Are Humans "Omnivores"?

John Coleman, 2008

Introduction

It is not unusual to hear the claim that humans are "omnivores", even authoritative text books and research papers use this term. Unfortunately the meaning of this term is somewhat vague. On the one hand, the term omnivore can simply be used to describe animals that eat plant or animal foods, and on the other, it may be used to infer that an animal is biologically adapted to consume both plant and animal foods, and perhaps, that it is supposed to do so. A broader, and perhaps more appropriate definition of an omnivore, would refer to animals than can consume all kinds of food. This is because omni derives from the latin *omnis* meaning all.

Therefore, in common use, the term omnivore may be used to describe both a) what an animal *does* and b) what an animal *is*. Clearly humans are omnivores in the sense that they do eat both plant and animal foods. As an example of the contrast between is and does, cattle consume animal remains in contemporary farming practices, yet cattle are still considered to be herbivores - though they could be said to be omnivores in that they can eat an omnivorous diet. This article addresses the suggestion that humans are biologically omnivores, because this is what people infer when they say "humans are omnivores".

Establishing a testable criteria for omnivorism

There seems to be no scientific procedure by which to establish that an animal is biologically omnivorous, and it is because of this that debate is possible. A reasonable proposition is an omnivore should be able to make both plant and animal foods a significant part of the diet without detrimental effects. To really make a convincing case for an animal being omnivorous we would like to see both biological adaptations to plant and animal foods. Without testable truth claims and concrete evidence, it is spurious to use the term omnivore. Even so, there is quite clear biological evidence, as we shall see, that could confirm that a species is adapted to a diet of both plant and animal foods.

This article is the result of a broad study of scientific evidence to identify human dietary adaptations, and presents data which together suggest that humans meet the criteria for being a *specialist frugivore*, and furthermore we see no compelling evidence that humans meet the omnivorous criteria set out above. Specialist frugivores could be defined as animals that have specialised adaptation to a diet high in fruit. As with other frugivorous animals, this classification is general, and would not necessarily exclude consumption of other kinds of plant matter, i.e. non-fruit plant foods, or even animal matter as lesser constituents of the diet. A specialist frugivore is therefore to be seen as distinct from an omnivore. An omnivore should be capable of eating significant amounts of animal matter, without detrimental effects, and would have clear adaptations to such a diet in order to make the claim convincing.

In this article I assume that the dog or pig is an archetype for the omnivore, because we know they well tolerate both plant and animal matter as a regular and significant part of their diet, and because they are well known to eat just about anything that is edible. However, many non-human primates include significant amounts of animal matter in their diet, and so might make a better comparison. Unfortunately, little is known and documented about how well the great apes, the group of animals to which humans are most closely biologically related, tolerate significant intakes of animal matter, and furthermore, primates seem far more selective with their food choices than the archetype omnivores suggested.

There are some confounding issues with studying primates. The non-human primates, like humans, are capable of learning new eating behaviours and forming localised food cultures, such that it may not be easy to generalise about their diets. Therefore, when we see one group of a species of primates consuming a diet that is mostly plant based, and another group of the same species that is consuming much more animal products, it doesn’t follow that the primate is omnivorous by biological adaptation - we may have a case of *does* an omnivore diet, rather than *is* an omnivore biologically. This we discover exactly the same issues that occurs in calling humans omnivores.

The Flawed Philosophy

Before examining the scientific evidence, there are serious problems with the proposition that humans are omnivores. These philosophical issues fall into 2 distinct camps. Both of these issues seem to make the topic unsuited to scientific discourse.

1) Lack of a testable proposition

Claims that humans are biological omnivores are hampered by the lack of any clear set of rules (i.e. a testable hypothesis) for establishing what an omnivore is. Some authors describe an omnivore as an animal that is neither a herbivore nor a carnivore. However, a definition of what something is not, is not a classification, in this case omnivores are said to be "non-specialists", able to eat either plant or animal matter. But these kinds of poorly constructed pseudo-definitions are weak, because under conditions of domestication where technology is applied to foods, even unequivable herbivores can consume processed animal remains.

2) Confusion of similarities and equivalences

Food processing technology can bypass adaptations, allowing animals to consume things they would naturally be incapable of aquiring or consuming. Indeed the use of technology in preparing foods would tend to indicate a lack of adaptation. Specifically, the applying of food processing technology, i.e. hunting with weapons or trapping, cutting, cooking and tenderizing, to render animal matter edible, seems to contradict the notion of humans being adapted to capturing and consuming animal matter. There is clearly a world of difference between wild animals which naturally procure and consume animal foods, and civilised humans who consume meat, which is technologically processed animal matter. Similar arguments can be made regarding other foods that humans must process using technology before consumption.

As has been demonstrated, while there is clearly a similarity in that both humans and non-human animals exist that eat practically anything edible, the behaviours are in fact not equivalents. Wild animals procure and consume their food by using innate biological systems, whereas humans obtain and consume a wide range of foods as a result of technology.

If we are forced to concede that humans can be called omnivores, even though this results from the use of technology, then we must also accept that humans can fairly be called birds as a result of using flying machines, and fish as a result of using underwater survival technology. Such positions are unacceptable, and if persued, only convince us that the claim that humans are omnivores, is not based on any form of natural equivalence, as proponents intend when they claim that humans are omnivores.

Classification Confusion

Because the term omnivore is vague, it is not surprising that authors often differ in their classifications of the dietary status of animals. Pilbeam(9) describes apes as very broadly "herbivores", as do Yerkes and Yerkes(4), whereas Maier(2) says primates should be considered to be "omnivores". Opinions on how to classify primates in general, and chimpanzees, our closest genetic relatives, seem to be at varience.

In order to classify digestive systems, Chivers has performed some of the most extensive study of mammal digestive system anatomy, yet his research on humans is inconclusive. Summing up in 'Diet and Guts'(1) he states that human gut anatomy is characteristic of meat-eating, or some other rapidly digested foods. However, his plots show the human digestive anatomy is at the edge of the "carnivore" cluster. Even more critically, at the centre of the "carnivore" cluster is Cebus capucinus (the white-fronted capuchin). According to The Pictorial Guide To The Living Primates, Cebus capucinus eats 95 types of fruit that make up 65% of its diet, while leaves make up 15%. The remainder of the diet consists of berries, nuts, seeds, shoots, buds, flowers, gums, bark and animal matter including insects, in that order. Cebus capucinus is primarily a foli-frugivore, not a carnivore, but they have also been called omnivores, because they consume a range of animal matter. Cebus capucinus is rumoured to have a digestive system somewhat like humans, and Chivers chart demonstrates some similarity, but his carnivore data set seems to be misleading, and is not objectively defined. We should be careful with using concepts such as "similarities", because they are subjectively formed.

Of the few examples of other species categorised as omnivores, none seem to closely resemble humans in their anatomy, unless perhaps the chimpanzee is to be categorised as an omnivore. However, the chimpanzee is often described as a frugivore, or foli-frugivore although others call it an omnivore and as we shall see, human anatomy is distinct from the chimps. Presently, there is no precise system for classifying a species diet based on either its anatomy or behaviour. Anatomical observations can be misleading, for example Milton(7) points out that the panda bear is said to have a digestive system that resembles a carnivore(p. 14), yet it normally eats a herbivorous diet - is it an omnivore? Furthermore within the order Carnivora species that all share anatomical traits (by definition) have diets that vary from pure carnivory, through omnivory to frugivory(p. 14).

Chimpanzees favour a high fruit diet when fruit is in season but diversify, and may include more foliage and animal matter when fruit supply is sparse. Furthermore, chimpanzees also have food cultures and procure foods using primitive "tools" (not technology), so that as with humans, their diet may not reflect their adaptations as much as local habitat, traditions and learnt behaviour to deal with food shortages. We might accept this as a good example of omnivores, but even rabbits engage in mild cannibalism, and many other "herbivores" are known to eat their placentas. Herbivorous species will also eat animal matter under captive conditions, and most "herbivores" will ingest incidental insect matter along with foliage, but this doesn't seem to allow us to call them omnivores.

It seems that an opportunity to eat nutritious food is not passed over by wild animals, even when it involves a herbivore consuming its own placenta. On this basis then, we might conclude that all mammals are "omnivores" - however a catchall definition is not really a category and such broad categorisation would allow similarities to be passed off as equivalents. Clearly, there are issues of frequency, quantity and type of animal matter consumed. These need quantifying before a species can be called an omnivore in the biological sense. Such clarification needs to separate animals that infrequently eat flesh in small amounts, or under unnatural conditions due to domestication or unusual environmental pressures, from those that eat animal foods more uniformly, and tolerate such a diet without detriment. Some might suggest that the practice of varying the diet under environmental pressure is what sets omnivores apart from carnivores and herbivores, and that such a behaviour is evidence of omnivory.

Having studied a significant amount of literature, it becomes obvious that as yet academics have not produced the kind of systematic quantified and widely agreed definitions found in and expected of a precise science. There are significant inconsistencies in classifying primate diets.

Note: In this article, 'animal matter' usually implies vertibrates, but may include insects.

Digestive Anatomy

The digestive system in humans is dominated by intestines that are relatively larger than in other primates, and a colon that is relatively smaller. Overall, the human digestive system is also a less significant portion of the body when compared to other primates. According to Milton(7) the human small intestine makes up greater than 56% of the total gut, whereas the colon makes up only 17 to 23%. However, in all other apes the colon makes up greater than 45% of the total, and the intestines from 14 to 29%. This corroborates Chivers findings, and demonstrates that the human digestive anatomy is in a class distinct from the other apes. This being the case is logical to look outside of the apes for a species that might better match our digestive anatomy, perhaps at monkeys, birds or bats.

In general, larger primates including all of the great apes are foli-frugivores but eat some animal matter, and the smaller are usually faunivores (Tarsius sp.) that may also eat fruit (e.g. Galagoides demidoff). Amongst the primates only Callithrix humeralifer (tassel-eared marmoset) and Ateles paniscus (black spider monkey) eat more than 80% of their diet as fruit (11), with the remainder coming mainly from gum or foliage respectively and then a small percentage from animal matter. The tassel-eared marmoset is almost totally frugivorous, in that the gums that make up 17% of its diet are also chemically similar to fruits in being primarily a source of carbohydrate. The remaining 0.5% of feeding time is spent on ingesting small insects. Strong frugivory is therefore found in only a couple of species out of the 234 known primate species.

A study of the literature on functional anatomy reveals that foliage is digested mainly in highly sacculated stomachs or haustrated colons. These adaptations dramatically increase the gut volume for a given length, thus slowing digestion down so that bacterial fermentation can occur. Humans also have haustrated colons, but the degree is not as great as in the great apes. The foods which digest mainly in the intestines are animal matter and fruits, which can be broken down speedily compared to leaves, due to lack of the indigestible cell walls found in foliage.

Chivers work omits birds and bats, so also omits any highly frugivorous species. It is only amongst birds and bats that we encounter animals that live exclusively on fruits such as the totally frugivorous pteropodid bats. It's worth noting that fruits are often infested with insects, so that frugivores are incidental insect eaters. Jordano mentions in his chapter 'Fruits and Frugivory'(5), that a gut dominated by the intestines is also characteristic of strong frugivores (p.145). For example frugivorous bats such as Wahlberg's fruit bat are reported to have small intestines that makes up 94% of the total digestive system(16), although frugivorous bats may spit the fruit fibres out, ingesting only the juices. Jordano also points out (p.138) that frugivores require no special adaptations or special digestive processes for processing fruit, the same claim usually made for "omnivores".

In contrast to Chivers findings(1), Hladik, Chivers and Pasquet(12) plotted the area of functional mucosa vs. functional body size for folivores, frugivores and faunivores, and found that humans fitted the frugivore trend. Each trend line was completely separate in this study. This technique therefore seems to be somewhat more accurate at prediction than Chivers methods, yet both researchers basically confirm that human gut anatomy is effective for speedily digested foods.

In summary, digestive anatomy research shows features of the human digestive system consistent with a diet of foods digested more rapidly than tough plant fibres. The surface area to functional body size ratio is consistent with that of frugivores. In terms of ratio of intestine to colon, humans fall between the figures found for the foli-frugivorous apes, and the extreme condition of soft fruit and juice eating bats (see table below). The digestive system in humans is dominated by the small intestines, a feature common to frugivores, but also to faunivores and omnivores.

Proportion of Intestine and Colon in Apes, Humans and a Frugivorous Bat

	Great Ape	**Human**	**Frugivorous Bat**
Intestines	14% - 29%	56%	94%
Colon	45%	17% 23%	4%
Diet	Foli-frugivore	Intermediate?	soft fruit/fruit juices
Fruit	~64%*	?	~100
Fibres	~27%*	?	~0 (ejected)
Animal Matter	~4%*	?	~0

* for chimpanzees (The Feeding Ecology Of Apes, Nancy L. Conklin-Brittain,1 Cheryl D. Knott,1 and Richard W. Wrangham)

Reducing the highly complex digestive system to a few simple measurements and in the absence of consideration of the chemistry and physiology is over-reductive. Digestive system anatomy can tend to reflect the physical properties of the food, rather than the source of food, and as such cannot determine the fine details of the diet, or may be misleading and is certainly inconclusive. Even so, there is no reason to exclude humans from being classed as highly frugivorous based on their digestive system anatomy.

Oral Features

Just as human digestive anatomy does not reflect the trend found in the great apes, similarly humans have dental and oral anatomy that sets them apart from nearly all of the other primates. In the great apes, prominent canine teeth are the rule, and they play a role in display, defence and in feeding. The remaining teeth are however strikingly similar to human teeth, for example, bonobo teeth and human teeth look almost identical, as pictures in the book 'Bonobo: The Forgotten Ape' reveal(10). This suggests a very similar diet or dietary strategy and thus evolution. In contrast to the other great apes, the human canine tooth is no longer prominent and resembles the size and shape of the incisors. Because of this similarity, human canines are known as "incisiform" canines, and it has been suggested(8) that they function as extensions of the incisors and by analogy perform the same function.

Incisiform canines that are large and spatulate are found in herbivores. The Dusky Titi monkey whose diet is 54% fruit, 28% leaves and 17% insect(11) also has incisiform canines(27). According to Pilbeam(8) "absolutely and relatively large incisors are correlated with food procurement tasks (what must be done to obtain bite-sized portions), such as biting into large fruits with hard rinds." A depiction in Dental Functional Morphology by Peter W. Lucas (p. 130), shows the functioning of incisors in primates as either removing the flesh of fruits, or stripping leaves from branches. Furthermore, humans have in common with animals that regularly suction-feed; a small mouth, a smooth and vaulted palate, a smooth and round tongue that can be shaped to fit tightly against the palate, a closed parabolic upper tooth row without long canines and diastemas, and a descended larynx(27). The human mouth is superbly adapted to scooping out and pulverising juicy fruits.

The dental and oral anatomy of humans is entirely consistent with that of a frugivorous great ape, with the addition of canine teeth further adapted to a biting plus suction fruit diet. Canine teeth still develop from a structure that is pointed, but juicy fruits have probably played such a significant role in human evolution that selection in favour of thick enamel outgrowths has taken place, so that they have evolved to form an incisor like “canine”.

Digestive Transit

Anyone who has observed the rate at which carnivorous and herbivorous species chew, cannot fail to see how slow herbivores chew - indeed many carnivores hardly chew at all before swallowing. According to Lucas (ibid., p.148) humans chew at a rate of 1.3 per second. In contrast pigs and dogs (archetype omnivores), chew at a rate of 3.03 and 3.16 per second respectively, whereas mountain goats chew at a rate of 1.28 per second - a rate consistent with a range of herbivores of a similar size to humans. Humans seem to eat too slowly when compared to the archetype omnivores.

According to Jordano(5), In order to receive sufficient protein from a high fruit diet, strong frugivores must consume large quantities of fruit which they digest and eliminate rapidly. Chivers concludes that the human digestive system is adapted for rapidly digested foods(1). Milton's paper(7) claims that the human digestive system is still in its ancestral slower digesting herbivorous state. If humans really are adapted to meat eating, and as alleged by Chivers meat is rapidly digested, then why do the subjects in Milton's study only digest slowly like herbivores?

According to Milton, mean transit time for liquid markers in chimps fed high fibre diets (a more natural scenario) is 35.1±2.3 hours, whereas in humans the figure is 38.9 to 61.6 hours for high and low fibre diets respectively (results for particle markers are similar). Evidently, despite the relative lack of haustration in the human colon, the human does not digest the cultural "omnivorous" diet faster than a chimp that has to break down tough leaf matter for a day and a half. According to Burkitts figures(13) only rural villagers on a high fibre diet have transit times comparable to those of the chimpanzee. In contrast, those that eat more processed Western diets had transit times from 42.4 hours for UK vegetarians to 83.4 - 144 hours for naval persons. It's worth pointing out that contemporary human "omnivores" suffer appendicitis, diverticular disease, cancer of the colon, indeed some 40% of the UK population suffer from constipation(14), while haemorrhoids affect about a third of the population, and about 2 thirds of the older population. It is not clear how these medical issues affect comparative digestive studies that include humans.

In Miltons study, all of the great apes studied and humans had a time of first appearance of digestive markers of roughly 24 hours. In the archetype "omnivore", the dog, mean transit times of 37.4 hours reduced to 28.7 when more fibre was added to their diet(15) - however time of first appearance may be much faster. Milton gives figures for some carnivores, which show that they digest and eliminate faster than humans can on high-fibre diets.

Research on digestive transit times seems to fit uncomfortably with the findings on digestive anatomy. Domestic dogs don't seem to digest meat centred diets faster than chimpanzees fed high fibre diets or humans fed high fibre diets, although they do so when more fibre is added to their diet. It may be that mean transit times are more reflective of diet and body size than anatomy. Reasearch on humans has also found that the addition of meat to the diet correlates with reduced transit times (17), a risk factor for cancer (17,18). Research on transit times seems limited to too few species and observations. However, Miltons study is not consistent with humans being efficient meat eaters. Futhermore, digestive transit times for meat in humans may be artificially lower due to artificial extraction of blood, from which the high iron content promotes constipation.

Biochemical Factors

Following the trend of humans being an outlier from great ape digestive anatomy, it is perhaps not surprising to find that our nutrient requirements are also unusual. The nutritional makeup(19) of human breast milk is shown in the table below along with that of great apes.

Primates	**Total Solids (%)**	**Protein (%)**	**Fat (%)**	**Sugar (%)**	**Ash (%)**
Human(*1)	12.5	1.0	4.4	6.9	0.2
Great Apes (*2)	11.5	2.8	3.0	5.5	0.2

The composition of primate milks. (*1) Homo sapiens, Packard, 1982; (*2) Pongo pygmaeus, Pan troglodytes, Ben Shaul, 1962; Gorilla gorilla, Tailor & Tomkinson, 1975;

The great apes produce milk that contains nearly 3 times as much protein as human milk, and slightly less sugar and fat. This is not surprising because human babies are born in a comparatively immature state of development because their relatively large head must pass out through the limited aperture of the cervix, while the body is still immature. The lack of development of the human infants body, and its relative immobility, is parsimonious with a low protein and energy milk that is consumed frequently.

The characteristic lack of development of the human body versus head development is called desomatisation, and is a characteristic of primates in general, as Terrance Deacon explains in his book '*The Symbolic Species'(20)*. According to Harper's Biochemistry, 24th Ed., the average male human body is 17% protein (p. 6), of which most is muscle. Human muscle is from 18 to 20% protein, whereas brain tissue is only 8% protein(21) but has double the fat of muscle. The proteins in brain tissue are also far longer lived than in muscles. Brain tissue is therefore cheap in terms of protein requirements compared to muscles.

Approximate figures derived from work by Nancy Lou Conklin-Brittain et al.(22), show that wild fruits eaten by chimpanzees are on average 0.9% protein, 4% carbohydrate (1% sugar and 3% fibre) and about 0.4% fat. As adult requirements for nutrients are lower than those required for growth and development, it is easy to see why chimpanzees can manage to live off fruits as a high proportion of their diet. By analogy a similar situation should follow for humans, with a lower protein requirement, and perhaps a greater requirement for sugars to fuel the brain, as glucose is the primary metabolite of brain tissue.

Human biochemistry is poor at dealing with high protein intakes, as one might expect of a species adapted to a high fruit diet. When dietary protein intake exceeds about 100 to 150 grams of protein per day infant birth weight has been found to be reduced(23). At higher levels of protein intake a deadly condition called 'rabbit starvation' is induced(24), although figures vary from 35% of daily calorie(24) intake to 50% of daily calorie intake(23). No similar conditions have been reported in faunivores or unequivable omnivores. In contrast, in dogs that are fed grain based pet foods they are reputed to develop skin and hair problems.

One idea of many anthropologists is that use of animal matter has allowed humans to provision themselves with sufficient additional calories per unit food weight over their original plant based diet, to allow them to evolve larger brains. But as Deacon points out(20), humans grow smaller bodies, not larger heads. Furthermore, this energy boost by consumption of high calorie foods is alleged to be part of a maternal dietary strategy(2). However, according to Speth(23), during this period women commonly experience aversion to meat and meat odours, and cravings are for the most part, for carbohydrate foods. Speth also speculates that high levels of meat during pregnancy may be deleterious to the foetus.

Humans are also unable to synthesise vitamin C, a characteristic unique to herbivores, including the great apes. This, and the fundamental differences in anatomy and physiology described above, should exclude humans from being grouped along with other omnivores, and fit the theory of a strong frugivory in humans. Vitamin C has only a 30 minute half-life in blood plasma, so humans must regularly ingest fresh food in order to maintain a significant pool(31). It is no surprise that fruit was found to be an effective remedy against scurvy.

One of the most common diseases associated with the human consumption of animal products is cardiovascular disease. Atherosclerosis is the most prevelant of the deadly degenerative diseases. According to Harpers Biochemcistry, 4th Ed., "The rabbit, pig, monkey and humans are species in which atherosclerosis can be induced by feeding cholesterol. The rat, dog, and cat are resistant.", and further that "Diets rich in palmitate inhibit the conversion of cholesterol to bile acids." Meat is a rich source of palmitate. On page 281, it is further stated that infrequent large meals versus more continuous feeding, adversely affects cholesterol statis,

Another dangerous affect of eating diets high in meat (or other sulphurous compounds), over plant based diets is the production of sulphuric acid in the colon. Bacteria in the gut will convert undigested sulphur amino acids into hydrogen sulphide (the rotten egg smell), this combines with water and makes sulphuric acid. This is thought to promote a number of diseases as reported in New Scientist(26). It seems that the human colon is after all better adapted to plant foods than meat.

Herbivory is in the genes

Primary hyperoxaluria type 1 (PH1) is a recessive disease in which an enzyme, alanine:glyoxylate aminotransferase (AGT), is mistargetted from the peroxisomes where it functions in the glyoxylate pathway, to the mitochondia (28) where it is inefficient. It can be caused by defects in at least 2 glyoxylate-metabolizing enzymes and leads to excessive urine oxalate excretion resulting in kidney stones and/or calcification of the kidney which can occur in childhood or adolescence. Patients used to die on average at age 36 (29), however vitamin B12 therapy and dietary changes can help to increase life span in certain forms of the disorder.

According to Birdsey et al., "One molecular adaptation to diet that is spread widely across Mammalia is the differential intracellular targeting of the intermediary metabolic enzyme alanine:glyoxylate aminotransferase (AGT), which tends to be mitochondrial in carnivores, peroxisomal in herbivores, and both mitochondrial and peroxisomal in omnivores."(30)

As we have seen, normal humans express the AGT gene effectively in their peroxisomes, but when AGT is targeted to the mitchondria such as in the PH1 mutation, it cannot operate effectively. It can thus be concluded that humans evolved through a herbivorous lineage, having evolved peroxisomes, but not mitochondria adapted to effective glyoxylate metabolism.

Behaviour

The Yerkes spent much of their lives working with primates and studying primate literature. According to Tuttle(4) Yerkes and Yerkes eschewed the "facile" use of the term 'instinct' throughout their book because they had concluded that most apes, particularly infants, will easy accommodate themselves to a wide range of human foods(p. 55). This is presumably the same situation in which we find humans, with no particularly strong instincts to eat particular foods in their natural state. Indeed some of the few drives genuinely found in humans, and therefore perhaps 'instincts', are the sweet tooth, a repulsion to bitter substances and the 'Pica' phenomenon. Humans would certainly not eat the bitter leaves and distasteful fruits that are part of the chimpanzees diet.

An instinctive attraction to the smell of prey species is also not a trait that we find in humans, and would expect of a typical carnivore or omnivore. Fruit eating species locate their foods visually. Archetypical omnivores such as pigs, dogs or bears have acute smell and can locate buried food. Of course, prey can be tracked visually, which is a good method for obtaining some kinds of insects.

According to Chivers(3) humans only make it as omnivores because the application of food processing technologies(p. 4), these allow humans to render tough plant and animal matter edible. He even goes further in stating that omnivorism is impractical because of the inability of any digestive anatomy to deal with significant amounts of tough plant matter, fruit and animal matter. Animals tend to focus on 1 or 2 different food types as the mainstay of their diet.

Without the application of fire and the use of hunting tools, what would ancient human ancestors have ate? Some of paleoanthropology literature suggest that human ancestors were frugivorous, although there is often a suggestion that animal foods were part of the diet, either as scavenged carcasses or as invertebrate matter. Whatever the truth, we do know that modern humans are not attracted to the smell of dead animals. Nor do humans typically hunt down other animals and consume the remains in their bloody raw state, or in the state of decay in which animal foods are sometimes found in the wild when eaten by omnivores. One might suggest that this is due primarily to cultural conditioning, but the facts remain that there are a number of unpleasant risks one faces in eating uncooked animal matter, including various parasites and toxins found in necrotic tissue, and the general unpallettable nature of carrion. Perhaps this is why so much effort is made by humans to disguise the genuine flavour and appearances of animal foods with herbs and other; often plant derived, seasonings a situation not parsimonious with a carnivore or omnivore. In contrast, humans are attracted to the smells of fruits and flowers, and to sweet flavours.

Confounding Issues

According to Milton(7) in a 1904 publication, the physiologists Elliot and Barclay-Smith had declared that the human gut was closer to that of a herbivore than an omnivore. They were either not believed or were forgotten, or perhaps people thought their conclusions imprecise? In the following century far more comparative biology has been performed, and despite (or because of) thousands of dissections, research still seems to be inconclusive.

There are axiomatic issues facing comparative biologists that make it impossible for their venture to yield usefully precise results. The further afield one goes in species gap between man and the subject animal for comparison, the less the chances that one will discover a species that is similar enough to man to be of use. The chimpanzee seems to have become a focus for many anthropologists, but examination of its teeth, faeces and a taste of the food it eats, should be enough to convince anyone that we don't share the same diet as chimps. Chimpanzees are simply not human ancestors, and have followed their own very different evolutionary path for millions of years. In any case, chimps have their own food cultures and environmental challenges, and they can learn new behaviours by observing humans, all of which could confound comparisons.

Perhaps because of the chasm between the great apes, other have chosen to focus on mans more recent ancestors by examining fossil finds, or by looking at contemporary hunter-gatherers. Unfortunately as Lewin commented(25) there is no way of knowing whether fossil finds are our ancestors, or simply our cousins(p. 59). As each new fossil find is incorporated into the evolutionary tree, the tree becomes more complex, and the simple linear view of our alleged ancestry that is presented, has to be adjusted. Lewontin says that "most fossils of different ages cannot be connected in a linear sequence, but represent a small sample from a lot of parallel lines."

Furthermore, since both enculturation and habitat discordance are confounding influences even in the chimpanzee, what chance have we of finding a naturalistic diet amongst ancient hominids? In addition, even if we could, how would we convince people that their diets were actually healthy with no medical records, or soft tissue to analyse? A similar issue applies to studies of contemporary hunter-gatherers - are they actually healthy? Certainly, there are lessons to be learnt, but a wealth of empirical nutritional research is sometimes ignored in the hope of finding a dietary ideal in hunter-gatherers or apes.

Before embarking on a mission to create a diet classification, it is essential to have rigid mutually exclusive quantified categories defined, and some kind of systematic method. The absence of such a precise system inevitably led to the confused naming free-for-all that has occurred. The term omnivore seems to apply to a vast array of different diets that range from small amounts of insect matter to regular and complete meals of carrion. Due to this imprecision, scientists would do well to refrain from using the term, as Chivers (and others) have pointed out.

Where does this leave the human? We can show a substantial range of adaptations to plant based diets, and in particular to juicy fruits. We can also show some not very close anatomical similarities to smaller primates that do make up a significant proportion of their diet from animal matter. However, there seems to be no compelling evidence of human adaptations to consume animal foods, and plenty of evidence of a lack of adaptation. This seems to make a bad case for humans being grouped in along with pigs, dogs or bears and other irrefutable “omnivores”. The behavioural evidence is perhaps the least scientific evidence, and yet in many ways is seems quite compelling. Taken as a whole, the evidence seems to suggest a foli-frugivous diet as natural for humans, with a digestive system that can probably tolerate small amounts of animal matter. It is therefore imprecise to call humans omnivores, but not necessarily entirely mistaken.

At the beginning of the article a criteria was suggested for testing whether humans are omnivores based on the health impacts of consuming significant amounts of animal products. Amongst the worlds populations, it is in general the Western populations that consume the most animal products. The epidemiology of these populations has clearly established that diets high in animal products are directly associated with the epidemics of degenerative diseases such as cardiovascular disease and cancer.

The problem is that epidemiology is based on statistical associations which do not reveal causative factors. So far, comparing meat eaters with vegetarians has failed to produce conclusive evidence(32). Even so, evidence does seem to suggest that reducing meat intake is associated with healthier outcomes. Studies that compare meat eaters and vegetarians are confounded by the fact that vegetarians have lifestyles which are healthier in many ways versus the average meat eating person - in any case vegetarians may still eat significant proportions of animal products. A better study would be on a population where the level of consumption of animal foods varies, while other lifestyle factors remain comparable. However, this would still not overcome the problems inherent in making statistical associations.

Even if it were possible to overcome the problem of using statistics, it might be suggested that contemporary animal rearing methods produce unhealthy animal foods. Indeed there is now a popular movement towards more "natural" rearing of animals, in the belief that such animals make healthy food. There seems to be little substance to this claim. Traditional populations that consume large amounts of animal products, from free roaming animals, have been found to suffer with extensive cardiovascular disease(33). If it is further proposed that their intakes are excessive, then this leads to the question of what level of animal food intake is believed to be free of adverse effects, and then onto the question of why humans should be adversely affected by eating more animal foods if they are supposedly adapted to such a diet.

Given all of the above information, the evidence for humans being omnivores is not compelling. Humans have no clear-cut adaptations to consume animal foods, and regular consumption of animal foods is associated with unhealthy outcomes. In contrast the evidence presented is completely consistent with the claim that humans are specialised frugivores.

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The author regrets that some of the literature cited may no longer be available.

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