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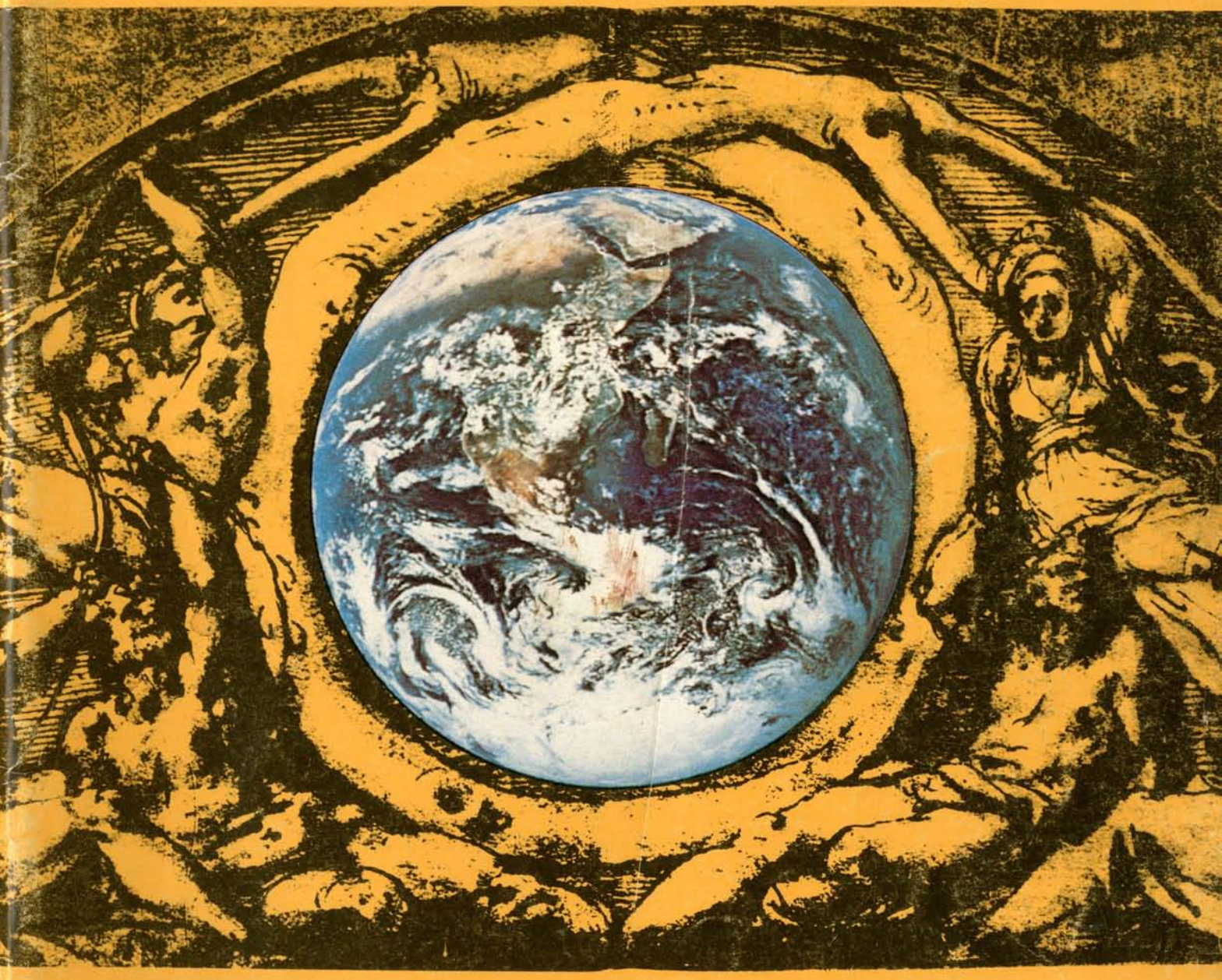

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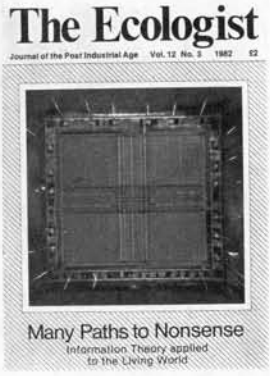

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An Ecological Defence Policy for Britain

Is there a coherent ecological defence policy? I have yet to see it. Most members of the Green Party or ecological parties in Europe are quite rightly strongly against nuclear weapons but few have considered exactly what defence policy should be set up in its stead. Some will argue that defence is unnecessary (this is fortunately not the case with our Ecology Party) on the principle that the Soviets have nothing to gain by invading the West.

It is probably true that for the Soviets to occupy Europe would simply add to their problems. Their military adventures so far have proved costly. Maintaining the pro-Russian puppet regimes in Angola, Ethiopia and in particular in Afghanistan have earned them the worst possible publicity and have proved to be economic disasters. Even if they did conquer western Europe, for how long could they hold on to it? The Russian empire is already very shaky. Nationalistic, anti-Russian movements appear to be building up just about everywhere within the Russian empire especially in the Asiatic states. To take over Western Europe would undoubtedly be irresponsible indeed idiotic from the Russian point of view. But that doesn't mean they wouldn't do it. The idea that people only do rational things is very naive. As Anatol Rapoport puts it "man is not a rational animal but a rationalising one". He does the most idiotic things and then tries to find reasons for justifying them so as to make them appear rational. It was an idiotic thing for Napoleon to have invaded Russia, even more idiotic for Hitler to have done so since one would have expected him to have learnt from Napoleon's experience.

The fact is you cannot discount a Russian invasion of the West on the grounds that such an action does not appear to serve Russia's interest. To predict how Russia will behave towards the West one must know very much more about the real forces at work within the Soviet Union. It may well be for instance that a war with the West is the best means of diverting attention from the growing discontent associated with the falling material standard of living, the food shortages, the tyranny imposed by the party on the population in general and that imposed by the Russians over all the other ethnic groups. Nor must we forget that the Soviets have built up the mightiest war machine of all time and that this machine is run by powerful and ambitious military men who may well be itching to make use of it in order to increase their own power and prestige. This view was expressed by Solzhenitsyn. It is very frustrating to be trained to do things and then not to be given the opportunity to do them. Thus not surprisingly if you train people to build dams they will search desperately for excuses to build them. If almost every river in America has been dammed, sometimes over and over again, it is partly at least, because America has trained so many engineers to build them. If you train surgeons to remove women's wombs they will spend much of their professional life looking for wombs to remove, and will be tempted to diagnose the health problems of their patients in such a way as to justify the performance of such operations. That is why it appears that three times more women have hysterectomies in California than in the UK.

Pacifism is not a tenable position for a very much more profound reason. It is that man is naturally aggressive. War has been a feature of the human experience on this planet from time immemorial. This is the thesis of ethologists such as Conrad Lorenz and Eibl Eibesfeldt. It is a thesis that is inescapable to anthropologists who have studied human behaviour in its natural state i.e. among the tribal societies of the past. I have gone into this issue at considerable length in "The Ecology of War" which I published in *The Ecologist* in May 1974. In it, I pointed out that aggression was a normal and indeed necessary feature of human life, among other things helping to maintain social identity and cohesion. It is certainly not the only operative factor. The Neo-Darwinists and, in particular, the sociobiologists have grossly exaggerated its importance and have, at the same time, correspondingly underrated the importance of cooperation without which there can be no family or real community—cooperation that is undoubtedly favoured by aggressive relations *between* communities.

To pretend that man is naturally peaceful is wishful thinking at its most naive. As I said in the Ecology of War, "self righteous exhortations in favour of peace or pious declarations of the universal brotherhood of man can serve no purpose other than to mask the real issues." And the *real* issue is how to accommodate man's aggressive nature without causing serious social and ecological destruction, and we can only learn to do this by looking at the experience of the past. So long as man lived in natural conditions i.e. as a member of a tribe living in its natural environment, his aggressive nature was perfectly well accommodated. In these conditions war was effectively ritualised. Among other things, its

goal was a purely ritual one. It was not to acquire a neighbour's land as it is often with us. There was no need for it. Population was culturally controlled and remained stable for tens of thousands, if not hundreds of thousands of years. Besides a neighbouring society's land was seen as inhabited by its ancestral spirits who were regarded as very hostile. Nor was there a need to go to war in order to acquire one's neighbours' mineral resources, because tribal people did not develop an industrial system which required the massive use of such resources.

War was in fact very little more than a sporting activity. War leaders who distinguished themselves, obtained great prestige. That was basically what they were after. Casualties were very low indeed. Even in our own Middle Ages war was quite effectively ritualised. Consider the story told by Runciman of the war fought between Peter of Aragon and Charles d'Anjou. They agreed to meet on the field of Poitiers, where the hundred most valiant knights of Aragon would confront the hundred bravest knights of France. To limit the conflict in this way was a very civilised thing to do, but the conflict was still further ritualised in that both monarchs made sure that their armies should never actually confront each other. The Aragonese knights arrived first at the arranged rendezvous. Since there was no sign of the French knights, King Peter drew his sword, proclaimed the French to be cowards for not daring confront the valiant knights of Aragon, who proceeded to charge a non-existent enemy in an empty field. Having thereby won their victory they returned to their capital to be feted as heroes. The French arrived a few hours later and did likewise and returned to Paris to a well-earned triumph.

Up to a point, war was ritualised until fairly recently as can be gauged by the splendour of the uniforms worn by soldiers as they went into battle. If the object of war is to kill, then to wear uniforms covered in gold braid and to sport tall and plumed hats is clearly counter-productive—to use a fashionable term. If, on the other hand, the object is to impress the enemy, intimidate him, impair his morale and induce him to flee from the field of battle then such displays may well be advantageous. In the same way, a tiger makes himself look as ferocious as possible when he attacks his rival and will roar at him in the most threatening way. The reason is that his aim is not to kill him but to frighten him away from his territory and from the female whose favours he seeks. When the tiger pursues his prey, his goal is quite different. It is not to frighten it away, but to catch and kill it. For this reason the tiger no longer adopts a threatening attitude nor does he roar. On the contrary he sneaks up to his prey as stealthily and unobtrusively as possible and then pounces on it out of the blue. It is significant that our soldiers today have given up the resplendent uniforms of old, and have donned drab camouflage instead. Their behaviour is like that of the tiger stalking his prey. Its object is to creep up on the enemy and kill him, rather than impress him with his splendour and flamboyance and frighten him away. This clearly reflects the changed role of war. It has ceased to be a sport. It is now dead earnest, purely utilitarian, highly efficient, a characteristic product of mass technological society.

Since we cannot abolish war, as I have already said, what we must aim for instead is to canalise it into less destructive channels, ritualise it in fact. The development of modern instruments of warfare and in particular nuclear weaponry is ritualisation in reverse. The first step in achieving our goal must therefore be to abolish the use of such weapons. That it has served in the last forty years as a deterrent against a possible Soviet invasion of Western Europe I don't think we can honestly deny. It would undoubtedly be very stupid for the Russians to invade us if this would mean seeing their major cities obliterated by American nuclear missiles, but as already pointed out, it is unrealistic to suppose that politicians, let alone military leaders, will always behave in a responsible way. We know that they will not, and the bomb would only always remain a deterrent if they did.

We must also remember that in the last thirty years only a few nations have been in possession of nuclear weapons. In the next decades, the atom bomb is likely to be generally available to whatever state is willing to pay for it and probably to non-government groups as well. Few people doubt that it is but a question of time before organised crime, for instance, whose turnover in such countries as America and, as we have seen recently, Australia—is simply enormous—has access to nuclear weapons.

Consider just how many wars are going on today. There is war between South Africa and Namibian guerillas. There is war in Angola between the Russian backed government and the Ovimbundu tribes of the south. There is war between Ethiopia and Somalia and also between Ethiopia and Eritrea. There is war between Morocco and the Polisario rebels of the Spanish Sahara. We are on the verge of a war between the Mashona and the Matabeles in Zimbabwe. A new war between the Nilotic tribes of the South Sudan and the Arab government may well be breaking out again in Khartum. There is war in the Chad between a Libyan backed government and rebels in the South. There is war in the Persian Gulf between Iraq and Iran which could easily spread to other parts of the Middle East. There is perpetual war in the Lebanon between the different ethnic groups that make up this totally artificial country, and war too between Syria and Israel could easily break out if the Syrians do not soon evacuate the Bekka Valley. There is also war in the Philippines between the Government and Moslem rebels. War in East Timor has only come to an end as a result of the virtual extermination of the nationalists by a brutal and cynical Indonesian government. There is war between the Vietnam-backed puppet government, aided by a large contingent of Russian troops. War between India and Pakistan could easily flair up again over Kashmir and other contested territories. There is war in El Salvador between the American backed government troops and powerful rebel forces. The Sandinista Government of Nicaragua is fighting on two fronts against right-wing invaders in the North and the partisans of Commander Zero aided by Mesquito tribesmen in the South, while another war could easily flair up again between Britain and Argentina over possession of the Falkland Islands.

It is difficult to believe that the governments and guerilla leaders involved in these conflicts would forego the use of nuclear weapons if these were made available to them, and if they were persuaded that their use would lead to the defeat of their

enemies. To suggest that they wouldn't is I think nothing more than sheer wishful thinking.

I don't have to explain what would be the human and environmental consequences of nuclear war. I am sure my readers are as aware as I am that nuclear war is something too horrible to imagine, something that only the most callous and the most cynical can conceivably contemplate. For this reason, the bomb must be banned and it must be an essential part of the policy of the ecological movement to render its production totally unacceptable to the electorate. Such a policy can of course be criticised by those who fear possible Soviet domination. If they consider the matter more carefully, I think that they would find, and I believe a lot of military men would agree, *that nuclear weapons cannot provide the basis for an effective defence policy.*

To defend oneself effectively does not necessarily mean using the most destructive weaponry. I once had dinner with Kakasaheb Kalelkar in Bombay. He was then well over ninety. He was one of Mahatma Gandhi's chief lieutenants, and also the founder of the Gandhian University in Ahmedabab where I gave a week's seminar in 1974. He told us during dinner that he had once been a member of a guerilla organisation whose object it was to get rid of the British by force. I cannot remember the name of its leader but I remember Kakasaheb Kalelkar telling us that he left him for Gandhi—not for ideological reasons as one might suppose, but because Gandhi, he thought, was the better general. Non violent resistance was indeed probably more effective aginst the British Raj than any terrorist campaign could have been. I am not suggesting that it would be effective against the Soviets. Gandhi was never a pacifist. He admitted very explicitly that his methods would be of little use against Hitler or Stalin.

But the fact remains that it is not just weaponry that wins wars. It is cooperation, morale, patriotism, pride, the spirit of self sacrifice. It is all these and a lot of other qualities that are difficult to define, still more difficult to quantify and which cannot be taken into account by politicians and military theorists whose thinking is conditioned by modern science and who, as a result are only capable of taking into account those factors that are visible physically, that can be quantified and arranged in pairs to constitute empirically verifiable one-way cause-and-effect relationships.

I think that one of the main reasons why the Western nations depend for their defence on nuclear weapons, is that their societies have disintegrated to such an extent under the influence of the industrial system and the welfare state and their citizens have become so totally alienated and demoralised that they can no longer be counted upon to defend their country as the Afghans today are defending theirs. The nuclear option is then the only option—but it is the soft option, the only one open to people who are unwilling and incapable of defending their family and their community against an external aggressor. It is the only option too that is open once defence has been taken out of the hands of society and handed over to a few specialised technocrats, once a function previously assumed by all citizens has been usurped by a few professional bureaucrats and politicians.

It is part of the same fatal trend that prevents people from looking after their own children, looking after their own health, producing their own food, governing their own community and fulfilling all the other necessary functions that they have fulfilled from time immemorial. If they have a right to do all those essential things they also have a right to defend themselves from aggressors, and, needless to say, there is no right without a corresponding obligation. To give up those functions, to hand them over to specialists is totally unacceptable, it is but a means of assuring the redundancy and alienation of modern man and at the same time the further disintegration of his family, his community, his society and his ecosystem.

There is another thing we must also not forget. The UK covers an area of 90,000 square miles, the Soviet Union an area of over 900,000 square miles. This means, that all things being equal, the Soviet Union could absorb 100 times more nuclear punishment than we can. A few bombs would obliterate this minute and highly centralised country while many more would be required to destroy the Soviet Union. To engage in nuclear war would thereby be self-defeating. In addition what happens once we have fired off our entire arsenal of nuclear weapons? What do we do next? Unless we have obliterated our enemy we are then quite helpless in the face of any possible invasion. We have no other means of defence left to us. That is why the nuclear deterrent is, in fact, *a more-up-to-date* version of the *Maginot Line.* Like the Maginot Line, once its possibilities have been exhausted, no further defence is possible.

There is another reason too why nuclear weapons cannot provide the basis of a sound defence policy. To produce the plutonium required to make nuclear bombs, nuclear power stations are required. That is one of the principal reasons why the governments of the countries that are building up a nuclear arsenal are so keen to build nuclear power stations in spite of the radioactive pollution they give rise to and in spite of their massive construction and operation costs (see the CSENE Report *The Ecologist* Vol. 11 No. 6).

Now conventional bombs wreak havoc with nuclear power stations, worse still with nuclear reprocessing plants. Professor Patricia Lindop, one of the country's leading radiobiologists, recently told us that if conventional bombs were dropped on Windscale (or Sellafield as our nuclear reprocessing plant is now called), it would be necessary to evacuate almost half the population of England—to where exactly we are of course not told. Not surprisingly a well known general on the French General's staff informed his government a few years ago that, in his opinion, a country with a network of nuclear power stations is *indefensible.*

Finally to base our defence on nuclear weapons is to opt for a high technology mass-society which is unacceptable on a host of social and ecological grounds of which our readers will be only too aware. For all these reasons we need a very different defence strategy and, in my opinion, and in that of quite a number of people within the Ecological Movement (for instance I recently received a short article from Frank P Hughes of Hawkesbury, Ontario in which the author comes to exactly the same conclusion as I do) there is only one possible answer. It involves quite obviously taking defence into our own hands. As Gladstone once said "there is no barrier like the breasts of free men." And free men are men

who run themselves, not helpless marionettes manipulated by distant bureaucrats. This means building up a highly decentralised citizens' army. It means too reintroducing national service which should never have been abolished. How else can we train our citizens in the use of sophisticated light weaponry? How else can they learn to become efficient guerilla fighters? Nor is it sufficient that they should undergo a single period of training during the course of their lives. As in the Swiss Army they should go on refresher courses every year for at least two weeks, possibly more. Nor should they be anonymous members of a vast anonymous army—mere faces in the crowd. The army should be reorganised as it was on a county basis. The old regiments must be restored with all their tradition and all their regalia. People are more likely to be motivated to defend their own area with the aid of their neighbours and friends than distant parts of the land in the company of strangers. By joining local regiments, they can also meet and cooperate with other members of their community and build up real local patriotism which has largely ceased to exist. This would also help to give them faith and pride in themselves in the knowledge that the defence of their country and of their homes rests squarely on their shoulders. Only such an army could possibly be able to operate in the event of our main cities being destroyed by nuclear warfare and only such an army is likely to be motivated to do so. Besides, the adoption of such a defence policy would be an important step in a strategy of social regeneration, a sine-qua-non for the solution of all the problems that confront our society today—not only that of defence but the associated problems of social and environmental degradation with which the Ecological Movement is primarily concerned.

Edward Goldsmith

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GAIA:
An Ancient View of our Planet

by J. Donald Hughes

We are told that when the king of the Persians travelled through any of his numerous and wide-flung provinces, he pointedly observed the condition of the land. Where a landscape was well-cultivated and thickly planted with trees, he rewarded the local governor with honours, gifts, and expanded territory; but where he found neglected fields, deforestation, and deserted lands, he removed the governor from office and replaced the miscreant with a better administrator. So the king judged the worth of his appointees by the care they gave to the land, and thus to its inhabitants, believing this just as important as maintaining a garrison for defence or a good flow of taxes. The principles seem clear: a governor who cares for the earth and can cope with environmental problems can be trusted to govern well, and the quality of an administration can be judged by the state of the environment in its territory.

This story comes to us from the *Economics* of Xenophon,[1] a Greek who knew the Persian Empire at first hand, since he had marched through about half of it at the head of a mercenary army. He was also a farmer who knew the land and how it responds to treatment of every kind. He summed up his experience of human relationship to the earth in a memorable sentence: "Earth is a goddess and teaches justice to those who can learn, for the better she is served, the more good things she gives in return."[2]

A key to Classical Greek and Roman land ethics and views of environmental problems in a period of decisive importance to the later history of the world can be found in this sentence. Specifically, it is to be found in an examination of the concept of the Earth: the Greek *Gaia* or *Ge*, the Latin *Tellus* or *Terra*, and the related idea of cosmos, as it developed through ancient history. No other idea is so central to the understanding of environmental history in this age, or probably any age in the history of mankind. Indeed, one possible meaning of the word 'earth' in classical literature is 'environment.' But the ancients seldom used the word in the passive, inanimate sense that often emasculates the word 'environment' in modern use. The Greeks and Romans spent most of their lives outdoors, developing their ideas of earth in active interplay with the living world of nature. They often speak from a point of view that is chthonic, which means, to translate the word literally, earthy. And the chthonic view does not draw a sharp distinction between human life and the life of nature, but sees human beings as children of Earth, sharing in her life and her nature. Instead of mere 'environment', then, they saw Earth as a primal goddess or a vast living physical being. If she demands worship it is not just in the conventional sense but in the form of good husbandry as well, and she can both reward good service and punish carelessness.

This article will examine three major classical conceptions of the earth: first, the traditional view of Earth as a goddess; second, the view developed in the sixth century B.C. and afterwards by some philosophers that Earth is a living organism; and third, the view, consistent with each of the two previous, that

earth exists in reciprocal balance with her human inhabitants and responds to their treatment in positive and negative ways that are appropriate and just. This third view is basic to the land ethic enunciated by the agricultural writers.

I—Earth as a Goddess

When Xenophon says, "earth is a goddess," he is articulating the dominant traditional image of the earth. Earth to the classical Greeks and Romans is the oldest goddess, the all-mother, *Ge meter panton, Terra Mater,* Mother Earth. Plutarch puts it this way: "The name of Earth is dear . . . and precious to every Greek, and it is a custom to revere her like any other deity."[3] The antiquity of earth-worship is hinted in the *Suppliants* of Aeschylus, where the repeated cry, *Ma Ga, Ma Ga,*[4] the simplest form of the name 'Mother Earth,' probably echoes ancient ritual. The perception of earth as a goddess can be traced even farther back, into the prehistory of the Mediterranean lands. Cultures that had no writing carved figures of a broad-bosomed mother goddess in wood, bone, and stone, often symbolically incorporating masculine elements, apparently so that she could give birth of herself. Her image on walls and seals is surrounded by figures of animals, birds, and trees. In the earliest of these representations no masculine gods are portrayed, and when they finally appear they are smaller, subsidiary figures, the sons and lovers of the Great Goddess. So it was among the Minoans of Crete, whose statues of the bare-breasted goddess holding snakes, the oldest of earth-symbols, are so deservedly famous.

With the Mycenaean Greeks, we reach an historical period where we can begin to read records scratched on clay tablets in the script called Linear B. Here the goddess is called *Wanaka,* Our Lady, to whom tracts of agricultural land were dedicated. She is pictured receiving offerings from men and women including animals and the produce of the soil.

Our first detailed evidence of how the early Greeks viewed the earth goddess comes from poetry of the Archaic Period, particularly Hesiod and the Homeric Hymns. In the beginning, they tell us, was wide-bosomed Earth, mother of gods and men, animals and plants. She nourishes and cares for all creatures as her own children. From her all things spring; to her return all things that die. Her creative womb bore all that is, including the first of all the sky and all that it contains; the stars and all the worlds are her children, not this world alone. Many of her offspring are monsters, like the one-eyed Cyclops and hundred-handed Briareos; her fecundity has a dark side. Indeed, Earth herself contains the underworld, which can be seen in one way as a vast uterus but in another way as the common tomb of all the dead. We are born from her, we are nourished by her, and return to her when we die.

Earth is portrayed by the poets in two aspects, cultivated and wild. Two Homeric Hymns celebrate her: one, 'To Earth the Mother of All', speaks of rich tilled land responding to human labour:

> Mistress, from you come our fine children and bountiful harvests; Yours is the power to give mortals life and to take it away. Happy is he upon whom your glance falls with favour, Finding him worthy; to him come all things in abundance. His life-giving acres of cornland at harvest are heavily laden, Cattle abound in his pastures, his house is filled with good things.[5]

The other, 'To the Mother of the Gods,' is a wild poem that sings of her delight in "the howling of wolves and bright-eyed lions among echoing hills and forested canyons."[6] In these lines we hear the deep past resounding. Earth is not just the medium of the farmer's toil, but provides food and fertility for the flocks of the herders, and also the wild animals and plants whose abundance supports people who live by hunting, gathering, and fishing.[7]

The Greeks of the classical period maintained traditions of closeness to the earth. They called themselves 'earthborn' or 'autochthonous,' particularly those who, like the Athenians, traced their ancestry back to the Mycenaeans on their own soil. Deucalion and Pyrrha repopulated the earth after the mythological Great Flood by casting stones, "the bones of their mother,"[8] over their shoulders, and Earth gave instant birth to human beings. Athens remembered her earliest kings as sons of Mother Earth, so intimately connected with their chthonic origin that they were said to be serpent-formed in their lower parts. The more old-fashioned among Athenians gathered their long hair with golden clasps shaped like cicadas, those insects that can be seen emerging from the earth in springtime, to symbolize that they were "children of Earth, who sustained them."[9] The Romans had similar feelings; Lucretius says, "the Earth deserves the name of Mother; by herself she made the race of men."[10]

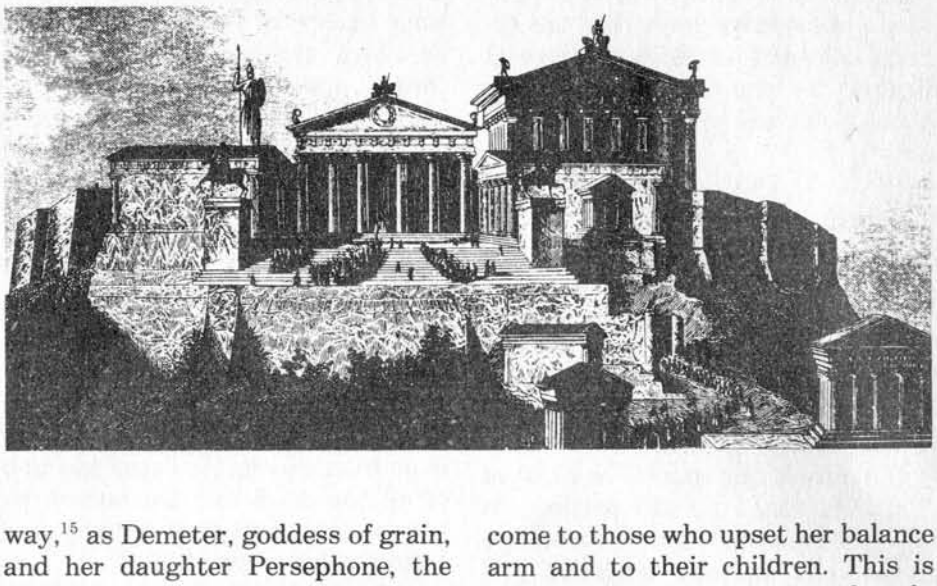
Earth's relationship to the other ancient gods was not always peaceful. The Greeks and Romans were descendants of invaders who worshipped a pantheon of warrior sky gods, predominantly male, and brought them with them into the Mediterranean lands. The sky gods became the Olympians; Hesiod worked them into his *Theogony* as grandchildren of Mother Earth whom she aided to overthrow the older gods. Everywhere shrines of Earth were rededicated to the worship of the upstarts, Zeus or Apollo most often. But the old religion was not supplanted totally by the new. Chthonic religion continued beside the Olympian as an alternative way of relating to the gods. Theologians who tried to reconcile the two joined them with the image of sexual union. Zeus as weather-god took the role of the cloudy figure Ouranos, Gaia's son and consort who had suffered a cosmic emasculation. Now Zeus could send the fertilizing rain and cause Earth to conceive; he could be father, she mother. "The rain falling from the beautiful sky impregnates the earth, so that she gives birth to plants and grain for beasts and men."[11] A statue of Ge on the Acropolis showed her imploring Zeus for rain.[12] But in spite of or because of such attempts at harmonizing, the chthonic perspective on the world remained and even infiltrated Olympian religion.

At this point we can look at the environmental dimension of ancient worship. Among the earliest places of worship of Mother Earth were caves where offerings could be placed inside her body in ritual enactment of sexual fertilization, or

springs where her life-giving waters emerged like milk from maternal breasts or menstrual flow. Other places holy to Earth were groves, since trees were regarded as daughters of Earth, growing from and remaining rooted in her. Any natural area set aside for worship was a *temenos* or bounded sanctuary. Within it nothing natural could be disturbed: no trees cut, no wood removed, no animals hunted nor fish caught. Obviously this had some effect in preserving areas of the ancient landscape from environmental damage. Vincent Scully wrote a perceptive book called *The Earth, the Temple, and the Gods* in which he demonstrated that the choice of location for temples, theatres, athletic stadia, and healing sanctuaries was determined by careful observation of the conformation of the earth's surface and the shapes and directions of topographical features visible from the sites. That is, Mother Earth herself was allowed to make the choice of the siting and orientation of any important structure dedicated not only to herself, but to any of the gods. Anyone visiting these places should be conscious of their great natural beauty, but Scully noted that particular shapes of hills and notches on the horizon, especially when these suggest feminine and masculine images, almost determine the spot selected.[13]

Gaia's shrines were oracular: a worshipper could sleep in one of them and expect to receive the dreams she sent. Also chthonic were initiation mysteries where men and women came to be integrated into the great cycles of nature: seedtime and harvest, reproduction and birth, through identification with the goddess, as at Eleusis. Here the life and death of mortals was identified with the sowing and growth of the crops that can be seen every year. People die and are buried in the earth, as seeds are planted in the soil. But as seeds send forth shoots in response to healing moisture, they believed, so those who were initiated into the mysteries would flourish again and live a happy life among the dead under the hollow earth, confident because they "knew the end of life and its god-sent beginning."[14]

Almost every goddess incorporates the archetype of Gaia in some way,[15] as Demeter, goddess of grain, and her daughter Persephone, the deities of the mysteries of Eleusis, clearly do. Artemis is 'Mistress of Beasts' and 'the wild wood.' Rhea or Cybele is 'Mother of the Gods.' Hera is a mother who seasonally renews her virginity and gives birth parthenogenetically to monsters, as Earth herself had done. Athena is nurturer of children and called 'Mother,' although a perpetual virgin, and her attributes include the earth-symbols of olive tree, owl, and serpent.



But the goddess most closely and importantly associated with Gaia is Themis, her daughter. In fact, one can call Themis the alter ego of Gaia: Aeschylus makes Prometheus, her son, say that she is the same goddess.[16] Worship was given to Ge-Themis at Delphi and Athens.[17] Now this is very interesting because Themis is goddess of law, of justice. Why should this be an attribute of Earth?[18]

It is because Earth has her own law, a natural law in the original sense of those words, deeper than human enactments and beyond repeal. It is not the justice of human morality; it is written in the nature of things. "Earth is a goddess and teaches justice to those who can learn, for the better she is served, the more good things she gives in return."[19] Who treat her well receive blessings; who treat her ill suffer privation, for she gives with evenhanded measure. Earth forgives, but only to a certain point, only until the balance tips and then it is too late: famine, disease, disaster, and death come to those who upset her balance arm and to their children. This is Gaia's view of environmental problems.

Ancient history and mythology are full of stories in which Earth has her revenge on those who harm her or the creatures she protects. Ecological sins meet with ecological punishments. Erysichthon, whose name means 'tearer of earth,' cut down a tree inhabited by a dryad in spite of the tree-spirit's protests; she complained to Mother Earth, who afflicted him with insatiable hunger. Orion boasted that he would kill all the animals in the world. This too was reported to Mother Earth, who sent a monstrous scorpion to sting him to death. Today they are constellations opposite one another in the sky. Oedipus' rule of Thebes was sinful (although some would say, unconsciously so) but we must not forget that he killed the Sphinx, one of Earth's monstrous offspring and probably an endangered species. A result of this was that blight hit the crops growing on the land he ruled. There is even a reference to overpopulation: Themis planned the Trojan War with Zeus in order to thin out the teeming tribes that were oppressing the surface of Mother Earth.[20] Hesiod and others warn against pollution as a religious violation. The fact that Columella had to put forth an argument that ploughing is not the wounding of Mother Earth by her children shows that there were those who thought it was, and probably feared her revenge.[21]

And the fear of Gaia's revenge was no light matter in ancient times.

For though she cares for all creatures as her children, they believed, and provides food for every living thing, she also knows that the droppings of cattle manure her trees and the bodies of men are humus for the grass of the plains. At times she is arbitrary and violent; the volcano too is her voice. But in Gaia's revenge is no vindictiveness at all, only the deepest and most natural working. Those who learn and obey her laws have the best chance, in the words of the Homeric Hymn, to see "their sons exult with ever-fresh delight, and their daughters in flower-laden bands play and skip merrily over the soft flowers of the field. Thus it is with those whom you honour, O holy goddess, bountiful spirit."[22]

II—Earth as a Living Organism

The second important ancient conception of the earth is that she is a vast living organism. For the Greeks this was a natural step from seeing her as a goddess. Farnell says, "the worship of the earth, conceived in some way as animate or personal, was a universal fact in human religion in certain stages of human life."[23] If the idea of Earth as goddess stressed the personal image, the concept of Earth as organism stressed the animate image.

Several years ago, artificial satellites were placed in synchronous orbits around our planet and made time-lapse motion pictures of one side of the Earth. I remember my sense of wonder at seeing this beautiful changing atmosphere for the first time as a whole. As the terminator between day and night swept repeatedly across the globe, the clouds moved in variegated patterns. Weather fronts marched in procession across the northern continents and a great cyclonic storm revolved in the Atlantic. It struck me immediately that what I was seeing was a gigantic system of circulation, like the streaming cytoplasm of a cell. It looked unmistakably organic and alive. This view of the whole atmosphere as a moving, literally breathing system did even more than the photographs of a spherical jewel hanging motionless in space, or the time-lapse films shown every day on television, which zoom in too closely on our own segment of the planet and superimpose a grid of state boundaries that mar Earth's natural cycles, to convince me that we are not just living motes on a vast mineral ball, but that the Earth itself is alive.

This is the hypothesis of James E. Lovelock, the British atmospheric chemist, who described its development and naming in these words:

> It appeared to us that the Earth's biosphere is able to control at least the temperature of the Earth's surface and the composition of the atmosphere. Prima facie, the atmosphere looked like a contrivance put together co-operatively by the totality of living systems to carry out certain necessary control functions. This led to the formulation of the proposition that living matter, the air, the oceans, the land surface were parts of a giant system which was able to control temperature, the composition of the air and sea, the pH of the soil and so on as to be optimum for survival of the biosphere. The system seemed to exhibit the behaviour of a single organism, even a living creature. One having such formidable powers deserved a name to match it; William Golding, the novelist, suggested Gaia—the name given by the ancient Greeks to their Earth goddess.[24]

Golding's choice of the name Gaia for the living entity of Earth is particularly appropriate, because some of the ancient philosophers enunciated a theory of the cosmos which is not far from the modern 'Gaia hypothesis.' Plato affirmed that the world is "that Living Creature of which all other living creatures, severally and generically, are portions."[25]

The idea of a living, sentient cosmos is not an isolated view among philosophers, but a dominant theme. It emerged first among the Pythagoreans, who held that the world is spherical, animate, ensouled and intelligent. They emphasised the cyclical interplay and balance of the elements and creatures within the organic unity of the world. Empedocles may have been enunciating a grosser vision of the Earth as a living creature when he said, "the sea is the Earth's sweat."[26] But Anaxagoras, in holding that the cosmos breathes, perhaps came closest to Lovelock's atmospheric hypothesis.

Plato gives us the first extant systematic account of the ancient theory. He maintains that the cosmos is "a living creature, one and visible, containing within itself all living creatures which are by nature akin to itself."[27] And this living creature is "endowed with soul and reason." As Cicero echoed him centuries later, "The world is an intelligent being, and indeed also a wise being."[28] The Stoics also followed Plato's view of the cosmos as an organism which is sentient, rational, pervaded by harmony, and of which all living things are parts. It is self-sufficient because it nourishes, and is nourished from itself.

An important difference does exist between the ancient philosophers' view and the modern Gaia hypothesis. In the former case, the living creater *(zoon)* is the *kosmos* or universe, while in the latter it is Gaia, the Earth, or more strictly the biosphere, that is considered to be the living entity. But the difference seems less important when the ancient conception of the universe is taken into account. In the usual picture, the Earth is at the centre and occupies a uniquely important position within the cosmos. Any philosopher who held that the cosmos is alive would also have asserted that the Earth, as its heart, was also alive. Plato clearly implies that the Earth shares the same nature as the cosmos of which it is part, which includes being alive.[29] The Earth is the locus of virtually all known living things, including rational man. In the general Greco-Roman view of the environment, therefore, saying "the Earth is alive" and "the cosmos is alive" would not be functionally different statements. Both, in popular speech, would amount to saying, "the world is alive."

Then what is the place of human beings within this living organism that is the world? Mankind is one functioning part of the totality, and we are what we are because we have a share of the whole. Our bodies are composed of the same elements as the world, since we were generated out of the Earth. Indeed Empedocles says that it is exactly because of this that we can know or perceive the world: "For it is by

earth that we see earth."[30] We are alive because the world is alive; our souls are extensions or parts in one way or another of the world-soul. As Plato says, "Whence can a human body have received its soul, if the body of the world does not possess soul?"[31] This view gives humanity an integral place within the living universe; we share the qualities of the whole organism by physical existence, living, sensing, and being conscious. Most philosophers gave mankind a special role within the cosmos, as possessor of reason *par excellence,* although they did allow a certain degree of intelligence to animals and even to plants. By her habit of growth, for example, the vine herself instructs the viticulturalist in her needs for support and shade.[32] Still, reason is our most distinguishing quality; man is the rational animal.

The modern exponents of the Gaia hypothesis tend to speak of collective humanity as the 'nervous system' of the biosphere, the organ through which it becomes conscious, not that we lack other functions but that our brains give us that special role. Lovelock speculates that we may not be unique in this respect, since the cetaceans also have large brains whose functions we do not fully understand.[33] Perhaps they are the nervous system of the sea, and the fact that we are hunting them to extinction may be a catastrophe of a more serious nature than we have suspected.

Not all ancient philosophers postulated a living cosmos. On what one proposition would they have agreed? The atomists and Epicurus would have denied it. Epicurus stated that there were many universes like our own, and that in some of them animals and plants were not present. How could a universe be alive if it lacked living creatures? Our particular universe does, of course, have life within it, although life for Epicurus was only an arrangement and motion of atoms within the void.

Granted such dissenters, the view of the world as living organism was so widely held among philosophers throughout classical antiquity that it must have been familiar to every educated person in the Greco-Roman world. And it was congenial with the general intellectual world-view of the times.

Now if the world is a living organism within which the parts function in harmony, environmental problems represent a disharmony or an illness of the organism. The world is in a state of natural dynamic balance; anything that puts stress on one part is adjusted for by a shift somewhere else in the system. But if it is nonetheless upset it is sickness, and a restoration of health must be sought through healing (therapeia) or purification (Katharsis). Thus the problem can be seen as miasma, a pollution that needs to be removed. This concept has very ancient sources, springing from the deepest strata of chthonic religion.

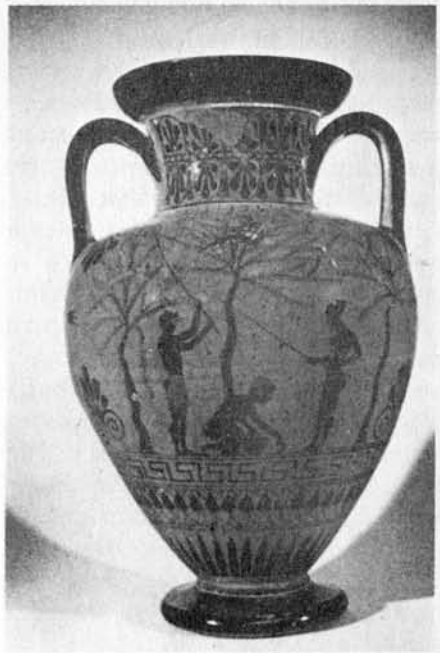
The modern scientists who have advanced the Gaia hypothesis undoubtedly were not aware of how far back in intellectual history the antecedents of their theory can be traced, and how fitting was Golding's suggestion of a classical Greek name for the entity they postulate.

III—The Ancient Land Ethic

We need to look at a third and last attitude of the ancient peoples toward the Earth. It is a teaching of primitive reciprocity: Earth rewards good husbandry and punishes a wastrel. It is the basis of the land ethic taught by the best agricultural writers and epitomized by Xenophon in the quotation that has emerged as this essay's theme, and which I will now translate in slightly different words: "Earth willingly teaches righteousness to those who can learn, for the better she is treated, the more good things she gives in return."[34]

The ancient economy was dependant on farming; as Aristotle affirms, "The greatest number (of those who labour to get wealth) obtain a living from the cultivated fruits of the earth."[35] So the question of assuring that Earth would continue to be generous from year to year was of the highest importance. Cicero used a financial metaphor: "The farmer keeps an open account with the Earth,"[36] and receives low or high interest as he invests his labour and materials.

But most ancient writers put the principle in more personal terms. Since "Earth as being your mother delivered you, now as if your land



were your mother and nurse you ought to take thought for her"[37] and tend her "with care passing that of son for mother, the more that the Earth is the divine teacher of her mortal children."[38] As children of Earth, human beings are totally dependent on her for sustenance and strength. The myth of Antaeus has a more universal meaning: as long as he was in contact with Earth, his mother, he was invincible, but as soon as Heracles held him up so he could not touch her he began to weaken. 'To give earth'[39] was the symbol of surrender and slavery to a foreign conqueror.

To the principles of economic return and filial gratitude the Stoics added the arguments that the Earth is beautiful and should be preserved for that reason, and that Earth is useful, providing the sphere for the exercise of human art, skill and labour.

The idea of agriculture as the care of the earth has a long and honourable history. The acts of tilling and sowing in earliest times were cast in the metaphors of sexual fertilization, and the nourishing response of Earth was compared to the maternal suckling of children at her flowing breasts. Not all the ancients had such a positive view of tillage, to be sure. Cultivation could also be seen as a 'wearying' of Mother Earth, who grows older as the generations go by and less able to produce what once she bore.[40] The well-known 'Hymn to Man' in Sophocles' *Antigone* says that the farmer tires earth

by ploughing her: "Earth, the supreme divinity, the immortal and unwearied one, he wears away."[41] But others like Columella countered this view, maintaining that cultivation properly done and compensated for by manuring need not exhaust the soil. Earth is now growing old, he said: the blame for her infertility lies in poor husbandry: declining crops are our fault, not hers.[42] The damage that humans can do to the earth was seen most clearly in industries that make their profit by taking things from the earth, as in the cutting of timber and mining.[43] But always the principle was the same: Earth responds to human treatment in kind. She rewards responsible, wise labour and punishes the lazy and harmful. This is the inexorable operation of the law of Themis.

From the chthonic viewpoint, the worst sin of all is failure to take care of the land itself. The Earth will never let the idle farmer prosper. If a man gets no grain from his field, it is reasonable to assume that it is because he "takes no trouble to see that it is (properly) sown and manured."[44] When a sheep is ailing, Xenophon observes, we generally blame the shepherd, so if a farm in otherwise good country fails to prosper, we can blame the farmer either for laziness or bad practices.[45] One who lets goats graze in a young olive orchard or vineyard, warns Varro, must expect to lose his trees and vines.[46] The results of mistreatment of the Earth were clear to the ancient writers: hunger, ill health, erosion, poverty, and general ruin were all forms her revenge could take. For "although she supplies things in abundance," she is not an easy taskmistress. "She does not allow her benefits to be won without toil," at least not in the Mediterranean climatic zone, "but accustoms folk to endure winter's cold and summer's heat."[47] And even the best farmer may have a bad year now and then.

If the agricultural writers warn of her poetic justice, they also reveal its positive side. Even the work she requires is beneficial, since "Earth gives increased strength through exercise to those who labour with their own hands."[48] And instances of Earth rewarding good husbandry are numerous. Homer praises Odysseus' father, King Laertes, for his horticultural ability. His orchard and vineyard were unusually fruitful because they were trimmed and cultivated with skill and care. The results "were the glorious gifts of the gods."[49] It was the same with the gardens of King Alcinous of the Phaeacians. Indeed, throughout classical history, flourishing agricultural environment was regarded as the sign of a good ruler. When Alexander the Great had to choose a new king for Sidon, he selected Abdalonymus, who was found watering a garden. Robin Lane Fox suggests that Alexander picked the man because he was such an excellent gardener.[50] The principle seems to be that one whose plot of ground flourishes will also be able to see that his land and people flourish.

Those who rule have responsibility toward the Earth. Lawgivers had to place the division of the land and the care of the Earth among their first concerns. Solon limited the amount of *ge* one man could own, not only to prevent the dispossession of impoverished small landowners, but also to make sure the earth received proper attention. And political philosophers urged that legislators make enactments to protect the land and control its use. Plato advised that the state make certain that arable soil not be preempted for other purposes. As he put it, "where Earth, a true mother to us . . . is minded to yield sustenance for us, our living should not be cheated of the benefit by any man, living or dead."[51] The laws made by the state affect mutual transactions between human beings and the Earth, so they should reflect those deeper laws taught by Earth herself.

And these laws are not hidden; the Earth is a teacher whose books are always open for us to read; she does not willfully lead us astray, so if human beings fail to discern the law of Earth and act on it, they have only themselves to blame. Xenophon states this clearly: "I think that just because she conceals nothing from our knowledge and understanding the Earth is the surest tester of good and bad individuals."[52] To flourish in their land, a people must first understand the nature of the Earth. And this is not difficult, since the Earth is such a gentle, humane teacher that all we need to do is see her and listen to her, and she at once will make us comprehend her. She herself gives many lessons in the best way of treating her. When deciding what to plant in a given place, "you are not likely to get a better yield from the earth by sowing and planting what you want instead of the crops and trees that the earth prefers,"[53] and you can find out what she prefers by observation of what grows there naturally. "For the earth never plays tricks, but reveals frankly and truthfully what she can and what she cannot do."[54]

Though the relationship with Earth was seen as a mutual interchange, Earth was always regarded as the senior partner, the stronger one, the encompassing one within whose embrace the human species was only one of many creatures. "All things come from the Earth," announces the pre-Socratic philosopher Xenophanes, "and they reach their end by returning to Earth at last."[55]

Conclusion

These, then, are the components of the chthonic viewpoint insofar as we can trace it among the ancient Greeks and Romans. First, the Earth is the oldest goddess, supporter and nurturer of her children, human and non-human, and therefore entitled to respect and worship. Her principles of justice, personified as her daughter and alter ego Themis, are deeper and more compelling than human enactments because they are written in the soil and rocks, are heard in the rain and winds, and have their inexorable effects without need for courts and juries beyond the land and crops themselves. Environmental problems are seen as a result of the failure of human beings properly to worship the Earth and follow her unwritten laws.

Second, the Earth is a living being of whom humans are only part. Right relationship with the Earth means that the total organism is in good health; so environmental problems are seen as illness, as a failure of one part of the organism to interact supportively with others.

Third, Earth is seen as responsive to human care or the lack of it, giving rich returns to those who treat her well and punishing those who are lazy or who weary her by trying to wrest from her what she is not ready to give. Environmental problems are seen as the passionless revenge of Earth on those who fail, either through ignorance or avarice, to practice well the art of the attentive tender of the land. "For Earth is a goddess and teaches justice to those who can learn, for the better she is served, the more good things she gives in return."[56]

A final observation seems in order. To paraphrase James Lovelock, the chthonic view of the environment does not envisage "a subjugated biosphere with man in charge." Mankind is not the "possessor of this planet," but "a part of, or partner in, a very democratic entity."[57] These words, which he applies to the Gaia hypothesis, express equally well the chthonic tradition in classical thought. Other tendencies in Western intellectual history have made man the lord of the Earth, conqueror of nature, uncaring consumer of the Earth's 'natural resources.' This is the attitude that continues to lead us in the present time, the Age of the Great Recessional, when each year Earth is losing more forms of life than in centuries before. In a decade when we are being told that we have to sacrifice environmental values for industrial growth and national strength, we could find healing in another voice, that of the ancient *Hymn to Earth, Mother of All:*

> Gaia, mother of all, I sing, oldest of gods,
> Firm of foundation, who feeds all creatures living on earth,
> As many as move on the radiant land and swim in the sea
> And fly through the air—all these does she feed with her bounty.
> Mistress, from you come our fine children and bountiful harvests,
> Yours is the power to give mortals life and to take it away.[58]

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3. Plutarch, *Moralia* 935B.
4. Aeschylus, *Supplices* 890.
5. *Homeric Hymn* 30. 5-10, trans. by Thelma Sargent, *The Homeric Hymns: A Verse Translation* (New York: W.W. Norton, 1973), p. 79.
6. *Hymn. Hom.* 14. 4-5.
7. W.K.C. Guthrie, *The Greeks and their Gods* (Boston: Beacon Press, 1954) pp. 58-59.
8. Ovid, *Metamorphoses* 1. 415.
9. Plato, *Menexenus* 237B.
10. Lucretius, *De Rerum Natura* 5. 820.
11. Aeschylus, *Danaids* fr. 25.
12. Pausanias, *Description of Greece* 1.24.3.
13. Vincent Scully, *The Earth, the Temple, and the Gods* (New York: Frederick A. Praeger, 1969).
14. Pindar, fr. 102.
15. Most instructive on this question is the chapter, "Beginning with Gaia," in Christine Downing, *The Goddess: Mythological Images of the Feminine* (New York: Crossroad, 1981), pp. 131-156.
16. Aeschylus, *Prometheus Bound* 209.
17. Farnell, vol. 3, pp. 13-14.
18. Many scholars have said that it is because when oaths were sworn, Earth was called to be witness. Demosthenes was said to have been able to reduce people to tears by intoning the well-known metrical oath, "By Earth, by all her fountains, streams, and floods . . ." (Plutarch, *Life of Demosthenes*, 9). But why Earth? Because she was everywhere, received shed blood and the bodies of the slain, and could exact vengeance from oath-breakers. She was mother of the Furies; Electra prayed to Earth for revenge on Clytemnaestra, who had broken the marriage-vow in a way more serious than usual, by murdering her husband.
19. Xen. *Oec.* 5.12.
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21. Columella, *De Re Rustica* 10. 57-58.
22. *Hymn. Hom.* 30. 13-16.
23. Farnell, vol. 3, p.2.
24. James E. Lovelock and Sidney Epton, "The Quest for Gaia," *New Scientist* 65 (1975): 304.
25. Plato, *Timaeus* 30D.
26. Philip Wheelwright, ed., *The Presocratics* (Indianapolis: Bobbs-Merrill, 1966), p. 153. The testimony is from Simplicius, quoting Theophrastus.
27. Pl. *Ti.* 30D.
28. Cicero, *De Natura Deorum* 2. 13 (35).
29. Pl. *Phd.* 109B.
30. Empedocles, fr. 378, from Aristotle, *De Anima* 404bl3.
31. Plato, *Philebus* 29A-30A.
32. Xen. *Oec.* 19. 18-19.
33. James E. Lovelock, *Gaia: A New Look at Life on Earth* (Oxford: Oxford University Press, 1979), p. 149.
34. Xen. *Oec.* 5.12.
35. Aristotle, *Politics* 1256a39.
36. Cicero, *De Senectute* 15.
37. Plato, *Republic* 3. 414 D-E.
38. Plato, *Leges* 5. 740A.
39. Aristotle, *Rhetoric* 1399b11. "Earth and water" was the customary demand by the Persians of Greek states during the Persian Wars.
40. Lucr. 5. 827.
41. Sophocles, *Antigone* 333.
42. Columella, *Rust.* 1. Praef. 1-3.
43. Arist. *Pol.* 1258b29.
44. Xen. *Oec.* 20. 4.
45. Ibid. 3. 11.
46. Varro, *De Re Rustica* 1.2.17.
47. Xen. *Oec.* 5.4.
48. Ibid.
49. Homer, *Odyssey* 7.132.
50. Robin Lane Fox, *The Search for Alexander* (Boston: Little, Brown, 1980), p. 184.
51. Pl. *Leg.* 12.958E.
52. Xen. *Oec.* 20.13.
53. Ibid. 16.3.
54. Ibid. 20.13.
55. Xenophanes, fr. 27; Wheelwright, p. 33.
56. Xen. *Oec.* 5.12.
57. Lovelock, p. 145.
58. *Hymn. Hom.* 30. 1-7; Sargent, p. 79.

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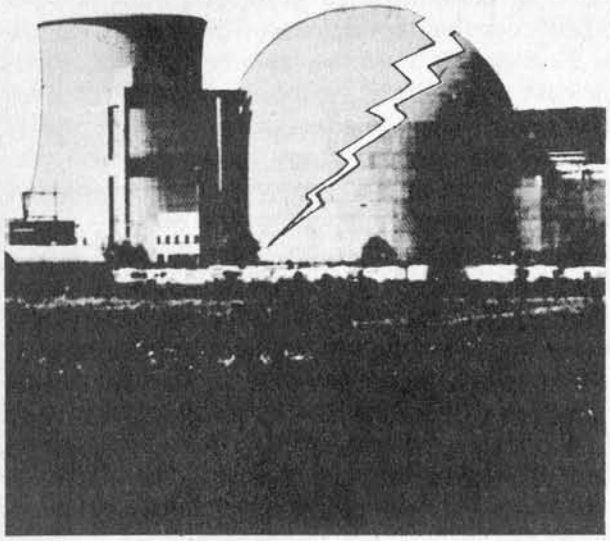


The Crumbling Case for Nuclear Power

by Peter Bunyard

The Sizewell B PWR public inquiry has been running since the beginning of the year and has now approached the time when objectors to the CEGB's proposal to build a PWR in Britain will be getting their opportunity both to cross-examine the Board and to present their own counter attack. The CEGB has ventured into the public inquiry, at no mean expense, because of its highly publicised conviction that a PWR—a pressurised water reactor—will help cut future costs of electricity generation in Britain, and will simultaneously provide it with a sound alternative to coal-fired generation which at present makes up more than 80 per cent of the CEGB's electricity production. The CEGB has strong government support for its proposal, despite rather unfavourable reports from the House of Commons Select Committee on Energy and from the Monopolies and Mergers Commission. Indeed Thatcher's Cabinet has barely concealed its twin obsessions to curb the power of the coal miners and to promote nuclear power. In that regard it is not surprising that it should have plucked Sir Walter Marshall from the Atomic Energy Authority and made him chairman of the CEGB, and more recently have put Ian MacGregor as chairman of the National Coal Board. The irony in all such power politics is that coal is potentially Britain's most important energy resource, while uranium, the fuel for Britain's nuclear reactors, has to be imported in its entirety, and with a large worldwide nuclear programme could be in short supply within a few decades.

Aside from economics and diversity of fuel, the other main plank in the CEGB's argument for the Sizewell PWR is that its present make-up of generating capacity, including both coal and nuclear, will be reaching the end of its life shortly after the turn of the century and will have to be replaced by new generating capacity. Meanwhile, any growth in electricity demand, as is still forecast by the Electricity Council and the CEGB, will accelerate the time when new plant will be needed, and since it takes some ten years from planning a new station until it is 'on stream', now is the time, claims the CEGB, for pressing ahead with a new station.

The CEGB has spent considerable sums of money and printed reams of information in defence of the PWR. A major part of the CEGB's case is to reassure the Nuclear Installations Inspectorate that its PWR design will be safe to operate when built; for without a licence no amount of economic justification or of need will enable the CEGB to proceed with construction. It must also be borne in mind that the licensing of the PWR, hence its supposed safety, and cost are intricately connected. One reason why Walter Marshall was asked by the government to head a task force two years ago to look at PWR design was because of the CEGB's dismay at the design proposed initially by the NNC—Britain's National Nuclear Corporation. Indeed, the NNC, a consortium of engineering concerns, had come up with a PWR that was likely to cost half as much again, if not more, than PWRs being built in the United States. Within a few months the Marshall task force had agreed on a design, one that was little more than a modification of a US Westinghouse PWR. Naturally enough, the cost of such a PWR would be considerably less than the NNC's, but the debate is now wide open as to the safety of the proposed reactor, many opponents of the PWR, including nuclear engineers from the US, France and Britain, believing that it is likely to suffer from similar generic faults as have bugged other PWRs in the world, and which particularly at Three Mile Island, and more recently at the Salem plant in New Jersey, have nearly led to catastrophic meltdown.

The Economics of Nuclear Power—
How they would like them to be

According to conventional thinking the high capital cost component of nuclear power stations should be more than offset by cheap nuclear fuel cycle costs. Thus, whereas nuclear fuel costs would comprise no more than one fifth of total generating costs, the coal used in coal-fired stations would make up more than 60 per cent of their total generating costs. In the mid 1970s, Sir John Hill, then chairman of the UKAEA,[1] stated that capital and operation charges for a coal-fired plant were 0.34 p/kWh and fuel costs 0.51, making a total of 0.85 p/kWh; while for nuclear power, the capital and operation charges were 0.41 and fuel only 0.12, making a total 40 per cent less, at 0.53 p/kWh.

In that respect, the multiple rises in fossil fuel prices after 1973 were expected to be nuclear power's proud moment, when it would surge ahead and give by far the cheaper electricity. The 'too cheap to meter syndrome' was still in play. Certainly the CEGB, in publishing its comparative generating costs during the latter part of the 1970s, gave a clear indication that nuclear power in Britain had a clear economic advantage over other thermal stations.

But, as Colin Sweet points out in his book *The Price of Nuclear Power*[2] (see book review p. 105) in reality a very different situation was developing, and instead of holding steady nuclear fuel costs were soaring at a rate that far exceeded rises in the cost of coal. To accommodate that embarrassing increase in nuclear fuel costs, the CEGB had the option either of coming clean and admitting nuclear power's dwindling competitivity, or of massaging the figures to suit general preconceptions about nuclear power's relative cheapness. Because capital as well as initial fuel expenditure had been made some years previously that component of cost, if kept in historic cost terms, would appear to diminish at a rate inverse to that of inflation. And, since the mid 1970s until the early 1980s were a period of rapidly rising inflation, all the CEGB had to do to make nuclear power's generating costs lower than those of coal-fired plant was to let the capital cost component remain as it was in historic terms so that in real terms it shrank. By the end of the 1970s the capital cost, inclusive of initial fuel, had become less than ten per cent of the whole, as Table 5.2, p.64 of Sweet's book shows, while nuclear fuel costs had risen to more than 90 per cent of the total. Inflation was also increasing the apparent cost of nuclear fuel through the CEGB having to put aside additional funds to cover the current cost of reprocessing the backlog of accumulated spent fuel. Hence to keep the funds adequate for reprocessing previous years' spent fuel, an interest rate must be included which is equivalent to the inflation rate. Should the real costs of reprocessing go up, as they evidently have, then the funds set aside have to be topped up still more. The combined effects of historic cost accounting and of a high inflation rate had therefore whittled away any real value in expenditures that had been made for the most part in the previous decade. Nevertheless, the Board, the UKAEA and other nuclear power advocates continued to state obdurately that the advantage of nuclear power lay in its cheap fuel costs.

By 1980, criticism of the CEGB for continuing to use historic cost accounting in presenting comparative generating costs began to mount. The Select Committee on Energy, for instance, commented that "The historic cost method used by the Board to justify past investments distorts the effect of inflation on capital costs, rendering the resultant figures highly misleading as a guide to past investment decisions and entirely useless for appraising future ones."[3]

The CEGB then rejoined that "The Board has consistently made it clear that the above calculations are not appropriate for appraising future investment decisions and that they cannot provide a comprehensive audit of past investment decisions. The figures simply show what element of the total construction and running costs of the power stations has been assigned by accepted techniques to the year under review and that they are not intended to represent a justification of past investments."

Table 5.2 Fuel cost of nuclear power as a proportion of generating costs

Year	*I CEGB generating costs*	*II CEGB Fuel and operating costs*	*III Fuel costs (col.II) as percentage of generating costs (col.I)(%)*	*IV Capital costs as proportion of generating costs (%)*
MAGNOX				
1971/2	0.43	0.15	35	65
1972/3	0.48	0.17	35	65
1973/4	0.52	0.20	38	62
1974/5	0.48	0.25	52	48
1975/6	0.67	0.41	62	38
1976/7	0.60	0.62	90	10
1977/8	0.76	0.64	85	15
1978/9	1.02	0.90	89	11
1979/80	1.30	1.19	91	9
AGR				
1981/2				
Hartlepool	2.28	0.77	34	66
Heysham I	2.31	0.77	33	67
Dungeness B	2.61	0.77	30	70
1986/7				
Heysham II	2.22	0.83	37	63

Notes: Unit of measurement for columns I and II is p/KWhr. AGR costs are in 1980 prices. Columns III and IV are based on figures given by CEGB to four decimal points (not two decimal points as used in columns I and II). Magnox fuel costs are accounting costs incurred for the years as given, but the AGR costs are future estimated costs for the lifetime of the reactor (approximately 1982-2007).
Source: CEGB Statistical Yearbook.

In the light of such a statement, it was hardly surprising that critics of the CEGB's investment strategy should wonder why the CEGB continued to publish such figures, especially since they always gave the clear advantage to nuclear power. In effect, the Board was forced, bit by bit, to come clean; first because of Government pressures that from 1980 the CEGB turn to current cost accounting, with the result that it could no longer hide behind inflation; and second because of outside criticism. Indeed outsiders who previously had been kept at arm's length from the figures making up the basis of the CEGB's comparative generating

costs were given a chance to make their own evaluations when a response to a parliamentary question yielded the CEGB's capital expenditure on its power stations—coal and nuclear—on a year by year basis.[4] An exercise, such as that performed by J.W. Jeffery and published in the CSENE Report, (*Ecologist*, Dec. 1981) to bring all historic costs up to date, including interest during construction, by using changes in the retail price index, indicated that the CEGB's nuclear power stations, whether its older Magnox, or its AGRs, were giving more expensive electricity than contemporary, and hence comparable coal-fired stations.[5]

With outsiders to the industry becoming such well-armed economic critics of the Board's investments in nuclear power, the CEGB has found it increasingly hard to fudge the statistics. Thus in its analysis of generating costs, presented during the Sizewell Inquiry, the CEGB has now admitted that its Magnox reactors have failed to date to produce cheaper electricity than have its coal-fired stations. Even on a monetary cost basis, whereby an annuity is calculated for each year's expenditure on capital and interest, using the average National Loan Fund rate applicable to the year in question, coal-fired stations come out marginally cheaper.[6]

The differences between the two, nuclear and coal, widen further once historic costs are converted to March 1982 values using the retail price index and then annuitising. With a 5 per cent real rate of return and test discount rate the CEGB estimates that Magnox is costing 3.37 p/kWh compared with coal's 2.28. Those results, given in the CEGB's Illustration II of its analysis, compare tolerably well with Professor Jeffery's estimates given in Table 4 of the CSENE Report, when those figures are updated from 1979/80 prices to March 1982, and allowance made for the alteration in lifetime introduced by the CEGB. With these corrections, the Report's figures become for coal generation costs: 2.26 p/kWh and for Magnox costs 3.32 p/kWh; the extreme closeness of the two sets of figures is, however, partly fortuitous. Meanwhile the CEGB comments that if the lifetime of its Magnox reactors is extended from 25 to 30 years, on the basis of a 5 per cent discount rate, their generating costs will be virtually the same as those of contemporary coal-fired stations. Nonetheless, in deriving such results the CEGB anticipates that inclusive coal fuel costs will increase by 22 per cent—averaged over the station's lifetime—compared with lifetime to date costs (March 1982); at the same time it expects nuclear fuel costs will rise by a mere 7 per cent on the same comparative basis.

Although the CEGB has had, belatedly, to agree with its critics, that Magnox stations have been, are and in all probability will be more expensive than coal-fired stations, it has consistently maintained that, with the exception of Dungeness B, its AGR stations will prove competitive with contemporary coal-fired stations. For the very reason that it was the first of the AGR stations to be completed, and therefore had the least onerous construction and cost overruns, Hinkley Point B is probably as close to a reference point with regard to economics of any of the AGRs. Its costs are compared with the coal-fired station Drax A. Meanwhile, the other CEGB AGRs, either coming on stream or under construction are compared with Drax B.

On a monetary cost basis, in which capital costs, as well as initial fuel and interest rates are reckoned in the money spent at the time, Hinkley Point B appears to be generating at 0.77 the cost of Drax A. On the basis of lifetime to date and bringing all the costs up to March 1982 prices before discounting and annuitising at 5 per cent, Hinkley Point B becomes more expensive to operate than Drax A; 2.92 p/kWh compared with 2.30 p/kWh. Yet, according to the CEGB, that situation is not one likely to prevail, being a result of the time taken—numbered in years—to bring Hinkley Point B up to its anticipated load factor of 54 per cent. Over its lifetime, according to Illustration IV, the CEGB expects Hinkley Point B to be cheaper to operate than Drax A, the main reason being a fall in the capital charges because of a better performance than has been achieved to date, and because inclusive nuclear fuel costs remain stationary while coal fuel costs rise to 2.02 p/kWh, an increase of 25 per cent over a lifetime of Drax A.

Even greater rises in coal fuel costs are expected during the lifetime of the second half of Drax, the B station. Indeed, compared to a present fuel cost for Drax A of 1.59 p/kWh, the lifetime fuel cost of Drax B is estimated at 2.40 p/kWh; a rise in real terms of 51 per cent. That increase is consistent with the arguments presented in the CEGB's statement of case for Sizewell Inquiry, and is a prime reason why future nuclear power stations appear to give cheaper generating costs than do coal fired stations. Thus, in Illustration V of its generating cost analysis, the CEGB gives the results of its comparative lifetime costs for power stations under construction; only Dungeness B with generating costs of 4.18 p/kWh appears to be more expensive than Drax B with generating costs of 3.38 p/kWh.

Systems Analysis—Net Effective Cost

Another way to look at the costs of new or proposed power stations is by calculating their net effective cost—NEC. On the basis that the assumptions concerning capital cost, construction time, and hence interest during construction, lifetime performance, fuel and operating costs are correctly estimated, the NEC indicates whether the introduction of the new station will lead to overall savings during its lifetime or to added costs. The savings come from the displacement of other stations either from their position in the merit order or entirely from the system. Thus older stations may have poorer thermal efficiencies and their displacement through the bringing on stream of new capacity will lead to fuel lifetime savings. In that regard a new coal-fired station may operate with a thermal efficiency of 35 per cent compared with less than 30 per cent for an older coal-fired station. Or the new power station may have much lower fuel costs, that being the assumption for nuclear power stations. Thus, in general the savings are made from pushing out stations at the margins of the overall system where operating costs are highest. By the same token, as more new plant is brought on stream, so the number of older plants with relatively poor operating efficiencies

diminishes and the savings become increasingly difficult to achieve. By that logic the addition of new nuclear power stations in a large programme, such as that proposed by the government in 1979, will show a gradual reduction in the savings achieved as each new unit is brought in, and there will come a time when more nuclear power leads to additional costs, rather than to further savings.

In Illustration VI, the CEGB gives its estimations of NECs for its AGRs other than Hinkley Point B, and compares those NECs with that for Drax B. A negative NEC indicates that savings are likely when the station concerned is integrated into the generating system; a positive NEC indicates potential losses. Nevertheless, the CEGB estimates that the net avoidable cost of retaining the least efficient plant on the system is +£16/kW p.a. during the 1980s and +£14/kW p.a. during the 1990s. Since by its reckoning Hartlepool, Heysham I and II have NECs lying between +6 and −6 they are borderline cases with regard to the Board saving money compared with keeping old plant in operation. Drax B appears to be even more marginal, with a NEC of +14. Dungeness B meanwhile has a NEC of +56.

CEGB prejudices the Results

As we pointed out in the CSENE report, the assumptions used by the CEGB in calculating its NECs in general favour nuclear power at the expense of coal-fired generation. An increase in coal fuel costs in the early years after commissioning a nuclear reactor will have a far greater impact on the savings side because of the present value of coal displaced than an equivalent increase that takes place further away in time from the commissioning date, or one that is spread out more evenly over a given period. In all its calculations on the economic benefits of nuclear power, the CEGB has assumed that coal prices will increase substantially before 2000.

Ironically the first indications of such an assumption of increasing coal costs came when the Board was successfully negotiating the 'understanding' with the National Coal Board for prices to remain stable in return for its commitment to take 75 million tonnes per annum. Furthermore the anticipated higher cost of coal was used by the Board when presenting its Net Effective Cost calculations for the first time for public consumption in its 1979/80 Annual Report Appendix 3. Thus while the CEGB gave Drax A a fuel cost of 1.25 p/kWh in 1979/80 prices; for Drax B it assumed a coal fuel cost for its lifetime nearly double that, at 2.30 p/kWh.

For maximum effect on the savings side of nuclear power's NEC, coal costs should be assumed to increase while the effect of discounting is still minimal as it is in the first few years after commissioning. In its evidence to the Select Committee in 1980/81, the CEGB stated that it expected a coal price for 1986/87 of 178p/GJ, in March 1980 prices and that without taking account of handling charges.[7] On the basis that the thermal efficiency of a new coal-fired station, such as Drax B, is 35 per cent, then the cost of coal per kilowatt-hour comes to 1.83 p/kWh. Subtracting the handling charges of 0.06 p/kWh from the fuel price for Drax A of 1.25 p/kWh gives an actual fuel cost of 1.29 p/kWh when that is adjusted into March 1980 prices. The anticipated increase in the price of coal between March 1980 to 1986/87 is therefore 1.83/1.29 or 42 per cent, such a massive rise coming precisely in time for what was then the projected date for commissioning the first PWR and moreover when the understanding with the NCB was in force.[8] In figure 3 of his *Energy Policy* paper—The Real Cost of Nuclear Electricity in the UK—(June 1982) Jeffery shows graphically the consequences of a sudden sharp rise in the price of coal prior to any PWR commissioning. Thus according to his calculations to obtain the same total present value savings as results from a 40 per cent coal price rise prior to commissioning a PWR is equivalent to a trebling of coal fuel prices over 25 years of operating a PWR.

With the Inquiry now proceeding into the Sizewell PWR, the Board has had to postpone the projected commissioning date until at the very earliest 1990/91. Since the understanding with the NCB will run until 1986 and may well be extended at even more favourable terms the Board has naturally had to push into the future its projected increases in the price of coal. Nonetheless, it has by no means forgone the notion of such increases, and in its statement of case has projected rises of between 34 and 95 per cent to take place within ten years of commissioning the Sizewell B PWR.

The CEGB's *Analysis of Generation Costs* shows what the present costs are for its generating plant and what the CEGB expects them to become. We thus find the fuel cost for coal-fired stations in March 1982 values going from 1.59 p/kWh in 1981/82 to 2.02 for Drax A during its lifetime, then up to 2.40 for Drax B and reaching 2.60 p/kWh for a coal-fired station contemporary with Sizewell B. Meanwhile for nuclear power the changes are from 1.38 p/kWh (1.723 p/kWh

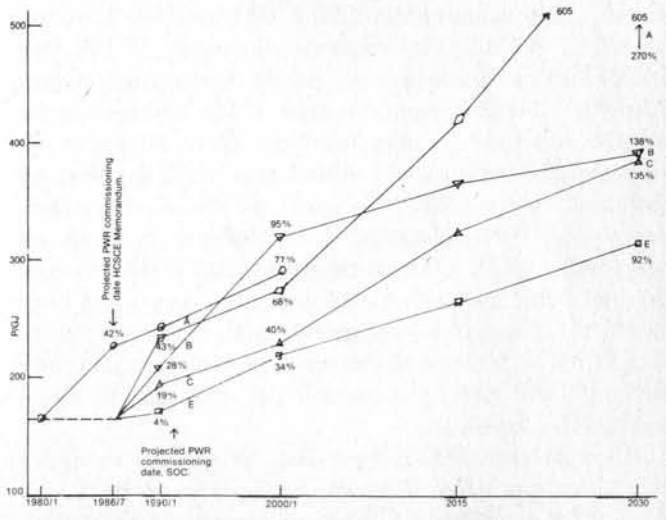


Figure 1: Future NCB coal prices assumed by CEGB for coal delivered to a Central Coal-Fired Station. March 1982 Price Levels. LH axis, coal costs in p/GJ. CEGB coal has a calorific value of approximately 24GJ/te. 100p/GJ is therefore £24/te. Time along the base, over the 40 year lifetime of a coal-fired station. Thick line—CEGB projections given to HCSCE[13] Thick dashed line—coal costs if the 'understanding' between NCB and CEGB holds until 1986/7. Thin lines—the future costs assumed by CEGB[17] for the four main scenarios (A, B, C and E). The percentage real price increases assumed, above the 1982/3 level, are given against each of the points on the graph other than those at 2015.

Each of the five Scenarios A—E, represents a different economic situation. The top ones, A—C, are growth-oriented Scenarios, while the bottom two, D and E, although termed by the Board, 'low-growth', are actually supposed to represent a shrinking economy, with E signifying instability.

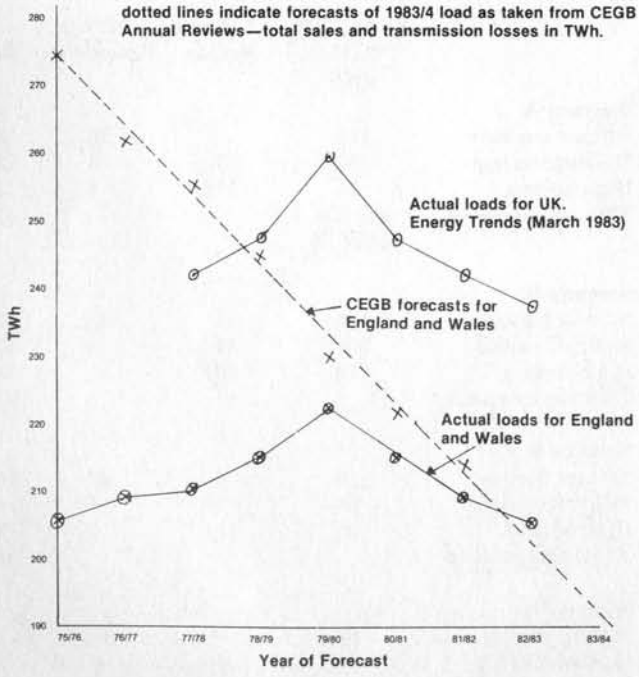
As F P Jenkin points out, the CEGB expects its "forecasts of the key economic and energy parameters" of Scenario C "to have a greater probability of occurring than those arising from Scenarios A, B and E."

Scenario C is therefore the Board's 'middle of the road' scenario and one which in the main provides the background to the CEGB's statement of case. The average projected growth in gross domestic product in Scenario C is one per cent per annum compared to 2.6 per cent for Scenarios A and B, and - 0.4 per cent for D and E. For the CEGB electricity demand is expected to rise from 225.8 TWh in 1979/80 to 325.3 TWh by 2030 in Scenario C, compared with 534.6 in Scenario B and to fall in Scenario E to 178.9 TWh.

In fact demand for electricity has been falling steadily since 1979/80[10]. Thus for the UK demand has fallen to 237.5 TWh in 1982/83 from a peak of 260 TWh in 1979/80, while for England and Wales, the area under the aegis of the CEGB, demand is down to just above 205 TWh from its peak of 225.8 TWh in 1979/80. The trend appears to be still downward, and for the last quarter — November 1982 to January 1983 — was actually down 6.2 per cent, on the same quarter one year previously, according to the Department of Energy in *Energy Trends*.

UK ENERGY DEMAND IN 2000 (PJ)

			CEGB				IIED		ERR	
	Scenario	(1979/80)	A	B	C	E	LOW	HIGH	A1	A2
	GDP (Index)	100	171	171	124	91	164	182	181	181
	Ind. Prod.	100	144	206	111	59	146	158	176	176
1	Population (m)	56.0	56.8	56.8	56.8	56.8	57.5	57.5	57.5	57.5
	Households (m)	20.3	24.7	24.0	23.7	22.7	22.2	23.1	22.2	22.2
2	Primary Energy Demand (mtce)	369	382	479	376	273	330	361	259	316
	Final Energy Demand (PJ)	6162	5813	7196	6035	4653	5608	6139	5435	6605
	Of Which Elec. (PJ)	834	1055	1298	960	696	759	836	464	606
3	Peak Elec.Demand (GW)	44.1	51.3	61.7	46.9	35.1	n/a	n/a	24.5	32.6
	Domestic Sector:									
	Final Energy Demand	1699	1519	1604	1709	1498	986	1037	792	1192
	of which Elec.	317	285	348	327	306	244	271	130	183
	Industrial Sector:									
	Final Energy Demand	2142	1773	2891	1815	981	2736	2973	2974	3461
4	of which Elec.	306	454	675	359	169	361	392	261	267
5	Comm. and Inst. Sector									
	Final Energy Demand	812	886	760	823	971	505	532	374	497
	of which Elec.	200	295	243	253	211	126	135	101	136



Studies by Gerald Leach's group at the International Institute for the Environment and Development, by the Energy Technology Support Group and by Earth Resources Research indicate that improved energy use through conservation and through implementation of energy efficient technologies will lead to a significant reduction in demand both for primary energy and for electricity, while the standard of living actually improves.

As the graph shows, the CEGBs forecasts of demand for 1983/84 have been coming down steadily since 1975/76. Indeed they have begun to approach the reality of actual demand only since 1980/81. Since its forecasts have been so widely off the mark in the past — more than 30 per cent too high in 1975/76 for 1983/84 — one must surely question whether the Board is correct in expecting Scenario C to be the most likely outcome in the years to come, with a 15 per cent rise in electricity demand by 2000 and a 44 per cent increase by 2030. Scenario B with a 137 per cent increase in electricity demand by 2030 is not a prospect that can be taken at all seriously. In fact, the Scenarios that most fit present trends appear to be D and E; thus a demand of around 190 TWh for England and Wales in 1990, as suggested for Scenario E, may well prove close to the mark.

in the CEGB's letter to Colin Sweet of December 1st, 1982) for a Magnox station in 1981/82 and 0.85 p/kWh for Hinkley Point B, shrinking to 0.88 p/kWh for Magnox stations over their lifetime and to 0.76 p/kWh for a new AGR station. The Sizewell B PWR is expected to have the lowest nuclear fuel cycle costs of all types of plant—0.58 p/kWh. Thus whereas coal fuel costs are expected to rise by 70 per cent per unit, nuclear fuel cycle costs are expected to fall by 58 per cent. It is on the basis of such estimates that the CEGB anticipates the savings that will accrue from a nuclear power programme.

What is the CEGB's justification for forecasting substantial rises in the price of coal? With regard to the present prices of NCB coal, the CEGB remarks that they have been held down only "with the help of significant and increasing deficit grants from the government" and that if such subsidies were removed, but the level of social grants were maintained, then the current pithead price would rise by more than 10 per cent. In addition, the CEGB anticipates that the NCB's costs of production will increase as the easier and nearer seams of old pits are worked out. In its evidence to the Monopolies and Mergers Commission, the CEGB told of its expectation that the government grants to the coal industry would come to a stop during the 1980s and that the NCB would therefore be forced to achieve a measure of profitability.[11] Consequently the CEGB expected the pithead price of coal would have to rise by some 4 per cent per annum from 1980 to 1987 and from then on by 2 per cent per annum until the end of the century.[12]

In his evidence P. R. Hughes of the CEGB has argued that coal will have the best future in the economic situation prevailing in a world where the recession is over and growth has once again taken off with a growth rate above 3 per cent per annum. Under those circumstances the worldwide demand for coal will be such, suggests Hughes, that prices of imported coal will rise marginally above those for NCB coal shorn of all its subsidies.[13] Furthermore, the Coal Board will have no difficulty finding the capital for new investment and in getting a reasonable rate of return. Hughes assumes 5 per cent. In Scenario A, for example, Hughes envisages NCB coal production gradually rising from its 1980/81 level of 126 million tonnes to attain 150 mt p.a. In B, with a return to fast growth, production is expected to reach 200 mt p.a. by 2030. In that scenario, the CEGB is reckoning on environmental opposition to the opening of new mines to melt away, the presumption being that the people of Britain will by then have realised that environmentalism must take second place to economic recovery and to the affluence that comes with it. While NCB coal production also reaches 150 mt p.a. in scenario C, albeit with more difficulty than in scenario A, in both scenarios D and E the British coal industry goes into decline, in E falling to half its present level by 2030 on account of lack of demand and therefore lack of investment.

The CEGB has committed itself, as far as can be gleaned from its proofs of evidence, to moving away from coal as its major fuel and turning to nuclear power. Thus, even though coal production is expected to increase in the growth scenarios, the CEGB intends not to remain coal's best customer, the notion being that coal will find other markets, including those of fuel substitution for both petroleum and natural gas, both of which will then be in decline. Thus the CEGB does not appear to be perturbed by its forecasts of the cost of coal in 2030. Indeed, if the CEGB is correct in its price forecasts, then electricity consumers will have great difficulty paying for electricity that is primarily coal-generated. On the assumption that all other costs remain the same as today, then the 2.5 times higher coal price assumed for scenarios B and C for 2030 will double the cost of electricity and the fourfold increase in coal price assumed for scenario A will triple the electricity cost.

The CEGB is therefore saying that the interests of the coal industry in Britain will be best served by the increase in demand that is concomitant with a renewal of economic growth, while simultaneously making it clear that its own intentions are to dispense with coal as far as is possible. In reality, the fortunes of the coal mining industry are highly dependent on the coal burn of the CEGB and will remain so for the foreseeable future. The following table, an abbreviated version of P.4 Table 6, shows what could happen to the CEGB coal burn should it opt for a high nuclear background. Indeed the coal burn could be as low as 3 million tonnes per annum as in scenario E and at best 19 million tonnes in the high growth scenario B. Should the trends take us to scenario E (D will be similar) then even in the no new nuclear situation, the coal burn will be no more than 63 million tonnes per annum, and hence 14 million tonnes down on the 77 million tonnes consumed by the Board in 1981/82.

As it happens, every new nuclear power station that is brought into the system increases the problems facing the coal board. Given that all the CEGB's magnox stations are again working and achieve their 1978/79 total of 21.4 TWh and that all four AGRs are

	YEAR 2030	Figures in MTCE		
	Coal incl. CHP	Nuclear	Renewables	Total
Scenario A				
No new nuclear	114	—	26	140
Medium nuclear	60	73	4	137
High nuclear	15	118	4	137
TWh requirements	see p.5 Table 50			312.8
Scenario B				
No new nuclear	186	—	47	233
Medium nuclear	103	123	4	230
High nuclear	19	207	4	230
TWh requirements				534.6
Scenario C				
No new nuclear	117	—	27	144
Medium nuclear	64	73	4	141
High nuclear	16	121	4	141
TWh requirements				325.3
Scenario E				
No new nuclear	63	—	15	78
Medium nuclear	31	43	4	78
High nuclear	3	71	4	78
TWh requirements				178.9

in operation at a 54 per cent load factor, then the total coal burn during 1983/84 may be no more than 60 million tonnes. With Heysham 2 on stream and the Sizewell B PWR then, with no growth in electricity demand, total coal burn could be down to 55 million tonnes per annum.

Since each PWR displaces some 2.7 million tonnes of coal per annum a large PWR programme of ten or more stations would spell disaster for the coal industry in Britain, and one from which it would be most unlikely to recover. Moreover large scale growth in the UK economy, at least on traditional lines, is most unlikely in the foreseeable future, and the CEGB's notion of the NCB finding new, profitable markets for coal is highly contentious. For the coal industry in Britain to have any future, it will need the CEGB to remain its main customer with a guaranteed yearly demand. In that respect, governments in Britain have for long realised the importance of the CEGB as a buyer of British coal, and in return for subsidising the NCB through deficit grants have demanded that the CEGB limit its intake of imported cheap coal.

In all probability demand for primary energy and for coal in particular will continue to fall in Britain, especially if improved technologies and conservation lead to a substantial increase in energy efficiency. The British coal industry is therefore unlikely to get any bigger; indeed a pared-down industry based on highly productive modernised mines may well produce coal that is more competitive in price with imported coal. In its own evidence at the Sizewell Inquiry, the NCB has made it clear that it disagrees fundamentally with the CEGB over the latter's projections of either NCB or world coal prices. Instead the Coal Board intends through the judicious shutting down of unproductive, costly mines and through the development of new highly automated mines to keep coal prices as stable as possible.[14]

For social reasons and to achieve the best results, continued subsidisation of the coal mining industry may well be necessary. But such an investment will be a relatively small price to pay for an industry that is wholly indigenous to Britain. Furthermore, if the coal is used in energy efficient processes such as in combined heat and power schemes, the actual level of subsidisation per unit of useful energy will fall by as much as a factor of two. In conclusion therefore, the CEGB's projections of a doubling, tripling and even a quadrupling of the price of coal, whether NCB or imported, over the next 40 years are unwarranted. Meanwhile the effect of such projections is to make coal-fired generation appear extremely expensive compared with nuclear power.

Discounting Future Costs

The CEGB's use of discounted cash flow accounting not only discriminates against coal-fired generation because of the projected sharp rise in the price of coal at the time of commissioning a new nuclear station, it also enhances the relative cheapness of nuclear power through the reverse process of discounting costs that take place beyond the lifetime of the station in question. Because of the dangers of radioactivity, whether from fission products, transuranics or activation products induced in cladding and structural material, many operations associated with nuclear power are postponed until a sufficient cooling period has elapsed during which radioisotopes with relatively short half lives will decay. Thus, in its proofs of evidence, the CEGB gives estimates of when it expects certain processes such as reprocessing, ultimate waste disposal and decommissioning to take place. The expectation is that reprocessing will take place between 40 and 50 years after commissioning the Sizewell B PWR, vitrification of the high active waste up to 60 years after commissioning, and engineered storage from then on. The reactor will be decommissioned, according to the CEGB, some 30 to 40 years after shutdown. None of those processes have yet been carried out on a full scale and the CEGB's costing is likely to be a gross underestimate. Nevertheless, the very fact of discounting at 5 per cent for periods of time of more than 80 years reduces any cost to a mere fraction of its real value: in fact the accuracy of the CEGB's estimates becomes increasingly inconsequential.

In his critique of the CEGB's statement of case for a PWR at Sizewell, Professor Jeffery has compared the full costs after commissioning with the discounted costs, using the CEGB's own figures and time schedule. As would be expected the nuclear full costs give significantly higher annual and unit generating costs than are obtained with discounted costs. However, the same is not true for coal in which the full post-commissioning costs are found to be close to the discounted costs. Thus, the full coal fuel costs averaged out over the assumed 40 year lifetime and 72 per cent lifetime load factor come to 2.99 p/kWh and £188 m/GW p.a., while the discounted costs, when annuitised over the 40 years at 5 per cent come to 2.70 p/kWh and £169 m/GW p.a. respectively. The difference between the two sets of results is therefore approximately 10 per cent.[15] For nuclear power the difference between the discounted and full costs, again using CEGB figures, is 40 per cent, and therefore a fourfold higher discrepancy than is found with coal-fired plant. In fact, because nuclear fuel costs are expected to remain stable, any costs incurred during the actual lifetime of the plant—given as 35 years—at 64 per cent load factor—will give similar results whether full or discounted. Thus the nuclear fuel costs incurred and paid for between commissioning and shutdown come to 0.54 p/kWh and 0.55 p/kWh respectively for full and discounted costs. After shutdown the picture changes dramatically and the discounted costs, including those for decommissioning the reactor, are less than one-seventh of the full costs. Since post-irradiated fuel management and decommissioning are essentially dirty jobs in that they involve waste disposal in one form or another and discharges of radioactive and chemical waste into the environment, discounting them away as the CEGB has done in its generating cost calculations has the effect of minimising their importance. The onus of dealing with any problems associated with decommissioning and the post-irradiated fuel cycle will essentially fall on future generations who will not necessarily have benefitted from nuclear power, and who may, in 60 years time, prefer that it had never been.

Back-end Costs Soar

In giving evidence to the Monopolies and Mergers Commisssion, the CEGB admitted that costs for the back-end of the fuel cycle were rising rapidly. In its Table 7.10[16] costs for reprocessing Magnox spent fuel were shown in which the 1987 cost was projected as being 10 times higher than the 1975 cost. In a letter to Colin Sweet, Director of Energy Studies at the Polytechnic of the South Bank, the CEGB gives an updated version of past, present and projected expenditure on Magnox reprocessing and associated services since 1971. The index of movement shows costs rising rapidly after 1976, and reaching a peak in 1984/85 when they are 15 times higher than in 1971/72. The costs of the Magnox fuel cycle have therefore risen to the point when they are on a par with the fuel costs of coal-fired plant, namely 1.723 p/kWh for Magnox[17] against 1.72 for coal-fired plant, as given in Illustration II of the CEGB's Analysis of Generation Costs.

		p/kWh		
		Reprocessing	**Other**	**Total**
1973/74	(HCA)	.015	.101	.116
1974/75	(HCA)	.029	.132	.161
1975/76	(HCA)	.063	.157	.220
1976/77	(HCA)	.207	.133	.340
1977/78	(HCA)	.229	.126	.355
1978/79	(HCA)	.467	.139	.606
1979/80	(CCA)	.535	.396	.931
1980/81	(CCA)	.699	.454	1.153
1981/82	(CCA)	.926	.797	1.723

Both BNFL and the CEGB claim that the high costs of the back-end of the fuel cycle are unique to spent Magnox fuel and are a consequence of problems associated with corrosion of the cladding in the cooling ponds and the need in recent years to refurbish the reprocessing plant as well as provide new treatment plants to overcome the unsatisfactorily high discharges of caesium and other fission products into the Irish Sea.

At the Windscale Inquiry of 1977, BNFL gave its estimate of the cost of building THORP—a thermal oxide reprocessing plant—for reprocessing the spent fuel of AGRs, and PWRs whether British or foreign. That estimate, some £600 million then, has been updated to £1010 million to account for inflation. Indeed according to a letter from D. G. Avery of BNFL to Colin Sweet[18] the estimated cost of reprocessing of thermal oxide fuel has not gone up in real terms since the Windscale Inquiry, when it was given as £250,000 per tonne of uranium. That amount, translated into 1982 money values, comes to £440,000/tU. Avery gives £400,000/tU, a figure which is some 10 per cent lower than the Windscale Inquiry one. Avery also points out[19] that the reprocessing charges represent full undiscounted costs; "they are only discounted when transformed by the CEGB into fuel cycle costs, at rates determined by them." Thus, on the basis[20] that the total volume of wastes produced by the PWR over its 35 year lifetime is 885.6 tonnes and that the total production of electricity is 214.55 TWh, then the full cost of reprocessing spent oxide fuel comes to $885.6 \times 4 \times 10^7 / 214.55 \times 10^9$ p/kWh = 0.165 p/kWh. Since the current cost of reprocessing Magnox fuel as indicated in Watt's letter of December 1, 1982 is 0.926 p/kWh, it would appear that the reprocessing costs for thermal oxide fuel are not more than 18 per cent of those projected for the PWR fuel. When that much lower cost is discounted at 5 per cent for 40 to 50 years back to commissioning, it reduces to virtual insignificance.

Since the purpose of giving estimates of likely lifetime generating costs of particular plant is for comparisons to be made with other types of plant, the exercise might be fairer if the operational costs, including all processes connected with fuel, and any decommissioning costs, were accounted for over a comparable period from commissioning. For instance, all post-commissioning costs could be evaluated over the expected lifetime of the plant in question. Furthermore, as we have already indicated, when such an exercise is carried out, as it has been for coal-fired plant, the differences between full costs and discounted costs tend to vanish, on account of the annuitising operation more or less counterbalancing the effects of discounting—as long as the latter is calculated over the station lifetime and not for any longer.

In France the official approach of the PEON commission has been to evaluate back-end fuel cycle costs of nuclear power by discounting for a much shorter period, the rationale being that reprocessing of spent fuel will take place three years after discharge from the reactor, and that that period should be the basis of any discounting operation. As seen from the following table,[21] only permanent storage has been discounted for any length of time—40 years—the other back-end processes being discounted at the French discount rate of 9 per cent for between 0 and 4 years. Consequently discounted costs are approximately 0.75 of full costs. The French also give a uranium and plutonium credit for such material recuperated during reprocessing. On the assumption that 10 French francs equal one pound sterling and that French inflation rates have been similar to those in Britain, the full back-end costs in France, inclusive of any credits, come to 0.19 p/kWh and the discounted costs to 0.14 p/kWh.

In P.9 Tables 8, 9 and 10 of its proof of evidence, the CEGB has given estimates of the year by year expenditure and credits from the back-end of the fuel cycle. A summary of the results indicates that the gross value, without any credits comes to £592.94m which for 885.6 tonnes equals £670,000/tonne U. That figure compares with an RPI adjusted £593,000/tonne U for France. With the credit the results are completely reversed with the French RPI adjusted figure coming out as £469,000/t U compared to £270,000/t U for the UK—all results in March 1982 values. Although the CEGB's credit is for uranium alone, the value of plutonium being ignored, it comes to just under £400,00/tonne U, which is more than three times the £124,000/tonne U credit that the French assess for uranium and plutonium combined. The reason for the massive difference between the French and British figures stems from the French evaluating the uranium and plutonium credits from present-day values of the two isotopes, while the CEGB uses uranium values

based on estimates of its price in 50 years time. In P.9 Figure 2, the CEGB shows uranium prices soaring from less than 40$/lb U_3O_8 in March 1982 values to between three and six times higher by 2030. The credits are in fact based on its estimates of uranium prices for scenario C, the assumption being that any pick-up in world economic growth will be reflected in a growth of nuclear power. Whether economic growth of any substance or of nuclear power will take place over the next half century must remain in the realm of speculation, and in the light of the present economic situation cannot be assumed. For the present, there is a glut of uranium on the market and its value has

Reprocessing Option Number of years for discounting purposes	Official figures - FRANCE Discount Factor		Gross Value F/kg	Discounted Value F/kg
Transport	0	1.0	250	250
Reprocessing and Treatment	3	0.806	4000	3224
Interim Storage	3	0.806	400	322
Permanent Storage	40	0.033	600	20
			5250	3817
Uranium credit	4	0.74	− 500	− 366
Plutonium Credit	4	0.74	− 600	− 440
			4150	3010

actually fallen in real terms from its high point reached in the mid 1970s. Under such circumstances it might be more realistic to accept the value of uranium and plutonium credits as conceded by the PEON Commission in France. Thus, the French discounted back-end fuel cycle cost of 0.14 p/kWh might be one that should more properly be used in the CEGB's calculations. In fact, by its method of discounting and using a high uranium credit, the CEGB derives a discounted back-end fuel cycle cost that is *one-fifth* of its full value; less than *one eighth* of the full French value: and less than *one-sixth* of the French discounted value.

Real Reprocessing Costs?

Readjusting the French reprocessing cost estimates to suit the discount cash flow system used by the CEGB is one way in which we might deduce a more realistic cost than that of the CEGB. Therefore assuming that reprocessing of spent PWR fuel is paid for on a year by year basis some three years after it is first discharged from the reactor, and that other costs of vitrification and disposal follow on automatically, we can carry out a discounting operation that for the most part takes place during the reactor lifetime. At 5 per cent discount rate, the French costs of the PEON Commission amount to £178.5 million when adapted for spent fuel from the Sizewell PWR. Assuming that the Sizewell PWR maintains its 64 per cent load factor over its full 35 year lifetime, the discounted number of units at 5 per cent is 99.95 TWh; hence the levelised post-irradiated fuel cost in March 1982 values comes to $\frac{178.5}{999.5} = 0.179$ p/kWh, compared with the full cost of 0.19 p/kWh. In P.9 Table 11, of its proof of evidence, the CEGB gives its summary of nuclear fuel cycle costs for Sizewell B; thus using 0.18 p/kWh for irradiated fuel management instead of 0.05 p/kWh as given by the CEGB, the total fuel cost becomes 0.75 p/kWh rather than 0.62 p/kWh; hence 21 per cent higher.

The question then arises whether the PEON Commission's figures are a proper estimate of likely thermal oxide reprocessing costs given that no commercial thermal oxide reprocessing plant is yet in operation and that decisions concerning ultimate waste disposal have still to be made. France of all Western countries has the most experience to date with reprocessing thermal oxide fuel, having dealt with more than 350 tonnes between 1968 and 1981. The operators, COGEMA, have also achieved the lowest relative discharges of radwaste into the environment and the least operational contamination of reprocessing workers.

While applauding COGEMA for its record, the Commission Castaing—an official body—recently reported to the French Government that there would have to be substantial improvements in containment of wastes and in preventing irradiation of workers given that reprocessing throughput would be increased to accommodate the spent fuel coming from the French PWR programme and from overseas. Evaluation of the collective dose received by workers at the reprocesing works at La Hague during the years 1979-1981, when dealing with spent thermal oxide fuel, indicates that the average value was in the region of 0.15 man-rem per MW(e) year. That value should be compared with a value of 3.27 man-rem per MW(e) year achieved at the US West Valley plant while it operated between 1968 and 1971, and 1.2 man-rem per MW(e) year for Windscale between 1971 and 1975.

"In effect," the Commission concludes[22] "given the hypothesis that 4000 persons work in the two plants UP2-800 and UP3, and taking into account COGEMA's objective to obtain an average individual dose below 0.5 rem per year, the collective dose must

P9 TABLE 11. CEGB SUMMARY OF DISCOUNTED NUCLEAR FUEL CYCLE COSTS

SCENARIO C: SIZEWELL B ALONE

FUEL SUPPLY	p/kWh
INITIAL CORE	
Uranium Supply	0.02
Conversion	0.00
Enrichment	0.03
Fabrication	0.01
SUB TOTAL	0.07
REFUELS	
Uranium Supply	0.26
Conversion	0.01
Enrichment	0.18
Fabrication	0.05
SUB TOTAL	0.50
IRRADIATED FUEL MANAGEMENT	
CEGB	0.00
BNFL (incl. waste management)	0.09
Uranium & Enrichment (credits)	(0.04)
SUB TOTAL	0.05
TOTAL:	0.62

remain below 2000 man-rems per year, which corresponds to 0.04 man-rems per MW(e) year (assuming a nominal throughput of 1,600 tonnes per year of spent fuel). That result indicates that one must reduce the dose/energy relationship by a factor of 3.6. Such a reduction must be carried to 7 if the aim is to keep individual doses to no higher than the present value obtained in UP2."

Bearing in mind the need for a safe reprocessing plant, in 1979 the French Atomic Energy Commission (CEA) came up with a preliminary design for the UP3 plant which envisaged the installation of several sets of components in parallel, the purpose being to meet stringent standards for effluent outflows and for personnel protection. The project was for a reference standard plant and the cost was then estimated at 20 billion francs, or practically double the cost of the plant on which the PEON Commission based its conclusions.[23] Radiation-induced cancers are now appearing among reprocessing workers at BNFL's Sellafield plant; furthermore discharge of radioactive waste into the Irish Sea has led to the public being exposed to a collective dose in 1978 of 13,400 man-rems, and thus three times higher than the collective dose of all reprocessing workers at the site. Given greater public awareness of the dangers of radiation, and in particular of low-dose radiation, the nuclear establishment will have to demonstrate its readiness not to spare expense in designing and operating a safe plant. On such grounds we should assume that BNFL will come up with a thermal oxide reprocessing plant for which the costs are close to £2 billion. That being the case, overall irradiated fuel management costs will increase by a factor close to 2.0. Thus, we can expect irradiated fuel management costs to be 0.35 p/kWh and total discounted fuel cycle costs to be 0.92 p/kWh; hence 50 per cent higher than those given by the CEGB.

In essence, therefore, we can claim that in its determination to present the economic case for a PWR in the best possible light, the CEGB has overestimated the future price of coal at a time when it will have maximum effect on the Net Effective Cost savings of a new nuclear power station; and has discounted away both nuclear fuel cycle costs and decommissioning costs. To compound the effect the CEGB has probably underestimated all back-end nuclear fuel cycle costs, which, given a reasonable credit of uranium and plutonium, are at the very least likely to be seven times higher than it indicates in its proofs of evidence.

Indeed, as Professor Jeffery and other critics have shown, including the Electricity Consumers Council, the CEGB appears to have weighted its assumptions so that whenever possible, they favour its case. On the savings side, for example, the operation of Sizewell B will lead to less fossil fuel being consumed, assuming that overall demand for electricity remains the same. As we pointed out earlier, those savings will be increased by a judicious rise in the price of coal either just before or soon after commissioning the PWR when its present value is high. However, not content with that, the CEGB has decided that the coal saved will be at high marginal cost. Yet the Board is now negotiating with the CEGB to pay less for marginal coal from the NCB rather than more. According to Jeffery's calculations, the CEGB has used a marginal coal cost some 18 per cent higher than its uses in calculating the fuel cost of a new coal-fired station. In addition the CEGB has some 12 GW of oil-fired stations, 10 GW of which are modern and either recently commissioned or still under construction. Because of the high escalation in the price of oil after 1973, coincident with the period of construction, the CEGB decided all its oil-fired stations would have to operate at very low load factors, if at all. It does have the option of converting oil-fired plant to burn coal, and apparently intends to convert 1 GW of older plant that was originally coal-burning as well as 1 GW of the new plant. The remainder it will keep for oil-burning or will mothball.

Again it is to the CEGB's advantage in calculating the NEC of Sizewell B to retain some oil burning capacity. In a letter to Jeffery, the CEGB points out that it expects Sizewell B to make savings totalling 2.7 million tonnes of coal equivalent p.a. of which more than 40 per cent in the early years is for oil. By 2005 the amount of oil saved will have fallen according to its projections to less than 4 per cent of the whole indicating that oil-burning generation has been almost eliminated from the system. Since the oil price, as projected by the CEGB between 1990 and 2004, is more than double the price of equivalent quantities of energy from coal, and that saving in oil takes place during the first crucial years of operating Sizewell B, clearly the CEGB is squeezing as much benefit as possible for its nuclear NEC.

In his own calculation, using a coal cost that accords with the CEGB's data in its Statement of Case, Jeffery shows that the discounted savings for the oil and coal saved by Sizewell B amount to £188/kW p.a. The CEGB using a marginal coal price 18 per cent higher derives overall savings of £221/kW p.a. The NEC for Sizewell B is therefore £33/kW p.a. better than it would be if the coal saved were at the standard price used elsewhere by the CEGB in its calculations. Meanwhile, should the conversion of oil-burning to coal proceed rapidly and the oil-burn be reduced to zero so that the introduction of Sizewell B saved only on coal, then, according to Jeffery, the discounted savings would amount to £155/kW p.a. and thus £66/kW p.a. less than the £221/kW p.a. given by the CEGB. Such a change alone make Sizewell B's NEC go from −£83/kW p.a. to−£17/kW p.a.

The NEC for Sizewell B deteriorates still further if the price of coal does not increase at the rate projected. In two additional calculations, Jeffery shows that a) if coal prices remain constant from 1980 in real terms, then the savings are no more than £100/kW p.a. and the B station's NEC is +£38/kW p.a., and b) if they remain constant until 1990 and then increase linearly by one per cent per annum, the savings amount to £113/kW p.a. and the NEC is +£25/kW p.a. Under such circumstances—and coal remaining stable in price until 1990 is a firm possibility given the NCB's willingness to come to such an 'understanding'—then Sizewell B would lose £25 x 1.11 million p.a. over 35 years. The total loss compared to the Net Avoidable Cost of

retaining older plant at +£16/kW p.a. would be £350 million.

The break-even point for Sizewell B when the NEC is zero comes when the savings are £138/kW p.a. Since the 1980/81 price of delivered coal—164 p/GJ—gives rise to savings of £100/kW p.a. then a zero NEC would result from a constant coal price of 164 x 138/100 = 226 p/GJ. "Thus," says Jeffery, "if one assumes rising costs until they reach 226 p/GJ, the station would be making a loss. For NCB coal delivered to a central station in Scenario C (figure 1) this does not occur until 1999. Thus, even on the extraordinarily favourable assumptions in CEGB's case, if Sizewell B were built, it would lose money until well into the next century (since the early losses would have to be made good after 2000 before an overall profit began to be made—always provided coal costs continued to rise as predicted)."

Various critics of the CEGB's case for Sizewell B have questioned the sensitivities of the basic assumptions employed. The capital cost component as well as construction time in particular have come under scrutiny in view of the CEGB's poor record with the AGRs. The load factor and availability on design rating assumed by the CEGB for Sizewell B and for a follow-up programme of PWRs, have also been queried in the light of operating experience elsewhere in the world.

AGR Costs Balloon

An original estimate for Dungeness B, for example, made in 1965, suggested a total capital expenditure including interest during construction of £526 million updated in March 1982 prices. *Atom* at the time of the 1965 appraisal[24] claimed that "The assessment was thorough. It is hoped that the results presented will be of value to electricity supply undertakings throughout the world." As a result of the data released in answer to parliamentary questions, the most recent being to Robin Cook, MP in March 1983, the actual costs, again in March 1982 prices, up until March 1983, including future estimates of work required to completion, indicate a cost of £2144 million; hence more than a fourfold increase. Even estimates as recent as March 1980 of the cost of completing Dungeness B have been below actual expenditure since that date by 94 per cent. For Hartlepool the original estimate of capital and IDC turned out to be three times too low. The best result was for Hinkley Point B, but even for that station actual expenditure was 60 per cent higher than originally estimated. In view of such results, and making the assumption that the CEGB will improve significantly on its previous record, Jeffery has tested the effect on NEC of a +30 per cent and +50 per cent increase on capital costs including interest during construction.

With regard to load factor, relevant US experience based on stations with lifetimes to date of no more than eight years, gives a value of 58 per cent. In France, where initial expectations were for load factors averaging 75 per cent over the 20-year lifetime of its PWRs, operating experience, and in particular growing problems with steam generators as well as other vital plant components such as the guides for the control rods are resulting in outages and an average load factor closer to 60 per cent. Indeed, because of breakdown, the addition of several new stations to the network in 1982 barely led to any increase in electricity production. To be on the safe side Jeffery has assumed a lifetime load factor over 35 years of 56 per cent.

At the same time, he argues that a fair comparison between coal-fired generation and nuclear power can result only if both plants are compared while on base load. Therefore, instead of the 72 per cent load factor assumed by the CEGB for a new coal-fired station, he takes 78 per cent as more reasonable, since that was the average over the past four years of the top five CEGB coal stations.

As a consequence of those alterations, the NEC fuel costs and savings must be multiplied by the ratio of the two load factors; hence 56/64 for nuclear power and 78/72 for coal. Thus, while nuclear fuel costs will fall, the decrease in fossil fuel savings will be far greater, thereby increasing the NEC significantly.

The CEGB has probably been optimistic too, in choosing a 35 year lifetime for the PWR and Jeffery has looked at changes to the NEC brought about by a shorter lifetime of 30 and 25 years. Decommissioning is another cost which could vary over a wide range. The CEGB has given an upper figure for decommissioning of 20 per cent of initial construction cost, but has reduced that to one-tenth of its original value through discounting from more than half a century beyond the

time of commissioning. Since BNFL uses a figure of 40 per cent of initial construction cost for the decommissioning of its installations, Jeffery has used values of 40 and 50 per cent. He has also tested sensitivities of +30 and 50 per cent on the costs assumed by the CEGB for back-end processes. Nevertheless, as pointed out earlier, a more reasonable way to evaluate both decommissioning and back-end fuel costs would be to discount over the reactor lifetime rather than into the distant future. Back-end fuel costs would, under such circumstances, be more than 100 per cent higher. In fact, using the French figures, which we assume to be closer to the mark than used by the CEGB, the actual increase on the CEGB's NEC figures for the back-end would be 260 per cent higher. Should the more expensive reprocessing plant be built in order to satisfy public and trade union demands for a 'safe' plant, then the increase in back-end costs would be 600 per cent higher.

A summary of the changes to the Net Effective Cost brought about by incorporating alterations to the CEGB's assumptions is as follows; and is basically obtained from Professor Jeffery's Table 3 of his critique of the CEGB's Statement of Case:

1) NEC derived from costs (discounted) as given by the CEGB P4, Table 14, p.80.

	COAL		NUCLEAR	
	£/kW p.a.	p/kWh	£/kW p.a.	p/kWh
Capital	50	0.79	91	1.62
Decommissioning	0	0	1	0.02
Other	10	0.16	10	0.18
Fuel	177	2.81	36	0.64
Total	237	3.76	138	2.46
Savings	−216		−221	
NEC	+ 21		− 83	

2) The CEGB's savings figures have been altered by assuming that all fuel saved is coal, and not a mixture of coal and oil; furthermore the price of coal saved is taken as the same as that of a coal-fired station instead of a much higher marginal price. More probable load factors are used and corrections made to both fuel costs and savings. Jeffery has also made adjustments (minor) to capital costs, and decommissioning; larger adjustments have been made to other costs.

Capital	49	0.72	92	1.88
Decommissioning	0	0	1	0.02
Other	5	0.07	16	0.33
Fuel	187	2.74	33	0.67
Total	241	3.53	142	2.89
Savings	−188		−136	
NEC	+ 53		+ 6	

3) As 2) but with lower coal price increases and 4) with 0% increase in coal price.

	COAL £/kW pa		NUCLEAR £/kW pa	
	3)	4)	3)	4)
Capital	49	49	92	92
Decom.	0	0	1	1
Other	5	5	16	16
Fuel	138	121	33	33
Total	192	175	142	142
Savings	−138	−121	− 99	− 88
NEC	+ 54	+ 54	+ 43	+ 54

5) In this calculation the conditions of 3) are assumed but with 30 per cent increases in both capital costs and in the back-end fuel cycle. Decommissioning is increased to 40 per cent of construction costs. Nuclear NEC becomes higher than that of coal.

In 6) the three increased values go up to 50 per cent.

	5)	6)	5)	6)
Capital	64	74	120	138
Decom.	0	0	1	1
Other	5	5	16	16
Fuel	138	138	35	36
Total	207	217	172	191
Savings	−138	−138	− 99	− 99
NEC	+ 71	+ 79	+ 73	+ 92

7) The conditions here are the same as in 3) except that the French back-end cycle figures are used and are discounted at 5 per cent over the station lifetime. Decommissioning too is similarly discounted, the 40 per cent figure being used i.e. £300m.

	Coal	Nuclear	
		Back-end cost 0.18/kWh	Back-end cost 0.35/kWh
Capital	49	92	92
Decom.	0	9	9
Other	/	−(	−(
Fuel	138	40	49
Total	192	157	166
Savings	−138	− 99	− 99
NEC	+ 54	+ 58	+ 67

The increases in the capital costs as in 6) would add +25 to the NEC of coal and +46 to that of the PWR taking both Nuclear NECs above +100. Under such circumstances the losses made by building the PWR would be £4 billion over its lifetime.

In conclusion we can say that on the basis of reasonable assumptions concerning likely increases in the cost of fuel, both coal and nuclear, likely performance, and capital costs, neither a new coal-fired station nor a PWR (the CEGB claims that the PWR will be cheaper than an AGR) will lead to savings. Rather, according to our calculations, both new plants will lead to substantial losses if integrated into the present generating system, and perforce must give rise to real price increases in the cost of electricity. While there might be some capital and operating savings from embarking on a PWR programme, rather than a single one-off PWR 'learning curve' any gains will be counterbalanced by diminishing savings on coal saved.

Given the present generating capacity surplus and little sign of any growth in demand, the building of any new power station in advance of need would be a gross extravagance. In essence the respite offered to the CEGB and to the government by the surplus capacity—increasing all the time because of the newly completed AGRs, oil-fired stations and nigh completed Drax B—should be used to make a thorough study of the best options available. Refurbishing older plant is one such option, developing CHP schemes another, as is an investigation of the possibility of using renewable energy sources, including wind and tidal.

The conventional coal-fired station, as we have seen, is likely to be marginally cheaper to build and operate than the Sizewell B PWR under the conditions of scenario C. However, the potential of large power stations to bring about such phenomena as acid rain must be taken into account. Consequently either refurbished coal-fired plant or new coal-fired stations should employ technology for pollution control. The

CEGB has suggested that the retrofitting of flue gas desulphurisation will add at least 20 per cent to the running costs of a coal-fired plant. But as many have pointed out, other technologies for controlling acid gases, such as fluidised bed combustion, can bring about significant control but without any loss in the thermal efficiency of the plant. It is on such lines that the Department of Energy and the CEGB should be working. Coal is an important fuel in Britain, and should remain so. To have it ousted by nuclear power would be economic nonsense—aside from the dangers to society of a technology that is surrounded by such fearful uncertainty.

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Mike Bradstock

ANTARCTICA: The Last Continent faces Exploitation

by Roger Wilson

". . . the world would not be benefited by a country doomed by nature never once to feel the warmth of the sun's rays, but to be forever buried under everlasting snow and ice."

Were the English explorer James Cook alive today, he would most likely be astounded that this same continent, to which he referred after his circumnavigation between 1772 and 1775, should now be at the centre of an international scramble for mineral resources.

At 14 million square kilometres, Antarctica occupies a tenth of the world's land surface, and is half as large again as the United States. Of this vast area, only a tiny fraction is, however, free of the ice which overlays Antarctica to an average depth of over 1,500 metres. In places, this icecap is as much as 4,000 metres thick. Because of its weight the icecap depresses the landmass by an average of 600 metres.

Antarctica is divided roughly in two by the Transantarctic Mountains which stretch across the entire continent, pushing their way up through the ice sheet and showing only their peaks. Beneath South America, a tail-like peninsula stretches north to within 1,000 kilometres of Tierra del Fuego. Permanent ice shelves up to 250 metres thick have formed in many places along the coast of the continent, spawned by glaciers and moving constantly seaward. Great tabular icebergs regularly break off these ice shelves and drift away north. Lighter 'pack ice' surrounds most of the continent all year round, though in summer water access to parts of the coastline is possible. In winter, the pack ice expands to cover some 20 million square kilometres and the continent is cut off from the outside world.

Of all our continents, Antarctica is the coldest, driest and windiest of all, the least accessible and the least hospitable. During the winter months, there is almost total darkness. Katabatic winds, caused by cold air from the interior flowing towards the coast, may blow at speeds up to 300 kilometres per hour. Ironically, considering the amount of snow and ice on the continent, it receives very little precipitation. For example, the water equivalent of the snow precipitated at the South Pole is of the order of only 25 millimetres per year—far drier than most deserts. The blizzards that occur on the continent are usually snow being blown from one place to another.

Antarctic Exploitation

The presence of a southern continent, Terra Australis Incognita, had been suggested as long ago as the time

of the ancient Greeks. Polynesian legends, too, hinted at the presence of a frozen southern continent. French explorers in the 1700s discovered some of the sub-antarctic islands and saw icebergs floating by with rock debris on them, but were still only able to surmise the presence of a great southern continent. Cook, though he circumnavigated the continent, did not actually see it, and thus was able only to prove that, if it existed, it lay below the 60th parallel. In the early nineteenth century, the Russian explorer Thaddeus Bellingshausen also circumnavigated the continent without sighting the mainland, though he did reach within 85 kilometres of the coast.

Although it is a matter of controversy as to who was the first to sight the Antarctic mainland, it is generally assumed that it was either the American, Nathaniel Palmer, or the Briton, Edward Bransfield. Both these sealers were operating in the Antarctic Peninsula area in 1820. The first landing on the peninsula was made in 1821 by another sealer, John Davis. In the nineteenth century, colonial empires were still being assembled. The first Antarctic territorial claim was made by the French explorer Dumont d'Urville in 1840, when he claimed the Adélie Coast for France. The English explorer Sir James Ross followed suit the following year, when he claimed the Ross Sea area for Britain.

The next fifty years, however, saw little further development of Antarctic exploration. Efforts were concentrated instead on the more accessible Arctic region. Around the turn of the century, however, attention once more began to focus south, and the so-called 'Heroic Age' of exploration began.

Although in the early years of the present century there were Antarctic expeditions by Belgians, Germans, Australians, Swedes, Frenchmen and Japanese, the men who are remembered as the true heroes of polar exploration are two Britons and a Norwegian—Scott, Shackleton and Amundsen. Robert Falcon Scott made two expeditions to the continent, finally perishing in March 1912 after being beaten to the South Pole by Amundsen. Ernest Shackleton, a veteran of Scott's first expedition, launched his own in 1908-09, and reached to within 175 kilometres of the Pole. In a later expedition, Shackleton's party suffered incredible hardships when their ship was crushed in pack ice. The Norwegian Roald Amundsen was the first to reach the South Pole, just a month before Scott, in December 1911.

This 'Heroic Age' of Antarctic exploration gave way in the 1920s to the 'Mechanical Age', led by the American, Admiral Richard Byrd. Byrd was the first to introduce air transport to the Antarctic, and also in 1929 the first to overfly the South Pole. A joint expedition by Britain, Australia and New Zealand was mounted in 1929-31, and this was followed in 1938-39 by a first German expedition to Queen Maud Land, a territory claimed by Norway. There Germans conducted extensive photographic and mapping work using an aircraft launched from a support ship. The aircraft also dropped metal swastikas at intervals of 25 kilometres to give substance to any claim that Germany might decide to make.

The two South American countries which claim parts of the Antarctic launched their first expeditions in the 1940s; Argentina in 1942 and Chile in 1947. Several other expeditions took place in the late 1940s and early 1950s, and the final act in the Mechanical Age of exploration could be said to be the joint British-New Zealand expedition in the summer of 1956-57.

The Scientific Age

The real impetus to begin a much higher level of human involvement in the Antarctic came during International Geophysical Year (IGY), 1957-58. During IGY, Antarctica was singled out as one of six parts of the world deserving of special scientific attention. Twelve countries—Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, the Soviet Union, the United Kingdom and the United States—co-operated to an unprecedented degree in an effort to unlock the scientific secrets of the continent. More than 40 scientific bases were established south of the 60th parallel and many thousands of personnel were involved. In spite of the spirit of international co-operation, the first hints of rivalry between the super-powers emerged: the highly enthusiastic involvement of the Soviet Union in the programme prompted the United States to double the number of American bases opened over that originally planned.[1]

Two positive moves came as a result of the success of IGY. One was the establishment of the Scientific Committee on Antarctic Research (SCAR), which was constituted in 1958 by the International Council for Scientific Unions.[2] This organisation was made open to any country actively involved in Antarctic research, whether based on the continent or marine-oriented. The purpose of the organisation was to co-ordinate research and to assist in the exchange of results between scientists of its member countries.

The Antarctic Treaty

The other move to result from the success of IGY was the establishment of the Antarctic Treaty. The level of international co-operation during IGY had been so great that the participants were keen to see it continue. In response to an American initiative in 1958, the twelve nations began to negotiate a treaty designed to preserve the continent as an international laboratory for scientific research and to ensure that it should be used only for peaceful purposes. The agreement, known as the Antarctic Treaty, was signed in 1959 and came into effect in 1961 when it had been ratified by all the signatory states. The twelve became the original 'Consultative Parties'.

The Treaty, which was to run for at least 30 years (it may be reviewed after 1991), contained a number of important provisions. It established the continent as an area which was to be kept free of military bases, and did not allow weapons testing or military manoeuvres. It ensured the freedom of scientific investigation for all nations and allowed for the exchange of scientific information and personnel. It also established the continent as the world's first nuclear weapons-free zone, and prohibited the disposal of nuclear waste there. Most importantly, the Treaty side-stepped the extremely touchy issue of territorial claims, asserting that no activity taking place while the Treaty was in

force should "constitute a basis for asserting, supporting or denying a claim to territorial sovereignty . . . or create any rights of sovereignty . . ."[3]

That the question of sovereignty was able to be put to one side enabled the twelve countries, representing a wide range of political views, to work together. Of the twelve, seven claimed territory (Argentina, Australia, Chile, France, New Zealand, Norway and the United Kingdom). However, only Australia, France, New Zealand and the United Kingdom recognised each other's claims. The claim of the United Kingdom completely encompassed the claims of Argentina and Chile, which themselves overlapped in part. Thus a potentially very complicated political wrangle was defused, at least for the time being.

Since the signing of the Antarctic Treaty, a dozen other nations have 'acceded' to it. This means that they recognise the Treaty and adhere to its provisions, but do not have the decision making powers of a Consultative member. Poland and West Germany, however, have undertaken sufficient research work in the Antarctic and have established permanent bases there to qualify for admission by the original twelve as full Consultative members. The 'twelve' have thus become the 'fourteen'.

Every two years or so, the fourteen Antarctic Treaty nations meet in secret 'Consultative Meetings' of two weeks' duration to make decisions on the management of the continent. In addition, they have from time to time scheduled special meetings to develop policies on important issues, such as the exploitation of Antarctic marine life and minerals.

Krill

The Southern Ocean surrounding the Antarctic continent contains a rich biota, but one almost entirely dependent on a single species, the shrimp-like crustacean krill. The habitat of this species extends as far north as the Antarctic Convergence, the zone where cold polar waters meet the warmer and more saline seas from the north. The Convergence lies between about 47 degrees and 63 degrees South.

Krill form the basic building block for life in the Southern Ocean. Almost all other species in the ocean feed directly on krill, including sea birds, penguins, seals, fish, squid and baleen whales. Sperm whales feed primarily on fish and squid, but these are themselves dependent on krill. While there are other links in the food web of the Southern Ocean, where fish, squid and baleen whales feed directly on zoo-plankton, these are of less significance than the links which bind krill into the web.

Vast amounts of krill are believed to live in the Southern Ocean, though exactly how much is not known. Estimates have ranged widely, from 180 million to 1,350 million tonnes. That there should be such uncertainty underlines the fact that there is still much to learn about krill. Estimates of the total annual sustainable catch that could be made have also ranged widely, up to a high estimate of 150 million tonnes by the United Nations Food and Agriculture Organisation.

A catch such as this would have a great impact on the world supply of protein, since krill has roughly the same protein content (15 per cent) as beef steak. The upper estimates of the sustainable catch for krill are of the same order as the total world fish catch today. It may thus seem that this tiny crustacean has the potential to solve some of the world's food supply problems.

There are, however, several problems which make it unlikely that krill will be used to this end. The first is that the technology required to catch krill is likely in the foreseeable future to be available only to the developed nations. Thus the only nations which have so far embarked on a serious krill-fishing programme are the Soviet Union, Japan and Poland. Other nations which have undertaken experimental fishing include both East and West Germany, Taiwan, South Korea and Chile. None of these nations have food supply problems of any great magnitude.

Processing of krill must take place very soon after they are caught, or they begin to spoil. This means that the vessels that harvest them must also be equipped for processing, necessitating considerable investment. The harvesting season is short (during the southern summer only) and the distances from the Southern Ocean to the markets for krill are vast, making a krill-fishing venture a doubtful economic proposition. There have also been problems with the chemical composition of the product itself. In Poland, cattle fed on krill have experienced a high incidence of abortion,[4] and recent research also indicates that the level of fluorides in krill may render them unsuitable for human consumption.[5] However, krill has already found its way onto diners' plates in Japan, and in a paste form has been used in a wide variety of food products in the Soviet Union.

In view of the food potential of krill, it is important that an understanding is achieved of the likely effects of krill harvesting on the rest of the Antarctic ecosystem before large-scale harvesting begins. It is sometimes argued that, with the decline of the whale populations of the Southern Ocean, there is now a surplus of krill which was formerly eaten by the whales which can now be harvested. However, this argument ignores that there has been at the same time a growth in the seal population, and possibly also the penguin population of the ocean. Because the Southern Ocean ecosystem is almost free from outside interference at the present, it has established an ecological balance which would be disturbed by the removal of millions of tonnes of krill. The consequences for the many other species which depend on krill is a matter for conjecture.

After debating the matter for some years, however, the Antarctic Treaty nations agreed in 1980 that the management of the Southern Ocean would be based on an 'ecosystem as a whole' concept. With this approach, the effects of the exploitation of any one species in the ecosystem on all other species must be considered when deciding what species may be taken, and in what quantities.

Whales, Seals and Birds

The lure of riches to be gained from the exploitation of the seals of the Southern Ocean was one of the factors which led to much of the earliest shipping activity there. From as early as the 1780s, vast numbers of

seals were slaughtered for their skins and oil. Some species, notably the southern elephant seal and southern fur seal, were hunted to near extinction. The peaks in the fur trade were in the 1820s and the 1870s. Millions of penguins, too, were boiled down for their oil on Macquarie Island, south of Tasmania, between 1895 and 1919.[6]

The most systematic and ruthless slaughter was, however, reserved for whales. The carnage started in 1904 with shore-based stations, but the technology of whale-catching improved rapidly to the point where large factory ships slaughtered as many as tens of thousands of Antarctic whales every year. The maximum of about 46,000 was achieved in the 1938-39 summer. The blue whale, the largest animal ever to have inhabited the earth, was the most attractive target. This species was hunted to the point where very few remained by the early 1960s. With the blue whale all but eliminated, attention turned to the next down in size, the fin whale, which was also hunted to drastically reduced numbers. Following the near-demise of the fin whale, humpback, sperm and sei whales have also been the targets of whalers, and the only whale which still remains in any quantity (albeit reduced) is the small minke whale. Today's stocks of blue whales amount to only five per cent of the original levels, of humpback whales only three per cent remain, and for fin whales the figure is twenty per cent.[7]

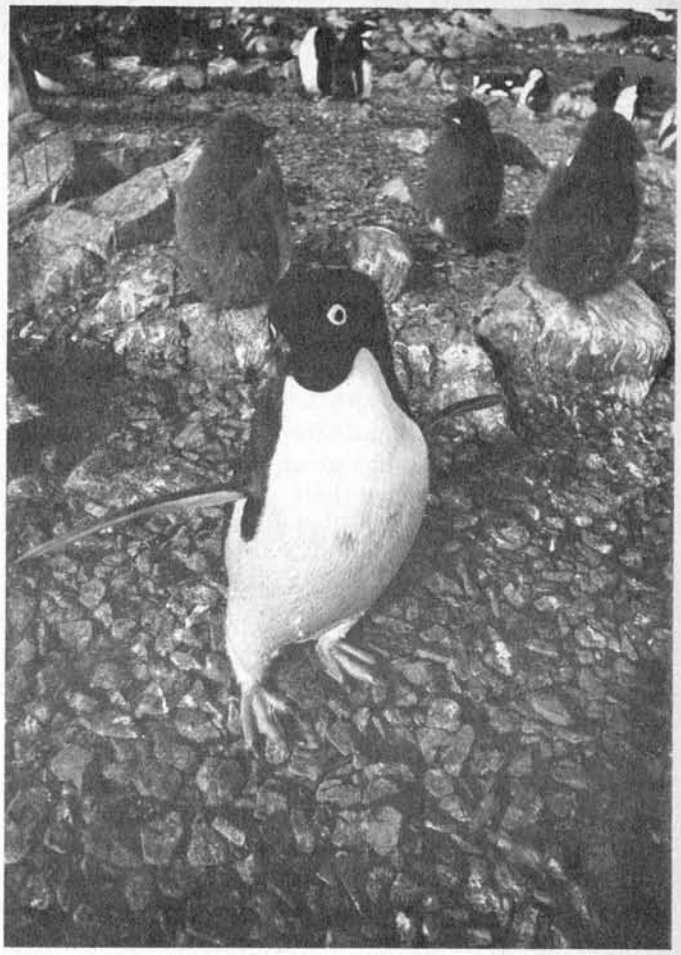
In spite of a vote by the necessary three-quarters majority to place a moratorium on commercial whaling by the 1982 meeting of the International Whaling Commission, four nations (the Soviet Union, Japan, Norway and Peru) have lodged objections to the decision which under the Commission's rules means they will not be bound by it.

It is estimated that over 100 million birds breed in the Antarctic each year. Seven major bird families spend all or part of the year in the Antarctic. The best known to most people are penguins, of which six species are represented, but there are also albatrosses, fulmars and petrels, cormorants, skuas, terns and gulls. Forty-one species are represented altogether. Penguins are by far the most numerous, representing about 85 per cent of the total bird population, and breeding in extremely large colonies that may contain as many as a quarter of a million birds.

The reason for the crowding of the penguins can be partly attributed to the fact that there are very few areas of ice-free coastline with suitable access on which they could breed. It is certain that a large increase in the level of human activity in the Antarctic would also involve the use of these same areas of ice-free coastline and seriously threaten the breeding patterns of Antarctic bird life.

Vegetation

Vegetation in the Antarctic is very sparse. More than 500 species of lichens, some of which grow to within 500 kilometres of the South Pole itself, have been identified in the Antarctic, and there are some 70 species of mosses known. However, only two species of flowering plant are recorded, in the far northern extremities of the Antarctic Peninsula, and there are no other



grasses, shrubs or herbs. As far north as Campbell Island, some 1,900 kilometres north of the Antarctic Circle, only a single example of one tree species is known.[8] Antarctic flora is very fragile, and human interference can have repercussions which may last for a very long time. A footprint in a bed of moss, for example, may remain for years. Again, increased human involvement in the Antarctic would seriously threaten the existing flora.

Antarctic Geology and Minerals

Antarctica is believed to be the centre-piece of the former super-continent of Gondwana. Nestled around the Antarctic in those times, 180 million years ago, were Australasia, the Indian subcontinent, Africa and South America. Because of the primeval proximity of these continents, some geologists speculate that there may be a continuation of the mineral riches of South Africa and South America in the Antarctic.

Mineral occurrences are known from many of the exposed areas of the Antarctic continent, though the economic feasibility of their extraction is a different matter. Coal, for example, is known to exist in very large quantities in the Transantarctic Mountains. However, it is thousands of kilometres inland, of high ash content and occurs in very thin seams. It is extremely unlikely that any attempt to mine this coal could ever be economically feasible. Iron ore, also, is known, in an area that could potentially be mined. The deposits do not, however, compare in quality or in ease

of access with other deposits in Australia, the Soviet Union or Canada.

In addition to coal and iron ore, silver, gold, cobalt, chromium, copper, manganese, molybdenum, nickel, lead, platinum, tin, titanium, uranium and zinc ores are also known. However, it is not considered likely that any but a rich deposit of platinum could even be considered exploitable for the foreseeable future.

Oil is, however, a different proposition. The proximity of the Bass Strait region (between Australia and Tasmania) to the Ross Sea area in the days of Gondwana has raised speculation about the possibilities of an oil-bearing structure similar to the Bass Strait oil field being found there. Preliminary scientific work in the Ross Sea has given promising results and it is almost certain that there will be pressure in the near future to permit a full oil exploration programme in the area.

Twenty-eight wells were drilled around the Antarctic continent by the American deep-sea research ship *Glomar Challenger* in the summer of 1972-73, including four in the Ross Sea. Three of these four gave shows of hydrocarbons, sufficient for oil company representatives to speculate wildly about the prospects for a major oil field in the area. A Gulf Oil representative stated in 1979 that the oil potential of the two most likely areas of the Ross and Weddell Seas was of the order of 50 billion barrels, or possibly more.[9] By way of comparison, the Alaskan North Slope oil field is believed to contain around eight billion barrels.

Oil companies are quick to assure the public that oil exploitation in the Antarctic is several decades away, at least. The technology, they claim, for such a venture in one of the most hazardous climates known has not yet been developed. Considerable experience is now being gained in the frozen wastes of the Canadian Arctic, however, much of which will have applications in the Antarctic if a full scale oil search begins there. While conditions are far from identical, there are many similarities.

The possibility that oil exploitation might actually occur in the Antarctic is disturbing. The main risk to the Antarctic environment would be the chance of an oil spillage of some kind which would lead to gross pollution of the sea and shore. Perhaps the worst eventuality of all is that a blowout might occur in an Antarctic oil well at the end of the summer drilling season. In this case, efforts to drill a relief well might be thwarted by the reforming of the sea ice and the onset of winter. Oil would gush from the blowout, beneath the ice, for perhaps as long as six months before a relief well could be drilled or the blowout capped.

Giant tankers, most probably of the order of 250,000 tonnes or more, would be required to transport oil away from the Antarctic. These tankers would have the ever-present risk of collision with icebergs to contend with. Antarctic icebergs are unlike those of the Northern Hemisphere, breaking off from the edges of the ice shelves as they do. They have a very deep draught, and even in water depths of 500 metres the possibility of an iceberg scouring the sea floor and damaging a well head cannot be ruled out. To guard against this, the well heads would have to be sunk deep onto the sea floor, further complicating the process of oil production.

The consequences of a major oil spill in the Antarctic can only be guessed at. The chances of being able to counter effectively such a spill and prevent it from reaching the coast would be minimal, given the extremely hostile Antarctic environment. Pollution of the rocky shoreline could bring the oil directly into contact with penguin colonies. Even if the colonies themselves remained free of pollution, it is possible that an oil spill could effectively cut a colony off from its access to the sea. So quite apart from the prospect of directly fouling the birds, there is a strong likelihood that a spill would interfere with their breeding patterns.

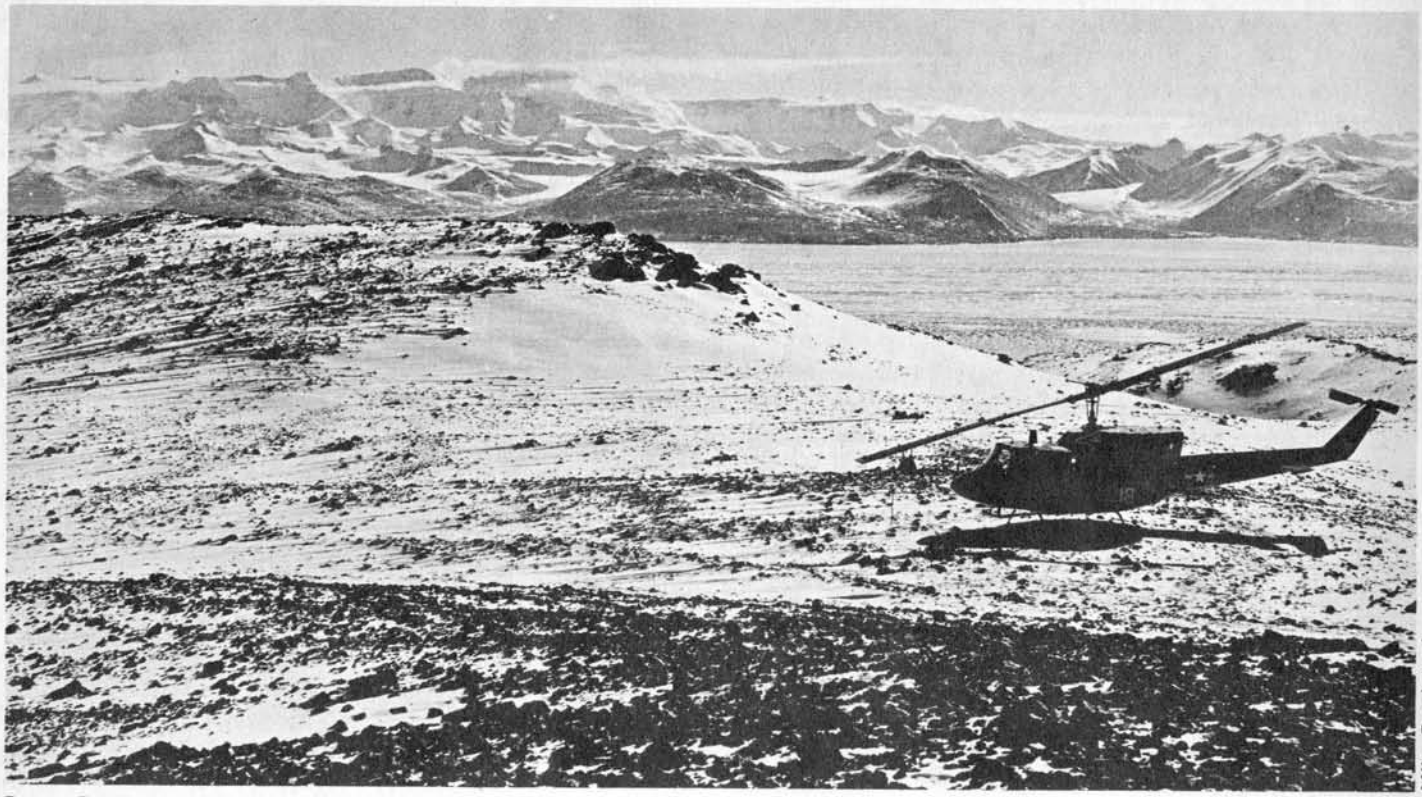
Once oil was released into the Antarctic environment, it is also unclear how long it would remain there. Because of the extremely low temperatures, the oil would take a very long time to degrade, and the more volatile constituents much longer to evaporate. Oil that was still close to the continent at the end of summer would get bound up in the pack ice, and could change the ice's colour sufficiently to affect its melting behaviour. Because pack ice is an important factor in determining the climate of the Southern Hemisphere, it is even conceivable that weather patterns hundreds of kilometres away, or further, might be affected.

Though the effect of a spill on Antarctic pack ice is unknown, an experiment was conducted in the Arctic in which a barrel of oil was emptied onto ice. Within a fortnight, over 1,800 cubic metres of ice had been discoloured as the oil seeped its way through microscopic cracks.[10]

Exploration or Science?

The very real interest shown in the possibility of a major oil field being located off the Antarctic coast now brings problems in the definition of exactly what constitutes 'science' and what constitutes 'mineral exploration'. The need for clarity of definition occurs because of an agreement made by the Antarctic Treaty nations in 1977 that ". . . pending the timely adoption of agreed solutions pertaining to exploration and exploitation of mineral resources no activity shall be conducted to explore or exploit such resources".[11]

The matter came to a head during the Antarctic Treaty nations' special meeting on Antarctic mineral resources in Wellington, New Zealand, in January 1983. Environmentalists charged that the Japanese seismic survey ship *Hakurei Maru*, then provisioning in New Zealand, was undertaking commercial exploration in the Antarctic under the guise of science. The



Mike Bradstock

Brown Peninsula summit, McMurdo Sound

environmentalists alleged a flagrant contravention of the 1977 agreement. They particularly emphasised that the ship was owned by the Metal Mining Agency of Japan, and was under charter to the Japan Agency for Natural Resources and Energy. On board were scientists from the Japan National Oil Corporation.[12]

The 1982-83 season's seismic survey programme was the third consecutive season that the *Hakurei Maru* had conducted such research in the Antarctic. In the 1980-81 season it made seismic traverses in the Bellingshausen Sea and in 1981-82 in the Weddell Sea. The most recent traverses were in the Ross Sea. The three areas are widely regarded as the most promising prospects for a major oil find in the Antarctic. At the beginning of the three-year programme, the Japanese were quite open about their intentions. They justified the programme by pointing to the head start that the United States had in Antarctic oil exploration.[13] Now they insist that the despatch of the vessel to the Ross Sea was purely for the purpose of scientific survey work.[14]

The Japanese claim further that because they are prepared to release the results of their survey work in the Ross Sea (as they have with the previous survey work in the Bellingshausen and Weddell Seas) as required under the free exchange of scientific information clauses of the Antarctic Treaty, then other nations have no cause for complaint. If the work did have any commercial value, they assert, then they would be most reluctant to share it.

Antarctic Treaty minerals regime negotiators were reluctant to discuss the alleged Japanese transgressions of the 'commercial moratorium' policy during the Wellington meeting. To ensure discussion, an allegation of a breach of the rules would have to be formally made by one of the member nations. None of those assembled was, in the interests of unity and speedy progress toward the conclusion of a regime, prepared to take such a step.

The Japanese are not alone in having undertaken seismic survey work in the Antarctic region. France, Norway, the United States, Australia and West Germany have all conducted similar studies. The problem of definition lies in the fact that the work is also of use to scientists in learning about the geology of the continent. The commercial applications are, however, undeniable.

Human Interference and Pollution

One of the great advantages of the Antarctic to scientists in some disciplines is that it is a corner of the world that is virtually free of pollution. Baseline studies can be conducted there which cannot be conducted anywhere else with the same accuracy. Even there, however, pollutants from the rest of the world are starting to be detected. While ice that was formed prior to 1940 appears to be free of lead, that laid down since, does contain detectable levels. Pesticide residues, too, including DDT, have been detected in Antarctic wildlife.

Year-round habitation by about 700 personnel, growing to 5,000 in the summer season has, however, left its mark on the Antarctic. In the early years of the Scientific Age, an inadequate understanding of the fragility of the Antarctic ecosystem resulted in decisions which would never be taken today. One such was the decision by United States and New Zealand authorities to build a base at Cape Hallett, in the middle of a penguin colony. The area around the base was fenced to physically prevent the penguins from returning to their habitual nesting sites. The base has since been closed and the area designated a 'Specially Protected Area'.

Even today, however, Antarctic wildlife does not

have complete protection from direct human interference. A current example is at the French base Dumont d'Urville, where construction has started on an 1,100 metre airstrip to allow a direct air link with Hobart, Tasmania. Using air transport, France hopes to lengthen the effective summer season from two months to five months. The project involves levelling a series of five islands in the Pointe Géologie Archipelago. The spoil thus removed will be pushed into the sea to fill the channels between the islands.

Of particular concern is the alignment of the runway, which passes very close to a breeding colony of Emperor penguins. The Emperor is Antarctica's rarest penguin, and there is no other colony on the continent which is as close to a base, permitting ease of access and study. The runway alignment chosen will cut off the paths used by 95 per cent of the colony's penguins on their way to their nesting sites.[15] Scientists cannot predict whether the penguins will be able to find another way to their sites, and if they cannot find a way some of the birds may cease to breed there. At the time of its discovery, 12,000 birds of reproductive age frequented the area; no more than 7,000 breed there now. A further diminution of numbers in the colony may result from this project.

France justifies the airstrip by claiming that it would facilitate scientific work in the area, including the study of the birdlife. The irony of this is not lost on some scientists. "We do not question the value of an air service to Adélie Land," says one. "But it would be paradoxical if the maintenance of the Ile des Petrels base (Dumont d'Urville), established in the interests of ornithology, involved even the partial destruction of the very ecosystems it was endeavouring to study."[16]

Gross interference in Antarctic ecological systems of this nature is not the only impact for which humans have been responsible in the last 25 years, however. Some of the bases themselves leave much to be desired in that waste materials are simply dumped, rather than being removed. An extreme example of this, fortunately now discontinued, was the practice of the Americans at their McMurdo base of driving unwanted vehicles out onto the sea ice just before the summer thaw. When the ice melted, the vehicles went to the bottom of McMurdo Sound.

A more subtle form of contamination of the environment has resulted from the lax use of radio-isotopes for dating purposes. It has been suggested that Lake Vanda already may have sufficient Carbon-14 residues from previous experimental work to make it impossible to obtain an accurate carbon dating of its waters.

Antarctica has also been host to a nuclear power plant. In the 1960s the United States used a small nuclear reactor to provide power for its McMurdo base. The plant was constructed in 1962 with the full euphoria of the nuclear age. United States Rear-Admiral George Dufek wrote that the plant "opens a dramatic new era in man's conquest of the remotest continent."[17] Nukey-Poo failed, however, to live up to the claims made by its supporters, and had a history of shutdowns, fire damage and radiation leakages. In 1972 it was decided to close the plant permanently and over the next six years it was dismantled and shipped back to the United States. In addition, over a hundred drums of radioactive earth, contaminated to over 200 times the US Navy's limits, was removed and sent back to the United States for disposal. Still later, a further 11,000 cubic metres of rock was removed and shipped to the United States to satisfy the Nuclear Regulatory Commission.[18]

Though Antarctica is protected against the possibility of becoming a dumping ground for nuclear debris by the Antarctic Treaty's Article V (which does not prohibit the use of nuclear power plants there), there have still been several proposals to use the continent as just such a dumping ground. The favoured procedure would be to place the hot wastes, in metal canisters, on the surface of the icecap and allow them to melt their way into the interior, to a depth of perhaps 1,500 metres. Fortunately, these ideas have so far not seriously been considered.

Conservation and Protection Measures

The world community has not been backward in drawing attention to the values for which Antarctica stands. In particular, there have been repeated calls for the continent to be designated a World Park, or registered under the World Heritage Convention. The Second World Conference on National Parks, meeting in the United States in 1972, was the first to call for the protection of World Park status to be bestowed on the Antarctic. New Zealand in 1975 went so far as to take such a proposal to that year's meeting of the Antarctic Treaty nations for formal consideration. The idea received no support from other Antarctic Treaty nations, however, and has not since been raised in that forum.

In recent years, the pressure on the Treaty nations to prevent the exploitation of the continent has intensified. The 1981 General Assembly of the IUCN passed a resolution calling for measures to be taken to enhance the status of the Antarctic environment and for the protection of the continent from harmful interference. The Antarctic was also the subject of part of the World Conservation Strategy issued in that year. Non-governmental organisations attending the meeting to commemorate the tenth anniversary of the Stockholm Conference on National Parks in 1982 backed its earlier resolution with a plea for the recognition of the Antarctic environment with an 'internationally protected area' designation. These initiatives have yet, however, to meet with any response from the Antarctic Treaty nations.

The Treaty nations have, to their credit, established a number of measures to protect aspects of the Antarctic environment. While these fall short of measures sought by conservation-minded organisations, they are nevertheless important and binding international agreements.

The Agreed Measures for the Conservation of Antarctic Flora and Fauna were drawn up in 1964, and though they have not yet come into effect (their ratification by Japan is still awaited) they have been adopted by the Treaty nations as interim guidelines. The measures prohibit the molestation in any way of any Antarctic mammal or bird without a permit, though permits are issued unilaterally by the government of any of the Treaty nations. The measures

require that harmful interference with flora and fauna should be minimised, and that pollution of inshore water should be avoided. The measures also establish the concepts of 'Specially Protected Areas', into which entry is prohibited without a permit, and 'Sites of Special Scientific Interest', in which the values that make the sites important are safeguarded.

The Convention for the Conservation of Antarctic Seals was negotiated in 1972 and came into force in 1978 when seven of the then 13 Antarctic Treaty nations had ratified it. It provides total protection for Ross seals, southern elephant seals and southern fur seals, and sets maximum quotas for crabeater seals, leopard seals and Weddell seals. There are, however, no commercial sealing operations now carried out in the area of operation of the Convention (south of 60 degrees South), and only one nation currently kills any seals at all. This is New Zealand, which takes a small number each year for food for the huskies which they maintain at their Scott Base.

The most important agreement so far entered into, however, is the Convention on the Conservation of Antarctic Marine Living Resources, which was drawn up in Canberra, Australia, in 1980. This convention has as its area of operation the biological boundary of the Antarctic marine ecosystem, the Antarctic convergence, and has adopted the novel 'ecosystem' approach. In particular, this should ensure that any large scale krill harvesting proposal will have to provide evidence that the effect on the other animals in the Antarctic food chain above krill will not be affected by the quantities taken.

The regime, still in its infancy, has been criticised for not setting even interim krill catch quotas. To some extent, this is because a consensus voting system was adopted which gave any nation the power of veto (as in the Antarctic Treaty itself). When the United States proposed a maximum catch per year of two million tonnes, this was blocked by the Soviet Union, with support from Poland and Japan. These three are the major krill-fishing nations.

The first meeting of the Commission established under the regime was held in Hobart, Tasmania, in May and June 1982. While the rules of procedure for the Commission were agreed to, negotiations over procedures for the Scientific Committee established to advise the Commission ended in deadlock. In particular, the use of vetos to prevent the tabling of information before the Scientific Committee was a contentious issue. Conservationists feared, along with some of the parties to the regime, that by use of a veto fishing nations could block information which ran counter to their own fishing interests. If this were to happen, the worth of the 'ecosystem' approach would become questionable. The Commission is next to meet in September 1983.

Mineral Negotiations

The Treaty nations began to recognise during the latter part of the 1970s that it would be very important to establish a set of rules to deal with the possibility that there could be commercially viable mineral deposits discovered in Antarctica. Since the New Zealand proposal that Antarctica should be preserved free of exploitation had been rejected, it was clear that Treaty nations envisaged such exploitation taking place at some time. The first steps to establish rules were taken at the 9th Consultative meeting of the Treaty partners, in 1977. However, it was important to ensure that no country pre-empted an agreement on exploitation. Thus, at the meeting, Recommendation IX-1 was also passed which prohibited exploration and exploitation activities while progress was being made towards a minerals regime.

The first serious meeting to discuss such a regime was held in Wellington, New Zealand, in June 1982. In spite of the fact that the war over the Falklands/Malvinas had only just concluded, both Britain and Argentina were present at the negotiations, along with the other twelve nations. Several countries tabled papers establishing their opening negotiating positions, but no firm decisions were taken. A subsequent, 'informal' meeting was held in Wellington in January 1983, and the next serious round of negotiations is due to take place in Bonn, West

Germany, in July 1983. It is known that at least one draft regime will be tabled at that meeting.

There are a number of problems which the Treaty nations must overcome before they can reach agreement on a minerals regime, not least of them the sometimes conflicting sovereignty claims of half the participants and their non-recognition by the other half. The Treaty partners refer to this aspect of an agreement as the 'internal accommodation'. Since it is extremely unlikely that either claimant states will relinquish their claims or that the non-claimants will recognise them, the successful regime will most likely avoid territorial claims altogether. Any royalties paid by a mineral exploiter in recognition of a sovereign claim would have to be agreed as a 'side deal' in exchange for that nation's support through the decision making processes of the regime.

While this is the most difficult hurdle facing the minerals negotiations, the question of how decisions are made is another which must be resolved. All decisions under the Antarctic Treaty are by consensus. The Soviet Union is keen to retain decision making by consensus in a minerals regime, a position that is totally unacceptable to the states which are most likely to be the early exploiters of Antarctic mineral wealth, the United States and Japan amongst them. The probable outcome is that consensus will apply to some decisions, but majority decision making to others.

Whatever their differences, the Treaty nations do have one thing in common—the fear that Third World nations will seek to have control of the Antarctic vested in a more representative body such as the United Nations. This fear was described by one delegate in Wellington in January as 'the engine driving the meeting'. Certainly, they take the threat seriously; after less than a year they are close to discussing a draft regime and confidently predict that a final regime may be signed before the end of 1984. Such speed in international negotiations of such complexity is virtually unknown; the Law of the Sea conference took over a decade to reach the same stage.

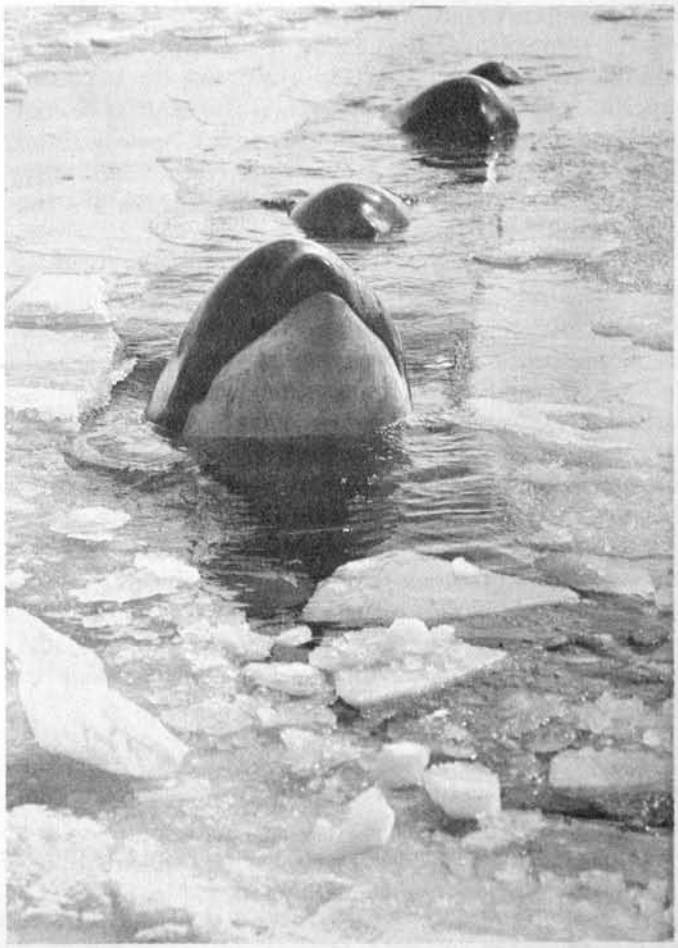
Malaysia is the country which is pressing the issue the hardest amongst Third World nations. The Prime Minister, Datuk Seri Dr Mahathir Mohamad, raised the issue during a speech to the United Nations in 1982: ". . . the day will come when Antarctica can provide the world with food and other resources for its development. It is only right that such exploitation should benefit the poor nations as much as the rich . . . While there is some merit in the (Antarctic) Treaty, it is nevertheless an agreement between a small group of countries and does not reflect the true feelings of the members of the United Nations or their just claims. A new international agreement is required so that historical episodes are not made into facts to substantiate claims."[19]

The matter was also discussed at the non-aligned nations' meeting in Delhi in March 1983. There, the proposal of the Malaysian Foreign Minister that Antarctica should be accessible to all nations and for the benefit of all mankind was included as part of the economic declaration of the meeting. The declaration urged the United Nations to take the first step by undertaking a comprehensive study on Antarctica. Malaysia hopes that the eventual result of this study will be a regime to govern the use and exploitation of Antarctic resources along similar lines to the Law of the Sea Convention.

It is likely, however, that a trio of the largest Third World nations—India, China and Brazil—will be most decisive in the Third World's efforts to broaden control of Antarctica. All three of these nations have undertaken Antarctic research in their own right in the last few years. India's first Antarctic expedition took place in the summer of 1981-82, when 'Operation Gangotri' established an automatic weather station 80 kilometres inland on the continent. China first displayed interest in the summer of 1979-80, when two Chinese scientists visited the Australian base, Casey. China has since participated with both the Australian and New Zealand research programmes.

Brazil is the third of the trio, and the only one to have acceded to the Antarctic Treaty (that is, to have recognised the treaty but without the right to participate in its meetings). After initially trying to purchase the British vessel *Endurance*, the Brazilians purchased the Danish polar vessel *Thala Dan*, and made a first voyage to the Antarctic early in 1983. Brazil's position is interesting, too, in that while it has not made a claim to Antarctic territory, it has reserved its rights to do so in a 'zone of interest' which overlaps the already overlapping claims of Britain and Argentina.

It seems likely that the issue will be raised in formal debate in the United Nations General Assembly later this year, a possibility that makes the Antarctic Treaty nations distinctly uncomfortable. They are not



so much concerned by the criticism that they may receive in that forum, but rather they fear the effect that such a debate may have on their unity. There are still many differences between the Treaty nations and they do not wish to have to air these publicly, certainly not in the United Nations. Further, they fear that the United Nations may be persuaded to set in train the development of its own minerals regime, in competition with that of the Treaty nations. With two competing regimes it would be impossible to police effectively the continent's environmental protection.

Another reason why the Treaty nations are very keen to retain control of the Antarctic is the protection against militarisation that the present treaty affords the continent. If two competing minerals regimes were concluded, the Treaty itself might be undermined, and instability result which could lead to the militarisation of the continent. The Southern Hemisphere nations which participate in the Treaty are particularly aware of the consequences for them of a militarised Antarctica.

The environmental movement is faced with a dilemma. On the one hand, justice might argue that a continent like Antarctica ought not to be under the control of fourteen of the richest nations in the world only, and that decisions regarding its future ought to be made by a far more representative body. On the other hand, statements made so far by the states which are promoting United Nations control have not indicated that they are at all concerned with the preservation of the Antarctic environment. Rather, they appear only to seek to ensure their own participation in the 'lolly scramble'. To the credit of the Treaty nations, they have all made it quite clear that the protection of the Antarctic environment will be one of the foremost considerations in evaluating a proposal to exploit Antarctic minerals. These nations claim that environmental protection in those countries which are promoting the internationalisation of the Antarctic leaves much to be desired. On the other hand, many environmentalists would argue that environmental protection procedures in the developed world also leave much to be desired.

The Antarctic Treaty nations' response to the increasing attack on it from without has been to reiterate that the Treaty remains open for any nation to accede, and that a nation which undertakes a sustained scientific programme may be granted full Consultative status and participate fully in decision making. The problem here, of course, lies in the fact that considerable investment and expertise, beyond the capabilities of most Third World nations, is required to make the scientific effort that would satisfy the existing Treaty nations' membership requirements.

An Uncertain Future

The future for the Antarctic is thus fraught with uncertainty. From an environmental point of view the exploitation of both marine and mineral resources contains the possibility, even the probability, of an ecological catastrophe. From a political point of view, the chances of reaching an agreement which is on the one hand just and on the other affords security and non-militarisation appear very slim as well.

It is in this context that the environmental movement, led by the Antarctic and Southern Ocean Coalition, has continued to promote as the best solution that the Antarctic be given protection as a permanent wilderness area. The mechanism for achieving this (establishment of a 'World Park', the registration of the continent under the World Heritage Convention or some other means) is not important. The first priority must be to ensure the protection of the continent in a way that has the blessing of all nations. If this cannot be achieved, then the existing Antarctic Treaty should be used to ensure a permanent prohibition on activities which could damage the continent.

Antarctica is the most fragile continent on Earth. It is also the only one which remains substantially in its natural state, free of the worst excesses of the human species. The exploitation of the Earth's resources must cease some time, for the resources are finite. Surely it is not too much to ask that a re-evaluation of our lifestyle and its effects on the planet that is our home should be undertaken *before* this last precious continent is destroyed?

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Traditional Agriculture in India: High Yields and No Waste

by Bharat Dogra

Today in India, as in many other developing countries with a rich agricultural tradition of their own, the words 'improved agriculture' and 'progressive agriculture' have become synonymous with the spread of HYVs (High Yielding Varieties of Crops) grown with ever-increasing doses of (often imported) chemical fertilisers and pesticides. Wherever the new crop varieties have spread, time-honoured crop rotations, inter-cropping patterns and other important features of traditional agriculture have been harshly uprooted (this choice, however, has not been made willingly by most farmers, rather it has been forced on them by a package of government policies, subsidies and selective price incentives).

At the back of this trend, and the official policies which support it, is the belief that traditional agriculture is 'backward' and incapable of meeting the desired objectives of agricultural planning, i.e. making adequate food available for the Indian masses and improving the living conditions of the peasants who constitute the overwhelming proportion of the Indian population.

But is this belief, widespread as it is among several international 'experts' and India's own development planners and policy makers, supported by hard facts?

In 1889, Dr John Augustus Voelcker, the Consulting Chemist to the Royal Agricultural Society of England, was sent by the British government to study Indian agriculture. Voelcker toured the country extensively for over one year. His report was published in 1893, and since then has often been cited as an authoritative work on Indian agriculture of this period. For instance, the Report of the Royal Commission on Agriculture (1928) said of the Voelcker Report, "Although thirty five years have elapsed since this work was written, the ability which Dr Voelcker displayed in his comprehensive survey of the agricultural conditions of India, in his analysis of problems they present and in the recommendations for their solution, still renders it a book of the utmost value to all students of agriculture in India."

How did Dr Voelcker view Indian agriculture as it existed nearly a hundred years back? Did he consider it backward and incapable of giving a good yield? The essence of what Dr Voelcker said can be summarised in the following extract from his report: "I explain that I do not share the opinions which have been expressed as to Indian Agriculture being, as a whole, primitive and backward, but I believe that in many parts there is little or nothing that can be improved, whilst where agriculture is manifestly inferior, it is more generally the result of the absence of facilities which exist in the better districts than from inherent bad systems of cultivation . . . I make bold to say that it is a much easier task to propose improvements in English agriculture than to make really valuable suggestions for that of India . . . the conviction has forced itself upon me that, taking everything together and more especially considering the conditions under which Indian crops are grown, they are wonderfully good. At his best the Indian raiyat or cultivator is quite as good as, and in some respects, the superior of, the average British farmer, while at his worst it can only be said that this state is brought about largely by an absence of facilities for improvement which is probably unequalled in any other country . . . I have remarked in earlier chapters about the general excellence of the cultivation; the crops grown here are numerous and varied, much more indeed than in England. That the cultivation should often be magnificent is not to be wondered at when it is remembered that many of the crops have been known to the raiyats for several centuries, rice is a prominent instance in point."

More especially he stated, "To take the ordinary acts of husbandry, nowhere would one find better instances of keeping land scrupulously clean from weeds, of ingenuity in device of water-raising appliances, of knowledge of soils and their capabilities as well as of the exact time to sow and to reap, as one would in Indian agriculture, and this not at its best alone, but at its ordinary level. It is wonderful, too, how much is known of rotation, the system of mixed crops and of fallowing. Certain it is that I, at least, have never seen a more perfect picture of careful cultivation, combined with hard labour, perseverence and fertility of resource, than I have seen at many of the halting places in my tour. Such are the gardens of Mahi, the fields of Nadiad and many others."

Voelcker did not believe that the existing ploughs and other implements used by the farmers were useless

and ready to be replaced, "It has been said that if the native cultivator had 'improved' ploughs he could dispense with the many ploughings which he gives to the land, and that he would thus save himself the cost of going over the field again and again, crossing and re-crossing. These ploughings are always three or four in number for ordinary crops, and eight, twelve and even as many as twenty, for sugar cane and other special crops. But the answer is that the end is achieved in time, a finer and better tilth is obtained and the moisture is not lost." Further, "If for ploughs of new designs there be but little room, still less is there for more expensive implements, such as seed-drills, mowers, reapers, threshing machines etc. The native seed drill will strike everyone who sees it at work as being wonderfully efficient, and leaving little to be desired . . . Anyone, who has watched the clever devices of the native cultivators in the implements which they use, for harrowing, levelling, drilling, raising water, etc., will see that if anything is to replace the existing implements it must be simple, cheap and effective. He will indeed be a clever man who introduces something really practical."

An important agent of traditional Indian agriculture was the well-developed irrigation system. "Irrigation by wells is at once the most widely distributed system, and also the one productive of the finest examples of careful cultivation . . . Further, as regards wells, one cannot help being struck by the skill with which a supply of water is first found by the native cultivators, then by the construction of the wells, the kinds of wells and their suitability to the surroundings and means of the people; also by the various devices for raising water, each of which has a distinct reason for its adoption. All these are most interesting points with which I am not called upon to deal, for I see little to improve in them which the cultivator does not know perfectly well."

Another aspect, less widely realised, was that of a scientific rotation system. Voelcker pointed out, "It is quite a mistake to suppose that rotation is not understood or appreciated in India. Frequently more than one crop at a time may be seen occupying the same ground but one is very apt to forget that this is really an instance of rotation being followed. It is not an infrequent practice, when drilling a cereal crop, such as jowar *(sorghum vulgare)* or some other millet, to put in at intervals a few drills of some leguminous crop, such as arhar *(cajanus Indicus)* . . .

"There are many systems in ordinary use which are far more complicated than the above. For instance, not only may there be rows of crops, side by side, as noticed above, but the alternating rows may themselves be made up of mixtures of different crops, some of them quick growing and reaped early, others of slower growth and requiring both sun and air, and thus being reaped after the former have been cleared off. Again, some are deep-rooted plants, others are surface feeders, some require the shelter of other plants and some will thrive alone. The whole system appears to be one designed to cover the bareness and consequent loss to the soil, which would result from the soil beating down upon it, and from the loss of moisture which it would incur."

Voelcker, moreover, was not the only agricultural scientist to point out these assets of traditional agriculture in India. There were several others, scientists and expert scholars, who did so. Here we quote from only two others—J. Mollison and A.O. Hume.

J. Mollison, who later became the first Inspector General of Agriculture in India, published in 1901 a volume *Text Book of Indian Agriculture.* Like Voelcker, Mollison stressed the suitability of the implements used traditionally in Indian conditions. "I believe that the implements in ordinary use are entirely suitable for the conditions of Indian agriculture. This satement may be objected to by other authorities, but if such is the case, I am afraid, I cannot change a deliberately expressed opinion. To those who are sceptical I can show in parts of the Bombay Presidency cultivation by means of indigenous tillage implements only, which in respect of neatness, thoroughness and profitableness cannot be excelled by the best gardeners or the best farmers in any part of the world. That statement I deliberately make, and am quite prepared to substantiate."

Mollison gives the following account of the practice of artificial warping in Bombay Presidency, "Artificial warping differs from the natural formation of alluvium only, in that the water of a turbid stream may be diverted from its course, and held in a particular area sufficiently long to deposit a large amount of sediment, and if the process is often repeated, a soil of considerable depth may be formed on rock or any other sterile area. Many of the small rice-fields on the Western Ghats have been formed by throwing bandheras across the turbid hill-streams and either diverting the water or allowing a small lake to form above the weir. In this way the current is so obstructed that suspended earthy matter is deposited and in time the silt layer becomes so deep that a rice-crop can be raised thereon. The lower terraced rice fields of the Ghats are annually warped and improved by the silt carried down by the drainage water of the uplands."

Speaking of the soil-mixing practices, Mollison writes, "Mixing is not unknown in India. Clay is often carted from rice-fields in sufficient quantity to add a layer one to two inches thick on sand land. The addition changes the consistence of the sand, so that it becomes better suited for sugar cane and other garden crops raised under irrigation. The cultivator appreciates the value of tank silt and in those districts where these water reservoirs are common they are cleaned out with the utmost care and regularly each year. The silt which has collected in these tanks being the washings of village sites and cultivated fields, has some manurial value, and applied as it is at the rate of 40 cart loads or more per acre, adds considerably to the body of the soil."

A.O. Hume, in *Agricultural Reform in India,* (1878) wrote about weed-control by Indian farmers at that time, "As for weeds, their wheat fields would, in this respect, shame ninety-nine hundredths of those in Europe. You may stand in some high old barrow-like village site in Upper India, and look down on all sides on one wide sea of waving wheat broken only by dark green islands of mango groves—many square miles of wheat and not a weed or blade of grass above six inches

in height to be found amongst it. What is to be spied out creeping here and there on the ground is only the growth of the last few weeks, since the corn grew too high and thick to permit the women and children to continue weeding."

Hume's tribute to the grain-storage practices of Indian farmers is no less glowing. "They are great adepts in storing grain, and will turn out of rough earthern pits, after 20 years, absolutely uninjured. They know the exact state of ripeness to which grain should be allowed to stand in different seasons; in other words under different meteorological conditions, to ensure its keeping when thus stored; and equally the length of time that, under varying atmospheric conditions, it should lie upon the open threshing floor to secure the same object."

All these statements were made in the latter part of the 19th century, but more recent research on tribal communities and other farmers following traditional methods of cultivation has also revealed several interesting facts about the assets of traditional agriculture.

Research work done during the last decade by a prominent agricultural scientist of India, Dr R.H. Richaria (former Director of Central Rice Research Institute in India) in the Chattisgarh region of the state of Madhya Pradesh has revealed the high level of skills of the farmers of remote tribal villages still untouched by the official development programmes. This scientist's travels in Bastar district, one of the most remote areas in Central India, where tribal communities still lead a life of their own, brought him into contact with farmers who were taking comparable and even larger yields from indigenous rice varieties, compared to the HYVs being spread officially in other parts of the state. Another revelation was the very large number of rice varieties being grown by the farmers, who possessed detailed knowledge of each of their properties. Some of those varieties were remarkable for their high yields, some for their supreme cooking qualities, some for their aroma, and some for other cherished qualities.

In the late seventies, Dr Richaria wrote: "A recent varietal cum agronomic survey has shown that nearly 9 per cent of the total varieties grown in MP fall under the category of high yielding types (3,705 kgs and above per hectare).

A farmer planting a rice variety called Mokdo of Bastar who adopted his own cultivation practices obtained about 3,700 to 4,700 kgs of paddy per hectare. Another rice grower of Dhamtari block (Raipur) with just one hectare of rice land, told me that he obtained about 4,400 kgs of paddy per hectare from chinnar variety, a renowned scented type, year after year with little fluctuations. He used farmyard manure supplemented at times with a low dose of nitrogen fertilisers. For low lying areas in Farasgaon Block (Bastar) a non-lodging mildly scented tall rice variety Surja with bold grains can compete with Java in yield potential at lower doses of fertilisation, according to a local grower who recently showed me his crop. During my visit to the Bastar area in the middle of November, 1975, when the harvesting of new rice crop was in full swing in that locality, I observed a field of Assam Chudi ready for

Anne Goldsmith

harvest with which the adivasi cultivator named Baldeo of the Bhatra tribe in the village Dhikonga of Jugalpur block, had entered in a crop competition. The cultivator had applied fertiliser approximately equal to 50 kg N/ha and had used no plant protection measures. He expected a yield of about 5,000 kg/ha.

In the Bichia Block of the Mandla district, Madhya Pradesh, our survey (1973-74) has indicated the following yields:

Indigenous rice variety	Yield in acre (1 bag=75 kgs)	Yield in kg/ha
1.Amar Jyoti	20	3750
2. Rani Kajar	30-35	5625-6562
3. Chattri	20	3750
4. Dubraj	20-25	3750-4687
5. Luchai	30-35	5625-6562

Dr Richaria stresses that the existing local practices of cultivation have emerged after centuries of experience, based on trial and error and have a sound basis for their wide acceptance.

While studying traditional agriculture, attention should not be focused only, or even primarily, on farming methods and on crop varieties. What is more important is the overall harmony of the traditional mixed farming system.

Traditionally, man, animals, trees (including grasslands) and agricultural fields were inseparable and harmonious components of a single system. The villager looked after the trees on his fields and also contributed to the maintenance of the community grazing land. He looked after the animals owned by him, sometimes with the assistance of a grazing hand and cultivated the fields owned by him, with or without hired labour or share croppers.

The trees provided fodder for the cattle. They also provided fuel for the villagers. The leaves that fell were put to uses beneficial to the agricultural fields. Meanwhile their soil and water conservation properties were beneficial for the villagers and contributed to maintaining the fertility of agricultural fields, as well as providing shade during the scorching summer. In addition, certain trees provided edible fruits, medicines, gum, toothpaste and a host of other com-

modities of every day use. In some villages trees were used for lac cultivation, and for raising silkworms and bees. Owing to their water conservation properties trees were also responsible in several villages for ensuring an adequate supply of drinking water.

Cattle provided milk and milk products and contributed to the nutritional content of the villagers' diet. Cattle dung provided organic fertilisers for the fields, while the poultry provided eggs and meat. The skins of dead cattle were used for making footwear and other leather products—all such activity being carried out in the village. Not least, bullocks ploughed the fields.

The fields produced foodgrains, pulses, oilseeds and vegetables for the villagers. The residues of those crops, of no direct use to man who could not eat them, were fed to the cattle. Poultry birds scavenged the wasted scattered grain.

Harmonious as the system was, disturbing a single component could have a chain effect of far-reaching consequences. For instance, if for some reason the villagers did not properly look after the community grazing lands and trees or if these were destroyed by some outside force, say a timber merchant, then soil and water conservation would inevitably suffer. The fertility of the agricultural fields would not only be directly affected but also indirectly, because shortage of timber would mean that more dung would have to be used as fuel, thereby leaving less for fertilising the fields. The next consequence would be shortage of fodder, leading to a weakening of the animals. In addition, the villagers would be gradually deprived of several commodities of everyday use, including fruits and medicines.

Over much of India, the traditional harmonious mixed farming system has been disrupted. Thus around most villages the land is eroded, agricultural yields are low, there is shortage of fuel and fodder, the bullocks are weak, and the milk yield is low.

Under such conditions it is vital that a massive tree planting programme in and around the village should be undertaken and the grazing lands be rehabilitated. Not only will such activities put agriculture and animal husbandry back on their feet, they will also help solve the problem of fuel shortage and help improve the drinking water situation.

Furthermore planners should study the numerous varieties of crops being grown in those areas, and should then make good quality seeds available to the villagers. Better field preparation and help with manuring, sowing operations, crop management and with post harvest storage will lead to better quality of crops as well as yields. All this can be done within the framework of the traditional system, that is, maintaining the essential harmony of agriculture, animal husbandry and forestry.

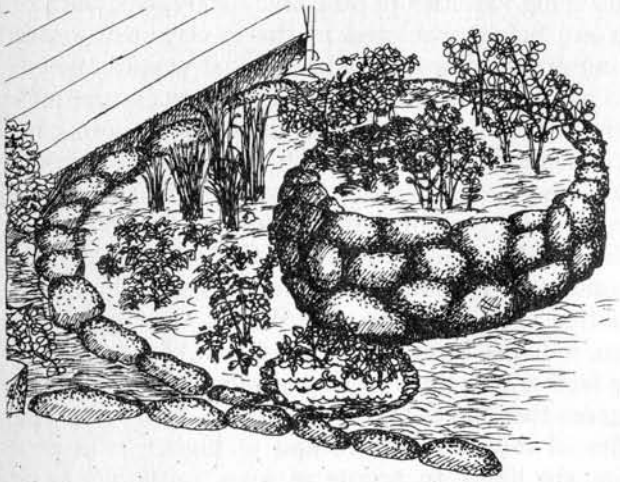
Any effort to rebuild or improve the traditional system of mixed farming must be done in a manner in which there is no conflict between agriculture, forestry, animal husbandry and the real needs of the village. It is all too easy to go against the essence of the traditional system—for instance, through planting tree species which while meeting the requirements of industry do not provide fodder to the villagers nor increase the fertility of the fields. Furthermore, breeds of cattle can be promoted which cannot thrive on crop residues but must be fed on foodgrains that before were consumed only by human beings.

Thus some varieties of pine and eucalyptus, both of which are being promoted in the government's tree planting programmes, have leaves that cannot be consumed as fodder, while their acidic properties diminish the fertility of agricultural land as well as lowering its moisture content. Moreover with certain breeds of cow that have been introduced, it becomes necessary to use village land for growing green fodder as well as coarse cereals in order to feed the cattle, thereby diminishing the availability of food in the village, even though milk production is expected to rise. Within the traditional system, milk production does not rise at the expense of losing food grains since cattle are expected to consume only green tree leaves and crop residues. Moreover, the benefits of cross-bred cows and of higher milk production are likely to accrue at least initially to the better off villagers, while the effect of decreased food production will probably be felt by the poorer sections of the community.

New agricultural technology in the form of tractors and fertilisers will again benefit the richer farmers, who will therefore be able to increase their agricultural production and cash receipts. On the other hand, their dependence on organic manure and bullocks is reduced, so that their requirement for fodder becomes less. All those factors may lead them to neglect the growth and proper maintenance of grazing lands. In fact, owing to the high value of any additional land, they may even be tempted to encroach grazing land and grow crops on it, using tractors and chemical fertilisers. In the process the rest of the village becomes worse off than before.

In recent years ambitious programmes of agriculture, dairy development and forestry have been undertaken and even more ambitious programmes will be undertaken in the near future. In view of the massive investments being made, the development planners should pause to think about the merits of the traditional system of the Indian village and the way in which the villagers made the best use of available resources with minimal wastage.

What Voelcker wrote nearly 100 years back may be valid today also: "I believe that it will be possible here and there to graft onto native practice the results of the western experience, but the main advance will come from an enquiry into native agriculture, and from the extension of the better indigenous methods to parts where they are not known or employed."



PERMACULTURE: Practical Design for Town and Country in Permanent Agriculture

by Penny Strange

Since the 1970s when Bill Mollison and his colleagues devised their 'perennial agriculture for human settlements' the idea has caught on worldwide, and people from different countries and cultures are beginning to adapt it to suit their own conditions. Last year Mollison received the Alternative Nobel Prize. In this article, Penny Strange indicates the basic principles and philosophy of permaculture as expounded in the two volumes *Permaculture One* and *Two* (1978 Tagari (ITCI) California).

Permaculture (*perma*nent agri*culture*) is an attempt to design an agricultural system that does not depend on finite resources or destroy its own base in natural resources such as water, soil and forests. It is a response to the ecological crisis brought about by deforestation, air and water pollution, desertification, and erosion.

Western agriculture, using heavy machinery and chemicals, though prized for its efficiency per worker, is extremely inefficient in terms of energy input for energy produced. As much as 15 units of energy may have to be expended to produce only six—and that before processing and transport, which themselves can account for energy equivalent up to 95 per cent of the energy value of the food, as well as bring about wastage during handling and storage. Modern farming also results in soil loss—29 tons per cultivated acre per year in a country such as Australia and even higher for crops such as sugar cane—as well as chemical pollution.

A Sustainable Agriculture

It is therefore critical that we develop a new approach to growing our food. The principles of permaculture are based on observation of natural ecosystems and on traditional polycultures. Permaculture aims to work with, not against nature, and thus establish a system that will be self-sustaining—a kind of cultivated ecosystem, based on maximum understanding and minimum interference. A sustainable agriculture has four requirements:

1) It must produce more energy than it consumes.
2) It must not destroy its own base, i.e. the soil.
3) It must meet local needs.
4) It must gain its own nutrients on site.

The natural systems which satisfy these requirements are forests and tree systems, lakes and swamps, and savannah. To these can be added no-tillage agriculture. In terms of food production for man the energy efficiency of the latter is remarkable. For example, New Guinea agriculturalists using forests, lakes, pasture and no-tillage culture consume one unit of energy to produce a net gain of at least 15 times that amount. It is by studying all such systems that permaculture has been devised.

Basic Principles

One basic principle of environmental systems is that maturity exploits immaturity and this process can be observed as mature forest trees use the resources of the grass to support their expansion over the grass. In permaculture this observation leads to a change in the usual method of reforesting an area.

Rather than planting individual trees at regular intervals with a high risk of trees dying, clumps of young trees, including pioneer species such as alder, together with companion plants such as thistle and

comfrey, are planted further apart. These trees are thus supported in establishing themselves, and once established, will spread the forest over the remaining spaces.

The stability of an ecosystem is related to its diversity, although diversity alone does not guarantee stability. Permaculture never looks at a site in terms of a single product: the purpose of the design is to fit together landscape, climate, plant and animal species, buildings, and human beings, into a stable high-yielding system. The aim is to ensure that:

1) every element has many functions
2) every function is covered in many ways

For example, chickens do not just produce eggs and meat; they also provide manure, feathers and dust. Their natural functions are scratching, moving, feeding themselves, eating pests and weeds—and the more of these functions a chicken exercises, the better for the chicken and the better for the whole system. All these natural characteristics become useful if the chickens are not isolated, but integrated with other parts of the farm. If roosting next to a greenhouse, their body heat provides warmth at night when the sun is not providing heat. They can be used in a 'chicken tractor' system, in which they are penned in a small area of garden, which they will scratch, manure and clear of pests, and then moved onto the next patch etc. Another garden use is to keep chicken in a strawyard next to the garden and throw weeds over to them: they will eat the seeds and some greens, and turn the rest into a rich mulch. Chickens are also excellent for pest control in orchards. Finally, they can forage for themselves, it is not necessary to harvest their food and bring it to them. The right mixture of tree crops and perennial plants such as comfrey will provide all the year round forage.

Meanwhile it is important to see that the glasshouse does not rely solely on chickens for night heat, but has good heat storage in water, dark walls or floor: it may also get extra winter sun by reflection from a properly placed pond. This pond may be stocked with ducks, as a second source of manure, and for pest control. Ultimately pigs can be used to harvest tree crops, and provide both manure and meat.

In permaculture, as much as possible must be known about the plant and animal species that are to be used, in order to get the best out of them. Nevertheless plant functions are not well known, and knowledge of companion planting is rudimentary. Plants are obviously good converters of solar energy into food for people and animals, some being more efficient energy traps than others. Trees are outstanding in that respect, an acre of black walnut trees being as much as 400 times more productive than an acre of wheat. Plants also provide fuel and shelter, and can modify climate. Special species can be chosen for winter insulation, or to reflect summer sun. Others are fireproof, others make good windbreaks. Some mat-rooted plants make barriers for weeds, others will keep out small animals. Certain plants will deter browsing animals from around young trees. Plants can be selected as green manure for a particular nutrient, or because their root systems support other crops or because they discourage competitors. Permaculture Associations in Australia and the US are building up computer profiles of plant and animal species to make it easier to find the species with the desired characteristics for a particular situation.

Although in design we consider all the possible functions of plants and animals, as we do with inanimate elements, trying to match functions and needs, it is an imortant principle that every living thing is an end in itself, and does not have to justify its existence in terms of human usefulness. Permaculture advocates the intensive use of the small areas of land near human settlements, and the return of large areas to wild, or managed forests. Gardens far outyield farms, and it has been calculated that if we practised intensive gardening, we could grow all we need on only two per cent of the land currently farmed. Indeed in Russia, the 96 per cent of cultivated land in the state farms produces less than 16 per cent of the food, while the 4 per cent in individual allotments yields 84 per cent.

Going with Nature

The approach taken by advocates of permaculture has been compared to practising 'aikido' on the landscape, rolling with the blows, and using everything positively. The other approach is to karate the landscape, striking hard blows to get it to yield, attacking nature and in the event sowing the seeds of our own destruction. A good example of using adversity positively is the permaculture approach to rampant species. These species are the first part of a cycle to repair damage done to an ecosystem. Rampant plant species generally have a very efficient form of photosynthesis, employing C4 photosynthesis, and lack natural disease, which make them very suitable for such a pioneering task. The plant lantana is rampant in many parts of the tropics where browsing cattle have damaged the ecosystem. Cattle do not eat it, but they eat everything else, and the lantana spreads. It begins to keep the cattle out of some areas and as its leaves drop they form a mulch, so that gradually trees, and eventually the forest, can return. Lantana does not thrive in the shade, and as the forest grows it recedes. A positive intervention is not to cut down the rampant plant, putting the cycle back, but to advance the cycle such as by planting a cucurbit which by shading and weighing down the lantana, hastens the return of the forest.

The basic practical aims of a permaculture design can be summed up briefly:

- ☐ Emphasis on perennial rather than annual crops, tree crops replacing annual crops for winter animal fodder and some human food;
- ☐ High species diversity, often with close planting;
- ☐ Combination of diverse activities: gardening, commercial farming, grazing, poultry, aquaculture, water management, tree and shrub planting;
- ☐ Use of small scale machinery and hand tools;
- ☐ Layout which minimises walking and transportation;
- ☐ Recycling of all materials;
- ☐ Use of three dimensional space—trees, shrubs, vines and low-growing plants using different levels of soil and air and increasing total yield; (see Fig. 1)

☐ Close relationship between land usage and climatic features and the location and design of buildings and their functions.

Designing

In order to design a permaculture system the site must be carefully surveyed. The aim is to derive useful storages of energy, from sun, wind, water, and if necessary to protect from their harmful aspects, such as fire, cold or storm winds, flood, erosion. Although each site will have its own design, certain general features are common to landscape types. Basic designs have not been worked out for arid lands, tropical islands and flatlands. In this article I shall concentrate on the features of a typical humid landscape.

Water

Water is of primary concern, being essential for plants and animals: yet it is also a potential agent of erosion. Figure 2 shows an idealised landscape profile, and schematic water control on it. The high plateau (A) is a gathering place for rain and snow: trees here prevent erosion and run-off, and at night water condenses on their leaves and runs down to the soil. The upper steep slopes (B) should in general not be cultivated, but forested. The trees in this area are groundwater pumps that prevent the rise of salted water to the surface downslope. They also reduce cold air flow and frost. The lower gentler slopes (C) are of most use to people for dwellings and cultivation. For the purposes of energy conservation and for cleanness, water storage should be above the settlement and cultivation area and not, as is frequently the case, pumped up from a valley dam or underground reservoirs. Water can be led to high saddle dams between ridges or to a tank at the keypoint, from which it is available to houses on the lower slopes. (The keypoint is the point at which the slope changes from the gentler concave lower slope to a high steeper and more generally convex profile.) From this point, the water can be led back and forth across the landscape by shallow diversion drains for maximum absorption. On the plains (D), water can be cheaply stored and is especially useful for aquaculture. Copses and hedgerow are needed to prevent erosion, and can be combined with no-tillage crops.

Sector Planning for Sun and Wind

Both sun and wind are important considerations in placing species and buildings in a design. The *sun sector* receives an important source of heat and plant energy, but is also a potential fire hazard in some climates and conditions, and fire protection such as water, short-grazed grass or fire-resistant plants must be provided. In cooler northern climates, water to the south of the house could usefully reflect winter sun into rooms or glasshouse. The *wind sector* may be affected by cold, or hot, dusty or salty winds. Windbreaks of suitable trees, or in some instances earth banks, should be established to protect both buildings

Fig. 1

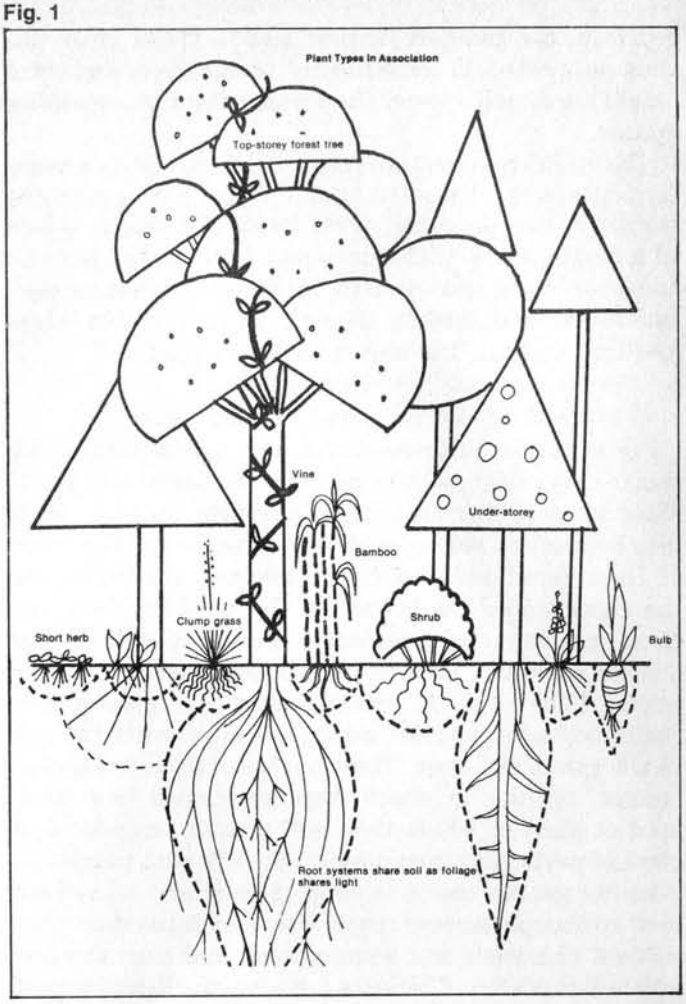
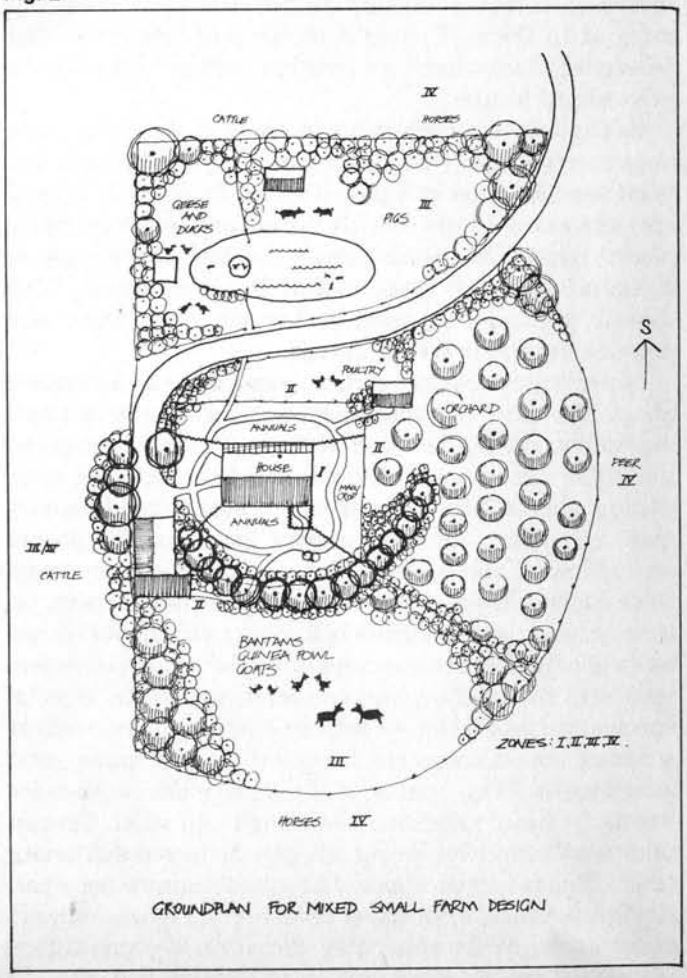
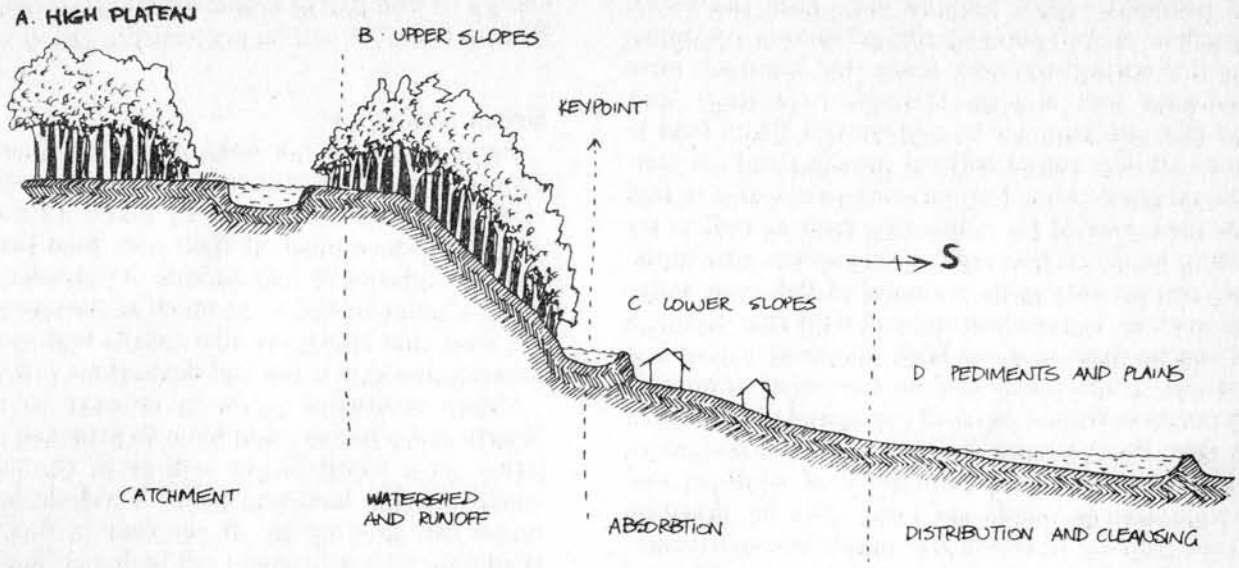


Fig. 2





DOWNSLOPE — IDEALIZED LANDSCAPE PROFILE. FIG.3

and crops, and to form a sun trap. The wind may be deliberately funnelled to drive a wind machine.

Zonation

Another important aspect of design is zonation. Each element is carefully placed to conserve human energy, according to the number of visits required for care and harvesting. Hence the annual garden is placed next to the house, the orchard and small animals further out, pasture and forest furthest away (see Fig. 3). The golden rule is to develop the nearest area first, get it under control, then expand to the perimeter. The principle is that if one cannot maintain and improve a system, it should be left alone. Therefore we should control only those areas that we can establish, maintain and harvest using small technologies. *Zone One* includes the house and glasshouse, and the kitchen garden. The zoning principle applies even within the annual garden. Herbs are grown by the back door for easy access; plants which can be plucked many times, such as perpetual spinach, go near the path; others which are harvested once, such as cabbages and carrots, go further back. The whole annual garden is covered in a special thick sheet mulch to eliminate digging, retain fertility, and greatly reduce weeds. Careful attention is paid to companion planting for plant nutrients and pest control; for instance nasturtiums should be put with tomatoes, comfrey near potatoes for potash, gladiolus with onions against onion rot. Nor should three dimensional space be overlooked and a trellis applied for climbing plants, so that plants of different heights can be integrated into the system. In *Zone Two* are the orchard and small domestic stock such as poultry. Here, techniques are much less intensive. Trees are pruned annually, and spot mulching used around individual trees. Animals provide good pest control and harvest windfalls. In *Zone Three* are the trees that do not need pruning, for forage and fuel, and small areas of main crop such as potatoes, sweetcorn and graincrops, all grown without ploughing by a method devised by a Japanese farmer, Fukuoka.

In his system, the usual crop rotation is replaced by a continuous grain/legume crop. In the autumn, rice, clover and another winter grain such as rye, barley, oats, winter wheat are sown into the ripe rice crop before harvesting. After harvest, the rice straw and husks are returned to the field as mulch. Clover provides a continuous nitrogen-fixing living mulch. Winter grains grow through the mulch, and are harvested in spring when the rice seedlings are small. The straw is returned to the fields, usually to one which will grow a different winter grain next season. The rice seedlings are trampled in harvesting but soon recover. Rice is flooded in summer for about a week. The flooding weakens weeds; but does not kill the clover which nevertheless turns yellow. Then the cycle begins again. Ducks are allowed in when the winter crop is young, to add manure and for pest control. The system has been used by Fukuoka for many years, and his yields are amazingly high, indeed rice yields can be as much as 3,500 lbs/acre (3,400-4,000 kg/ha). Work is now in progress to find the best combination of crops for such a system in different climates. One successful combination is maize, rape and buckwheat. A simpler system is to grow wheat and beans together. This is equally good for the soil, but less good use of time, since the best systems are timed so that the crops just overlap each other.

In *Zone Four* are species which need little attention. Here trees grow as in a forest, providing forage, fuel and timber; permanent pasture is in between. Management is minimal, but if the soil is impacted and exhausted, a special soil conditioner can be used. This is called the Wallace plough; it does not turn the soil but makes small channels under the surface, aerating the soil and improving absorption.

Animal ranges frequently run through more than one zone, with animal housing at the edge of Zone One and the forage range running out to Zone Four. In this

way, animals harvest distant crops, and accumulate useful products—eggs, manure etc.—near the house and garden. A well-planned forage system combines greens (for spring/summer); seeds (for summer); nuts (for autumn and storage through to spring); and berries (for late summer to mid-winter). Thus food is provided all year round without growing and harvesting annual grain crops. Forage systems can also be laid out for bees, needed for pollinating fruit as well as for providing honey. Wherever suitable on the site, aquaculture can provide large amounts of fish, and water plants such as water chestnut and wild rice. Seepage areas can be used to grow such plants as celery and watercress, while much can be harvested from still water ponds or from a series of connected ponds with a water flow. Furthermore sewage water increases insect life, and therefore the productivity of wildfowl and fish; thus sewage ponds are ideal sites for breeding stock for transfer to clearwater ponds before harvest.

Lake systems can in fact be used for sewage disposal and for water purification. The town of Maryborough in Australia treats all its sewage in a system designed by permaculture consultants. The sewage passes first through a rock bed where it is aerated, then through wildlife ponds, and lastly through a soil filter on which crops are grown. Various plants are particularly useful for water purification, while freshwater mussel will remove phosphates and dyes; watercress, nitrates and nitrites; *cirpus validus* will remove heavy metals.

Structures

Houses are at the centre of the zonation system of permaculture. It is essential that shelters both for humans and animals are constructed to supply their own heat and at least some food. The vegetable garden is a source of food that needs little or no cooking: the old emphasis on grains and pulses has created a demand for cooking fuel that some countries, like India, cannot afford. To the basic architectural designs for a reactive house, which are readily available, permaculture adds biological aids such as turf roofs, wall and roof creepers for external insulation, glasshouses and shadehouses for food production and climate modification. The attached glasshouse is of particular importance, as a major heat source and a means of food production, particularly significant for supplying winter greens. There are also permaculture designs for deserts, tropical climates, and snow and ice. The principles behind all these designs can be used to improve existing buildings, and have proved successful in many different climates.

I have given examples of few permaculture strategies and techniques to indicate that it is not merely an attractive theory but of immense practical use. Nevertheless, I must stress that it is not a collection of techniques, but a set of principles for proceeding from observation to design. Many of the techniques are already known but used in isolation. What is new is the careful way elements are planned to interact, and the attempt to use every function and product, including 'waste', to advantage. These principles provide strategies for every situation in which people live. Permaculture can make the desert productive, reforest eroded slopes, reclaim derelict or exhausted land; it can make swamps productive and use sewage to produce energy or feed fish or crops. Perhaps most relevant for Britain today, it can be practised in the city.

Urban Strategies

Permaculture is not only, or even primarily, of relevance to farming: it stresses the importance of intensive gardening very close to home. Cities can and should produce most of their own food needs within their boundaries or just outside. At present, transport costs amount to almost as much as the energy value of the food, and transport also entails high wastage and necessitates expensive and deleterious processing.

Urban strategies begin in or next to the house. Nearly every house could have an attached glasshouse either on a south facing wall or in the attic, which would provide food and heat. A well-designed glasshouse can save up to 70 per cent in fuel. Dr Sonia Wallman, a New England cell biologist, has developed planting plans for her glasshouse for summer and winter, and has found that in a glasshouse of 20 square metres she can produce 70 per cent of salad and vegetable needs and 30 per cent of fruit needs for a four person household. She uses clever positioning, thus stacking of plants according to type, size, and light needs and clever harvesting methods, (taking for instance the outside leaves only of salad plants to allow the head to produce again, and provide sustenance for months on end). All organic kitchen and household waste is placed in a box on top of some compost, well enriched with earth worms and other micro-organisms, and hay put over the top. The waste is quickly composted and can be spread like mulch around the plants. In the winter, herbs, salads and cabbages are the main crops, and in summer, climbing fruits, cucumbers, stringbeans and nasturtiums. Many houses even in cities have gardens which could be used for intensive vegetable production instead of being given over to large expanses of lawn and ornamental shrubs. In some cases, it makes sense to join small gardens together for a community garden. A good example of suburban permaculture is a group called 'Compost' living in a suburb of Melbourne, Australia. Eleven years ago, Gil and Meredith Freeman decided not to move to the country as many of their friends were, but to try to create an alternative way of life within the city boundary. Together with three other families, they bought four houses in a suburban block, took down the fences, and began to transform the gardens into a polyculture. Some five years ago they met Bill Mollison who was just formalising his idea of permaculture, and who suggested improvements to their ideas, which they have now put into effect. They have a chicken-heated glasshouse, an orchard which is kept pest-free by poultry while providing forage, and a dense jungle of nutritious perennials, together with annual vegetables. Some 80 per cent of the food needed by the household of four is produced on the Freeman's own area of 350 square metres. Their house has an attached glasshouse for winter heat and a shadehouse from which cool air is drawn into the house in summer—both being full of useful plants. In a small space, plants must be chosen carefully to get the best

overlapping in plant species, plant size and growth periods.

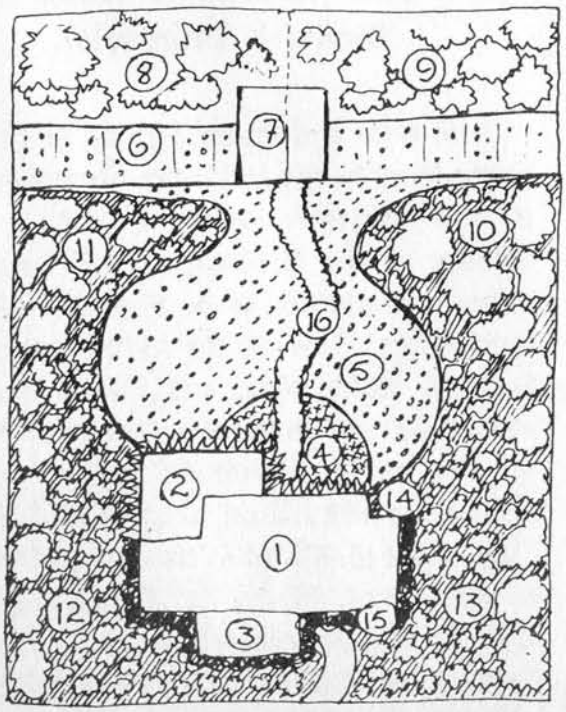
Many ideas have been devised for city dwellers who do not have gardens. Derelict land, for instance, can be taken over for a city farm. In Britain such farms are primarily for demonstration and social purposes, to give children experience of growing plants and caring for animals and not for production *per se*. But a group in Brunswick calling itself Ceres, has taken over city land for productive farming. Permaculture can be a way of reclaiming derelict land, including that within cities. Another simple idea is to link people wanting gardens with those who cannot manage theirs.

Another possibility is for city people to obtain a connection with land just outside the city boundary. Farm Link is a scheme used widely in Japan and Australia in which about 20 families are linked to a nearby farmer. They discuss with him or her their needs, and help work out what is to be grown, while providing labour at busy times. The farmer gets a better assured market, and townspeople get cheaper and better food, as well as more control over its production, and a chance to stay occasionally on the farm in visitor accommodation. Another idea is for city people to get together to buy a farm and pay a farm manager. Many large food co-operatives in the USA have done just that. In other instances, people can buy shares in a farm, giving them privileged access to its products and a place in the country to stay. Such shares can be sold if desired, allowing for people who move on. Other schemes are designed to utilise the resources already in the city.

The Political Dimension

All such initiatives may seem small gestures in the face of the global crisis we face. But it is only by people taking responsibility and control over their needs that the roots of the present crisis will be undermined. We live in an hierarchical society in which power resides at the top and obedience, conscious or unconscious, is expected from the lower ranks. Our basic needs are controlled by governments or transnational corporations. This concentration of power is the major cause of hunger in the world, and it not only affects who gets food and shelter but what is grown, how it is grown, and how it is processed. Monocultures are not productive, but they are profitable: processing adds money value—the more processing, the more profit. Why were productive polycultures destroyed to make way for much less productive monoculture? Because products became commodities. Many traditional polycultures were destroyed to make way for plantation crops, whose purpose was the accumulation of economic power. Complex systems need many hands to harvest them, and benefit many people. Simple systems benefit a single person or organisation and destroy the ecology of the area. The trends towards more specialisation, more extensive monocropping, decreasing varieties of plants, and more concentration of economic power, are all linked, and are equally disastrous ecologically and politically.

Permaculture is not a means of isolated self-sufficiency, but it is a way to self-reliance. The difference is crucial. Self-sufficiency is cutting oneself off from the hierarchy and trying to avoid the disaster. Self-reliance means each community having control over its essentials so that it can make links and exchanges with other communities on an equal basis, without fear or threat. It is about remaking relationships, dismantling the hierarchy. Permaculture is a movement trying to build strong links between its parts, and together take back some control. For example, a few transnational corporations now control the world's food through their control of the supply of seeds. Many local varieties have been lost, and most growers now use hybrids which are dependent on chemicals, which the same transnationals also make, while not producing good seed for next season. Permaculture groups have set up a Seed Exchange and published a Seed Catalogue, aiming to preserve many old varieties with



DESIGN FOR 1/4 ACRE BLOCK (PLAN).

useful characteristics, and make them available worldwide. Members produce their own seeds for sale, or if sale of certain varieties is illegal, as it may be under EEC regulations, for exchange. Other things needed for permaculture, such as the Wallace Soil Conditioner, water collection tanks, and books, are produced within the movement, and patents and profits are kept for further development. Meanwhile, three computers are available to permaculture groups to provide easily accessible information about species and their characteristics.

Permaculture is the brainchild of Australian Bill Mollison. Although he points out that others were already working on similar lines, he was the first to bring the ideas together into design principles. His first two books were immediately bestsellers when published in 1978 and 1979, and many now use his principles and designs in gardens, glasshouses and on farms. Bill Mollison has the credibility of a man who lived from his fifteenth to twenty-eighth year alone in the Australian bush. He was a trapper, logger, fisher and farmer, and can support his theories with a wealth of practical experience. After studying he later taught Psychology and Environmental Studies in Hobart, Tasmania, but left the academic world to develop his permaculture concept. In his far-ranging studies he has found ample evidence to support his ideas. He has set up examples of his proposals all over Australia and parts of the USA, trying to find ways of communicating his findings to more and more people. He has also contributed to the study and dissemination of long-forgotten agricultural and survival techniques from old or little-known cultures. His work on Australian aborigines is one of the most authoritative to be found, and has influenced the development of permaculture. In 1981 he was awarded the 'Alternative Nobel Prize'.

To some, Bill Mollison's approach will seem too simple: "People think I am slightly crazy when I tell them to go home and garden, but a little thought and reading will convince them that this is in fact the solution to many world problems". Behind his thinking, however, is a deeply considered political analysis. Nevertheless, he does not thrust his political views at people along with permaculture, indeed Bill has no wish to be a guru or teacher of opinion or belief. At the end of his book, *Permaculture Two,* Bill states: "I believe that the days of centralised power are numbered, and that a re-tribalisation of society is an inevitable, if sometimes painful, process. The applied theories of politics, economics and industry have made a sick society; it is time for new approaches. We live in the post-industrial world, and have an immense amount of sophisticated information and technology which enables us to exchange information while living in a village situation. Permaculture is a basic technique for such an evolution, and like all biological, holistic systems, is within the reach of everyone.

"Permaculture both conserves and generates the fuel energies of transport systems, and would enable any community to exist comfortably on very restricted land areas. Supplemented with the appropriate and available technologies of methane and alcohol fuels, dry distillation processes, and wind, water and solar energies, it would provide the basis of a sustainable and regionalised society. Combined with community co-operation, permaculture promises freedom from many of the ills that plague us, and accepts all the organic wastes of the community it serves."

Since the books were published, the ideas have been eagerly taken up in the USA and Australia. Hundreds of local permaculture associations and design consultancies now flourish. A permaculture designer is someone who has taken a short intensive course, and served an apprenticeship, working in a group and submitting designs to more experienced designers. Some have training in architecture, others in landscape gardening, or farming, still others have no relevant prior training at all, yet working in a group, expertise and observation can be shared. Designs can be worked out for any site on request and designers work very closely with clients taking account of their requirements and of their knowledge of the site and area. A number of basic designs for particular needs and situations are available for those who cannot afford a fee. In 1982, the first European designer's course was held in Berlin, where there is now a Permaculture Association. In Britain the ideas are only beginning to be known and the practical applications in small gardens and some city farms have just been started. A designer's course ran in Cumbria in November 1982.

Permaculture links a vision of a complete change in society with practical steps that can be taken. It is based on sound knowledge, observation and experience and on profound respect for the natural world.

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Henry David Thoreau and Nuclear Energy

by Lawrence English

A century before men began experimenting with atomic energy in Alamogordo, New Mexico, Henry David Thoreau was conducting experiments of his own at Walden Pond. Thoreau had decided to try to live life deliberately, as free of unnecessary distractions as possible. In the early days of the Industrial Revolution, when the United States was still primarily an agricultural economy, Thoreau could already perceive the beginnings of the dehumanizing forces of a material world. The human price of technology was already evident as the first telegraph lines were being stretched from Washington, D.C. to Baltimore. Today, when the debate over whether or not to implement nuclear power to fill the growing demand for electricity, fills the news with photographs of protesters, Thoreau's thoughts seem singularly relevant. Thoreau thought in terms of men being human beings first and foremost, and the entire question of nuclear energy takes on quite a different cast when viewed in solely human terms.

Thoreau began his first drafts of *Walden, or Life in the Woods* in a cabin of his own construction on the banks of Walden Pond in 1845. He would spend more than two years on this 'experiment', writing and reflecting, tending his small garden, taking in Nature first hand, occasionally venturing out for day labour or to visit with neighbours. *Walden* became Thoreau's personal doctrine of living, an unhesitating, uncompromising, constantly questioning doctrine. "I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could learn what it had to teach, and not, when I came to die, discover I had not lived." By stripping away the clutter of contemporary society in isolating himself in the woods, Thoreau sought to "drive life into a corner, and reduce it to its lowest terms, and, if it proved to be mean, why then to get the whole and genuine meanness of it, and publish its meanness to the world; or if it were sublime, to know it by experience, and be able to give a true account of it in my next excursion." He would not accept half-measures; he sought an intimate knowledge of the truth of human life, for better or worse. "Rather than love, than money, than fame, give me truth." This demand for the real significance of events and actions gives *Walden* its power to motivate re-evaluation of beliefs and behaviour even today. Thoreau saw the need for the establishment of values based on human morality, the fundamental base of all human conduct. The lives of his neighbours too often seemed those of people not quite awake: "Why is it that men give so poor an account of their days if they have not been slumbering?" Industry manufactures products, governments pass laws, workmen turn in their forty hours, all without any feel for any underlying value to their efforts.

In Thoreau's day the trappings of industrialization, the "clean paint and paper, Rumford fireplace, back plastering, Venetian blinds, copper pumps, spring lock, a commodious cellar, and many other things," cut as vivid a contrast against the agrarian background or pre-Civil War Concord as do the cooling towers of Three Mile Island against the Harrisburg horizon. The dehumanizing aspect of civilization differ today only in specifics and perhaps degree. Thoreau said in 1845, "Look at the teamster on the highway, wending to market by day or night; does any divinity stir within him? His highest duty to fodder and water his horses!" The teamster of today drives a semi rather than a team of horses, and can be found staring at the passing headlights out the window of an all-night truck stop, drinking bitter black coffee to stay alert a few extra hours. "What is his destiny to him compared with the shipping interests?" But isn't the teamster also a human being, deserving of a life that recognizes the dignity of the human soul?

Thoreau believed that anything not leading to a better understanding of the Self is simply not good, if not manifestly evil. The everyday conveniences bought with the wages of untoward labour fall into question when examined for any real benefit they bestow. "Most of the luxuries, and many of the so called comforts

of life, are not only not indispensable, but positive hindrances to the elevation of mankind." The elevation of mankind, Thoreau believed, is the only endeavour really worth the time and effort. Anything less is something of an insult to man himself. "In the long run men hit only what they aim at. Therefore, though they should fail immediately, they had better aim at something high." Thoreau was aware that moral revolutions are not overnight achievements, and recognized that such a struggle at first glance appears to be quite futile. It comes as no surprise then that so many take refuge in easily obtained material comforts, resigning themselves to a life of distractions and amusements. "Our life is frittered away by detail." Nothing less than life itself is threatened by the acceptance of the din of civilization.

Trivialities—calculators and video games, amusement parks and neon-lit dance floors run on megawatts of electricity—take man further and further from what the poet-philosopher Thoreau believed he can be. In the deepest sense, "the more you have of such things, the poorer you are." From such a value system, centred on man himself, "a man is rich in proportion to the number of things he can afford to let alone." Minimize, then, the distractions from man's true course. "Simplify, simplify."

From his own experiment at Walden Park, Thoreau determined that a reasonable limit to simplification are the essentials of "Food, Shelter, Clothing, and Fuel; for not till we have secured these are we prepared to entertain the true problems of life with freedom and a prospect of success." Thoreau tested these limits himself, eating mostly vegetarian food of his own cooking; sheltered by a cabin that "was not finished for winter, but was merely a defence against the rain"; clothed in the same simple, sturdy trousers and shirts from day to day; and keeping warm by burning stumps turned by his plough or driftwood gathered at the pond. Thoreau does not suggest we do anything that he has not done himself or has rationally considered, however extreme his ideas appear. He says, for example, that in a case of inordinate need seeking shelter in a larger and more luxurious box who any means a despicable alternative." Though this seems preposterous at first, Thoreau is quick to point out that "Many a man is harrassed to death to pay the rent of a larger and more luxurious box who would not have frozen to death in such a box as this. I am far from jesting." Thoreau is interested in radically different aspects than are usually considered in a discussion of housing. More important, however, than any question of affording shelter—which is not a small issue in itself in these days of escalated mortgage rates—is that of the intrinsic value of the shelter itself. "While civilization has been improving our houses, it has not equally improved the men who are to inhabit them."

Thoreau's observations pertaining to shelter are easily extended to other facets of practical day-to-day living. Nuclear power probably could fill the growing demand for electricity to run the increasing number of time-saving microwave ovens and blow dryers, and could possibly fill that need more efficiently than coal, gas, or oil. But filling a growing demand is an inadequate defence, considering that "if there were bestowed on us the wealth of Croesus, our aims must still be the same, and our means essentially the same." Men waste the larger part of the energy they have now, Thoreau contends, and to increase the amount available would only increase the amount wasted. The excess power would not be put to use in bringing man to a greater realization of himself if a proportionately smaller amount is not so directed today.

Some would argue that cheap, available fuel would provide investment incentive for industrial expansion, creating millions of brand new jobs virtually overnight. But such jobs, whether on an assembly line or behind a desk, are, again, not the sort that would bring man closer to the philosopher-poet ideal. Men so employed are "so occupied with the superfluously coarse labours of life that its finer fruits cannot be picked by them." Commerce is little more than running in elaborate circles without accomplishing anything of value to anyone as a human being, and "men labour under a mistake."

" 'What!' exclaim a million Irishmen starting up from all the shanties in the land, 'is not this railroad which we have built a good thing?' Yes, I answer, *comparatively* good, that is, you might have done worse; but I wish, as you are brothers of mine, that you could have spent your time better than digging in this dirt."

Substitute the words 'nuclear power plant' for 'railroad' and you are close to what Thoreau's reaction might have been regarding the merits of fission. Whether nuclear power production is better than coal, gas, or oil, Thoreau would maintain, is merely a matter of degree of undesirability. "Our inventions are wont to be pretty toys, which distract our attention from serious things. They are but improved means to an unimproved end, an end which it was already but too easy to arrive at." Not surprisingly, Thoreau continued, "I desire to speak impartially on this point, and as one not interested in the success or failure of the present economical and social arrangements." Thoreau wished men free to find themselves, to live life in the direction of their dreams, and would be happy with nothing less.

From his direct personal experiences and his reflections on them, Henry David Thoreau could not support the development of nuclear energy. Rather, he would suggest the abandonment of all public power generation and a return to life in the woods. Though this seems to run against the common sense of people raised in the Machine Age, "the commonest sense is the sense of men asleep, which they express by snoring." Henry David Thoreau would be in the photographs of the protesters on the front page of the newspaper. He'd be wearing a t-shirt reading: "Split wood, not atoms."

All quotes are taken from *Walden, or Life in the Woods*, Henry David Thoreau, *The Norton Anthology of American Literature*, Shorter Edition, Ronald Gottesman, Laurence B. Holland, David Kalstone, Francis Murphy, Hershel Parker, William H. Pritchard, W.W. Norton & Company, New York, 1980.

WETLANDS UNDER THREAT SYMPOSIUM

The British government was heavily criticised last March at a symposium entitled 'Wetlands under Threat' organised by the environment division of the Institute of Biology. A major concern was the system of grant-aiding environmentally damaging agricultural practices only to add to the large crop surpluses that already exist. The greatest threat to wetland sites comes from agricultural drainage improvements, and these are eligible for a government grant of up to 80 per cent in accordance with the government's policy towards 'efficient and modern agriculture'. Drainage enables the farmer to change his use of the land from grazing to arable and thereby to claim government subsidies which raise the price of his crop to the artificial levels set by the EEC's Common Agricultural Policy. CAP prices may be double the true value of the crop, and these subsidies are paid regardless of large grain and other 'mountains' which ensure that the crops cannot be resold at a profitable level. Thus wheat bought at £135/tonne in Kent may be sold to Spain at only £65/tonne, and it is the British taxpayer who loses.

These artificial 'farm-gate' prices further disrupt the economics by affecting the initial drainage grant. The government prepares a cost-benefit analysis of each drainage proposal and the grant is dependent on the scheme showing a predicted annual return of at least 5 per cent. However, the CBA is based on farm-gate prices, described by MAFF as a 'simple, commonsense test', but making the scheme appear much more profitable than it really is. The analysis also uses high theoretical yields which may not be attainable in practice and assumes that all farmers benefiting from the drainage scheme will maximise their output, whereas in fact many farmers welcome the increased capital value of their land without themselves realising its potential. Dr D.E. Penning-Rowsell from Middlesex Polytechnic, speaking on the evaluation of wetlands, suggested that cost-benefit analyses should take into account all impacts of a scheme, should not be undertaken by interested parties (e.g. MAFF), and should be open to public review. They should also include a farm survey with an assessment of the motivation of the farmer and of his personal characteristics such as age and financial backing. Subsidies should be deducted from farm-gate prices and discounting should be used to reduce future benefits to very small present benefits. Drainage benefits should then be evaluated as a return on investment of tax revenue, requiring a careful assessment of community losses and community gains. Unfortunately, the cost-benefit analysis is not open to public scrutiny because figures supplied by farmers are regarded as confidential. MAFF pursues this confidentiality to the extent of not communicating new drainage proposals to the NCC who may only learn of the plans when the drainage contractors move in.

For many sites, protection depends on conferment of SSSI status, but many conservationists regard this protection as illusory, basing their judgement on past experience at West Sedgemoor and other sites. Dr David Goode, formerly a scientist at the NCC, expressed deep concern over the number of wetland sites which have "no protection except SSSI (Site of Special Scientific Interest) status". To prevent a farmer from draining valuable wetland the NCC must formulate a management agreement with the farmer and compensate him for loss of profits. If a firm offer of compensation is not made within three months the farmer is free to carry out his plans, but the NCC is so severely under-staffed and under-financed that it is unlikely to be able to meet these deadlines. In the very first case under the Act, a proposal to develop a SSSI on Romney Marsh, the NCC had to withdraw its objections to the scheme because it did not have adequate money for compensation. Further, protection of a site is not effective legally until the landowner or occupier has been notified of the status of the land, but the 4000 SSSIs in Britain share almost 30,000 owners or occupiers—a great deal of work for the NCC. The delay has enabled a Norfolk farmer to plough up 40 acres of the Halvergate Marsh SSSI, claiming that he was unaware of its status.

New SSSIs are also at risk because the Act requires three months' warning of designation. This effectively gives farmers three months to carry out damaging agricultural operations destroying the conservation value of the land, as has already occurred at several sites including Ripon Park in Yorkshire and three areas on West Sedgemoor. Professor Norman Moore has complained of the "total absence of recognition of responsibility for conservation" in Britain and throughout the EEC, and it is widely reported that Sir Ralph Verney, formerly chairman of the NCC, lost his job because he designated the whole of West Sedgemoor as a SSSI, a move which upset landowners and farmers.

Public attention has recently been concentrated on the plight of SSSIs but these are simply a part of the countryside in general and not isolated entities. Dr Chris Newbold from the NCC emphasised the importance of large areas of undesignated sites which are worthy of protection. These areas may be crucial if, as we suggested, the NCC is not designating sufficient SSSIs to maintain viable areas of some habitats.

The NCC claim that no progress can be made until all Britain's SSSIs have been designated, but wetlands should be a priority. They are the only habitat with an international convention especially devoted to them, a clear indication of their importance and of the concern felt internationally for their safety, and there is therefore an urgent need to put pressure on the government to protect vulnerable sites.

Claire E. Appleby

The Mediterranean Monk Seal—Inevitable Extinction?

Bill Johnson is a former contractor for the World Wildlife Fund (WWF) and the International Union for Conservation of Nature and Natural Resources (IUCN), as well as a former representative of the Franz Weber Foundation, Switzerland. He and his associates have recently formed their own group—One World—whose first priority will continue to be the protection of the monk seal.

The barbarity of the Canadian sealhunts has caused a surge of emotional outrage in Europe, a groundswell which in turn applied pressure on the European Parliament to ban the import of harp seal products. Yet what of Mediterranean-Europe's own seal species, the killing of which is usually no less barbaric? Does it not reach the heights of hypocrisy for Europe to continue criticizing Canada whilst turning a blind eye to the extermination of its own seals? Will the European Parliament persist in taking no effective action on the monk seal which is critically endangered by the practices of Community countries? Realizing the dismal failure of their cul-de-sac diplomacy approach, will the most influential conservation organizations now be prepared to press the Greek government to establish Marine Parks in the politically sensitive Eastern Aegean, the core population area of the monk seals? And moreover, will those organisations now be prepared to tackle seriously all the mortality factors affecting the monk seal, the same factors which are destroying the Mediterranean ecosystem as a whole? These are: direct killing/hunting, overfishing, tourism, industrial and agricultural development and pollution, and military impact. This last factor actually forms the very basis of our recently released report: the contention that within the Greek Ministry of Defence and the Greek intelligence services KYP and YPEA there exists a top-secret directive which vetoes any proposed reserve areas in the Eastern Aegean. Over seventeen such proposals have been rejected since 1976. Furthermore, since 1979 my Swiss counterpart Miss Rita Emch and I have been accused by YPEA of being risks to national security, and of being 'Turkish spies'.

In Homer's age, monk seals were placed under the protection of Poseidon and Apollo because they showed a great love for sea and sun. To fishermen and seafarers, the sight of the seals was considered to be a good god-sent omen. Although ancient Greece venerated its seals, more recent times saw a poignantly ironic and drastic change. By the 19th century, the seals were being systematically slaughtered and the colonies decimated. Furthermore, as a result of modern mortality factors, it is thought that the number of monk seals has been reduced by 90 per cent in the last fifty years, and that the species will be virtually extinct by 1990 if the trend is allowed to continue. Despite the existence of legislation designed to protect monk seals from the hunting and direct killing factors, slaughtered and tortured seals still find no mercy whatsoever under Greek law. Because of the isolation of many fishing villages and seal habitats, or simply because of blatant apathy or collusion, there is little or no interference from the authorities. Seals and their pups are sadistically kicked, tortured and clubbed to death, stoned, shot and dynamited. Despite bureaucratic paper protection, agreements and conferences, there are still no monk seal reserve areas in Greece. As a result of our team's research in 1979, the 'First Biogenetic Reserve of Europe' at Seitani on the Eastern Aegean island of Samos, was declared 'Strictly Protected' by the Greek government in March 1980, but is now under continuing commercial or military development, despite the orders of the Minister of Environment.

The conservation status of the monk seal leapt from 'Urgent' in 1978 to 'Immediately Urgent' in 1979 to 'Imperative' in 1980. One may be permitted to wonder, perhaps rather cynically, when we shall run out of suitable adjectives. Compounding this ironic and frustrating situation is the fact that paper protection and scientific research have cost hundreds of thousands of dollars whilst proposals for direct action have been awarded pitiful sums. Research and conferences continue even though conservation goals have been known for over a decade. At present estimates only 500 monk seal individuals remain throughout the Mediterranean—a species which was once renowned for its tameness and friendliness towards Man. Dwindling fish resources now make the seal a competitor and enemy of the fishermen who complain that the seal damages their nets and steals their fish. They usually don't hesitate to kill the creature when the opportunity presents itself, though various forms of compensation could solve this problem. Yet preserving suitable habitat for the seals is essential. Over the recent years of peak development the seals have been forced from their natural habitat of sand beaches to inhabit dismal caves as a refuge for their lives. It is doubtful that this will help them survive—winter storms often cause surges into the caves, washing the weaning pups out into the sea where they drown. The commercial genocide which took place in the 19th century also seems to have had a profound psychological effect upon the creatures, rendering them acutely sensitive to all disturbance. The monk seal is a symbol of the ecological destruction of the Mediterranean, a sea Jacques Cousteau called 'mortally ill' and perhaps a symbol and omen of what is befalling mankind, ecologically, culturally, spiritually.

The Eastern Aegean border areas of Greece have been in an extremely volatile political and military state since the Turkish invasion of Cyprus in 1974, and also because of the hotly disputed territorial rights issue between the two countries. There have been a number of recent 'border incidents' between the two NATO countries which have aggravated fears over national security. The monk seal could well become one of the innocent victims in the continuing conflict. In recent telephone conversations with IUCN, I was informed that it had been com-

municated through IUCN's 'top-level contacts' that Greece is in fact unwilling to establish reserve areas in the Eastern Aegean because of objections from a national security point of view. The same sources reiterated IUCN's policy that nothing more than the most prudent intervention could be considered. Many other organizations share IUCN's conviction that the military factor is taboo. Is the monk seal therefore a lost cause? And if the monk seal is a lost cause, is not the Mediterranean also a lost cause?

As the deadline to extinction is thought to be only eight years away, then effective action must take place within the next five years. The creation of a network of fifteen to twenty Eastern Aegean reserve areas is deemed essential by a consensus of scientific opinion yet it has also been termed 'unrealistic' and 'impossible' to establish these because of military objections. Is the monk seal therefore trapped in a 'catch-22' situation which will result in its inevitable extinction?

Rita Emch and I headed a project in Greece for IUCN/WWF in 79/80 and the FWF in 82. As described in the comprehensive report, the military factor repeatedly resulted in grave and unpleasant difficulties for all those working on the project, in the form of harrassment by police and military intelligence agencies. This resulted in almost a tug-of-war situation between the civilian authorities in Athens who supported the project, and the KYP and YPEA which were determined to halt the project at all costs. The latter's fabrication of groundless accusations subsequently halted all active protection work in the East. Ironically, although the report provides comprehensive documentation that both IUCN/WWF and the FWF were well aware of the situation, when grave 'national security' accusations materialized they termed them as their representatives' 'personal problems' and rapidly withdrew.

Some of the most pertinent aspects of the report are given below:-

☐ That the commerical and/or military inspired development of the Seitani reserve area continued despite the intervention of the Minister of Environment Mr. A. Tritsis. The Minister and Ministry officials assured Johnson and Agence France Presse that an order had been issued halting the development, and that a presidential decree to fully protect the area would be issued "in the weeks to come . . ."

☐ That although YPEA considered Johnson to be a 'risk to national security' they only ordered him to stay out of Eastern border areas, yet did not take any action against him (apart from constant threats of deportation and arrest) when he, concerned at the continuing development of Seitani, persisted in returning to Samos. The harrassment however finally destroyed the monk seal project in the Eastern Aegean.

☐ That despite the top level personal interventions of Ministers Tritsis, Melina Mercouri, and the Greek Secretary of State Mr. Potakis, and despite widespread media coverage of the issue, the development of Seitani continued. YPEA and the Ministry of Defence were unwilling to provide any statement apart from their view that the issue was 'top secret'.

☐ That the well documented circumstances suggest that it was not Bill Johnson and Rita Emch who were considered to be 'risks to national security' but the project itself, whose aim was to move towards the creation of fifteen to twenty East Aegean reserve areas.

☐ That documentation proves without doubt that the authorities in Athens and IUCN/WWF were aware of the military inspired harrassment of the project in 79/80. In one such document relating to a meeting between an IUCN official and the Permanent Secretary of the National Council for Physical Planning and Environment (Ministry of Coordination), it is stated that ". . . there is a need to expand this programme and support it more fully and ensure it would have continuity rather than being impeded by local pressures—there was however agreement that the project should be kept on Samos as long as possible . . ." Both IUCN/WWF and the NCPPE later termed the harrassment as Johnson and Emch's 'personal problem.' The same occurred with the FWF in 1982. The documentation clearly suggests that the organizations became fearful for their own reputations, and that the relevant sections of the former and present government were finally informed on the top secret directive prohibiting the establishment of reserve areas in the East Aegean. They were also deterred from revealing the directive publicly for diplomatic reasons: such an act would also be to sign the death warrant of the monk seal before a world audience. The report asserts that it is precisely because of growing international concern to protect the species that the Ministry of Defence stipulated that its directive is top secret.

☐ Also described in October 1982 is Johnson and Emch's visit to the Samos reserve with 2 representatives of Greenpeace; the continuing development, and how they observed hunters entering a seal cave and exterminating any seals present with shotguns. It is contended that these 'paid hunters' are an additional method of ensuring that the reserve will not be fully established as promised by the Ministry of Environment.

☐ The report and photo material also describes Johnson's final expulsion from Samos to Turkey on October 23rd when, after 36 hours under armed guard, he was forcefully taken onto a passenger boat (destination Kusudasi) and accompanied by a patrol boat and police and intelligence agents until Turkish territorial waters.

☐ The issue has been brought to the European Parliament by British Euro-MP Eric Forth.

It is our intention, by launching this report, the One World association, and press material, to evoke concern amongst Europeans of the plight of the Mediterranean monk seal. Specifically it is our intention to press the Greek government (through the EEC, Council of Europe, UNEP, and independent conservation groups) to establish the essential network of reserves in the Eastern Aegean; to raise funds to continue the project's educational and public awareness programmes, and to sponsor a European petition, requesting the Greek government to undertake concrete measures to save the last Mediterranean monk seals.

Bill Johnson

WHO IS DESTROYING INDIA'S FORESTS?

In the forests of India, from Himachal Pradesh to Kerala, it will soon be a crime to go for a walk or even to collect leaves which have fallen to the earth. Over the last thirty years the people who live in these forest areas have been gradually driven to the margins. Their lands have been taken away, families have been split through poverty and debt and their youths are increasingly facing imprisonment and death for their involvement in political movements. Now the government of India is to bring a new Forest Act which will conclusively make them trespassers on their own land.

The Forest Act will affect 74.8 million hectares of land—23 per cent of India's total geographical area. It is being introduced not only as a law which is supposed to be democratic but as a response to an impending ecological crisis. India's forests are vanishing away (4.2 million hectares are said to have been lost since 1947) and the Act, according to the government, will protect the trees from those who destroy them— the people, mainly Adivasi (tribal), who have lived in harmony with the forests for thousands of years.

Are the Adivasis in fact destroying the forests? A fast-growing and increasingly active lobby, including democratic rights groups, ecologists and peasants' organisations think otherwise. It is the Act itself, they say, which will open the way for devastating ecological changes. It will also, they point out, make thousands destitute, increase state repression in forest regions (which include such high-tension areas as Nagaland) and facilitate the syphoning of capital to the west. In a country acceding to the conditions imposed by a recent IMF loan, the Forest Act is seen as the rural counterpart to such urban legislation as the Essential Services Maintenance Act which can be invoked to make strikes illegal.

While the forests controversy continues, few people deny that life is already extremely hard for India's forest dwellers. Their community rights and civil liberties have been gradually erased since 1878 when the British colonialists first classified forests in terms of government control. The policies which now determine forest legislation and administration were formulated in 1952. They have brought increased poverty, landlessness and the tyranny of a bureaucracy whose power and corruption are remarkable even by Indian standards. Thus 93,000 forest officials rule the forests through a network of permits and licences. Bribes are essential and fines frequent. There are fines for cutting firewood, grazing cattle, tapping toddy, and brewing liquor out of wild flowers. It is a stranglehold which will be tightened if the Forest Act comes into force. The Act proposes to give forest officers magisterial powers, to increase sentences to up to three years and to create many new offences (including for example the absurd, but easily abused, failure to inform officials about accidental cattle grazing).

But laws and regulations determined in Delhi are not all that the Adivasis are up aginst. In some states their land has simply been taken away by Forest Departments, in others they have faced mass evictions. in Andhra Pradesh, in 1972, a government order declared all occupation of Forest Land after 1964 to be illegal and was then used to evict 15000 people.

While the Adivasis are losing their land international agencies like the World Bank and UNDP are guiding India's euphemistically named afforestation programme. These convert existing natural forests into single species plantations and are often linked to multinational companies. Many of them are seen as ecological threats because by destroying the plants and bushes present in natural forests they are altering the ground water level and depleting the soil of nutrients. In the Bastar region of Madhya Pradesh for example, a World Bank project recommended by the Ford Foundation, is tearing out a rich 'sal' and 'mahua' forest and replacing it with imported pine plants. The ground water level is being so drastically altered that plants and trees can no longer grow in neighbouring areas. It is the same in the World Bank's Eucalyptus plantations in Karnataka. But projects are forging ahead all over India; in Tamilnadu for example, SIDA a Swedish development agency is funding a Rs 1050 million scheme whose products will eventually be channelled to WIMCO a Swedish multinational. The government is eagerly aiding private companies. Thousands of acres of forest land are being leased out. Birlas alone own bamboo forests in Madhya Pradesh, Andhra Pradesh and Orissa, and in Kerala even reserved forests have been leased out to Gwalior Rayon.

The forests are overrun with contractors middlemen employed both by industrial firms and government departments. They are the most ruthless exploiters of the rural people. A critique of forest policy from one civil rights organisation, the Delhi based People's Union for Democratic Rights, describe how the contractors have entrenched themselves in the forests by buying up local politicians and forest officials and eventually themselves becoming moneylenders and landowners.

Faced with destitution or the most exploitative employment, the Adivasis are fighting back. They have had some victories. In Uttar Pradesh for example, the Chipko movement stopped a scheme to cut down ash trees for British cricket bats (Chipko means to stick, forest dwellers would embrace the trees they wanted to save). But their struggles have unleashed the most violent repression. In Bihar for example, Adivasis trying to stop the destruction of their ancestral burial grounds have faced battalions of militarized

police. Villages have been burnt to the ground, women raped and hundreds of people imprisoned.

Increasingly the Adivasis are allying with non-tribal poor peasants. In Adilabad on the Andhra Pradesh—Maharashtra border a strong representative organisation, the Girijan Rytu Coolie Sangham (Tribal Peasant Labour Association), has developed. It is affiliated to a Marxist-Leninist Party. Last April a mass meeting of the Sangham was banned at the last moment and the police fired indiscriminately on hundreds of Adivasis approaching the village. Some 250 people were killed and hundreds more injured.

But in India such incidents are becoming increasingly common. The proposed Forest Act will now provide legal justification for them. More significantly the Act will be a message to the IMF that the Indian government is ready to provide an investment environment unruffled by civil liberties.

Amrit Wilson

TRYING TO SAVE THE BARN OWL

When I first settled in the country, over thirty years ago, a pair of barn owls would hunt regularly at dusk, one at a time, beating backwards and forwards, along the straight lane in front of my cottage like eerily silent creamy-white ghosts less than twenty feet from the ground, reducing our local rodent population with infallible skill. I often used to watch them at close quarters, for they paid no heed to a mere human, least of all when they had a brood of hungry, spiky-looking owlets in their nest in an old barn in the farmyard across the road. They were a favourite part of the rural scene I had moved out from the town to enjoy. But alas, I see them no more. Maybe ten or twelve yers have passed since 'our' owls were to be seen on patrol. A pity indeed; for I still miss them.

A far greater, more disastrous pity is that this sad pattern of things has been repeated in recent years all over the country, and in some counties, from Devon and West Dorset to Hertfordshire, this beautiful and so valuable bird is apparently already extinct.

Barn owls, or white owls, the most striking of all Britain's commonly breeding owls, have been in steady decline since 1900. Writing during World War II, that great ornithologist H.F. Witherby described them as "generally distributed but not abundant and scarcer in some parts than formerly". Now it would be true to say 'scarcer in all parts than formerly.' One survey in the early 1970s suggested that the number of these most distinctive birds might have actually halved in the previous forty years. More disturbingly, later studies have shown the rate of loss accelerating alarmingly over the past decade or so. The World Wildlife Fund announced not long ago that this species, a cosmopolitan one normally extending from Belgium and Switzerland south to the Mediterranean is now decreasing "at an alarming rate in Britain and much of Europe," with the suggestion that widespread extinction is imminent if not inevitable.

Why should this be so? Various theories have been put forward, none conclusive or exclusive, and most of them tending to ignore the inexorable trend of barn owl decline for all of this century. Launching a special new scheme for providing nest-boxes for these owls the Royal Society for the Protection of Birds says: "Undoubtedly one of the underlying causes of their disappearance is that many traditional nest sites in very old trees and derelict buildings have been lost. Brick and timber farm barns are being replaced by modern steel-framed structures." The use of silos instead of corn ricks may well be another factor. Dr. Ian Taylor of Edinburgh University's Department of Forestry and Natural Resources further suggests that the current trend towards monoculture cereal production, the widespread removal of hedgerows and the reclamation of rough ground and wetlands as further reducing the barn owl's habitat. Such changes not only remove nesting-sites and roosting places but also reduce the available numbers of shrews, mice, voles, rats and insects on which barn owls feed.

Modern intensive crop-rearing with the extensive farm use of chemical pesticides undoubtedly mean bad news for barn owls. When toxic pest-killing chemicals started to be freely used in the 'fifties and early 'sixties, barn owls came second only to sparrowhawks in severe damage therefrom, but unlike the latter species they have never recovered. Some rodenticides freely used to keep down rats and mice, like Warfarin, may be in the bodies of their animal prey and eventually prove fatal also to the owls that eat them. Insecticides like dieldrin that are commonly used to treat woodworm and death-watch beetle infestation in old timber could be yet another factor in barn owl mortality. Many owls are killed by fast rail and road traffic, too. They have the habit these days of hunting over busy roadside and even motorway verges, where rodents are often plentiful, often getting hit by passing vehicles. Hard winters spell almost certain death for these birds too. As Dr Taylor points out: "Mortality of adult barn owls seems to occur mostly in winter coinciding with prolonged periods of deep snow cover." The death rate seems further to be related to altitude, he has found, "so that it falls most highly on the birds on sheepwalks, and much less on the birds on lowland farms." Finally, these helpful birds are even now still persecuted by some gamekeepers, in spite of official protection, and the striking fact that the scientist undertaking the last investigation into barn owl feeding habits, in 1974, found the remains of only one game-bird chick in 42,000 prey items in the many thousands of regurgitated barn owl pellets he examined.

As bird biologist David Glue has said: "It would be difficult to name a bird that is more beneficial to man than the barn owl." It is our greatest mouser. It hunts by night when the rodent horde is most active and its opportunities for pest destruction are greatest. A single hunting owl may destroy more vermin in one night than may fall to a dozen farm cats. They have been computed to destroy 23,980 assorted rodents annually per square mile of territory. One observer found no fewer than twenty freshly-killed rats in one nesting-hole; another watched 27 mice and four rats being brought in a single night, as well as several voles, while a third saw a half-grown owl eat nine mice in rapid succession and become hungry again within three hours. So, if it is remembered that they also take considerable numbers of farm sparrows and starlings, plus the odd rabbit, it is clear that barn owls are not merely one of the farmer's best friends, but the nation's also, and their loss would be grievous to us all.

For this reason, 1983 is to see a major complete survey of this bird in present-day Britain to investigate the causes of its decline and to see what can be done to help it recover. This is to be undertaken by the 500 members of the Hawk Trust spread around the country, under the national co-ordination of ornithologist Colin Shawyer, who hopes to enlist further help from various other bodies including the British Trust for Ornithology and the R.S.P.B., numerous local Natural History Societies and anyone interested enough to report sightings and nests.

Their first task is to take an accurate population census, and Mr. Shawyer requires both positive and negative information from all areas. He believes that habitat changes are not the primary reason for the way these birds are disappearing from our countryside. He is therefore most anxious to find positive links between barn owl deaths and any of the various factors suggested. To this end, dead owls are welcome for expert scientists to examine.

Nest-boxes are best provided in lowland regions and can be fashioned from the large plastic drums available on most farms, or from old barrels or casks and wooden packing-cases, all fitted with a four-inch diameter entrance hole and fastened securely at a fair height on walls. Certainly such efforts are well worth making to further this handsome owl's cause in its time of present dire need.

David Gunston

Note Details of the Barn Owl Survey are obtainable from the Hawk Trust, Freepost, Beckenham, Kent; and of the R.S.P.B. nest-box scheme from 10 Richmond Road, Exeter, Devon, EX4 4JA. Any dead barn owls found should be sent to Mr. J.E. Cooper, Royal College of Surgeons, 35-43 Lincolns Inn Fields, London, WC2 3PN.

Books

A Wealth of Nations

NEW POLITICS, by John Papworth. Garlandfold Ltd in association with Vikas Publishing House, New Delhi. £15.95.

Slowly slowly the movement started, one might think, by Leopold Kohr back in 1957 when *The Breakdown of Nations* was published, is beginning to progress.

This movement, which is based upon the theory that size is the most important factor in determining human affairs, had its roots probably well before Kohr—back among the Distributists perhaps—but Kohr was the first writer to state clearly what this issue is all about. To put this theory (or whole philosophy for that is what it is) into a nutshell—there is a right *size* for human institutions just as there is for human noses. They should neither be too big nor too small. Fritz Schumacher magnificently displayed this belief in *Small is Beautiful.*

John Papworth carries the whole thing a big jump further. This book he has written is one long argument in favour of considering very carefully what *size* we want our human institutions to be and an examination of the problems that afflict our world as a result of incorrect scale. Thus he classifies human societies along a scale which starts with Robinson Crusoe, who could hardly be called a society at all, through his association with Man Friday, the advent of whom on the island immediately raised problems of precedence, authority and power, through *tribal societies* which had (and still have where they still exist) a rough and ready democracy in spite of the fact that they were supposedly ruled autocratically (Papworth and I have both seen this working in Africa); to the City State which again, no matter how autocratic its government was supposed to be, was actually very much governed from below and not from above, to the *nation* which he tells us "may be defined as a political unit which can be within the general control of its members if the requisite conditions of freedom exist, and which is able to reflect in its day-to-day workings, its citizens wishes and preferences" to the *meganation* "which is able to reflect the general will in its workings only with the greatest difficulty" (he gives as examples West Germany and Britain) culminating, to date at least, with the *continental meganation,* of which there are four examples on this planet: U.S.S.R., U.S.A., China and India. This is a unit "which is so huge that no effective functioning of democracy is remotely possible except for brief interludes such as on the issue of war or a national crisis."

He touches only briefly on the next logical step along the road to giantism: the *world state.* My own feeling is that if we ever get that far the only course open to a sensible man, if he finds suicide too hard for him, will be to enlist in the secret police. There will be plenty of room in it and the pay should be good.

Now the whole book, from the first line to the last, is written with intense conviction and passion. It is fairly exhausting to read it. An unrelenting irony runs right through it. His condemnation of the continental meganations is scorching:

> (Of China). Its record since 1949 is one of almost unceasing hostility and belligerency to the world at large. Not satisfied with having the largest population in the world to care for and worry about, it proceeded to invade and subjugate the proud, independent people of Tibet, it has invaded India over the issue of some border posts so high up in the Himalayas that nobody in his right mind would dream of living within a hundred miles of them, it has intrigued and conspired in the quarrel between India and Pakistan, it has become embroiled with the U.S.A. over the fate of Korea . . .

He goes on to list the rest of China's interferences in the rest of the world ending with its ridiculous claim to rule the island of Taiwan (a hundred miles away) and in this connection he says the thing that, for me, sums up the whole argument: *Taiwan belongs to the people of Taiwan.*

The U.S.S.R., or the Russian Empire as Papworth quite rightly calls it, is of course a sitting target and Papworth scores a 'possible' with the bullets of his rhetoric and then goes in with the butt and bayonet.

But lest you should think that it is only the so-called communist continental meganations that come in for stick, listen to this:

> Within a few score years these gracious tribesfolk were being hunted down everywhere like carrion; genocide followed one broken 'treaty' after another, and where it did not succeed was followed in turn by forced evictions, starvation and attempted slavery . . .
>
> In viewing what was done to these people it gives us a grim intimation of what was to be done to the land and its flora and dependent fauna . . .

—and after cataloguing but a few of the ghastly things the North Americans have done to their once-lovely continent he quotes a large chunk from Henry Miller's *Air Conditioned Nightmare* which, if I were an American (and I half am) would make me squirm. And he follows this by showing, to this writer's perfect satisfaction at least, that there is no possible chance for an aggregation of human beings of the size of the U.S.A. to act in any sort of a responsible or moral manner. As one little tiny example of this he recalls that Lt. Calley, who was found guilty in a fair trial of butchering men, women, children and tiny babies, in the Vietnam horror, is now a free man and was in fact publicly honoured by the president of the United States.

India, too, comes in for a lambasting. Since the British got out, India has been at war with nearly every single one of its neighbours (if it hasn't simply moved in and taken them over). Even tiny Goa didn't escape, and Papworth makes the point that Goa should belong not to India, not to Portugal, but to the Goanese! Just try telling that to Mrs Gandhi.

He compares, devastatingly, the cultural and artistic achievements of the giant states with the tiny city states of the middle ages.

> "The people of the city states were no less greedy, sensuous, vicious, cruel, spiteful, violent, selfish and depraved than those of any other time before or since. What must compel our wonder is the way in which they ordered their affairs and kept their vices in sufficient check to enable a civic life of the most matchless achievement to flower from generation to generation in a perpetually rising crescendo of splendour and loveliness which holds the mind spellbound with the richness and variety of its accomplishment. How did they do it? What was the secret which enabled them to produce so easily such a staggering abundance of creative manifestation to which to this day millions of people flock for no other purpose but to gaze at it in wonder, whilst scarcely a single city of the modern era does other than bore its own inhabitants and mock the wider aspirations men once had and have now, irretrievably, it seems, lost? Why do we return again and again to these splendours of the past and find

none of our civic forms worth a second look? What went wrong? In what way was the spring broken and the magic circle of mens' private dreams and public splendours so rudely snapped?"

He can say that again. I have stood with John among the splendours of Salzburg and almost wept when I have compared them, in my mind, with the banality and ugliness of what is being built today in our super-duper meganations and continental meganations.

I have heard the criticism of Papworth that he is one-tracked minded and attributes all the evils of our age to giantism and to nothing else. And I have to admit that nothing very splendid and lovely is arising now in, for example, Belgium. Or Denmark. Or even Liechtenstein. Has something *else* gone wrong too? I find it surprising that Papworth, who is an Anglican priest, does not look for other causes beside the one of giantism. He gives us in one instance in the book (page 213) his sovereign political remedy for the ills which beset us and which bid fare to destroy us off the face of the Earth:

> If a nation, as we have defined it, finds it difficult to order its affairs in democratic terms because of its growth as compared to the size of a city state, then the answer to its major problem stares it in the face; either it should fragment itself into city-state size units in order to reap the advantages of both democracy and control that such a human scale is able to yield, or it should go for a policy of maximum devolution and non-centralisation of power of all kinds, so that only the most tenuous and residual forms of power remain at the centre.

But of course no meganation *can* take these remedies so long as it is being menaced by the military might of another meganation. Or thinks it is, which is the same thing.

John Papworth is very dismissive of the peace movement and I have heard him in many an argument about this. He tells us in a footnote:

> Britain tops the board with no less than 104 (peace) organisations, the U.S.A. gets by with a mere 62, the democratic, peace-loving people of the U.S.S.R. scrape along with a mere four, whereas the heroic toiling masses of the Peoples Republic of China, all 800 million of them, under the inspired leadership of whatever group has grabbed the reins of power at the moment, can manage its quest for peace quite well with only two.

But he goes on to say that "none of these organisations appears to have had the remotest effect on the wars that have erupted over the last two decades" and he lists thirteen conflicts, including among them Vietnam. But would America have got out of Vietnam when it did if it had not been for the growing and highly effective peace movement back home? It is my private belief that the ladies of Greenham Common, aided by their obedient males, are going to make it very difficult for *this* meganation to go on with its mad race towards destruction.

Certainly *nobody* is going to read this book without finding himself in sharp disagreement somewhere. And nobody is going to read it, if he is capable of thought at all, without being made to think.

It is just terribly sad that, due no doubt to the timidity and lack of imagination that evil times have forced on British publishing, this book had to be made in India and sent over here for the abominable price of sixteen pounds. It should be published in paperback, immediately, and sold for a price that people could afford and I'll warrant it will put a lot of cats among a lot of pigeons. It is an extremely stimulating book.

John Seymour

No Shelter

THE DAY AFTER MIDNIGHT. The Effects of Nuclear War. ed. by Michael Riordan, Cheshire Books, Palo Alto, 1982. £5.95.
LONDON AFTER THE BOMB. What a Nuclear Attack Really Means, by Owen Greene et al. Oxford University Press, 1982. £1.95.

The British Medical Association has recently endorsed the opinion of the American Office of Technology Assessment's report that both the Pentagon and the Home Office grossly underestimate the carnage we can expect from nuclear war. *The Day After Midnight* is based on that report, which was prepared at the request of the Senate Committee.

This book familiarises us with the effects of nuclear war in a number of case studies which compare different sizes of nuclear attack on America and Russia. The first study, involving attacks on Detroit and Leningrad, suggests that between two hundred thousand and two million people would be killed immediately. The second, examining the results of attacking oil refineries, argues that between one and five million may be killed. 'Counterforce' attacks aimed at military (rather than civilian) targets cause between one and twenty million deaths. And, finally, between twenty and one hundred and sixty million would perish in massive all-out attacks. The report might have added that even these figures underestimate the death toll. For given the existence of N.A.T.O and the Warsaw Pact, surely it is misleading to estimate Russian and American casualties without mentioning European. Moreover, it is worth noting the Swedish Academy of Science's journal *Ambio* recently suggested that all-out nuclear warfare in the Northern Hemisphere would cause more deaths in the Southern Hemisphere where not a bomb is dropped, (see *The Ecologist* Vol. 12, No. 5).

With such large but imprecise and widely fluctuating figures, it is not surprising that the authors acknowledge the impossibility of conveying the human and psychological effects of such a war in abstract statistical language. In an attempt to meet this problem, the book begins with a fictional account of conditions in Charlottesville during and after an attack in which the town is not directly hit. If this is not convincing, it is because the weakness of characterisation prevents the necessary suspension of disbelief.

But ultimately faith is placed in the educative value of academic information rather than fiction, since its premise is that 'an informed public, it is hoped, should be able to make better decisions about the use and disposal of nuclear weapons'. It may seem churlish to question this premise. But whose decisions will the public better? Surely the implication is that it is the leaders' decisions. But it is doubtful that those decisions can be castigated on grounds of inadequate information; after all, the effects of Hiroshima have been well documented by U.S. governments.

And for all its information, the emphasis of the book does not convey the idea that it is not merely Russian and American societies that are threatened by nuclear war but the ecological foundations of all living forms which may be irreparably damaged. I was staggered to find only six pages covering the environmental effects of nuclear war. This scanty treatment is defended on the grounds that such effects are incalculable. So the old prejudice that the unquantifiable does not merit objective discussion virtually censors an appraisal of questions of far greater moment than the survivial of particular political systems.

Let me demonstrate from the last pages of the book how the presentation of information undermines the sense of alarm which the book sets out to generate. The final sentence says 'The incalculable effects of damage to the earth's ecological systems might be on the same order of magnitude as the immediate effects of an attack', that is between twenty and one hundred and sixty million deaths. On the opposite page is a photograph which might have been captioned Resurrection, as it depicts new shoots on a chestnut tree in Nagasaki only

two months after its bombing. To suggest that ecological damage can be equated with an estimate of death roughly similar to World War II alongside such a picture betrays a faith that a holocaust is survivable. The well informed public might well endorse Mr. Reagan's policies, rather than heed the warnings of the B.M.A.

London After the Bomb provides a shorter and more succinct description of the effects of nuclear bombardment on a major city. Its clear exposition of the diverse ways of dying from a one megaton detonation through blast, heat, initial radiation, and later cancers and genetic damage suggests it does not much matter which your creed or nationality is.

But, in contrast to *The Day After Midnight,* the information in the book is presented in a manner which engages the present political debate about nuclear armaments. For it is specific in its criticism of Home Office publicity. Using the same O.T.A. report as well as evidence from Hiroshima, the authors argue that the Home Office underestimates the extent of blast damage and casualties, overestimates the protection ordinary housing affords against radiation, and omits to consider how blast damage reduces protection against radiation. It demonstrates how Home Office pamphlets such as *Protect and Survive* and *Domestic Nuclear Shelters* deceive the public.

What gives the book it cutting edge is its exposure of the discrepancy between this grossly optimistic propaganda and the Internal Circulars between government departments which acknowledge that there can be no meaningful protection against nuclear attack. For instance, government publicity conjures up an impression of the population quietly and efficiently preparing for war. It recommends making fall-out shelters in the garden or basement; but neglects to mention that only 3.5 per cent of Londoners have access to either. Under conditions of supplies' shortages and panic is it likely they will heed government advice to stay at home rather than seek safety elsewhere? Internal circulars do not give the impression politicians think so.

According to one, 'the current aims of Home Defence are defined as those defensive measures necessary in the U.K. to secure the U.K. against internal threat' i.e. refugees. After an attack another Circular candidly states that the role of civil defence at the sub regional level 'would aim at conservation of resources rather than immediate short term aid to hard hit areas' i.e. London.

Again our attention is brought to bear on the inconsistency between the suggestion in *Domestic Nuclear Shelters* that an attack on this country is likely to be in order of two hundred megatons and a statement from the Secretary of State for Defence which assesses 'more than one thousand megatons would be needed to destroy our ground launched missiles'. Are we to believe that these missiles will not be targeted?

London After The Bomb shows that it is not so much the lack of information about the physical effects on the environment and man that hinders our understanding; but rather the distortion and partial suppression of knowledge by successive governments which induces a collective state of lemming-like lassitude amongst us, so that we feel safest when we are most in danger. To guard against this, we should ask of any publication whose interest does it seek to further, when it purports to inform objectively.

David Lomax

Nuclear Costs

THE PRICE OF NUCLEAR POWER, by Colin Sweet, Heinemann Educational Books, 1983—paperback £3.95.

By now, with so much written and still being churned out, nuclear power as a subject should be a crashing bore; and for the most part it is. Nevertheless, in the grey areas of controversy where proponents and opponents are battling it out, each trying to score points, there is enough going on to stimulate anyone wishing to get embroiled. Colin Sweet is clearly a fighter; a man who is prepared to take a few swipes at the institutions and score. In his new book, which comes hard on the heels of his pamphlet for the Anti-Nuclear Campaign, it is the institutionalisation of nuclear power that he attacks most vigorously, for therein, in his opinion, lies nuclear power's drive and momentum; hence its danger to society.

Nuclear power without the institutional factor would be as inconceivable as a body without the head, and like the whole being, it is just as prone to rationalisation to justify its existence. Indeed, without the Manhattan project to realise the power of atom splitting, no-one in his right mind would have pursued the notion of putting the peaceful atom to work. But once begun, self-preservation takes over and those actively involved in nuclear power—from giant engineering corporations to governments', nuclear engineers and physicists—see much to be gained from its expansion. That is where the myths begin, and they include the cheapness of nuclear energy as well as its potential dimensions. As Colin Sweet points out, the energy gap is an institutional notion nurtured by those who see the opportunity for filling it. Thus we have all that nonsense put out by eminent men of the establishment, including scientists such as Sir Alan Cottrell and Sir Walter Marshall, that nuclear power is absolutely vital if the teeming millions of the world and their progeny are not going to be left cold and starving on a naturally inhospitable planet. And many who have scarcely the first clue about nuclear power and who might have known better have swallowed the propaganda without even bothering to savour it. What could be more self-righteous than the railing by Frank Chapple, 1982/83 chairman of the TUC, when he identifies the critics of nuclear power as 'Hysterical voices of environmentalists, ecologists and sundry political opportunists, who exploit public ignorance . . . they skilfully conceal the fact that a logical outcome of their policies will, at worst, leave us with a shortage of energy around the year 2000, and at best lead us first to stagnation and then to a reduced standard of living.' How Chapple can talk of energy shortage when the world is in the throes of an energy glut is more than common sense can grapple with. Moreover, as Sweet explains, if nuclear power were such a good bargain it would have proved itself when energy prices began to rise more than a decade ago. In fact rather than its strength, the weakness of nuclear power has been exposed; thus it is neither cheap nor can it easily substitute for other fuels except in the limited area of electricity production.

For anyone who still fails to understand why nuclear power has support from government to the tune of hundreds of millions of pounds spent on research and development when it actually delivers such a tiny proportion of end-use energy, Colin Sweet's book will help clear up the confusion. I would also suggest that Nigel Lawson read it, since he might then get some much-needed insight into the realities of nuclear power. The worst aspect of nuclear power, aside from the dangers, is its potential to gobble up capital and therefore preempt other options which if implemented would benefit society.

The Price of Nuclear Power is eminently readable and although well-supported by evidence does not get bogged down in facts. Indeed we can hardly fail to be convinced by Sweet's plea for a change in energy policy in Britain away from its fixation with nuclear power. In that respect the government announcement of a 15 GW PWR programme in 1979, with work starting in the early 1980s, was made without any reference to the massive surplus in generating capacity existing then (and now) in Britain. The justification of the programme, once critics had pointed out

the lack of need, was the savings it would make once implemented. But, as Sweet concludes, even that justification is being challenged at the public inquiry into the Sizewell PWR. Even if the objectors win the argument he does not necessarily expect them to win the battle. Nevertheless, time may be gained when public opinion and reality will prove stronger than the institutions and their policy making.

Peter Bunyard

Medical Horror Show

DES: THE COMPLETE STORY, by Cynthia Laitman Orenberg. St Martin's Press, New York, $6.95.

By now, the bare outlines of the DES story are well known: starting in the late 1940s, diethylstilbestrol was prescribed widely for pregnant women, in the belief that it would reduce the risk of miscarriage; in the late 1960s, it was discovered that the daughters of these women have an abnormally high susceptibility to vaginal and other cancers. Cynthia Laitman Orenberg's book confirms that this is a classic medical horror story.

DES is a synthetic drug which in many ways mimics the effects of the hormone oestrogen. At the time that it was introduced into medical practice, no one understood the basis of its considerable biological potency; and yet there was little fear that the interaction of this drug with the body's hormone system could have serious and unpredictable consequences. Worse than that, the 1948 report recommending DES use to prevent miscarriage was based on a study with fundamental flaws: not only was there no control group of DES-free women, but the specifications given to the participating doctors did not prescribe any details of the treatment regimen for the patients, other than strict doses of DES. More rigorous studies published in 1952 and 1953 found that DES was *not* effective in taking pregnancies to term. Drs George and Olive Smith, the authors of the original report, continued to insist that DES would "save babies" and their prestige was such that its use continued, tapering off in the 1960s. There is still no evidence that DES benefited any of the women to whom it was prescribed.

Ill-effects of DES continue to be discovered. DES daughters not only run the risk of cancer (current estimates are that between 1 in 700 and 1 in 7000 will develop cancer), but are also likely to have various benign abnormalities which must be carefully monitored for signs of turning malignant. They have a higher risk of infertility, of malformation of the reproductive system, and of menstrual irregularities. There are also psychological effects: anxiety, negative associations with sexuality that may result from frequent examinations for genital cancer, and possibly also the consequences of direct in-utero action of DES on the foetus.

It is not only DES daughters who suffer health complications. DES sons, too, are prone to abnormalities of the reproductive system and to infertility, and may have a higher risk of cancer. DES mothers themselves are thought to be more prone to endocrinal disorders and cancer. (Carcinogenic effects of DES were first discovered in experiments on mice—in 1938!) They also suffer "DES guilt"—the knowledge that their actions may have jeopardized their children's health.

There is no way of knowing what long-term effects of DES remain to be discovered. The oldest children of DES mothers are now in their late thirties, and it will be their medical histories over the next few decades that provide the answers. The most outrageous aspect of the DES story is that women were used as experimental subjects, without knowledge or consent. Said Dr Olive Smith, in 1976, "We have always done our work with human material. We've used animals, of course, but we thought human material was the most interesting." Enthusiastic doctors began trying DES out on their patients practically as soon as it became available.

Cynthia Orenberg is herself a DES mother, and her book provides DES victims with the information they need about their condition. Her explanations of medical and legal matters are clear and jargon-free, and she provides information about support and resource centres, as well as a list of the many names under which DES has been marketed. (Readers should note, however, that the book is published in the USA, and has no information specific to the UK.)

She also draws some general lessons from the DES episode: that pregnant women should be cautious about *any* drug; that all women should beware of the sexism of doctors, who are apt to regard their female patients as irresponsible and neurotic; and that women and men alike should not passively submit to their doctors' judgements, but should actively participate in decisions relating to their health.

While DES is no longer prescribed to pregnant women (it *is* widely used, however—in the "morning after" contraceptive, for example), other potent drugs are. One such is Bendectin, suspected of causing birth defects, which in 1978 was prescribed 3.4 million times to pregnant women in the USA, earning revenues of $14.4 million.

As this compact, informative book makes clear, the DES story is by no means over.

Bernard Gilbert

A Body Blow to the Farm Lobby

THE CHANGING UPLANDS, by The Countryside Commission. £6.70.
AGRICULTURE: THE TRIUMPH AND THE SHAME, by Richard Body. Temple Smith. £2.95.

The Changing Uplands is a very readable version of a massive landscape study by a team, prepared for the general public by Michael Allaby. It covers eleven upland parishes in England and Wales and the statistics for all of them show a progressive decline in the numbers of people, farms and farm workers. Before farming became an integral part of mass urban industrialisation—agribusiness has now spread from the lowlands to the uplands—rural parishes were largely self-sufficient. The process of destroying the traditional landscape in addition is now underway together with what remains of rural schools, transport, fire services, postal services, community housing and police; *and this despite all the government aid poured into agriculture.* No hill farms and few upland farms could survive without massive public assistance. But if this aid is intended to support rural life it is having the opposite effect. In fact the hills and most of the uplands are no longer economically necessary and it would relieve the Exchequer to abandon them, as Body points out in Agriculture: the Triumph and the Shame.

The destruction of the rural community and the landscape Body calls the shame of agriculture; its triumph is its efficiency in producing more per man from less land and stock. Like the economy as a whole it increases efficiency at the expense of human beings and the environment. This is more calamitous in agriculture than in any other industry.

The Farm Lobby must have been surprised to get a kick up the backside from a Tory M.P. and Lincolnshire farmer. What a traitor he must seem to them! But he is a stockfarmer and suffers from the high guaranteed price of corn that makes undeserved fortunes for his arable neighbours. These high prices also enable corn to be grown in places which are unsuitable and damage the soil and the landscape. If, Body argues, we had free trade such farmers would not be

able to compete with imported corn; only the farmers on corn growing land could compete. The same would be true on farms on 'improved' heaths and wetlands and moors which receive massive public assistance. If they kept stock they would have to compete with Argentine beef and New Zealand lamb. The public pays for the high capital costs of what it does not want; only the farmers are the beneficiaries. Body shows that the Farm Lobby's defence of the present system of Protection is blatant hypocrisy. If they are as efficient as they boast, why do they need to be protected? Why are they more heavily subsidised per capita than any other industry? They are the lamest of lame ducks, not the great example to the rest of us that they claim to be. This argument has recently been advanced by Marion Shoard and several rural sociologists—but they have been contemptuously dismissed as meddling with what they do not understand. No one, however, can say that Body is a sentimental female or a slick urban intellectual. He has given the case the validity it required. As a consequence the message is percolating among the media and MPs. The lobby has a tough fight on its hands. Signals of reluctant compromise are being received along the grapevine.

What should be done? Is Body's remedy the right one?

I have written a great deal myself on this subject and come to the paradoxical conclusion that the two worst things for farming are guaranteed prices and free trade. Guaranteed prices result in massive surpluses and other disagreeable consequences such as Body analyses. But to leave everything to be decided by market forces has unwelcome results too. I do not believe the remedy can simply be left to economics. A likely effect of Free Trade would be to finish the depopulation of the hills (land above 800 feet) and much of the uplands as well, as was the case with the Highlands of Scotland in the 19th century for the same reason. Do we want this to happen? What about the hill and upland character? Do we want a population conditioned by nothing but urban life, even if they can take their camping holidays in an upland wilderness?

In any case the economic remedy would take too long. The environment must be protected by suitable legislation at once—if the farmers resist we can threaten them with total free trade. Assistance to farmers solely on grounds of increased productivity must be ended. The intention must be to integrate the agricultural economy with the needs of the community as a whole.

The Uplands Report suggests a good step in this direction: the resurrection of the Rural Development Boards. But they should be extended to Regional Development Boards, so that hill, upland, and lowland farming could be worked in unison as was the case before agribusiness. Such Boards would have the power to control the sale of land and adapt husbandry to local conditions.

It is a big subject of importance to everyone and one to which our urban politicians give too little thought leaving the future of 80 per cent of our land area to the 'stewardship' of the agricultural barons who, for reasons of self-interest, are unfitted for such a responsibility.

Robert Waller

Re-animating Nature

THE DEATH OF NATURE by Carolyn Merchant. Wildwood House, London, 1982. £8.95.

The scientific revolution of the sixteenth and seventeenth centuries has been treated by most historians as a period of intellectual enlightenment in which scientists and natural philosophers wrested themselves free of the animistic superstitions of the Middle Ages. The new mechanistic world view and the quantitative, atomistic science that accompanied it are usually regarded as a coming of age of rational scientific thinking, enabling beneficial technological, social and economic advances to occur. However, the displacement of the ancient and medieval view of the world as a living organism by the modern mechanistic view is one of the principle reasons why we are now faced with grave ecological problems. Certain constraints in the way human beings should behave towards nature were built into the old organistic view of the world, which saw nature as a living, and even sentient, being. The overturning of the old world picture by the mechanistic philosophy of Descartes, Mersenne, Hobbes and others in the seventeenth century overthrew these constraints, making way for the exploitation and subjugation of the natural world for human benefit. In modern times we have come to see the scale of environmental devastation increase to a level at which a critical reassessment, from an ecological perspective, of the scientific revolution and its philosophy seems to be urgently needed.

In *The Death of Nature,* Carolyn Merchant undertakes just such a critical reassessment from a perspective which extends beyond the ecological to include also the feminist. The shift from the organic to the mechanistic view of the world involved a change in the way people perceived nature. In the old organic world view, living nature was felt to be endowed with a female soul, identified through the ages variously with the goddess Isis, the Virgin Mary and in medieval times—the Lady Natura, or "Dame Nature". As the nurturing mother, whose body was the world in which they lived, the attitude of premoderns towards nature was reverential and governed by normative constraints. "As long as the earth was considered to be alive and sensitive, it could be considered a breach of human ethical behaviour to carry out destructive acts against it." (p.3) The transition from the organicist to the mechanistic world view, rather than eradicating the image of nature as a living being, involved its subtle transformation from Mother to unruly woman, whom the new mechanical scientist must subdue and conquer. The new science was, from its inception, indissolubly allied with the notion of gaining power over disorderly nature, and subjugating her for the benefit of mankind.

The correlation of this shift in perception of nature with an assertion of male dominance in other spheres—social, economic and sexual—is a major theme of Carolyn Merchant's book, and should be given careful consideration. Carolyn Merchant argues that during the sixteenth and seventeenth centuries, women were persecuted as witches, tortured and forced to confess their secrets much as the new scientist was, in Bacon's words, to "hound nature in her wanderings", subject her to inquisition and force her to render up her secrets. Both disorderly female nature and unruly women had to submit to the experimental method and technological advance. Thus, while until the seventeenth century midwifery was the exclusive province of women, after this time male doctors with their new mechanical implement—the forceps—were to encroach upon women's natural province of reproduction. The social and economic roles of women declined from their earlier significance, as they became merely psychic resources for their husbands and lost their previous status as integral parts of the (economically) productive family unit.

Thus the advancement of science worked in such a way as to lower the symbolic and social status of women. If this thesis is correct, it is paradoxical that the strengthening grip of scientific attitudes and modes of thought during the centuries following the period covered by this book (the sixteenth and seventeenth centuries) should have culminated in the present comparative liberation of women from previous, narrowly defined roles and subservient social status. Although Carolyn Merchant

shows beyond dispute that early scientists such as Bacon and Boyle made use of sexual metaphor in their aggressive advocacy of mastery over nature, this is not enough to allow us to conclude that there is a necessary correlation between the mechanistic outlook and anti-feminism. Not only were previous organicist philosophers (like Aristotle) by modern standards anti-feminist, but also later empiricist philosophers such as J.S. Mill (whose doctrine of Utilitarianism is an implicitly anti-ecological ethic) were fervent champions of the women's cause. Although we may feel instinctively drawn to the view that a feminist philosophy would be anti-mechanistic, I think that while Carolyn Merchant contributes to its appeal she does not adequately show its necessity.

Several chapters of the book are devoted to an attempt to display the connections between the older traditions of organicism and a pro-environmental, pro-women philosophy. Certainly, it seems clear that a return to a more ecological philosophy of nature at least, demands that the underlying assumptions of the mechanistic outlook be challenged. The ethic associated with this outlook is human-centred, with inanimate nature simply regarded as a resource divorced from, and to be exploited by, human beings for their own advantage. At best, this philosophy will permit a merely pragmatic approach to conservation and human restraint over the exploitation of nature, in the interests of our own long-term human benefit. The managerial approach to nature, which has many advocates today, and which was already being advocated in the seventeenth century, fails to deal with our ecological problems at their root. In order to do this we need to re-animate nature and come to a living awareness of our connectedness with the world.

Although the organicist tradition in philosophy, allied to a qualitative and holistic science, has always existed in different forms as an alternative to the mechanistic philosophy, it has since the end of the seventeenth century been only a minority tradition of protest against the orthodox mechanical world order. The time has come, however, for ecologists and (according to Merchant) feminists, to turn to this tradition in order to build anew a metaphysic which will restore our respect for the earth, and a philosophy in which the values of co-operation, non-violence and sensitivity towards nature and other human beings replace the dominant "male" values of competition, aggressiveness and self-assertion. In the sixteenth century, the organic tradition encompassed three different streams of thought Neoplatonism, naturalism and vitalism. It is the last of these, vitalism, which Carolyn Merchant favours as having the most to offer our contemporary situation. Originally advocated by such figures as Paracelsus and Van Helmont, and taken up in the seventeenth century by the woman philosopher Anne Conway and Leibniz, vitalism sees spirit and matter as interconvertible terms referring to single living substances. In contrast to mechanicism, which seeks for the explanation of things in the actions of forces external to them, vitalism looks for immanent, internal principles by which things determine themselves according to their own inner nature. Again, rather than viewing the world as a mechanical ordering of parts, governed by rigid scientific laws, vitalism sees nature as an organic whole, in which the various entities of which it is composed interact together by virtue of a kind of concensus or, as Leibniz put it, a "pre-established harmony". The compatability of vitalism not only with an ecological perspective but with libertarian social and political ideas strengthens its appeal as the philosophy of the alternative movement.

Jeremy Naydler

The Future is Wild

WILDERNESS, ed. Vance Martin, Findhorn Press, £3.95.

Aldo Leopold, in one of his prophetic essays, recalled how godlike Odysseus returned from the Trojan wars and hung six slave girls for misbehaviour. It was not murder; the slaves were private property, and he could do what he liked with them.

Twentieth century man, he says, sees land as a slave, as private property he can dispose with as he chooses. He is still a conqueror and has not discovered a land ethic. He has yet to see, as 'inhabitory' people see, land as part of community with rights too. He must become a biotic-citizen along with other land 'citizens' from microscopic soil azotobacters to big carnivores.

If he did, Leopold adds, he would see that land management is right "when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise."

This holistic approach, putting man back into the landscape, going beyond crude economic domination to discover our true obligations of stewardship is demonstrated in almost every page of Wilderness.

The text is knitted together from the main contributions at the 1980 World Wilderness Conference in Australia. It is an eloquent, passionate and reasoned exploration by leading scientists and environmentalists of two big questions: Why do we need wilderness on our planet? And how do we keep it wild?

The answers takes us away from the terrifying terminus of a world without wilderness, beyond the exploitation which is snatching 15 million hectares of rainforest every year, to a vision where people and nature can co-exist peacefully and enhance each other.

The contributions are chosen to examine many viewpoints—scientific, social, cultural and spiritual. They are divided into three sections. The first explores the common ground between three 'inhabitory' peoples; Australian aboriginals, American Indians and Zulu Africans. Laurens van der Post brings home the crisis to our urban roosts when he says: "These two forms of abuse—exploitation of the natural resources of the earth and the denial of the natural being within—are really one and interdependent."

The next section looks at specific wilderness areas, from the expanses of Antartica and Greenland, to the rain forest of Papua New Guinea and the remnants of European wilderness. The paradox that there is no wilderness without people; the conflict between ecological wilderness, long-term management and economic interests are explored in the final far-seeing action.

Wilderness is needed not only to maintain the genetic pool, maintain the stability of the planet's biosphere (and that means our own future) but also because wilderness has a right to exist independent of its benefit to humanity.

The decisions need to be made now, both locally and on a planetary scale. It has taken sixty million years for the tropical rainforests to develop; they can disappear within less than a human lifespan says Alan Grainger, and he adds: "The forests are the soul of a nation. As Ehrenfried Pfeiffer said: 'When a culture reaches maturity and becomes over ripe, it must return to the forest, the source of all life, in order to rejuvenate itself. If a culture sins against the forest, its biological decline is inevitable.' "

To conclude with another speaker, C.J. Armstrong; "An African chief, when a European asked him who owned a particular piece of land, replied: 'The many who have lived here in the past, the few who live here now and the many who will live here in the future.' It would be . . . delinquent of any present day manager, as the representative of the few who live here now, to make decisions which would needlessly destroy values which should be available for the many who will live here in the future."

Peter Please

Classified

PERSONAL

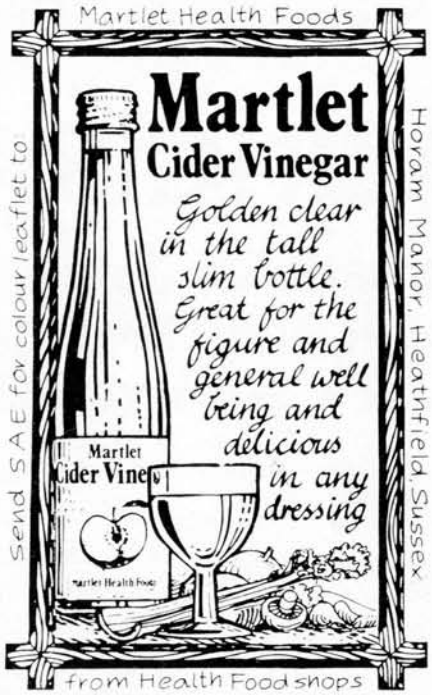
MOPSS (Make our power station safe) committee is campaigning for the installation of Gas Blast Protection at Hartlepool Nuclear Power Station.
The Nuclear Installation Inspectorate, the organisation responsible for enforcing safety standards at nuclear installations, refuses to do so in this case. As we do not believe that Hartlepool Nuclear Power Station could withstand an explosion at the nearby petrochemical works, we feel that we have no alternative but to take the NII to court.
During the next three months, we need to raise in the region of £10,000 to enable us to finance the necessary research and pay for a barrister during the court case. We hope that you share our concern, and urge you to make a contribution towards our cost.
For further information please contact: Kevin Daws (0642-477697), 10 Scanbeck Drive, Marske-by-sea, Redcar, Cleveland.

PROPERTY FOR SALE

"To do something, you have to be specific to a place". (Gary Snyder).
Here at Canon Frome Court, we are developing 40 acres by the River Frome as an organic agricultural collective, a small mixed farm. Old meadow, river bank, some wilderness, old trees, new plantings, carp-lake, greenhouses, large walled garden. Workshop/office space. And some 40 souls aged 1-77, in 12 households. Join us? Leasehold starter home £18500. Leasehold 4-bedroomed maisonettes £38000.
Windflower Housing Association, Canon Frome Court, Ledbury HR8 2TD. Phone Trumpet 534 or 574.

BUSINESS OPPORTUNITIES

Create your own work (and new income) with THE ENTREPRENEUR, probably the most exciting newsletter in the world. Free introductory offer. S.a.e. THE ENTREPRENEUR, Dept. B172, Alston, Cumbria, CA9 3RP.



SITUATIONS VACANT

HONDURAS AGRICULTURALIST. An experienced, general agriculturalist is needed to join an agricultural promotion project in Honduras. The agriculturalist will train local agricultural promoters, and develop new production and storage methods. Applicants should have a broad training as an agriculturalist—BSc or HND—and at least 2 years post-qualification experience including grains, vegetables, pigs and cattle; they should also have experience or an interest in training other people. 2 year contract on basic salary for a single person, with return flights to Britain, insurance, equipment and other grants. Language training and local orientation course are provided by CIIR. For job description and an application form, please send brief details of your qualifications and experience to CIIR Overseas Programme, 22 Coleman Fields, London N1 7AF. Please enclose a large SAE and quote ref EC/1.

MISCELLANEOUS

FOUNDER MEMBERS required for a new political party and conservation society, with the aim of stopping and reversing the destruction of wildlife, as well as improving general standards of life. Especially welcome are people who are willing to stand for parliament, or who will help run the organization. Membership is free, but please send S.A.E. for details to M.D. Somes, Kilravack, Park Lane, Twyford, Winchester, Hants. SO21 1QS.

THE GREENS ARE GATHERING! From 26th-31st July, Greens will be gathering on a beautiful site overlooked by Glastonbury Tor to discover a new way of living and to bring together people interested in radical, alternative and Green activities—ecologists, feminists, anti-nuclear and peace campaigners, libertarians and many others working for a freer, safer and more just society. At the heart of the Gathering will be a special area for children.
Until the end of June advance tickets will be available at £7.50 for the 6 days. On the gate, tickets will be £10 for 6 days, or £5 for the weekend only. All children under 14 will be FREE. For tickets and enquiries contact Dean Holden, 5, Tor Park Road, Paignton, Devon. Send S.A.E., or phone Paignton (0803) 552397.

HAND-CARVED NOAH'S ARK SETS: animals in oak, cherry, yew, mahogany, etc. Ark in Douglas Fir. All with bees-wax finish. Also richly painted sets and other toys. SAE for details. David Plagerson, 5 Cliff View Terrace, Gunnislake, Cornwall. Tel. 0822 833035.

CONFERENCES

The SECOND NATIONAL RECYCLING CONGRESS will be held in Boulder, Colorado, August 16-19, 1983. The event will include presentations from all fields of recycling and resource recovery.

For more information on congress registration and recreational opportunities, contact the Congress Office, UMC 331, Campus Box 207, University of Colorado, Boulder 80309, USA.

BIO-DYNAMIC AGRICULTURAL ASSOCIATION. Annual Conference open to all: "The Rythms of Nature and their Significance". July 15-17, 1983 at Hawkwood College, Stroud, Details from: Secretary, B.D.A.A., Woodman Lane, Clent, Stourbridge DY9 9PX.