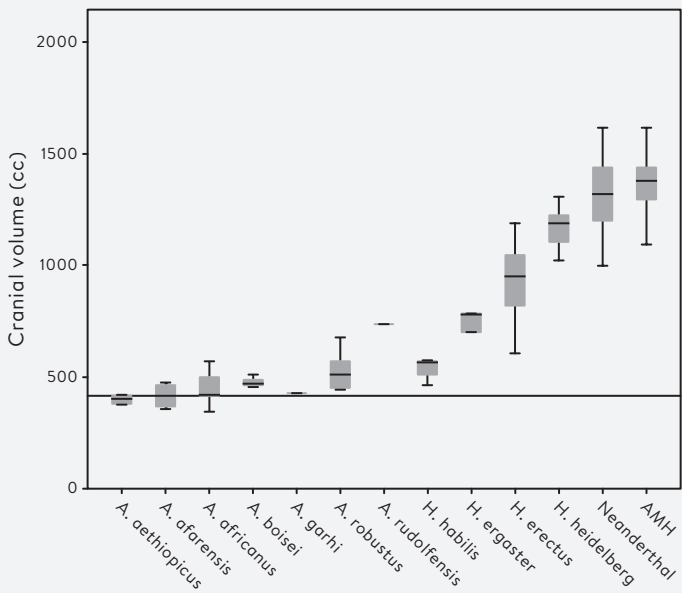


Figure 1.3

Median cranial volumes for major hominin species. The grey boxes show the range within which 50 per cent of all values for each species lie; the whiskers show the range for 95 per cent of the values. The horizontal line marks the equivalent value for modern chimpanzees. Source: De Miguel and Heneberg (2001).

1.8 million years ago (although this is presaged by a smaller, perhaps transitional, increase among the habilines, *Homo (Australopithecus) habilis*). The second is associated with the appearance of archaic humans, the *heidelbergers* (*Homo heidelbergensis*), around 500,000 years ago, and the last is associated with a further rapid increase in brain size that comes with our own species, anatomically modern humans (*Homo sapiens*) around 200,000 years ago. There is a parallel increase in brain size from its archaic baseline in the Neanderthal lineage during this same period, and we will have more to say about that in Chapter 6. Each of these triggers a pair of correlated problems for the species concerned: how to fuel the extra costs of these big brains, given that brains are, in energetic terms, exceptionally expensive, and how to bond the ever larger social communities that these large brains were designed to allow. Finding the time in an already busy day is the rack on which these species were all stretched – so stretched, in fact, that without finding novel solutions to the problems of time allocation, they would never have been able to break through the glass ceiling on community size that each phase represents.

To these four fundamental transitions, I will add a fifth that does not actually involve any changes in brain volume: the Neolithic Revolution that took place around 12,000–8,000 years ago in the Near East. The Neolithic is particularly intriguing because it is a reversal of everything that went before. It is characterized by two major innovations: the switch from nomadism to settled villages and, eventually, the invention of agriculture. Although the agricultural revolution has always attracted more attention than anything

else, in fact agriculture was just the means to an end. The real revolution was being able to live in settlements: irrespective of why communities gathered together in fixed settlements, doing so created social stresses that had to be neutralised before the Neolithic could take off. Once this problem had been resolved, however, it opened up the possibility for evolving ever larger communities, and hence eventually the rise of city-states and petty kingdoms and the whole historical development that eventually gave rise to the nation-states of the modern world. Understanding how we managed this transition is thus a key part of our journey.

The way ahead

As I observed at the start of this chapter, the archaeologist's bread-and-butter is a combination of stone tools and fossil bones, combined with a bit of local geology. However, this conventional focus on 'stones and bones' has inevitably left the social aspects of human evolution, and even more so their cognitive underpinnings, largely unexplored. The archaeologist's understandable worry has always been that it is just too easy to infer what you will about social behaviour from the sometimes scrappy and invariably indirect evidence available in the deep time record. Yet it is precisely these social and cognitive aspects of our biology that mark out the road that led, tortuously and often uncertainly, from the Last Common Ancestor some 6–8 million years ago to the modern humans that we now represent. If we want to account for that trajectory, we have to grapple with this murky, unseen social world, however difficult that may be.

In the societies of primates (including contemporary humans), the social community takes the form of a highly structured network of individuals linked to each other through ties of kinship, friendship and obligation. The way in which these social networks are structured in terms of kin and non-kin and the way they are distributed in space both have implications for how easy it is for an individual to call for assistance, as well as how well the relationships on which the coherence and persistence of the network depend can be serviced.

We are now in a position to address these kinds of questions because we have a much better understanding of primate social behaviour and ecology. This improved understanding is crucial because it neatly sidesteps one of the perennial problems that have long bedevilled attempts to reconstruct the behaviour of fossil hominins. Hitherto, the standard approach has been to identify a living species that is thought to share some key trait with a particular fossil hominin, and then assume that the fossil had the same ecology and social organization as the living species. At one time or another, chimpanzees, gorillas, baboons, lions, hyenas and even African wild dogs have all had the distinction of being 'the model' for early hominins. It was for this reason that the great fossil hunter Louis Leakey sent Jane Goodall and Dian Fossey off into the forests of central Africa to study chimpanzees and gorillas: he hoped they would be able to tell us something about how fossil hominins might have behaved. These 'analogue' models⁸ suffer from the weakness that they are invariably based on a single similarity shared by the living and fossil species – which might or might not actually

be relevant to why the living species has the social system it does. They also assume that each species has a characteristic ‘style’ of behaviour, and while this is very broadly true, the one thing we have learned from the last half-century of field studies on primates is just how adaptable most species are behaviourally and ecologically.

The approach that I will adopt here is very different. It exploits our much improved understanding of how primates allocate time to the various core activities (feeding, travel, rest, social bonding) that are crucial to their ability to survive in a particular habitat. This approach builds on a series of time budget models that we have developed for a number of monkey and ape species – models that allow us to predict exactly how much time an animal should devote to each of these core activities in a particular habitat. The key issue here is that the length of the working day is limited (we all sleep at night) and all these core activities have to be performed within the waking day. The fact that we are dealing with a biological system here is a crucial advantage: in biological systems, changes in one component cannot happen without having knock-on consequences elsewhere in the system. A species cannot increase its brain or body size without affecting the time it has to spend feeding, and it cannot change its feeding time allocation without affecting the time available for other equally crucial activities like travel or socializing. In a word, the numbers have to add up. And this gives us a powerful tool for exploring species’ responses to changing circumstances.

The second major foundation for our task is the social brain hypothesis, since this provides what is in effect the

fulcrum that will underpin the time budget analyses. Originally proposed by the psychologists Andy Whiten and Dick Byrne as an explanation for the fact that primates have much larger brains for body size than all other mammals, the social brain hypothesis has since come to be an explanation for the correlated differences in cognition and sociality *between* primate species. The crucial feature of this hypothesis is that it provides a quantitative equation relating brain size to social group size. The fact that this relationship is extremely robust and almost independent of any *direct* effects due to ecology means that we have a way of predicting typical social group size in fossil species. This provides us with two key insights into time budgets. One is the fact that, because brain size predicts group size, we can determine how much extra time is needed for bonding larger groups; the other is that an increase in brain size has to be fuelled by additional foraging time. The question we ask for each species is simply this: how did they accommodate these additional demands on their time? And if their time budgets were already stretched to their limit, what novel solutions did they find to make the extra time they needed available?

What we have to explain

How was it, then, that one particular lineage of African great apes set out on a trajectory that appears to have been unique? And, having done so, how was it that one particular subset of these early hominins emerged from the scramble of the australopithecine radiation to colonize the Old World and ultimately become the only member of this adaptive

array to survive the climatic changes of the later Pleistocene? And, again, how was it that, of the flurry of highly successful lineages that emerged out of the genus *Homo* in the middle Pleistocene, only one lineage – our own – managed to make it through to the present?

To a large extent, the trajectory that defines our pathway over these 6–8 million years reflects the dramatic changes in brain size and organization that mark out the sequence of events that makes up this story – the speciations, the migrations, the extinctions and the cultural novelties that litter the timeline of hominin evolution. Associated with these changes in brain size are a number of other core traits, some of which we can infer from the archaeological record and some of which we know reliably only from modern humans. I summarize these in Table 1.1 under four main headings. Some are anatomical, some behavioural or cognitive, but all have to be fitted into a single seamless sequence against both the changes in brain size (and hence group size) and the constraints of time, as well as the archaeological record. It is this triangulation between the different sources of information that makes our task possible, since it allows us much less room for speculative manoeuvre than has hitherto been the case. We cannot assemble the pieces of the jigsaw in Table 1.1 in any random order and simply make up some plausible story for the particular pattern we happen to favour. Instead, our approach will allow us to provide principled reasons for assembling the pieces in a *particular* order – or at least arriving at a limited number of alternative possible ways of doing so.

Some of the traits listed in Table 1.1 will be familiar to

**ANATOMICAL
MARKERS****ARCHAEOLOGICAL
MARKERS**

bipedality

fire

striding gait

hearths

plantar foot

changes in tool style

pelvic restructuring

decorative art/jewellery

brain size increase

home bases

loss of canines

delayed dental
development

modern human lifehistory

handedness

gracilization

menopause

precocial babies

Table 1.1

Modern human traits that differentiate us from the apes.
Our task is to build a sequence in which these were acquired.

**BEHAVIOURAL
MARKERS**

**CONGENITIVE
MARKERS**

fission–fusion sociality
laughter
dietary change
[esp. underground
storage organs]
meat-eating
cooking
hunting
grandmothering
language
(romantic) pairbonds
allo-parental care
division of labour
story-telling
music and dance
religion

theory of mind
(mentalizing)
high order mentalizing

palaeoanthropologists and are the bread-and-butter of traditional accounts of human evolution. These include bipedalism, the changes in pelvic structure and the acquisition of a plantar⁹ foot, the loss of canines, the increased gracilization (i.e. lighter body build) of modern humans, the progressive increases in brain size, the acquisition of a modern human life history with delayed maturation (signalled by delayed molar eruption) and precocial babies, tools in all their complexity, hunting and artwork. Others (fission–fusion sociality, division of labour, grandmothing, the menopause, cooking, religion and pairbonding) have played a central role in anthropological discussions of human social evolution but often lack plausible archaeological signatures by which we can recognize them in the fossil record. Some, however, are genuinely novel and have never really been considered in the context of human evolution: these include music and dance, story-telling, religion, those forms of social cognition known as theory of mind or mentalizing, and laughter. These have, I shall argue, played a particularly important role in the story of human evolution. Our task will be to explain why these changes took place, and why they occurred at the particular times and places they did.

This, then, will be an exercise in detection. We have the crime scene before us in the archaeological record, tantalizingly imperfect as every crime scene always is. Our task is to try to infer what happened where, when and why. The social brain hypothesis and the time budget models provide us with a forensic toolkit that we can apply rigorously to each stage

in the unfolding story. We shall proceed, like all good detectives, by trying to fit the bits of the jigsaw together. Because our forensic toolkit is quantitative (the numbers must add up in a time budget model), we can't just make the jigsaw pieces fit into some arbitrary pattern that happens to suit our particular predilections. We will build this picture step by step through time, placing the new crises that beset each species in the context of how its predecessor(s) resolved the ones they faced. By working incrementally in this way, we should be able to build a more coherent picture than has hitherto been possible.

There are two notes of caution that I should probably sound.

One is that many palaeoanthropologists will view this whole enterprise with something close to horror, so sacred are the stones-and-bones to their way of thinking. They have a long history of suspicion about new approaches and new technologies: many expressed disbelief when molecular genetics upended hominid (i.e. ape and human) taxonomy in the 1980s. The moral is that, rather than viewing new approaches with suspicion, we must ask how we can use them to help us better understand an all too fragmentary archaeological record. Science proceeds not by getting the answers right on the first shot, but by making us ask questions. In this book I ask entirely new questions about the story of human evolution, and propose entirely new approaches to answering them. I don't doubt that the details of the story laid out here will change as we acquire new fossils and new kinds of technical understanding; that is nothing new in a discipline

where, famously, every new fossil is heralded as changing the story of human evolution. The important point is that we ask questions that make us interrogate the archaeological record in new ways.

The second caveat concerns the exact taxonomic status of different hominin fossils. Taxonomy has been the focus of much of the debate in the study of human evolution over the last century, and a great deal of ink has been spilled on this issue. I do not intend to spill any more ink at all on the subject, and many will no doubt be affronted by such a cavalier attitude. This is not to say that taxonomy isn't important. I simply crave indulgence for ignoring it for now on the grounds that we do not, in my opinion, have a sufficient a handle on the detail to be able to undertake a more refined analysis. Instead, I want to dispense with the detail and focus on the big picture: how was it that these species managed to survive where they did, and why, eventually, did most of them go extinct. To the extent that this exercise is a success, it will provide us with the justification for further investigations at the level of individual populations – and at that point the details of taxonomy will surely become more important since we will need to know exactly who these individual populations are.

First, however, I need to introduce the key ideas and concepts that will form the basis of our story. The next chapter summarizes some essential principles of primate social evolution that will frame our whole approach. In effect, these provide the rationale for much of what follows. Hominins have to work within this framework precisely because they

are primates – or, at least, if they escape it, we shall need to be able to show how, when and why they did. The following chapter will then explore in more detail the two crucial theories that provide the template for the rest of the book. Our whole exploration of human evolution will depend on these two theoretical dimensions.