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Evolutionary basis for the human diet: consequences for human health

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The relationship of evolution with diet and environment can provide insights into modern disease. Fossil evidence shows apes, and early human ancestors were fruit eaters living in environments with strongly seasonal climates. Rapid cooling at the end of the Middle Miocene (15–12 Ma: millions of years ago) increased seasonality in Africa and Europe, and ape survival may be linked with a mutation in uric acid metabolism. Climate stabilized in the later Miocene and Pliocene (12–5 Ma), and fossil apes and early hominins were both adapted for life on ground and in trees. Around 2.5 Ma, early species of *Homo* introduced more animal products into their diet, and this coincided with developing bipedalism, stone tool technology and increase in brain size. Early species of *Homo* such as *Homo habilis* still lived in woodland habitats, and the major habitat shift in human evolution occurred at 1.8 Ma with the origin of *Homo erectus*. *Homo erectus* had increased body size, greater hunting skills, a diet rich in meat, control of fire and understanding about cooking food, and moved from woodland to savannah. Group size may also have increased at the same time, facilitating the transmission of knowledge from one generation to the next. The earliest fossils of *Homo sapiens* appeared about 300 kyr, but they had separated from Neanderthals by 480 kyr or earlier. Their diet shifted towards grain-based foods about 100 kyr ago, and settled agriculture developed about 10 kyr ago. This pattern remains for many populations to this day and provides important insights into current burden of lifestyle diseases.

Keywords: apes, bipedalism, climate, fire, forest, fruit, hominins, human evolution, nutrition, uric acid.

Introduction

Human evolution is strongly influenced by changes in the environment and diet. Our basic tenet is that understanding of modern diseases can be aided by insights from the past, and that knowledge of evolutionary processes and our interactions with the environment may provide insights into the challenges we face as a species as we progress through changing environments that we are, in part, driving. The approach we will take to understand human dietary evolution will be to evaluate environment and diet as they relate in time from fossil apes to modern humans.

The evolution of humans from ancestral apes, to hominins (members of the human lineage) to modern *Homo sapiens* can be evaluated in part by evaluating the fossil record as it relates to changes in the environment and diet. Fruit is the primary diet of apes and early hominins, and as it is dispersed in space and time, this requires good memory and knowledge of location (Fig. 1). Secondly, the collection of dispersed food items requires the necessary locomotor skills, important in the case of hominins as they converted from 4-legged walking to two legs. Thirdly, hands are used in the preparation of food in hominins, as in most primates, and the human hand changed little from the morphology present in many fossil apes. Fourthly, mastication of food is related to morphologies of the teeth and jaws, and the enlarged teeth with thick enamel in later Miocene fossil apes and Pliocene and early Pleistocene hominins is a function of their coarse or hard-object diets. Finally, digestion of food and storage of energy is based on the concurrence of genetic and metabolic factors.

Fossil apes were frugivorous and both arboreal and terrestrial

The earliest fossil apes emerged in Africa during the early Miocene, approximately 25–18 Ma. These apes represented a marked advance over prior primates and were larger (three to four feet long and weighing 10–60 kg) and with a bigger cranial capacity. These early fossil apes had a gracile skull, low alveolar prognathism, and relatively small teeth. They were pronograde tree-climbers. They have been found associated with both tropical rain forest and tropical woodland environments [1–5] and appear to have been mainly fruit eaters [4] and arboreal within these habitats [5].

Evidence for later fossil apes, 16–8 Ma, is that most known species were associated with deciduous woodlands, both tropical and subtropical, and no evidence of rain forest associations has yet been found. Woodlands differ from tropical forest in that they have single tree canopies, making it difficult if not impossible for animals bigger than squirrels to move from tree to tree without coming to the ground [6]. Fossil apes from this period have both arboreal and terrestrial adaptations [7, 8]. The woodlands were seasonal, losing their leaves in the off-season, either cold or dry, with most plant species fruiting only once a year [9].

At the beginning of the Middle Miocene, at about 16–15 Ma, there was an increase in global temperature, and at this time, the earliest migration of fossil apes out of Africa reached Turkey and Western Europe. They are associated with subtropical, summer rainfall woodlands, for example at Pašalar, Turkey [10]. Later species, probably from a separate migration (see below), are associated with subtropical deciduous woodlands in Spain and Hungary [11], and later still with mixtures of deciduous coniferous woodlands and sclerophyllous evergreen woodlands [12–15]. The earliest known hominins at 5-4Ma also lived in tropical deciduous woodland [16–18], and the evidence suggests that this habitat did not differ to any significant degree from that of later Miocene apes.

Shortly after the arrival of apes in Europe, global temperatures dropped sharply, marking a period of aridification and falling temperatures. In Africa, the cooler and more seasonal climate would have had the effect of contraction of equatorial forest and increasing seasonality in woodland habitats, and fossil apes are found not in forest but in seasonal woodland habitats. In Eurasia, the cooling resulted in an increasingly seasonal world in

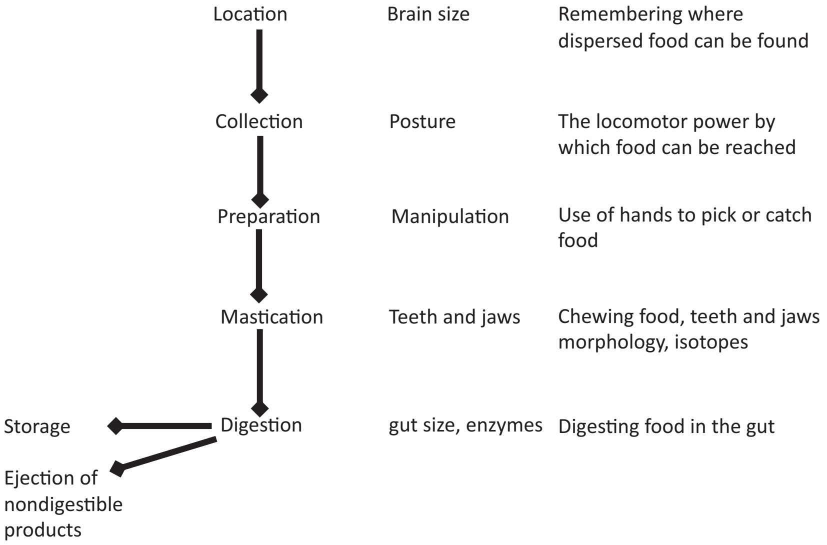

Fig. 1 *Five stages in feeding process in human evolutionary history [4].*

which dry/cold seasons were more extreme and longer [19]. As a consequence, fruits that had been the primary food for apes, became hard to find during the cooler months. Evidence for intermittent (likely seasonal) starvation has been found at Pašalar in Turkey [20], and all ape colonies receded to small regions (refugia) until complete extinction occurred in Europe and Asia, approximately 8 Ma. Nevertheless, there is some evidence, based on the fossil record, that some of the European apes may have migrated back to Africa during this time [20–25].

Uricase mutation and its potential impact on human nutrition

The changing climate placed stress on the fossil apes, and rapid changes in genome occurred during this period [26], and there was a complete silencing of the uricase gene in the great ape and human clade [27, 28]. The observation that a parallel mutation in uricase occurred somewhat later in Lesser Apes (Hylobatidae) during the late Miocene suggests the mutation provided selection (survival) advantage. The effects of the mutation were to shut down the gene and stop the production of the enzyme uricase [19, 27], the function of which is to break down uric acid.

Uric acid is a metabolic product of purine metabolism, and in most mammalian species, it is metabolized by the enzyme uricase (urate oxidase) to generate allantoin. However, in the great ape and human lineage (Hominidae), a progressive reduction in uricase activity occurred due to mutations in the promoter region followed by complete silencing of the gene from mutations in the coding region of codon 33 of exon 2 [28]. The genetic shutdown must have preceded the divergence of the orang utan, for the same mutation is present in this Asian great ape as well as the African apes and humans (Fig. 2). The consequence was a rise in serum urate, likely from levels of 1–2 mg dL^{-1} (based on measurement of uric acid in primates that still carry uricase) to levels of 3–4 mg dL^{-1} (based on studies of great apes and humans living on native (nonwestern) diets [29].

While several potential hypotheses have been forwarded for why an increase in serum urate may have been beneficial [30, 31], one of the stronger hypotheses is that it may have amplified the ability to store fat and glycogen from fruit sugar (fructose) [19]. Recently, it has been shown that where fructose is the nutrient of choice, animals are able to increase their fat stores to protect them from periods where food is not available, such as during hibernation, long-distance migration or nesting [32]. Fructose metabolism, unlike other nutrients, lowers energy levels in the cell, triggering adenine nucleotide degradation and uric acid formation that stimulate fat accumulation and insulin resistance [33, 34]. The uricase mutation results in more uric acid formation in response to fructose, and this translates into higher blood pressure, a greater increase in liver fat and an increase in gluconeogenesis [28, 35, 36]. The ability of the mutation to enhance the ability of fructose to generate fat creates a survival advantage that would be greater in temperate habitats in Eurasia, where dry/cold seasons would have been greater and longer. Thus, the uricase mutation, by amplifying the effects of fructose to increase fat stores, blood pressure and insulin resistance may have acted as a ‘thrifty gene’, providing survival advantage to fossil apes in seasonal habitats during times of food shortage [37].

However, in present human populations, the intake of fructose has increased markedly due to the introduction of refined sugar (sucrose) and the sweetener, high fructose corn syrup. As a consequence of increased sugar (fructose) intake as well as purine-rich foods, such as meat, serum urate is now between 3 and 12 mg dL^{-1}, and those with the higher levels are at increased risk for developing type 2 diabetes, obesity, fatty liver and hypertension [38]. Consistent with these findings, pilot clinical studies suggest reduction in fructose intake [39–41], or a lowering of serum uric acid, may improve features of metabolic syndrome, including blood pressure, insulin resistance, fatty liver and weight [42–44].

Evolutionary adaptations to famine are likely to affect nutrition and metabolic outcomes [29]. On the other hand, the ‘weather hypothesis’ proposes that animals evolved to withstand periods of starvation by changing life history strategies to undergo regular periods of calorie restriction [45]. By this means, lifespan could be maintained or even increased [46–48]. For example, data on time spent hibernating in Turkish hamsters suggest that hibernation in small mammals retards biological ageing in proportion to the amount of time spent in the hibernating state [49]. For animals that do not hibernate, periods of calorie restriction would be a regular feature in seasonal habitats, with animals losing more than half their body

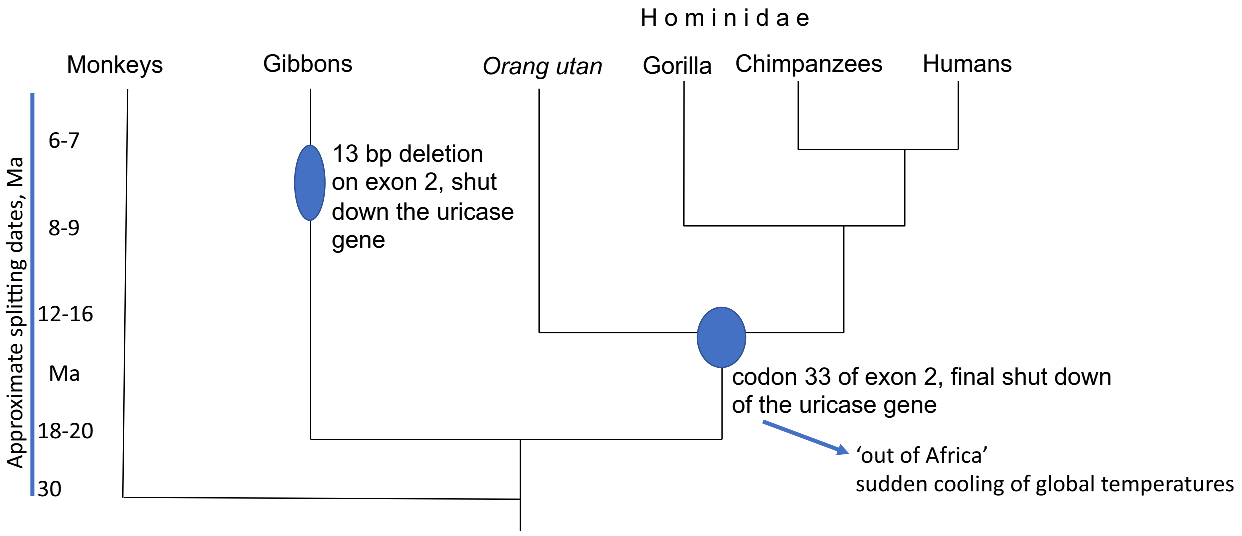

Fig. 2 *Phylogeny of apes and humans, showing the location of uricase mutation in the common ancestor of the great ape and human lineage and the independent mutation in the gibbon lineage later in time [38].*

weight in winters, and the 'weather hypothesis' proposes that this is a biological or evolutionary strategy rather than necessity imposed by occupation of strongly seasonal habitats. As prolonged periods of fasting activate Nrf2 in animals [50] and man [51], it can be hypothesized that up-regulation of this anti-inflammatory cytoprotective transcription factor may contribute to the survival advantage in species that undergo fasting.

Early hominins: adaptations for bipedalism

The evolution of bipedalism has often been assumed to be due to leaving the shelter of forest and woodland and coming down to the ground, and it has been further assumed that upright posture was both a necessary pre-adaptation for bipedalism and itself an indication of its presence. The former may be true, but the latter is clearly not, for upright posture is present in many fossil apes that manifestly were not bipedal. Upright posture is seen in adaptations of the axial skeleton, such as reduction in lumbar vertebrae, broadening of the chest and long clavicle, and these are character states present in some later Miocene apes and all hominids, that is the great apes and humans. The earliest adaptations for bipedalism in human ancestry took place in deciduous woodlands, similar to those occupied by fossil apes for the 5 to 9 million years previous to the appearance of hominins [16, 17, 52, 53]. Seasonal climates and diets composed largely of fruit were retained in the earliest hominins [18].

The present evidence suggests that adaptations of the hip and feet were amongst the earliest to change at 4-3Ma [54–57]. Even after broadening of the ilium in *Ardipithecus ramidus* [58], the foot from the same individual [59] still retained a divergent and grasping big toe. Similarly, lengthening of the legs had not taken place in early hominins and the earliest evidence is on the australopithecine called 'little foot' at 3.6 Ma in South Africa [55, 56], where leg length exceeded arm length (Fig. 3). Human striding ability was not fully established until 1.8–2.0 Ma with the appearance of *Homo erectus*.

Bipedalism may have provided some evolutionary benefits other than as a form of locomotion, such as the fact that an upright posture may have been improved heat control by reducing exposure to sun and enabled long-distance running [60–63]. On the other hand, if bipedalism evolved in woodlands, not savannah, heat stress would not have been significant. Four-footed canid species are able to run down their prey over long distances, and so that these features of bipedalism would seem to be side effects rather than a major contributing factor in the evolution of bipedalism. Its major evolutionary advantage is that the forearms are released from their locomotor function and hands become free for other uses.

Fig. 3 *The skeleton of STW573 from Sterkfontein [56]. Copyright paul john myburgh (with permission).*

Many animals use their 'hands' for feeding, for example most rodents, many carnivores and all primates, but use is restricted because nearly all of them use all four legs for locomotion. Freed from locomotor function, mobile arms and prehensile hands (long thumbs and short fingers) are essential feeding tools for fossil apes and hominins at all stages of evolution. All fossil apes as known at present had long thumbs and had a form of precision grip analogous with that of hominins, such as *Ardipithecus ramidus*. However, known fossil apes had nonrotatory joints of the thumb [64], but the human thumb rotates at its joint to form the uniquely *human precision grip between thumb and fingers* [65, 66]. The human precision grip is unique to humans, and its function is dependent on freeing of the hands from locomotor function.

Bipedalism and dietary change

Most of the evolutionary developments of bipedalism and freeing of the hands are interlinked, and all are linked with the environment and diet. They did not, however, all occur at once. The earliest hominins lived in similar environments and had similar diets to those of fossil apes [67, 68], in both cases with low quantities of animal products being eaten, as in living chimpanzee populations [69–71]: chimpanzees hunt and eat smaller animals, providing survival value during dry seasons when fruit is scarce [69–73]. However, the quantity of animal products in chimpanzee diet is below 10% and, thus, below the threshold of omnivory. It is likely that the last common ancestor of chimpanzees and humans also ate some animal products, and since early hominins remained in the same woodland environment as fossil apes and still remained dependent on trees for food and shelter, it is likely that this diet remained with little change for the first few million years of human evolution (5–3 Ma) [53].

At 3 to 2 Ma, major evolutionary changes occurred in hominin diets. During this time, there was another period of global cooling [74, 75] and the formation of the rift valleys [76], which brought about changes in wind and water flow across the continent [1] and increasing climatic seasonality. This had a major impact on animals depending on fruit for the main part of their diet, resulting in reduced availability of fruit during the drier or cooler months, and even fall-back foods, such as leaves and bark becoming scarce. Figs would have partly mitigated the seasonal shortages [77] and no doubt scattered fig trees would have been highly prized [53]. Evidence of dietary stress is seen in the teeth of fossil apes living 15 Ma in Turkey, some of which have prominent hypoplastic lines (Fig. 4), formed during periods of disease or starvation, and patterns of cyclical growth/stasis have also been found in South African australopithecines, also attributed to seasonal changes in food availability [78].

Dietary shift from fruit (Frugivory) to include animal products (Omnivory)

Early Miocene forest-living apes had relatively small molar teeth, but most of the later Miocene apes had relatively larger molars with thick enamel [79], as in early and later hominins (but not as enlarged as in australopithecines). Nearly, all had posterior teeth with rounded cusps, and some had thick enamel. There was little change in molar and premolar size between later Miocene apes and the earliest hominins, including early species of *Homo*,

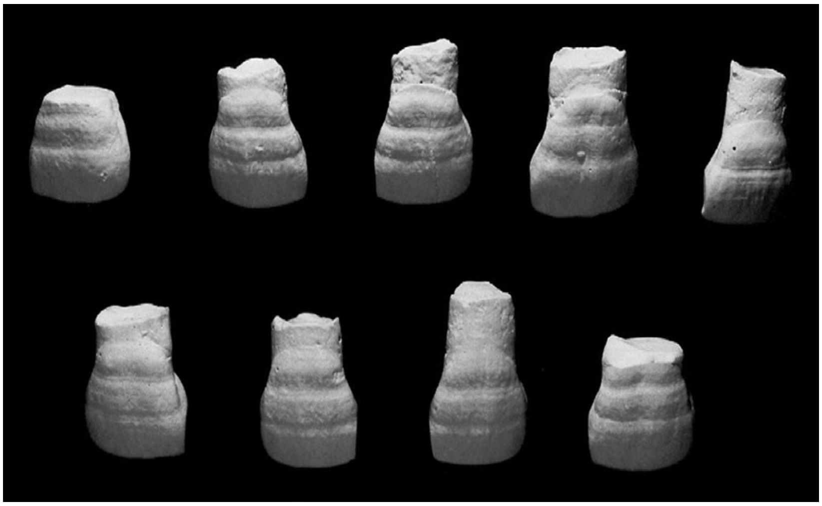

Fig. 4 *Double hypoplasias on the teeth of 9 individuals of* Kenyapithecus kizili*, 15 Ma from Turkey [25]. Copyright Jay Kelley (with permission).*

and tooth size reduction did not occur until the time of *Homo erectus*. Canines were generally large and projecting with P_3 honing, whereby the front of the premolar rubs against the back of the projecting upper canine (Table 1). At least one putative hominin, *Ardipithecus kadabba*, had a single-cusped lower premolar honing against the upper canine [53]. The large canine in apes is not linked to diet as it is in most carnivorous animals but is the product of sexual selection, used by males in particular in sexual displays [80]. Reduction in canine size and loss of P_3 honing help define the origin of the human lineage.

Fruit continued to be important in early *Homo,* for example *H. habilis*, which also was associated with more open woodland environments [81, 82]. Fruit was probably still an important part of the diet, for *H. habilis* teeth were still large, but the presence of increased meat in their diet is shown by the

Table 1. *Summary of the morphological trends in apes and humans. See text for explanation of character states*

	Fossil apes	Great apes	Early hominins	Australopithecines	Homo habilis	Homo erectus	Homo sapiens
P_3 honing	Present	Present	Lost	Lost	Lost	Lost	Lost
Molar size	Small to large	Small to large	Large	Large	Very large	Reduced	SMALL
Leg length	= arms	Short	Short	Short	?	Long	Long
Body size	Small	Large	Small	Small	Small	Large	Large
Sexual dimorphism	High	High	High	Moderate	Moderate	Low	Low
Arboreal adaptations	Present	Present	Part lost	part lost	Most lost	Lost	Lost
Ilium	Long, narrow	Long, narrow	Broader	Very broad	Broad, curved	Curved	Curved
Gut size	?large	Large	?large	?large	Smaller	Small	Small
Brain size	Small	Small	Small	Small	40% larger	40% larger	50% larger

presence of cut marks on animal bone made by stone tools. Cut marks are striations incised into bone by hard objects such as stone or shell, and examination of the marks provides information about the nature of the tool, the direction of the cuts, the handedness of the operator and the reason for the cut, for example filleting muscle or cutting tendons [83–86]. In addition, the type of bone and species of animal being butchered provide further information, and the superimposition of cut marks and carnivore chewing may distinguish between primary and secondary access to carcasses, that is between predation and scavenging [86]. Before the advent of stone tools, it is probable that tools were made from perishable materials such as wood, as used by chimpanzees today, but these leave no marks on bone. Earlier use of stone tools has to be viewed with caution because cut-mark mimics can be made by trampling [87–89].

The increase in animal products in the diets of hominins marked a major change in human evolution, and it is associated with the first increase in brain size soon after 3 Ma, as seen in *Homo habilis* [90]. This increase is also linked in time with the appearance of stone tool technology. Before this time, hominins had small brains and teeth adapted for relatively soft fruit diets. The brain is an 'expensive' tissue, using about 20% of energy in modern humans compared with 8% in living apes [91]. The other expensive tissue is the gut, for the food that primates ate was not like the fruit and vegetables we consume today but were relatively hard-coated and often having secondary compounds that either inhibited digestion or were to some degree poisonous. As meat-eating began to increase and was easier to digest than vegetable matter, the gut began to decrease in size and length [91]. As the metabolic requirements of the gut declined, the surplus energy could be channelled into brain size increase (Fig. 5), with approximately 30–40% increase in *Homo habilis*.

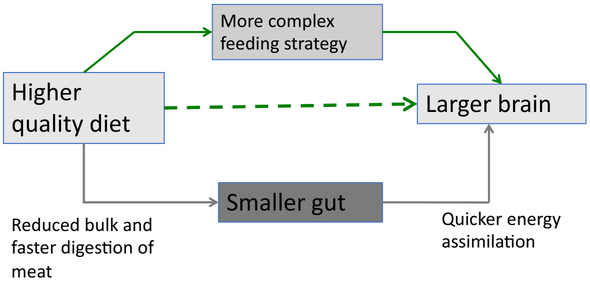

Fig. 5 *Expensive tissue hypothesis: our large brains came at the metabolic expense of our guts, which shrank as our brains grew as a result of more complex feeding strategy. Adapted from [91].*

Homo erectus and the introduction of controlled fires

Homo habilis still had some ape-like features of the skull and limb bones, but with the appearance of *Homo erectus* soon after 2 Ma this all changed. The legs lengthened to similar proportions in modern humans (although at least one species of *Australopithecus* had lengthened legs [56]); body size increased, approaching modern human size, and sexual dimorphism decreased to less than that of australopithecines and the great apes; adaptations of the shoulder, hands and feet for arboreal locomotion present in australopithecines and to some extent in *H. habilis* were lost; the lower part of the rib cage became less flared indicating less space of a smaller gut. There was another 40% increase in brain size compared with *H. habilis* and more than double the size in australopithecines and great apes; and tooth size was reduced compared with Pliocene and early Pleistocene hominins (and australopithecines) (Table 1). There was total reliance on terrestrial living, with greater emphasis on eating animal products, greater brain size and smaller gut. It is surely no coincidence that *Homo erectus* was the first hominin not only to spread out of Africa but to extend its range across Europe and Asia to Java within a period so close in time that their times of arrival cannot be discriminated with present methods of dating (1.8 Ma in Kenya, Georgia and Java). It has been proposed that the adaptation that promoted all these changes was the controlled use of fire for food that has been cooked is both easier to digest and produces more energy per food item [92].

The control of fire was critical in human evolution for many reasons. For a start, fire provided protection against predators since most animal's fear fire. [93] By controlling fire, hominins were able to leave the shelter of the trees and move into open savannah and spread across Africa and into Europe and Asia. Secondly, they could use fire to cook food, which produced many advantages: it made food, and especially meat and seafood, safer to eat. Scavenging from rotting carcasses would have been safer as the many pathogens in the meat would be killed by fire. It made all kinds of food easier to eat and digest, adding to the nutritional value of the food; vegetables become softer and easier to chew, and animal products become denatured and easier to digest, yielding energy more quickly. Chimps and other animals prefer cooked food if it is made available and are better nourished as a result. Finally, cooking makes most kinds of food smell and taste better and makes it more palatable. The immediate effect in human evolution would have been the sudden availability of increased sources of energy from the same quantities of food products [92] and, combined with the ease of digestion, would have allowed the increase in brain size at the expense of the gut [91].

Evidence for controlled use of fire is hard to distinguish from natural fire [93], but the presence of burned bones and ash deposits in Wonderwerk Cave is perhaps the best substantiated use of fire and dates to at least 1Ma [94, 95]. It is probable that fire was first used as a means of protection against predators in environments where trees were not available, and only later was it found that putting food, whether seeds and nuts or shellfish, and pieces of meat, into the fire made them more palatable. It was almost certainly one of the factors that allowed *Homo erectus* to migrate out of Africa and into cooler temperate zones and survive the long cold winters.

In conclusion, the diet of early hominins is linked with many other aspects of their daily life. Originating as obligate frugivores, they changed to a more carnivorous diet in early *Homo*, enabling skulls and brains to get bigger and their teeth and guts smaller. *Homo erectus* populations learned to control fire enabling them to leave their ancestral woodlands and spread into open savannah habitats. This in turn enabled them to travel long distances and populate parts of Europe and Asia. In open country, they would have formed larger social groups both for protection and for hunting or searching for food, their body size increased and they perfected bipedal walking (Table 2).

Diet in later stages of human evolution

It has been seen that early hominins ate a diet of fruit similar to that of fossil apes and lived in similar environments to those of ancestral apes. Increase in meat-eating, and the move from wooded habitats to more open ones, is linked with the emergence of the genus *Homo*. *Homo erectus* completed the move into savannah habitats [96, 97] across Europe and Asia. The importance of animal products in the diet increased still more with the control and use of fire for cooking it: mammalian prey is associated with hominins at most sites, together with birds, fish and shellfish, but nearly all for which evidence is available indicate freshwater aquatic systems [98]. Marine shellfish were exploited by some populations of large-brained hominins, which are currently divided into a number of different species based mainly on geography. We will treat them here as a single superspecies (defined as a group of largely allopatric species which are descended from a common evolutionary ancestor and are closely related but too distinct to be regarded as subspecies of one species – Oxford English Dictionary). They probably all had similar diets [91], shellfish being seasonally important in some populations

Table 2. *Climate trends and dates for taxa of apes and hominins, the vegetation associated with the taxa, the type of locomotion and degree of arboreality or terrestriality, the main diet and the distribution in and out of Africa*

Climate	Taxon	Vegetation	Locomotion	Diet	Distribution
Stable warm climate	Forest apes	Tropical forest	Arboreal	Fruit	Africa
Rapid cooling 15 Ma	Woodland apes	Deciduous woodland	Semi-terrestrial	Fruit	1st dispersal out of Africa
Little change 8–6 Ma	First hominins	Deciduous woodland	Semi-terrestrial	Fruit	Africa
Rapid cooling 3 Ma	*Homo habilis*	More open woodland	Terrestrial, bipedal	Omnivorous	Africa
Rapid cooling 1.8 Ma	*Homo erectus*	Open savannah	Terrestrial, bipedal	CarnivorousFire, cooking	2nd dispersal out of Africa
Large shifts in temperature after 800 kyr	*Homo sapiens*	All habitats	Terrestrial, bipedal	CarnivorousFire, cooking	2 + dispersals out of Africa

[98], and all had control of fire. They are presently geographically distinct, and culturally, they mark the transition from Early to Middle Stone Age. This change is linked with greater foraging distances and more active hunting, but addition of shellfish may have broadened the hominin dietary niche [98]. Cannibalism was practised by all members of *Homo* for at least the past million years [99–101].

The earliest record of modern humans (*Homo sapiens*) is at 300 kyr at Jebel Irhoud, Morocco [102], with later occurrences in Greece (Apidima, 210 kyr) and the Middle East (>100 kyr). *Homo neanderthalensis* and *H. heidelbergensis* are known from deposits at least 500 kyr, and the last common ancestor of this group of species was probably at least 600 kyr. All are associated with a continued hunter–gatherer existence until approximately 10–12 kyr ago, when early settlements were formed with evidence of domestication of cattle and sheep and the introduction of farming. One of the first crops to be cultivated was the fig [103] followed by wheat and barley. The introduction of farming ushered in improved means for providing steady sources of food.

The introduction of wheat and barley resulted in an increase in starch intake. Starch requires the enzyme amylase to break it down to glucose. It is interesting that during this time there were some genetic changes in which the amylase gene underwent multiple duplications, thereby resulting in relatively more amylase that would have made the digestion of a starch-enriched diet easier. There is evidence that people from farming communities have higher amylase gene duplications than those who still maintain a hunter–gatherer existence [104, 105]. Thus, genetic adaptations have continued to occur in response to dietary changes [106], but the remarkably low genetic variation in present-day populations, much lower than is present in closely related chimpanzee populations [107] may hinder the adaptive potential of dietary change.

Today most humans are eating high sugar, salt and fat diets easily available at a local grocery store. In addition, there has been a decrease in intake of foods that can activate antioxidant (such as Nrf2) pathways [108]. From an evolutionary basis, we are still adapting to this rapid change in our diet and environment. Understanding the nature of how we evolved and were influenced by diet provides insights into human disease. An example is the recognition that evolutionary changes to aid survival in the past may not necessarily translate into benefit with our current environment, lifestyle and diet [19]. Knowledge of evolutionary biology provides important insights into current human conditions.

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