THE ERGONOMIC APE – part 1 **Ivan Crowe FLS**

There are now seven billion human beings inhabiting the Earth: evidence, if any is needed, of our success as a species. What is largely unrecognised is that our success is due to the one thing that also makes us truly unique as a species – and that is our relationship with energy. This same characteristic though now makes humankind extremely vulnerable and it is a critical factor that we overlook at our peril.

The looming fuel crisis we are now facing has its roots around six million years ago, when our ape-like ancestors first emerged from the rainforests on to the African savannas. The climate was becoming increasingly arid and as a result the rainforests were receding to leave a more open, mosaic landscape on the margins and extensive grasslands. Geochemist Thure Cerling was able to quantify how much shade was available in the geological past from isotopes in ancient soil to measure tree cover. He says,

"it shows there have been open habitats for all of the last 6 million years in the environments in eastern Africa where some of the most significant early human fossils were found." [1]

There is every reason to believe that the diet of our ancestors while living in the rain forest was originally very similar to that of the chimpanzees living today. If so, it would have most probably consisted of mainly plant foods, such as fruit, nuts and leafy plants; but with also a relatively small amount of animal protein gained from eggs, insects and occasionally small mammals like monkeys.[2] This forms an important supplement as the inclusion of a small amount of animal protein would be necessary to maintain the correct balance of amino-acids in the diet, which are needed to build body tissue.

This practise though may not have been so easily maintained on the open savannas, for two reasons. Firstly there was not the same range of botanical biodiversity and it is therefore possible that the choice of edible plants available did not contain the full range of amino acids required by a primate. There are two important amino-acids missing in fruit for example.[4] Some amino–acids can be synthesised by a primate, but there are still other essential amino-acids that can only be obtained from the food eaten.

Secondly, whereas within the rain forest any shortfall could have been compensated for by occasionally eating meat, just as chimps do today, catching game on the open savannas would have been far more difficult and I would suggest that resolving this difficulty was to be the trigger that singled out our species from all others.

Dr David Chivers of Selwyn College, Cambridge, has demonstrated that the way in which they move around hanging and swinging in the trees, means that the shoulder anatomy of apes is far more flexible than in other animals. It is as a consequence uniquely adapted in a manner that enables them to throw objects in a way that other animals, including other primates such as monkeys, cannot.

Dr David Chivers demonstrates the difference between the shoulders of monkeys and apes

"In monkeys the forelimb is on the side of the body, whereas apes have a more upright posture because they use their arms for pulling themselves up, for climbing, hanging to feed - and the thorax is dorsa-ventricular compressed, with the scapula around on the back - not on the sides and the shoulder joint sticks out sideways. Because it sticks out sideways you can move all round, a great range of movement." **Dr David Chivers** while filming `*The Ergonomic Ape*'.[5]

It is known that chimpanzees will wave branches and pick up and throw stones at predators like leopards to deter them to protect themselves from being attacked and eaten. [6] It seems logical to assume that this practise used as a defence, must at sometime have been adapted as a means to obtain meat, by using missiles to stun and bring down small animals. Initially natural objects would have sufficed, but it was nevertheless the rudimentary beginnings of human weapon technology that propelled our ancestors on to an entirely new evolutionary path.

What is significant is that in order to survive an animal has to ensure that the energy gained from their food exceeds that used to obtain it. It is a golden rule and the reason why predators such as lions will instinctively break off from a chase that is taking too long and using an excessive amount of energy. Using missiles would have allowed our ancestors to catch and kill prey using far less energy, simply by reducing the need for prolonged pursuits. This therefore could have given them a huge advantage to thus help them survive and it is our species effective utilisation of energy that makes humans unique.

This is particularly significant because saving energy is one of the fundamental prerequisites for survival. Another strategy employed to save energy by avoiding the need to hunt, would be scavenging meat from animals that had died, or had already been killed by a predator. Observing the behaviour of vultures circling around a dead or injured animal would have helped them find meat in this way.

Eating raw meat though is hard work and our ancestors may have also inadvertently been obtaining additional nutrients and energy from the meat itself by beating it between rocks to tenderise it.[7] Tougher plant foods could have been processed in the same way as well to break up the fibrous tissue. Apart from providing more energy and nutrients, this process could have been responsible for two very significant innovations. At times sharp shards of stone must have broken off of the rocks being used to pummel the meat, or other food stuff, to provide a sharp edge that could have been used to cut up meat and even dismember carcasses for easier transport. It seems reasonable to assume that it was the adaptations required, which enabled our ape-like ancestors to survive on the savannas, which eventually gave rise to tool making and eventually better weapons for hunting.

Prof Richard Wrangham of Harvard University has demonstrated that beating meat can occasionally produce sparks, when the two rocks strike together and even at times start small fires.[8] This is obviously, at the very least of equal importance, both because it represents the first use by our ancestors of an external source of energy and because the control of fire eventually enabled our ancestors to cook their food. Prof Wrangham believes that this probably first occurred about 1.9 million years ago, when there is evidence of changes in hominoid anatomy associated with a switch to eating cooked food, in particular smaller jaws and smaller guts, which in turn allowed an investment in a far larger brain. [9]

While comparing the jaws of two of our hominid ancestors during the making of, `*The Ergonomic Ape',* Richard Wrangham points out that the smaller jaw, on the left of the picture, comes from a larger hominid than the jaw on the right, which although bigger, is from an earlier, smaller hominid (not eating cooked food).

"As a biologist I look at the ways in which our bodies have been designed and we have some very peculiar features compared to other primates. We have the smallest teeth compared to body size of any primate. We have the smallest guts compared to other primates. There is no doubt that our small teeth and our small guts are related to the fact that we have food that has been cooked and is therefore far more easily digested. So when did these changes happen? The answer is that our small teeth emerged around 1.9 million years ago. And that says that is when our ancestors started to cook". **Prof Richard Wrangham** [10]

Prof Wrangham suggests that this is because cooking food not only makes it easier to eat but also reduces the amount of energy needed to masticate and digest it. He believes that in addition, it means that far more nutrients are released from the food and energy gained from it.[11] These benefits could have further ensured that our ancestors could have gained even more energy from their food than they used acquiring it, once more fulfilling the primary criteria for survival and contributing hugely to the continuing success of these hominoids. Indeed the control of fire was a pivotal factor in our evolution.

Fire could have also helped our ancestors to retain their body heat during the cooler nights, which would have meant that less food was actually needed to replenish the energy used keeping warm. This would have been of added importance when hominids began to colonise cooler latitudes. Being able to cook their food would have also been an advantage too, not only by helping them keep warm but also because it renders a far greater number of plants edible. This is because cooking also destroys the toxins in many potential plant foods that would otherwise have been poisonous to hominids.[12]

This would have meant that the percentage of edible plants in any given area, or region would have increased and made foraging easier: once again reducing the expenditure of energy required to obtain food whilst increasing the energy acquired as a result of cooking the food collected. [13]

In conclusion, it is my contention that the move away from the forests on to the savannas was responsible for a whole gamut of changes in behaviour that not only helped our early ancestors to survive, but was to also serve us well in the future and ensured our incredible success as a species.

This was achieved by technological changes that enabled our ancestors to both conserve their energy by reducing the effort required to obtain food, by the use of such things as missiles and obtaining more energy from the food resources available, by for example cooking. This gave us the capacity to improve our overall ergonomic efficiency and that is why I think we should consider humans as `The Ergonomic Ape', because it is our capacity to utilise energy in different ways - and employ different forms of energy other than our own - to aid our survival, that I believe truly makes our species unique.

It is also this uniqueness that has led to a dangerous dependence upon external forms of energy. This began nearly two million years ago, with fire to cook and keep warm and has now cumulated in humanities' eventual reliance upon other fuels too: particularly this planet's rapidly depleting hydrocarbon resources. In fact we are the only animal on the earth that cannot survive using our own energy alone and that makes humankind extremely vulnerable, because it means without fuel humankind could not survive.

References – Part One

1 CERLING Thure, Savannas Accompanied Human Evolution for 6 Million Year, in *Nature* Aug. 4, (2011)
2 GOODALL Jane, `*In The Shadow of Man'*, Chapter 3, First Observations. (1971)
3 KIMBALL SR, JEFFERSON LS. Regulation of protein synthesis by branched-chain amino acids *Curr Opin Clin Nutr Metab Care*. 2001
4 CHIVERS David, Measuring food intake in wild animals, P321, *Proceedings of the Nutritional Society* (1998)
5 CHIVERS David, While being Interviewed during the filming of `*The Ergonomic Ape'* (2011)
6 KORTLANDT Adriaan, How Do Chimpanzees Use Weapons when Fighting Leopards? *Pub. American Philosophical Society*, (1965).
7 WRANGHAM Richard - Personal communication while filming `*The Ergonomic Ape'*. (2011)
8 WRANGHAM Richard - Personal communication while filming `*The Ergonomic Ape'*. (2011)
9 AIELLO Leslie C, WHEELER Peter, The Expensive-Tissue Hypothesis, in *Current Anthropology* (1995)
10 WRANGHAM Richard, While being Interviewed during the filming of `The Ergonomic Ape' (2011)
11 WRANGHAM Richard, 'Catching Fire: How Cooking Made Us Human' *Harvard Thinks Big* lecture (2010)
12 HILLMAN Gordon - Personal communication while researching p66.`*The Quest for Food'*. (2000)
13 WRANGHAM Richard - Personal communication while filming `*The Ergonomic Ape'*. (2011)

THE ERGONOMIC APE – part 2 **Ivan Crowe FLS**

Technological changes enabled our ancestors to both conserve their energy by reducing the effort required to obtain food and obtain more energy from the food resources available, by using fire to cook. This gave us an ergonomic efficiency that aided our survival and was what underpinned our species' success. But the advent of farming created a change in the trajectory of human culture that set our species on the course to fuel dependence.

While humans remained hunter-gatherers, developments in tools and weapon technology continued to gradually progress, to allow humans to become increasing efficient in acquiring food and gain protection from the elements.[1] Many new developments were probably in response to the last glacial period that occurred in the Northern Hemisphere. For example, more substantial shelters, clothing and storage of food to aid survival when conditions were at their harshest, were to act as an engine for change and only served to make humans even more successful at surviving in an ever wider range of habitats. Later traps, snares and lures further increased human effectiveness, as did the use of dogs when hunting.[2]

"It is only with *Homo sapiens* that we have any evidence of sophisticated tailoring. The burials we have of Homo sapiens show that we are dealing with leggings, parkas and the use of fur to ring the edge of hoods, so after 35,000 years ago we have almost Inuit style clothing". **Prof Paul Pettitt** [3]

"The dog is clearly the first domesticated animal. Essentially they may have been hanging around human settlements where there was lots of food stuffs and we created a new niche for them to exploit. And as an aid to hunting that may well be how dogs became involved with humans". **Prof Keith Dobney** [4]

Consequently, when the glaciers began to recede and the climate became warmer our ancestors had a whole new gamut of skills to aid their survival and help them prosper. Some communities were so proficient at exploiting the resources available close to hand, that they were able to reduce both the time and distances involved when foraging. In some places this resulted in a more settled way of life becoming possible and sedentary communities appearing. They were nevertheless still dependent upon wild plants and animals for food,[5] although on occasions this may have been supplemented by produce from doorstep gardens.

Things had improved for our hunter-gatherer ancestors as the last glacial ended. But another shift in climate was to effect a profound change in some parts of the world that resulted in a reversal in human fortunes that was to eventually be instrumental in creating our modern world of urban societies and industry. It occurred around 13,500 years ago and is known as the Younger Dryas.

One of the best examples of the changes that occurred is represented by a village in Syria that once existed on the banks of the Euphrates known as Abu Hureyra. Initially the people continued to survive as hunter-gathers. Fish was taken from the river, gazelle from the nearby foothills provided meat too, and a huge diversity of food plants was to be found in the local habitat. But one of the most important sources of food was the wild cereals that grew in dense stands on the slopes of the hillsides.[6] Once harvested the grain could be kept in pits or granaries to provide a staple food throughout the year.

The Younger Dryas represented a change in climate that led to a period of colder, drier conditions. Many of the plant foods upon which the people of Abu Hureyra relied disappeared – and in particular the wild cereals. It would appear that the people began to collect the seeds from the wild stands to plant them elsewhere, in more sheltered places and closer to water where they could also be irrigated. [7]

When ripe the seeds of wild cereals easily disarticulate and sow themselves naturally when they drop to the ground when the plant is disturbed by wind or other agents. Experiments conducted at the University of Cardiff though showed that in the process of transporting the seed grain the more loosely attached grains were frequently left behind, whereas those with the least fragile attachment and less likely to disarticulate remained.[8] This meant that an increasing number of those that disarticulated easily were lost each time the cereals were relocated. Within a few generations mutant forms became dominant that could not sow themselves, because they would not disarticulate as the wild cereals did.

The mutant cereals therefore had to be sown by hand and were thus dependent upon human intervention to reproduce. Consequently the people of Abu Hureyra and others like them were forced to become farmers and cultivate the cereals that had once been wild. With the loss of many wild food plants dietary diversity was reduced, the land worked and crops had to be sown and harvested instead of simply gathering food from the wild. Farming meant people were forced people to stay in one place to guard and tend their crops. Because this made foraging expeditions more difficult, people also begun to domesticate some of the animals they once hunted as a living larder.[9]

The physical effort required when farming was far greater and the rewards less. Eventually people began to employ some of the animals they had domesticated to do such tasks as ploughing the land. Animal power began to be used to supplement human muscle, to turn mills to grind the corn and to carry heavy loads among other things. Machinery began to be developed to take advantage of the new source of power: becoming farmers thus effectively kick-started the technological revolution that led to our modern, worldwide industrialisation.

The invention of gearing to turn mills - a direct outcome of farming- literally drove technological development.

Following on from animal power watermills and wind power were used to drive machinery and then steam. The internal combustion engine may not be the final incarnation but it has certainly made a greater demand upon our fuel resources than any other form of energy. We now rely on hydrocarbon fuels to produce our food and other goods, to transport what we need and even to collect our food from the supermarket or do other shopping.

Without the switch to farming none of this would have probably happened. Our increasing success while hunter-gatherers was because we learnt to gain extra energy by the use of fire and conserve our own energy ever more efficiently when obtaining food and gaining protection from the elements. Now we must once again learn to conserve energy. This time though it is not the energy of our own muscles we must conserve, but instead the fuel resources we so depend upon if our species is to survive. For nearly two million years humans have been dependent [10] upon cooked food and there are now seven billion of us. Without cooking, many foods would be unpalatable or even poisonous and we would derive far too little energy or nutrients from them.[11] Famine would inevitably result. Therefore, to put it simply, without sufficient fuel our species could be facing extinction.

References – Part Two

1 PETTITT Paul, Personal communication while filming `The Ergonomic Ape' (2011)
2 DOBNEY Keith, Personal communication while filming `The Ergonomic Ape' (2011)
3 PETTITT Paul, While being Interviewed during the filming of `The Ergonomic Ape' (2011)
4 DOBNEY Keith, While being Interviewed during the filming of `The Ergonomic Ape' (2011)
5 MOORE Andrew, HILLMAN Gordon, et al `A Pre-Neolithic Farming Village on the Euphrates' *Scientific America* (Aug 1979)
6 HILLMAN Gordon, Wild Plant Foods of the Northern Fertile Crescent, `*The Origins and Spread of Agriculture in Eurasia*' (1996)
7 HILLMAN Gordon, Personal communication while filming `The Ergonomic Ape' (2011)
8 HILLMAN Gordon, DAVIS Stuart, Domestication Rates in Einkorn-Type Wheat, *Botanical Journal of the Linnean Society* (1990)
9 CLUTTON-BROCK, Juliet P.278 *The Walking Larder,* One World Archaeology, Routledge, (1990)
10 WRANGHAM Richard, Personal communication while filming `The Ergonomic Ape' (2011)
11 WRANGHAM Richard, 'Catching Fire: How Cooking Made Us Human' *Harvard Thinks Big* lecture (2010)

Other Reading

Ivan Crowe, *The Quest for food: its role in human evolution and migration,* Tempus 2000

David R Harris (Editor), *The Origins and Spread of Agriculture in Eurasia*' 1996

Adriaan Kortlandt, *How Do Chimpanzees Use Weapons when Fighting Leopards*? American Philosophical Society, 1965

Mathias Osvath, *Stone-Throwing Chimp Thinks Ahead*, The Richard Dawkins Foundation, 2012

T Douglas Price, Gary M Feinman, *Images of the Past,* Mayfield, University of Wisconsin, 1992

Ucko, Dimberby et al, *The Domestication and Exploitation of Plants and Animals*, Duckworth, 1969

Proceedings of The Royal Society, *Foraging Strategies and natural diet of Monkeys, Apes and Humans,* Oxford Science Publication, 1991

The Ergonomic Ape Video Production

The Video Film referred to, "The Ergonomic Ape", was produced by Pastworld, a small production company run by the author. It is planned to offer it for screenings in schools, colleges and universities. It has an impressive array of contributors and interviewees:

Ian Redmond OBE, Tropical Field Biologist and Conservationist
Dr David Chivers, Primate Biologist, Selwyn Collage, Cambridge
Prof Richard Wrangham, Ruth Moore Professor of Biological Anthropology at Harvard University
Prof Paul Pettitt, Palaeolithic Archaeology, University of Sheffield
Prof Keith Dobney, Human Palaeoecology, University of Aberdeen
Thomas Schoor-Kon, Woodcraft and Survival Expert, Woodcraft, East Sussex
Pro Gordon Hillman, Honorary Visiting Professor in Archaeobotany, Palaeoethnobotany, UCL Institute of Archaeology
Dr Lady Jane Renfrew of Kaimsthorn, Archaeologist, Lucy Cavendish College, Cambridge
Prof Ken Thomas, Human Palaeoecology, UCL Institute of Archaeology,
Godfrey Bevan CBE, Government Advisers, Director, Energy Technologies, Dept of Trade and Industry

Contact: Ivan Crowe FION, FLS
Tel: 01424 772704 / 0788 1583 900
Email: production@pastworld.net
Skype:pastworld
Website: www.pastworld.net (or Google/Search) Pastworld Productions

REVIEWS of The Ergonomic Ape

Ray Heaton GIBiol, MSc, FRGS, FLS
Assistant Director, London Royal Zoological Society

This film 'The Ergonomic Ape' explains humankind's current position on Planet Earth better than any other presentation I have seen. Ivan Crowe's account is not judgemental but clearly demonstrates how we got to be where we are now.
Using a diverse documentary style, the film gives an explanation of the way that humans have inexorably used up more and more natural resources. By considering our primate origins and by invoking the periods when cultural and technological change is known to have occurred, Ivan Crowe and a series of other experts from archaeology and anthropology chart human use of earth's resources up to the present day and the dramatic demands we make on energy resources.

Anyone interested in current environmental problems would do well to study this film. An understanding of our past activities and current position may well hold the key to future resolutions or at least give ideas for future action and perhaps help avoid the repetition of mistakes already made.

With enough of the right sort of space (habitat) that provides the resources and protection they require, species can survive and persist. We humans have already exceeded a threshold in our use of resources, particularly fossil fuels, and this is causing alteration and probable irrevocable damage to the ecosystems upon which we and the other species on earth are entirely dependent.

Prof Sir Ghillian Prance MA DPhil DSc FLS FIBiol FRGS FRS VMH
Scientific Director at The Eden Project (previously Director Royal Botanical Gardens Kew)

It is an excellent concept to base human history on energy development. It seems to me that it will be a most useful teaching tool in schools and undergraduate courses. I liked the concept and hope that you are able to get it out to a wide audience. I am impressed with the amount of work that went into this and the impressive array of contributors.

Amy Hurst
Energy Officer, The Eden Project

Very interesting film. It all makes sense and is very informative, be great for school children, collage students and undergraduates to get to see this. We could realistically go forward and take the examples from our past to reduce our reliance on energy now. It is really about over population too I feel: how we have over exploited the land to try and improve our quality of living. I am unsure where we go from here bar extinction. I am pleased that the contributors talked about energy wastage too. I think it is all explained very coherently.