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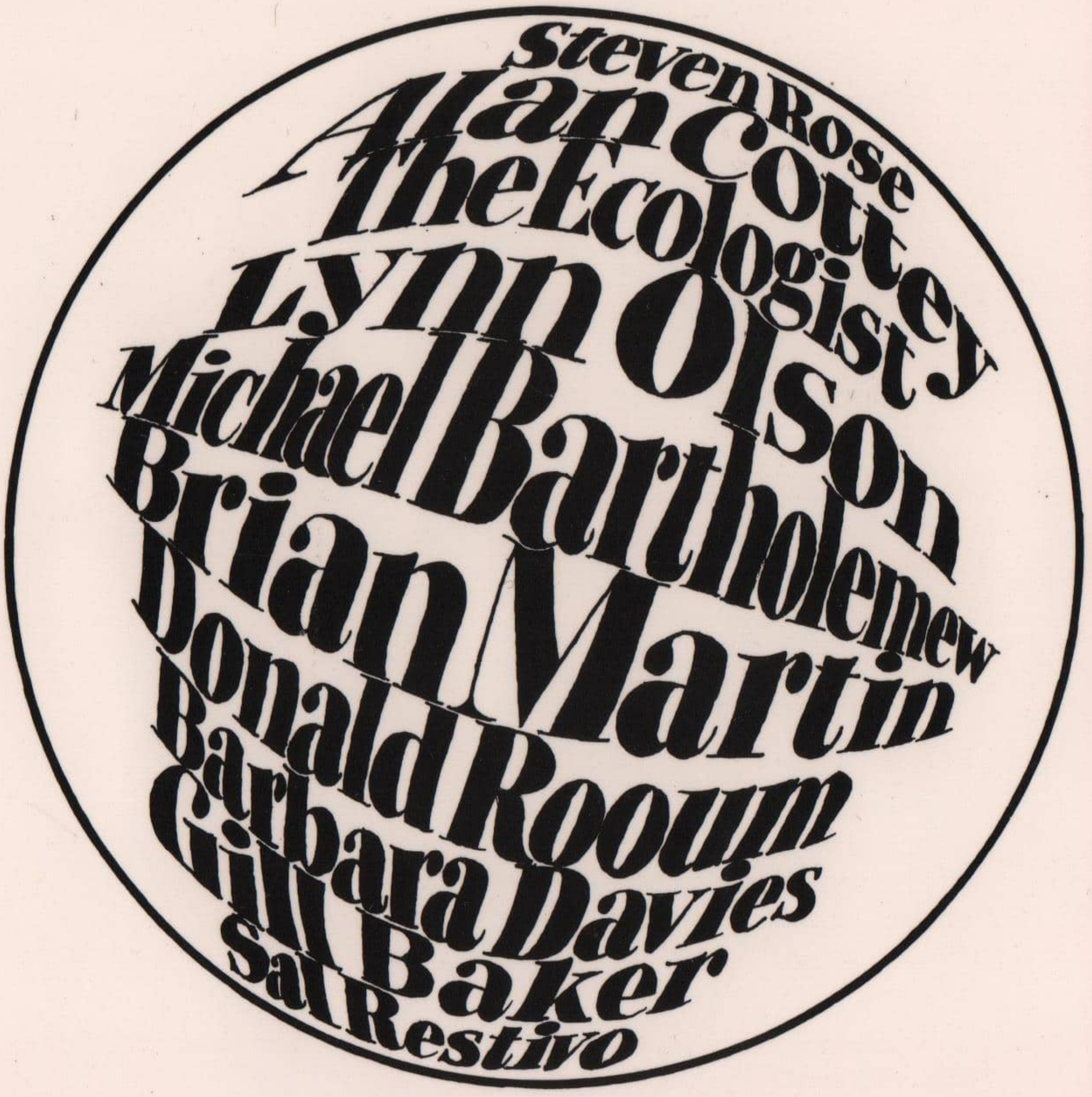

THE RAVEN ANARCHIST QUARTERLY 26

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Editorial

Scientific theories say nothing about what is right, but only about what is possible.
John Maynard Smith, 1988

Science ignores completely the idea of good and evil.
Errico Malatesta, 1913

The issues of *The Raven* 'on science' are not about scientific questions. They are about questions of ethics and social values in relation to science, non-scientific questions which some moral philosophers confusingly call 'broader issues' of science.

Lynn Olson supplies a useful introduction, with a concise description of the scientific method and the distinction between science and technology. Justifiable alarm at the current uses of technology cause some people to turn against science, but Lynn argues that the scientific way of thinking is essential to the anarchist struggle.

Darwin's theory is a scientific hypothesis, with no intrinsic ethical message, but because it supplants various myths of origins it is sometimes used as a myth of origins, a story with a moral. **Michael Bartholomew** investigates the moral lessons which Darwin, Wallace, Huxley and Kropotkin found in Darwin's theory, with a glance at George Bernard Shaw, most articulate of those who saw the explanatory power of Darwinism but rejected it because of its inadequacy as a myth.

Donald Rooum considers the arguments of those who contend that a particular myth of origins is the scientific truth.

Brian Martin lucidly describes how the priorities of science are decided today, and discusses alternative approaches to decision-making which might commend themselves to anarchists.

The **Ecologist editorial team** enlarges on one of Brian Martin's topics, the dismissive attitude of professional scientists to science done by non-professional 'non-scientists'.

The physicist **Alan Cottey**, who wrote on 'Science, Scientists and Responsibility' in *The Raven* 24, here describes the course on values and ethics which he conducts with university science students.

Barbara Davies presents an ethical justification for the use of animals in medical research. The attitudes of experimenters to animal welfare have changed quite a lot in the past century, for reasons which include a growing perception of how humans and other animals are related,[1] and the collapse of origin myths in which 'man' is given dominance over nature. Another reason may be that 'antivivisectionist' agitation has forced scientists to think about animal welfare, defining the middle ground by establishing the extremes. **Gill Baker** contributes a good example of antivivisectionist polemic, with a useful point of clarification from **Steven Rose**.

Sal Restivo's paper was prepared for an expert audience (a Sociology of Science Workshop in Dubrovnik) and non-experts may find parts of it difficult, not to say opaque. But it is worth the struggle for its analysis of the 'epistemological anarchism' of the late Paul Feyerabend.

Squeezed out of this issue, regrettably, is a draft preface by Nicolas Walter to Kropotkin's *Modern Science and Anarchism*. We hope this informative and incisive essay will be included in a third issue of *The Raven* on science.

This issue is mostly compiled and largely edited by **John Pilgrim**, who also edited *The Raven* issues 18, 19 and 24, on Anthropology, Sociology and Science 1. The final stages of editing were undertaken by Donald Rooum (who takes full responsibility) because John is ill and would have been unable to complete the project on time. We wish him a speedy recovery.

1. When Darwin wrote of 'maternal tenderness' in apes, his contemporary St John Mivart accused him of 'the attribution of human qualities to brutes'. This year, eminent zoologists are campaigning for a widening of the United Nations Declaration on Human Rights to include rights for gorillas, chimpanzees and orang-utans (not that the Declaration does humans much good). See P. Cavalieri and P. Singer (editors) *The Great Ape Project*, London, Fourth Estate Ltd., 1994.

What they say about science

There is no 'scientific method'; there is no single procedure or set of rules that underlies every piece of research and guarantees that it is 'scientific' and, therefore, trustworthy.

Paul Feyerabend, *Science in a Free Society*, 1978

Professors have no more conscience about obligations than has any other group chosen at random.

Morris Kline, *Why the Professor Can't Teach*, 1977

In a situation where scientists are working for security of service and have the objective of attaining a better salary and status, they would tend to be conformists and more prone to follow the dictates of those who are in power. They, therefore, would be less likely to show independence of mind, follow the dictates of their convictions, raise controversial issues and involve themselves in matters of policy and broader issues of science.

A. Rahman, *Anatomy of Science*, 1972

Basically, I exploited the phenomenon of the technician's often blind devotion to his task. Because of what seems to be the moral neutrality of technology, these people were without any scruples about their activities. The more technical the world imposed on us by war, the more dangerous was this indifference of the technician to the direct consequences of his anonymous activities.

Albert Speer, *Inside the Third Reich*, 1970

'Objectivity' has come to be simply the academic uniform of moral cowardice: one who is 'objective' never takes a stand.

Wendell Berry, *The Unsettling of America*, 1977

Mathematics is a man-made, artificial subject. It is not *the truth*.

Morris Kline, 1981

Science is not beyond the natural shrewdness of the human race.

Paul Feyerabend, *Science in a Free Society*, 1978

I doubt that the basic issues in the natural and social sciences and the humanities are beyond the grasp of ordinary educated people. In fact this is what a liberal education is supposed to impart but rarely does. A liberal education should impart considerably more ... I still suspect that it would be possible if the society chose to direct its efforts in that direction. In such a society the level of judgement would be sufficiently high to exercise a check upon sheer expertise. Nothing of this sort is likely to happen, however, until and unless modern culture overcomes its present fragmentation. That prospect is remote.

Barrington Moore Jr, *Reflections on the Causes of Human Misery and Upon Certain Proposals to Eliminate Them*, 1972

Science *is* social relations.

Bob Young, *Radical Science Journal*, 1977

Focusing on specimens rather than scientists highlights the crucial duality of all scientific activity – tension between the necessary social embeddedness of all scientific thinking and progress towards more adequate factual knowledge of external reality.

Stephen Jay Gould, *Eight Little Piggies*, 1993

... the idea that we can evaluate a scientific theory by reference to the society in which it was born, or to the moral or political conclusions which might be drawn from it. Once accept that view, and science is dead, as genetics died in Russia in 1948.

John Maynard Smith, *Did Darwin Get it Right?* 1988

Science ... looks sceptically at all claims to knowledge, old and new. It teaches not blind obedience to those in authority but vigorous debate, and in many respects that's the secret of its success.

Carl Sagan at a meeting of the American Astronomical Society on 5th January 1993, quoted in *Skeptical Enquirer*

Scientific discovery and scientific knowledge have been achieved only by those who have gone in pursuit of them without any practical purpose in view.

Max Planck, *Where is Science Going?* 1932

The eventual goal of science is to provide a single theory that describes the whole universe.

Stephen Hawking, *A Brief History of Time*, 1988

Lynn Olson

Science – Knowledge or Method?

'Science' is a word on almost everyone's tongue. The dictionary traces 'science' to the Latin *scire* which meant 'to know'. This may explain why science has long been associated with knowledge and especially with 'systematic and formulated knowledge'. And with the expansion of systematic and formulated knowledge into every corner of life almost every activity now calls itself a science. We hear of traffic science, atomic science, energy science, prison science, building science, computer science, political science and Christian science to mention only some. The word has become a status symbol tacked on to anything that wants to up its image.

The dictionary also tells us that the Latin *scire* is akin to *scindere* meaning 'to cut'. We can think of science as a method to cut through problems. If instead of systematic and formulated knowledge we think of science as the cutting edge of knowledge then the word takes on a different significance. Instead of concerning ourselves with carefully organising, classifying and formulating the already existing knowledge the cutting edge concept puts the emphasis on the method of discovering knowledge. It has been observed that we have discovered the method of discovery.

This method of science has been described with separate steps, such as:

1. Define the problem.
2. Suggest a solution that may solve the problem. This proposed solution is also known as the hypothesis.
3. Devise a way to test the proposed solution (hypothesis). This test is also known as the experiment.
4. Carry out the experiment to test the hypothesis.
5. Evaluate the hypothesis. Did it solve the problem? If not did it help us understand the problem better.

Assumed is that each of these steps will be carried out with as much objectivity as possible. Understood is that some problems may reduce the number of steps to only two or three. Some problems may expand

the steps to more than five. And one may use this method without being aware of following any steps.

Obviously the second step – suggest a solution – is where the creative intelligence is required. Almost any well trained intellect can define a problem, can carry out experiments and can make evaluations. But only the creative intelligence can invent a possible solution that has never been considered before.

The method of science is often a group undertaking. One person may be the first to observe a problem and to define it. Another may suggest the possible solution or hypothesis. Still others may construct the experiment and others may evaluate the hypothesis. For complex problems the process may take many years. The people involved may not even meet each other. Einstein could suggest a new and radical possible solution – the hypothesis of relativity – that might solve the contradiction between traditional concepts of motion, time and space and the new observations about the behaviour of light. Others could devise and conduct the experiments that might verify Einstein's hypothesis such as carefully observing the apparent shift in the stars near the eclipsed sun. And come to realise that light bends when passing through a gravitational field. And that space might be curved.

Nor is it necessary that the proposed solution solve the problem. The method is of value even when the hypothesis fails completely. By testing the hypothesis our understanding – our perception – of the problem changes. As our perception changes we change. As we understand the problem better we can invent better hypotheses to test. Even if we never find the perfect solution – and for most problems we never do – we discover that some hypotheses seem to work better than others. We discover a *working hypothesis* – something we can use. If the complex problems of society and economics seem to defy solution at least the method of science can give us working hypotheses that will help us understand the problems and ourselves much better.

Science as education

Another important value develops as we test hypotheses and our perception of the problem changes. Perception and understanding are basic forms of behaviour. Education is defined as a change in behaviour. As our perceptions and understandings change we undergo education. Whenever we seriously try to solve a real problem in any area of our lives – by testing proposed solutions – we are using the method of science and the method of education. Note that this is

genuine education and is not to be confused with the pedagogical processing that goes on in the schools and colleges. Lectures and demonstrations on systematic and formulated knowledge are pedagogical processing. They require the memorisation of verbalised forms of knowledge and deal with presenting the history of science. Education results from the actual testing of possible solutions to real problems. The method of science – propose, test, evaluate – is the method of education.

The systematic and formulated knowledge in the academic textbooks is often regarded as law beyond question. By contrast the working hypothesis enjoys no such protection. The humble hypothesis must forever run the gauntlet of re-testing and re-evaluation. The cutting edge of knowledge changes faster than we do. But like Keats' truth and beauty, the hypothesis is all we know on earth and all we need to know.

Science as invention

We easily confuse technology with science. Technology is the myriad collection of tools from the simple hammer to the complex computer and all the symbols we use to describe them. Millions of years ago the early hominids invented the first tools – the hammer and the hand axe – and launched the development of technology. We cannot be certain of the exact sequence of steps our ancestral hominid followed to invent the hand axe. But we can assume she was busily smashing the skull of an abandoned carcass (or clam shells or coconuts) by swinging a heavy rock to get at the tasty meats inside. The rock may have accidentally broken to produce a sharp edge and our hard working hominid may have noticed how the broken edge did a better job of cutting. She may have wondered what if she could purposely break rocks to produce sharper edges and better cutting tools. To wonder 'what if' is to propose a possible solution – to suggest a hypothesis. Our hominid may have decided to test this hypothesis by deliberately breaking rocks – and the experiment was born. By doing what comes naturally she had discovered the essential features of the method of science – propose, test, evaluate. Not that she could have systematically formulated this new knowledge or even talked about the method of science. The conscious awareness of this method and its verbalisation had to wait for millions of years. But the method itself is perfectly natural to human behaviour – is as old as humanity – and

is the method that has produced all the basic tools and all of our technology.

The objection may be raised that this is not the method of science but is only 'trial and error'. We should consider the massive amount of trial and error the modern scientist struggles through. Most hypotheses are errors. The ones we hear about are those very few that actually work.

The record of how the method of science developed our basic technology is lost in antiquity. The destruction of the Great Library of Alexandria was a tragic loss of what is believed to have been 900,000 manuscripts. Beneath the modern city of Jericho archaeologists have uncovered concrete walls and floors that had been mixed, placed and finished with a cement made nine thousand years ago. That was in the Neolithic period (new stone age) and thousands of years before bronze had been invented. Only the method of science – propose, test, evaluate – could have developed such a technology. We know how thousands of years ago a certain Archimedes used the method of science to discover the principle of buoyancy. The ancient Greeks could only have used the method of science when they built their steam engine with the tangential ports that produced rotation when the water inside the sphere was boiled. That we had to wait thousands of years for a Newton to systematically formulate the theory of anti-reaction does not detract from their initial discovery.

It is often assumed that science got started about five hundred years ago. If we think of science as an encyclopaedic body of 'systematic and formulated knowledge' then this assumption would seem reasonable. The last five hundred years have seen an explosive expansion of systematic knowledge probably because of the invention of the printing press. But if we see science as the cutting edge of knowledge – as the method of finding workable solutions – then it would seem that science has been with us much longer than five centuries.

Among our tools are the words and symbols we use to communicate. Words, symbols and the knowledge they convey are special tools of our vast and complex technology. 'Systematic and formulated knowledge' is a vital part of our technology, and like any technology is created by the method of science. All of our impressive technology has been produced by applying the method of science. But technology is not science. And science is not technology.

We are justifiably alarmed by the misuse and abuse of modern technology. The horrors of nuclear and other military devastation,

and the rampant destruction of our natural environment, should make us wonder if the human species will survive. The use of medical technology to reduce disease and infant mortality can hardly be called an abuse, but it takes place in the absence of contraceptive technology, and the resulting population explosion threatens to consume and destroy all of the vital resources upon which our civilisation depends.

Science and the consumer society

We live in a finite world with limited resources. Science cannot increase those resources. It can only show us how to use them more efficiently and perhaps make them last longer. We easily forget the basic pillars of thermodynamics. Neither matter nor energy can be created or destroyed (although one may be converted into the other) and entropy always increases. Energy always dissipates and once consumed can never again be restored to its concentrated state. Available energy is locked in our fossil resources and once released becomes entropy – dissipated and unavailable. Nor can solar power, wind power or nuclear fusion eliminate our dependence on fossil resources. All of these so-called renewable energy sources require a massive and complex technology that depends upon fossil energy and ever diminishing minerals.

Agricultural technology may produce enough grain to feed more billions of people. But man does not live by bread alone. Our species demands the humanising culture of civilisation. Maintaining our civilisation requires the constant consumption of vital but limited minerals locked in the ores and rock of this earth. Once the billions of consuming men and women have exhausted the available minerals and natural resources our civilisation – with all its humanising wonders of communication, transportation, medical technology and construction – will vanish from this earth. If any humans survive it will be back to the old stone age with no hope of ever again advancing beyond a rudimentary foraging existence. It is not the nuclear holocaust that will destroy us. It is our orgy of consumption that will do the job. A growing number of us can see how rapidly we are consuming and destroying the very limited resources that make our civilised humanity possible, but we are so enmeshed in our technology of consumption that we do nothing effective to control it.

Alarmed by the destructive abuse of technology some want to control and limit science. They demand that science be limited to only the 'good' purposes and that all 'bad' science be forbidden. If

science is seen as 'systemic and formulated knowledge' then clamping a stranglehold on this knowledge by whatever horrendous bureaucracy may seem to be one way of saving at least a segment of our civilisation from the ravishes of abusive technology. But if science is seen as the cutting edge of knowledge – as the method of problem solution – then trying to limit and restrict science can only destroy the one method that can help us solve the problem of how to use our technology to promote our humanity.

As children we were all programmed to believe that science cannot help us to solve our ethical and moral problems. Since the major social and economic problems involve ethical and moral elements we assume that science cannot help in their solution. We have made a sacred cow of our social-economic structure to protect it from the scrutiny of science. We have embarked on an orgy of consumption that equates success with conspicuous consumption. Our social-economic system thrives on the consumption and waste of our irreplaceable resources. With its demand to control and exploit resources and people our social-economic system fosters the military power that can now destroy all life on this earth.

Only the method of science can propose, test and evaluate possible solutions to our social and economic problems. Only science as a method, as the cutting edge of knowledge, can enable us to find those working hypotheses that we need to deal with the pressing problem of human survival. As we learn to propose, test and evaluate social and economic systems we will perceive and understand the systems and ourselves much better.

Anarchists and libertarian socialists are asked to carefully describe in detail the exact society they would create to replace the existing society. This begs the question. It assumes that we can already know how that society will be constructed and that its design is already a part of our systematic and formulated knowledge. There is no such existing knowledge. We can discover the shape and design of that anarchic and libertarian society only by proposing, testing and evaluating possible solutions to the problem of social organisation. Only with the method of science can we find those working hypotheses for the truly libertarian society. And only by testing and re-testing that society can we develop its full potentials.

The price of freedom is constant testing and evaluation. The method of freedom is the method of science.

Michael Bartholomew

Evolution and Ideology

The connections between scientific theories and the scientists who formulate them are commonly not obvious. For example, if we were to be presented anonymously with a theory that said 'If the volume of a gas is halved, its pressure is doubled', we would be able to say nothing certain about the ideological outlook of the theory's originator, beyond making the obvious observation that he or she must be keen on science. But no trace of the scientist's gender, race and political views could be detected in the theory itself. Obviously, in European science, it is highly likely that the scientist will have been white and male, as was actually the case in this example. But the presence of the theoriser isn't directly registered within the theory. Indeed, it looks as if there's no ideological content to the theory at all.

In other cases, however, there is. Notably, theories which have bearings on who we are and how we ought to behave, have ideological footprints all over them. When scientists are addressing the problems of human origins, human evolution and human nature, the boundaries between the scientists, the natural phenomena they investigate, and the theories they formulate, are sometimes so trodden down that it's difficult to see where one stops and the other starts. They go round and round in muddy loops. It is difficult to separate the object of study, the person studying it, and the theory in which the results of the study are embodied.

The most notable example of a scientific theory that bears the marks of ideology is Darwin's *Origin of Species*, published in 1859. Darwin's book set off a great, ramifying enquiry into humanity's place in nature. This enquiry is of interest to anarchists because in 1890 Kropotkin pitched into it with the first of a series of articles which were eventually published in book form as Mutual Aid, in 1902[1]. A simplified interpretation of Darwin's and Kropotkin's positions would be this: Darwin, whose intellectual outlook was decisively shaped by Victorian capitalism, produced a theory of evolution which pictured nature as a battlefield where plants and animals fight out a bloody struggle for existence in which only the fittest survive, whereas

Kropotkin, shaped by an intellectual tradition which stressed cooperation, pictured nature as a haven of peaceful, friendly, mutually supportive behaviour among animals[2]. Thus, it seems that Darwin's and Kropotkin's ideologies influenced, or perhaps even governed the visions of nature presented in their biological work.

If the case were as straightforward as this, we could routinely predict the sort of evolutionary theories that scientists will propose, simply by investigating their prior ideological commitments. At the same time, we would have little confidence in the evolutionary theories themselves, for we would tend to see them not as reliable descriptions of what really goes on in nature, but as projections of their originators' politics.

A less crude and more interesting picture emerges if we look afresh at some of the famous contributions to the enquiry that Darwin opened up.

Darwin

Let us start with Darwin himself. In the first edition of *The Origin of Species* (1859) he set out a vision of nature which, despite some softening features, was grim. Individual plants and animals vary, and these accidental variations, when submitted to the ruthless rigours of natural selection in a world where there will never be enough food to go round, determine who shall survive and who shall perish. It is a process of unremitting selfishness. Adaptive variations help only their possessors; that's what is meant by 'adaptive'. 'If it could be proved', Darwin wrote, 'that any part of the structure of any one species had been formed for the exclusive good of another species, it would annihilate my theory'.[3] The theory, as Darwin made clear, was not restricted to plants and animals; he intended it to be applied, without modification, to the emergence of humankind from the brutes. Thirty years later, Kropotkin was to respond to the selfishness of this first Darwinian account by proposing that there is plenty of evidence of animals selflessly helping each other. Thus, it might seem that Kropotkin and Darwin were ranged against each other in defence of quite different accounts of the way nature works, and that ideology gives us an explanation of those accounts. This won't do.

Darwin's own position on the sufficiency of Natural Selection shifted a great deal during the twenty or so years between the first edition of the *Origin* and his death in 1882. In succeeding editions of the *Origin* and in other books, he steadily reduced the emphasis given

in his evolutionary theorising to the Natural Selection of accidental variations, and increased the emphasis on other factors. Additionally, during the decades following the first edition of The Origin, numbers of naturalists had joined the enquiry into evolution and had given their own spins to the evidence. So when Kropotkin joined the fray, thirty or so years after it had started, he was adding to an already weighty, complicated and often contradictory enquiry. The enquiry had two enduring features. First, virtually everybody within the scientific community accepted that evolution has happened. But secondly, there was no agreement on precisely how it has happened. Notably, the theory of Natural Selection came under fierce and well-informed attack, and Darwin was obliged to beat a somewhat confused retreat. At his death in 1882, Natural Selection theory was in deep trouble, whereas evolution itself was no longer contested.

It is often thought that the sharpest, most anguished ripostes to the starkest formulation of Darwin's theory came from Christians. Certainly they had a great deal to worry about if they wished to preserve a belief in a wise and loving god, but if we set Christian objections to one side, we can find still find plenty of anguish, felt by people who had no orthodox Christian allegiances. George Bernard Shaw, for instance, was deeply disturbed by the desolate prospects opened up by Darwin. In a lecture given in 1906, which he later worked up into the preface to his play *Back to Methuselah* (1921), Shaw wrote that the 'Darwinian process may be described as a chapter of accidents':

> When its whole significance dawns on you, your heart sinks into a heap of sand within you. There is a hideous fatalism about it, a ghastly and damnable reduction of beauty and intelligence, of strength and purpose, of honor and aspiration, to such casually picturesque changes as an avalanche may make in a mountain landscape, or a railway accident in a human figure.[4]

Shaw's objection to the theory is plain enough, but he was not a scientist and thus could draw on no solid biological evidence to help him out. He could only bluster: 'When a man tells you that you are the product of Circumstantial Selection [i.e. Natural Selection] solely, you cannot finally disprove it. You can only tell him out of the depths of your inner conviction that he is a fool and an liar'.[5] Shaw's moral revulsion at the implications of Natural Selection and the Survival of the Fittest was, and remains, quite common. We can track the same revulsion, though backed up with arguments more substantial than Shaw's 'inner conviction' when we move into the

work of the biologists themselves. Indeed, Darwin himself was revolted by the prospects opened up by his own new world of accident and struggle; he was never able completely to come to terms with his own recognition that there is no more design in the process of evolution 'than in the course which the wind blows',[6] and that the ways of nature are blundering and cruel. He was certainly no unfeeling, mechanical conduit for the transfer of brutal capitalist competition from the factory floor to the forests and oceans of wild nature.

In 1871, twelve years after he had published his *Origin of Species*, Darwin published his *Descent of Man*. It is a frustrating, anecdotal, rather unclear book. Its one consistent, convincing drive is to show that the physical and mental resemblances between humans and animals are so close that there can be no doubt that a single set of evolutionary forces has shaped both animals and humans. Whenever Darwin is faced with the challenge of explaining a characteristic that seems to be distinctively, or uniquely human, he searches for an example of a rudimentary form of that characteristic in an animal. A famous example is his explanation of the supposedly exclusively human characteristic of religious belief. If Darwin could find no evidence of something akin to religious belief in pre-humans, he would be compelled to concede that there is a distinct rift between humans and the brutes, and that a supplementary law of some sort will be necessary to account for the uniquely human. In the case of religion, he speculates that primitive humans would have practised a crude animism. Then, searching for an even more rudimentary form of religion among the animals, he gives the example of the behaviour of his own dog, who growled when a parasol lying on the lawn was moved by a slight breeze:

> He [the dog] must, I think, have reasoned to himself in a rapid and unconscious manner, that movement without any apparent cause indicated the presence of some strange living agent.[7]

It is not a very impressive explanation, though we do well to remember how difficult it is to explain the complexities of human behaviour by reference to evolutionary origins. And the difficulties become prodigious if we limit ourselves – as Darwin initially tried to do - to the theory of Natural Selection. If the only permissible explanation for every single feature of humans is that these features, at some stage in evolution, must have conferred on their possessors significant advantages in the struggle for existence, how do we explain features

like altruism, or aesthetics, or religion? – What possible survival advantage could have been conferred on somebody who had a tendency to risk his or her life for others, or who had a talent for music, or who believed that there is a God? In general, it was – and remains – hard to frame explanations for the emergence, in imperceptible stages, of a society of moral humans from non-moral brutes. Darwin wrestled, page after page, with such problems, and his examples are usually much more plausible than the one concerning the dog and the parasol. But in the process of working out complex examples and marshalling mountains of evidence, he attentuated both his earlier notion of the Struggle for Existence, and his reliance on Natural Selection. It is sometimes unclear who is struggling with whom. Is it an individual struggling directly with nature (with an intensely cold climate, for, example); or is it two individuals of the same species struggling with each other for the means of subsistence; or is it the members of one species struggling with another species; or is it groups of individuals from one species struggling with other groups from the same species? In Darwin's examples it is not always clear. And when the going gets tough for Natural Selection theory, Darwin falls back on five or six other evolutionary mechanisms, including the inheritance of acquired characteristics (if I learn to hunt, my offspring will be born with a hunting ability), and Sexual Selection (certain features exist because they have been beneficial in the struggle to find a mate).

Also, far from revelling in the idea of Nature red in tooth and claw, Darwin gave humane ethical evaluations of some of the evidence he was producing. The tendency of animals to expel wounded members from the herd is, he says, 'almost the blackest fact in natural history',[8] and when he reaches his discussion of the evidence that, among modern humans, the poor and feckless are out-breeding the well-to-do and respectable classes, he stops well short of the disturbing eugenic recommendations that were proclaimed by writers like Francis Galton and Herbert Spencer.

Darwin, then, by the 1870s was by no means the single-minded advocate of the one, all-sufficient evolutionary mechanism of Natural Selection, nor was he at ease with the ethics that might be held to flow from such a heartless law of nature.

Huxley

The writings of T.H.Huxley, 'Darwin's bulldog', on the evolution of humans have an air of great clarity and force, but unlike Darwin, Huxley was not inclined to work through reams and reams of anthropological and biological evidence, puzzling his way towards evolutionary explanations. Darwin is frank, painstaking, unpretentious; Huxley is combative, dazzling, flashy. In 1888, he published an article on 'The Struggle for Existence in Human Society'. It has a single, powerful idea running through it, an idea that he was to elaborate more fully in his famous lecture on 'Evolution and Ethics' in 1893.[9] The idea is that far from there being an evolutionary continuum linking the non-moral, the rudimentarily-moral, and the fully-moral worlds, there is an absolute disjunction between the moral and the non-moral: humans can behave morally; nature cannot. 'From the point of view of the moralist', Huxley writes, 'the animal world is on about the same level as a gladiator's show'.[10] Huxley presents Nature as a war of all against all. And while primitive humans necessarily had to fight tooth and claw to hoist themselves clear of the brutes, once into the fully human world, they had equally necessarily to stop, turn, confront the Struggle for Existence that had governed their own evolutionary emergence, and set about establishing tight ethical limits to its operations. Huxley does not explain precisely how this dramatic change in evolutionary tactics happened. His more urgent concern is to warn his readers that the growth in population in the most wretched areas of industrial cities, coupled with intense international competition, are likely to overwhelm the ethical systems that have been established in defiance of Nature. The primeval, brute struggle for existence, he fears, will begin again. Darwin was cautious about drawing overt political lessons from his biology, but Huxley was unabashed. He pompously and mock-modestly proclaims: 'I am merely trying to deal with facts, to some extent within my knowledge, and further evidenced by abundant testimony, as a naturalist.' The boundary here between science and ideology has collapsed.

Despite the closeness of their collaboration, Huxley and Darwin were saying very different things about the origins of ethical human society. For Darwin, it has steadily evolved from pre-human origins, whereas for Huxley it has been achieved by some sort of heroic existential confrontation between humans and their sordid evolutionary past.

Wallace

By around 1890, then, the enquiry into human origins, human nature and human destiny was wide open. Kropotkin's entry into the debate was by no means eccentric. But before turning to Kropotkin himself, it is instructive to look at the work of Alfred Russel Wallace.

Wallace was doomed always to play second fiddle to Darwin. He generously accepted this humble role, but the clarity of his thinking during the decades following the publication of *The Origin of Species* should give him a higher claim. Back in the 1850s, and perfectly independently of Darwin, he had formulated the theory of Natural Selection. But when he found that Darwin had got there first, he magnanimously gave him priority. During the 1860s, Wallace's interests in socialism and spiritualism drifted him away from the inner circle of Darwinians, and Darwin grew impatient with him when traces of spiritualism began to appear in his evolutionary writings. But in nearly every way, Wallace was steadier on his feet than Darwin was in the difficult territories of Natural Selection theory and human evolution. In 1889, seven years after Darwin's death, Wallace published a magisterial survey of evolution. With characteristic self-effacement, he entitled it *Darwinism*. Darwin himself, while insisting that humans and the brutes have been produced by a single set of evolutionary forces, had increased the number of forces in the set rather incoherently. Natural Selection was pretty well suffocated. Wallace, by contrast, re-asserted the theory in its pristine form; in his preface he declares that his 'whole work tends forcibly to illustrate the overwhelming importance of Natural Selection over all other agencies in the production of new species'.[11]

Now, this might lead us to expect that Wallace would write, like Huxley, in the Nature-red-in-tooth-and-claw mode. Given his assertion of the primacy of Natural Selection, Wallace would be likely to emphasize the pitiless struggle for existence. However, unlike Huxley, he plays it down. As a socialist, and as a believer in 'an unseen world of spirit' which manifests itself in humans, he was perhaps predisposed to look on the bright side and to give the biological evidence, which he marshals with a skill at least equal to Darwin's, a cheerful interpretation. He argues, for example, that it is misleadingly anthropomorphic to imagine that in the great struggle for existence, animals suffer in the way that humans would . Animals' deaths are usually swift, and the doomed creatures can't anticipate their fate. 'As

a rule', he says, animals 'enjoy all the happiness of which they are capable'.[12]

When it comes to the emergence of humans, though, Wallace, quite unlike Darwin, insists that new evolutionary forces must have come into play. Natural Selection will have been competent only to seize on features strictly useful to their possessors in the struggle for existence. It will have been incompetent to guarantee the consolidation into human populations of things like the capacity for mathematics, or music, or humour.

What this rapid survey of the views of Darwin, Huxley and Wallace – three of the leading contributors to the enquiry about human origins – shows, is that there is surely some sort of interplay between ideology and scientific theory, but that it is not at all easy to specify precisely what it is. The liberal Darwin was ready to diminish the importance of the chief factor (Natural Selection) of his own grand theory, but insisted, come what may, that no special provision needs to be made to account for the emergence of humans. The equally liberal Huxley, by contrast, was not especially concerned about the intricacies of various evolutionary mechanisms, but had a passionate desire to proclaim a disjunction between Natural Selection, which has guaranteed the emergence of humans, and ethics, which are constructed in defiance of it. Meanwhile, out on the left wing, Wallace, the socialist, was surprisingly, but unswervingly committed to a demonstration of the sufficiency of Natural Selection to account for the evolution of every feature of the plant and animal worlds save for certain features of humans. Plainly, it's not easy to read off this trio's biology from their politics.

Kropotkin

What position on these issues did the anarchist, Kropotkin, take?

He did not limit himself simply to skirmishing back and forth across the issues defined by Darwin, Wallace and Huxley, although, oddly, when he did specifically address these issues, he was in many ways closest to Darwin. Like Darwin, he was fundamentally committed to a vision of nature that presented animals and humans in one, uninterrupted evolutionary continuum. Unlike Wallace, he envisaged no special spiritual interventions, and he denied Huxley's claim that ethical human behaviour can be founded only upon a repudiation of the evolutionary forces that have shaped us. Kropotkin's chief aim was to show that although Natural Selection and the Survival of the

Fittest are undoubtedly at work in nature, 'mutual aid' is at work too. In his own words: 'Mutual aid is as much a law of nature as mutual struggle'.[13] In order to demonstrate this, Kropotkin's ambitious project took him into territory that Darwin had not even staked out. Kropotkin's account did not stop at the emergence of humans from animals; it carried on, through ancient history, the Middle Ages and up to modern industrial society. In one grand sweep, Kropotkin connected up the evolutionary and the historical past. His book is as much a work of history as of biology.

Like Darwin, Kropotkin's method is to pile up anecdotes. He relates how he watched crabs combining to help a 'comrade in need' who had fallen onto his or her back and who couldn't turn over unaided. He relates how, in a population of sparrows, each sparrow 'shares any food it discovers with all the members of the society to which it belongs'. He suggests that migrating birds gather together, before they start, and 'evidently discuss the particulars of the journey'. Prairie dogs, he observes, sociably 'go visiting one another'.[14] These examples – and there are plenty more like them – may sound whimsical, but if we compare them with Darwin's own anecdotes, we find that Kropotkin is by no means embarrassed, as it were, by the comparison. Here is an example from Darwin, for comparison: 'I have myself seen a dog, who never passed a cat who lay sick in a basket, and was a great friend of his, without giving her a few licks with his tongue, the surest sign of kind feeling in a dog'.[15] The tendency of both writers to use anthropomorphic language when describing animals makes them both occasionally sound like Beatrix Potter.

It is not only in their anecdotal style, and in the point of their anecdotes, that Darwin and Kropotkin sometimes resemble each other. Their conclusions too converge from time to time, or differ only because of verbal, rather than substantial disagreements. For instance, in developing his argument for Natural Selection and the survival of the fittest in humans, Darwin suggested that sociable behaviour exhibited by a member of a human tribe might well directly favour him or her in the struggle for existence, whereas a member who exhibited only ruthlessly individualistic behaviour might antagonise members of the tribe to the extent that his or her survival would be jeopardised. Kropotkin noted that if just the emotive terminology is modified, examples like this could be used to establish his seemingly quite different, more genial law of mutual aid:

> ... while fully admitting that force, swiftness, protective colours, cunningness, and endurance to hunger and cold, which are mentioned by Darwin and Wallace, are so many qualities making the individual, or the species, the fittest under certain circumstances, we maintain that under any circumstances sociability is the greatest advantage in the struggle for life. Those species which willingly or unwillingly abandon it are doomed to decay; while those animals which know best how to combine, have the greatest chances of survival and of further evolution . . . The fittest are thus the most sociable animals, and sociability appears as the chief factor of evolution.[16]

Reconciliation seems more or less complete when Kropotkin goes on to say that 'Darwin was quite right when he saw in man's social qualities the chief factor for his further evolution'.[17]

But in the later chapters of *Mutual Aid*, where Kropotkin tours through human rather than biological history, Kropotkin addresses himself to issues that were not Darwin's concern, namely, issues to do with the advocacy of anarchism. Briefly, Kropotkin's argument is that peaks of civilization have come when societies have been at their most co-operative and most free from state interference. Troughs in civilization come when natural disasters force people into wars for the means of subsistence, or when power is concentrated in the hands of tyrants or the state. His arguments drawn from recorded history could stand on their own merits, but one of Kropotkin's most cherished beliefs was that history is continuous with biology, and that when people engage in co-operative, anarchistic activity they are in tune with the most fundamental principle at work in nature: 'the feeling of human solidarity . . . has been nurtured by all our preceding evolution'.[18] Clearly, an ideological thread runs through Kropotkin's formulations: his scientific theories are congruent with his politics, and the congruence is greater than it is in the cases of Darwin, Huxley and Wallace.

To echo my opening example, if we were presented anonymously with a copy of *Mutual Aid*, and were asked to say something about the likely ideological stance of its author, we could say a lot more than we could say about the author of the theory of gases and pressures. With some confidence we would suggest that the author of *Mutual Aid* wished, by reference to biological data, to promote a genial, co-operative vision of human society.

Conclusion

Ideology theory is sometimes an all-or-nothing affair. In its strongest form it declares that nothing is free from ideology and that everything – science included – is equally ideological. The sketches of four nineteenth century biologists and their theories presented in this paper do not confront the strong form of this theory, but they do make use of a weaker form of the term. A distinction can be made between on one hand the biologists' world-views, values, desires and needs (their 'ideologies', in the weak sense), and on the other hand, the facts about nature that their researches uncovered. And if we make this distinction, it appears that in the four cases discussed here, ideology is most powerfully evident when the scientific evidence is thinnest.

Starting at the thin end, we find Kropotkin and Huxley. They are an improbable pair: their visions of the significance of evolution for human affairs could not have been more different, with Huxley seeing an absolute disjunction between moral humans and savage nature, and Kropotkin seeing harmony between co-operative humans and co-operative nature. But they make a pair because despite their obvious interest in the topic of the evolutionary emergence of human society and human values, neither was committed full-time to research into the topic. Both the fervour and the high ideological content of their visions depends, it seems, on their relative ignorance of the issues involved. This may sound odd, especially in the case of Huxley, for he did, after all, write a book called *Man's place in nature*. But neither Huxley nor Kropotkin wrestled, day by frustrating day, year after year, with the bewildering complexities of issues like the emergence of altruism or aesthetics.

Moving to the end where the scientific evidence is at its most profuse we find Darwin and Wallace, another improbable pair (a rich liberal squire and a socialist-spritualist of working class origins). It is possible, as I hope I've shown, to discern the contrasting ideological threads in their work, but these threads do not dominate the fabrics. Much more impressive is the piling up of huge assortments of observations, coupled with determinations to make sense of them all. And when the sense runs contrary to their prior ideological positions, Darwin and Wallace yield their ideological positions, not their hard-won observations.

Where does this leave the issue of evolution and ideology? The most interesting studies in recent history of science have been those which have challenged the commonsense distinction between science and ideology. Regularly, they have shown that what was thought to belong

to a realm of hard, objective fact belongs equally to the realm of ideology.[19] Somewhat to my surprise, I find that such an enterprise, when directed at a survey of Darwin, Wallace, Huxley and Kropotkin, doesn't pay off very well. Any distinction drawn in the name of commonsense needs to treated suspiciously, but in this case, guilt isn't at all obvious. Darwin and Wallace lived full-time in a hard world of knobbly, awkward, uncomfortable biological facts that forever got in the way of any sort of smooth presentation of the visions of nature that were directed simultaneously by their desires and their ideological positions. Kropotkin and Huxley, despite their traveller's knowledge of that hard biological world, didn't live there and could thus tell their ideological traveller's tales.

Notes

1. P. Kropotkin, *Mutual Aid: a Factor of Evolution*, (Heinemann, London, 1902). (Hereafter *M.A.*) The chapters of the book were originally published as articles in the periodical *The Nineteeenth Century* between 1890 and 1896. The book is currently (1994) in print, published by Freedom Press, London.

2. The intellectual tradition that shaped Kropotkin has been described by Daniel Todes. See D.P.Todes, 'The scientific background of Kropotkin's Mutual Aid', *The Raven*, vol 6, no 4, 1993, pages 357-76.

3. Penguin reprint of first, 1859 Edn., (Harmondsworth, 1968) pages 228-9.

4. (Constable, London, 1927 edition), page xl.

5. ibid, page xlviii

6. G.de Beer, (ed.), Charles Darwin, Thomas Henry Huxley; Autobiographies, (Oxford University Press, 1974), page 51

7. C.Darwin, *The Descent of Man* (Murray, London, 1971). 2nd edition 1874, page 145. Hereafter *D.M.*

8. *D.M.* page 156.

9. Both are reprinted in *Evolution and Ethics*, (Macmillan, London, 1894).

10. ibid, pages 199-200.

11. A.R.Wallace, *Darwinism*, (Macmillan, London, 1889) page vii.

12. ibid, page 39.

13. *M.A.* page 30.

14. *M.A.* page 11, page 24, page 37, page 44.

15. *D.M.* page 157,

16. *M.A.* pages 57-8.

17. *M.A.* page 110.

18. *M.A.* page 292.

19. A good example is A.Desmond and J.Moore, *Darwin*, (1991) repr. Penguin, 1992.

Donald Rooum

Faith, Science and Scholasticism: an approach to Creation Science, especially in Britain

Faith is firm belief unaffected by evidence. Usually it means religious belief, and it often means dogma, or faith dictated by authority. But I use the term here (for want of a better word) to mean any fixed belief, including non-religious beliefs and convictions arrived at independently. Perhaps faith is needed to sustain endeavour. Certainly most people embrace faiths of one sort or another, presumably because they satisfy some emotional need.

To use myself as an example, I firmly believe that society could be organised without coercive institutions, almost entirely on the basis of voluntary co-operation. This has less to do with my experience of society than with my dislike of injustice. I think my belief is consistent with available evidence, and quite enjoy discussing evidence for and against. But my mind is made up in advance, which makes my belief a faith.

Science, in contrast to faith, makes evidence paramount. Some good ideas, such as Newton's laws of motion and Darwin's theory of natural selection, come to form theoretical frameworks and are consequently very hard to shift. But in principle, all the hypotheses, theories, paradigms and presumed laws of science are open to falsification by experience. There are no firm beliefs in science, only provisional opinions.

Throughout most of history, thinkers have studied to reconcile faith with science. The general term for this study is *scholasticism* (see Sarton, 1927), and its best documented practitioners are the schoolmen of medieval Europe, who studied to reconcile the 'necessary truths' of Christianity with the science of ancient Greece. They failed in their endeavour, but in so doing they laid the foundation for modern science.

The schoolmen were erudite, systematic scholars, who might have been scientists themselves in a different intellectual ambience. They set out as precisely as they could the two bodies of knowledge – sacred

and profane – which they intended to reconcile, and the arguments they used. William of Ockham (1964) wrote a treatise on the general principles of scholastic argument, by analysing the work of other schoolmen, including the brilliant St Thomas Aquinas.

One of Ockham's principles, 'Entities are not to be multiplied beyond necessity', has become the 'Ockham's razor' of scientific reasoning. But another of Ockham's principles is 'A necessary truth follows from anything, for example I am white, therefore God is triune', and yet another is 'Anything follows from an absurdity'. Ockham remarks that such arguments should not be used often, presumably because he doubts their validity. However, because he is intellectually honest, he does not try to hide the fact that they are used.

Modern science begins with the recognition of what the schoolmen demonstrated unintentionally: that faith and science cannot be reconciled. Modern scientists do not necessarily abjure faith, but keep faith and science apart, as entirely separate modes of thinking.

Until the sixteenth century, the history of science is world history. Discoveries were made in China, India, Persia, Arabia and Uzbekistan, as often as in Europe. In the sixteenth century, when Europeans learned to keep science and faith separate, the history of science became European history. Recently it has become world history again, as the rest of the world has learned the European trick.

Scholasticism, however, is not dead. It lives on in the form of Creation Science (I use capitals to distinguish it from science), the study to reconcile creationism with the data of physics, astronomy, geography, geology, palaeontology, biochemistry and comparative physiology. Huse (1986) defines creationism as 'the belief that the universe and the things in it were spoken into existence by miraculous acts of God as described in the Book of Genesis, chapters one and two'.

Recently in America, Creation Science has been linked with right wing evangelical sects like the ingeniously misnamed Moral Majority, and the faith that God ordains an unequal society, where the righteous can prosper at the expense of the undeserving. In Britain, however, the creationist groups who import Creation Science literature from America do not yet seem to be importing the associated political faith. Here, at least for the time being, it seems appropriate to treat Creation Science as an intellectual curiosity rather than a social menace.

Creation Scientists, and some others, believe that Darwinism and creationism are rival explanations for the wonderful complexity of life on earth, but this is an error. Darwinism is an explanation, while creationism contends that no explanation is possible.

Darwin's hypothesis explains how complexity may have arisen from simple beginnings, while creationism 'explains' complexity by postulating that a Being of unimaginable complexity existed at the start.

The methodology of Creation Science

Creationist controversialists often attack evolutionists with sneers and vituperation, from Bishop Wilberforce's famous question, whether Thomas Huxley was related to a monkey on his mother's side or his father's side, to a strip cartoon for children (quoted by Hayward, 1985):

> The monkey is pointing at a man who looks like a monkey. His name is Charles Darwin. He didn't want to believe that *God* created people. So he thought up a *big lie* instead. He said 'People came from *monkeys*'! He called his big lie '*Evolution*'.

But such insults are not part of the study to reconcile creationism with science, and I will not refer to them again.

Creation Science has three methods of argument: to present evidence consistent with creationism; to point out errors and doubts among evolutionists; and to 'interpret' Genesis in such a way as to make it consistent with scientific findings.

Evidence consistent with creation

There is an old argument for the existence of God known as the Argument from Design. As William Paley argues in *Natural Theology* (a book which Darwin studied in his youth), if I found a stone on the heath I might say it has lain there forever, but if I found a watch I must infer the existence of an intelligent artificer. An eye is a mechanism many times more complex than a watch, so we must infer the existence of an artificer many times more intelligent than a watchmaker.

If everything complex is due to something more complex, as Paley argues, then the question of how anything became complex in the first place is unanswerable. Darwin showed how complex things like eyes might be produced from simple beginnings by the simple, blind, unthinking forces of physics. But Paley's argument is still to be found in Creation Science literature, with Paley's eye still a favourite example, though Paley himself is not mentioned.

Watch Tower (1985) is full of examples like 'The remarkable genetic

code', 'The incredible cell', 'The amazing design of seeds', 'Nest building and instinct' and 'The miracle of the human brain' all presented as evidence for creation.

However, the examples are carefully selected to avoid the many examples of what looks like poor design.

Consider, for instance, goose pimples. Mammals have *arrector pili* muscles attached to hair follicles, which contract when the skin is cold and pull the hair erect. In most mammals, this traps a layer of air which prevents the skin from losing heat so quickly. In humans the hairs which are pulled erect are minute vellus hairs. We waste energy producing the little swellings called goose pimples, which have no effect on heat loss.

Or for a less trivial example, consider the conflation of reproductive organs with excretory organs. What mad architect put the nursery in the sewer?

Such imperfections are easily explained by Darwin's theory. *Arrector pili* muscles were useful to the ancestors of humans, and humans are not under sufficient selection pressure to get rid of them, so we keep them. The jumbled piping of the urino-genital systems works, so there is no selection pressure for a more elegant arrangement. All biological 'design' is a compromise between efficiency and ancestry.

Imperfections are awkward for creationists, since they will not allow the Creator to be careless or incompetent. One explanation they offer is that God created imperfections when He cursed His creation in Genesis III and/or Genesis VI:7, in a divine wrath resembling a childish tantrum. A pleasanter suggestion is that apparent imperfections are not real imperfections, but serve a purpose which we do not perceive.

Showing that evolutionists are wrong

Another method of Creation Science is to show that evolutionists make mistakes, or that they have reservations, or that they cannot answer every question, or that they disagree with each other, or that Darwin used expressions like 'it seems reasonable to suppose', or even that evolution is described as a theory.

This method relies on two unspoken assumptions. One is that unless evolutionists are right and certain about every little detail, the theory is wrong in general. The other is that there are only two possible models of development, so that if the evolutionists are wrong, the creationists must be right.

Some applications of this method are downright dishonest. It is quite common, for instance, to quote Darwin (1859) out of context:

> To suppose that the eye ... could have been formed by natural selection, seems, I freely confess, absurd in the highest possible degree.

Huse (1983) writes of 'the honest example of Charles Darwin who conceded this serious flaw in the evolutionary theory', and Watch Tower (1985) says 'More than a century has passed since then. Has the problem been solved? No'.

But Darwin does not in fact concede a flaw, or fail to solve the problem. He continues in the very next sentence:

> Yet reason tells me, that if numerous gradations from a perfect and complex eye to one very imperfect and simple ... can be shown to exist; if ... the eye does vary ever so slightly and the variations be inherited, which is certainly the case; and if any variations be ever useful to an animal under changing conditions of life, then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, can hardly be considered real.

In other words, when Darwin says the idea *seems* absurd, he does not mean it *is* absurd. He means only that the idea is startling (to readers in 1859), though the reasoning is inescapable. His meaning is unmistakable, and the statement that he could not explain eyes is a deliberate lie.

This is not to say that all the authors who repeat the statement are deliberate liars. It seems more likely that some of them copy the lie from others, whom they assume to be truthful.

Interpreting the firmament

The third method of Creation Science argument is to say that while Genesis is absolutely true, it is not all meant to be taken literally; some passages need interpreting. There are some who profess to take all passages literally, but in practice they all 'interpret' Genesis I:6-7, the bit about the firmament dividing the waters.

The literal meaning of this passage is clear (see Whitehouse, 1990; Bennett, 1903; Skinner, 1930; Hartman, 1962). The sky is an inverted bowl of some solid substance beaten out like metal (Hebrew *rakia*, variously translated as firmament, vault, expanse or dome). Its function is to divide the mass of primeval water into upper and lower oceans. It was created on the second day, and subsequent creative developments all took place within the space between the sky and the

lower ocean. In Genesis VI:12, apertures open in the sky and water from the upper ocean pours down, causing Noah's flood.

Hartman (1962) remarks that 'the biblical view was not seriously challenged until the sixteenth century', but he is mistaken. The ancient theory has been refuted long before the New Testament was written. Eudoxus published a spherical astronomy about 400BC, and Eratosthenes calculated the circumference of the spherical earth about 200BC. The view which was not seriously challenged until the sixteenth century was that the earth is at the centre of the universe.

In 748AD, Virgilius, Bishop of Stuttgart, preached that if people inhabit the opposite hemisphere then they have no eyes, since it is a necessary truth that every eye shall see the Second Coming of Christ. Boniface, Papal Missionary to Germany, wrote to the Pope denouncing Virgilius as a heretic because Virgilius took the earth to be spherical, contrary to Holy Scripture. Boniface was revered as a saint in his lifetime, and officially recognised as such after his martyrdom. Virgilius was canonised in the thirteenth century, when the schoolmen were at the height of their influence.

Most early Christians (and Martin Luther) followed Genesis in believing the sky to be a dome supported on a flattish earth. Most schoolmen followed Augustine in equating the firmament with the sphere of fixed stars. Modern Creation Scientists agree with scientists that the sky is neither a solid bowl nor a vast sphere, but boundless space. So they have no alternative but to 'interpret' Genesis I:6-7.

The most evasive interpretation I know is that of Watch Tower (1985), which ignores the upper water altogether. It uses a translation which renders *rakia* as 'expanse', misunderstands 'expanse' to mean an expanse of space rather than an expanded solid, and commends the bible for its accuracy in saying that the atmosphere came into being.

Other 'interpretations' say nothing about the firmament itself, but take 'the water above the firmament' to mean vapour.

Whitcomb and Morris (1961) say that on the second day of creation the earth was surrounded by a vast canopy of vapour. This persisted until the time of Noah's flood, when it was precipitated, increasing the volume of the oceans by 30%. Hayward (1985) calculates that such a canopy would cause 65 times the present atmospheric pressure, and would need a temperature of 160°C to prevent its premature precipitation.

Joseph Dillow proposes a lighter canopy, equivalent to a layer of ocean only forty feet deep. Hayward says this could not be sustained

as a canopy but would be mixed into the atmosphere by the wind: 'There would inevitably be winds in the pre-flood atmosphere'.

The interpretation Hayward favours is that the 'waters above the firmament' simply refers to clouds. This, he says, is the usual and oldest view. Not so, Dr Hayward: the usual and oldest view is that the authors of Genesis meant the *rakia* to be taken literally.

Interpreting the days

A majority of Creation Scientists insist that the development of the world, from primeval chaos to homo sapiens, took place between five thousand and twenty thousand years ago, and was over in six days. A minority, however, are convinced by the evidence of geology that the world as we know it took hundreds of millions of years to develop, and have to reconcile this with the six days of Genesis.

The pioneers of modern geology said that on God's timescale a 'day' can be millions of years, and most 'ancient creationists' appear to be satisfied with this. The more fastidious, however, prefer to reconcile the millions of years with the *literal* six days.

A perfect reconciliation is that of Gosse (1857), who says that when God created the dry land on the third day, He created all the evidence of prior development, including the apparent remains of creatures which had never in fact existed. This ingenious idea, however, is rejected on the ground that it presents God as a deceiver.

Hayward (1985) discusses the following four schemes of reconciliation, all intended by their inventors to be taken seriously.

God created the world in whatever time it took, then destroyed it and re-created it in six days, recycling the debris. (Genesis I:2 is usually translated 'The earth was without form and void', but 'The earth *became* without form and void' is equally correct.)

The six days were not continuous in time, but separated from each other by millions of years. (Proposed in 1855 and again in 1981.)

God created the world in whatever time it took, and the process was revealed to Moses, or someone else, in a series of six daily visions. (Proposed in 1857 and again in 1977.)

God made his fiats in six days, after which it took millions of years for the orders to be fulfilled. This is Hayward's own opinion.

Interpreting creation as evolution

Creation and evolution are often presented as irreconcilable, yet there are some who 'interpret' Genesis as meaning that God used evolution as the method of creation.

'Directed evolution' is a Creation Science idea, in that it 'explains' complexity in terms of a greater Complexity which in inexplicable. Where its intention is to protect the faith that Genesis is true, it is no different in principle from 'interpretations' of the firmament.

The erudite Creation Scientists of the Institute of Creation Research hold that evolution is 'false and absurd scientifically' and 'the anti-God conspiracy of Satan himself' (Ecker, 1990). But they also hold, paradoxically, that evolution has occurred on a limited scale and produced new species.

The reason is that they assert the literal truth not only of the creation story, but also of Noah's flood. Genesis VI:19-20 says that two of every 'kind' of bird, beast and reptile travelled in Noah's ark. Genesis VI:15-16 gives the precise dimensions of the ark, and it is far too small to accommodate two of every known species. A 'kind', therefore, must be a larger taxon than a species, perhaps the equivalent of a family. And speciation must have occurred since the flood.

Gladstone (1885) demonstrated the divine authorship of Genesis by showing that the sequence of creation in Genesis agrees with the fossil succession. Both, he said, had the 'water population' of animals appearing first, then the 'air population', then the 'land population' and finally the 'consummation in man'.

T.H. Huxley pointed out that land animals appeared before flying animals, to which Gladstone responded that Genesis intends to say only that birds appeared before mammals. Genesis in fact says that God created 'cattle, reptiles and wild animals' on the sixth day, but according to Gladstone reptiles do not count, as they 'are a family fallen from greatness'.

So, like the interpreters of the firmament, Gladstone denies what Genesis actually says in order to prove that what is says is true.

Even if it were true, that the geological succession of minerals, plants and animals coincided with the sequence in Genesis, Gladstone's argument would be invalid. There are a limited number of possible sequences. An ancient text hitting the 'correct' sequence would not be proof of divine authorship.

What harm can Creation Science do?

Creation Scientists, or other pseudo-scientists, may harm science and society in two ways. They may seize power and subordinate science to dogma by force, and they may distort science education through their influence on education authorities.

The forcible subordination of biology to anti-Darwinism occurred for a time in the Soviet Union, though there the anti-Darwinist dogma was not creationist but Marxist. From 1948 to 1953, the pseudo-scientific faith of Trofim Lysenko was legally imposed on science. The Institute of Genetics was closed and most geneticists re-employed as radiation biologists (the nuclear reactor accident at Kyshtym occurred in 1948). The Institute of Statistics survived only by a false declaration from its director that statistics is a branch of pure mathematics with no valid applications in the real world.

Attempts by Creation Scientists to wreck science teaching have occurred, and are occurring now, in the United States. Fortunately, the United States constitution allows education laws to be contested.

In 1925, as part of a political deal with a Senator who needed the votes of creationist constituents, the State of Tennessee enacted that evolution was not to be taught in schools or universities. The law was challenged by the American Civil Liberties Union (ACLU) and the case is famous for the conflict between two famous reforming orators, William Jennings Byran who was counsel for the prosecution, and Clarence Darrow for the defence. Darrow was not permitted to call expert witnesses on evolution, but was allowed to put Bryan on the stand as an expert on the bible, and demonstrated that Bryan was an ignorant old twit. Nevertheless, the campaign to get the law declared unconstitutional was a failure.

The ACLU needed someone to be found guilty of breaking Tennessee law in order to bring an appeal to the Supreme Court. They advertised in the Tennessee newspapers for a test case. The town council of Dayton (population two thousand) volunteered to prosecute a teacher, and John Scopes volunteered to be prosecuted.

Then, it seems, the Tennessee legal establishment decided to beat the ACLU at the game of legal shenanigans. The judge found Scopes guilty and fined him $100, allowing a higher court to reverse the verdict on the ground that only a jury could bring in a fine of more than $50. So the case never reached the Supreme Court and the law remained on the Tennessee statute book until 1957 (Gould, 1988; Ecker, 1990).

The more recent case was in 1980, when the State of Arkansas passed a law requiring 'equal time' for the teaching of creation, whenever evolution was taught. This time the ACLU did not need a test prosecution. They could appeal on the ground that it is unconstitutional to pass a law requiring religious instruction in public schools.

The case is called 'McLean and others v State of Arkansas'. McLean was Principal of the Arkansas Presbyterians, and 'others' included the local Bishops of the Methodist, Episcopalian and Roman Catholic churches, and a Rabbi, to demonstrate that Creation Science is not mainstream religion.

The Creation Scientists would probably have lost anyway, but their case was badly argued. One of their witnesses was Chandra Wickramsinghe, who told the court that evolution is a fact and that the idea of a separate origin for man and apes is 'claptrap'. The judges said they were 'at a loss to know why Dr Wickramsinghe was called'. We can make a guess. Professor Wickramsinghe proclaims that Darwin's theory is untenable, and the scruffier sort of Creation Science literature confuses Darwin's theory with the concept of evolution.

Hayward (1985) contends that they might have won if they had given way on the matter of the age of rocks: 'The strong case for creation is brought crashing down when it is tied rigidly to the hopeless case for a young earth'.

In 1987 a Bill was introduced in Louisiana, which did not mention creation but required 'abrupt appearance' to be taught as an alternative to evolution. The Supreme Court declared it unconstitutional before it was passed.

Members of the religious right, few as they are, can get themselves elected onto School Boards by concealing their allegiance until after the election. They regularly challenge 54% of School Boards in California, and from November 1992 to November 1993 they actually had a majority on the School Board of Vista (Reed, 1993). Since the Supreme Court judgement of 1987, no legislature in the United States may require the teaching of creationism in public schools. But School Boards influence the choice of textbooks, and the publishers of textbooks have 'updated' them to circumvent this barrier to sales.

According to Gould (1984), *Biology for Beginners* by Truman J. Moon, a widely used American schoolbook, was published in 1921 with a portrait of Darwin on the cover and a preface which said 'The course emphasises that biology is a unit science, based on the

fundamental idea of evolution'. Recent editions of the same book mention evolution only in chapter 58 of 60, 'The hypothesis of racial development', which chapter agrees with evolution but wraps it in waffle to avoid giving offence.

In Britain, things do not look so bad. The content of school textbooks is decided not by school boards but by examiners, and biology examiners are biologists. The Science Syllabus for Key Stage 4 of the National Curriculum, intended for all 14 year olds, includes a mention of evolution. All the GCSE Biology textbooks include a section on the evidence for evolution, with some account of Darwin's theory. All the A-level Biology textbooks include sections on Darwin's theory and neo-Darwinism (the conflation of Darwinism with genetics), and generally take a Darwinian view.

The Living World (Anon, 1993), a children's reference book designed for primary school libraries, tells the reader 'It will help you to build up a picture of how living things are related to each other, and how humans fit into that picture'.

We should not be complacent about ideas coming into this country from the American evangelical right. But we may hope that Creation Science is doing no significant harm here, so far.

Institute of Creation Research (ICR) of Santee, California (Ecker, 1990; Reed, 1993) was founded in 1970 by Henry Morris, co-author of Whitcomb and Morris (1961). It employs more than thirty full-time staff, including twelve 'science' staff with genuine degrees from mainstream universities. Henry Morris has a PhD in hydraulic engineering, his son John Morris has a PhD in geology, and ICR vice-president Duane T. Gish has a PhD in biochemistry. They work hard writing books and articles for many publishers, and touring the USA to give lectures and take part in debates.

Since 1981 the ICR's 'ministries' have included a graduate school granting MAs in biology, geology, physics and education science. In 1989 an evaluation team recommended to the California education authority that ICR's licence for these subjects be revoked, on the grounds that students were taught religion or creation, not science. But ICR retains its licence.

ICR contends that the real facts of science agree perfectly with the biblical record, and that the prevalence of evolutionary beliefs is due to a Satanic conspiracy. The writings of its science staff agree with the literal meaning of Genesis to a remarkable degree. Like the writers of Genesis, they take blood to be the criterion of life, and regard plants

as not living things but products of the earth; a remarkable opinion in a biochemist. Their doctrine of flood geology is no less remarkable in a hydraulic engineer and a geologist.

However, the are inconsistent in their literalism. They accept that the sky is space, and 'interpret' the biblical firmament out of existence.

ICR has come to dominate Creation Science thinking, at least in the English-speaking world.

Creation Science Movement (CSM) is a British society, founded in 1932 as the Evolution Protest Movement. After 1970 it came increasingly under the influence of ICR, and in 1980 it changed its name to Creation Science Movement. Now, despite its prior foundation, it might be taken for a British offshoot of ICR. One difference is that it will publicise Creation Science arguments which ICR rejects as too daft, such as Setterfield's theory (Bowden, 1988).

In 1991 its president was a physician, Dr Verna Wright, and its chief speaker a chemist, Dr D.T. Rosevear (see Dorricot, 1990).

Philip Henry Gosse, father of the writer Edmund Gosse, was a distinguished biologist, inventor of the marine aquarium, author of books like *Birds of Jamaica* and *Manual of Marine Biology*, and a Fellow of the Royal Society.

His book *Omphalos* (1857) was written in response to the challenge of the geologist Charles Lyell, 'patiently to untie the Gordian knot' of evidence for the great age of rocks. It reviews the data of geology and palaeontology available in 1857, with a section on coproliths or fossil droppings, and how they can be sliced up and examined to find out what dinosaurs ate.

But its main interest is in the contention that dinosaurs and other fossil organisms were never alive. For Gosse was an elder of the Plymouth Brethren, bound to the dogma that the world was created in 4004BC.

Gosse argues that Adam at the moment of creation was a full grown man with all the evidence of growth, including a navel (Greek *omphalos*), the scar of an umbilical cord which had never existed. Similarly, trees at the moment of creation contained annual rings indicating years of growth which had not taken place. Similarly, earth at the moment of creation contained evidence of millions of years of development, including fossils of organisms which never were.

Evidence of evolution is not evidence against creation, because God created the evidence of evolution, three days before He created Adam.

Gosse's theory cannot be refuted by evidence, and it was a great disappointment to him that creationists did not warm to it. He thought its rejection was a punishment from God.

Creation Scientists reject 'Gossism' because it implies that the Creator is a deceiver (though that is not how Gosse saw it). But they use Gosse's argument when other methods fail. For instance, ICR answers the question of how we see stars millions of light years away, if nothing is more than twenty thousand years old, by saying that the light was created en route.

William Ewart Gladstone was often Prime Minister. He also wrote a book showing that Genesis tallies with Homeric legend, which was discredited by Homeric scholars. Later (1885) he wrote an article for *Nineteenth Century* showing that Genesis agrees with the fossil record, which was discredited by Thomas Henry Huxley.

Jehovah's Witnesses sell for £1 a little book profusely illustrated in colour, entitled *Life, how did it get here?* (Watch Tower, 1985). Chapter 3 is a version of Gladstone's thesis, asserting that Genesis lists ten major stages of development of the earth in the right order, with a long digression on the mathematical possibility (1 in 3,628,800) of getting ten things in the right order by chance.

One of the ten stages is 'a beginning', which by definition has no chance of being anywhere but first. *Rakia* is mistranslated as atmosphere, and the 'water above the firmament' simply ignored. The Genesis story that flying animals came before land animals is interpreted Gladstone-style to mean that birds occurred before mammals (ignoring the small mammal fossils which predate the earliest known bird).

'An additional reason for evolution's acceptance is the failure of conventional religion ... to represent properly the Bible's creation account.'

Eric Laithwaite is Professor Emeritus of Electrical Engineering at Imperial College, and an erudite amateur lepidopterist. I looked up his work because he is reputed to be a creationist, but he writes (1975) of 'millions of years of evolution in which nature developed ... the perfect flying machine'.

Laithwaite is interested in the limits of thought (Laithwaite, 1974). He may be mistaken for a creationist by those who suppose that to notice limits in Darwin's theory is to embrace the faith of creationism.

Fred Hoyle and **Chandra Wickramsinghe** (1988), professors of astronomy and mathematics at Manchester and Bristol Universities, have written several books on evolution. They prove that there has been too little time for life to have evolved by what they suppose to be Darwin's mechanism, but as Dawkins (1986) shows, they misunderstand Darwin's theory.

Their own view is that life on earth originated and evolves by the injection of molecules from space, and that the Universe itself is intelligent. This is not creationism by Huse's (1986) definition, since it is informed by Buddhism and pantheism, not by the book of Genesis. But it is Creation Science in the sense that it 'explains' in terms of the Inexplicable.

Barry Setterfield is an Australian, but his work is perhaps more respected in Britain than anywhere else. CSM publishes pamphlets about it (e.g. Bowden, 1988), while ICR dismisses his theory as untenable.

He read somewhere that when Roemer first measured the speed of light in 1675 it was a lot faster than it is now. He looked up measurements since then, and plotted the measurements on a graph, which he extrapolates backwards to show that in about 5300BC the velocity of light was infinite.

Unfortunately, his original reference was incorrect. Roemer's estimate of the speed of light was not faster than the current value, but 25% slower.

Norman and Setterfield's (1987) paper has the imprint of two reputable scientific establishments, both of which denied responsibility for it in 1988 (Rooum, 1992).

Colin Wood (1983) is worth mentioning here as a creationist who does not believe there are only two possible models of development, but recognises three: Evolutionary Theory (i.e. guided evolution; he shows no knowledge of Darwin's theory), Biblical Creationism and Divine Creationism.

Divine Creationism was revealed to him in a near-death experience, following a suicide attempt in 1971 (Wood, 1991). Among other revelations, God did not give the first humans permission to have sexual intercourse, but they went ahead anyway and the result is the present crisis in over-population.

Alan Hayward is a scientist (a consultant engineer), and also a

Creation Scientist. But, uniquely among the Creation Scientists I have read, he does not get the two mixed up. The charge against Creation Science, that it falsely pretends to be a science, cannot be laid against Hayward. He writes (1985) 'It is a pity the term "Creation Science" was ever invented. Creation is not a branch of science, and never can be. Creation is a matter of faith.'

Hayward attributes the succession of fossil forms to continuous creation. The theory that later forms are descendants of earlier forms requires fewer hypothetical entities, and is therefore preferable according to Ockham's razor. But Ockham's razor is an arbitrary rule; the absence of evidence that something exists it not proof of its non-existence. Hayward sets Ockham's razor aside, and like the schoolmen of old he explains precisely what he is doing. His scholasticism is intellectually respectable.

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Hypothesis versus Dogma

In common with almost everyone working in the field, I am an unrepentant Neo-Darwinist. That is, I think that the origin of evolutionary novelty is a process of gene mutation which is non-adaptive, and that the direction of evolution is largely determined by natural selection. I ... know that this is a hypothesis, not a fact, and that observations may one day oblige me to abandon it, but I do not expect to have to.

John Maynard Smith
'The limitations of evolutionary theory' in
The Encyclopaedia of Ignorance, 1977

[The theory of evolution] has wrought havoc in the home, devastated morals, destroyed man's hope for a better world, and contributed to the political enslavement of a billion or more people.

Tim LaHaye
'Introduction' to Henry Morris,
The Troubled Waters of Evolution, 1975

Brian Martin

Anarchist science policy

Introduction

To illustrate some of the difficult decision-making issues involving science, consider fluoridation. The idea is to add about one part per million of fluoride to public water supplies in order to reduce tooth decay in children. A large number of studies since the 1940s show that fluoride reduces tooth decay, and most dental and medical experts say that there are no demonstrated harmful effects from ingesting fluoride at one part per million in water.

Proponents of fluoridation used these arguments – plus the argument that fluoridation is far cheaper and more reliable than any alternative in getting fluoride to all children – to promote the measure. They have had a large degree of success in Australia, Canada, New Zealand and the United States, where a large fraction of the population drinks water with added fluoride. But most other industrialised countries have little or no fluoridation.

Since the beginning of the push for fluoridation, there has been considerable public opposition. Opponents have raised two main arguments. The first is that there are health risks from fluoridation, including allergic and intolerance reactions, skeletal fluorosis and possibly genetic effects (birth defects and cancer). The second is that fluoridation is a violation of individual rights, because it is compulsory medication at an uncontrolled dosage (although the concentration of fluoride in the water is controlled, the amount of water consumed by any person is not). A minority of dentists, doctors and scientists have been part of this opposition. They have also questioned the scale or even existence of the benefits, noting that tooth decay has declined in unfluoridated as well as fluoridated regions.[1]

Here is a complex policy issue involving scientific issues. What can anarchist principles contribute to a solution?

An outline of 'anarchist principles' would be useful for a start. I take a broad interpretation of anarchism as involving opposition to all forms of hierarchy and domination – especially the state but also monopoly capitalism and patriarchy, among others – and support for

self-management namely people collectively running their own lives. Another important anarchist principle is that the means for achieving self-management should incorporate the ends. Suitable methods include rational argument, autonomous learning, egalitarian groups and grassroots organising. This principle rules out the approach of seeking state power, whether by armed struggle or electoral politics, even when done allegedly as a means of abolishing the state.

These principles can be readily applied to some aspects of the fluoridation issue. A first implication is that decisions about fluoridation should be made only at local community levels and not imposed by remote governments. This rules out fluoridation of large cities imposed by governments, as in Seattle, Sydney and Singapore.

It's still possible to imagine popular support for fluoridation in a small community, or perhaps even in a large one. But obtaining unanimous agreement is unlikely: many of the fiercest fluoridation disputes have been in towns of only a few thousand. If a referendum is held and a solid majority votes for fluoridation, should that be considered an aspect of self-management or domination of the majority over the minority?

It turns out that there are some intermediate solutions. First, if the water supply is fluoridated, it is not compulsory to drink the water. Bottled water can be obtained or a rainwater tank installed, although these options involve considerable additional expense. Likewise, if the water supply is left unfluoridated, it's still possible to obtain fluoride by taking fluoride tablets or using fluoride toothpaste. Another solution is to have table salt available both with and without added fluoride, as in Switzerland today. There are also some more expensive solutions, such as having two water supply systems, with and without fluoride. Finally, if the scale of fluoridation is limited to small regions such as a neighbourhood, people could choose to live in a location with the water supply they preferred.

These options reduce or eliminate the compulsion that has been the key bone of contention in the fluoridation debate, at least for the opponents. But it doesn't begin to resolve a more difficult issue for most individuals: should I be taking extra fluoride? Since the benefits are much greater for children than adults, many adults might answer 'no' for themselves. (They certainly should if they have no teeth!)

Adults have a responsibility to look after the well being of small children. This is not something that can be left to each individual's judgement, since a two year old is not in a position to make an informed choice. Proponents of fluoride recommend that it should

be taken from infancy. Should parents or guardians make decisions for their children, or should there be common community standards? In either case, how should the decision be made?

At this stage, the conscientious person might begin a personal investigation to find out the truth about fluoride. Does it really reduce tooth decay? If so how much? What are the real health risks? How serious are they?

The published scientific literature is the place to start. Unfortunately, the range of information is both enormous and doesn't resolve the issue. There are tens of thousands of scientific papers about fluoride, with more produced every year – a quantity impossible to digest. A deeper problem is that even this amount of research has not provided a definitive answer to key questions. The existence and size of both the benefits and risks of fluoride continue to be debated.

There are several interlinked reasons why science cannot produce a single 'correct' answer. First, the production of knowledge is influenced by various vested interests, directly or indirectly. Governments and corporations fund most scientific research, and scientists are much more likely to do research in areas that are funded and also to avoid, often unconsciously, conclusions that are unwelcome by funders. In 1950, the United States Public Health Service endorsed fluoridation and thereafter poured money into promoting it and researching it. Most of the research was into the benefits of fluoridation and very little into potential risks. Furthermore, once fluoridation was endorsed by major dental associations, editors and referees of major dental journals were very resistant to publishing any criticisms of fluoridation. Even without large-scale vested interests, scientific results are influences by the psychological commitments and career interests of individual scientists, many of whom build their reputations on a particular stance.

Second, it is impossible to separate facts and values. Critics of fluoridation point to instances of skeletal fluorosis (a potentially crippling bone disease) in a number of countries, especially India, usually linked to high levels of fluoride intake. They suggest that water fluoridation may be leading to sub-clinical cases of this disease. Proponents, on the other hand, argue that there is no evidence of skeletal fluorosis in temperate climates when water fluoride levels are one part per million, and dismiss a few isolated cases as exceptions. A fundamental difference in values underlies the assessment of the evidence: proponents believe fluoridation is safe until clearly proven

otherwise; opponents believe the burden of proof lies on the proponents to conclusively prove that fluoridation is safe.

A third reason why a 'correct' answer is forever elusive is there can never be a definitive study or incontestable evidence. No matter how tight the protocols, there is always some basis for criticism of and disagreement with the results. Epidemiological studies showing that fluoridation reduces tooth decay have been subject to searching critique by scientist critics. For example, there are many epidemiological studies showing a substantial reduction in tooth decay in children living where fluoride is added to the water supply. Proponents conclude that fluoride reduces tooth decay. Some opponents are not satisfied. They point out that the studies have flaws in their design. For example, in most of the studies the dentists who count cavities know which children are from the fluoridated community. Because there is a subjective element in deciding whether a cavity exists, they might be unconsciously producing pro-fluoridation results. The proponents believe that, despite any flaws, the weight of evidence supports fluoridation. Opponents believe that studies without such design flaws should be carried out before introducing a measure with potential risks.

The problem here is not just the bias and stubbornness of the scientists involved in the fluoridation controversy – though that plays some role – but that scientific research always involves interpretation, and this is always subject to challenge. Contrary to most science textbooks, there is no unambiguous truth residing in nature than can be determined simply by reading the data from an appropriate experiment. *Rather, every observation and every experiment is premised on a range of assumptions and is incorporated into a wider social context.* Change the assumptions and the context and the observations and experiments take on a new meaning.[2]

The upshot of these limitations is that science cannot be used to provide a definitive answer for any real-world questions. The impact of vested interests cannot be eliminated; facts and values cannot be separated; and interpretation is inevitably involved. This means that decisions should not be left to experts: they are often compromised by funding and, in any case, they are no more expert in value judgements than anyone else. Nor is it satisfactory to let the experts just comment on the facts and have everyone else debate the social issues, since the 'facts' are not neutral and independent.

Nor is it really satisfactory to say that everyone should be involved in assessing the issue. Very few people have the time to study the

fluoridation issue in depth, much less hundreds of other issues of similar complexity. Full popular participation in all issues is an impossibility, whether or not they involve technical dimensions.

I've used the case of fluoridation to illustrate some of the issues involved in making decisions involving science. With this example in mind, I now turn to the general issue of science policy, discussing its key dimensions in the light of anarchist principles. After this, I canvass a number of strategies for moving towards an anarchist science policy.

Dimensions of science policy

What is usually called science policy is concerned with a range of issues, including:

- the setting of research priorities;
- the establishment and maintenance of institutions for carrying out research;
- salaries, conditions and career structures for scientific workers;
- decision-making about issues with significant technical dimensions.

The fluoridation controversy falls into the last category. The other categories are fundamental but much less discussed.

'Science policy', in its usual usage, refers to decisions made and implemented by governments. Therefore, 'anarchist science policy' may sound like a contradiction in terms. Here I use the word policy in a general way to refer to collective decision-making or decision-making affecting a community. In this latter sense, anarchists need to be concerned about science policy even if there is no state. 'Policy' – both the word and the practice – needs to be taken over by the people who are affected by it.

Research Priorities. Most research today is carried out for the purposes of profit or social control.[3] A large fraction of research is funded by the military to develop more powerful weapons, build secure communications systems, develop effective strategies, and so forth. A large amount of apparently innocuous research in fields such as computing, materials engineering and climate is funded by the military to ensure that it is able to take advantage of any useful developments. Profit is the main driving force behind much research in areas from pesticides to pharmaceuticals.

The priorities for ostensibly 'pure' research are often influenced by government and corporate priorities. A prominent example is

high-energy physics, an indirect beneficiary of the priority placed on nuclear weapons and nuclear power. Similarly, the high prestige of molecular biology is linked to potential applications to biotechnology.

An anarchist science policy would have a different set of priorities. These priorities would be established by popular participation. It is likely that they would include research to build community self-reliance, to provide satisfying work to everyone, to promote ecological sustainability, to prevent common diseases, to foster interactive communications, to improve methods of non-violent struggle and to enable popular participation. All of these, among others, would contribute to building a society without domination.

Such an alternative set of priorities would undoubtedly see a change in emphasis on different scientific fields. Some fields, such as nuclear physics, would receive less support. Others, such as renewable energy systems and computer networks, would receive more. Overall, it's likely that much more emphasis would be placed on social science than currently – but social science priorities would also change.

Would anarchist research priorities mean that science would be 'political', in the sense that it would not be pure and independent of social interests? Certainly – but no more than present-day science, which cloaks itself in the guise of neutrality. Science today is certainly political in this sense; it is shaped by powerful interest groups. Anarchist research priorities would mean that scientific knowledge would be shaped by a *different* set of social interests.

How would this affect the fluoridation controversy? One possibility is that communities would favour research into a range of ways to reduce tooth decay, including better nutrition, a variety of mineral supplements and improved oral hygiene. This might enable the fixation on fluoridation, by both proponents and opponents, to be side-stepped entirely.

Institutional structure. Today, most scientific research is funded by governments and large corporations and takes place in research labs run by governments, corporations and universities. This is a large part of the explanation for research priorities.

Does it matter where research takes place? Isn't science a 'universal language'? Institutional issues may seem irrelevant to those who think of science only in terms of pristine bodies of knowledge. But there is much more to science that facts in textbooks, just as there is much more to language than words in a dictionary. Science is much more than knowledge: it is a culture, a process of intellectual work, a

community of practitioners, a political economy of institutions and workers. Scientific knowledge is inextricably linked to science as a social system, which in turn cannot be understood separately from wider social institutions.[4] Knowledge only has meaning in a context, and research institutions are a crucial part of that context.

An anarchist science policy would seek to promote a scientific research system that is managed by the community and researchers, rather than by elites. Funding decisions would be made by communities, in a participatory fashion.

It's difficult to be more specific than this, because there are a number of different models compatible with the general idea that research is managed by the community and the researchers. One model would involve a significant decentralisation of research, with small groups of researchers working with different enterprises or with community groups. Another model would involve large numbers of researchers working on major projects, overseen by community representatives. There are also questions concerning science education, scientific journals and editors and professional associations, few of which have been thought through from the point of view of self-management.

A large fraction of research relevant to fluoridation has been funded by government bodies and carried out in government health departments and university dental schools. With greater local community control over funding priorities, it is likely that a much greater diversity of research on fluoridation would be undertake, from a wider range of initial assumptions, and perhaps involving a wider range of skills. But there's certainly no guarantee that this would help resolve the bitter disagreements over the issue!

Professional structure. Science is one of the most highly professionalised of all areas of human endeavour. Amateurs are actively involved only in a few areas, such as astronomy and zoology. Almost all of what is recognised as scientific knowledge is produced by full-time professional scientists and students training to become full-time professional scientists. To complete the monopoly, people who are not professional scientists but who make observations and logical inferences about natural phenomena – such as gardeners or sailors – are defined as 'non-scientists'. To be acknowledged as a scientist, one needs to write up results in a formal fashion and publish them in scientific journals, whose editors and referees generally frown on contributions from outside recognised scientific institutions. In other words, scientific research is a successful occupational

monopoly.

Occupational monopolies are found in many fields, but in most cases there are vigorous challenges. Many people do their own home repairs and some even build their own houses. Health self-help groups and alternative practitioners are active. The legal profession is under challenge from those who want to eliminate its monopoly over certain tasks. By contrast, there is very little agitation for community participation in scientific research.

Another contrast is that many occupational monoplies are protected by the state. Law and medicine are the best examples: unlicensed practitioners can be prosecuted. Science is different. The occupational monopoly is largely sustained by state and corporate funding – hardly any of which goes to outsiders – and by the profession itself. Scientific elites – including top government advisers, heads of research institutes, key players in funding bodies – are the front line in maintaining professional control. They are the ones who ensure that resources and positions are denied to outsiders.

An anarchist science policy, by transforming the institutional basis for research, would also undercut control by scientific elites. But more generally, an anarchist science policy would seek to make scientific research a more participatory activity, something in which virtually any interested person could be involved.[5]

A society can pour resources into developing the skills of a few elite sportspeople, or it can foster participation by all. It can promote a few musical child prodigies or it can enable all interested children (and adults) to play music. It can reward the management skills of a few bosses or it can develop everyone's leadership abilities. Science is no different.

But, it will be objected, surely only a talented minority are able to do scientific research? The objection sounds plausible. A closer look at the analogies helps explain the argument.

Agreed, not everyone can be a star of soccer or gymnastics. But it is certainly possible for just about everyone to reach a high standard of performance at some sport – maybe not at the level of the very best, but far better than a non-participant. Furthermore, if everyone is given the opportunity and encouragement to participate, a greater number of top performers are likely to come to light. Finally, to complete this analogy, high-level success at some sports is possible only for a few, for example the very tall in basketball. Redefining sports, for example by promoting cooperative sports, would foster more participation and more satisfaction.

There is evidence that participation in advanced scientific research, even the way it is presently organised, is possible by people with very little training. In one case, ordinary high school students were able to do publishable medical research after working on specific projects for a number of months.[6] Scientific research is by no means as difficult as it is commonly made out to be. Every scientist knows of colleagues who demonstrate that a person without much talent is still able to do acceptable research.

The evidence that ordinary mortals can do scientific research is encouraging, but it is not the essential part of the argument. This is because science, as practised today, is set up to make participation difficult. Obstacles include long training, apprenticeships only for those who have excelled in prior courses, the use of special jargon, limited access to expensive equipment and definition of significant research as only that which takes up issues pursued by the professional research community. By relaxing these and other barriers, participation could be much greater. This greater participation would be in a science that would be more diverse, more understandable to outsiders and less dominated by elites.

In such a science, many participants might be involved on an occasional basis, as a part-time activity or for a few years at a time. Long-term, full-time participation would be the exception.

Would this mean a decline in quality? Not necessarily, even by existing standards. With greater participation, there could be a flowering of skills of a larger fraction of the population. More importantly, though, the criteria for worthwhile science would change. The goals would be research to serve self-managing communities, of whom the researchers would be a part. They could hardly do worse than present-day science for this purpose.

One good example is the citizen research teams in Japan that investigated environmental problems.[7] The sort of research they have done – such as looking at flowers for evidence of the effects of ionising radiation, or interviewing people affected by pollution – often seems much more 'simple' than the high-powered computer modelling and chemical analysis done by industry or university teams. But it is only 'simple' in the sense of being able to be done by citizens, since in terms of gaining understanding it can be quite powerful. Citizen researchers managed to discover the cause of Minamata disease before heavily-funded teams of scientists were able to do so. The orthodox scientists, by the way, were funded by industry and hence perhaps had a disincentive to discover that industrial effluent was responsible

for the disease.

One type of research that seems especially in tune with anarchist principles is called 'action research'. In action research in the social sciences, two goals are tied together: seeking knowledge and making a better society. Examples are promoting worker self-management via studying decision-making in industry and mobilising communities as part of studying systems of exploitation. What action research means when applied to natural science is not so clear, but there are certainly opportunities in applied fields.

There seems ample opportunity for popular participation in research on tooth decay, for example by getting people to make reports about experiences with dental problems, diet, water supply and so forth. Present day research relies almost entirely on 'experts' collecting all the data, but even after decades of research the biochemical process by which tooth decay occurs and is prevented remains incompletely understood. Participatory research could easily lead to new insights.

Collective decision-making. How should decisions be made about research priorities, investments in equipment or social issues involving technical dimensions? These are all the things normally understood as science policy. The discussion above of research priorities, institutional structures and participation in research deals with *outcomes* that are compatible with anarchist directions. What about the *methods* to achieve these outcomes?

Currently, the key decisions about science policy are made by government, corporate and scientific elites. An anarchist decision-making system would be much more participatory. There is no fundamental obstacle to such participation. The key decisions about science do not require specialised expertise. You don't have to be a doctor to participate intelligently in formulating health policy and you don't have to be an airline pilot to participate meaningfully in setting transport policy.[8]

There are many participatory models, including consensus, modified consensus, direct voting on issues and voting for delegates, each one of which can be applied at different scales, from a small collective to a substantial-sized community. In turn, links between different decision-making units can be coordinated by federations, networks or canton-systems. There is no need for standardisation in decision-making systems: a range of methods can be used, in different places or at different times.

Somewhere down the line, individuals will have to make decisions,

such as whether to build a telescope, to develop pesticides, to give fluoride to children, or indeed to remove fluoride from naturally fluoridated water supplies. As was argued earlier, science cannot provide a definitive answer because there are always uncertainties, because technical and non-technical issues are inextricably mixed together and because any evidence can be challenged. So these are essentially social issues with technical dimensions. As social issues, everyone should have an opportunity to be involved if they want to be. Experts can be listened to, by all means, but they should not be relied upon to provide answers.

There have been quite a number of proposals for allowing citizens to be involved in science policy issues. Some of these, like the science court, unrealistically assume that facts can be separated from values. Most of them, such as the citizens hearing panel, rely on participation from only a very few representatives of the community.[9]

One approach that I believe has a lot to offer is the 'policy jury'. A 'jury' is set up to deal with a specific issue. Its members are chosen randomly from all those who are interested. The policy jury can ask for submissions, listen to arguments, take account of popular action, study and discuss the issues and make a recommendation.

There have been some experiments with policy juries in the US and Germany. They have dealt with issues such as water pollution due to run-off from farms, and directions for energy policy. The juries seem to work well in the sense that the randomly-chosen participants take their task very seriously and come up with 'sensible' recommendations.[10]

Because they are based on random selection, policy juries are less susceptible to takeover by experts or elites than other methods. The juries deal with issues as a whole, without any assumption that technical and social dimensions can be separated. They allow an in-depth look at the issue which would be impossible if everybody were involved with every issue. Finally, the jury has no mandate: members obtain their positions neither by election nor by appointment on the basis of special expertise. Therefore, to have any sway, the jury must rely on developing a sound, sensible proposal. In an anarchist society, without a state to back up decisions, policy juries could only succeed by persuasion rather than power. They would be persuasive precisely because they are randomly selected and therefore without vested interests, just like juries for criminal cases.

Strategy

This set of directions for an anarchist science policy implies a dramatic shift in the present social context of science: many research topics would be different, communities rather than powerful institutions would support and control the scientific enterprise, many more people would participate in research and everyone could be involved in making science policy. Such a change is unlikely without similar changes in other aspects of society. Indeed, it has long been my opinion that science is one of the social institutions most resistant to popular participation and control.

Even radical critics of science have seldom explored the implications of self-management. Critics of science are prone to reject science itself. Science is seen as either good, neutral or bad, in each case having an essence that is independent of society. A more useful perspective for radicals is to see science as a feature or aspect of society, currently mainly oriented to the requirements of elites but with potentials for developing to be a useful part of a society without hierarchy.

This is quite different from the idea that science is neutral and can be 'used' for good purposes or 'abused' for bad purposes. This is like saying that 'the economy' (that is, the current capitalist economy) can be used or abused, to produce food or weapons. This use-abuse model ignores the possibility of other economic systems or other science systems. As I've indicated, various aspects of science could potentially be changed: research directions, institutional context, participation in research, decision-making.

But how? Because the present system of science has so successfully convinced people that it is the only possibly system which, therefore, must be either accepted or rejected, it is difficult to do more than indicate some directions that will contribute towards a self-managing science. There is no strong constituency ready to take action.

The radical science movement that sprang up in the late 1960s and early 1970s did much good work, but radical science groups have usually had a precarious existence.[11] Some members are practising scientists who adhere to traditional ideas about science; they are mainly concerned to challenge the grossest abuses. Most of the radical critics have used a Marxist framework to develop attacks on capitalist science. But their picture of an alternative, a socialist science, has never been well developed. A number of foreign models – China, Nicaragua, Tanzania – have been used for inspiration, often with some justification but also often with blindness to their limitations.[12]

In this context, in which there is little development of the possibilities for anarchist science policy, I will canvass briefly a range of options.

Anarchist epistemology. The late Paul Feyerabend is the most prominent philosopher to champion a different philosophy of science. He criticises the positivist, dogmatic approach to knowledge that is common in establishment science, in which almost all resources are devoted to exploring the implications of the dominant theoretical framework. He supports, instead, investigation of a range of competing theories. This is called 'anarchist' because there is no central theoretical dogma that dictates scientific research.[13]

Actually, Feyerabend's approach is what many scientists think is or should be going on anyway. Many scientists, after all, do investigate non-standard hypotheses.

Feyerabend is careful to say that while he supports anarchist epistemology, namely a theory of knowledge that is more pluralistic than present-day science, he does not support anarchism in a political sense. The problem, of course, is that most scientific knowledge is an outgrowth of the conditions that generate it, including funding, institutional structure and professionalism. Pluralism in theories cannot be created by intellectual will alone. There are plenty of alternative theories today. The problem is that dominant institutional forces give overwhelming emphasis to theoretical directions compatible with their interests. The epistemological road to revolution is filled with blind alleys. Creating 'liberatory' theory can be stimulating and worthwhile, but it cannot be relied upon as a means of achieving self-managing science.

Action by scientists. There are a range of things that radical scientists can do to help move towards self-managing science.[14]

- Give talks and write articles presenting critiques of science.
- Write exposés of the behaviour of scientists.
- Do research on socially relevant topics.
- Incorporate a radical critique of science in one's teaching.
- Promote greater participation and sharing of work in scientific workplaces.
- Enable non-scientists to join in scientific work.

These are all pretty obvious, but it is very difficult to carry them out. For most scientists, deviation from the range of expected behaviours

can lead to serious consequences. To openly take a critical stand about science, especially the work of colleagues, can seriously jeopardise one's career. Just writing an article to a newspaper about social problems associated with science, implying criticism of the scientific establishment, makes one liable to being categorised as 'political' or 'unscientific'. It is yet more difficult to democratise the laboratory or involve non-professionals in research. This would be challenging even if all one's colleagues were supportive, which is rarely the case.

There is an hypocrisy in the allegation that critics are 'unscientific', a hypocrisy deeply embedded in the incorporation of science in dominant social institutions. It is not considered 'political' or 'unscientific' to obtain research funding from corporations, to produce results favourable to funding bodies or to do weapons research. But to do research for an environmental organisation, thereby deviating from business as usual, is to be seen as 'political'.

There are some remarkable scientists, such as Steven Rose and Richard Lewontin, who undertake devastating critiques of science. Because of their position as working scientists, their criticisms have a credibility among outsiders unavailable to others. But many others who make criticisms, especially before their careers are established, are forced out of jobs, denied opportunities or leave voluntarily, disillusioned. Like most occupations, few vocal critics can survive on the inside.

Participation in science policy. Another way to move towards self-managing science is to promote community involvement in science policy.[15] The best groups to promote this are 'community groups', including trade unions, women's groups, environmental groups and many others. Few such groups today play any formal role in science policy. They often get involved in debates about scientific and technological issues, from automation in factories to genetic engineering, but not at the level of what scientific research is done or the institutional arrangements in which it occurs. Some things they can do include:

- Lobby scientific organisations to carry out research relevant to community interests.
- Push for community representatives on high-level scientific bodies, such as funding organisations, university councils and research institutes, and also membership of review committees of research groups such as university departments.

- Help establish 'community extension services' such as the science shops in the Netherlands and elsewhere.[16]
- Push for measures to reduce hierarchy in the scientific community and increase opportunities for participating in research, such as more equal salaries and permanent part-time work.
- Support tax incentives for individuals and small groups to undertake research linked to community concerns.

Essentially, these measures aim to reduce the orientation of establishment science to dominant vested interests and to make it easier for less powerful groups to do science. It should be obvious by looking at this list that these are at best mild reforms to the institutional structure of science. But such reforms can be useful. Currently there are very few 'independent researchers' who do high-quality science. A few more could make an important difference in a number of crucial debates. But even these reforms can be enormously difficult to achieve, mainly because there are no groups organised to push for them.

Social movements. Perhaps the greatest challenge to establishment science comes from social movements when they take on issues which lead to a confrontation with scientists and engineers linked to vested interests. The movement against nuclear power took on the pro-nuclear experts and gave them a hammering. In the course of this debate, claims to objectivity have been challenged, vested interests have been exposed and research priorities have been questioned. The 'soft energy path' of energy efficiency and renewable energy sources stands as a well-elaborated example of how research priorities could be different.[17]

Similarly, some feminists have challenged research into reproductive technology. Gay and AIDS activists have challenged standard protocols for evaluating therapeutic drugs and established their own community-oriented methods.[18] Portions of the labour movement – inspired by the initiatives of workers at Lucas Aerospace – have challenged production for profit and proposed socially useful production.[19] Social movements continue to be the most effective means by which science in the service of vested interests is challenged.

The limitation of most of this activity is that there is very little challenge to or change in the way science is funded or done. Most of the movements are quite happy to support the use of counter-experts against the establishment experts. In other words, they are happy with

science when it supports their side. There is not a lot of interest in questioning the institutional foundation of science.

As others have noted, science is a modern religion. Even the critics couch their criticisms in religious discourse. Arguments against smoking in workplaces are mainly based on health risks to non-smokers, not on people finding it unpleasant. Environmentalists can mount effective arguments against a project when it threatens a rare species but not just on the grounds that people enjoy things the way they are. Even anarchists may be tempted to argue for self-management because it is more efficient, rather than because it is more satisfying and reduces exploitation and injustice. There is a need to give more priority to 'non-scientific' arguments – but how?

Promoting self-management. Perhaps the most consistent way to promote anarchist science policy is to treat science just like any other social institution. Anarchists have long criticised dogmatic belief systems, especially religion, capitalism and state socialism. Science needs to be included. In promoting self-management at the workplace, scientific workplaces should be included. In arguing for popular participation in decisions, science policy should be included along with policy on industry, transport, education and health.

A unified strategy? It might seem attractive to put these different approaches together. A unified strategy, though, is currently speculative and possibly counterproductive. There are certainly some potent challenges to establishment science, but most of these grow out of challenges to particular technological developments such as nuclear power or genetic engineering. There is very little questioning of institutional and professional structures. Until more is known about how to move towards self-managing science, it seems sensible for multiple paths to be tried out. Individuals can do what they can in their own situations while linking with others who are in different situations.

Fluoridation again

Both sides in the fluoridation debate have relied on scientific authority, though the opponents, having less of it, have been more ready to use ethical and political arguments. The fluoridation debate, then, reflects the powerful role of science in our society: challenges to scientific experts and to the vested interests they serve often take the form of claims about doing truly objective science. Science is a

powerful legitimator of decisions because it largely serves the interests of the powerful.

The case of fluoridation illustrates the different ways and levels in which anarchist principles can be used to analyse science policy. When looking at a controversial issue that involves technical dimensions, various options can be assessed to see whether they empower the population or reinforce the position of dominant institutions. Most anarchists are likely to oppose fluoridation when it is imposed by the state and to favour options that allow individuals and communities to be involved in choices about fluoride. But this doesn't help answer questions such as 'should I give fluoride tablets to my children?'

If science were organised in a self-managing fashion, it would mean that research priorities would be different, more oriented to community needs; it would mean that participation in doing science would be different, with many more people joining in a more user-friendly research process; it would mean that communities would make decisions shaping the organisational framework and research priorities for science. With a self-managing science along these lines, research priorities dealing with dental health would probably be different, with much less attention to fluoridation and more, for example, to diet. With no powerful interests promoting fluoridation, it would be unlikely to become as contentious an issue – and some other issue might become the most contentious one in dental health!

I thank Gabriele Bammer, Sharon Beder and Mark Diesendorf for helpful comments on a draft of this article.

Notes

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6. See John Holt, *Freedom and Beyond* (Harmondsworth, Penguin, 1973), who discusses a programme run by Gary L. Huber.

7. Jun Ui, 'The Interdisciplinary Study of Environmental Problems' in *Kogai – The Newsletter from Polluted Japan*, vol. 5, no. 2, spring 1977, pages 12-24.

8. John Doble and Amy Richardson, 'You don't have to be a rocket scientist ...' in *Technology Review*, vol. 95, no. 1, January 1992, pages 51-54.

9. See, for example, Malcolm L. Goggin (editor), *Governing Science and Technology in a Democracy* (Knoxville, University of Tennessee Press, 1986); James C. Petersen (editor), *Citizen Participation in Science Policy* (Amherst, University of Massachusetts Press, 1984).

10. Ned Crosby, Janet M. Kelly and Paul Schaefer, 'Citizens Panels: a new approach to citizen participation' in *Public Administration Review*, vol. 46, March/April 1986, pages 170-178; Peter C. Dienel, 'Contributing to Social Decision Methodology: citizen reports on technological projects in C. Vlek and G. Cvetkovich (editors), *Social Decision Methodology for Technological projects* (Dordrecht, Kluwer, 1989), pages 133-151.

11. See the journals *Science for the People*, *Science for People* and *Radical Science Journal*, and Rita Arditti, Pat Brennan and Steve Cavrak (editors), *Science and Liberation* (Boston, South End Press, 1980).

12. See, for example, Science for the People, *China: Science Walks on Two Legs* (New York, Avon, 1974), whose picture of science in China would serve better as an ideal than a description of reality.

13. Paul Feyerabend, *Science in a Free Society* (London, NLB, 1978).

14. More details on some of these ideas are given in Brian Martin, 'The Goal of Self-Managed Science: implications for action' in *Radical Science Journal*, no. 10, 1980, pages 3-17.

15. A fuller discussion is given in Gabriele Bammer, Ken Green and Brian Martin, 'Who Gets Kicks Out of Science Policy?' in *Search*, vol. 17, January-February 1986, pages 41-46.

16. Rolf Zaal and Loet Leydesdorff, 'Amsterdam Science Shop and its Influence on University Research: the effects of ten years of dealing with non-academic questions' in *Science and Public Policy*, vol. 14, December 1987, pages 310-316; Gabriele Bammer, Merrelyn Emery, Linda Gowin and Jennifer Rainforth, 'Right Idea, Wrong Time: the Wisenet Science Shop 1988-1990' in *Prometheus*, vol. 10, December 1992, pages 300-310.

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The Ecologist editorial team

Technology Transfer

[This article first appeared in a special issue of *The Ecologist* devoted to 'Whose Common Future' (July/August 1992) in which all the articles are anonymous. We are grateful for permission to reprint. *Whose Common Future?* is now published by Earthscan as a book, price £9.95. Some copies of the original issue, priced at £3 (US$6) are still available from *The Ecologist*, Agriculture House, Bath Road, Stourminster Newton, Dorset DT10 1DU.]

There is a general view that more Western science and technology is indispensable for curing the world's environmental ills. This view is often expressed in the form of a beguiling syllogism:

> Only Western science and technology can solve the world's environmental problems.
> The developing countries, by definition, are lacking in scientific and technological resources.
> *Therefore*
> a massive transfer of science and technology is required from North to South, involving in turn a massive transfer of funds.

This argument was almost universally accepted in the discourse of the United Nations Conference on Environment (UNCED), the Rio 'Earth Summit' of 1992. Any disagreements – and there were many – centred around secondary concerns, such as how much money should be transferred and what particular technologies should be employed.

Science versus ignorance

Central to the logic of technology transfer is the presupposition of the recipient's ignorance. 'Ignorance' according to the World Bank, 'is an important cause of environmental damage and a serious impediment to finding solutions ... Frequently, especially in developing countries, decisions are made in the absence of environmental information. Collecting basic data can be expensive, but the rewards are usually high'.[1] And again:

> Poverty, uncertainty and ignorance are the allies of environmental degradation ... Better-educated people can more readily adopt environmentally sound but complicated techniques such as integrated pest management.[2]

It is predictable that the World Bank should have chosen an agricultural example – pest management – to illustrate their point. The peasant farmer, 'especially in developing countries', has always been represented by experts as an archetype of ignorance,'backward' and bound by tradition. In the words of E. Alvord, an agricultural missionary to Rhodesia in the 1920s and 1930s, 'we have in my opinion little or nothing to learn from native culture' which he characterised as 'wasteful, slovenly, ineffective and ruinous to the future interests of Rhodesia', while the natives themselves were 'heathens who were grossly immoral and incredibly steeped in superstition'.[3]

The language used today by World Bank policy-writers is every bit as racist, if not as crude, as that used by Alvord, and it reinforces similar attitudes further down the hierarchy: for example, Zambian extension agents, working on a World Bank project in the 1980s, described local farmers as 'ignorant peasants too lazy to farm'.[4] The word 'ignorant' is pregnant with contempt. It epitomises an attitude that is consciously or sub-consciously held by all those who consider that Western technology is a *sine qua non* of environmental stability and human comfort; those who assume, without question, that a small, noisy, polluting refrigerator must inevitably be better than a large, cool larder, that a two-litre motor car must inevitably be more efficient than a two-pedal bicycle, or that an expensive tractor-drawn plough must inevitably be superior to the nimble mattock.

The science of the commons

The assumption, implicit in the World Bank's allegations of 'ignorance', that scientific research and technological advance cannot exist outside the research laboratories and computer networks of the developed world is inherent to the logic of technology transfer. Yet until quite recently, even in Europe, almost all scientific research and technological advance took place in the field or on the shopfloor. Waterproof suits made from fish-gut and watertight bowls made from grass were not developed in research laboratories; nor were the junks of China, or the kayaks of the Aleut: nor even the traditional 'wootz'

steel of India, which in the 1840s was judged to be better than anything produced in Britain.[5] The technological advances of the English 'agricultural revolution' were originally developed, not by theorists such as Arthur Young who propagated them in the eighteenth century, but some two or three hundred years earlier by a succession of nameless farmers.[6] This tradition of vernacular science is still very much alive, though its disdain for publicity and the written word have led many academic scientists to doubt its value and even its existence.

Human beings are for the most part curious, experimental and concerned for their own well-being. It should therefore come as no surprise to us that groups of people who have lived in an area for generations should evolve systems of agriculture and ways of living that are congenital, effective and sustainable – unless they are prevented by someone else from doing so. This process of native scientific selection and discovery is not always as slow as we have been led to believe. Winin Pereira has described how when the *dandavan* tree, from Australia, was introduced to an area north of Bombay, in the first year that it came into flower the local Warli tribals discovered that its seeds could be used to stupefy and catch fish; and subsequently started using it as medicine as well. The following year a paper describing experiments by two scientists on the effects of the seed on two species of fish confined to a laboratory aquarium was published in *Environment and Ecology*. Not only did the tribals beat the scientists – their research needed no expensive equipment, no submission of reports and budgets, no academic accolade, and was tested on the fish that needed to be caught, in their natural environment.[7] This was research carried out by and for the commons – rather than in the enclosed and jealous world of the academic institution.

The intimate knowledge of the properties of plants is reflected elsewhere in the widespread practice of intercropping. Whereas northern agriculture finds it easier to cope with one crop at a time – and frequently with one crop all the time – in many parts of the tropics farmers have found it advantageous to grow two or more crops together in one field. In West Africa, 80% of all farmland is inter-cropped, with up to sixty crop species being grown on any one farm.[8] N.S. Jodha notes a tradition in India 'that every farmer should plant nine crops in at least one of his plots. This ritual practice known as *nava dhanyam* (nine grains) is guided by a belief that it is the duty of every farmer to preserve the germplasm which nature has provided'.[9]

There are many advantages associated with intercropping. Often

there is simply a net gain in yield over growing a single crop on the same area of land. Certain combinations of plants complement each other by providing shade or windbreaks and by exploiting nutrients at different levels of the soil. They can also protect each other from pest attacks. Intercropping also minimises the risks of farming. The more crops and cropping schedules used, the less likelihood of total crop failure; and staggering different crops means that there will be something to eat in the uncertain period before the main harvest. Also, the workload is spread evenly throughout the year rather than concentrated in a few critical periods. This can be the crucial limiting factor to the amount of food that a farm produces. Paul Richards argues that West Africans are turning increasingly to intercropping techniques as a response both to land shortages and to labour shortages caused by out-migration. In this respect it might be better to view 'intercropping ... not as a set of "traditional" techniques but as evidence of progress towards an agricultural revolution'.[10] Certainly the fact that one observer counted no less that 147 distinct intercrop combinations in three villages in northern Nigeria suggests that much experimentation is taking place.[11]

The sophistication of vernacular science may also be observed in the numerous indigenous irrigation systems that are still operating throughout the world. For example, the *qanats* of the Middle East constitute a vast network of underground conduits stretching over 170,000 miles in Iran alone. In contrast to modern pumped irrigation technologies, they only tap spring water from mountain areas conveying it by the force of gravity. As a result, the aquifer cannot be depleted and the quality of the water is maintained. Though some of the channels were built thousands of years ago, many are still functioning: until recently they supplied 75% of the water used in Iran both for irrigation and for household purposes.[12] Many other smaller-scale systems, such as that of the Chagga people on the slopes of Mount Kilimanjaro, have impressed western engineers with their technical sophistication.

The most intractable problem faced by many irrigating societies is salinisation of the land caused by the evaporation in the soil of unnatural amounts of water. Farmers know that overwatering and poor drainage threatens the whole community: there are thus a raft of sanctions and social arrangements that work to safeguard against salinisation by giving the whole community a stake in preventing abuses. Different cultures have also developed rotations to control salinisation. The farmers of the Euphrates, for example, do so by

fallowing their land with two wild legumes, *shok* (*Proserpina stephanis*) and *agul* (*Alhagi maurorum*), which besides supplying nitrogen to the soil draw moisture from the water table and dry out the subsoil, this preventing water from rising and bringing salt to the surface. J.C. Russell has described this system as 'a beautiful solution for living with salinity', adding that the 'villagers understand it, in that they know it works, and they know how to do it and they insist upon it'.[13]

Of course not all indigenous technologies have been sustainable. Some of the ancient irrigating civilisations became over-ambitious and sacrificed ecological stability for the increased short-term output they could gain by abandoning fallows and adopting perennial irrigation.[14] But those that were not sustainable have perforce died out; while those that have survived represent a vast repository of human knowledge too large to be documented by any academic system.

A litany of disasters

For those who rely on the commons, defending this body of vernacular knowledge is fundamental to defending the commons. For them the experience of technology transfer is not that it solves problems so much as that it creates them.

Technology transfer has led to an influx of experts and other outsiders determined to impose their 'solutions' on the commons. Since the nineteenth century, when the scientific academies blossomed and universities acquired departments of agriculture, physics and chemistry, the credit for innovation and the licence to innovate have been progressively lifted out of the public domain and placed in the hands of the professional scientist. New breeds of expert have appeared – the architect, the soil engineer, the planning officer, the conservationist, the health and safety officer, the agricultural extension officer – educated in the classroom and the laboratory, entitled with paper qualifications and entrusted with the enforcement of a growing body of legislation that has been formulated in those same institutions.

No one has suffered more from this invasion of experts than those who have been most consistently stigmatised as ignorant, the poor of the Third World. In the words of Bill Rau: 'The widespread failure of agricultural and rural development projects in Africa is largely due to the failure of planners to work with and reflect the complexity and diversity of rural and urban realities' or indeed to understand them.

'The dreams and myths of development "experts" have been repeatedly altered or rejected by peasants, artisans and the urban poor because the projects were irrelevant, impractical or directly threatening to their well-being'.[15]

The schemes devised by these experts have so far led to a litany of ecological and cultural disasters – and there is no reason to suppose that they will not continue to do so. Most frequently the problems are caused not by one or two basic miscalculations, but by a fundamental failure to comprehend the complexities of the local ecology and culture.

The Kano River Irrigation Project, for example, is an attempt to modernise a local farming community in northern Nigeria. In 1911 E.M. Morel wrote:

> There is little that we can teach the Kano farmer ... they have acquired the necessary precise knowledge as to the time to prepare the land for sowing; when and how to sow; how long to let the land be fallow; what soils suit certain crops; what varieties of the same crop will succeed in some localities and what varieties in others ... how to ensure rotation; when to arrange with Fulani herdsmen to pasture their cattle upon the land.[16]

Sixty years later the Nigerian government and agencies such as USAID and FAO thought differently. A project was initiated to replace the local *shadoof* bucket-irrigation system with water supplied by the new Tiga dam, which was completed in 1975. The main object was to supply wheat to make western-style bread for sale in the cities.

Although the area had been identified as being suitable for wheat, after the first five years of the project yields were only about 15% of the amount predicted.[17] Farmers were pressurised to give up intercropping guinea corn with millet, because the harvest date interfered with the wheat crop, and were encouraged instead to grow maize, which is more demanding on the soil and more dependent in fertiliser. Soil fertility dropped as intercropping declined, and erosion increased because of the work involved in levelling the land. The project drastically altered the people's way of life. The co-operative arrangement between the farmers and the nomadic Fulani herders, mentioned approvingly by Morel, was stopped by project organisers who considered the cattle disruptive, and consequently *fura*, a vital food for both groups made out of milk and millet, could no longer be made. Poultry was banned from domestic households and there was a decline in foodstuffs such as sorghum, dates, locust beans (a weaning food), vegetables and other crops dependent upon the

defunct *shadoof* irrigation.[18] The increase in men's income and the growing integration into the market economy resulted in a power imbalance between men and women, which led women to remove themselves 'as much as possible from the household economy, creating a separate women's world into which to place their energies and generate independent resources, however meagre, with which to endow their daughters'.[19] Despite these problems and repercussions, the Kano River Project is regarded as more successful than others. A similar project in neighbouring Bakolori encountered determined resistance from peasants, culminating in 1980 in the massacre of at least 23 and probably over 100 farmers by the Nigerian police.[20]

The Kano story is just one of a now familiar stream of disappointments and failures that does not seem to be drying up. A report published in May 1992 by the UK National Audit Office found that of seventeen recent projects funded by the Overseas Development Administration (some in conjunction with the World Bank), the ability of more than half to survive after the project teams left was in doubt, and two were already written off as complete failures. In one drainage scheme in Pakistan, designed to alleviate the salinisation of cotton fields in the Sind caused by the British-built irrigation systems, only three out of the projected 79 drainage sumps were working properly, and in these three cases 'the water table had fallen below the optimum level and crop yields had reduced'.[21]

Technology as Trojan Horse

In the wake of such disasters, advocates of technology transfer have adopted two lines of defence. The first of these insists that it is not the technologies themselves that have caused the problems but the manner in which they have been applied. The UN Food and Agriculture Organisation, for example, argues that 'since farm chemicals are essentially tools of farm management, environmental problems stem from their misuse rather than being inherent characteristics'.[22]

Even on its own terms, this statement is false: numerous pesticides are carcinogenic to consumers and dangerous to wildlife, regardless of how they are used in the field – that is why many of them have been banned. But the suggestion that pesticides are 'environmentally neutral' – that is to say that they are not inherently dangerous, there is simply a right way and a wrong way to use them – is at the same time an admission that they are *not* socially neutral. To use pesticides

safely, it is not enough for farmers simply to mix them up and spray them: they must adopt a 'pesticide culture', with *its* prescriptions for 'safe practice', 'agricultural management', 'wildlife protection', 'food quality' and so on. In effect, pesticides, like other western technologies, act as a Trojan Horse for western assumptions, practices, beliefs and social relations.

The networks of interest that promote technology transfer are well aware of this, and use it to their advantage. The use of technology transfer to change cultural attitudes is made explicit in a text prepared for a pre-UNCED seminar organised by the Norwegian government and attended principally by representatives of the large dam-building industry. This states that hydropower projects – euphemistically renamed 'waterfall technologies' – 'are often very appropriate vehicles for introducing an appropriate mechanical culture into a developing country'.[23] Significantly, the seminar had been called primarily to discuss how dam builders could best exploit any funds generated by UNCED for technology transfer.

Environmentally-friendly enclosure

The second line of defence adopted by the agents of development is more complex and involves a grudging acknowledgement of past failures and of the value of vernacular knowledge and technologies. The World Bank, alongside its denunciation of 'ignorance', now concedes that:

> the belief that traditional knowledge of the environment is simple and static is changing rapidly. More and more development projects are taking advantage of local knowledge about how to manage the environment ... Development projects that do not take existing practices into account often fail.[24]

These admissions, however, are coupled with a generalised assumption that vernacular systems are inadequate to the task of 'saving the planet'. In its recent policy document on Sustainable Agriculture and Rural Development (SARD), for example, the UN Food and Agriculture Organisation states that:

> low-input production is probably the most environmentally-friendly system and has been practised since time immemorial, but every country has abandoned this practice during the process of development due to its low productivity and inability to meet the food requirements of an ever-increasing population.[25]

Rather than considering the possibility of reclaiming for peasant

agriculture land currently used for crop exports, FAO uses the population argument to justify the further intensification of agriculture. The technologies that it recommends for transfer are those of the Green Revolution, which has caused such damage to the environment and to society. Nonetheless, alongside the call for a 50-60% increase in the use of pesticides, SARD also calls for greater use of biological husbandry. In the same vein, the Agenda 21 text on technology transfer repeatedly stresses the need for 'environmentally [safe and] sound' technologies.[26]

But what is environmentally-friendly to the development of industry is not necessarily environmentally-friendly or culturally acceptable to those who rely on the commons. The belief that intensive development can be rendered 'safe and sound' by the infusion of a little vernacular technology – by 'taking advantage of local knowledge' as the World Bank puts it – poses a new, more insidious threat. Far from being rescued, the technology of the commons is likely to be 'chewed up and spat out by the big development agencies, its original aims masticated out of all recognition'.[27] In that respect, the 'appropriate technologies' now being promoted for transfer can be just as powerful tools for enclosure as the inappropriate technologies that are to be cleaned up with post-UNCED funding.

For example, the National Research Council (NRC) of the US National Academy of Sciences has issued a report entitled *Alternative Agriculture*, half of which is given over to eleven farm case studies.[28] As Jack Kloppenburg reports:

> ... the conclusions reached in the report relate almost entirely to the need for the application of more *scientific* effort to the development of alternative agriculture, and the report's recommendations focus on how this strategy might best be accomplished. Farmers are regarded as the recipients of technology, advice and information. The authors of the NRC report simply do not conceive of any potential for farmer-generated knowledge except in connection with or translation through 'science'.[29]

Similarly, 'integrated pest management' is now being promoted by the World Bank and other agencies as a means of reducing the damage done by pesticide use. 'Integrated pest management' has, of course, been practised for centuries by farmers whose inventories include techniques such as mixed cropping, fallowing, selection of resistant varieties, decoy crops, pest-deterrent plants, predator-attracting plants, natural pesticides, burning, flooding and manual labour. The integrated pest management proposed by the World Bank, however,

differs in three respects.[30] Firstly, it uses toxic chemicals in 'small, carefully-timed applications'. Secondly it keeps the farmer dependent upon chemical companies, for whom he or she must earn or borrow money to pay for the input. And thirdly, the farmer is no longer in control but must bow to the opinion of 'experts' who will be hovering round the farm checking that the applications are small and carefully-timed. The farmer is integrated into the scheme – but only as one of a number of factors in a pest-management process determined largely by outside experts.

Forced in this manner into a marriage of convenience with development, 'alternative agriculture', 'integrated pest management' and similar 'appropriate' techniques become complicit in the further enclosure of vernacular science. Indeed, as the conventional technological solutions, such as large dams, become discredited, other more acceptable technologies must be found to take on the role of Trojan Horse. One agronomist, David Norman, explains frankly how mixed cropping improvements are used by extension agents to get a foot in the door and gain the confidence of farmers:

> ... once the farmer has adopted an innovation that does not conflict too much with his present traditional outlook, e.g. improvement of his returns from mixed cropping, it will then be easier for the extension worker to suggest more radical changes, e.g. sole cropping, if evidence obtained under improved technological conditions indicates that this is desirable as far as farmers are concerned.[31]

This is not to imply that appropriate technologies can never be successfully exchanged, but rather that, as David Burch has pointed out, there is no permanent place for appropriate technology in a society that is committed to the standard models of technological growth. The pressures of a market fuelled by the consumption patterns of a wealthy minority are too great:

> What is produced within a country is not determined by some objective assessment of needs ... Patterns of income distribution biased towards the middle and upper classes produce a structure of effective demand for products that can only be produced by capital-intensive technologies.[32]

The current nod in the direction of vernacular science should be regarded in this light. As long as a wealthy minority of people concentrated in the north and within southern élites continue to exert an effective demand throughout the world for exotic foodstuffs, western-style clothing and other luxuries, and as long as they rely upon an ever-expanding market for produce such as fertilisers,

pesticides, machinery and wheat, we can expect a further enclosure of vernacular science, a continuing succession of hare-brained schemes to drag the 'ignorant peasant' into the 21st century, and the relentless growth of an environmentally unsound industrial economy. When cultures develop alongside each other on an even footing, they can and do benefit by borrowing ideas from each other. But this process is in no way linked to the systematic colonisation of knowledge that is taking place under cover of the term 'transference of technlogy'. As SONED, an umbrella organisation for southern NGOs, has stated:

> From the southern point of view, technology is a product of diverse cultures and environment and therefore should not be transferred ... Technology must reflect people's culture, environment and science. Northern technology, which is the root cause of the environment and development crisis, is rejected. What is sought is an alternative science and technology reflecting the traditions, cultures and achievements of southern peoples.[33]

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Alan Cottey

The Ethical Dilemmas awaiting Science Students

The list of world-scale crises is already impressive: ozone-layer depletion, soil erosion, deforestation, water shortage, overpopulation, chronic unemployment, risks of nuclear war and of greenhouse effect ... Some of these are already having an observable effect on societies. We seem to be witnessing a general increase in human strife, conducted with improved weapons.

The power conferred by science is a factor in all of these crises. Contrary to the claims of many scientists, science is as much a part of the problem as of the 'solution'. (By 'solution' here I mean society passing through the present dangerous phase of culture. Life will, of course, always have some problems.)

The way science is used depends on a complex interaction between scientists, the public and political and economic elites. Scientists cannot unilaterally control the application of basic science. Their responsibility does, however, have some special characteristics:

- only they can understand and perform the technical aspects of their work;
- only they can produce non-technical expositions of the current state of science for elites and for the public;
- only they can produce significant forecasts of likely future scientific developments. (Jules Verne and H.G. Wells are often credited with scientific foresight, but their scientific ideas originated with scientists.)

Here, I am not 'talking-up' the role of technical expertise relative to the role of the current social, political and economic ideologies. The scientists' emphases depend on these factors as well. Rather, I am emphasising the importance of scientists' views 'in the round', meaning not simply their technical expertise but also their ideas about science-and-society. Their views are strongly influenced by their

professional education. I believe the traditional education of scientists does not adequately prepare them to use their professional skills to make science 'more a part of the solution than of the problem'. Science education, especially at advanced levels, concentrates on technical expertise. Questions about the values of individuals and of societies are avoided. It is not surprising that science education should be like this.

The firm knowledge achieved by focusing on clear, soluble problems is satisfying and usable. Still, the difficulty with science as a whole, which becomes more obvious with each passing decade, is not 'what use is science?' but 'does science give humanity too many new choices, too quickly?'

Turning from values to ethics, one may ask 'what about professional ethics?' There are several professions with established concepts of professional ethics. Nursing, medicine, law and engineering are examples. Ethics is discussed explicitly in these professions and finds its way into education.

Science is different. This is because of the use (when convenient) of the notion that science is not a profession, or even a human activity, but rather a body of objective knowledge. Human values and ethics are irrelevant. This position has some validity, if held consistently. Few scientists do hold it consistently. Most switch easily, when it suits them, to using the word 'science' in the broader sense, which includes all the tacky human connections. This never was philosophically sound. It is now also practically unacceptable, because it gets in the way of a serious analysis of such questions as:

- what choices are open to us concerning the direction of basic scientific research?
- how can basic science be made to work for, not against, a sustainable future?
- what, realistically, can be expected, by way of global responsibility, from the individual scientist working in a scientific institution?

Science, Values and Ethics

As a university physics lecturer, I was motivated by the concerns expressed above to press for a course on 'Science, Values and Ethics', to be offered to natural science students. This course is now running

for the fourth time at UEA. It's 'bottom line' is anticipation of the ethical dilemmas awaiting these students when they graduate. Courses about science from a philosophical or sociological perspective are widely available in UK higher education. This course is different, first because its motivation is practical rather than academic and, second, because it is specifically for natural science students. It aims to correct an imbalance in science education. It treats the ethical dimension not as one more intellectual specialism, but as a field in which each person must make choices. I had hoped that if all the students of the class were studying natural science, they would be able to ponder and discuss their choices in an especially significant way. This has proved to be the case.

A few case-histories, studied in some depth, are an important part of the course. Only the 'big modern problems' of nuclear weaponry, global environment and biotechnology are considered indispensable in the syllabus. Beyond that, topics covered depend on the availability and interest of the teaching team. Animal experimentation is included, as it is widely considered by students and staff to be an important area. The resulting list of topics covered is wide-ranging, but that has not been found to be a problem. On the contrary it helps to ensure that no group of students, say environmentalists, have an undue 'lead'. Religion, gender, social justice, economic and political power do not receive formal syllabus slots, but are mentioned and discussed by teachers and students when relevant to other topics. Theoretical ideas, using the approaches of philosophy and social studies, are introduced gradually; natural science students have to see the need for themselves.

Obviously personal development is fundamental in this course. Nevertheless, a high level of scholarship is a necessary tool; without it the personal development might not occur, or might occur in directions not intended, such as prejudice or dogmatism. The course does not provide answers to Science, Values and Ethics problems. It provides a spread of thought and advocacy from various quarters. It also encourages the students to value their own considered views. Most of the students have not had much recent practice in reading, thinking and speaking about values and ethics in an academic setting. Some specific techniques from informal logic, critical thinking and the word-by-word criticism of very short texts are taught. Advice on writing is also given.

One element of the course is that the students keep Working Diaries, in which they record thoughts stimulated by lectures, seminars,

reading, radio, television, informal conversations, etc. They are told that the diaries need not be confessional but they should be a franker and more spontaneous response than the traditional types of written report. The diaries help the students to find an appropriate level of valuation of their own views.

One seminar is given over to a role-play based on a case-history the students have earlier studied. The role-plays to date have simulated a committee making a decision, relating either to a biotechnology or nuclear power approval or an animal experimentation licence. The aim is to understand in immediate personal terms what it is like to be involved in science-and-ethics decisions.

Conclusion

The fundamental aim of the 'Science, Values and Ethics' course is to give natural science students the experience of cases, the analytical skills, the confidence and the courage to address practical science-and-ethics questions and to relate them to their own lives.

Alarming dilemma

The scientist has been under an obligation, all along, to the promotion of human welfare without being very keenly aware of the exact scope of his obligation, and often without taking the trouble to express it to himself in words. Now he finds himself, often to his great alarm, being asked to put unlimited powers of genocide, coercion and destruction into the hands of limited groups of individuals, many of whom show themselves by all their public gestures quite unfit to control a sporting gun, let alone a vast military machine.

Alex Comfort
Social Reasponsibility in Science and Art, 1951

Barbara Davies

Why animal research?

Is the use of animals in medical research ethically justified? I believe that, given certain restrictions and conditions, most thinking people would agree that it is. The following statement is a useful starting point in the discussion:

> The use of living animals in scientific research can be considered justified if it is likely to bring appreciable benefit to society, if there is no other way to conduct the research in question and if all reasonable steps are taken to keep any distress or suffering to a minimum.[1]

There are some who are ideologically and fundamentally opposed to animal research, who do not consider it justified whatever the benefits, whatever measures ate taken to protect animal welfare. They believe in animal rights, as espoused by philosophers such as Singer[2] and Regan.[3] This philosophy states that animals have rights equivalent to those of human beings, or are entitled to equal consideration. However, it is clear that the vast majority of the population does not hold these views, because in doing so they would have to reject most of the uses of animals that our society finds currently acceptable: as working animals, as pets, for sport and entertainment, in clothing and as food. About 99% of the population eats dairy products, eggs, meat or fish.[4]

While the majority clearly does not support the uncompromising animal rights philosophy, the animal rights movement does enjoy a degree of popular support. It is easy to see why it is such a broad church. It encompasses many who are anti-science or anti-conventional medicine, green sympathisers, New Agers, the left, the right, the young, the old. It provides a vehicle for anti-establishment protest while appearing to be concerned about the welfare of cuddly animals. In fact it has very little to do with animal welfare, and some campaigns have actually led to a deterioration in welfare.[5]

A disproportionate amount of animal rights activity is directed at the use of animals in medical research. It could be argued that, based on the number of animals involved, there is far greater potential to protect animal rights in stopping the population from eating animal

products. In this country we eat over six hundred million animals a year, excluding fish.[6] In contrast, less than three million animals are used in medical research.[7] While welfare comparisons are difficult to make, most laboratory animals are better looked after and more humanely killed than most food animals. And it is very difficult to see how many of the discoveries in fundamental biomedical research, or advances in medicine, could have been achieved without the use of animals in research. So we receive great benefits from animal research at the cost of fewer animals and less animal suffering than that involved in the consumption of meat.

This is not an examination of the pros and cons of vegetarianism, but a question of the motivation and strategies of animal rights groups. Many of these groups, realising that most people will not accept that animals have equivalent rights to humans, have deliberately chosen not to campaign on a rights platform. Instead, they seek to persuade the public that animal research is not beneficial, is not necessary and involves wanton cruelty or neglect of animal welfare. Much of their propaganda promotes these messages in quite a moderate way, and appears quite credible. Many who hold even slightly anti-science attitudes or green sympathies will want to believe that animal research is all the things that animal rights groups say it is. But if these animal rights arguments were correct, there would be no debate because nobody would be doing animal research.

Medical and scientific opinion is in no doubt that most major medical advances have depended on laboratory animals. I will return to measures of the informed view later, but here I want to concentrate on the medical benefits. These advances include vaccines for infections such as polio and for animal illnesses such as canine distemper and feline enteritis; anaesthetics for safe surgery; medicines to control diabetes, asthma and high blood pressure; and life support systems for premature babies. And animal testing of products has played a vital role in protecting consumers, workers in industry and agriculture, and in protecting the environment.

Animal rights groups, however, deny the overwhelming evidence of history. In doing so, they are able to espouse the animal rights philosophy while continuing to enjoy the benefits of modern medicine. The argument goes something like this: 'If I were seriously ill and needed a kidney transplant, this would not pose an ethical dilemma for me because I do not believe that animal research has contributed anything to the development of kidney transplants'. Such views clearly run counter to the expert view, such as that of Dr Joseph

Murray, who won the 1990 Nobel Prize for his pioneering work on kidney transplantation: 'There would not be a single person alive today as the result of an organ or bone marrow transplantation without animal experimentation'.[8]

Another animal rights argument revolves around 'species differences', which, they say, are too great for the results of animal research to applicable to human beings. Of course there are differences, but these are greatly outweighed by the biological similarities. All mammals, including humans, have the same organs – heart, lungs, kidney, liver, etc. – performing the same functions. The similarity between species explains why many veterinary medicines are the same, or nearly the same, as medicines for human patients.

The argument about species differences is usually used to attribute drug side effects to animal testing of medicines. This is illogical and must be based on ignorance or misunderstanding of the extensive testing which potential medicines must undergo. If drugs pass extensive screening by test tube methods, they are then tested on animals. These tests give valuable information about how the drug reacts in the living body and often show up previously unpredicted side effects. It is obviously important, and is required by law, to find out as much as possible before drugs are given to human volunteers and patients in clinical trials.

Human clinical trials will involve testing a potential drug on thousands of patients. If a side effect shows up only *after* this stage, then how could it have been spotted before? Take the example of the heart drug Eraldin, which, in clinical trials in over 2,000 patients, produced only constipation in 44 patients – the most serious side effect found. It was only after it had been prescribed hundreds of thousands of times that another side effect was discovered, serious, bur rare (affecting about 1 in 10,000 patients).[9] The drug was then withdrawn from the market.

It is absurd to blame the animal tests for rare side effects, after a drug has been tested on cells and tissues, in animals, in people, and after it has been used by many thousands of patients. About a dozen examples like these are used repeatedly by animal rights groups, and it is often implied or even stated that this is just a selection from some endless list. In fact, of the 2,000 types of drug available, less than 40 have been withdrawn because of side effects – a safety record of over 98%. Thus not only are the numbers of drugs causing serious side

effects greatly exaggerated, but attributing this to animal testing is completely wrong.

A similar argument is applied to drugs that are safe for people but apparently kill animals. Examples, from a similarly brief list, include penicillin and aspirin. Animal rights supporters do not tell you, and I suspect that many simply do not know, that the effects seen in animals follow very large doses. These doses are equivalent to giving a person 35 times the normal dose of penicillin[10] or 50 times the normal dose of aspirin,[11] so adverse reactions leading to death or birth defects are hardly surprising.

What about the future? Just because animal research has been valuable in the past, that alone is not a valid reason for it to continue. Are there still potential benefits to be gained? Can animals now be replaced by non-animal methods?

Although great progress has been made in medical research, there are still all too many serious illnesses that doctors cannot cure or treat effectively. So if society wants cures for cancer and a vaccine for AIDS, if it wants to help the youngsters affected by fatal genetic disorders like cystic fibrosis and muscular dystrophy, if it wants to stop the suffering caused by arthritis, Alzheimer's disease and Parkinson's disease, then medical research, including the use of animals, must continue.

Despite the progress of science in developing techniques at the level of molecules, cells, tissues, organs, and the progress of technology in developing sophisticated computers, scanners, etc., there is still a need to look at biological processes in whole living animals. The living body is amazingly complex, and we still don't know enough about how it works when healthy, what happens when illnesses strike, and the best way to tackle those illnesses. So despite what the animal rights protagonists claim, there are stages in medical research programmes when there is no alternative to using animals. You can't measure blood pressure in a test tube, you can't simulate all the events of pregnancy and embryonic development using a computer.

No one would use animals in research if it wasn't necessary. Those involved in research – from animal technicians to senior scientists – care about animals just like anyone else, and funds are far too scarce to waste on unnecessary research. For these reasons, and because there are very strict controls, animals are used humanely and only when there is no alternative. A lot of effort goes into trying to reduce the numbers of animals used, and trying to develop new methods to

replace animals. As a result, the number of laboratory animals used annually in this country has almost halved in the last twenty years.[7]

Non-animal methods – tissue culture, computer modelling, studies of patients and populations – are widely used. In fact, only about 5p in every £1 spent on medical research goes on animal studies.[12] The word alternatives is often used to describe non-animal methods, but this can lead to confusion because these methods are generally used alongside animal studies, not instead of them. All these techniques have their place, and it is rarely possible to substitute one for another.

Thus, as science progresses, it may be possible to reduce the numbers of animals used in some areas, and everyone would welcome this. In other areas, the numbers of animals may increase. For instance, new and better animal models may be developed. It is now possible to breed animals with exactly the same genetic faults that cause some human diseases. So mice with cystic fibrosis, for example, have the same symptoms as children with cystic fibrosis.[13] These mice are the ideal way to test gene therapy, which may offer a medical breakthrough for the disease.

I referred earlier to the fact that the majority view of doctors and medical researchers throughout the world is that animal research continues to be essential for medical progress. This is apparent from opinion surveys, declarations and statements made over the last few years.

In 1990, over a thousand top doctors and scientists, including 31 Nobel Prize winners, signed a Declaration by the British Association for the Advancement of Science on animals in medical research. This Declaration stresses the importance of animal experiments for 'major improvements in the health of human beings and animals'. It says there is a need for continued research involving animals 'for the conquest of many unsolved medical problems such as cancer, AIDS, other infectious diseases ...'[14]

In 1993, a British Medical Association survey[15] showed that 94% of doctors agree that animal research has made an important contribution to medical advances and 85% agree that it will play a key role in developing future treatments. Like many others, doctors would like to see alternatives to animals developed, but most are realistic and believe that animal research will continue to be necessary. Also in 1993, the Royal College of Physicians stated[16] that animal research had made immense contributions to human and animal health, and will continue to be necessary in future. In a survey of American physicians in 1989,[17] 99% agreed that animal

experimentation had contributed to medical progress, and 94% thought it would be impractical to eliminate the use of animals in medical research by substituting alternatives.

I conclude with a quote from the American Medical Association:[18]

> How humane or moral is it, to deprive the human victims of Alzheimer's disease, stroke, disabling injury, and countless other diseases or disorders, of hope, knowing that the solution to these problems that afflict a large and growing proportion of the population can only be solved or lessened through the conduct of biomedical research with animals? To many scientists, that is the real moral issue. Sometimes it is necessary to inflict pain or to sacrifice the life of an animal in the laboratory to avoid or eliminate suffering and pain – or even save a greater number of human and animal lives.

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Steven Rose

Clarification

Standard editorial practice at *The Raven* is to publish controversial articles without comment, and give opportunity for reply in later issues. In the case of Gill Baker's polemic, however, a draft somehow came into the hands of Professor Steven Rose before publication, and he has sent this rejoinder to the bit about himself. We are delighted to publish it, since it not only clarifies his own position but also adds something to our understanding of Gill Baker's meaning.

Steven Rose is also mentioned in Brian Martin's article, where he will find himself described as one of 'some remarkable scientists ... who undertake devastating critiques of science'. We trust he will not find this objectionable.

Dear Editor, Gill Baker in her article 'The Dark Face of Science' alleges that I have made the claim that Alzheimer's disease 'bears any resemblance to the behaviour of artificially brain-damaged chicks' and cites a reference, apparently giving authority to her statement. First, the reference in question is to a paper of mine which has nothing to do with Alzheimer's disease and makes no mention of it. Second, her claim is a travesty of what I have actually said and which I continue to maintain. What I will argue is that understanding the processes of memory formation and its pharmacology in non-human animals is a first step along the path of developing a rational psycho-pharmacological treatment for the distressing memory loss which occurs during the early stages of Alzheimer's disease. Work from many laboratories had helped in the development of a number of quite promising drugs which may be effective in this condition and all of it has depended upon animal experimentation. I see nothing ethically or scientifically dubious about this claim. I should also make it clear that all the animal and other research carried out at the Open University is openly published in the scientific literature and available for public scrutiny. Ms Baker and her colleagues from the rather small group she represents have been invited to see our work and regularly receive reports from the Animal Ethical Committee at the Open University, a mixed lay and professional body which supervises our activities.

Gill Baker

The Dark Face of Science

Students for Ethical Science is a campaigning organisation consisting of Open University students who are dismayed that an organisation such as the Open University, with its reputation as a progressive and forward looking institution, could possibly be involved with something as barbarous as the vivisection of live animals.

We are not opposed to science in general, although we recognise that it is only one of many ways of looking at the world. What we are opposed to is the use and abuse of other sentient beings in the quest for knowledge. Our grounds for opposing vivisection are twofold. First of all, we refute the androcentric assumption that animals are some kind of lesser human beings whose lives matter little and can be sacrificed for some greater good. Secondly, we maintain that vivisection is 'bad science'; the consequences of this old fashioned dogma which attempt to extrapolate the results of animal tests to human subjects are well documented.

Researchers often argue that they are pursuing a 'line of enquiry' that will lead to immeasurable benefits to humanity. As I have said, we refute this entirely, vivisection is not only morally bankrupt but inevitably bad science. Animal experiments tell us about animals, not people, they suffer from different diseases, their metabolisms are different and they react to drugs differently. To suggest, as Professor Stephen Rose from the Open University does, that Alzheimers Disease, a progressive disorder with strong links to aluminium in water, bears any resemblance to the behaviour of artificially brain-damaged chicks in the Open University Laboratories at Milton Keynes[1] seems to be a sad waste of life and resources.

Every year in the UK millions of animals ranging from primates, rats, dogs and mice to fish and birds, suffer and die in laboratory experiments in the name of science. They are routinely poisoned, burnt, frozen, given electric shocks and addicted to drugs; they are deliberately infected with diseases such as arthritis, ulcers, cancer, diabetes, AIDS and syphilis. Their eyes are surgically removed, their

brains damaged and their bones broken. There is no need to exaggerate – the scientists' own reports are enough.

Bland assurances are routinely proffered by the Research Defence Society (don't be fooled by the name, they only defend animal research) to vindicate these cruelties. To them the choice is simple: 'Your baby or your dog, madam'. If pressed and the choice was between their own baby and a stranger, most would choose the baby, but this obviously does not justify experiments on strangers. Such hypothetical and emotive arguments are plainly absurd. The assumption that animals are some sort of lesser human being whose suffering matters little is as irrational as racism and sexism.

Many philosophers and writers have proposed the principle of equal consideration of interests, in some form or other, as basic moral principle, but not many of them have recognised that this principle applies to members of other species as well as to our own. Jeremy Bentham was one of the few who did realise this. In a forward looking passage written at a time when black slaves had been freed by the French but the British dominions were still being treated in the way we now treat animals, Bentham wrote:

> The day may come when the rest of the animal creation may acquire those rights which never could have been withholden from them but by the hand of tyranny. The French have already discovered that the blackness of skin is no reason why a human being should be abandoned without redress to the caprice of a tormentor. It may one day come to be recognised that the number of the legs, the villosity of the skin, or the termination of the os sacrum are reason equally sufficient for abandoning a sensitive being to the same fate. What else is it that should trace the insuperable line? Is it the faculty of reason, or perhaps the faculty of discourse? But a full grown horse or dog is beyond comparison a more rational, as well as a more conversable animal, than an infant of a day or a week or even a month old. But suppose they were otherwise, what would it avail? The question is not, can they reason? nor can they talk? but can they suffer?[2]

Yes they can, and as such there can be no moral justification for refusing to take that suffering into account no matter what the nature of that being. Surely we should all be justifiably concerned when a legal boundary is drawn between those whose suffering the authorities believe worthy of consideration and those who are classified as worthless: the parallels between this attitude and those of Nazi Germany are really too obvious to point out. To mark this boundary by characteristics like intelligence or rationality would be arbitrary and unjust. Why not choose some other characteristic like skin colour

or sex? Just like the racist who violates the principle of equal consideration of interests by giving greater weight to members of his own race when there is a clash of interests, or the sexist who favours the interest of his own sex, the defender of vivisection is a speciesist for allowing the interests of his own species to override the interests of members of other species. The pattern is identical in each case.

George Bernard Shaw said: 'If we attempt to controvert a vivisectionist by showing that the experiment he has performed has not led to any useful result, you imply that if it has led to a useful result you would consider his experiment justified'.[3] While most people would agree that vivisection is morally bankrupt, many still believe that there is some sort of scientific validity in the practice. Well meaning people still believe that we can relate artificially induced disease in animals to sick patients in hospitals, as the army of collectors and voluntary workers for the famous charities that fund vivisection proves only too well.

As I have said, the main justification put forward in defence of vivisection centres around its applicability to man. I feel this position needs to be challenged. There are many myths surrounding vivisection, but perhaps the biggest one is that it has saved millions of human lives in the past and continues to do so. Not so. The death rate had already declined by 92% in the 1950s, yet the overwhelming majority of animal experiments (85%) carried out in the last 100 years have been performed since the 1950s.[4] In short, there is no correlation between reduction in death rate and vivisecting animals. Since the 1950s life expectancy for the middle aged has changed little, chronic diseases are on the increase and heart disease has reached epidemic proportions. In fact animal experiments are protecting us so well that drug side effects have reached epidemic proportions, giving rise to a new classification of disease, iatrogenic or doctor induced disease.

Animal experiments are not only unnecessary but dangerously misleading and, far from protecting us against hazardous drugs, they are actually adding to the burden of disease – Opren being a case in point. In 1980 Eli Lilley brought their new drug Opren onto the market after it had safely negotiated animal tests. Opren had a distinct advantage over previous anti-inflammatory drugs in so far that it actually modified the disease – and it did, but only in laboratory rats. By the time the disastrous side effects in humans (3,500 reports of harmful effects including 61 deaths) were discovered it was too late. Opren is by no means an isolated case. Out of some 18,000 new drugs brought on the British market each year, some 15,000 are withdrawn

because of harmful side effects. So if animal experiments give a misleading impression of drug safety, it surely follows that they must lead to the rejection of potentially valuable medicines on the basis of side effects found in animals which would never occur in people. The finding that *at best* only one in four side effects produced by animals actually appears in patients proves the point.[5]

The useful drug penicillin was delayed for years because it had no effect on rabbits. Years later Florey and Chain resurrected the drug after finding that it cured deliberately infected mice. Florey was led to comment: 'Mice were tried in the initial toxicity tests because of their small size, but what a lucky chance it was, for in this respect man is like the mouse and not the guinea pig – if we had used guinea pigs exclusively we should have said that penicillin was toxic, and we probably should not have proceeded to try to overcome the difficulties of producing the substance for trial in man'.[6] Their *lucky chances* continued. In order to save a critically ill patient, Fleming wanted to inject penicillin directly into the spine (an untried procedure), so he tried it on a cat first, but there was no time to wait for the results so they went ahead with the experiment on the patient who subsequently recovered. The cat died.

The penicillin story serves to show just how unscientific and irrelevant vivisection actually is. Tests on animals, whether for developing new techniques or testing the efficacy and safety of new treatments, cannot be extrapolated to man. Animals have different skeletons, different digestive tracts, different metabolisms, different skins, and different behaviour. These facts cannot be overstated. There is no predicative value in animal research, a drug or technique developed on animals when extrapolated to humans will either produce the same effect, no effect or adverse effects (ranging from the mild, headaches and nausea for example, to the severe, paralysis, blindness or even death). You can never tell. So, when proponents of vivisection hold up this cure or that as proof of the benefits of vivisection, it really means at best no more than Fleming's 'lucky chance' or unfortunately more often than not a deliberate attempt to mislead the public into believing that the major breakthroughs in health care were dependent on animal experiments and not the less glamorous but so effective measures instigated by far-sighted members of the community, such as the provision of clean water and an adequate diet.

The idea of the noble scientist burning the candle in his laboratory as he struggles to rid the world of the evils of disease is as absurd as

denying that the provision of adequate housing and proper nutrition did nothing to reduce infant mortality. We all know that disease is linked to lifestyle, and poverty more than anything else is the major contributing factor. Measles owes its reputation as a mild childhood disease to increasing standards in the community, not to some miracle vaccination process. In the third world we see the drug companies cashing in every day with their vaccines and remedies when what these people really need is clean water and enough to eat. The vivisectors would have you believe differently, but just check the vaccination statistics and the mortality rates yourself. The death rate for children with measles in the UK had already dropped off the scale before vaccination was introduced.

You may be asking yourself at this point why, if the flaws are so glaringly obvious, does vivisection continue. There are many factors at work. Vivisection is a huge multi-billion pound industry, and powerful vested interests whose profits and livelihood rely on the continuation of animal research act as a major incentive. During a nationwide referendum campaign to ban vivisection in Switzerland in the 1980s, the resident drug companies spent nine million dollars on propaganda and, not surprisingly, the vote was lost.[7] Coupled with this, the related industries, animal suppliers and breeders, suppliers of equipment (restraining devices, for example), all pressure governments and the media to portray animal experiments as vital for both human health and the economy.

Apart from these commercial interests, many scientists base their entire careers on animal based research, the animal models of human disease become and end in themselves with researchers having little or nothing to do with clinical medicine. For some their original motive for going into research may well have been to help humanity, but according to the former Research Defence Society chairman David Smythe:

> The real motives are a mixture in varying proportions of scientific curiosity, desire to explore new fields, desire for recognition and fame, career ambition, a wish to spend time deeply absorbed in something of a special interest.[8]

> Career advancement is primarily dependent on publication. Dr E.J.H. Moore, writing in *The Lancet* in 1986, notes that: 'The pressure on young doctors to publish and the availability of laboratory animals have made professional advancement the main reason for doing animal experiments'.[9]

Successive governments have traditionally defended even the most outrageous animal tests. In 1983 when the government were setting out the proposals to update the Cruelty to Animals Act 1876, it stated:

The United Kingdom has a large pharmaceutical industry which makes a large contribution to our balance of payments and employs 67,500 people. In devising new controls it is very important not to put industry as risk unnecessarily.[10]

With so much at stake it is little wonder that medical arguments against vivisection are ignored. Even the choice of species is largely dependent on economics. It is no coincidence that the animals most commonly used in research, including mice, rats, rabbits and guinea pigs, are also among the cheapest.

Like other social evils – slavery, child labour or the suppression of women's rights – vivisection is all about power. The power to capture and subject normally sociable animals to a life of solitary confinement; the power to maim, poison and kill; the power to manipulate governments, and finally the power to dupe the public into believing that their health and the health of their children depends on animal sacrifices. If like us you feel that to do the right thing is more important than the fear of being ridiculed, then write to us at S.E.S, 18 Woodrow Crescent, Knowle, Solihull, West Midlands, B93 9EF, to find out how you can help.

It often happens that the universal belief of one age, a belief from which no one was free or could be free without extraordinary effort or genius or courage, becomes to a subsequent age so palpable an absurdity that the only difficulty is to imagine how such an idea could ever have appeared credible.

– John Stuart Mill

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Sal Restivo

Science, Sociology of Science, and the anarchist tradition

Peter Kropotkin carried a commitment to scientific method into his struggle for mutual aid and individual liberty. He understood scientific method to mean the inductive method of the natural sciences. Anarchism itself was conceived as one of the modern sociological sciences. Its goal was to study human institutions scientifically, and to 'foresee' the future development of humanity 'on the road to liberty, equality and fraternity'. The ultimate aim of research and prediction was to realise 'the greatest sum of happiness for every unit of human society'. Kropotkin has some appreciation for the limitations of using natural scientists as role models for anarchists since most scientists were members of or employed by the ruling elites. And he understood that science was social relations. But he could not imagine the possibility that science and the state might be so intimately intertwined that a convergence between science and anarchism might be impossible.

Kropotkin recognised that the state and capitalism are inseparable, and thus that state-justice, state-church and state-army are core aspects of capitalism. The state thus appears to Kropotkin as a society for the mutual insurance of landlords, warriors, judges and priests. He did not see that he could add state-science to his list of capitalism's institutions; nor that scientists and scholars could be included in his list of exploiters and oppressors. Kropotkin was a victim of the hegemonic ideology of modern science which had already infiltrated (one might say contaminated) the emerging sociological sciences.

The anarchists, alongside marxists and others busy manufacturing sociological sciences, simultaneously conceived science as the paradigmatic mode of inquiry and as social relations. This led to ambivalence about the place of science in the anarchist tradition. This ambivalence is nowhere more explicit than in the writings of Michael Bakunin. He seems to be anti-science when he argues for the revolt of life against science. But he quickly clarifies this. It is not science as one of the pearls of human culture that he is opposed to, but rather

the *government* of science. He stood with Proudhon and other anarchists in arguing that social order must be grounded not in a 'religion of authority' but in science, the unity of humankind. Science and thought, he proclaimed, are the 'guiding stars of any human prosperity'. But he was sceptical of arriving at socialist or anarchist convictions *only* by way of science and thinking, and critical of the 'cold light' of science that produces powerless and sterile truths when it does not go 'hand in hand with life'. He also opposed what he understood to be one of the perils of a marxist state, the reign of 'scientific intelligence'. This would make marxism 'the most aristocratic, despotic, arrogant and scornful of all regimes'. A new hierarchy would be created, and the world would be 'divided into a minority that rules in the name of science and a vast ignorant majority'.

There is more to the anarchists' general commitment to science – even to scientism – than simple Newtonian confidence. Modern science had discarded 'the hypothesis of God'. God and the state stand together as the major symbols and sources of the authority universally opposed by the anarchists. For this reason, modern science was an important affirmation of the anarchists' anti-authoritarianism. At the same time, the religious fervour characteristic of at least some anarchists made science a substitute for God.

There is a species of anarchism that radically separates science from the central value of anarchism, the primacy of the person. Berdyaev, for example, argued that personality is not nature and is therefore not subject to any natural laws. He viewed the world of science, objectivisation and determinism as a world of alienation, hostility and law; the world of personality, by contrast, was a world of spirituality, freedom, love and kinship. The non-scientific wing of anarchism also includes Tolstoy (perhaps a better representative of this position than Berdyaev), Thoreau and perhaps Gandhi. Gandhi's thoughts on the ties between science, government and morality, and the irresponsibility of science, should not go unheeded by science adoring anarchists.

Modern anarchists continue to express ambivalence about science. Paul Goodman, Herbert Read and Alex Comfort, for example, followed Kropotkin in insisting on scientific observation in the study of society. But Goodman also associated modern scientific research with the mark-up of drug prices.

The ambivalence about science in the anarchist tradition is a reflection of debates in the wider society about the cultural meaning of science. The defenders, advocates and ideologues of science have been heard; they were, and (for most of us) continue to be, our teachers, our mentors, our educators. But modern science has been described as a machine-like product of our 'matter-of-fact' industrial and technological era, an 'instrument of terror', an assault on the natural world and a tool of greed, war and violence. C. Wright Mills' conception of the transformation of science into a Science Machine echoed Marx's critique of modern science as alienated, bourgeois science. The anti-science chorus runs from Rousseau, Hegel and G.K. Chesterton to Theodore Roszak. And now there is an association of third world scholars and intellectuals who argue that violence lies at the very core of the modern science world-view.

The social, political and economic foundations of the scientific revolution were built by (to use William McNeil's uncompromising vocabulary) pugnacious, reckless and militaristic Europeans. And the scientific revolution integrated the 'world politick' and the 'world natural'. Modern science emerged and developed as an alienating and alienated mode of inquiry, the mental framework of capitalism and the cognitive mode of industrialism. Since the seventeenth century we have been learning to think (as Veblen observed) the way our technological processes act.

Modern science came into the world as a commodity and has developed in close association with the discipline of the machine. It does not, therefore, seem too heretical to paraphrase Bourdieu and Passeron on 'pedagogic action' and say: 'all scientific action is, objectively, symbolic violence insofar as it is the imposition of a cultural arbitrary by an arbitrary power'. And what else is the myth of pure science but a prime example of symbiotic violence, 'power which manages to impose meanings and to impose them as legitimate by concealing the power relations which are the basis of its force'.

Nietzsche and the sociology of objectivity

In order to proceed towards a defence of the notion of human inquiry – a variation of the theme of human science in the writings of Marx – I want to import Nietzsche into my discussion of the anarchist tradition. Nietzsche was not, to put it mildly, fond of the anarchists. But his opposition to the state and his defence of the individual, the 'single one', make him an anarchist in the sense I intend here. He

criticises modern science as a reflection of the same motives underlying religion, in particular Christianity, even though modern science has helped to 'kill' – anthropologise – God. Nietzsche's criticisms are balanced by a defence of demystified science, and a proposal for an alternative 'gay science' or 'joyous wisdom'.

Modern science, Nietzsche claimed, has been promoted owing to three errors. The Newtons promote it as a means to understanding the goodness and wisdom of God – the first error. The Voltaires pursue it out of a belief in its absolute utility and its intimate association with morality and happiness – the second error. And the Spinozas promote it because they believe that evil impulses play no part in science – the third error. Science (specifically here, explanation) is suspect because we initiate it by transforming the objects of our inquiries into images of ourselves. It is dangerous because it impetuously demands certainty. Thus, science possesses the potential for divesting existence of its 'rich ambiguity' and for reducing life to 'a mere exercise for a calculator and an indoor diversion for mathematicians'. What, is science an idiotic crudity, a mental illness – 'the *most stupid* of all possible interpretations in the world'? This does not mean that there is nothing to value in modern science. We should value mathematics – but not because it will help us know things, rather because it will help us *determine* our human relation to things. And Nietzsche has the slogan 'long live physics' – but what he values is not physics itself; rather it is 'that which *compels* us to turn to physics – our honesty'.

The alternative to science, and in particular to modern science as a Science Machine, is joyous wisdom – the gay science. Here the emphasis is on *thinking*. And for Nietzsche thinking is grounded in inclinations that are 'strong', 'evil', 'defiant', 'nasty' and 'malicious'. Success and failure are above all 'answers' for the thinker, whose actions are experiments and questions – 'attempts to find out something'. In order to find pleasure in wisdom we must be capable of finding pleasure in folly – the *hero* and the *fool* must be discovered in our passion for knowledge.

There is no wisdom without love and passion – thus the aphorism, *all great problems demand great love*; and there is no wisdom without the WILL TO TRUTH – 'I will not deceive, not even myself'. 'Objectivity' cannot mean 'disinterested contemplation'; that is a 'rank absurdity'. But Nietzsche does not discard the notion of objectivity; instead he has it stand for 'an ability to have one's pros and cons within one's command and to use them or not as one chooses'.

The foundation for Nietzsche's views of 'good thinking', of science and of inquiry in general is a sociological theory of (or perspective on) knowledge. That he stands with Marx and Durkheim as a co-founder of the sociology of knowledge can be variously illustrated. The faith in proofs, for example, is according to Nietzsche merely a symptom of what in hard-working families has for ages been considered 'good workmanship'. Every scholar, he writes, has an 'intellectual idiosyncrasy'; if we catch that idiosyncrasy 'in the act', we will find behind it the scholar's pre-history – the scholar's family and the family's occupations and crafts. He attributes a high regard for logic to marginal social roles in urban settings rather than making it a matter of genius, ethnicity or race. (This is consistent with the thesis that logic was born out of commercial interests in rational calculation, and articulated among the ancient Ionian philosopher-merchants represented in the first instance by Thales (see Restivo, 1983). And his notion of consciousness as 'really only a net of communication between human beings' suggests that he should be credited with helping to formulate the idea of a sociology of mind (along with Durkheim, Gumplowicz, Mead and C. Wright Mills).

When I conceived the idea of a normatively driven sociology of objectivity in the early 1970s, I did not know or remember enough Nietzsche to credit him with formulating such an idea. But I now recognise the seeds of that idea in the following statement on the conditions for good inquiry:

> It is of the greatest importance to know how to put the most diverse perspectives and psychological interpretations at the service of intellection. Let us, from now on, be on our guard against the hallowed philosophers' myth of a 'pure, will-less, painless, timeless knower'; let us beware of the tentacles of such contradictory notions as 'pure reason', 'absolute knowledge', 'absolute intelligence'. All these concepts presuppose an eye such as no living being can imagine, an eye required to have no direction, to abrogate its active and interpretative powers – precisely those powers that alone make of seeing, seeing *something*. All seeing is essentially perspective, and so is all knowing. The more emotions we allow to speak in a given matter, the more different eyes we can put on in order to view a given spectacle, the more complete will be our conception of it, the greater our 'objectivity'.

So far as Nietzsche claims, science may be better known for depriving us of joy and making us cold. And it might yet be found, he thought, to be the 'great dispenser of pain'. Then its counter-force might simultaneously turn up – the immense capacity for science (one might say inquiry here) 'for making new galaxies of joy flare up'.

The will to power operates in science as everywhere else. Here it manifests itself as a lust for new knowledge, for *possessing* new knowledge. One may indeed then speak of THE WILL TO TRUTH.

Paul Feyerabend and the pseudo-anarchist theory of science

Feyerabend is harder to pin down than most of his readers – admirers and critics alike – imagine. On the one hand he is a persuasive defender of something very much like the gay science. On the other, he tries with all his might not to stray too far from a conservative – and even Popperian – model of science.

His 1975 book *Against Method* is subtitled 'Outline of an Anarchistic Theory of Knowledge' and is dedicated to Imre Lakatos, 'friend and fellow anarchist'. Feyerabend's basic claim is that 'science is an essentially anarchistic enterprise: theoretical anarchism is more humanitarian and more likely to encourage progress than its law-and-order alternatives'. But the word 'anarchistic' in the subtitle is asterisked. The asterisk is there to dissociate Feyerabend from the self-styled anarchists of the 1960s with their restricted spheres of caring and their puritanical dedication and seriousness. Barely 25 pages into his book one discovers that he is ready to throw the term anarchistic overboard. Now he prefers the term Dadaist – primarily because a Dadaist shares many of the qualities of an anarchist that Feyerabend admires, but a Dadaist 'would not hurt a fly – let alone a human being'. Feyerabend wants to be remembered as a 'flippant Dadaist', not as a serious anarchist.

In the recently published *Farewell to Reason* Feyerabend claims that the slogan 'anything goes' is not his and was not meant to summarise the case studies in his previous works. But the slogan or phrase appears often and prominently in his earlier books. The explanation for the disclaimer must be that Feyerabend did not mean by 'anything goes' the principle of disorderliness it seems to have meant to his critics. The grounds for the slogan or claim 'anything goes' are the actual practices of scientists in contrast to philosophical and other ways of reconstructing science.

The limits of epistemological anarchism

Feyerabend is very careful to point out that he is urging epistemological anarchism, not political anarchism. The debate is about – and only about – methodological rules. The objective is to

remove – and only remove – methodological constraints on the scientist who is otherwise still restricted by instruments, finances, assistants, colleagues, playmates and innumerable physical, social, historical and natural constraints. The fundamental theorem of epistemological anarchism is that:

> ... given any aim, even the most narrowly 'scientific' one, the non-method of the anarchist has a greater chance of succeeding than any well-defined set of standards, rules, prescriptions.

Feyerabend defends a highly specific and restricted form of anarchism, epistemological anarchism. And even then, this seems to mean in practice something more like *methodological* anarchism. But even this restriction is diluted in his reply to Joseph Agassi. Here he claims that he does not want epistemology to become anarchistic. Rather, he finds that epistemology is sick and prescribes anarchism as a medicine to be taken temporarily until a cure is effected. Then, Feyerabend asserts, we may return to a rationality, but one that will be more enlightened and more liberal.

In the end (already reached in *Against Method*) Feyerabend embraces Lakatos. He joins with him rather than continuing to 'beat the drum of *explicit* anarchism'. Indeed, he claims that 'anything goes' is compatible with reason as defined by Lakatos. So Feyerabend eventually gives up on explicit out-and-out anarchism (in the limited form of epistemological anarchism) because it is 'liable to paralyse the brains of almost everyone' and stands with Lakatos' theory of rationality as the best instrument 'for freeing the mind'.

Foundations for an anarcho-sociology of science

Contemporary science studies have done much over the past quarter century to reveal the wisdom of the Nietzsches and Feyerabends on the nature of good inquiry. And they have done this within the boundaries of current scientific practice. They have focused attention on the tinkering aspect of knowledge production in science, the commonplace rationalities that guide scientific inquiry, the ways in which choosing particular technical assumptions can (to use Brian Martin's phrase) 'push an argument', and the nature and significance of selecting, interpreting and using evidence. We have learned that in a specialised form of intellectual labour such as science, presuppositions seem to be missing because they have become embodied in scientific instruments and scientific practices. And we

have learned more about the institutional and intellectual linkages between scientific research and theory and the power centres of modern industrial technological societies.

Unlike the view from the standpoints of functionalist and related sociologies of science, the view of science from the anarcho-sociology of science standpoint reveals a mode of knowing that is neither well-functioning nor progressive. The rationalisation of the scientific world-view has proceeded hand in hand with the modernisation and bureaucratisation of the industrial and technological states. The source of reason, like the old source of God, continues to be located in the power centres of these societies. This key process of the modern period is the source of the separation of rationality and science from ethics and values. This separation is a core feature of the ideology of science.

To say that there is an ideology of modern science means in part that there is a dogmatic support for modern science as a way of life, false consciousness about the intellectual, social and cultural grounds and consequences of scientific activities and products, and false consciousness about the social role of the scientist. The ideology of modern science sustains struggles for power and status, and for institutional survival. And it promotes the use of science (to the extent that it overemphasises quantification, rigour, control and prediction) as a resource for reducing personal anxieties and fears.

The pursuit of 'science for its own sake' generally requires a commitment to work and profession guided and reinforced by the less enlightened aspects of professionalism (for example, the 'publish or perish' imperative and 'grantsmanship'). This makes it difficult or impossible to value, or to find time for, activities outside of science and intensifies and ideological hold of modern (professionalised, bureaucratised) science on scientists and on society. The process of rationalisation that Max Weber wrote and worried about now underlies the mechanisation of individuals, and increasingly manifests itself as a routinisation of rationality. One consequence of sustaining that routinisation of rationality is that the range of the schema of criticism in our culture will be increasingly narrowed and our individual capacities for critical thinking will slowly wither away.

Conclusion

In the modern sociology of science, one person stands out as the bearer of the traditions I have traced to the anarchists, including

Nietzsche; C. Wright Mills was the intellectual leader of those of us who were sociology graduate students in the 1960s struggling with the idea of a critical sociology of science. Mills is rarely recognised today for his contributions in the sociology of knowledge and science. But he drew our attention to the 'highly rational moral insensibility' of our era, raised to higher and more efficient levels by the 'brisk generals and gentle scientists' who were planning the third world war during that time. He did not describe their actions as sadistic but rather as 'merely businesslike' – not emotional at all but 'efficient, rational, technically clean cut'. Inhuman acts, then, because they were impersonal.

It is now time to give up our worship of science, its laws, its icons. Now we must ask new questions with a new agenda: what do scientists produce and how do they produce it; what resources do they use up; what material by-products and wastes do they produce; what good is what they produce, and for whom; in what social contexts is it valued and why; what are the costs, risks and benefits of scientific work for individuals, communities, classes, ethnic and minority relations, gender systems, societies and the ecological foundations of social life? What are the relationships between scientists and various publics, clients, audiences, patrons; how do scientists relate to each other, their families and friends, their colleagues in and out of science? What is their relationship as workers to the means of scientific production (and, under capitalism, to the owners of the means of scientific production)? What are their self-images, their levels of self-esteem, their levels of respect for themselves and others; how do they fit into the communities they live in; what are their goals, motives and visions? The collective hagiography that portrays scientists as 'ingenious', 'creative' and 'benefactors of humanity' does not tell us what sorts of people scientists are or what sorts of social worlds they are helping to build.

Normal sociologists of science in normal society have concluded that normal science is efficient, productive and progressive. But normal science is a factor in the production and reproduction of a society burdened by widespread environmental, social and personal stresses, crises and dangers. Normal sociologies of science cannot help us see, let alone prevail, in a world of Science Machines and Cheerful Robots. Fundamental categories of experience must be examined, challenged and changed to even begin to address the social problems of science and society. The dichotomy between 'nature' and 'culture', for example, has fostered a dominative, exploitative orientation to nature,

women, workers and the poorer socio-economic classes in general. A fascination with spectacular discoveries, inventions and applications in the physical sciences, and with 'genius' has blinded people to alienation in scientific work and in the everyday lives of scientists. Inside and outside of sociology (especially in the United States) there has been widespread and deep misunderstanding about and resistance to unadulterated social structural analyses of self, knowledge and mind. Individualistic and voluntaristic assumptions and perspectives have obstructed the development of such analyses and the theories they generate. And the hegemonic ideology which has never been vanquished in social studies of science is now coming back to life as the novelty of relativistic and constructivist perspectives on science begins to wear off.

The full implications of sociology as an intellectual revolution that has moved the group, the collectivity, and social structure to the centre of the social universe have yet to be realised *within* sociology let alone outside the field. This revolution has transformed the individual from a being of soul and free will to a set of social relations and a vehicle for expressing the thoughts and thought styles of thought collectives. This idea – already apparent to Nietzsche, Durkheim and Gumplowicz, and later in the works of Spengler, Mead and C. Wright Mills, and recently developed into forecasts of a sociology of mind in the writings of myself and Randall Collins – does not subordinate the individual to society in any political sense. By providing a better and more profound understanding of what it means to be a human being, it helps us to recognise the liberating and the oppressive aspects and potentials of the variety of special formations human beings can be socialised in.

Sociologists have generally traced their origins to ideologues of modern industrial society and protectors of moral order such as Saint-Simon, August Comte and Emile Durkheim (who to a great extent conceived of sociology as a transform of Christianity). The Marxian origins of sociological thinking have not been ignored, but (again, especially in the United States) they have not received the attention they deserve, especially in terms of the social and value concerns of Marxian sociology. More importantly, the feminist, working class and anarchist origins of sociology as a perspective have not merely been ignored, they have not even been recognised. These 'oversights' have prevented the development of a sociology and a sociology of science infused with values, interests and goals that would permit, and indeed provoke, critical analyses of science and its social

contexts. In particular, norms of scepticism and criticism have not been unleashed by conventional sociology and sociology of science that could act on our deepest beliefs and assumptions about social life and about science. Obviously, the sociologies and sociologies of science we get are the ones generated by the social milieux in which we carry out our lives and work and not matters of choice.

Recognising the diverse origins of sociology and the sociology of science depends on recognising the distinction between the history of a discipline and profession on the one hand, and the history of a way of looking at the world on the other. That distinction can help us to identify plural origins of science in general and identify alternative, unrealised possibilities for the scientific revolution of the Galilean and Newtonian ages. That there is such an alternative in the history of science is illustrated, for example, by Caroline Merchant's study of women, ecology and the scientific revolution. Obviously the potentials that get realised depend on the ways of living and working that come to prevail in a society.

Modern science (allied with and indeed inseparable from technology and the myth of progress) is a social problem because it is impersonal – as thinkers from Nietzsche to Wright Mills have recognised. This seems paradoxical because after all impersonal, machine-like truths and measures are supposed to guarantee that what we do is scientific and progressive. But it is precisely this notion of validation through proof-machines, logic-machines, language-machines and number-machines that we must challenge in order to see, criticise and change the world of Science Machines.

The questioning, critical, sceptical posture I want to adopt in relation to science does not involve simply erasing our notions of what counts as objective knowledge. But it does mean transforming our understanding of objectivity in terms of sociological consciousness. The norm of disinterestedness, for example, is defended by conventional science worshippers as a necessary feature of a truth-generating science (interestingly, the norm seems to have become an issue in the art world before it became one in the world of science). Yet, it is usually interpreted in psychological terms (one might even say it is spiritualised). To interpret it sociologically requires seeing it in terms of social interests. That is, disinterestedness should mean that commitments to specific social institutions are either dissolved, diffused or attenuated. In practical terms, this means that we are in a better position to understand the world around us and ourselves to the extent that we can and do put aside specific

commitments to and interests in, for example, the national state, religion and the bureaucracy of science. The more generalised and diffuse our interests are, the more disinterested we are and the more objective our statements about the world and about ourselves and others will be. Objectivity then is a social process, always a matter of degree, characteristic of all social systems and enhanced by disinterestedness and a well-developed schema of criticism.

We must be prepared to criticise facts, laws, instruments, technological procedures, specific theories, the deepest and most general levels of our conceptual frameworks, the very manner in which we rank these areas of criticism, and finally the established structures of research and criticism themselves. Ultimately, we should be able to bring a millennia-long cultural and epistemic tradition into question. This critical enterprise must be built into social structures at all levels – from the social structure of a culture or civilisation to the social structure of minds and selves. Human inquiry (my version of Marx's human science) is distinguished from other modes of inquiry by its *capacity* for criticism, self-criticism, reflexivity and meta-inquiry. It is not oriented to the search for binding necessities or ultimate foundations; conjectures should never be invested with positive or absolute belief. The trick here is the ability to grant the acceptability of *necessary* statements, and the weight of evidence (within the boundaries of our thought collectives), but always as nothing more than 'well-founded'. The anarchist who grounds individual liberty in the denial of authority in all forms is equally unwilling to participate in linguistic institutions such as the institutions of Logic and Proof.

A sociology of science that draws its inspiration from the anarchists is in part, and figuratively if not literally, a call to arms. What sorts of rearrangements are necessary, for example, to transform scholars from hired hands to peers of the powerful – or, more radically, to make intellectual work and politics coincident? What sorts of changes are necessary to develop 'a free and knowledgeable public' (Mills' phrase)? Democratic reform is not enough; such changes require much more far reaching social transformations than usually imagined.

The question that has driven my work for nearly twenty years is: given the sociological transformation of our understanding of objectivity and disinterestedness, what sorts of social formations foster human inquiry? The general answer to this question is not that human inquiry flourishes best, or would flourish best, in an anarchistic social formation. It is rather that human inquiry will

emerge and flourish in an anarchistic social formation and that just as such a social formation will foster the greatest development of human creative and intellectual powers, so will it foster the development of ways and methods of knowing that will promote individual liberties, enhance community life and cultivate healthy environments while doing minimal damage to all these areas of social life.

Anarchism and human inquiry are not in my view utopias or utopian. There is no hope for evading the endemic conflicts, tensions and contradictions of the human condition. But it is possible to imagine and even to realise the principles of anarchism as a critique and as an alternative to the ways things are. Anarchism is at the very least a reminder that we have the capacity to decapitalise 'truth' and give relatively free rein to scepticism and criticism. The very idea of Truth, Nietzsche observed, is 'conclusive proof that not so much as a start has been made on that disciplining of the intellect and self-overcoming necessary for the discovery of any truth, even the smallest'. Capitalised, Truth is the province of the 'man of conviction'. Thus my slogan 'nothing matters', like Feyerabend's slogan 'anything goes', is a slogan of resistance to established Authority and not an invitation to valueless, undisciplined inquiry.

The anarchist agenda is an offensive against all forms of authority, Mysticism and Supernaturalism. It is a defence of and programme for freedom and liberty in everyday life and in inquiry. Anarchism always has priority over inquiry – to paraphrase Feyerabend, Free Inquiry should always be subordinated to the Free Person in a Free Society, although in practice these form an inter-related mutually reinforcing web of freedoms. This is a forced choice, brought on by the course of historical and cultural development summarised in my 'thug theory of history'. Social and cultural change has been driven primarily by greed profit motives, and the quest for power in various forms. As a result, we live today in a world dominated by inhuman economics; terrorist, fascist and authoritarian states; chemical disasters, oil spills and radiation accidents; ecological deterioration; the mechanisation of selves and minds and the commodification of interpersonal relationships; and (in spite of the winds of change) nuclear winter scenarios. For the most part, this situation is a technologically intensified version of the normal human condition.

The anarchists have been in the vanguard of those men, women and children who have not stood idly by as human beings have been pushed and shoved, deprived of basic dignities, tortured and killed by

robber barons, pirates, profiteers, bureaucrats and dictators. William Morris speaks for all of us when he cries out:

> What! Shall we go on generation after generation gaining fresh command over the powers of nature, gaining more and more luxurious appliances for the comfort of the body, yet generation after generation losing some portion of our natural sense: that is, of our life and soul?

This process can be reversed – or at least slowed or attenuated – only to the extent that we recognise and act on the affinities that link anarchism and inquiry. Modern science has no place in this programme – it cannot be a synonym for open human inquiry because as a partner in structures of domination and authority over human beings and nature, it has wedded a tyranny of abstractions to a tyrannical rule of men. Anarchism promises human inquiry – holistic, unitary (but not unified), global, degendered, declassed and dealienated. This is the mode of inquiry of the sort of world order we will need to fashion if we are going to give the coming generations an opportunity to live lives of dignity and fulfilment.

Science? Pooh! Whatever good has science done the world? Damned bosh!

George Moore
to Philip Gosse, 1932

Why don't you give up your fiddle-faddle of geology and zoology, and turn to the occult sciences?

Lord Stanhope
(father of the historian Lord Stanhope) to Charles Darwin

Before the scientists are let loose with their implants what about a moratorium ... It's about time we were left in peace by PROGRESS!

Anon
Freedom, 2nd April 1994

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