Problem-solving and the Evolution of Human Culture

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1999

Monograph Series No. 33

THE INSTITUTE FOR CULTURAL RESEARCH

Monograph Series No. 33
This version prepared for free download 2006.
The original hard copy edition:
ISSN 0306 1906 – ISBN 0 904674 25 8 – Published 1999
may be purchased from the address given above, or on the ICR website, www.i-c-r.org.uk

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Author's Note

This paper derives from a presentation at *Human Solutions: Problem Solving and Society,* a seminar given by the Institute for Cultural Research in January 1998. I am most grateful for having been invited to participate in that meeting, to the other speakers and audience for their questions and comments, and for the opportunity to publish this paper.

Problem-Solving and the Evolution of Human Culture

We are surrounded by testaments to the remarkable human capacity to solve problems. In our daily lives we depend upon technological solutions to the practical problems of living within the world. Our clothes, our houses, our telephones, our cars and so on through endless material items, solve the problems that arise from the interaction of our desires with the environments within which we live. Occasionally in our lives we require extraordinary technological solutions, such as medical equipment when we become ill. Indeed perhaps it is in the domain of medicine that the human capacity for solving problems is most valued and has its greatest achievements. That capacity lies within individual human minds, and more effectively within the collaboration of minds, either by one person building upon the knowledge gained by previous generations, or by the joint research of many specialists, each of whom can add a tiny snippet to the solution of a problem that is too great for any single mind alone.

There are, of course, other sorts of problems that humans try to solve beyond those of medicine, or those which involve technical innovations. Painters try to solve problems of how to express pure emotion through colour and form; poets how to convey more than just the meaning of words through words alone; sportsmen how to surpass the seemingly physical constraints of the human body to run like cheetahs or to swim like fish; comedians how to make people laugh. And of course there are scientists – not just those applied scientists who invent better computers, better cars, and new gadgets for the kitchen, but those who tackle problems which lack any apparent utilitarian benefit: the problem of how the universe came into existence; how it will end; the problems of pure mathematics; the problem of whether there is life elsewhere in the cosmos. All of these are fascinating problems requiring considerable investment of the state's resources for the funding of research within universities; all seem to be of no practical value and all are

probably completely unsolvable. But do not think for a moment that a time will come when people give up on them. For the human mind is a most peculiar entity, it is like a three-year-old child at Christmas: it just cannot sit still.

Never forget just how peculiar the problem-solving human mind actually is. To remind yourselves just think of our closest living relative, the chimpanzee. As is commonly known we share 99% of our DNA with this species of African ape, having also shared a common ancestor about 6 million years ago. Now chimpanzees need to solve many problems in their day-to-day lives. Some chimpanzees need to solve the problem of how to get termites out of their nests, and do so by using sticks from which they strip the leaves and sharpen to a point (Goodall 1986). Others tackle problems of how to get kernels out of their shells, solving this by the use of stone hammers and anvils (Boesch & Boesch 1993). All chimpanzees face problems of building social friendships and alliances to survive and prosper within their competitive social groups (de Waal 1982; Byrne 1995). But whether they solve these problems in the same way that we solve ours, by conscious thought, is not clear to us.

Indeed quite what goes on in a chimpanzee's mind remains unknown. We know some things that do not – but perhaps ought to: such as that they face problems of habitat destruction and of poaching which threaten their very survival. I guess they have no inkling of this threat within their minds. Moreover the problems chimpanzees face today appear to be the same problems they have always faced. Each generation of chimpanzees appears to begin from scratch on the same old problems as their parents, grandparents and all great-grandparents before them had to learn to solve. There is quite limited social learning, and even less teaching within their societies, and certainly no gradual accumulation of knowledge through time (Tomasello *et al.* 1993; but see Boesch 1991 for evidence of teaching). How different this is to us humans who face problems today simply inconceivable 35 years ago when Jane Goodall began to watch the chimps of Gombe. In that time, neither Goodall nor any other observer had seen a chimpanzee version of, say, the Kyoto environmental summit, or a meeting of foreign ministers – groups of chimpanzee delegates trying to find compromise solutions to shared problems

which are in everybody's best interest. As problem-solvers they are individualists.

So although we may be momentarily impressed with the termiting and nut-cracking activities of chimpanzees, the universe of problems they face is static, highly constrained and personalised. There are no problems concerned with composing verse, or telling jokes, or solving environmental crises. There are no questions about the origin of the cosmos or the nature of being to occupy the chimpanzee mind.

How very different to our human mind with its seeming compulsion not just to solve problems, but to seek new problems to solve: problems of practical utilitarian nature, problems of academic interest, problems to ponder in the privacy of one's bath, problems requiring international summits. So if the chimpanzee is our closest living relative, and one to whom we are genetically so similar, where could these compulsions of the human mind have come from? Where are their roots?

The answer lies deep within our prehistoric past. This peculiar problem-solving human mind arose during the course of human evolution; it arose within that span of time since we diverged from the ancestors of the chimpanzee, 6 million years ago. To understand why the human mind is so restless, so inquiring, so desperate to acquire knowledge we must trace back in time to that point when our ancestors first began to distinguish themselves from all other animals by the emergence of this curiosity about the world, this thirst for knowledge which burns so intensely within.

When was that? When did this peculiar problem-solving human mind emerge? The answer is not easy, as we have no more than the mute remains of fossil skulls and the stone tools and other scant remains of the archaeological record as our guide. Indeed identifying when, where and why, the human mind evolved is a problem faced by archaeologists such as myself. In this paper I want to provide some possible solutions to these problems, by taking you on a short journey through our prehistoric past – a journey that has time to make just four brief stops at different points in space and time of our evolutionary path to examine what problems our ancestors were facing, how they were being solved, and whether those distinctive features of our problem-solving minds today had arisen.

Our starting point on this journey is with the first stone tools of the archaeological record, those made between 2.5 and 1.5 million years ago in East Africa and called the Oldowan culture (Leakey 1971; Toth 1985). These artefacts were first found by Mary Leakey when she and her husband Louis Leakey excavated in Olduvai Gorge, and have since been found in several other areas, such as Koobi Fora (Isaac 1997). Oldowan stone tools were made by the first member of our genus known to us, *Homo habilis.*

Homo habilis is a little understood species – indeed its fossil remains are so varied in size and shape that some anthropologists believe there are at least three different species of early *homo* being represented (Wood 1992; Jones et al. 1992). *Homo habilis* was quite unlike us, standing up to 1.5 metres tall and weighing between 40 and 80 kilograms. Note the word 'standing', as *Homo habilis* walked upon two legs – although perhaps not quite as efficiently as we do today. Such bipedalism evolved at least a million years prior to the appearance of *Homo habilis,* as is evident in australopithecine specimens such as Lucy, *Australopithecus afarensis*, dating to 3.5 million years ago. In terms of brain size *Homo habilis* reached a maximum of 750cc, which is about half that of the average brain of modern humans. It is, however, more than twice as large as that of a modern chimpanzee.

Oldowan artefacts are very intriguing. They are made from nodules of stone, principally basalt and quartzite, by removing flakes from what becomes known as the core. These flakes were removed by striking directly with a hammer-stone. In many cases we can tell from the artefacts that this was not just a random bashing of two rocks together. *Homo habilis* was carefully selecting nodules, identifying appropriate places to strike the nodule, and using just the right amount of force at the correct angle to detach a flake (Toth 1985; Potts 1988). The required technical skills seem to be beyond the capacity of modern chimpanzees. One bonobo, or pygmy chimpanzee, has had the opportunity to learn to produce flakes from stone nodules but does not appear to be able to master the knowledge of fracture dynamics that was clearly understood by *Homo habilis* 2 million years ago (Toth *et al.* 1993).

But Oldowan tools are also quite different to the tools that you and I are familiar with. They lack any imposed form. By that I mean that *Homo habilis* does not appear to have had an image of a stone

tool in his or her mind, an artefact of a particular size and shape, which he or she then sought to achieve in stone. Instead nodules were simply flaked, with the final shape of the core being determined by no more than the shape or the original nodule, and the number of flakes removed.

So what were these cores and flakes used for? Probably their main function was to butcher animal carcasses – the sharp flakes could have been used for cutting skin and tendons, and for slicing meat; the robust cores for crushing bones to extract the valuable marrow (Potts 1988; Schick & Toth 1993). We do indeed have direct evidence for such uses, as the tools are often found dispersed amidst scatters of broken animal bones, such as at Olduvai Gorge. Microscopic analysis of those bones sometimes shows the actual presence of a cut mark where it had been detached from a carcass or skinned. We also have indirect evidence from experimental work today, as it has been found that Oldowan artefacts are indeed very effective at butchery of animal carcasses. But experimental work also indicates that Oldowan tools could have been used for other tasks, such as removing tree bark, chopping plants, or digging for roots.

If we remain with animal carcasses we can see how these tools solved a problem faced by *Homo habilis* on the East African savannahs of two million years ago. Now the African savannah was not an easy place to live, especially if one had a taste for meat as seems to have been the case for *Homo habilis.* There were other animals around who also had a taste for meat, such as lions, leopards and hyenas (Brain 1981; Binford 1983). And those animals had a taste not only for the meat of antelope and wildebeest, but also for *Homo habilis.* Compounding *Homo habilis'* problems was the fact that he was not a very big chap – indeed he was the epitome of the prehistoric seven stone weakling. Armed with just Oldowan tools, he seems to have lacked any ability to hunt animals himself, and would have been quite limited in his ability to defend himself against carnivores. So how was *Homo habilis* to get his meat?

The solution appears to have been by scavenging from the kills made by lions and other carnivores (Binford 1983; Isaac 1983). Several of the archaeological sites show that *Homo habilis* was indeed taking meat and marrow from the least productive parts of a

carcass, the bits that would be left behind when not only the carnivore that killed the animal had eaten, but after the hyenas and vultures had also gained their share. But in other cases, *Homo habilis* seems to have had access to some quite productive bits of the carcass, perhaps by being one of the very first scavengers after the top carnivore had its fill (Bunn & Kroll 1986).

Being a scavenger on the East African savannah must have been a fairly hazardous experience, one full of problems caused by competing carnivores and other scavengers. We can see two ways in which *Homo habilis* solved these problems. The first was in fact a solution created by biological evolution rather than *Homo habilis* himself – it was bipedalism, walking on two legs. By walking on two legs *Homo habilis* could have behaved rather differently to those other animals which had a taste for meat; he was able to go out in the midday sun – or at least at less cost than could the quadrupeds. By walking erect on two legs the amount of solar radiation on a body is considerable reduced, so that when those four legged carnivores and scavengers had to rest in the shade, *Homo habilis* could search for carcasses (Wheeler 1984, 1994).

Bipedalism opened up a niche in the landscape that was relatively little used by other carnivores. It also freed the hands for tasks other than locomotion, tasks that included making artefacts and carrying objects. The artefacts, the Oldowan tools, were the second means by which the problem of accessing carcasses was solved. Imagine yourself as *Homo habilis.* What would you want to do as soon as you had found a carcass? There is only one answer – butcher it as quickly as possible and carry parts away to a safe eating place before other scavengers are alerted. And that is what the stone artefacts allowed: rather than labouriously twisting and tearing limbs off with hand alone, tendons could be swiftly sliced; and rather than trying to break open bones with one's teeth, a chunky Oldowan chopper would easily crush the bone so that the valuable marrow could be extracted. In other words, the stone tools solved the problem of how to minimise time in those dangerous locations where carcasses were be found (Potts 1988). But it was by no means an easy solution. One had to be prepared, to have stone at hand. So some archaeologists, such as Rick Potts, believe that *Homo habilis* effectively created caches of stones in the landscape which could then be used when the need arose. And we also have

clear evidence that stones and cores were transported around the landscape, seemingly in anticipation of their use (Isaac 1997).

So in this first stopover on this brief journey through the prehistory of problem-solving we can see that the first member of our genus had a technological solution to a problem of living in the world. But in many ways this solution was much more like that of the chimpanzee's solution to extracting termites, or kernels from their shells, than the technological solutions we are used to in the modern world. Oldowan tools were made in basically the same manner for over a million years. Just like the chimpanzee culture there was no gradual accumulation of knowledge, no innovation, no creative thinking as to how a better solution could be developed. And there seems to have been no collaborative problem-solving, which may be because it is unlikely that *Homo habilis* had any linguistic skills beyond the types of vocalisations used by chimpanzees.

So let us now jump forward in time to another type of pre-modern human, but one who was still surviving just 30,000 years ago: the Neanderthals. What problems did they face, and how were they solved? First we must see how we get to the Neanderthals from *Homo habilis*. We begin with a relative of *Homo habilis,* a species known as *Homo ergaster,* splendidly represented by a 1.5 million year old skeleton from Koobi Fora known as the Nariokotome boy (Walker & Leakey 1993). *Homo ergaster* was the first of our ancestors to leave Africa – stepping out for Asia soon after 2 million years ago (Larick & Ciochon 1996). But it was a later descendant of *Homo ergaster* itself, *Homo heidelbergensis,* who was the first to enter Europe, this seeming to happen about 800,000 years ago. That is when the earliest fossils in Europe are found, those at the site of Atapuerca in Spain. At 500,000 years ago we find *H. heidelbergensis* remains at Boxgrove in Sussex, England, and after that date they are found throughout Europe. *Homo heidelbergensis* was the direct ancestor of *Homo neanderthalensis,* who lived in Europe and West Asia as from 250,000 years ago, with the last Neanderthals surviving in southern Spain and Gibraltar just 30,000 years ago (Stringer & Gamble 1993). So let us consider what problems the Neanderthals faced, and how they were tackled.

In Europe Neanderthals faced the problems of living in an icy,

glaciated environment. For most of their existence much of northern Europe would have been either covered in ice, or a polar desert. South of this the landscape would have been tundra – although a tundra quite rich in animals such as horse, deer and bison. Mammoths and woolly rhinos would have roamed along the margins of the ice sheet. The winters would have been harsh, with freezing temperatures, and severe problems with finding food and keeping warm. So how did the Neanderthals solve these problems?

The first means appears to have been like *Homo habilis,* simply by their anatomy – so this again is a problem solved by biological evolution rather than mental capacities. Neanderthals had stout, muscular bodies, with barrel chests and short limbs – just the sort of anatomy suited to maintaining body heat. They had large projecting noses to help warm the air as they breathed and most probably carried large fat reserves on their bodies. These were physiological adaptations solving the problem of living in a cold climate (Trinkaus 1987; Stringer & Gamble 1993).

But Neanderthals also had large brains – brains as large as those of modern humans, and this allowed them to solve their problems of survival in ways quite unlike *Homo habilis*. For one thing they were hunters. Even by 400,000 years ago there is evidence for wooden spears in the archaeological record (Thieme 1997), and for hunting activity such as at Boxgrove (Roberts 1997). The Neanderthals made sharp stone points for their spears which appear to have been mainly used for killing animals at short distances (Shea 1988, 1989). These animals were predominantly deer, bison and horse. Sometimes Neanderthals seemed to have worked together, such as for hunting the largest of the ice age animals. At the site of La Cotte on Jersey, for example, there are piles of elephant bones in a cave at the base of a cliff. It seems most likely that Neanderthals had forced a small herd of elephants off the top of the cliff, seeming to have required some joint action (Scott 1980).

Neanderthals had further means at their disposal to solve the problems of living in an ice age world. One was the use of fire. In many of the caves that they used, we find thick layers of ash across the floor, perhaps having been spread out from hearths to make a warm surface on which to sleep (Stringer & Gamble 1993; Mellars 1996). Now the use of fire may have been essential for warmth; but

it may also have been used for thawing out frozen carcasses hence providing food not available to other scavengers especially during those cold winter months.

Another crucial means for survival in these harsh environments seems to have been that of simply caring for each other. A skeletal specimen from Shanidar in Iraq, for example, is of a man who was a cripple, blind in one eye, and clearly unable to cope for himself. Yet we can see that his injuries had begun to heal before he died, and there seems little doubt that he was being cared for by other members of his group.

So we see that the Neanderthals were effective problem-solvers. They made hunting weapons, co-operated together, used fire, cared for each other. But while these allowed them to survive in their icy world, it was not a particularly glamorous lifestyle; indeed they seem to have been only just hanging onto survival. As far as we can infer from their fossil remains, hardly any Neanderthals survived into their late 30s; a forty year old Neanderthal would have been a very senior citizen of their world (Trinkaus 1995). And almost all Neanderthal individuals that we know of were suffering from disease or injury – many bone fractures, most probably arising from their rather hazardous hunting tactics. But these injuries, and indeed the thickness of bone and bulk of muscle on these Neanderthals tell us of another means they used to solve the problems of living in an ice age – sheer hard work. Neanderthals lived physically demanding lives, surviving by brawn as much as – and probably more than – by brain (Trinkaus 1987). Sometimes this was not enough: when conditions in Europe became too cold for them, rather than inventing new ways to live they simply left Europe, and moved further south. Or in other words they became locally extinct.

In some ways the Neanderthals seem more like *Homo habilis* in terms of their problem-solving abilities than modern humans, even though they had brains as large as we have today and lived a mere instant ago in evolutionary time. They had clearly hit upon good solutions – stone-tipped spears, fire, co-operation – but then they stuck with these through thick and thin, in warmer climates and in colder, in the Near East, in southern, eastern, western and northern Europe for several hundred thousand years with no innovations, no improvements, indeed no signs of any creative thinking (Mithen

1996). In a manner quite unlike modern humans, Neanderthals do not appear to have worried themselves with any problems beyond those of survival – there are no traces of art, of story telling or science of any sort.

Now this very narrow behavioural repertoire that they possessed, this small range of solutions to the problems of the world, was not a function of living in an ice age world. This is demonstrated by considering a third member of our genus, who also lived in ice age Europe – indeed in a period of the ice age that was even more challenging than that faced by the Neanderthals. But these people solved their ice age problems in quite different ways; often with style. They were modern humans.

Modern humans, *Homo sapiens sapiens,* first evolved in Africa between 250,000 and 100,000 years ago (Stringer & McKie 1996). Genetic evidence provides a relatively earlier date than that of the first fossil remains, those found at the site of Klasies River Mouth at the tip of south Africa 125,000 years ago, and then in the caves of Skhul and Qafzeh in the Near East 100,000 years ago where several modern skulls are found. From their African origin, modern humans spread throughout the globe, displacing all other human species such as *Homo erectus* in Asia and the Neanderthals in Europe. Unlike these earlier humans they also spread into Australia and the New World. Our interest, however, is how they survived in Europe, how they solved the problems posed by ice age landscapes, and how their solutions contrasted with those of the Neanderthals.

It was 40,000 years ago that the first modern humans spread into Europe, and for as much as 10,000 years they overlapped in that continent with the Neanderthals – although whether they ever came into face to face contact, let alone inter-bred, remains unclear (Mellars 1996). When they entered Europe the climate was beginning to get worse, as the last ice age was approaching its climax. The climate of Europe continued to get colder and harsher until the late glacial maximum was reached 20,000 years ago when massive glaciers spread across northern Europe, creating uninhabitable polar desert to their immediate south. So these modern humans faced environments even more challenging than those of the Neanderthals; moreover they lacked the physiological adaptations. Indeed the first modern humans in ice age Europe appear to have a rather slender morphology, the type more suited to

equatorial African environments (Stringer & Gamble 1993). But while the Neanderthals appeared to have just been able to hang onto existence, modern humans flourished in a most spectacular manner.

Some solutions were shared with the Neanderthals: the modern humans were hunters, they co-operated with each other, they used fire and they cared for each other. But each of these was undertaken in a far more effective, and creative fashion. Consider hunting. As regards technology they not only used a much greater range of raw materials, especially bone, antler and ivory, but they made multi-component tools, and tools that were very specifically designed for particular game in particular contexts – such as particularly skilfully crafted, and lethal, spear and arrow points used when the ice conditions were at their worst (Knecht 1993; Straus 1991). When the climatic conditions began to improve, the modern humans changed their weapons, innovated new designs, suitable to the changing distributions of game and appropriate hunting practices. This flexible innovative behaviour, this dynamism to technology, is quite different to the great simplicity and stability of the Neanderthal hunting weapons.

It wasn't just hunting weapons that were invented by the modern humans. Perhaps their most critical inventions were items such as the tiny bone needles which first appear in the archaeological record 18,000 years ago (Geneste & Plisson 1993). No doubt these were used for making stitched clothing, and perhaps tents – something that Neanderthals never appeared to have thought of doing. Modern humans used even more radical innovations to create their own environments, such as the construction of mammoth-bone dwellings on the Russian plain – the first architecture (Soffer 1985).

But constant technological innovation is just one way in which the modern humans contrasted with the Neanderthals in their problem-solving abilities. They also began completely new types of behaviours, most notably the production of art. The first painted caves and carved objects of ivory and stone appear 30,000 years ago, and they continued to be produced throughout the ice age – with the most intense artistic activity happening just as the ice age climate reached its most severe (Mithen 1989; Straus 1991). The art disappeared when the ice age came to its sudden end 10,000 years

ago. This association with climate gives a clue that the art was not simply produced for aesthetic pleasure but it functioned to help the modern humans survive in the ice age world.

Consider, for instance, the carvings known as Venus figurines. These were carved from ivory and stone in basically the same form throughout a vast geographical area in the period between roughly 23 and 26,000 years ago. Examples are found as far apart as western Europe and Russia. As such they tell us that people were linked across these vast distances into alliance networks, and these common symbols functioned to facilitate the social negotiations involved (Gamble 1982). Alliance networks were an essential means of survival; they meant that when food resources were depleted in one area, one had social links enabling the use of those elsewhere. Such alliance networks, maintained by the use of material culture, seem to have been notions quite beyond the Neanderthal mind. Modern humans also made all sorts of body decoration such as beads and pendants from materials such as animal teeth, shell and ivory. In fact these were not just decoration; they would have communicated information about a person's status, affiliation, experiences, wishes and desires (Mithen 1996). Such material culture was a means of mediating social relationships – it helped solve the problem of personal identity and social communication.

What about the cave paintings themselves? No doubt these made the ice age world a brighter place, but again they were far more than mere decoration. These paintings, and the stories and myths with which they were no doubt associated, acted as a tribal encyclopaedia containing crucial survival information (Pfeiffer 1982; Mithen 1989). We get some clues about this information from the paintings themselves. We can see, for instance, how there are references in the paintings to how animals are tracked, such as by the depiction of their feet not as hooves but as hoof prints. Perhaps such paintings were used in education of children, perhaps they acted to mentally gear up a hunter. We don't really know. When we see carvings of flying geese from the site of Mal'ta in Siberia, we are immediately reminded of how the sight of flying geese for hunter-gatherers is of such importance as it tells about imminent change in the landscape, either the beginning of the great freeze-up of winter, or perhaps the thaw. It is not surprising that

such animals became enshrined in the art – animals that carry messages as if from the gods. So this art was part of the modern human ecological adaptation to their environment. The art functioned to extend human memory, to hold concepts which are difficult for minds to grasp, and to instigate creative thinking about the solution of environmental and social problems (Mithen 1990).

Now these paintings and carvings also tell us something else about the modern humans. They were not just worrying about the problems of survival, but had new concerns – concerns that we still have today. There was the problem of how to express the grace of deer through a simple line – something that they achieved as effectively as any artist of the renaissance or twentieth century. There was the problem of how to represent supernatural beings, as they appear to have done in their art with images of half-animal/half-human figures (e.g. the bison/man figure in Chauvet Cave, Chauvet *et al.* 1996). There was the problem of how to compose music to stir the emotions, which they seem to have been doing with their eagle-bone flutes.

It is, therefore, in this icy world inhabited by the first modern humans in Europe that we find the first evidence for the peculiarly creative problem-solving mentality that we possess today. But I do not want to finish my journey through prehistory in that icy world, for I want to make one final brief stop, a stop in the Near East at 10,000 years ago. In fact we can go to a site in Jordan known as WF16, which I am digging myself. For it was at sites such as this, sites in the Levant, where perhaps the most radical solution ever to a problem faced by hunter-gatherers was made, and one which changed the history of the world.

Recall that all of the humans we have looked at so far, *Homo habilis,* the Neanderthals, the modern humans of ice age Europe lived by hunting and gathering. So too did everyone else in the world up until just 10,000 years ago. In the Near East people lived as hunter-gatherers throughout the last ice age, but at about 12,000 years ago they did something radical. They settled down. They began building permanent houses and villages; those people we call the Natufians (Bar-Yosef 1998). Quite why this happened is not clear as they still continued to live by hunting and gathering. It may simply have been because game and plants were quite abundant, and regularly replenished by migrating populations so there was no

need for people to be mobile. But these Natufian people then faced a major difficulty at the end of the Pleistocene, 10,000 years ago. At that time dramatic global warming occurred, increasing global temperatures by as much as 7 degrees in a decade – today we fear the consequences of a no more than 3 degree rise in temperature over a 100 year period. Moreover this dramatic global warming followed a period of substantial climatic fluctuation involving periods of prolonged drought. These climatic changes would have caused biogeographic havoc, radically changing the distribution of food resources in the landscape. It was probably as a means to solve a shortage of food created by these climatic fluctuations that the Natufian hunter-gatherers of the Near East did something highly innovative, something quite remarkable that had never been tried before: they began farming. Rather than hunting and gathering for their food, they planted crops, and eventually domesticated animals.

This may not seem too original for us today, as farming is the normal way of life; we feel that hunting and gathering is the exception. But imagine generations upon generations of people having relied on hunting and gathering for their food being then faced with ideas of planting seeds, cultivating crops, domesticating animals. In effect beginning social relationships with plants and animals, caring for them as one would have cared for one's children. As a solution to food shortage it was as bizarre as it was brilliant.

There are, of course, many details about this transition from hunting and gathering to food production that we do not understand. I am presently working at the site of WF16 to uncover further information about the society and economy of the very last hunter-gatherers of around 10,000 years ago. The dwellings at WF16, and at all other sites of this period (such as Netiv Hagdud, Bar-Yosef & Gopher 1997), are quite simple – small circular structures associated with a great amount of plant grinding equipment. Just a few hundred years later, however, once farming had begun, we find dramatically different types of settlements. In a space of a few hundred years settlements changed from those with small scattered dwellings, to bustling villages, with streets and store houses and rapidly growing populations. And what did that mean? Well, it meant that many new problems were being created: how

does one solve social disputes between so many people all tied to living within one place? Mobile hunter-gatherers could have just moved on. How does one keep settlements hygienic with the amounts of human waste that now accumulated, again a problem of no concern to mobile hunter-gatherers? What does one do when the land becomes exhausted due to over cultivation? How can one gain sufficient supplies of raw materials for an ever growing human population? How is the surplus from a harvest to be distributed?

So we can see that the origins of agriculture ultimately arose as a solution to a major environmental crisis; but it in turn created a vast number of new social and economic problems that required solution. Therein lies the emergence and history of powerful élites and then of civilisations.

Let me conclude by returning to early prehistory, the hunter-gatherers whom I find of such interest. I have explained how ever since the first emergence of our genus, the first *Homo* 2.5 millions years ago, technological solutions were found to the problems of living in the world – solutions that appear to be the roots of the technological solutions that surround us today. The Oldowan tools of *Homo habilis,* the stone spear points of the Neanderthals mediated human interaction with the world, and extended the physical capabilities of the body. Yet for the vast majority of human evolution, right up until a time perhaps no more than 50,000 years ago, we see a mind solving problems that is quite different to ours today. It was a mind that could find good solutions, but then stuck with them for generations, rather than seeking to innovate and improve. Creative problem-solving seems quite absent from human experience throughout much of prehistory. It is only with those modern humans, especially those who lived after 50,000 years ago, that we can see a truer reflection of ourselves (Mithen 1996). People who could find radical new solutions to old problems; people who seemed compelled to innovate and improve upon their technology; people whose minds were restless, people who could make that most radical leap of our past to the cultivation of plants and domestication of animals.

So if we are looking for the roots of our problem-solving abilities today we cannot look to just one single origin. We have to recognise that part of this ability has its roots deep in our evolutionary past, not just going back to early humans, or even *Homo habilis* but to

earlier ancestors such as those we shared with the chimpanzee. Yet other aspects of our problem-solving ability, the creative, imaginative aspects that lie behind our science and art today, are very recent developments. These lead to radical solutions to problems, such as the use of cave paintings as a means to solve problems of living in an ice age world, and the cultivation of plants to solve food shortages at the end of the Pleistocene. But radical solutions create even more radical problems, seen most clearly in those created by a farming lifestyle. And as global populations increased and knowledge accumulated over the last 10,000 years solutions have become ever more radical, creating in their wake ever more serious problems for us to tackle. The result is that today we face multiple global environmental crisis, bloody warfare and terrorism blight so many parts of the world, social deprivation, poverty and disease are pervasive among human populations. That restless, creative mind that emerged 50,000 years ago is continually giving us more problems to worry about, problems that seem to be beyond our comprehension – the most recent are the ethical dilemmas about genetic manipulation and cloning, those about whether we should begin to design life itself. Indeed, perhaps it might have been better if we had kept that rather plodding problem-solving mentality of the Neanderthals and hence never had these problems to face; but then neither would we have had the art of Lascaux, nor the poetry of Shakespeare, nor the science of Darwin and Einstein with which to fill our minds.

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