21 Cold and Watery? Hot and Dusty? Our Ancestral Environment and Our Ancestors Themselves: An Overview

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SUMMARY

The chapter begins with a discussion of the nature of scientific arguments generally, and the matter of consensus in scientific progress. Next, a number of substantive topics bearing on the Aquatic Ape Theory are reviewed, including bipedalism, body hair, sweating, subcutaneous fat and the 'diving response'. The conclusion is reached that while human ancestors were never truly aquatic, the evidence suggests that they may have been selected for their ability to make occasional use of rivers and lakes in the ancestral African habitat.

INTRODUCTION

This overview will be brief and, inevitably, incomplete. The details of the arguments for and against an aquatic phase in hominid evolution have been presented in earlier chapters. What I shall do here is, first, make a general point about the nature of this particular kind of scientific inquiry; and, second, take a look at the key issues raised, and come down on one side or the other. For the most part, I shall favour the arguments for savannah evolution, but in some respects the evidence for adaptation to water is convincing. These are, of course, personal decisions rather than definitive judgements.

PROLOGUE: ON ADVOCACY

The question of whether we went through an ancestral aquatic phase cannot, by its nature, be subjected to an empirical test. Behaviour leaves no trace in the fossil record. We thus are obliged to use secondary, circumstantial evidence for our arguments. The kind of work that results from this necessity is commonly called 'advocacy'.

Perhaps the best known work of advocacy is Richard Dawkins' *The Blind Watchmaker* (1986) (Dawkins himself labels it a work of advocacy – it is not I who do so). What he means is that he presents lines of evidence that lead to one conclusion rather than to another. In the case of *The Blind Watchmaker*, the conclusion is that life, including human life, has evolved in all its complexity as a result of the process of natural selection and not as a result of the process of divine creation. Would it be possible for Dawkins to 'prove' his argument by means of an experiment? It would not. Dawkins is not dealing with the field of falsifiability, with a Popperian world of hypothesis-testing by experiment. He is, rather, dealing with systems of argument, characterised by canons of epistemology, and those canons are validated by consensus among communities of like-thinking people.

We thus have to remind ourselves that, in the field of evolutionary theory, the best we can hope for is to deploy the evidence about any given problem in such a way as to mount a convincing argument – that is, one that would convince any rational person. Clearly, this is asking more than can actually be done. Assuming that all authors in this book are rational, we can conclude that the evidence has not yet been assembled in such a way as to convince one and all.

Science is a very human enterprise, but it is also a very moral one. In *Varieties of Realism*, Rom Harré (1986) declares that science is among the most moral of human enterprises. What he means by this is that scientists are forced to adhere to the principle that they should be as honest and truthful as possible in their work by the constant scrutiny of other scientists. If a scientist selectively uses facts or data to push a pet theory, it does not matter too much because in the long run other scientists will put matters straight. This may seem to some to be too optimistic. It can be argued that all treatment of data by scientists is selective. That is true as well, but it remains a fact that in an open society all the different selections of data compete with each other; and over a period of time, as the scientific community forms a consensus, some issues are resolved. For instance, in modern anthropology there is an emerging consensus that man had an African ancestry. This consensus is arising as more and more anthropologists become aware of the findings of palaeontology and molecular population genetics, both of which point to an African origin. The Asianists are gradually being defeated.

The details of just *how* man evolved in the African continent are still unclear. From Laetoli in Tanzania we have the evidence for bipedalism some three million years ago, in the form of fossilised footprints. Lucy, far off in Hadar in Ethiopia, had a pelvis more human- than ape-like at the same time horizon. These ancestors of ours, *Australopithecus afarensis*, were remarkable, with their ape-sized brains and ape-like heads but human-like bodies. Had this early hominid passed through an aquatic phase? We have no direct evidence either way. The circumstantial evidence is reviewed in this book.

THE EVIDENCE AND THE ARGUMENTS

Some substantive topics are reviewed below. These are not the only discussion points, by any means, but cover the main ground. Each is reviewed rather summarily to avoid repetition of what has gone before. The views expressed are entirely personal, as is the inevitable selectivity with which each topic is approached.

Bipedalism

As mentioned above, we know that our earliest hominid ancestors were already bipedal. There is some evidence from the bones of the foot of *Australopithecus afarensis* that tree-climbing may have been practised as well, and we would not expect to find bipedalism in its full-blown form in the earliest hominids, since evolution of radical new morphology and function takes time. Clearly, in order to establish this novel characteristic, a strong selection pressure has been at work in the period from 5 to 3 million years ago. There is no indication of bipedalism in the Miocene–Pliocene apes from which *Australopithecus* evolved. What, then, was this selection pressure? Those who favour the AAT find an explanation in the survival value of being able to stand upright in water, with feet on the bottom and only head exposed, thus enabling the early hominids to get into deeper water than their predatory pursuers. Also, locomotion in water is easier with an angle of 180° between legs and spine. Elaine Morgan has pointed out that amongst the birds it is the penguins, which have been selected for aquatic life, that stand most upright on land. AA theroists also point out that bipedalism, in its early stages, would be selected against, as inevitably there would be stumbling. Other savannah mammals all move quadrupedally, including savannah primates such as baboons, so clearly bipedalism is not an inevitable savannah adaptation – indeed, it is extraordinary.

What, then, were bipedalism's advantages? C. Owen Lovejoy (1981, 1988) has argued that bipedalism arose because it gave reproductive advantages to those hominids (*males* especially) who could travel widely from a home base and return carrying, using their hands, high protein foods (meat) for their own particular offspring. He envisages bipedalism evolving as part of a set of coevolving properties of early hominids, including social processes such as monogamy and home-base living. Nancy Tanner (1981) discounts the details of Lovejoy's scenario, which she claims is sexist anyway. She favours the idea that freeing of the hands was advantageous because it enabled individuals (especially *women*) to carry vegetable foodstuffs to a processing place, rather than just foraging as they moved around in the way that apes do. She considers that the invention of the basket was a crucial step forward for the hominids.

Quite apart from the freeing of the hands, Peter Wheeler (chapter 13) points out that there is an advantage to standing and moving bipedally in terms of reduction of heat loss and protection of the skin from sunburn during the heat of the day, because at midday the erect bipedalist exposes the minimum of his or her body to the sun (that is, to intense ultraviolet radiation). He points out that other African savannah species such as the ungulates deal with heat loss in two ways. First, they absorb heat in their bodies; and second, they have evolved a carotid rete – a cooling mechanism beneath the brain – absent in primates. We therefore cool our bodies in other ways, one of which is the exposure of minimal surface area to the direct rays of the sun. This idea is supported by the existence of copious hair on the top of the head – in the case of Africans, woolly hair – and this acts as a buffer both between the brain and the sun's heat, and between the skin of the scalp and the ultraviolet radiation.

Finally, mention should be made of the improvement in visual field that results from bipedalism. I have observed both chimpanzees and vervet monkeys standing bipedally to get a better view of distant objects in open conditions in Africa, and others have reported the same for many species of primates. We can well imagine that our early hominid ancestors might have gained considerable survival advantages to being able to see predators a long way away and take evasive action. Potts (1987) has indicated that the early Australopithecines were in all probability afraid of the savannah-adapted animals around them, of wild dogs, jackals and hyenas as well as the predatory cats. To this day some African prey species such as topi use hillocks to gain a better view of predators.

On balance, I would conclude that the arguments that bipedalism evolved on the savannah are stronger than those that it evolved in water.

Body hair

We do not know when our ancestors began to change the pattern of body-hair cover from its original ape-like form to the modern one. Apes have a lower density of body hair than humans, and their hair is longer than ours. If you look at an orang-utan, you will see that the hair is really quite sparse, but very long and orange–brown in colour. The hair of gorillas and chimpanzees is black, intermediate in density, and intermediate also in length. In man, hair colour varies from pale to dark, and it varies from one part of the body to another. It is characterised by very high density, especially on the head, and is of course extremely short over most of the body, although this varies from place to place, the Ainu of Japan being well known for their long body hair, and the well covered Europeans coming, in many cases, a close second. Africans and other Asians are the least hairy of humans today.

Elaine Morgan points out that there are several disadvantages to the substantial loss of body hair found in modern man. Life without body hair in a sunny climate gives rise to a high incidence of skin cancer, as Australians are currently finding out, and as expatriates living in the tropics have known for a long time. The explanation for this may, however, be in terms of light skin pigmentation rather than hair cover.

One of the best known correlations in anthropology is that which exists between skin colour and intensity of ultraviolet radiation. Quite possibly a covering of dark hair would give humans of any skin colour protection from the sun. But instead, skin pigment has been selected for. The argument that hair loss has led to skin cancers thus overlooks the question of skin pigmentation, for Africans have very little body hair and very low rates of skin cancer.

Two other arguments of Elaine Morgan's concern skin-scratching and slipperiness. She argues that hair cover protects the skin against the tearing action of thorns and other obstacles encountered on the savannah. Second, bare skin is poorly adapted to carrying babies, as, especially when sweaty, it becomes slippery and can lead to difficulties. She may be right about both of these points. Hair does have many advantages. Following Sir Alister Hardy, she stresses the fact that hair loss is of particular advantage in the water, so that all aquatic mammals have either very short hair or no hair. This point seems valid although, as Paul Leyhausen (chapter 10) points out, only *fully* aquatic mammals have become hairless, while a number of hairless mammals – for instance, rhinoceros and elephant – have become hairless without being in the least aquatic.

Peter Wheeler in fact reverses the argument, claiming that water mammals do in fact have body hair, which they use to reduce body heat loss by trapping a layer of warm water around the body, thus insulating themselves from the cold environment in which they live. Certainly it is true that some fully aquatic mammals such as sea-lions do have plentiful body hair. In humans the length and distribution of body hair is insufficient to achieve effective insulation in cold water. What, then, is the function of the small body hairs that cover the human body? Wheeler finds the explanation in increased efficiency of heat loss. When a human being is standing upright body heat is emitted by radiation and warm air then flows upwards around the body surface and disappears above the head. The small hair tracts around the body point downwards, and act to trap this air and slow down its vertical movement, which prolongs the time it takes for the sweat to evaporate, thus giving the body more prolonged cooling per unit of water used up as sweat. This is thus an argument for understanding body hair as a savannah cooling device. It would presumably be possible also to argue that body hair traps warm air around the body in cold conditions, so that it serves a dual function.

The arguments for seeing the fine covering of hair on the human body as a savannah adaptation rather than an aquatic one seem convincing.

Sweat

The human skin is characterised by a high density of sweat glands, higher than in any other primate species. These glands produce two kinds of sweat, apocrine and eccrine. Apocrine glands are activated by emotional stimulation, whereas eccrine glands are activated by body temperature. The latter are by far the most frequent, and testify to the intensity of natural selection during human evolution for the ability to produce copious amounts of sweat.

Elaine Morgan points out that sweating is not a wholly efficient way of losing heat. Sweating is slow to start, and a body can become seriously overheated before sweating has had time to get under way. Because sweating uses a large amount of body water, it is dehydrating just at the time when the body needs to conserve its moisture, because at times of dry heat water in general is in short supply. Other species such as camels and hamsters that are adapted for dry, hot conditions have evolved physiological mechanisms to retain body moisture; man, by contrast, is profligate with body moisture and as a result needs to drink large amounts of water each day in hot conditions. This must amount to a serious disadvantage in conditions of water shortage, such as are characteristic of large parts of Africa during the dry season. Sweating additionally excretes a large amount of body salts, which also need replenishing. It is known that humans who become seriously dehydrated are at risk from death as a result of thickening of the blood leading to failure of the circulation, and this could be expected to be a grave disadvantage to copious sweating.

Yet sweat we do. As always, advantages and disadvantages are weighed in the evolutionary balance. If the benefits of sweating outweigh the costs, then natural selection will enhance sweat mechanisms. Perhaps the most convincing positive argument of the AA theorists is that the salty component of sweat, which seems to have no advantage on the savannah, does provide a means of salt excretion for a sea-living primate, or a primate ingesting a lot of salt as a result of eating a diet of seafood.

For their part, the Savannah theorists point to the long-held 'bare-skin-and-sweat' hypothesis, whereby body heat is efficiently lost in the hominids by covering the body with a thin film of moisture which then evaporates, taking heat from the body surface and putting it into the atmosphere. We have already mentioned the role of small body hairs in achieving an economy of water loss. Sweating is a particularly efficient adaptation in two conditions: where there is a plentiful supply of water, and where the air is dry rather than moist. We know from findings of *Australopithecus*, *Homo habilis* and *Homo erectus* at sites such as East and West Turkana in northern Kenya that these early hominids lived in a lake-shore environment, where drinking water would not have been a scarce resource. We also know that the climate of East Africa was everywhere, except in the rain-forests themselves, inclined to be dry and hot. In such circumstances sweating can be readily understood as a primary adaptation to a savannah environment rather than an aquatic one.

Subcutaneous fat

One of the initial insights of Sir Alister Hardy, himself a marine biologist, which led him to formulate the Aquatic Ape Theory, was the observation that man, like the sea mammals he knew so well, has a distinct layer of subcutaneous fat. It is a fact that this layer is not found in any other primate species in the wild (though captive apes, deprived of exercise and wrongly fed, develop one). Wheeler points out, however, that the amount of subcutaneous fat found in humans is insufficient to keep the body warm for long in cold water. By comparison, aquatic mammals of human weight or greater have vastly more subcutaneous fat, enough in fact to round off their bodies, whereas the human body remains angular with long extremities, and is covered in a porous skin which is permeable by water and unsuitable for prolonged immersion, quite unlike the skin of aquatic mammals. These seem rather serious objections to the AAT.

Caroline Pond (chapter 12) has made a detailed study of the anatomy and distribution of fat in mammals, and has dissected numerous species, including primates. She finds that all primates, even those that look skinny and are disinclined to store subcutaneous fat, do in fact have fat depots in particular locations around the body. These adipose sites are essentially the same in primates as in other mammals. In some species, such as hedgehogs that hibernate in winter, fat storage is enormously increased in the pre-hibernation period. In other species this variation does not occur. The subcutaneous fat of humans is very largely a simple extension from the normal fat depots, which are located anatomically in the typical mammalian locations. This is in contrast with the situation in aquatic mammals, in which subcutaneous fat is not extended from local depots but exists as a continuously thick layer over the whole body.

There is another characteristic of human body fat, which is the sex difference in fat deposition. Women have, at least since the Willendorf Venus and doubtless well before that, accumulated fat around the buttocks and thighs, and on the breasts, to an extent matched neither by other primate species nor by male humans. This fat is of the same kind as other body fat. What is responsible for the extra deposits in particular peripheral locations in women? Caroline Pond suggests that sexual selection may be responsible, as well as natural selection. In other words, selection would favour not only fatter women at times of pregnancy and lactation, but also selective mating by males with women with these extra reserves. The buttocks, thighs and breasts may have been the most convenient or least costly places for such storage to occur.

Besides its function as a nutritional reserve, a subcutaneously distributed layer of fat must inevitably increase body temperature. We have been at some pains to explain how the bare-skin-and-sweat adaptation functions to keep the body cool; are we now going to have to explain the need for fat to keep the body warm? The answer is yes. There is no contradiction involved here. Hominids or humans on the open savannahs of Africa would find themselves experiencing very hot days, but night-time temperatures would be cool or even at times cold. Adaptations have to cope with all conditions, not just some of them. In the discussion of body hair, above, we concluded that such hair had both cooling and warming functions. The same is true here. While the bare-skin-and-sweat adaptative complex excels during the daytime it is not at all useful at night, when the fine body hairs become inadequate to the task of keeping the body warm, even though they make a contribution. Subcutaneous fat is much more effective as an insulator, and the thickness of the fat layer is optimally that thickness which keeps the body just warm enough at night while not interfering with heat loss during the day. As a result, adequately nourished humans have a thin layer of body fat; but as we know from experience, this can easily become a thick layer in conditions of idle prosperity, where almost none of the checks and balances of a natural way of life apply.

Overall, the arguments for an aquatic origin for human body fat seem weak or untenable, while the savannah arguments seem more convincing.

The 'diving response'

John Patrick (chapter 14) has shown that human beings have a set of rather specific respiratory adaptations for swimming and diving. First of all we have voluntary control of respiratory function: although our respiration is controlled automatically by the nervous system, we have a limited amount of control over it and can inhibit breathing for a short time, which can be increased by training. This enables us to hold our breath when diving. Further, the body's natural buoyancy while we are holding our breath ensures that we surface again. Breath control is also useful in swimming. The fastest method of swimming, known as the crawl, involves holding the breath for longish periods while the head is held face down in the water and the legs and arms propel the body forwards, and then breathing out and in again rapidly before beginning the next cycle.

What is perhaps most remarkable is the *reflex* closure of the human airway in water. It is not known whether this occurs in other primates, but the evidence suggests that it does not. In humans, experimentation by John Patrick has shown that it is the contact of the face with water that brings about this reflex. A person can be treading water up to his or her neck and the reflex does not occur. But if a person is wholly out of the water, with just the face placed in a shallow dish containing water, then the reflex occurs. It appears that there are receptors on the surface of the face that trigger the response. Nor is it just the closure of the airway that occurs: constriction of the bronchioles of the lungs occurs simultaneously. Finally, when the head emerges from the water, humans have a clear-cut gasp response, rapidly making up the oxygen deficiency. But Patrick concludes that these reactions in humans are 'slow in onset, small in extent, and not triggered by immersion in warmer water'; he therefore emphasises cortical control of breathing as the best evidence of aquatic ancestry.

These certainly do look like aquatic adaptations. It is unclear how any of the above would increase the fitness of a hominid for life on land. How do these human adaptations compare with those of aquatic mammals? The answer is that they have gone a good deal further than we have. Seals actually reduce their respiratory drive while diving. In this way they are able to stay under water for many minutes, far longer than any human can do. Nevertheless, we can see the human level of adaptation as a step on the way to aquatic adaptedness.

What conclusion should we draw from this? We know that some of our ancestors were living by the lake-shore at what is now Lake Turkana, from 3 million years ago. The fossil fauna there indicates that there may have been rich pickings in the lake itself. For instance, the carapace of a giant turtle has been found in hominid deposits at Lake Turkana. Such benefits, and others such as the availability of shellfish, crabs, slow-moving fish and maybe even young crocodiles (which live in this lake), could well have led to selection for individuals who were able to move efficiently in the lake waters, perhaps for an hour or two every now and then.

For a largely savannah-dwelling hominid, however, the water would inevitably have been a dangerous environment. Jan Wind (chapter 17) has pointed out that drowning remains a common cause of death at the present time; we have to learn to swim, it is not innate, and not all humans are able to learn it. Would we not expect swimming to be innate if it had been selected for as suggested above? As for the voluntary control of breathing, this might have been selected for in other contexts – for instance, in stalking prey or in connection with the evolution of speech. And it has been pointed out that holding the breath is essential in picking up heavy loads, as well as in diving.

All in all, however, the evidence here points to the presence of an aquatic element in the environment, and one which was important enough to bring about some selection for agility in the water. There are things here that the Savannah Theory cannot properly explain.

Marsh-wading

Derek Ellis (chapter 4) lays emphasis on the details of the ecology of the early hominids. He stresses that a marine shore environment can be one of the richest of all. There is plenty of good nutrition in such wetlands:

oysters, mussels, the eggs of marshland birds, and the possibility of capturing animals by driving them into the marshes from which they have no escape. He thus shows that there is an environment that is neither 'aquatic' nor 'savannah', but somewhere in between. A hominid exploiting this niche would not have to be a fine swimmer, nor a diver, and would have ample opportunity to keep cool in the heat of the day. Certainly this environment does need close consideration, but could it be a lake-shore marshland rather than a sea-shore one? That would seem to accord more with the facts. And the swimming and cooling adaptations that we see indicate a greater degree of adaptability of the hominids than a marshland habitat alone would produce, so that marshes may well have been a contributing habitat, and one that we should remember, but are unlikely to be more than this.

Location

Leon LaLumiere (chapter 3), an acoustic physicist with the US Navy, has mounted a clear argument concerning the whereabouts of the evolution of aquatic life in the early (pre-*Australopithecus afarensis*) pongid–hominid period. He posits a decline in the sea level some 5–4 million years ago in what is now the Danakil Depression in north-east Ethiopia, leaving exposed a large tract of land surrounded by water, which he calls Danakil Island. A relic group of pongid–hominids, isolated on that island, rapidly evolved a set of aquatic adaptations as they adapted to the new conditions, which included saltwater/freshwater marshland and the sea itself. Later, with further decline in the sea level, these water-adapted hominids spread south into the Afar triangle, where Lucy (*A. afarensis*) was found, and further still into the rest of East and South Africa. This scenario is appealing as an explanation of aquatic adaptations, if such an explanation is really needed. But in the absence of any fossil pongid–hominid evidence from the Danakil area it has no real substance, and further evidence would be needed before it could be taken seriously.

CONCLUSION

A number of other arguments exist on either side, but I shall not discuss them all; in any case, they are fully dealt with in the chapters of this book. All I have tried to do here is to pick out a number of key arguments, present them as fairly as possible, and then make a personal choice. Overall, it will be clear that I do not think it would be correct to designate our early hominid ancestors as 'aquatic'. But at the same time there does seem to be evidence that not only did they take to water from time to time but that the water (and by this I mean inland lakes and rivers) was a habitat that provided enough extra food to count as an agency for selection. As a result, we humans today have the ability to learn to swim without too much difficulty, to dive, and to enjoy occasional recourse to the water.

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