ecologist

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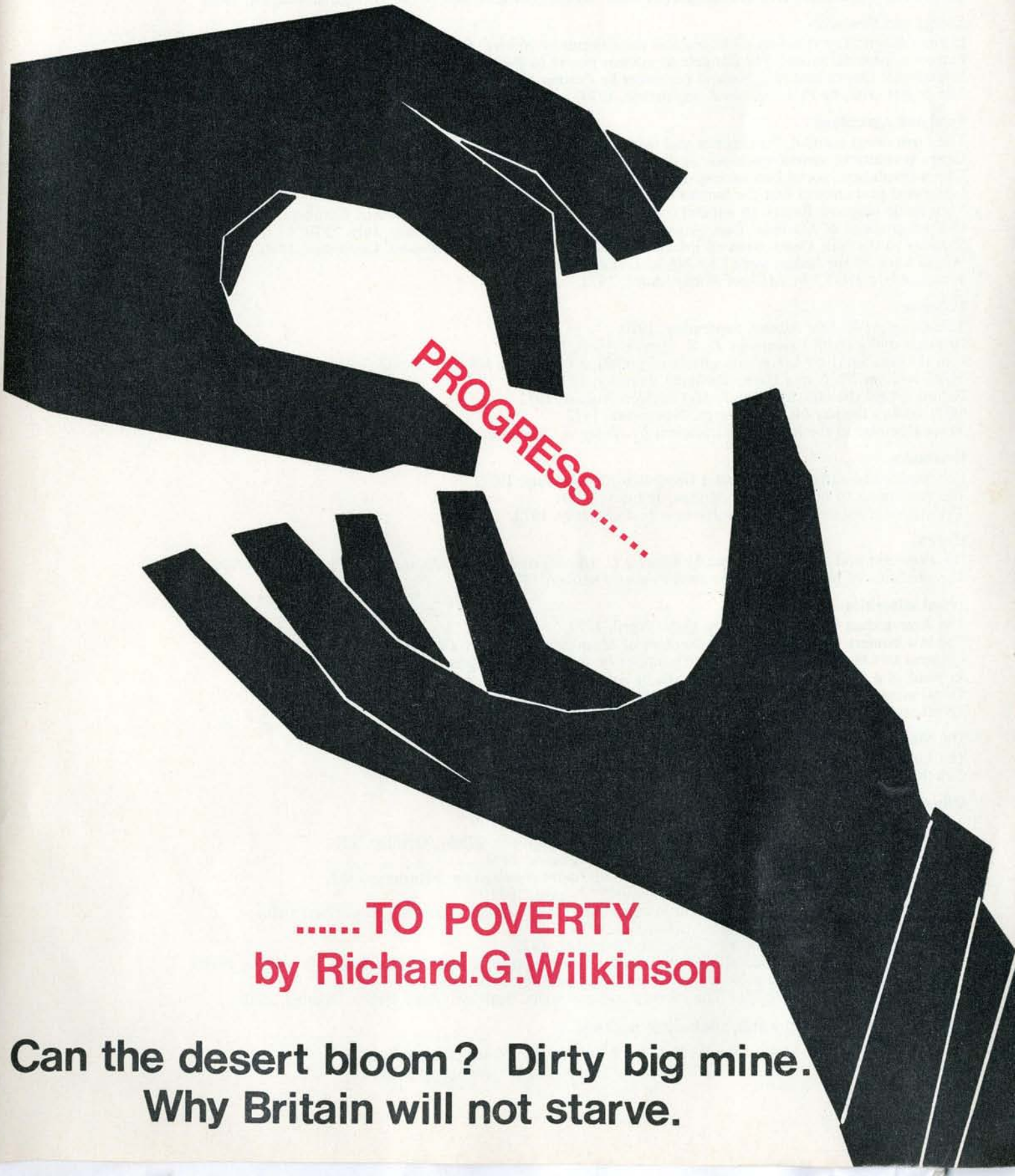

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Why Britain will not starve.

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Vol. 3 No. 9 September 1973

Can open cast mining be clean?

RTZ's dirty big mine

When Bougainville copper, one of the world's largest copper mines, began operation on 1 April 1972, on the Island of Bougainville, Papua-New Guinea, Conzinc-Rio Tinto, Australia, the majority shareholders, claimed it to be a "model mining operation". Now, less than 18 months later, disclosures to the *Ecologist* suggest that not only are thousands of tons of crushed rock tailings sliding into the river that flows through the mine site, but that every day some 71 tons of pure, finely divided and highly toxic copper are being pumped into the river together with other toxic chemical reagents. As a result the river and the forest beside it have been killed stone dead all the way into the sea some 14 miles away, and in the sea itself a large, grey expanding scar indicates some of the effects of the daily burden of wastes flowing into it from the mine.

In a typical day's operation 90,000 tons of copper ore are dug out of the hillside with enormous electrically operated shovels and fed into 100 ton trucks. For every ton of ore there is 0.7 tons of waste and every day some 63,000 tons of waste rock get piled by the river. Floods and erosion then carry some waste rock into the river.

In addition the company is actively dumping the debris of 90,000 tons of ore into the river, which, together with the waste rock is filling the river up. The original intention was that the river would carry all the debris out to sea. At the end of the first year's operation about 40 per cent was being retained in the river valley. This year the retention is 60 per cent and the position is worsening by the day.

Added to that onslaught of debris the river which was very near neutral in pH, becomes very alkaline where the copper ore tailings are piped in, and the pH remains high all the way to the sea.

Rio Tinto Zinc has gone to some lengths to explain to visitors that the river has died because of the silting up with the tailings and that two years after bringing mining operations to an end in an estimated 40 years' time the river will once again spring to life. The company has given no indication that the more likely cause of the river's death is its daily dose of copper, at a high pH which in one year amounts to

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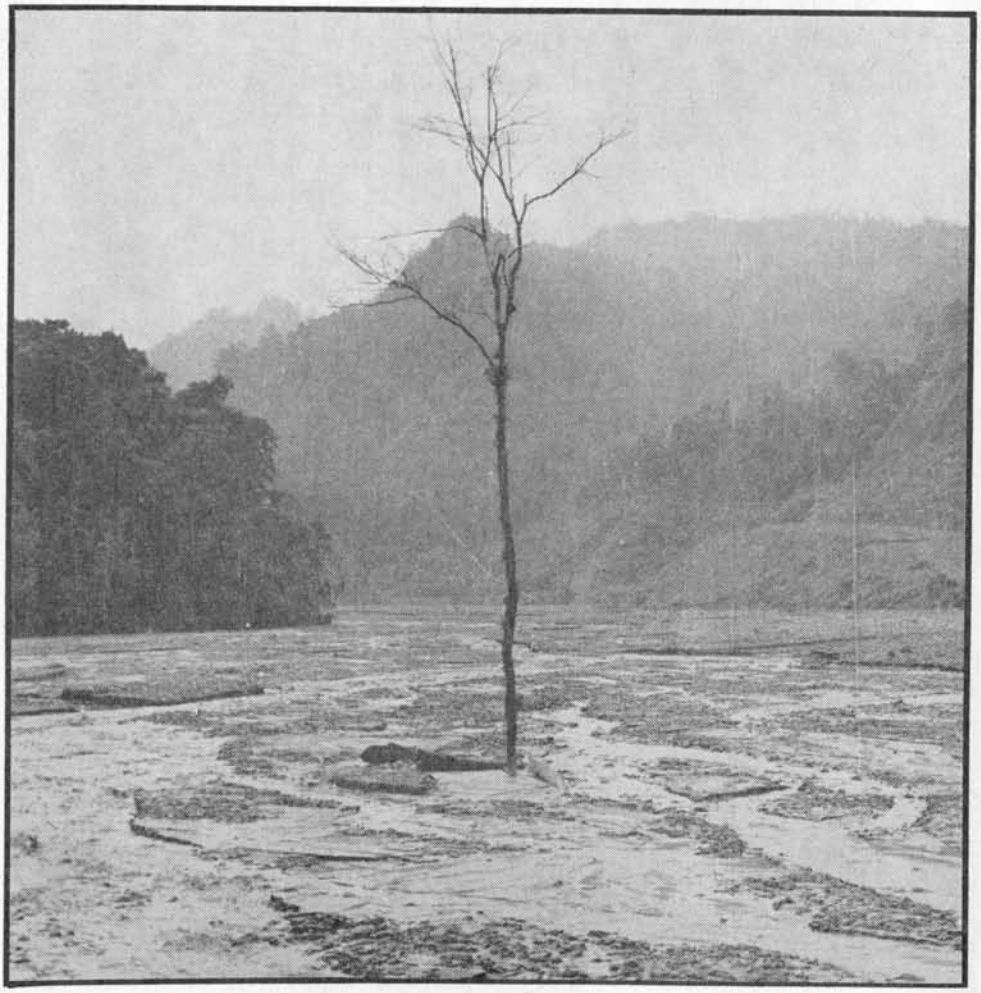
The river of tears flows on



In this issue

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Dirty big mine *continued from page 321*

26,000 tons.

After the ore has been separated from the tailings and crushed it is processed in a huge chemical extraction plant. The grade of the copper sulphide ore varies from 0.25 per cent to 1.2 per cent of copper. In order to maximise its profits the company is going for the highest grade ore, and the highest possible throughput per day. The plant is now working 24 hours a day, seven days a week at the point of "overload" and therefore its efficiency of extracting copper is diminishing, although a higher tonnage of copper is extracted. In fact more than 15 per cent, or 71 tons, gets lost daily with the effluent, together with considerable quantities of lime, potassium amylxanthate and methylisobutylcarbinol—chemicals that are added to the process to make it more efficient. The majority of the copper that is lost is not recoverable by the process used at Bougainville.

On being asked whether he thought a 15 per cent loss of copper to be "normal" an RTZ spokesman exclaimed that it would be "very bad" and if it were so "we'd be looking at our ways of operation".

During normal operation one would expect, he said, the recovery of copper from the ore to be 88 to 92 per cent efficient. As to the rest—the 8 to 12 per cent that is not recovered—"that goes back to God". He failed to mention a dead river and a swathe of destruction out to sea.

In 1970 RTZ estimated that 80,000 tons of ore would be processed each day and that 95 per cent of the copper would be extracted. In view of the spokesman's comments the company has long since abandoned any pretence to such a high efficiency of extraction. It is also interesting to compare RTZ's copper mining operation at Palabora in the Transvaal. The mine, also open cast, was started in 1964, and the recovery of copper is stated by the company as being 84 per cent; a figure which seems to fit close to that actually being attained at Bougainville.

But even if the best recovery were obtained and only 5 per cent of the copper was lost the amount discharged would still be more than 8,500 tons each year; enough in fact to destroy all life in the river and along its banks.

Papua-New Guinea is the other side of the world and few people in Britain

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Superphosphate farming in New Zealand

Cockies and chemicals

A "cockey" is a New Zealand farmer, defined as a man who makes mud into milk. This alchemy has been no sinecure. The pioneers found a forest-clad country and, in a few decades, with axe and fire, converted it into 40 million acres of grassland. Initial results were wonderfully productive, but short lived. The primitive stable forest ecosystems presented a virtually closed cycle of nutrients, circulating between trees and litter layer. Soils were basically poor, deficient in trace elements, phosphorus and nitrogen. The rich ash after burning masked these deficiencies, but poor soils deprived of protective tree cover were further depleted by widespread erosion.

The first farmers, then, attempted to apply agricultural methods suited to Europe's rich soils (after centuries of skilled husbandry) and poor climate, to New Zealand's poor soils but wonderful climate, adequate rainfall and abundant sunshine stimulating plant growth throughout the year.

Our resourceful cockies overcame the anomaly, developing the use of dogs and aircraft for farming economically vast tracts of inaccessible, forbiddingly steep hill country. Aerial top-dressing was pioneered in New Zealand, and the industry in frozen meat which, exported with wool and dairy produce, justified 40 million acres of felled forest.

Another innovation was the ryegrass-white clover mixture basic to pastures on all terrains. Clovers adequately compensated the soil's nitrogen deficiencies, those of phosphorus were made up by superphosphates. The initial boost this gave to pastures and livestock was so spectacular as soon to acquire the aura of a ritual practice, a panacea against all the farmer's ills. An attitude enthusiastically supported by a powerful High Priesthood, the Agro-Chemical Barons who, in the past half century, developed superphosphates into a major industry. Today a dozen factories are engaged in its production, distribution covers one fifth of New Zealand's total area, and 1972 sales topped two million tons.

Most New Zealand soils contain the chemical, allophane, which "fixes" 90 per cent of the soluble phosphorus in superphosphate, leaving only 10 per cent available for plant growth. This grossly inefficient figure was known 30 years ago, shown by D.S.I.R. Pasture Research studies. It is confirmed by recent research at Waikato University, but further research on the fixation process and means of making this store of phosphorus available is impossible for lack of funds. Instead, a "sledge-hammer" solution to the problem, pouring on more "super" annually, is advocated by the Department of Agriculture, to the satisfaction of Agrobiz. The farmer's loss is staggering, $30 millions spent on superphosphate annually, with nine-tenths wasted.

Further, New Zealand's sources of phosphate, Naru and Christmas Islands, are becoming depleted of first-

Continued on page 324

Dirty big mine *continued from page 322*

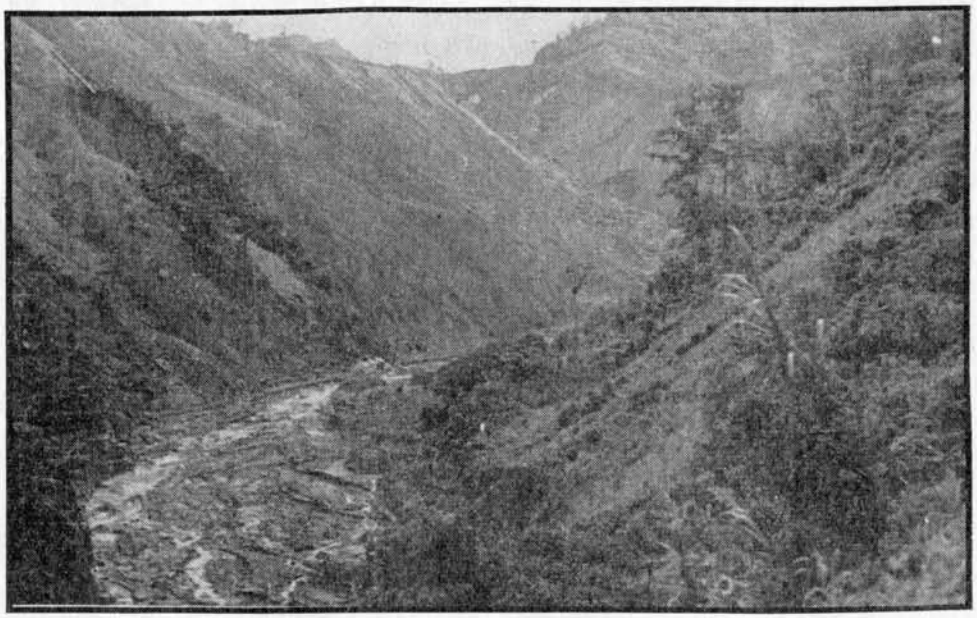
care one way or the other that a valley and its river should be destroyed, but the brutal facts of open cast mining take on a different significance when a National Park is threatened as is Snowdonia at the present time. Largely because of a public outcry at their intentions to mine for copper and other minerals in the National Parks, the large mining corporations set up a Commission led by Lord Zuckerman on Mining and the Environment, and they promised to adhere to its findings. The Commission's report was published on 13 September 1972 and its recommendation 16 states:

"As much water as possible should be recycled within the mine site and any toxic substances produced by the workings should be contained and dealt with within the site".

The evidence from one of the world's largest and most modern open cast copper mines suggests that the mining corporations are incapable of meeting that recommendation. Any government granting permission for new mining ventures in Britain involving toxic metals such as copper should bear that deficiency in mind.

Peter Bunyard

Tailings are introduced just above this point. Waste dumps in background.



Cockies and chemicals *continued from page 323*

grade material so, to get quantity, third quality stuff is added, introducing additional impurities. Fluorine is the worst, seriously affecting stock, e.g. breaking of sheep's teeth, pull-out of wool. Twenty years, moreover, may well see these phosphate sources exhausted.

Most damaging, is superphosphate's effect on soil. Shelford's Law is inexorable, too much is as bad as too little. Moderate phosphate applications are beneficial; immoderate quantities, accumulations of unused ninety-per cents, it's poison. First to go is the sensitive soil flora and fauna, including the invaluable earthworm. The consequent inevitable decline in fertility and livestock health is met by the Agricultural Department's standard advice "apply more super", until the soil has lost life, structure, fertility. Sterile hardpan results, dung and plant debris, undecomposed, matting the surface, lack of visible life beneath.

Correction comes with abandonment of artificials, generous liming to raise pH, de-stocking for pasture recovery, planting hedges and shelterbelts. Within two years, I've seen soil fauna, heralded by earthworms, reappearing, pastures and stock recovering.

There are various correctives, all start with abandonment of superphosphate. Foliar feeding with dilute phosphoric acid shows dramatic results, a 33 per cent increase in butterfat yields in three years on one farm.

But research on this promising approach is done privately, not by the Agricultural Department.

Many farmers have gone organic, and never looked back. South Island's Jack Nicholls has farmed 40 years without artificials or sprays, his stock in perfect health. Harry Leaman converts Oamaru's city garbage into rich compost; light and friable, it can be aerially top-dressed. John Scott's 300 green acres show an exemplary application of ecology's basic law, variety spells stability. Shelterbelts give protection, debris and predator-niches; there's manure, compost, straw; a rich herbal ley contains chicory, plantain, deep-rooting lucerne, several species of grass and clover; planned rotation replaces dollar-mad monoculture. Crop yields double those of neighbours using superphosphate. His stock flourish on the prolific variety, with vitamines, enzymes, amino-acids, anti-biotics present in his pastures, never found in NPK formulae.

Despite New Zealand's basically different agricultural pattern, her problems are identical with Britain's, the wisdom of centuries of sound husbandry threatened by a sordid pursuit of profit. Solutions will never come from Government, remote, pedantic, brainwashed. They will come from the resourceful, independent "cockey", with Nature's rhythm in his pulse.

Kenneth Morris

London's owls

Tawny and brown owls are threatened with extinction from Tower Hamlets Cemetery in London's East End.

The dense undergrowth, undisturbed since Victorian times, has provided food and protection for a variety of bird and animal life unknown elsewhere in East London: not only owls but cuckoos, robins, tits and thrushes, fieldmice and foxes have been found there.

Already the GLC has grassed over the south eastern corner of this natural woodland and now plans to clear the rest of the thirty acres in three stages spread over two or more years. "Trees of Merit" are to be retained, but the municipal mind cannot tolerate the untidy growth which is essential for the support of the wildlife.

On the weekend of the 17th and 18th March, this order of priorities was challenged when Queen Mary College Ecology Society, a local amenity group of clergymen, teachers and school-children about 50 strong "raided" the cemetery—and collected 38 bags of plastic, tins, paper and assorted rubbish in less than half an hour. Large objects including an oil drum, a pram and corrugated iron fencing were removed to the local council dump. The bulkiest bag of all was deposited on the steps of County Hall.

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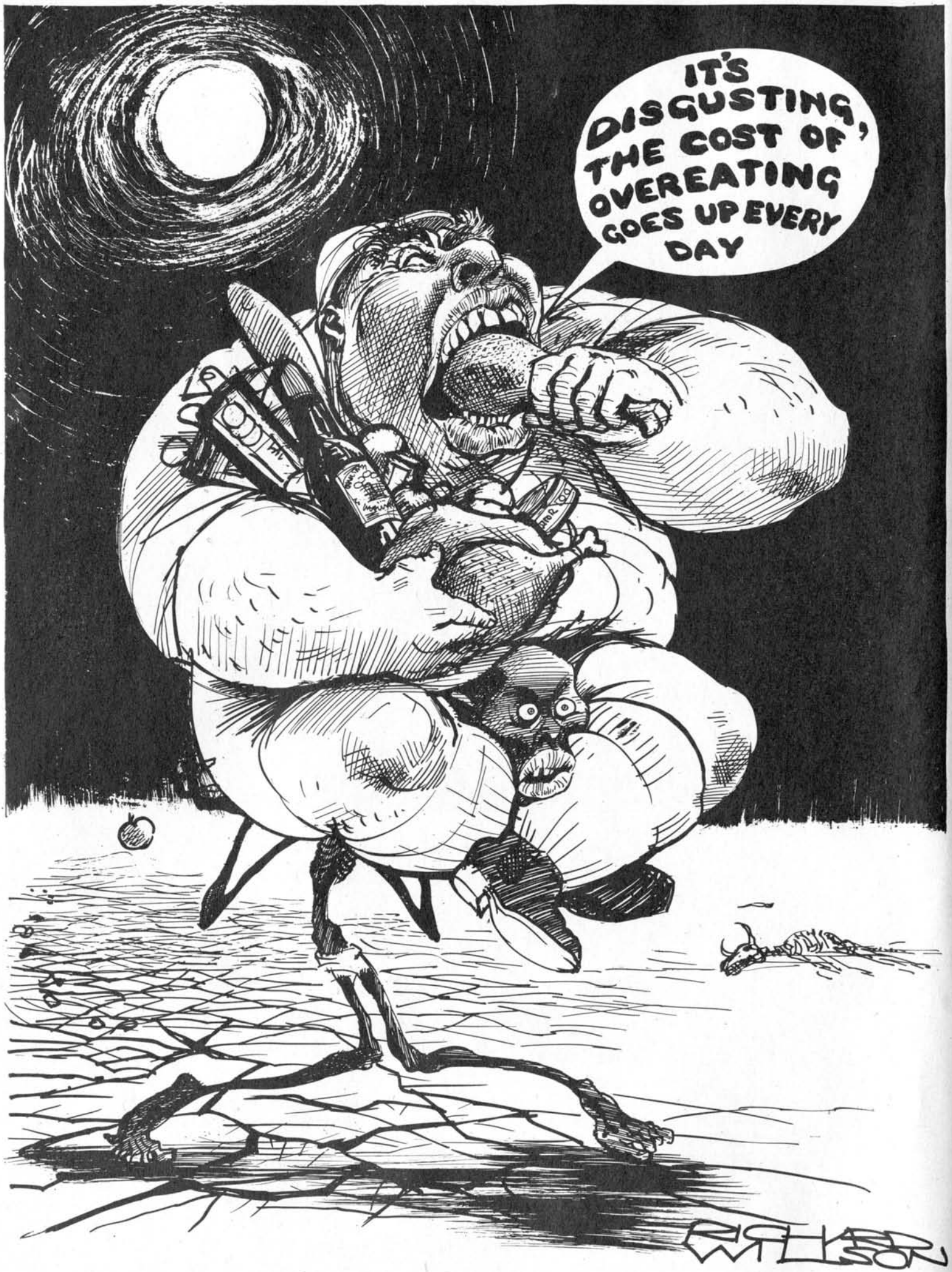

IT'S DISGUSTING, THE COST OF OVEREATING GOES UP EVERY DAY
RICHARD WILSON

Comment

Food prices—why we won't starve

There is something ludicrous and macabre about the inevitable slanging matches in the Commons over rising food prices, with government and opposition resorting to their time honoured game of blaming each other for a situation which both might have foreseen, yet blindly chose to ignore. While we in Britain protest bitterly at the inflationary prices we are having to pay for our meat and vegetables, millions of people elsewhere in the world are facing the biggest and most devastating famine of all time. Angry housewives may make good TV viewing and they may actually arouse sympathy, but what they are complaining about has absolutely nothing to do with starvation. Indeed they and their families might well be better off for a little less of that high quality protein that we have been led to believe is our essential right.

Money speaks louder than suffering and the big food producers of the world, themselves now victims of galloping inflation, are hardly likely to give their food away to those for whom it means life or death but who lack the means to pay the right prices. On the contrary, the producers will continue to sell to the highest bidder as they have always done, even when the buyer is Russia or China and the seller the United States. And last year, when India bought wheat from the United States it had to pay even higher prices than the high prices paid by the Russians.

Last year was a year of reckoning. One harvest failed after the other. Drought wiped out harvests in India, Australia, in the south west Sahara and South Africa. For one reason or another the anchovy shoals disappeared off the Peruvian coast, putting paid to one of the largest single sources of cheap, high quality protein. Russia practically lost its wheat and sugar beet crops, and the United States was not able to produce as much soyabean as had been hoped, owing to a bad autumn. Nor did this year get off to a good start. Drought is still affecting large areas of the world and the United States had an appalling beginning with flood and bad weather wiping out crops in the main food producing belt in the mid-west.

Inevitably and predictably the world now lacks food, but to imagine that we in the west will suffer real shortage is to misunderstand the power of being affluent. What it means in effect is that we will have to begin to pay a more realistic price for our food. Before the war the French spent on average 60 per cent of their incomes on food and were apparently happy to do so. The British are now moaning at having to pay just over one-quarter of their incomes on food. Indeed so upset are they that the government has been threatened with a loss of its substantial housewife vote unless it subsidises food prices and boosts family allowances. That the government prefers the idea of supplementing families with low incomes and old age pensioners is a neat inexpensive way out since it depends on where the "poverty line" is drawn.

The government's enfeebled attempts to keep prices down by curbing wages and by trying to put ceilings on the cost of consumer goods has been doomed from the start for the simple reason that Britain has to import most of its raw materials including feedstuffs for livestock. Prices have rocketed and will go on doing so as competition stiffens for the world's raw materials. Not that world production has gone down; on the contrary it has generally gone up; but then so has demand. The EEC countries for example have bought 5 million metric tons of the US 1972 soyabean crop compared with 4.39 million metric tons in 1971, and they are willing to pay the price—three times what it was one year ago.

Ironically, basic economics are effecting some changes for the good. Battery and intensive livestock farmers are being forced out of business primarily because the world shortage of basic feedstuffs has caused prices to soar. To make matters worse for the farmers President Nixon has imposed price restraints on farm produce and breeders are now faced with the ticklish dilemma of making a loss whatever they do. A good many farmers have calculated that they will make less of a loss if they slaughter their animals young, and wholesale butchery has been taking place throughout the States with poultry breeders grinding up chicks for fodder and killing off cattle including good milking cows at an unprecedented rate. It has even been reported that some cattle farmers in the United States have been forced to fatten their steers on old-fashioned grass instead of on growth-inducing concentrates.

Basically because of subsidies, most British farmers tend to overstock and they therefore have to import considerable quantities of feedstuffs to augment what they can produce from their own land. Soaring costs of these feedstuffs, together with increases in the cost of fertiliser and machinery, have inevitably pushed prices up. The government is now in the same position as President Nixon in the United States, and by trying to impose price restraints is shutting its eyes to the realities of the situation. In Britain farmers are still on to a "good thing" and they are making money from their sales of animal protein, but if ceilings are put on prices there will come a time soon when it will no longer be worth their while to keep so many animals on their farms. They too will slaughter and the resulting shortage will in all probability send prices soaring still higher. It could be a true turning back of the clock with the lower income groups eating chicken as a hard-earned delicacy once a year at Christmas.

Modern agriculture is absolutely dependent on cheap inputs of energy, mainly in the form of petroleum and electricity. These cheap inputs have enabled the west to undercut prices of all farm produce so that the consumer has lost sight of what he really should be paying. The undercutting has had other serious consequences, for whenever developing countries have managed to squeeze out surpluses using labour intensive methods rather than capital, they have found themselves up against give-away prices. As a result they have been virtually unable to make a profit.

Without petrol agriculture would collapse and because of the current fuel

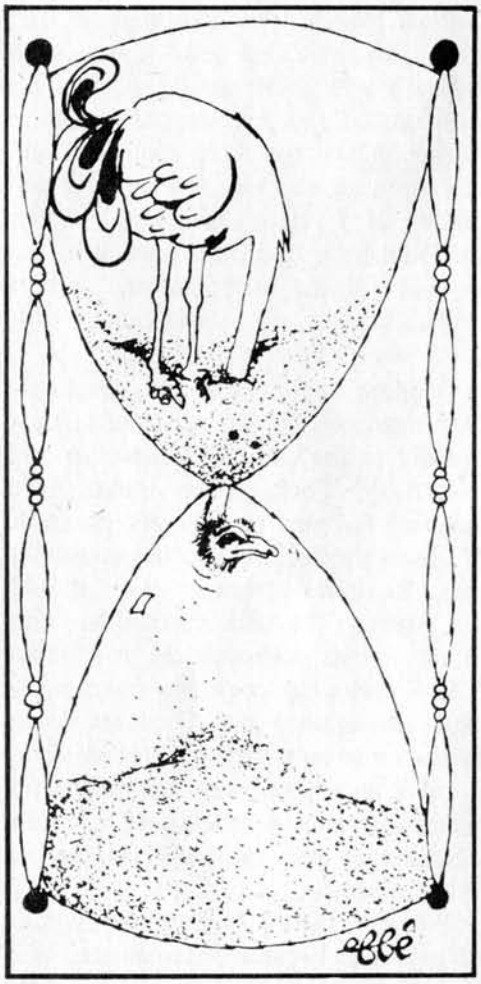
crisis is already in danger of doing so in the American midwest. Agriculture is proving to be America's only reliable dollar-winner abroad and Nixon has therefore had to make it clear that agriculture in the US—the largest single user of petroleum—has absolute priority over supplies, even before doctors.

Britain too could soon be facing a fuel crisis and it must begin now to take steps to stabilise an almost impossible situation. In the long term the only way to stabilise food prices is to make Britain as self sufficient in food and other raw materials as possible. Labour is one such raw material and it is now recognised that farm productivity measured in yields per acre does not go up with machines. Quite the contrary, the most productive farming in the world is done by hand. Thus, instead of whittling down the number of people working the land to less than 100,000 people, and increasing the capital costs of farming we should be putting policies into practice which have the opposite effect. The government should in fact be taking desperate measures to get labourers back on the land. Predictably it is doing worse than nothing; it is, in fact, offering substantial compensation of up to £1,000 an acre to persuade small farmers to leave the land.

Unfortunately Britain is now in the most unenviable position of having largely destroyed traditional labour intensive agricultural practices and of having allowed agricultural accommodation to be sold off to non-labourers. Too often the labourer's cottage has become a second home for the city-dweller. Yet something must be done and one suggestion would be to subsidise the farmer for every labourer he uses over a certain minimum. In addition, crash training programmes would have to be instituted and reasonable wages offered to entice labourers back on to the land.

To go on as now is to court disaster. As Howard T. Odum mockingly suggests in *Environment, Power and Society*, when petrol and other farm essentials begin to rocket in price—out of reach of the farmer—the west will have little choice but to import peasants from developing countries such as India. To prevent that absurd possibility we must establish the means now to get people back on the land. It will give us a chance to survive even though we can no longer afford to eat meat twice or even once a day.

Peter Bunyard



Roads to independence?

If Government plans to make drastic cuts in the railway network are carried out, quite large regions of Britain will lose their passenger rail services altogether. In the West Country, for example, passenger trains will stop at Plymouth. Cornwall, which at the present time has only one line, to Penzance, will have no service at all. The proposed motorway, which would speed tourists down to Cornwall during the four month holiday season, only to abandon them on the county's already overcrowded roads, is at best controversial, at worst wholly inappropriate. The need is to bring in visitors without their cars and then provide adequate transport services between towns and beaches.

Cornwall, then, cannot afford to lose its railway. Indeed, in common with other regions, it needs more lines not less. Faced with the arbitrary withdrawal of its service, it may have little choice but to take matters into its own hands. Should it decide to do so it might discover that an apparent disaster in fact presented an opportunity to achieve a measure of independence and real control over its destiny.

Parts of what used to be passenger lines still exist and the track is maintained for the conveyance of industrial goods: mainly the china clay and minerals extracted in Cornwall. It might be possible for a consortium formed from mining companies, ECLP Ltd., the group which dominates the china clay industry, the local authorities, railway enthusiasts and amenity bodies to take over the county's railway network and to operate passenger as well as goods services. Moroever, it may well be possible to operate profitably, so permitting the service to expand. Thus Cornwall could become the first area in Britain to have a transport policy designed, implemented and controlled within its own borders.

Having started there, why not assume still more independence? The Westminster Government, for reasons best known to itself, seems terrified of making any coherent statement on population, its economic polices are in disarray and it can do nothing to halt the rising price of food. Cornwall could regulate its own economy and, of course, it could become entirely self-sufficient in food, exporting its surpluses eastward along its own railway lines. Suddenly, economic and political decentralisation begins to look both attractive and feasible. And what applies to Cornwall must apply equally to other regions.

All the world's imperial powers have learned that empires cannot long outlive the communications systems that bind provinces to the capital. As soon as these are severed, the empire begins to fragment. It happened to the Romans, to the Incas and it is a recurring theme in Chinese history. Should we then applaud the Conservative transport non-policy, rather than castigate it? Far from detracting from the quality of life, may it not offer people their first opportunity to decide for themselves how they will live?

In the interests of good neighbourliness, Mr Peyton might like to consider holding discussions with the representatives of the nationalist and separatist movements in Cornwall, Wales, Scotland, the North-East, Yorkshire, Lancashire, Wessex, East Anglia, the Midlands and the Borders in order to arrange a smooth transfer. No doubt Westminster could retain some interest in the affairs of London Transport.

Michael Allaby

Notebook

Clean air for America?

The Environmental Protection Agency has wasted no time in seeking to implement the Clean Air Act, 1970, but reactions to its efforts show just how much clean air will cost. The automobile manufacturers are urging a complete review of the Act, claiming that unless limitations on emissions of nitrogen oxides are relaxed, cars will become too expensive to buy. As things stand, from 1976 the annual bill for devices to clean up car exhausts will amount to $23.5. This is a lot of money —nearly half Britain's national budget. Will Americans have so much to spend and if they have, what will be the effects on the economy? It seems unlikely that such priorities as growth will be compromised, or the fight against inflation, or the improvement of the balance of payments, in the interest of what many people will regard as a luxury.

However, the car manufacturers are not alone in their concern. The generation of power could also be affected and this would have ramifications throughout the whole of US industry. The Navajo Project, for example, now under construction on the Colorado River in northern Arizona, will have to be abandoned unless the law is interpreted in favour of the company. The project, estimated to cost $100 million, should begin operations in May 1974, with a generating capacity of 750 MW. Two further units will give it a total output capacity of 2.25 thousand MW. In spite of the fact that the latest anti-pollution equipment has been installed, air quality standards required by 1975 will not be met. Will it close? America is already short of generating capacity and the energy crisis is certain to be regarded as more urgent than the need for clean air.

Developers are likely to be affected as well, for many projects such as new highways, airports, and shopping centres will have to be modified or abandoned because, according to the law, they must not be allowed to generate volumes of traffic that will cause automotive pollution to exceed permitted levels. Who will win this particular battle?

If industrial society is to expand, it cannot be deprived of its basic infrastructure; and expand it must, or die. The sad fact is that you cannot have both an industrial society and clean air. One has to choose. If the Americans want motor cars, electric toothbrushes and vaginal deodorants, then they must put up with polluted air. They can't have their cake and eat it, nor, in this instance, can they eat someone else's. So they will have to breathe their own filthy air—unless, of course, the energy crisis deprives them of the means of polluting it.

The Greeks understood . . .

"The Law has no power to command obedience except that of habit, which can only be given by time, so that a readiness to change from old to new laws enfeebles the power of the Law." Aristotle. *Politics Book II.*

Clean water for Britain?

You can't have an industrial society and clean water, either. Few things illustrate better our inability to control pollution by technological means than the present plight of our rivers. Industrial society makes use of all sorts of biologically potent substances on an ever increasing scale. Some 500,000 different chemicals are used by industry and when they are required no longer all of them must be disposed of somehow, somewhere. And each year some 3,000 new ones are added, of which only a small fraction is tested for possible effects on biological organisms. Since these effects are likely to be different in different combinations (synergy being more often present than absent) the problem becomes logistically insuperable. Even with the best safeguards the processes in which these substances are used are subject to accidents, allowing poisons to find their way into rivers and ground water supplies. Thus recently a considerable amount of damage was done to horticulture in Essex by an as yet unidentified hormone weedkiller.

London's drinking water was seriously compromised when a 400 gallon cyanide tanker overflowed, spilling into the River Lee, which supplies one-sixth of London's drinking water. As a result inlets were closed for five days, 100 million gallons of water were lost and hundreds of fish were killed.

Toxic chemicals, many of which have yet to be identified, have been dumped on at least 40 tips throughout the country, where they may seep into our waterways. One such tip, Maendy Quarry, contains at least 31 different contaminants of which five are very toxic, nine are toxic, and three are mildly toxic. Many of these chemicals, including PCBs, are known to be leaking in increasing quantities down the hillside.

If it is difficult to identify the pollutants on the tip, it is even more difficult to do so once they have been diluted in our waterways. In a letter to *The Times*, Pastakia pointed out that "discharges are often at low levels of concentration which escape detection and are not shown up by fish kills, but whose cumulative effect on the aquatic environment can be extremely damaging". This appears to be true in the case of the hormone weedkiller in Essex which did considerable damage at concentrations as low as one part in a thousand million. As Mr Sturgess of the Essex River Authority points out, also in a letter to *The Times*, "Present methods do not even enable one to detect the presence of pollutants in this dilution, let alone face them".

If one cannot monitor them, still less can one eliminate them by any known purification process.

Analyses of Rhine water have so far identified some 200 different pollutants and these are regarded as constituting perhaps no more than one-tenth of those present. Dr Sontheimer, a chemist involved in this work, has said they have no way of foreseeing "what will be floating in the river tomorrow . . . A cleaning process that works one day, works badly the next day". Moreover, even were it possible to devise the correct monitoring equipment and purification plant the cost would be prohibitive. Sontheimer considers that it would cost at least 10 times more to extract poisons already diluted in the Rhine than it would to keep them out

of the water in the first place. Yet this, too, is expensive. At Maendy Quarry, for instance, it is regarded as impossible to drain off the chemicals from the tip. The Quarry itself may have to be encased in steel plates. One estimate suggests the cost might be £1.5 million, and Maendy is only one of 40 tips that are known to present a serious danger to our water supplies.

It seems that no amount of science and technology can enable us to have clean water in an age of large scale enterprise so, again, we must choose. Will we have clean water or industry? Man lived perfectly happily for two million years without industry. It has yet to be shown that he can live without fresh water.

The official view

"Properly designed, a large scale industrial plant actually enhances the environment".—A member of the British delegation to the Stockholm Conference.

Conjurors or sages?

"Progress" consists in taking over the management of the biosphere and methodically replacing it with what can be called the "technosphere", the world of human artefacts. Unfortunately for its adepts, the self-regulating processes of nature which have taken billions of years to evolve are very much more efficient than those with which we replace them. Their major defect (if it can be regarded as such) is that they occur outside the cash economy, do not contribute to the GNP and hence to general prosperity, which means that, in modern parlance, they are not "economic". It is only now that people are slowly becoming aware of the bad deal they are making in countenancing this substitution. Thus it is in the name of science and progress that over 80 per cent of our children are fed on bottled cow's milk. Since the nutritional requirements of calves and human babies are rather different, it is astonishing that cow's milk can be regarded as a substitute for the human milk to which babies have been adapted by millions of years of evolution. It is only now that we are beginning to learn the true cost of this brazen defiance of evolutionary principles. (See Bunyard, P. 1972. "Breast-fed babies are healthier". *Ecologist*, II, 34-35.)

For some time now our scientists have stated their determination to bring, not only lactation, but also the whole business of human reproduction under human management and hence into the cash economy. The first victims are to be infertile women, but undoubtedly others, too, will be victimised as the fashion spreads. The technique is to remove the egg from a woman, fertilise and grow it as an embryo in a test tube and then implant it in the mother, or even in the uterus of another woman, where it will continue to develop until full term. There could be side effects. The development of an embryo is a delicate process. Should it not occur in the optimum environment—the mother's womb in which it is designed to occur—then accidents are likely. If a test tube is as crude an approximation to a womb as a psychiatric ward is to a tolerable lifestyle and since in a biological process the earlier a mistake occurs the more serious it is likely to be, we may look forward to the production of deformed children with clockwork regularity.

What shall we do with them? Dr James Watson, who earned the Nobel Prize as co-discoverer of the structure of DNA, argues very convincingly that such deformed children will have to be killed at birth. Infanticide will become necessary as genetic engineering, and eventually cloning, get under way. Dr Watson suggests that a child should not be declared "alive" until three days after birth, which would permit legal infanticide. Parents would be able to decide for themselves whether the child should live.

Infanticide has a bad name, although today we are getting used to the idea of abortion. Let us consider, however, that practically all the pre-industrial societies practised infanticide in some form or other, to varying extents, and whereas abortion is largely indiscriminate and all too often the result of irresponsible action, infanticide as practised by primitive societies is highly discriminating, deliberate and provides a qualitative as well as quantitative means of population control.

The real answer, of course, is for society to stop indulging in irresponsible conjuring tricks.

Chinese environment

"We must not give up eating for fear of choking, nor refrain from building our own industry for fear of pollution and damage to the environment."—A member of the Chinese delegation to the Stockholm Conference.

Vaginal deodorants for social stability

The success story of the vaginal deodorant in the US provides a comment of a kind on the values of the consumer society. The market for this absurd and dehumanising device has climbed in seven years from $3.8 million to an estimated $55 million. Predictably, these sprays are beginning to produce side-effects: rashes, irritations and even burns, while no one can predict what long term effects there are likely to be. Consequently, the Federal Drug Administration has taken action. Since vaginal deodorants cannot, by any stretch of the imagination, contribute to personal hygiene, manufacturers are now forbidden to use the words "hygiene" or "hygienic" when referring to them in their publicity material.

The more this market is allowed to grow, the more difficult it will be to curb. If the present rate of growth is maintained, it will amount to $715 million by 1980, at which point it will probably be as immune to legislation as are the cigarette and firearm industries. To reduce it could lead to economic and social upheaval resulting from widespread unemployment.

It is encouraging, perhaps, to note that attempts to market a testicular deodorant for men have failed.

Last word on Maplin

"The alternatives to Maplin in terms of cost, land use and environmental pollution would be intolerable, socially and economically.—Eldon Griffiths, Environment Under-Secretary responsible for aviation.

A question of size

Communalism is the basis of African traditional culture. People do things together and individualism is eschewed. When the white man came to Africa, he introduced his idea of individualism. He never did things in common with others. When he cooked it was for himself and his family, rather than for the whole community. Appropriately, the Zulus called him "he who cooks in small pots".

Gremlin

Biodegradation

The city fathers of San Pedro, California, are a bunch of spineless, anti-progressive pessimists. They have decided to pull up $50,000 worth of plastic trees and shrubs which line their roads, and replace them with so-called natural greenery. You know, that rather offensive material that causes hay fever in the summer and litters the roads in the winter. They claim that the plastic plants are less resistant to pollution than natural ones. Maybe, but they shouldn't have given in so easily. They should have tried the $100,000 versions.

Brazil eco-nut

During last year's UN Conference on the Human Environment, Brazil won the hearts of all environmentalists by brazenly refusing to fall for all that anti-pollution rot. Brazil, announced the head of its delegation, was going to take advantage of environment protection laws in industrial countries to invite dirty industries to set up shop there with no strings attached. That way, Brazil would develop still faster: its useless jungle would be cleared to make way for the farms needed to feed the rapid progress to the day when they in turn would be replaced by factories. Then Brazil would be top nation, and all its citizens would live happily ever after, until they died of cancer and despair at the age of 10.

It was heaven. For 10 whole days, Brazil made not one reasonable, civilised statement. All those otherwise gentle worm-preservers, moth-lovers, and litter-removers could indulge in an orgy of Brazil-bashing.

Thus it grieves Gremlin to announce that now even Brazil has succumbed and climbed on the anti-pollution bandwaggon. Interior Minister, Col. José Costa Cavalcanti has called for "industrial development adjusted to the preservation of the environment". A Japanese consortium planning a cellulose plant in Brazil has been ordered to install "the most advanced anti-pollution safeguards". Might as well go back to Japan. The state of Sao Paulo, host to Ford, General Motors, Kodak, Mitsubishi, Volkswagen, and many others, has started a three year $9 million clean-up.

The end of the world is at hand.

Breast-fed executives

The Director's Lodge Club, Masons Yard, off Duke Street, London SW1, has sent Gremlin a free admission pass for lunch or dinner. It is rather vague about whether the meal is free as well, but it doesn't sound like it. However, it does say this:

"To look after you on your visits are a number of attractive waitresses in our idea of see-through costumes, together with TOPLESS girls attending you at the Directors Bar. (Most Spirits at 35p)".

The Director's Lodge describes itself as a businessman's club, and it suggests it is a good place to relax in after work and before the journey home. Gremlin's advice to businessmen is:

1. be warned: you may get in free, but it looks as if you'll be socked heavily for the meal;

2. the nakedness of waitresses is generally in inverse proportion to the quality of the food;

3. on the other hand, "our idea of see-through costumes" is as ambiguous as the invitation, so you may be lucky;

4. however, genuine topless waitresses will have difficulty serving you unless they are deft with their toes;

5. if working in and commuting to and from London is so excruciating that the Director's Lodge seems a fun place to relax in (Most Spirits—presumably low—35p), change your job and live in the country.

Battelle scars

The Battelle Institute, Frankfurt, West Germany, has been awarded the Gremlin Plastic Plunger for pernicious self-fulfilling research. Two projects in particular are commended. The first is a programme to estimate the world-wide demand for central heating and air conditioning to 1980. Battelle appear to believe that the best way to keep noise and dirt at bay is "by closing the windows and filtering the air". This increases power consumption, prevents damage to health from fresh air, and allows Battelle's sponsors to continue to pollute with impunity.

The second project is a study which predicts that there will be more juggernaut lorries on our roads. Battelle's economists report that the roll-on/roll-off transport ship can be operated "on a substantially cheaper basis" than the container vessel on sea crossings of less than 280 miles. Container ships can be linked with railways, but roll-on/roll-off ships can be used only by lorries. This finding, say Battelle, "will inevitably lead to increased pressure on the roads".

Haven't they heard of planning?

Problem pike

Oh dear, the Scottish Wildlife Trust have a problem. Slavonian grebes bred successfully on their Loch of Lowe reserve. Unfortunately, the four young did not last long. A coot ate one, pike demolished two others, and the fourth disappeared, presumably also down a pike.

The problem is, say the Trust, the Slavonian grebes might breed again, "and the Trust must decide whether to protect the grebes or whether to look on pike as natural predators and leave the birds to fend for themselves".

No problem. Call in Gremlin's precision conservation team who, equipped with the very latest aids (napalm, electric chairs, and the Annual Report of the Chief Inspector of Alkali and Clean Air), will ensure that the *only* species left alive in the Loch of Lowes reserve is the Slavonian grebe, *Podiceps auritus* (Smirnoff).

Cranks' corner

"Finally, I am launching a conservation drive to reduce anticipated personal consumption of energy resources across the nation by 5 per cent over the next 12 months. The Federal Government will take the lead in this effort, by reducing its anticipated consumption by 7 per cent during this same period."—*President Richard Nixon's 29 June statement on energy policy.*

He'll be putting a brick in his WC next.

Prepare to meet thy technology

by Brian Johnson

The critique of *The Limits to Growth* report (Dennis Meadows *et al.*), offered by the Science Policy Research Unit of Sussex University[1] is the most impressive and elaborate that has so far appeared of a number of evaluations of that celebrated volume. In their analysis of the MIT group's *The Limits to Growth* 13 Sussex contributors come unanimously to their "final verdict: not good enough".[2]

One reason for the failure of the Sussex report to raise ripples on the pond of public consciousness, may be that the public seems to have had enough, for the time being, of UNIVERSAL COLLAPSE, an event that was heralded last year with the kind of public anticipation and commercial assiduity generally reserved for Christmas. Now, apparently, the pre-Christmas fervour has faded. After all, doesn't even the Club of Rome concede that there may still be about 36,500 shopping days to Doomsday?

We should not, however, be deceived by the slight notice paid to the Sussex Thirteen by the media. Their message appears to have been received and well understood (or misunderstood, if Sussex protestations are to be believed) by the cohorts of national and international officialdom. Around the world's corridors of power, the reaction to the Sussex response to the Club of Rome has been a faint but audible sigh of relief and dismissal. The sigh actually anticipated the publication. Months before the Sussex arguments were in print, a friend in Lord Rothschild's Think Tank was shrugging off *Limits* with "but your own university have discredited it haven't they? Didn't they run the world model backwards and discover that the Great Catastrophe occurred in the 1880s?"

The Sussex critique did indeed reveal that the MIT Model made nonsense when run backwards—or indeed forwards, if the wrong time-span is chosen for the run. What it also revealed was an apparently faulty understanding by Messrs Cole and Kernow in their chapter "An Evaluation of World Models" of inherent characteristics of the device that they elected to criticise. To criticise a systems dynamics model for failing to "work" backwards is akin, as some have pointed out, to casting doubt on whether an aircraft could take off for the simple reason that if you flew it backwards from two minutes after take-off it would not make it back to the end of the runway. The only possible reasons for such criticism are either ignorance of systems dynamics principles or precisely the sort of attempt to bamboozle simple folk in Think Tanks of which the Sussex Thirteen accuse the MIT Group.

But the misleading fun and games of Cole and Kernow should not divert anyone from noting many very sound and valuable criticisms of the assumptions and structure of the MIT world models which Sussex offer. These criticisms will, it is hoped, rise above the loud mutual accusations of the Sussex and MIT groups that each others' conclusions are conducive to escapism and complacency respectively.

It really is not quite fair of Meadows to say, as he does in his response to the Sussex reply[3] that "If their exercise had led them to construct an alternative model, free from the imperfections they perceive in our work, their study would have been a fruitful exercise. Without that alternative model . . . their review is simply an argument for the *status quo*." Even the most negative criticism *can* be a fruitful exercise: failure to come up with a constructive alternative is no necessary debar to criticism. Besides as an exercise in clarification of the limits to such modelling—its crudeness, weak factual basis and mechanistic one-sidedness—the Sussex effort could be seen as a valuable step towards further refinements to systems dynamics, and a useful stimulus to other efforts to build intellectual frameworks for long-term policy.

Not the least useful aspect of the Sussex group's counter-accusation of encouraging escapism is that it sheds light on the alternative socio-political and philosophical assumptions of the two groups which ought to be further clarified before others delve deeper into technical aspects. Marie Jahoda, in an admirably succinct concluding essay "Postscript on Social Change" scores most of the points for the Sussex team. What she attacks, as do others, especially Harvey Simmons in his chapter on "Systems Dynamics and Technocracy", is the usefulness of describing a world system which deliberately ignores the political process and the importance of social structure and human needs and wants.

The MIT model ignores such pro-

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cesses in that it assumes a fairly constant set of human values in the future as regards satisfactions, and has quite inadequate "feedback loops" to recycle such factors as dismay at the destruction of the natural world or at frightening social impacts of technological "fixes". The MIT group deal with this criticism in two ways. First by pointing out that their work is *projection* not *prediction* (though often their assertions sound more predictive than projective). Secondly, they stress the fearful resistances in social systems against impulses for change, and assert that these, together with the massive momentum of population growth in particular, are more than likely to counteract our ability to buy time with technology.

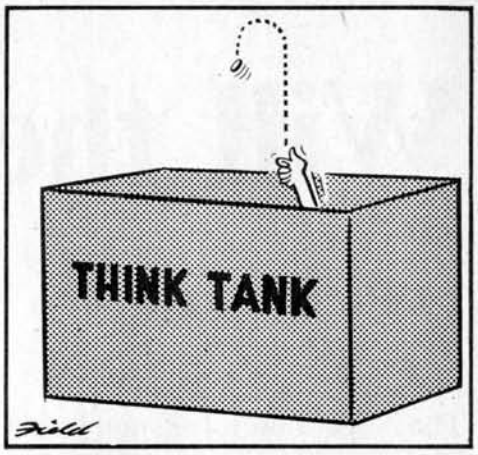
Nevertheless, the Sussex charge partly sticks. The MIT model, despite its apparent complexity and built-in sensitivities, represents an absurdly simple, two-dimensional view of the way the human world works. Is it more likely that an unreformed world of 80 years hence will perish together in a night of starvation, pollution and disease, or that a still relatively unpolluted, though already hungry, planet will collapse at a much earlier date in a shower of radioactive sparks at the intending, or unintending, hand of nuclear man struggling to lay claim to the resources used to heat his home or make his golf caddy-cart.

To be fair to the Meadows team, however, *The Limits to Growth* does look beyond the crude and simple message of their models, to offer us a doom with a view. They stress the fact that man's capacity to survive will be conditioned less by his choice of capital/output ratio than by his ability to educate his masses in the next few decades to regard altruism and compromise (now only treated as virtues necessary to domestic peace) as viable replacements for "the idols of the market and the idols of the tribe". Their sin, in Jahoda's eyes, is that although moral and spiritual development is the prescription or motor offered to impel us to the desired equilibrium state, the MIT authors neglect, in their mechanistic modelling, to include fundamental human values which must be considered (as both impediments and assets) when possible rates of change of population size and developmental behaviour are being discussed. This excessively mechanistic focus of the bulk of the *Limits to Growth* report is especially unfortunate in view of its origins in an American school of business management. There can, however, be no intellectual justification whatever for Jahoda's hysterical leap to the conclusion that one should refrain from emphasising physical limits to population for fear that this will be used as justification for genocide.[3]

The Sussex Group's philosophical position in relation to future prospects is undisguisedly confused. While Jahoda and others speak of the need to consider human and non-physical factors in forecasting the future, the entire basis of a Sussex salvation into the 22nd century and beyond is an ever-increasing dependence on massive and highly energy-consuming technology. Even that socio-economic Dr Strangelove Herman Kahn shows in his latest view of the "multifold trend"[4] more qualms than Sussex's Science Policy Research Unit, over the prospect of future bureaucratic concentration and human alienation that he admits is the inevitable by-product of a nature-replacing technosphere. The humanistic Miss Jahoda rests the case of the Sussex Group for there being far more time for gradual change than MIT perceive, on the basis of 210 pages of blithe technological optimism which implies a sociosphere to raise the hairs even on Dr Kahn's plump neck.

In fact Miss Jahoda and her colleagues appear to be caught inextricably in the current liberal trap. They criticise Meadows' and Forrester's call to action for springing from a hopeless outlook, an outlook which they believe will on the one hand induce hedonistic escapism by those empowered to act and an undermining of the credibility of scientists to help in solving the world's problems on the other. They insist on the futility of the "struggle to explain action and purposeful adaptation in mechanistic terms" in efforts to "guide world policy for a century in advance". Instead they ask that efforts to guide world policy be limited to shorter periods and "include adaptive negative feedbacks rather than exhortations to a change of hearts".[5]

What the Sussex Thirteen appear then to foresee is infinite technological ingenuity enabling us to postpone hard decisions on population limitation and the distribution of wealth; despite this



technological postponement and continued material growth, at some future date the gradual redistribution of wealth from (presumably) traditional liberal altruistic motives; that when all the human inhabitants of a man-made technosphere are happy and content with an average of two children per family, they will, at some time in the late 21st or early 22nd century, gradually opt for a state of material equilibrium.

Hopes for such an achievement, while maintaining Miss Jahoda's fine concern for the human factor, seem a great deal more far-fetched than Professor Meadows' plea for a planned non-coercive shift to concern for 21st century equilibrium. For at least Meadows' reliance on spiritual values is itself a negative feedback loop which tends to guarantee that the path of progress to equilibrium minimises the discounting of human life and well-being as we know it. The means to the solution is, in other words, in sympathy with the end. Sussex's means—massive high-risk technology—is, by contrast, not in sympathy but in direct opposition to the end of preserving humanity. In the year 2100 would you be able to tell Sussex man from a machine?

After reading *Thinking About the Future*, doom takes on a wholly new complexion as we prepare to meet our technology.

References

1 *Thinking About the Future* (London Chatto and Windus, 1973). The SPRU Critique first appeared in *Futures* Magazine, Vol. 5, Nos. 1 and 2, February and April 1973. Vol. 5, No. 1 contains a response by Professor Meadows *et al.*, which is omitted from the book.
2 Ibid., p. 214.
3 Ibid., p. 213.
4 Herman Kahn and B. Bruce-Briggs, *Things to Come* (New York: Macmillan 1972).
5 *Thinking About the Future*, op. cit., p. 215.

Will the desert bloom?

by Peter Bunyard

The Negev desert in Israel is one of the world's harshest deserts, yet by resurrecting an ancient system of desert farming Michael Evenari and his colleagues at the Department of Botany, the Hebrew University, Jerusalem, have shown that it is possible to make the desert productive even with a yearly rainfall as low on average as three to four inches.

Peter Bunyard visited two of Evenari's experimental farms both situated on sites that were abandoned more than 1,300 years ago when they were overrun by the Muslim invaders.

The growth and development of Israeli agriculture in the anguished 25 years of its short history almost surpasses the imagination. Having "inherited" sand dunes, thorny scrubland and desert the Israelis have developed an agriculture which is the fastest growing in the world and is one of the most productive. Amazed at the fantastic feat of transforming the landscape from a harsh barren wilderness into fields and orange groves no wonder people have got it into their heads that by some miracle of ingenuity and grit the Israelis have made the desert bloom.

Nor is the lie given when travelling south of Beersheba towards the stark moonscape of the Negev with its deep canyons, eroded limestone hills and broad sweeping wadis, etched like wizened wrinkles on the ancient face of the earth; for in that sunscorched emptiness, here and there, one finds the fruits of Israel's labours; a sudden glimpse as one drives down the desert road of a green oasis of cypresses guarding a peach or apricot orchard, or of a battery house for chickens and of cattle grazing out in pasture.

But the desert agriculture of Sde Boker and Mashabey Sade, two of the handful of Kibbutzim that have become established in the driest parts of the Negev, has not been won through some magic use of the very limited rain which falls sharply and briefly during the winter months only to cease for the rest of the year, but through the piping in of water from the Sea of Galilee where rainfall in the wet season is comparatively abundant. Kibbutz Sde Boker obtains only 30 per cent of its water from local rain, the rest comes from the Galilee. Kibbutz Mashabey Sade gets as much as one million cubic metres of water each year piped in from Galilee.

Water is the one big limiting factor in Israel and water shortage now threatens to cripple the economy and prevent the rapid industrial expansion and development to which Israelis aspire with something approaching avidity. After the rains have fallen, and most has evaporated or has been transpired through the leaves of plants, the Israelis are left with the water that has drained into the Jordan and the Sea of Galilee as well as with the water that has percolated down to recharge the aquifers along the sandy coastal plain of the Mediterranean and the aquifers to be found in the limestone mountains of the interior. This water, amounting to a maximum of 1,500 million cubic metres each year, has to provide for all Israel's needs, including agriculture, industry and domestic, during the long, dry summer season. The Israelis are now using more than 90 per cent of the maximum water available to them and with a couple of dry seasons behind them are facing a very real water shortage indeed.

With its yearly consumption of more than 1,000 million cubic metres of water, agriculture is by far the biggest user of water in Israel and the government is actually contemplating reducing the size and extent of agriculture so as to channel more water towards industry and give it the chance to expand. In addition, as Israel becomes more modernised and new towns proliferate to house the many newcomers, so the water demands on the domestic side are increasing at a very rapid rate.

Desert Kibbutzim, with their very high dependence on irrigation water brought in from elsewhere could be an obvious target for the government's plants to reduce the amount of water for agriculture. There have already been several occasions when an agricultural settlement has been castigated for using too much water and been told to reduce its demands.

It is something of a contrast therefore to leave Sde Boker, with its lush green avenue of trees watered unashamedly from a conspicuous irrigation pipe, for Professor Evenari's experimental farm at Avdat, just a few miles to the south at the edge of the Valley of Zin. Avdat is not lush. When one climbs the hill to reach the ancient and now totally ruined city and looks down at the experimental farm one sees a relatively tiny rectangular patchwork of small fields with widely spaced trees, amid barren wasteland stretching for miles.

Evenari's work and the history of Avdat are intricately interwoven and cannot be separated from each other; for basically what Professor Evenari and his colleagues have done is to re-establish the same system of farming that was developed first by the Nabateans, from the 3rd century BC until the 1st century AD, and then in its final flourishing by the Byzantines. In the 7th century AD Avdat fell, first to the Persians, and, just a few years later to the Muslims who had no use for the place and left it in ruins. Avdat was rediscovered by an Englishman, E. H. Palmer in 1871, and it was he who wondered at the innumerable stone

mounds and strips that he could see running down the hillside from his vantage point in the ruined city.

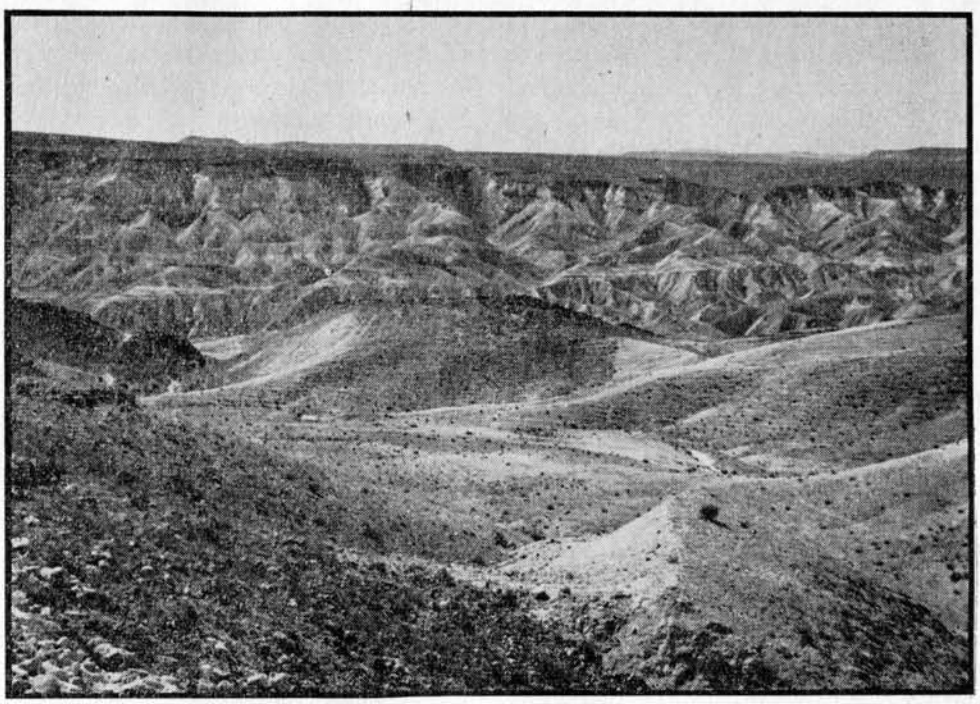
Nabatean agriculture

In essence the system was very simple. The rains in the Negev tend to be heavy and run-off from the hillsides into the wadis soon creates swirling floods that sweep down towards the Rift Valley that divides the great land masses of Asia and Africa. That water, unless checked and directed, is quickly lost for unlike the other deserts such as the Sinai desert or parts of the Sahara, the Negev desert is very poor in groundwater and the few boreholes that have been made generally produce water too salty for human consumption.

The Nabateans, however, developed an ingenious system of run-off channels, small dams, trenches, terraces and cisterns, whereby they were able to collect water from a wide area and concentrate it all into a single growing area. From rebuilding the water-collecting system at Avdat and to the North-West at Shivta, another Nabatean town that became Byzantine, Evenari estimates that each unit area which was cultivated received water from a catchment area that was 20 to 35 times larger.

On average, Avdat and Shivta receive only three to four inches of rain each year, an amount of rainfall that makes the Negev one of the driest deserts in the world. And being an average it gives no hint of the wide variation that can be expected. In the 1962/63 season Avdat got less than one inch of rain and in the following season six inches. Nevertheless because of the multiplication possible through the use of the run-off system it is quite feasible in an average year to get as much as 6,000 cubic metres of water to every hectare of cultivated land—an amount of water equivalent to 24 inches of rain.

Inscriptions found at Nizzana, beyond Shivta to the west, show that the Nabateans successfully grew wheat, barley, legumes, almonds and grapes in the desert. Other records left by the Byzantines show that they were able to achieve yields that were remarkably high considering the quantities of water available, and that they did not use modern methods of fertilisation and of pest control. Evenari's own results over the past 15 years on the reconstructed farms give ample, incontestable proof that even in one of the world's harshest deserts it is possible to produce a surplus of food.



The Negev is one of the world's harshest deserts

The Nabateans may have had ingenuity. They also had a lot of luck. The loess soil of the Negev plains is very fertile when enough water is available, and given water, plants respond quickly. The soil also has another feature which is crucial for the collection of water; for after being wetted it forms a thin crust which is relatively impermeable to water. The impermeability works two ways. First to enhance run-off, and second to slow down evaporation of water that has permeated into the soil. Because of the low rainfall the vegetation is extremely scanty and spaced too far apart to have much effect in trapping and siphoning off any rain. At first the rain penetrates the soil, but then the crust forms and the rain begins to run into any nearby depressions. When those are filled the run-off proper begins.

Discovering how the Nabateans and Byzantines watered their cultivation plots and what plants they grew was a major undertaking for Evenari and his colleagues, and they were intrigued, just like Palmer before them, by the mounds of stones gathered along the contours of the slopes leading from the hills to the plains and by the innumerable dams and terraces that in step-wise fashion followed the winding treacherous course of the wadis. Experimenting on slopes of varying degrees, on slopes that had been left with the stones intact, or with the stones cleared, on slopes that had been rolled, and on different sizes of catchment area, Professor Evenari came up with some rather curious results that both vindicated the techniques devised by the ancient farmers and at the same time indicated that they had not exploited the desert as fully as they might have.

The first curious fact is that the steeper the slope the smaller proportionately the run-off. During 1965-66 for example, when the total rainfall at Avdat was 90.7 mm, the run-off from a slope of 1 in 10 was 23.64 mm compared with only 13.61 mm from a slope of 1 in 5. By gathering the stones of adjacent plots into mounds the run-off for the 1 in 10 slope increased to 26.02 mm, by taking the stones away and leaving the plot bare the run-off increased to 30.26 mm, and by rolling the cleared plot when wet the run-off increased still further to 31.46 mm.

Evenari then tried catchment areas of different sizes. He found that the largest catchment area of 350 hectares produced only 2.5 mm of run-off with an annual rainfall of 100 mm, a smaller catchment area of 10 hectares produced about 13 mm of run-off for the same rainfall, and a very small catchment area of 0.1 hectares produces about 50 mm of run-off for the same rainfall.

In *Food, Fiber and the Arid Lands* (The University of Arizona Press, 1971) Michael Evenari, Leslie Shanan and Naphtali H. Tadmor indicate what to expect from an average annual rainfall of 100 mm. Thus, an untreated catchment area of 100 hectares with a 1 in in 20 to 1 in 10 slope will yield about 70 cubic metres of run-off per hectare.

The same area cleared of stones will produce about 130 cubic metres of water per hectare. A microcatchment, on the other hand, will yield under the same conditions about 160 cubic metres of run-off if untreated, and 210 cubic metres if cleared of stones. Assuming then a ratio of cultivated area to catchment area of 1:30 the larger untreated catchment area will yield 2,100 cubic metres for each hectare of cultivated land, and 3,900 cubic metres when cleared of stones. The microcatchment will yield 4,800 cubic metres and 6,300 cubic metres of run-off respectively for untreated and cleared. The equivalent in rainfall for the latter is considerable—630 mm or approximately 25 inches.

Cultivating the plains

Since a slight slope and a microcatchment gave the best results Evenari hit on the idea of cultivating the desert plains far away from the hills and wadis on which the Nabateans depended for run-off. To make life as difficult as possible for himself he chose a barren loessial plain in which soluble salts made up more than 1 per cent of the soil. He then established microcatchments—or in Hebrew, negarin—of different sizes ranging from 16 to 1,000 square metres. The stones were cleared and a gentle incline made to a collecting point where the planting was to be done. Almonds, pomegranates, olives, grapevines and saltbush were then planted, each tree having its own microcatchment area.

After one or two rainy seasons the run-off on the negarin leached out the salts and the plants began to take, Evenari and his colleagues found that 250 square metres was the best size of microcatchment for almonds, olives, pomegranates and grapevine, and 32 square metres for the saltbush. Another fact emerged from the experiments; rains which are ineffective in causing run-off on large catchment areas will run off on the negarin. During the 1967-68 rainy season there was only one large flood on the 350 hectare catchment area whereas there were 11 on the experimental microcatchment areas.

A disadvantage of the negarin is that the plants, each with their own microcatchments, are relatively far spaced, and it would be wholly erroneous to imagine the desert plains becoming thick with fruit trees. On the plains near Avdat, Evenari is able to grow four trees per duna, or 16 trees per acre. Using the ancient run-off system at Avdat and Shivta he is able to plant and sustain 26 trees. Yet, as pointed out, the old system uses rain less efficiently and requires a very elaborate network of dams, terraces, run-off channels, sluices and many man-hours to create.

Without the watering made possible on the desert Kibbutzim by the waters of the Jordan and Galilee, Evenari is unable to get maximum yields from his plants. And some years when the rainfall falls well below average his fruit trees do little more than survive without producing any fruit. Yet on the whole his yields are extraordinarily good considering the conditions in the Negev. Thus over a two-year test period using the ancient farm methods he was able to get 8–12 tons of peaches per hectare, 5–8 tons of apricots, 12–15 tons of grapes, 6–8 tons of figs and 0.43–0.93 tons of dry, shelled almonds.

He also tried pasture crops, testing more than 100 different species. The most efficient user of water was *Avena sterilis* which gave 2.6 to 2.9 kilograms of dry matter for each cubic metre of water used. Alfalfa also did well, and Evenari obtained 1.8 kg of dry matter for every cubic metre of water even though the total quantities of water received over the year amounted to no more than 2,000 cubic metres—equivalent to 8 inches of rain.

"It is usual in Israel", says Evenari, "to give alfalfa as much as 13,000 cubic metres of water. In the light of our experience the question arises as to whether this practice is worthwhile, taking into account the scarcity and high price of water in Israel."

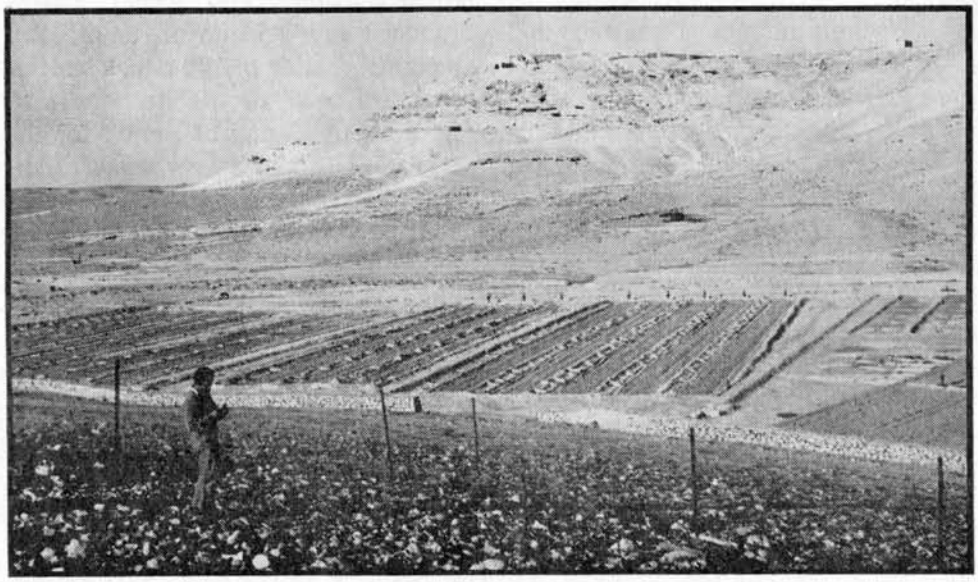
Optimum, rather than maximum yields

Evenari is for the optimum use of water and he condemns what he calls the maximisation of yields. In fact, although they go on growing when given more than a certain amount of water, all plants show a tailing off of yield per unit of water when in excess of the optimum. Thus there is a fall in the efficiency of water use and it would be better to distribute the water to more plants than to apply it to a single plant. Curiously enough the optimum watering for alfalfa is just about 2,000 cubic metres per hectare which is the amount received by alfalfa in Evenari's desert plots.

Because of the success of his negarin the Jerusalem botanist has now begun desert farming on a much bigger scale. Between Mashabe Sade and Beersheba in a hot barren plain close to the Wadi Mashash, Evenari and his colleagues have established a farm based on the negarin principle with some 2,000 almond trees, 500 pistachios and 150 olives. They have also planted 50 hectares of pasture in strips, using the negarin method of run-off to supply the strip with water and are bringing 500 sheep in. The sheep will be watered by run-off collected and piped in from the surrounding hills.

Even though the experiment has only been going for two years it already seems to be taking off, and with aid

A general view of Professor Evenari's experimental plots. This photograph was taken some years ago and the area is now supporting a stand of trees. The old city can be seen on the skyline

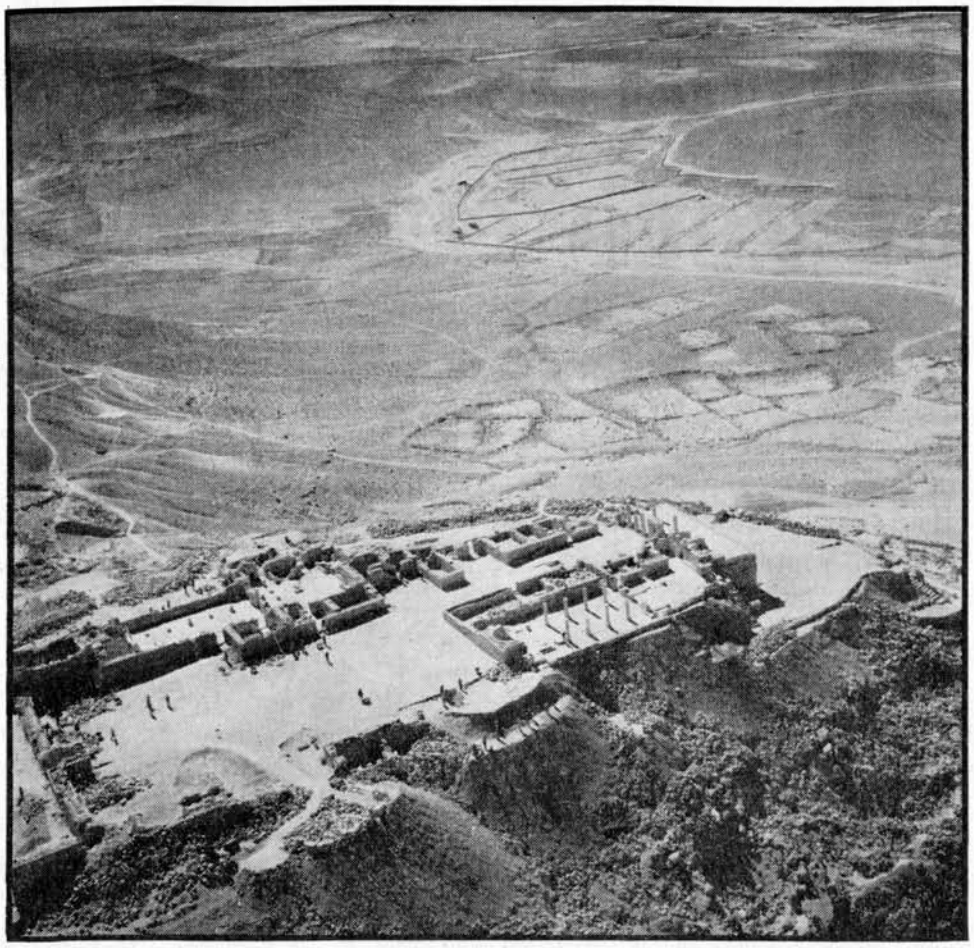


from West Germany a huge venture has been started in Afghanistan covering some 70,000 hectares of desert. That scheme has been expressly set up so that it can be worked by local farmers and peasants.

The economics of desert farming seem to be very good. Even with modern machinery the cost of clearing the land and making microcatchments comes to no more than 20 dollars per hectare. If planted to saltbush one hectare will produce some 30 kilograms of protein, which is nearly a 30-fold increase on the productivity of the desert if left in its natural state. In Israel, in 1971, it cost around 5 dollars to produce that amount of protein. In a few years then a farmer would make good the cost of establishing negarin. And if instead the clearing was done by hand by subsistence farmers the cost would be considerably less. An advantage of the negarin is that they require very little maintenance. Evenari reckons that a man need spend no more than a day or two on average each year to keep a relatively large area in good working operation.

Because of the critical shortage of water in Israel and because of the government's intention to promote industry at the expense of agriculture Professor Evenari's experiments in the desert have taken on a new relevance. Nevertheless many Israeli agronomists shrug off Evenari's work with something approaching irritation, as a kind of clever but crankish exercise in agricultural history but absolutely nothing to do with modern farming and productivity. As one veteran Kibbutznik from a desert setttlement told me: "The yields obtained at Avdat may be good for nomads and simple farmers, but Europeans cannot work at that low productivity."

In a way what the Kibbutznik said is true. The desert cannot be made to bloom using its own resources of water and a European used to high mechanisation would find it wasteful and irritating to have to cover large expanses of ground for spraying and fertilising his crops, and then finding the yields nothing like as good as his neighbours' who can afford to bring water in from outside. Yet the world cannot afford to do what the Israelis have done and for the simple man in Afghan or in the Sahara Evenari's experiments may be the one hope that they have left.



The city of Avdat, showing the outlines of the ancient fields. Farm workers used to live in the city and there are no dwellings on the farms. This suggests that agriculture was a communal activity, calling for a high degree of co-operation

Towards a policy of zero energy growth

by Kenneth A. Dahlberg

The "energy crisis" seems to be the latest in a long series of crises that have been dramatised in recent years. The advance billing so far has included the appropriate number of scare stories, a few disclaimers, the posing of several costly technological alternatives, and little in the way of environmentally based policy suggestions.

To the degree that conventional economists agree that there is an energy crisis, they see it more as an inconvenience that may cause some slowing of the *rate* of growth of energy consumption (and implicitly, for them, of the GNP). They do not see the energy crisis as a limit to growth.[1] As with what they call the "pollution problem", it is assumed that *post hoc* measures will be sufficient. Once the energy crisis (or pollution problems) becomes serious enough, then the necessary market shifts will take place, price ratios will alter, technologies to deal with the problems will be encouraged, economists will develop measures to assess the additional costs, and regulations or penalties can be introduced to handle any remaining market imperfections.[2]

Environmentalists have, of course, challenged all of the above assumptions —pointing out that such an approach seriously risks having irreversible damage done *before* the hoped for adjustments take place and that, moreover, given the realities of economic power, *post hoc* measures play into the hands of the large corporations since they are most skilled at manipulating or avoiding regulatory measures. Various economists of unorthodox stripe have also recognised that major changes in economic thought are required to deal with energy and environmental dilemmas. Nicholas Georgescu-Roegen has done a great deal of the basic theoretical reworking in his book, *The Entropy Law and the Economic Process.*[3] Some of the political, institutional, and moral dimensions have been discussed by Herman E. Daly.[4] Daly admits, however that he sees no simple broad strategy for conserving resources and managing the problems of their distribution analagous to Kenneth Boulding's suggestion regarding the licensing of children.[5] Hopefully, the following proposal will go some way towards suggesting such a strategy.

What is outlined here is a strategy aimed at achieving several goals simultaneously. Borrowing a lesson from those trying to attack wasteful military spending, the emphasis is upon a levelling off—arms control—before the psychologically more difficult problems of disarmament are tackled. Similarly, it is clear that any policy that can aid in a levelling off of total energy consumption, will have gone a long way towards setting up the institutions required—if it is deemed necessary—to actually reduce total energy consumption. As with Zero Population Growth, it is argued that what one should seek is a policy providing an overall net result that still permits as much individual flexibility and freedom as possible. Such a policy should be as comprehensive as possible and should also contain various "multiplier effects" to encourage conservation of other resources as well as energy. Such a policy will necessarily involve a number of major *a priori* actions. And needless to say, it must be firmly based on environmental grounds.

Basic policy requirements

There are four requirements for an energy policy that would accomplish the above objectives:

(1) At a minimum, it would have to be national in scope, regulating all sources of energy. Since the US is the largest energy consumer in the world, the advantages of national legislation probably predominate over whatever benefits might accrue from trying to include Canada in the scheme (probably at the cost of lower levels of joint agreement). For the United Kingdom, it is not quite so clear whether policies would be better pursued at the national or European level. My inclination would be to favour strong national legislation as a prod to other members of the EEC. Such an approach risks having corporations move out of the regulated states, but given the nature of most high energy consumption industries it is doubtful that this would occur on any large scale. In addition to its geographic scope, the policy must cover all sources of energy or risk ecologically costly shifts from regulated sources to those that are unregulated. Finally, while the policy should aim at overall national (or regional) results, there should be as much individual and corporate flexibility as possible.

(2) The basic operating principle would be that energy costs would increase progressively as individuals or corporations increased their energy consumption. This, of course, would represent a great switch from present practices—which generally offer energy to the consumer at flat rates and give large industries even lower rates. A progressive energy use rate (or tax), analagous as it is in many ways to the progressive income tax, raises similar broad questions. What

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are the larger social objectives of such a policy? What sort of exceptions if any, should be allowed? And so on. The overall objective has already been stated: to level off and—if needed—to reduce total energy consumption. Beyond that, another objective is to try to build in a "multiplier effect"—so that, for example, as automobile manufacturers find that large cars become much more costly to produce (since the energy costs of extracting and processing raw materials are increased), the building of smaller cars is encouraged just as the purchaser is encouraged to buy a smaller car not only because of greater price differentials, but also because petrol costs make driving a large car very expensive (cf. the immediate post-war experience in Europe). There would, of course, still be individual flexibility and those who were prepared to pay the cost could continue to drive large cars. The effectiveness of such a policy depends in large part on the degree of progression in the use rate, and the ways in which such rates are introduced.

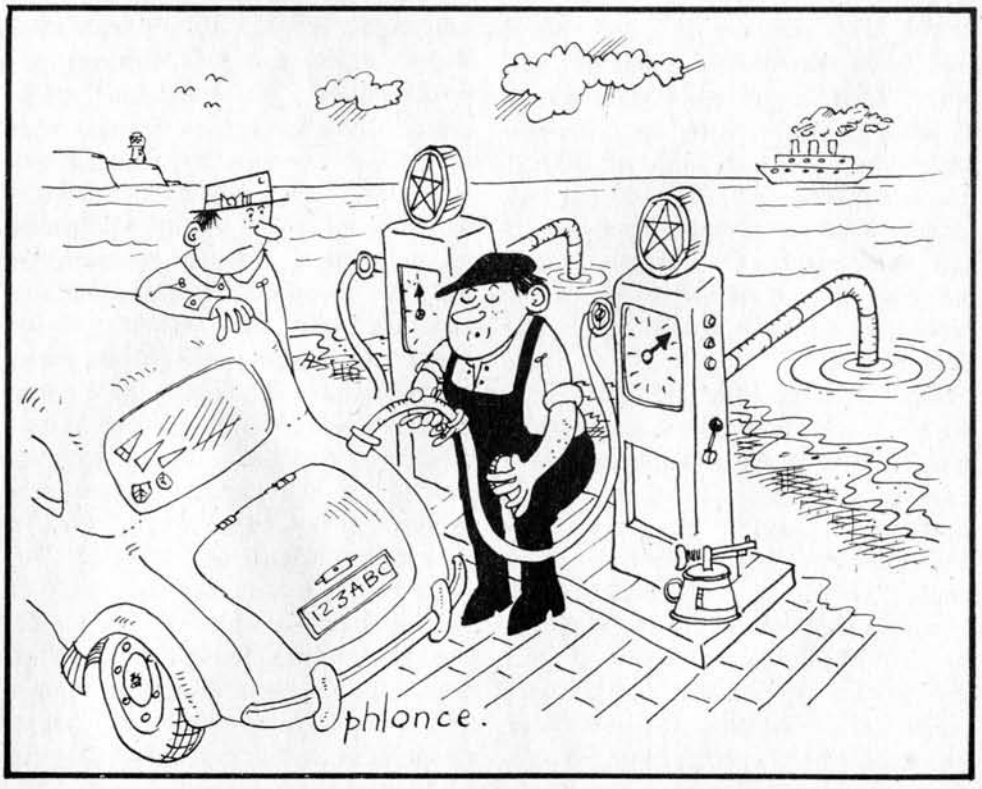
(3) It is suggested that the policy be implemented on a step-by-step basis, much like the various clean air and water standards in the United States. While such an approach naturally has risks in that the overall objectives of the policy may be weakened or diverted over a period of years, I must admit that some of the demands of my ecologist friends for immediate and drastic changes, while understandable, do not reflect the "ecological" truth that complex social, political, and economic systems, like complex ecosystems, can adapt or change their fundamental characteristics only slowly. Such a long-range, step-by-step policy also assumes a long-range popular will to pursue such a policy. While this is a tall order, we must face up to its implications, for in the long run *all* significant environmental programmes will need such support.

(4) Finally, such a policy would be enhanced by the use of thermal efficiency and/or pollution coefficients. These might be applied in a manner analogous to tax surcharges and would add additional costs to the use of those kinds of energy (e.g. soft coal) that are thermally inefficient and/or highly polluting. During the initial stages of application these would have to be based on rather rough data regarding the long-range comparative ecological costs of different energy sources. However, their use would tend to have another useful ecological dimension in that such coefficients would also be compatible with the development of long-range regional energy plans—where it might turn out that certain meteorological or geological conditions indicate that the use of one kind of energy in a particular region is preferable to another. This would also be compatible with the general goals of *A Blueprint for Survival*, which favour decentralisation of policies and structures in order to make them more adaptable to local conditions.

Finally, it may have been noted that the proposed policy does not attempt to cover animal or human energy. This is deliberate and is designed to encourage their use (or perhaps more precisely, to remove the present discriminations against their use encouraged by "cheap" energy policies). While machines will continue, lower level technologies will be encouraged and the displacement of animal and human labour by machines will be discouraged. This is particularly important in the field of agriculture where the "green revolution" threatens a disastrous switch from energy sources that are based on the flow of solar energy to sources dependent upon limited terrestrial stocks.[6] The general impact of the policy on other areas and life styles is unclear. Within the macro-results sought by the policy, a number of different life styles can be expected, different groups will undoubtedly decide on different trade-offs according to their values and interests. The latter can also be expected to shift as people will have to work out much more carefully what their real priorities and values are since they will no longer be able to easily afford superfluities. Just as under a "cheap" energy policy, "conveniences" soon become "necessities" we can expect a reverse shift once the true energy costs are assessed.

Institutional arrangements

What then about the more detailed provisions of such a plan? As indicated, progressive use rates would necessarily have to cover all sectors of society—consumers, producers, and governmental units—although each of these might be treated somewhat differently. In each sector, however, there would have to be some basic decisions made regarding certain administrative trade-offs that are apparent in the administration of the income tax. For example, if one wishes to keep administrative mechanisms at a minimum, then one must accept the inevitable inequities that result from rather simple overall policies that apply equally to all within a given category. On the other hand, if one wishes to try to take individual situations and problems into consideration (as is now the case with the income



tax), then a large administrative machinery is necessary, and with it come all the Parkinsonian tendencies of large bureaucracies as well as the risk that the overall policy goals will be lost in a maze of technicalities and legalities (as also seems to be the case with the income tax). My own strong preference would be to start on the simple side.

One way of doing this with consumers, while at the same time not placing an undue burden on the poor, would be to continue the use of a flat rate up to a certain cut-off point where the progressive rates would then go into effect. This would be somewhat complicated by the different number and kind of energy sources which different households have. However, it should not be too difficult to work out appropriate cut-off points according to the number and kind of energy sources. More difficult would be how to deal with the automobile—since there are no pre-existing metering and monthly or quarterly billing mechanisms. The difficulties that showed themselves during the World War II rationing of petrol suggest that the best overall compromise might be to have rather high flat rates—say a trebling of current costs—which would average out many of the hidden social and ecological costs associated with the internal combustion engine. There could then be a system of "petrol stamps" (very much like food stamps) for the poor and for those who can demonstrate the need for lower cost petrol. The increase in price might well be in the form of a national tax which would go to build mass transit systems, for research on air pollution, and perhaps even to build, as Oregon has, a network of bicycle trails (I can already hear the screams from Detroit and Coventry). Of course, other measures will be needed to deal with problems relating to spatial concentrations of cars.

The situation with industrial producers would be at least as complicated. There would be the same problem of multiple energy sources. However, if one tried to develop minimum flat rate allotments there would be the difficult problem of whether these would be established on the basis of the size of the firm, on the basis of the most efficient usage levels within a given industry, or what. There might also be the temptation to use the cut-off points and the rates or progression to try to achieve other policy goals, say for example the encouragement or discouragement of large firms. Here it should be kept in mind that one of the primary purposes of this policy is to develop rate structures that accurately reflect the real ecological costs of using various sources of energy. For this reason, and given the magnitude of this goal, I would suggest that other social or political goals be sought by the many other means that governments have to pursue them. Thus, in terms of industrial production, the simplest and most rational approach would appear to be one where the progressive rates are applied on each source of energy without any flat rate provisions. The situation regarding governmental units would be analogous though there would certainly be temptations to grant rate exemptions for "essential" services—street lighting and sewage at the local level or defence production at the national. Here again, it can be argued that one should know the full and true costs, and then, if so desired, various positive subsidies, etc. can be arranged.

Determination of the progressive rates

The question of how the progressive rates for each energy source are to be determined is certainly one of the most important of the whole policy, for the above institutional arrangements make sense only if the rates reflect true ecological costs with some degree of accuracy. Two strategies are possible here. One would be that the policy should not be implemented until all of the necessary research and study had been completed. The other would be to follow the approach used on automobile exhaust emissions in the US: to establish initial standards and deadlines which would provide greater incentives to find the necessary answers and technologies than otherwise. Similarly, I would argue that it is clearly necessary for us to start moving in the right direction—less average energy consumption—even if we are not in possession of all details. A series of rough approximations of real ecological costs could be made, various implementation dates established, funds provided for government and university research, etc. These rough rates would be a great spur to private industry to engage in research themselves, while the prospect of step-by-step implementation of the rates would give them both the necessary time for adaptation as well as the possibility of having the rates adjusted as more accurate information became available. The same general points would apply to the thermal efficiency and pollution coefficients.

Likely objections

The above proposal will no doubt be considered radical by many (although many radicals may be disturbed at the idea of advocating "less power to the people"). To me, it would appear to be perhaps the minimum for dealing with the basic human and political problem of the environmental crisis: how to take important actions in critical sectors and encourage people to change their habits *before* irreversible damage is done.

In any case, in surveying the likely objections to such a programme it will be easily concluded that some very fundamental issues have been raised. Turning first to the multitude of political problems, the most obvious is the number of powerful vested interests that would be touched by such a policy. Any time you are likely to have the automobile industry, the steel industry, the railroads, the aluminium industry, the oil industry, the utilities, as well as many unions against you, you are, to put it mildly, in political trouble. At least in the short run. In the longer run, we must hark back to other battles between vested interests, outdated orthodoxies, prejudices, etc., and potent new forces that are able to mobilise youth, appeal to the larger sense of rationality and justice of the average citizen, and claim important support from influential leaders. The present health of the environmental movement is a good example. Ten years ago very few people (particularly industrialists and politicians) would have predicted a fraction of its current successes. However, it must also be recognised that the environmental movement is at present in danger of fragmenting and is in need of a number of specific long-range challenges around wihch it can coalesce and mobilise.

While many attitudes would have to be changed and many habits altered to implement such a programme, there should also be strong support for it.

Almost everyone is willing to accept the principle of people paying for services according to use (at least when the principle applies to other people or groups). Also, the analogies with the graduated income tax are obvious and should be stressed. Finally, there is a fundamental ecological logic to such a programme, which while it can be ignored, cannot be denied. Another critical point then is the need to educate people to the realities of our ecological situation and to convince them that we must make a basic change in direction—one, which as stressed above, could be spread over time and structured to permit large areas of choice.

What about the effects of such a policy on the utilities and other energy suppliers? Would they not be driven to bankruptcy as energy consumption levelled off or went down? While their opposition would be among the most vocal, it would not seem too difficult to arrange that they continue to receive a "fair" return on their investments. Their rates and returns are already largely regulated by various governmental agencies. If their share of the increased income per energy unit from the graduated rates does not prove sufficient to cover the losses due to declines in energy consumption, then it would not be particularly difficult to provide for offsetting subsidies, tax write-offs, or whatever else might prove to be appropriate. This, it would seem, would be a small price to pay for a much more rational and resource-conserving energy policy.

Another area where one can expect objections would involve the general impact of such a policy upon the competitive position of the United States or the United Kingdom in world trade. Since one result of the policy would be to make many export goods more expensive, I am sure that many would argue that this would tend to price those who adopt such a policy out of the world market. There is some validity to this argument, but it must be qualified in several important ways. First, this is a problem which all industrial countries will face as they introduce various environmental protection measures. Right now, US steel makers complain that they have more stringent (and costly) air pollution standards to meet than their competitors, thus enabling the latter to undersell US corporations. While it can be countered that what the Japanese or German steel producers are doing is in effect taxing their fellow citizens, neighbours, or future generations with clean-up and/or health costs, this does not get at the immediate competitive situation.

A second qualification relates to the generally increasing difficulties of regulating world trade. The era of enchantment with world-wide free trade and its encouragement through tariff and quota reductions is past. Today, the obstacles to trade are varied and complex—and there is talk that negotiations to reduce "non-tariff barriers" to trade may take 10 or 20 years. What this suggests is that any compensatory measures that a country might take to reduce the competitive disadvantages resulting from the suggested policy would be different only in degree and not in kind to many of the protectionist trade measures or export subsidies currently being discussed in the United States.

It can also be pointed out that there would be certain advantages for American or British trade in such a policy. One natural result would be that our products would be designed for longer life, and of better quality. The appeal of such products can be seen in the success of the Volkswagen around the world. Another argument in favour (and one that has long been favourite of the oil companies) is that such a policy would postpone the day when the United States might have to become dependent upon foreign oil supplies (or one might add, upon environmentally dangerous or costly forms of oil production, such as offshore drilling or Alaska pipelines).

Summary

Several themes run throughout the above discussion. One is that this is only one possible approach to one major aspect of the environmental crisis. It is not suggested that this would have any great effect on population problems, for example. On the other hand, some happy solution to the population question, either on the national or international scale, would not resolve the many pollution problems that relate to higher and higher levels of consumption. It is doubtful that the global ecosystem could support the present world population (were it to be stabilised) at US levels of consumption. For that matter, it is not clear that in the long run we can sustain our own present population/consumption levels. Consequently, there is a need for a policy that establishes a set of snow-balling incentives to reduce energy consumption and other types of excessive depletion. The proposed policy would not get at all types of excessive resource consumption, and it might be that analogous approaches would be desirable to deal with the more critical of these.

What has been suggested, then, is to "think big", and to set a policy goal that will have fundamental and cumulative effects. There has been an attempt to discuss the implications of such a policy realistically, although some will certainly question the realism of making such a proposal. My only answer is that today's "realities" (particularly when their trend is in the wrong direction, as is the case with our current approaches to energy use) are often tomorrow's obscurities and that narrowness of interest often blinds one to the larger trends, movements, and problems overtaking a society. However, there is the risk that lacking proposals that really get to the ecological foundations of the energy crisis, we will continue, like the alcoholic, to seek solace in what is destroying us. Hopefully, the above proposal shows at least one way of getting back on the environmental wagon.

References

1. A very strong case for the latter position is made by Nicholas Georgescu-Roegen, "Economics and Entropy", *Ecologist*, 2, 7 (July 1972), pp. 13-18. He points out that unless there is some unexpected breakthrough in capturing much greater amounts of the daily *flow* of solar energy, we will rapidly use up our terrestrial *stock* of free energy, that is to say, low entropy energy.

2. A typical example of this sort of thinking is found in an article by a former member of the President's Council of Economic Advisers, Edwin S. Mills, "Economic Incentives in Air-Pollution Control", in Harold Wolozin (ed.), *The Economics of Air Pollution*, New York: W. W. Norton, 1966, pp. 40-50. Otherwise, his discussion of the pros and cons of various incentives and forms of regulation is very good.

3. Cambridge: Harvard University Press, 1971.

4. Herman E. Daly, "The Stationary-State Economy", *Ecologist*, 2, 7 (July 1972), pp. 4-12.

5. Kenneth E. Boulding, The Meaning of the 20th Century, New York: Harper & Row, 1964. Briefly, he suggests that upon sexual maturity each person be given a licence to have one child. These would be saleable and each couple could choose to have children at no cost, could sell one or both of their licences, or could buy licences if they want more than two children.

6. Georgescu-Roegen, "Economics and Entropy", op. cit., p. 17.

Progress to poverty

by Richard G. Wilkinson

Most attempts to analyse economic development have been based on the assumption that development is mainly concerned with increasing economic efficiency. In his book *Poverty and Progress**, Richard G. Wilkinson takes an opposite view. He suggests that development is primarily a matter of increasing the rate of environmental exploitation.

Here the *Ecologist* prints extracts from his chapter on disequilibrium and the stimulus to development.

A society moves out of ecological equilibrium as a result of a disturbance to some part of the cultural system which acted to restrain the society within workable limits. Often historical and anthropological records do not show exactly how the delicate mechanisms maintaining a particular society in equilibrium were disturbed: perhaps all we know is that the society is currently suffering from population pressure on land and that the population started to grow soon after European influence became significant in the area. In a number of societies however there is clear evidence that they used to exist in an equilibrium situation which has, in one way or another, now been disturbed. After the society has moved out of ecological equilibrium, subsistence becomes a problem, economic conditions worsen and the society finds itself facing a number of difficulties which together indicate a mounting crisis. The most obvious repercussions are the real or potential threats to the standard of living which force people to explore alternative means of livelihood. Not only are we usually without information on the initial source of a disturbance to the cultural mechanisms for maintaining equilibrium, but in theory one can see that there are likely to be a very large number of points at which the system could be disturbed; one has only to look at the complex of social, economic and superstitious elements which played a part in maintaining equilibrium. But wherever the disturbance starts, it appears that if it is to lead to economic development it must, somewhere along the line, damage the society's restraints sufficiently to cause conditions to deteriorate as the society moves out of ecological equilibrium. Most typically this involves breaking the restraints on population growth. The quantitative expansion of the traditional economy up to the limits of equilibrium ushers in the process of qualitative change.

A study of a village called Hsin Hsing in Taiwan by Bernard Gallin shows a very common pattern of transition from a system of self-sufficient peasant agriculture, based on growing rice, sweet potatoes and soybeans, to a market economy producing specialised cash crops augmented by temporary wage labour in local towns. Early this century the population in the area was "sparse". Since then the population has grown at rates varying between about $1\frac{3}{4}$ per cent per annum and $3\frac{3}{4}$ per cent per annum, roughly in line with the rest of Taiwan. (Two per cent per annum compounded would cause population size to double in 35 years.) The available land proved insufficient to support the population and we can safely assume that the society moved out of the ecological equilibrium based on its traditional methods at some time during this century. By 1957 the average amount of arable land per household had fallen to 1.6 acres. Initially agricultural methods were intensified in an effort to meet the increased demands within the traditional framework. The irrigated area was increased till it covered 93 per cent of the cultivable acreage. Three crops were often grown on the same land within a year, one sometimes being planted between the rows of the previous crop, just before harvest, as a way of increasing the length of the effective growing season. These changes meant people had to do more work per unit of output as well as bearing the costs of such things as fertilisers, but production failed to keep up with population growth. It was estimated that during 1957 the village's intensive agriculture provided only 65 per cent of the village income. The break with local self-sufficiency took two forms: one was the small scale, but rapidly expanding, cultivation of vegetables for market (earnings from which are included in the 65 per cent), and the other was the tendency to temporary migration to work in local towns which earned villagers the other 35 per cent of village income. Most of the migrants go to Tapei where a few run small businesses, but many work as unskilled labourers, coolies, or pedicab drivers. Others find work in a local menthol oil factory or in the brickworks. In the late 1950s several women had started working in a sugar factory in the mountains, but more stayed in the village and earned additional income by making fibre hats. The hat industry was organised on a "putting out" system like the domestic woollen industry in pre-industrial England; an agent distributed the bark fibre and collected in the finished hats. There can be little doubt that the rapid and diverse changes in Hsin Hsing are the result of the breakdown of the sufficiency of the traditional subsistence economy and represent a search for supplementary sources of income. Gallin himself emphasises repeatedly that the changes are responses to the land shortage produced by population growth. It is likely that processes such as these are leading to the increased urbanisation and industrialisation of Taiwan generally.

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South African Makhanya

D. H. Reader's study of a Zulu tribe—the Makhanya in South Africa, shows a society where the process has gone a little further. Large areas of Zulu land were alienated from them when, in 1902, a commission was set up to demarcate areas for black and white occupation. Perhaps partly because of the European and Christian interference with Zulu social customs (traditional polygamous marriage is giving way to monogamous Christian marriage for example), the population has grown and pressure on resources mounted. By 1950 the population density in the Makhanya country had reached 200 per square mile and not all areas were equally fertile. There were already lean seasons when food had to be bought and the pasture showed signs of serious overgrazing. Reader says that the ideal way of life was still regarded as being the traditional pastoralism and shifting cultivation appropriate to the plentiful land supply of the past, although methods had had to be changed to meet the new situation. More intensive techniques involving ploughing had become almost universal. A few farmers used fertiliser and some grew a surplus for market. But here, as in the last example, the agricultural changes proved insufficient to solve the subsistence problem. Reader tells us that there was a "steady deterioration of conditions in the Bantu areas of South Africa". Faced with the inability of the system to meet their growing need the Makhanya had no alternative but to sell their labour in Durban. Seventy-eight per cent of the male working population (15 to 55 years old) worked in Durban during the week leaving the women to do most of the agricultural work. (The proportion working in Durban was lower in outlying areas.) Again there can be very little doubt that the Makhanya became migrant wage earners out of necessity rather than because they chose it as a way of life preferable to their traditional one.

A couple more examples will help convey the picture of this pattern of change working in other types of societies. The development of an Indian village in highland Orissa, described by F. G. Bailey, shows the same pervasive pressure of growing necessity behind economic development. This part of north-east India underwent an "immense" increase in population during the nineteenth century. During the short period for which there are figures, from 1891 to 1931, the density of population in the highland region as a whole increased from 83 to 103 persons per square mile. In addition we are also told that during the past 100 years the population of the village itself has been increased by "a large number of immigrants". Under these conditions of population growth the system of partible inheritance led—predictably—to the division of holdings into units too small to provide for "the normal contingencies of the owner's lifetime". One of the results of this was that land became saleable and the landowning monopoly of the warrior caste, on which much of the social system was based, was broken. But what is more important to us is that by 1953 every household in the village had become at least partly dependent on a source of income other than agriculture. However, many of the non-agricultural occupations did not increase the village's total income but were concerned with the exchange of goods and services within the village. Sources of additional income to the village as a whole included the export of cash crops such as oilseeds, lentils, ginger and turmeric. Some people worked for the Leaf Company which provided the outer wrappings for cigarettes, others traded in cow hides, and a few were government employees. The situation was summed up by O'Malley in 1941: "A largely increased population has caused pressure on the soil, which is acute in congested areas, where all cultivable land has been brought under the plough and holdings are incapable of expansion. There is no longer the same uniformity of interests owing to the small size of holdings and the pressure of circumstances necessitating the adoption of different callings; one son, for example, may be an agriculturalist, another a mechanic, a third a clerk."

A developing society which still shows the remains of its system of population control is Rusembilan, a Malay village in southern Thailand. Their practice of abortion, and use of a doubtfully effective form of herbal contraception, linked with a system of bride price, is now insufficient to prevent population growth. The population has grown through natural increase and immigration. The clearance of new areas of jungle suggests that the community was expanding as early as the 1850s or 1860s. Presumably in the initial stages the clearance represented an expansion up to what were the limits of ecological equilibrium given the society's traditional methods. At some point people must have been forced to use more intensive agricultural techniques, but Rusembilan's final break with self-sufficiency did not come until the 1950s. Fraser says that until about 1950 Rusembilan had been entirely self-sufficient in terms of its rice production. However, by 1956, after the loss of 75 acres of rice paddy to a scheme involving the construction of a navigation canal, only the largest and most productive family holdings were capable of growing enough rice for a family's rice subsistence. Deficiency was practically universal, and people felt that "making even a supplementary living by cultivating rice (was) becoming increasingly difficult..." Although land suitable for growing rice was scarce, the villagers were fortunate enough to have previously unused land suitable for growing other crops. The subsistence problem forced them to put this land to use, producing copra and rubber for world markets.

The growth of "need"

Once one has the concept of a society existing in ecological equilibrium there is no difficulty in accepting that the development of need is the real cause of economic development. The problem before was that the populations of underdeveloped countries were often regarded as having experienced the same level of unsatisfied need, or poverty, since time immemorial—without showing the rates of economic change which we have come to regard as significant. But as soon as one can see how cultural systems can establish themselves in an equilibrium situation in which unsatisfied needs are limited, it is easy to see how the pressure of need brought to bear on the economic system is subject to important variations. At this juncture it may be argued that the industrial capitalists who played a leading role in Western industrialisation are, of all people, the ones least subject to the kinds of need discussed. The explanation is that their role would have been impossible if the mass of ordinary people had already had adequate means of subsistence at their disposal. The general bulk of the population does not become exploitable until they no longer have the

means (land and other productive resources) at their disposal to satisfy their own needs. Only in so far as people have unsatisfied needs will they be amenable to the twin roles of worker and consumer. Not only the methods and the technology but also the institutional organisation of nineteenth century capitalism was a response to the growth of need.

Although there are many studies, such as the four already mentioned, which show that the breakdown of an equilibrium system is fundamental to development, there are few which cover a long enough time span to show the complete process—starting with a description of the society in equilibrium, showing how it was disturbed and what was the initial course of development. Two societies for which we have reports which go some way towards providing the information we need are the Tikopia, a community in the Polynesian Islands, and the Vunamami in New Britain. The Tikopia were visited twice by Raymond Firth, once in 1929 and once in 1952. During his first visit he was able to see the effects of European contact and Christianity on the traditional methods of population control: things were just beginning to change. Apart from practising abortion, Firth said that contraception, celibacy and infanticide are resorted to consciously by the Tikopia as a reflex of the population situation. Responsible people were supposed to have only two children and in families where there were more, only the eldest boy and girl were supposed to marry. But the influence of Christianity in the decade prior to 1929 had already begun to stimulate population growth. Since becoming a Christian, the chief had stopped giving the traditional ceremonial exhortation to people to limit their families by practising coitus interruptus. Contraception was ceasing to be "part of the moral code of Tikopian, publicly inculcated with the weight of the chiefs and the religious values of the (ceremonial) occasion" which Firth says it had been. Formerly men and women who remained unmarried had not been denied sexual satisfaction but had used coitus interruptus and abortion to avoid having children. The church threatened to bar anyone guilty of infanticide or abortion, and "young people who (were) discovered to have had an intrigue (were) threatened by the Mission teacher and sometimes thrust into wedlock". By 1952 most of the traditional checks on population growth had disappeared. People had more children and all of them tended to marry. The situation was regarded, especially by the non-Christian elders, as the result of "improvidence" and "a loosening of the sense of responsibility". Firth's description shows clearly how, in the case of the Tikopia, the initial source of disturbance to the system for maintaining the society within ecological equilibrium came from the proselytisation of European social values under the auspices of the Christian church.

Appearance of food shortages

Although population was growing in 1929 the situation had not yet become critical; some people were becoming anxious about the future, but the threat was still "potential rather than actual" and there was "no real shortage of food". Between 1929 and 1952 the population grew by 35 per cent, from 1,300 to 1,750, apparently creating "acute pressure on food supplies". Unfortunately Firth's second visit to the Tikopia was immediately preceded by a hurricane which meant that the subsistence situation which he saw was worse than it otherwise would have been, but he was usually able to distinguish between the special effects of the hurricane and what was normal. In agriculture, the cultivated acreage was already incapable of significant expansion. People were shortening the fallow period of their garden lands and intensifying cultivation by planting short-term crops in the orchards. There was also a tendency to substitute easier growing and quicker maturing crops such as manioc and sweet potato for those demanding more care and maturing more slowly, such as taro. Firth also says that the Tikopia were keen to try out new plants but had found none which added to their production. He thought that as a whole their efforts had increased production but he feared that the shortening of the fallow and the changes in the balance of their diet would be damaging in the long run. The Tikopia had no resources on which they could base significant production for trade, and the only way they could increase their incomes was by going abroad as temporary migrants to work on other islands. In 1952 the number of people working abroad ranged between 30 and 40 per cent of the effective male working population of Tikopia.

R. F. Salisbury's account of the Vunamami in New Britain is the other reasonably complete account of a small community going through the stages of transition we are interested in. As recently as about 1875 Salisbury says that the population appears to have been in an "equilibrium of low birth rate and low death rate" established "as a means of stabilising a relatively high standard of living". Apparently families were small and people married late. The society was stabilised well within the limits of its environment: "the land could have supported a much larger population with ease". In the late nineteenth century the Vunamami lost some of their land to a missionary and more to other settlers. By the 1890s the encroaching coconut and cotton plantations were causing considerable resentment, and people from surrounding villages who had had their lands taken were coming to swell the Vunamami population. Conflicts between European and Vunamami concepts of property and land-use led to a European legal ruling in 1896 that the Vunamami would have to settle and plant their land within the following fifty years if they were to retain ownership of it. On the initiative of one of their headmen the Vunamami started a conscious policy of increasing their numbers and planting coconuts on disputed land. By decree they lowered bride prices from 100 fathoms of shell money to 10, in order to encourage earlier marriage. Salisbury says the effect was dramatic. He says people married younger and that an annual increase of 3 per cent would fit the known figures for Vunamami populations. Through population growth and the loss of land, the amount of land available per person dropped from three and a half acres in 1875, to just over two-thirds of an acre in 1961. The response to these changes followed the pattern we are now familiar with. Although most of the Vunamami still cultivate subsistence gardens, they use the land more intensively and many use land some distance away where it is less scarce. In addition to copra and cocoa plantations, some of them grow garden crops for cash, but the largest part of village income comes from wage work either on local European plantations or as migrant labourers further afield.

Adam and Eve

These two studies, of the Tikopia and the Vunamami, as well as providing remarkably clear illustrations of the sequence of events which lead to development, also give some indication of the variety of influences which do in practice cause societies to move out of ecological equilibrium. Symbolically the story of Adam and Eve outlines a pattern of events which is strikingly similar to the one just described. The garden of Eden symbolises the hunting and gathering way of life, where food is there for the taking. The one condition for maintaining this idealisable state of affairs is to practise sexual restraint or some other means of population limitation. As soon as Adam and Eve break the symbolic sexual taboos, they are cast out of the garden and thenceforth have to till the ground.

So far we have dealt only with societies which fit particularly easily into the theoretical framework. The historical development of any of the modern industrial nations presents many more problems. Development does not seem to have sprung from a disturbance to a clearly defined stable equilibrium situation. This is largely because class societies—such as these—are much less likely to develop adequate social mechanisms for population limitation than classless tribes, village communities or chiefdoms are. One of the features found in many societies was the practice of food sharing. Within each society there was often relative equality as far as subsistence goods were concerned. Firth's statement that hunger was impossible in one Maori family while others had food to spare was quoted as fairly typical. In class societies (which, from European feudalism to the Indian caste system, usually originated in territorial conquest), there is no longer a unified view of the society's subsistence problem: instead there are major inequalities between large groups of people. The rich upper classes have no need to limit their family size for fear of inadequate subsistence. This affects practices such as abortion and infanticide which are, at best, necessary evils. If the upper classes find them unnecessary, then practising them will come to be regarded as an unmitigated evil. Because the upper class has a disproportionate influence on the society's ideology and law, frequently infanticide and abortion cannot be carried on openly but become illegal undercover activities. Throughout the history of Western Europe abortion and infanticide have been carried on as surreptitious backstreet businesses. They certainly have not had the official backing and religious support which in some societies help to make them an effective means of population control. There is a lot of evidence to suggest that if these methods of population control could have been practised freely, population numbers would not have increased in many periods when they did. The prohibitions could, as suggested, be simply because these practices are abhorrent to those who are not forced to adopt them, but in societies where the ruling class could actually benefit from an increasing working population it may reflect a more fundamental divergence of interests. However, we do not need to go into this problem to see how common it is for the dominant value-systems of class societies to forbid methods of population control which are used elsewhere. The general tone

of Christian thought is well known and we have already seen the impact of Christian missionaries from Europe on the methods of population limitation practised by the Abipones and the Tikopia. But the position is even clearer in Muslim countries. The Koran contains a number of references to infanticide including the following two: "slay not your children because of penury, We provide for you and for them" and "slay not your children fearing a fall to poverty, We shall provide for them and for you. Lo! the slaying of them is great sin". Societies which are denied the most direct methods of population control are forced to develop less direct and inevitably more tenuous methods. These less direct methods, such as controls on the marriage rate and so on, are often only partially effective; they are prone to intermittent breakdown and rarely seem to stabilise population size much below the upper limits of ecological equilibrium. It is this situation which provided the historical background to the developed nations.

It is now time to start drawing a few theoretical strings together. The connection between the expansion beyond bounds at which ecological equilibrium can be maintained and the appearance of economic development makes sense at the level of both the individual and society. At its simplest, the theory of economic development—or perhaps the lack of development—was summed up by a South African Bushman who, when asked why they had not taken up agriculture, said "Why should we plant when there are so many mongongo nuts in the world?" There is no need to labour to increase the productivity of the environment when the present level of subsistence is adequate. Though simple and apparently obvious, this approach places development in a completely new perspective. Development is here primarily an attempt to increase the amount of the means of subsistence which the environment can provide. Changes in efficiency are secondary and are subject to the constraints imposed by the problems of providing a particular quantity of the means of subsistence. In some periods economic efficiency increases, in others it decreases. One of the reasons why in the past it has been assumed that development is primarily a process of making improvements, and increasing the efficiency of the economic system, is that people presumably make changes because they seem beneficial. That they are beneficial in the contexts in which people find themselves need not be disputed. But we have seen how people may be unwilling to accept changes while their society is in ecological equilibrium and yet be willing to accept them later on when they face subsistence problems. The appearance of subsistence problems makes them willing to accept changes which previously seemed to require too much work or to suffer from other prohibitive disadvantages. Population growth, in a society established at a particular level of environmental exploitation, leads to a steady worsening of the standard of living until people are ready to accept any disadvantages which may go with the changes in methods necessary to increase the supply of the means of subsistence. Most of the changes are accepted because they represent improvements in the supply of subsistence, not because they represent increases in efficiency for societies with adequate subsistence. This point was made explicit in a study of peasants' motives for changing their methods of cultivation.

Interviews with some 200 cultivators in the Punjab and north-west Pakistan revealed that 92 per cent of changes were made to increase production and only 5 per cent because they were cheaper or easier—i.e. more efficient—than the old ones. (Changes involved cropping patterns, seed varieties, fertilisers, number of livestock etc., and were motivated by the need for more food, clothes and household items.)

Leisure preference

If some societies are not unwilling to sacrifice existing levels of efficiency for increased production, others are unwilling to sacrifice possible increases in leisure. That some societies show what is called a "leisure preference" has been the despair of many development economists. Many societies have shown a tendency to use improvements in techniques which have reduced the amount of time necessary to produce their subsistence, to increase their leisure time. Economists who have attached a higher priority to increasing output of goods would have preferred the extra time to have been used to increase production. A leisure preference is a clear indication of the relative sufficiency of a society's material means of subsistence and should be regarded as a feature of societies in ecological equilibrium. If a society is in equilibrium and has adequate subsistence then the leisure preference of its members will prevent increases in economic efficiency leading to what we would recognise as economic development. Only if a society is already out of equilibrium will it plough back increases in efficiency to achieve greater output and higher levels of environmental exploitation. A study which illustrates this point particularly clearly is Salisbury's monograph on the Siane of New Guinea. The replacement of stone axes by steel ones had the effect of reducing the amount of time men had to spend on subsistence activities to less than two-thirds of what it had been. They could afford to leave most cultivation work to women, and instead of using any of their new-found spare time in subsistence or other economic tasks, the Siane spent it on additional ceremonial activities, fighting and leisure. They were keen to take advantage of any possible way of increasing their efficiency, but because land was plentiful and subsistence adequate, increases in efficiency had very little connection with economic development.

The general character of the stimuli to development can be summarised by reference to a society where they are conspicuously absent. The Pakot, a Nilotic tribe in Western Kenya who are primarily herders but also practise a little agriculture, have been studied as an example of a society which has resisted all attempts to change its traditional culture. Europeans, and the British colonial administration in particular, have tried to get the Pakot to change their herding and agricultural methods because it was believed that the land suffered from overgrazing and that there was a threat of soil erosion. But whether or not this view was correct, the environmental deterioration had not yet affected the Pakot: they were able to keep more cattle than they needed and Europeans were constantly surprised by how their "healthy, fat cattle . . . contrasted sharply with the seemingly sparse grass". The Pakot did not want to plant new crops which would have decreased the threat of soil erosion because they required more labour than traditional crops. Where possible the Pakot ignore the government's attempts to change their ways; elsewhere they counter its moves "with passive resistance or active obstructionism". They cling to their own culture, methods and beliefs, of which they are proud, they reject European clothes "and remain unconvinced of the alleged benefits of government schooling and Christianity". Schneider says that "The Pakot's determined resistance to British pressures is based upon their satisfaction with their traditional culture and their feeling that it is superior to and more desirable than Euroamerican civilisation. . . . Their herding life provides all they need and all they want, and they have found almost nothing in Euroamerican culture that will entice them to abandon their old ways". This type of cultural pride and conservatism is a common feature of societies in ecological equilibrium; it reflects a lack of unsatisfied needs in the cultural system which it serves to protect. But if the colonial government's prognosis of overgrazing and soil erosion is correct and the Pakot have expanded beyond the limits which their environment can sustain—given their productive methods—then the end of their traditional culture is in sight.

Adam and Eve revisited

by Edward Goldsmith

The industrial world behaves as if it is outside nature and not subject to its laws. Any problems that arise are treated on their own, as particularities, instead of being treated as part of a larger whole, and it is this failure to see the relationship between the parts and the whole that is taking the industrial world at headlong speed towards catastrophe and chaos. The situation is exacerbated by a tendency among scientists to believe that each problem has its own solution and by governments and industry which then accept those solutions.

In this article Edward Goldsmith spells out the principles which he believes govern the behaviour of social systems, and which none—including industrial society—can violate with impunity. These principles indicate that primitive man is the only one who is actually living a sound and completely ordered existence. The rest of us, depending on whether we are part of an industrial society or a rural economy, to varying degrees have simplified our environments, to the point where we are in danger of destroying both them and ourselves. According to Goldsmith the more we try to overcome disorder in our industrial society by technological means, the greater will be the ultimate price that we shall have to pay.

Limitless growth cannot be sustained in a world of finite resources and with a limited capacity to absorb waste. This means that we must develop a society that is not geared to ever increasing growth, which is thereby less dependent on resources and which generates correspondingly less waste. It doesn't matter whether industrial society can be maintained for 10, 50, 100 or 200 years. The fact is that it is moving in the wrong direction and at an exponential rate and the sooner the direction is reversed the easier will be the transition. This movement is accelerated and encouraged by much of modern scientific research.

One doesn't need any experiments to show that one cannot build a perpetual motion machine, since such a device would defy the second law of thermodynamics. Still less is it regarded sensible to advocate their large scale manufacture.

Neither does one need experiments, even if relevant ones could be devised, to show that chemical pesticides will not eliminate pests, that you cannot get rid of poverty by slum clearance, that industrial growth cannot be sustained for very long.

In each case, basic principles, some not yet properly formulated it is true, but nevertheless very difficult to deny, can be invoked, as they can to demonstrate the illusory nature of the main tenet of the religion of industrial man: that science, technology and industry can combine to create a materialistic paradise on earth from which can be eradicated all the ills man is supposed to have suffered from since the beginning of time, such as poverty, unem-

ployment, disease, homelessness, crime and famine.

On empirical grounds alone, it is clear that our society is failing to achieve this paradise, as far from being eradicated these ills are everywhere on the increase, not only in the non-industrial countries but also in the richest industrial ones such as the United States. Thus in America there are now 25 million people who are officially regarded as poor while an equal number of Americans are displaying symptoms of malnutrition which one would have thought impossible in so prosperous a country. Indeed, if America cannot solve such problems with all its science, all its money, all its technology, how can any other country be expected to do so?

Current scientific methodology cannot solve the problems of a modern industrial society. On the other hand, if we wish to interpret and understand such problems, the study of general systems is the approach most likely to provide an overall view.

Human society, it is essential to realise, is but a unit of behaviour or a system, and it can only be understood in terms of the behaviour of other systems at different levels of organisation. What one requires therefore is a general model of behaviour in terms of which one can attempt to understand the behaviour of an industrial social system. This is a big undertaking. I shall limit myself to stating what must be some of the basic principles of behaviour common to all systems, some of which have not previously been formulated. If these principles were accepted that if it were generally realised that they applied to all behaviour, including that of industrial societies, then it would become clear how in industrial societies all we are doing is trying to build perpetual motion machines. Indeed, practically all the major undertakings of our industrial society are unsustainable in terms of these basic principles.

1. The principle of a system

A natural system is best defined as a unit of behaviour, and by its nature must be made up of differentiated parts in dynamic interrelationship with each other. Systems, regardless of whether they be cells or societies, have a great deal in common. The generalities, hence the basic principles, of their behaviour are the same.[1]

2. The unity principle

The biosphere developed as a single process; and must be regarded as a single system. This means that we should not study its parts in isolation or for that matter in terms of the different disciplines we have developed. Another implication is that human beings, their families and the societies into which they are organised are not above nature, nor are they exempt in any way from any of the principles governing other natural systems. This means that the same methodology must be used to understand the behaviour of humans and their societies as is used to understand the rest of the biosphere.[2]

3. The "Man the Hunter" principle

It is significant that for nearly 99 per cent of man's tenancy of this planet he has earned his living by hunting and gathering and his activities have been limited to the fulfilment of his normal ecological functions in his particular environment without in any way upsetting its balance, i.e. he has until extremely recently behaved as a normal differentiated part of the biosphere. It may seem strange but when we generalise about man, we must mean "man the hunter". If man has existed for two million years, then his experience as an industrialist is not more than two days in the life of a man of 70, in fact quite negligible, certainly far too short a sample on which to base any generalisations about the behaviour of man.[3]

4. The "Original Sin" or niche principle

The hunter-gatherer mode of life appears to be the only one compatible with the maintenance of a climax ecosystem. Any departure from it must mean at least a measure of biological and social disruption. The greater the departure the greater the disruption. (See the optimum environment principle.)

5. The principle of economy

Behaviour takes the line of least resistance or of least effort. It is probable that the origin of life can be explained on this principle alone. Matter organised itself the way it did because it was the easiest course for it to take. Nature is consequently very efficient. In the correct sense of the term it makes the minimum effort necessary to achieve its goal (stability, as we shall see). Efficiency in the technosphere is a very different thing. It means achieving the maximum output for the minimum input measured arbitrarily in terms of their market price which has nothing to do with their real biological and social cost. One of the most important implications of this principle is that systems and their mechanisms which are no longer made use of, i.e. for which there is no longer a niche, tend to atrophy—they can, in fact, be destroyed by depriving them of their function.[4]

6. The teleonomic principle

Behaviour is goal-directed. Empiricist philosophers and scientists who insist that all knowledge is derived from observation refuse to accept this because no experiment can be rigged up in a laboratory that will either prove or disprove it. Unfortunately this also holds for most of the general principles governing behaviour on this planet. It is also conveniently ignored because it justifies the deductive method. It establishes a generality from which particularities can be deduced without resorting to experimentation. It is ironic that if behaviour were random, i.e. if it displayed no order, and hence was not directive, the behaviour of dynamic systems (and all natural systems are dynamic) could not be interpreted or predicted (and it is the function of science to interpret and predict) and science would simply not be possible.[5]

7. The principle of stability

The goal is the achievement of stability which can be defined as a course or trajectory on which discontinuities, i.e. disequilibria and their corrections, are reduced to a minimum, hence that ensures survival taken in its broadest sense. Human societies until recently satisfied this requirement. Their culturally determined goal was the maintenance of traditional norms, which were upheld by public opinion, the council of elders and the ancestral spirits. Stability is another word for continuity. It does not mean immobility as an immobile system would not be stable since it would not be capable of adapting to a changing environment. The importance of this principle is that it provides the only possible criterion for judging behaviour at all levels, i.e. in accordance with its contribution towards the achievement of stability.[6]

8. The principle of self-regulation

Stable systems must be self-regulating. They are maintained on their course by a control mechanism which in all systems regardless of their level of organisation functions on the same principle. Data are detected and organised (cybernised) to constitute a model of the relationship of the system to its environment. (In a social system this is usually referred to as its world-view.) The responses are mediated in terms of it, otherwise they are random and the system unnoticed is out of control. Also essential is that each of the constraints a self-regulating system is subjected to is subject to the constraints of the system as a whole, which means that the latter acts as a unit. As soon as a system is regulated from outside (asystemically), the mechanism which is alone capable of assuring that the system's responses satisfy all environmental requirements breaks down. It can no longer be kept on its optimum course, the course being determined arbitrarily by the external controller. It is significant that the behaviour of human societies has been until very recently entirely self-regulating. Primitive societies had no dictators or bureaucracies. They were run by tradition. They are often referred to as gerontocracies, government by the elders. I prefer "neocracrocies", government by the dead. As soon as institutionalised government takes over, the arbitrariness of the society's behaviour is painfully manifest.

Note: Perception is not an objective measure as empiricists seem to think it is. What one sees depends on one's model of one's relationship with one's environment. Since everyone will have developed a slightly different model, so different people will see different things. This is also true of different societies, which have developed different cultures in terms of which they will interpret (see) their environment in a different way.[7]

9. The probability principle

The cybernism, by which term I refer to all organisations of information to constitute models made use of by control mechanisms, can be regarded as probability calculators. The brain is no exception. What one sees, i.e. the hypothesis one formulates to explain one's relationship to a particular environmental situation, is the most probable one in terms of one's model. The notion of evidence, i.e. of an interpretation that is 100 per cent certain, is totally unknown in the natural world. Scientists, whether they know it or not, are also part of the natural world and none has ever formulated a hypothesis which is more than probable. One's policies and actions must therefore be based on those hypotheses which in terms of existing knowledge appear to be the most probable. One cannot do better than that.[8]

10. The continuity of information principle

Systems must be looked at four-dimensionally. They exist in time as well as in space and their continuity can only be assured if the information transmitted from one generation to the next (i.e. the generalities of the system's behaviour pattern) reflects the experience of the system as a whole, i.e. which temporally speaking means as far back in its evolutionary history as the experience acquired is relevant to the conditions of the day. Only in this way are the constraints subjected to those of the system as a whole (which as we have seen is a *sine qua non* of self-regulation).

In this way a system is adapted to dealing with situations whose nature and the probability of whose occurrence can be predicted on the basis of the greatest possible experience and not just on that of the preceding generation. We know that this is true of genetic information. It is not generally realised that it has until recently also been true of cultural information. Education has until recently consisted in imbibing youth with the traditional wisdom which will enable them to fulfill their functions as members of their families and communities and ecosystems. By breaking away from tradition, by elevating our scientists and other improvisors to the status of the priests of our industrial society, by putting a premium on change and originality, we are violating this basic principle which we only do at the cost of decreasing stability. At the other end of the scale, only the particularities of a system's behaviour pattern are developed on the basis of its own experience and constitute thereby differentiations of the original instructions designed to ensure adaptation to specific, possibly short-term, environmental conditions. For us, the most important implication of this principle is that there is no substitute for the traditional society. It is only in this type of society that the continuity of information principle is not violated.

11. The optimum environment principle

The optimum environment for any system—that in which it will be the most stable—must be that to which it has been adapted phylogenetically and ontogenetically. The inescapable conclusion is that as industrial society proceeds, as the technosphere replaces the biosphere, so must instability increase at all levels.

12. The limits principle

A system can be maintained along its optimum course only if change both to itself and its environment occurs within acceptable limits. It cannot re-respond adaptively to situations of which it has had no experience during the course of its evolution and whose nature and occurrence it is thereby incapable of predicting. It is significant that societies have only been able to maintain their stability in relatively unchanging or slowly changing environments and few primitive societies have been able to withstand dramatic changes such as those induced by contact with industrialised man. The limits can be organised hierarchically in accordance with their degree of generality (see the hierarchical constraints principle).

13. The counter-intuitivity principle

As a system's environment departs more and more from that which it was designed to deal with so must its interpretations and predictions become ever less accurate. Our normal intuitions, i.e. the mechanisms we developed to determine our basic responses to our environment in such circumstances are increasingly unreliable. As Forrester puts it, our environment is increasingly counterintuitive. As a result our responses are correspondingly counterproductive.

14. The ecosystem principle

A system does not develop in a random manner but as an adaptive response to a particular environmental situation.

It must follow that it cannot be understood apart from this situation. The two must be studied together as constituting a larger, slightly less orderly system, one that is normally referred to as an ecosystem. This must be true regardless of the level of complexity of the system one is examining i.e., whether one is trying to understand the behaviour of a molecule, a cell, an organism or a society. An essential implication is that if one destroys the specific environment to which a system is an adaptation, i.e., deprives it of its niche, then it must die. As the biosphere deteriorates this is rapidly happening to the world's larger mammals, including man. The converse of this principle is that if a niche is available a system will evolve to fill this niche. Our sprawling urban areas and huge stretches of monoculture must give rise to large populations of micro-organisms and insects adapted to them and in terms of which epidemic diseases are alone explicable. (See the principle of selection.)

15. The levels of complexity principle

Behaviour does not proceed in a continuous way but in jumps. Critical points are reached when specific systems cannot further increase their complexity (see the principle of complexity) without going unstable except by associating with others to form a new one at a different level of complexity; thus atoms joined to form molecules, molecules to form cells. Also in the same way families join to form small communities (clans or villages) which in certain circumstances will join to form larger ones. The limit to the size of a particular type of system is probably set by the extendability of the bonds used to link together its constituent parts. In a social system these appear to be extensions of the family bonds and they will not extend very far. There appears to be a limit to the size of a society capable of acting as a self-regulating and hence as a stable system, and such a system appears to be quite small. A monolithic nation state is a relatively new institution and it does not satisfy these conditions in any way (see the ecosystem principle). Since the unit of study is the ecosystem, we should think of levels of complexity as those ecosystems comprising molecules plus their respective environment, cells plus their respective environment, organisms plus their respective environment, etc.

16. The generality principle

Behaviour proceeds from the general to the particular. As most scientists today are concerned with particularities, generalities (being difficult to study in laboratory conditions) tend to be ignored and are often referred to disparagingly as "value judgements". Nevertheless it is they which are important. If the British army invades China what is important is not whether Sergeant Snooks has polished his bayonet but whether the basic principle of invading China is right. It is the first and most general stages of any process which should concern us most. The implications are obvious in medicine, psychology and education. It establishes the mother as the basic educator and not the school, let alone the university.[10]

17. The differentiation principle

Behaviour proceeds by differentiation. A behavioural process cannot be understood solely in terms of the original instructions (except in the hypothetical situation of absolute order). These are adapted to local conditions at each stage, determining correspondingly differentiated behaviour. This further emphasises the importance of the early stages which will control all subsequent

stages in terms of which they are differentiated. It also implies that subsystems are designed to fulfil different complementary rôles. To suppose that the members of a family, for instance, are equipotential and that the bonds linking them together are symmetrical either genetically or culturally (in a stable society) is to misunderstand the forces that determined the development of the family unit.

18. The principle of self-reliance

In order to ensure necessary supplies a system will not allow itself to become dependent on external sources of nutrients and other resources unless it can predict that supplies can be maintained. Ecosystems tend to become more and more autonomous as they develop.

Our industrial society, on the contrary, in order to exploit the so called economies of scale, becomes more and more specialised and hence more dependent on external sources of supply, sometimes very unreliable ones, usually increasingly so, and on external markets for the funds with which to purchase such supplies, thereby violating this fundamental principle.[11]

19. The principle of diminishing production

As a system develops towards higher stability and eventually reaches adulthood—or a climax situation, the rate of biological production decreases. This means that to maximise production—as in marine agriculture—it is necessary to maintain the system artificially at a lower phase of development and hence at a more unstable one. The result is and must be great discontinuities, i.e. more droughts, floods, pest outbreaks, etc.

20. The sequential principle

Responses must occur in a particular sequence (succession). This is so because each one must be triggered off by the occurrence, or the prediction of the occurrence, of a situation which will be influenced by the preceding one. The more orderly the process (as in the development of an embryo), the more essential it is that the sequence be respected. Education or socialisation is a normal behavioural process and, as a child grows up, it acquires its basic information from the family unit. Subsequently it is subjected to the influence of its peer group and it is later let out in the community as a whole. Information is received from these different systems in the correct order. This order is critical if the child is to be properly socialised. In a stable society information from random sources extraneous to the system in which socialisation occurs (from television, personalities, films and most educational establishments) can only interfere with socialisation. The idea of education as subjecting a child to a massive barrage of non-selective data in no particular order, simply on the principle that the more knowledge the better, is indefensible and an educational policy such as ours that is based on such a notion must be fatal to the survival of society.[12]

21. The accumulation principle

Behaviour is cumulative. When new levels of organisation are achieved the previous ones don't simply disappear nor do they fuse with the new. They are modified by virtue of the fact that they are subjected to new sets of constraints but they are still there. This means that it is of little use to study behaviour at different levels of organisation by themselves. Its main implication is the following.

22. The hierarchy of constraints principle

All systems are subject to constraints. This is the same as saying that they are increasing order or reducing randomness. As each level of complexity is achieved a new set of constraints becomes operative. These can be organised hierarchically. The lower the level of complexity to which they correspond, the more they are important because the greater their generality (see the generality principle). Thus physical constraints apply to all systems. Everything obeys the laws of gravity, also the laws of thermodynamics. Biological constraints apply not only to biological organisms but to families and societies. Social constraints apply to all societies, however artificial. Our society is nonsustainable principally because its priorities are wrong. It puts economic constraints, i.e. those that are supposed to favour the distribution of resources within a system, before those that ensure the survival of the system itself and even subordinates to them physical and biological constraints.

The principle of "Consumer Sovereignty", for instance, which states that everything must be subordinated to the satisfaction of—on the whole—artificially induced material requirements of individual consumers, reflects this lunatic state of priorities, as does that of permissiveness, which implies that it is actually advantageous to ignore that set of constraints that individuals are subjected to to enable them to fulfil their differentiated functions within their family and social systems.

23. The cyclic principle

One of the most important ecological constraints at the physical, chemical and biological level of complexity deserves to be stated separately. Indeed in order to prevent the running down of our world and to permit the increase in order that has characterised the last few thousand million years, during which time our biosphere has developed, the raw materials of life have been exploited in an extremely subtle way, each one of them being recycled via complicated processes permitting their constant re-use and avoiding the accumulation of waste. It is significant that our industrial society has ignored this key constraint. The development of the technosphere has been largely a one-way process, the biosphere being systematically transformed into the technosphere and the waste matter of the technosphere, both of which from the point of view of the biosphere constitute waste, randomness or entropy.

24. The rate of "cybernisation" principle

The rate of change which a system is capable of dealing with depends among other things on the rate at which the control mechanism can function, i.e. the rate at which it can detect data, transduce it into the informational medium used by the model, organise it in the model (or cybernise it), permitting interpretation or prediction and responding accordingly. In the case of a population whose model is contained in its gene-pool, this rate is very slow. The phylogenetic changes or responses are slow, especially as generations become longer as in man. In order to increase the rate of cybernisation, a new set of responses is developed based on a new informational medium, that

used by the brain. The information in terms of which one can understand the behaviour of a human social system is formulated partly genetically, partly culturally (neuro-genetically), its generalities in terms of the former, its particularities in terms of the latter. The particularities of a model are easier to change than the generalities. Their rôle is to permit petty short-term adaptations which are justified on the basis of small short-term experience, whereas the generalities reflect the long-term experience of the species (see the continuity of information principle).

25. The principle of variety

The improbability of the environmental change to which a system can respond is directly proportional to its "variety". The concept is applicable to a gene-pool as well as to a brain, i.e. to all cybernisms. It is also applicable to cultures which we are systematically destroying in order to spread our own industrial culture. It is also applicable to ecosystems which are everywhere being simplified as monoculture replaces mixed farming and as herbicides, fungicides and insecticides eliminate "unwanted" species. One does not need any laboratory experiments to tell us the result can only be to increase instability and hence discontinuities such as "pest" epidemics.

26. The principle of complexity

The precision with which a system can adapt, is the extent to which oscillations (disequilibria and their corrections) can be reduced in a given situation which in turn depends on its complexity (both temporal and spatial). For instance, in an ecosystem, by increasing the number of trophic levels or levels of predation, new qualitative and quantitative controls become operative which must reduce the size of population oscillations occurring through disease and famine—hence increasing stability. It is to be noted that society, in accordance with the principle of economy, will display the minimum complexity required to deal with environmental challenges. Also its complexity is limited by the levels of complexity principle—thus if increasing complexity is at the expense of its basic structure into families, small communities, etc. it will cease to display order and will become unstable. (See the principle of order.) It is significant that the technosphere which we are substituting for the biosphere is not as complex as we think. In fact, by nature's standards it is rudimentary. The most sophisticated piece of equipment devised by man is far less complex than an ordinary virus.

27. The principle of order

The most adaptive situation when no predictions concerning environmental changes can be made is randomness (which I shall take as synonymous with entropy) or an absence of order. As it becomes possible to discern some order in the environment and hence make interpretations and predictions concerning likely changes, so does order build up. Order is organisation, a departure from randomness. Not any organisation but that which most favours the goal of stability. The technosphere does not display order as its organisation is not homeotelic (see the homeotelic principle) or self-regulating and hence tends towards increasing instability. In the same way a modern state, however centralised, does not display "order". The most adaptive organisation when predictions can be made with total accuracy (assuming this were possible)

would be a system in which the steps succeeded each other without change of any sort, i.e. in which a pre-established response were replicated. I regard this latter situation as displaying the highest possible order. Needless to say, it can never occur. But order will increase as we move from the situation of no prediction to the theoretical situation in which infallible predictions are made. We think of order as synonymous with centralisation. This is apparent in the case of a system displaying high temporal complexity using an informational medium permitting rapid cybernisation and responses, such as the day to day behaviour of a human organism with a centralised nervous system, or that of an army. It is less apparent but equally so in a system made up of generations of amoebas in a stagnant pool or, for that matter, of Australian aboriginal hunter-gatherer societies. It could also be regarded as displaying high centralisation since the original instructions were handed out a long way back and have scarcely been modified since. This fits in with the normal criterion of order—the extent to which a system can be understood in terms of its generalities or basic instructions. It is to be noted that a large society will be made up of communities subjected to different environmental pressures in order to respond adaptively to which they must evolve divergent behavioural traits—thus a centralised society is likely to be unadaptive.

28. The principle of the optimum strategy

There must be an optimum value to every variable representing a strategy exploited by a system to achieve stability. No such strategy is desirable per se. Therefore there is no possible reason for maximising any one of them. On account of the principle of economy, the optimum will in fact coincide with the minimum required for dealing with environmental challenges. Only a self-regulating system which is linked by feedback-loops to all those parts of its environment whose behaviour can affect it, is capable of maintaining itself along the optimum course that provides the best compromise between environmental requirements. Our society, needless to say, is geared to the maximising of such things as education, prosperity, number of housing units, productivity, etc. Such aims (even were they tending in the right direction) would be incompatible with the maintenance of a stable social system.

29. The principle of competition

Competition is a mechanism whereby systems organise themselves hierarchically in accordance with their ability to fill available niches. It permits thereby the establishment of order within the larger system. If a system is tending towards stability, the greater the competition the greater the hierarchy (which is synonymous with order). If, on the other hand, it is tending towards instability, the greater the competition the greater will be the extent of the organisation tending in the wrong direction and the faster will it move towards its ultimate collapse. In our industrial society, the greater the competition, the more long-term biological and social considerations are subordinated to short-term "economic" ones.

30. The principle of selection

Selection is competition looked at from the point of view of the environment. It does not only occur among mutants or random changes. It occurs also—and primarily in fact—among adaptive, i.e. controlled responses. Such responses can be regarded as selected by the environment in the sense that their rôle is to satisfy an environmental requirement and if there is no such requirement there will be no response. It is precisely because there is no environmental requirement for the mutants, accidents or random responses that they tend to be eliminated (see the niche principle). The operation of this principle within a society or a population may appear disagreeable to us. We tend to refer to it as discrimination against the genetically and culturally unadaptive. Yet there is no alternative save the development of a population or a society displaying increasing entropy and eventually breaking down. To encourage the latter appears to be far more immoral than to accept the basic principle that man is subjected to selection like all other forms of life. Measures tending to prevent the operation of selection by feather-bedding the unadaptive, i.e. via the welfare state, must correspondingly reduce social stability by increasing entropy or randomness. If we decide to take them, then we must be prepared to pay their cost.

31. The homeotelic principle (from the Greek "Homeo": same, and "telos": goal).

If a system is capable of running itself then its parts or sub-systems at all levels of complexity must be tending towards the same goal. If they were tending towards different and incompatible goals the system would break down, unless of course an external force were introduced to hold it together. However, it would then cease to be self-regulating, would become unstable and eventually collapse. If the parts are capable of behaving homeotelically it is because they were designed that way by differentiation. This applies equally well to human beings who have been designed phylogenetically and who in a stable society are trained culturally to fulfil their different functions as differentiated members of family and community systems. It can only be expected that a man will obtain the maximum satisfaction by fulfilling such functions as a husband, a father, a son, and a member of different social groups. This explains the counter-productivity of "progressive" education, which is based on Freud's totally mistaken notion of society as frustrating and inducing neurosis. It is also clear that it is only if its members behave homeotelically in this matter that a system such as a family or a community can survive. In our society everything is done to impair homeotely at both the family and communal level. Women are encouraged to take jobs, put their children in crêches and so neglect important maternal functions. Worse still, they are subjected to an education which places no store on the fulfilment of such functions (in which many of the household tasks that have previously provided people with undoubted satisfaction are classified as "drudgery" by those who wish to draw the housewife more directly into the orbit of the cash economy). Also the father is prevented from fulfilling his essential functions as protector of and provider for the family by the all-pervading welfare state that takes over the education and the health problems of his children. Similarly, homeotely is being impaired at the communal level, since people are being systematically taught that it is the duty of the State to satisfy all their requirements including the most superficial, while the spirit of duty and participation in social

affairs which alone insured the survival of stable societies in the past is discouraged in every way. In other words, the introduction of external controls on the massive scale that they now operate in a modern national state must impair homeotely and hence disrupt the self-regulating mechanisms which are alone capable of insuring stability in our family and social systems.[13]

32. The heterotelic principle (from the Greek "heteros": different, and "telos": an aim or goal).

As a system disintegrates, so it fails to provide the appropriate stimuli required to trigger off the homeotelical responses on the part of its members. The responses that the latter will trigger off will be heterotelic, tending towards different goals from that of the system as a whole and incompatible with them. Thus, to return to the family as it disintegrates the husband might leave his wife for a mistress or resort to various forms of retreatism such as alcohol or drugs, all of which might provide him with personal satisfaction but do nothing to hold the family together. As a result, the family will disintegrate still further until it eventually ceases to constitute a system capable of autonomous behaviour. This is what is happening today. The extended family which displays complexity and order has already disintegrated into the unstable nuclear family, which in turn is further disintegrating into its constituent parts, the process being most advanced in the suburbs of the large urban agglomerations in America and elsewhere.

33. The accommodation of trends principle

A heterotelic response is not solving a problem, only suppressing one of its manifestations, thereby rendering it more tolerable, and contributing to its perpetuation. Thus the tranquillisers that are now dispensed in astronomical quantities do no more than render man's plight as a member of a disintegrating family, community and ecosystem that much more tolerable, serving thereby to perpetuate the process of industrialisation that has actually put him in this plight. Most of the so-called services provided by industrial society fit within this category. Houses for the old are only necessary with us because the family unit has broken down and people have lost their sense of responsibility towards their parents, which leads them to exile them to such institutions. To provide them is simply to accommodate this tendency and so it is with crêches for children who should be looked after by their own mothers. So it is with most of the welfare which, in a stable society, is dispensed at the family level, where it must cause the minimum disruption. So it is with most of the consumer goods people are acquiring in ever greater quantities because their acquisition satisfies a heterotelic goal structure, a substitute for that which is normally provided culturally by the family and communal environment.

34. The problem-multiplier principle

Heterotelic responses, by tending towards the satisfaction of single requirements to the exclusion of all others, must give rise to more problems than they solve. In addition, external or heterotelic controls, by their very nature, must render systemic ones redundant, which in accordance with the principle of economy must cause them to atrophy. Pesticides will thus destroy the natural controls on insect pests; artificial fertilisers nitrogen-fixing bacteria; in social systems centralised bureaucratic controls such as those operative in Western type nation states must destroy social structures and consequently society's capacity for self-regulation.[14]

35. The solution-multiplier principle

On the other hand, by setting about to reconstitute or imitate the environment to which a system has been adapted phylogenetically and ontogenetically, one is ensuring the increasing stability and hence the better functioning of very many more than one specific system. Homeotelic responses will thus do far more than solve those problems one may be temporarily concerned with.

In fact, as they are adopted so must other systems temporarily in disequilibrium fall back into place, for so will the biosphere function that much more closely to the way it has been designed by thousands of millions of years of evolution.

Only homeotelic measures, which reduce rather than increase man's impact on ecological systems (physical, organic and social) thereby reducing systemic disruption at all these levels, can provide real solutions to the problems of man.

36. Conclusion

Induction and experimentation do not permit us to understand the world we live in. This can only be done by arguing deductively from basic principles. If we do this, it becomes apparent that man's problems have been totally misinterpreted by the scientific world. They are not due to a "lack of development" calling for further research, technology and industrial development. The opposite is the case. They are the result of a systemic deviation from man's optimum environment—that to which he has been adapted by millions of years of evolution. This deviation started with the neolithic revolution and has been accelerated with the development of industry. Further development, i.e. further deviation from the optimum, can only increase these problems while their solution must reside in developing that way of life, and reconstituting that environment which, in the very unfavourable circumstances in which we find ourselves today, most closely imitates the optimum.

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Friends of the Earth

Whales 73

1973 has proved to be a bad year for the whales. At the 1972 International Whaling Commission meeting, the International Observer Scheme was finally put into practice after 14 years of deliberations, the blue whale unit was finally abolished and catch quotas for each species were established. This year there were no further improvements; and the non-whaling nations largely acted as a rubber stamp to the wishes of the biggest whaling countries —Russia and Japan.

At this year's meeting the US resolution for a 10 year moratorium on all commercial whaling was defeated; the Russians and Japanese threatened to ignore the International Observer Scheme in the Antarctic, the fin whale —the next species in line for commercial extinction—was left unprotected; and the overall catch quota was only reduced by 1,100, from 38,600 to 37,500.

The only glimmer of hope during the meeting came in the Technical Committee session, when the moratorium was discussed. The American delegation, ably led by Dr Robert White, introduced a resolution to phase out commercial whaling over a period of three years. The American delegates said that they did not accept many of the views given by the Scientific Committee who had agreed that there was "no biological requirement for the imposition of a blanket moratorium on commercial whaling" at the present time. The Americans pointed out that the Scientific Committee would only say there was a biological need for a moratorium when species had become commercially extinct. Needless to say, the Japanese and Russian delegates did not agree with Dr White. Mr Iwao Fujita of Japan said that he "upheld the views expressed by the Scientific Committee and could not accept the spirit or the substance of the US resolution".

Dr Lafitsky of the USSR said that the "Convention was not set up for the regulation of non-whaling" and that if the resolution was accepted an "era of unregulated whaling would approach", and those countries "voting against would have to form another commission".

The Russians and the Japanese were in the minority, however; the resolution was passed with eight votes for and five against with one abstention. The UK, USA, Mexico, Argentina, Panama, Australia, Canada and France voted for the resolution; the USSR, Japan, Norway, Iceland and South Africa voted against. Denmark abstained. This was a great improvement over last year when a similar resolution was defeated by six votes to four, with four abstentions. Last year Australia, Canada and France abstained from voting; this year they voted "yes". Panama switched her vote from "no" to "yes". At Technical Committee meetings resolutions can be passed by a simple majority vote. However, at the following Plenary meetings—where all the issues are finally decided—a three quarters majority vote is needed. The voting pattern on the resolution was the same at the Plenary session; the resolution did not obtain the required three-quarters majority and was therefore defeated.

The next big issue to be discussed was the setting of catch quotas for the 1973/4 season. The Japanese were mainly interested in getting high quotas for baleen whales—especially the minke, to make up for the decline in fin whale stocks—for use as whale meat. This is used for human food for home consumption, and is considered a luxury food. The Russians were more interested in sperm whales as they use large quantities of sperm oil in their space programme. In each case, the Russians and Japanese asked for high quotas and then reluctantly accepted lower ones "in the spirit of compromise". The toughest battle was in the Plenary session over the fin whale quota for the Antarctic. Last year's quota was 1,950; but only 1,761 were found to kill. Because the fin whale population was so low a zero quota was proposed and passed by the Technical Committee. But at the Plenary session Mr I. Rindal (Norway) proposed that the quota should be 1,450 on the understanding that Japan and Russia should work towards further reductions next year. Dr Lafitsky (USSR) seconded the proposal and promised that the USSR would work towards a complete cessation of fin whaling by the 1975/6 season—in their view a major concession. Dr White (USA) then made his only blunder by dismissing the USSR's generous attempt to come to a compromise, and proposed a quota of 1,450 with a phase out of fin whaling over a period of three years. This amendment was subsequently voted on and passed. But the Russians claimed that they would have difficulties in implementing these decisions; they would have to consult with Japan about adhering to the International Observer Scheme in the Antarctic, and reserved the right to lodge an objection within 90 days. (Under the IWC regulations if a country objects to a resolution within 90 days, the resolution is not binding on it.)

It was in this vein that the Convention proceeded. The Japanese did not give way on a single issue. When pressure was exerted on them they threatened to walk out. The other nations would then bend to their wishes. The only encouraging aspect of the meeting was the growing responsibility shown by the majority of the member nations. However, if the IWC is to be effective, it must be strengthened by broadening its membership base. Ideally the IWC should be taken under the auspices of an independent, international body like the UN.

Angela King

Coming events

10-14 September—Residential week to begin Technology, Ecology and Conservation course for teachers at Trent Polytechnic followed by a series of day and evening sessions at Nottingham College of Education and a residential long week-end at Matlock College of Education 5-8 April 1974. Further information from the Secretary for Short Courses, School of Education, University of Nottingham, University Park, Nottingham NG7 2RD.

12-16 September—Conference on Landscape for People to be held in the grounds of The University of Birmingham. Further details from The Institute of Landscape Architects, 12 Carlton House Terrace, London SW1Y 5AH.

Books

Tyger, tyger

WHERE THE WASTELAND ENDS by Theodore Roszak, Faber, £3.75.
ARTS OF THE ENVIRONMENT, edited by Gyorgy Kepes, Aidan Ellis, £5.50.

Every schoolchild learns Blake's "Tyger, tyger burning bright". Not many are told that the tyger is Urizen, one of Blake's mystical figures, who is also the bearded Ancient of Days, the creator of a fallen world which he measures with calipers, and Satan. Urizen personifies the "single vision" of Newtonian science which Blake spent so much of his life and energy attacking. It was this vision which led to the "dark Satanic mills" and if Blake saw them as a visionary while we see them in metal and concrete and filth, it makes little difference.

Professor Roszak attacks it, too, in the most elegant and the most withering demolition of reductionism I have read. Blake and the Romantic poets, who perceived, albeit dimly, that society had taken the wrong path, are central figures in Roszak's book, but he traces our alienation from the world and from ourselves back to Bacon, who laid the foundations of modern scientific method. Even Bacon was no more than a product of a religious and philosophical tradition that is much older still.

He shows how the Judaic and then Christian acceptance of monotheism required an assault on idolatry, but that this assault was based on a profound misunderstanding of the relationship between primitive peoples and their symbolic representations of forces they could neither control nor comprehend. Thus magic had to be absorbed, as in the Christian communion, or more usually, abolished. This obsession with idolatry itself became idolatrous when its most extreme manifestations, as in Calvinism, permitted us to worship our own intellect. Thus real idolatry triumphed and God was assassinated by priests. We are left with a craving for knowledge, by which we mean Faustian knowledge—Goethe was well aware of this—knowledge that gives us power over nature, in a culture that has secularised even religion. The ecological and social crises which face us are the entirely logical outcome of our preoccupation with logic. The conclusion has been reached by others, but never so forcefully or convincingly.

Yet this is a book about politics, not religion. It aims to assist those engaged in devising a new ethic by placing them and their quest in historical and philosophical context. The ecological movement may supply the needed unifying principle that takes into account the whole of human experience, rather than a mere part of it. Ecology may permit science a moral dimension. Even so, there is a real danger that the ecologists, who have done so well so far, may allow themselves to be diverted into abstract studies of systems and energetics as reductionist as any scientific discipline. The opportunity to resolve the human predicament may be lost and society will accelerate to its logical and inevitable collapse.

The unification required is not only of the sciences. Arts, politics and religion must be embraced as well. Sadly, all the evidence suggests that the scientists are so far ahead that the others may never catch them. *The Arts of the Environment* provides a nice counterpoint to Roszak's book. Here are the visual artists, entranced by such technological playthings as skylabs and homes on the ocean floor. Here are the architects who have studied the loveliest of medieval cities and never understood the culture that built them. They have created concrete and neon nightmares of which they boast that inside them all man's needs will be satisfied; except, perhaps, his need to escape from concrete and neon nightmares. There is even one who has constructed a vast and totally inane spiral jetty projecting into the Great Salt Lake. Having completed his creation he dismisses the earth-moving juggernauts, hires a helicopter and proceeds to admire and photograph his handiwork so that he may produce pages of specious rationalisation to justify the outrage he has committed. Eminent scientists, such as Rene Dubos, Albert Szent-Gyorgyi and Dennis Gabor have contributed chapters to this book, but even they are rendered banal and lost amid the precious ravings.

All is not despair. Roszak is right. There are those who appreciate and wonder at the world in which we live and who seek to make peace with it, not conquer it. Roszak takes the ecological debate several stages further and *Where the Wasteland Ends* must become a standard work.

Michael Allaby

Doing well by doing good

BEYOND CONFLICT OR COMPROMISE: Human progress and the United Nations Development Programme, UNDP, 866 United Nations Plaza, New York, NY 10017. Free.

At the end of the Stockholm Conference, Maurice Strong summed up the proceedings by saying, "man cannot manage his relations with nature unless he learns to manage better the relations between man and man—that is if he is to preserve planet earth for future generations, he must also make it a better home for present generations". This, of course, is only part of the lesson of Stockholm. The Conference also asserted that henceforth man must operate within constraints imposed by the availability of the resources on which he depends, and by the physical and biological systems of which he is a part.

Not only does the UN Development Programme (UNDP) appear to have missed this aspect of the debate, it has produced a slender, but expensive and glossy booklet in which it exhibits its misunderstanding in public. True, it makes mention of the international concern over resource depletion and pollution, and over political, economic and social injustice, but concludes that what we need is more of the same.

The overall aim, of course, is to take nature firmly in hand and improve on it. To this end artificial lakes are being built and stocked with exotic fish brought in by air while crash programmes are launched to repair the ensuing ecological damage; rivers are diverted to irrigate a desert; transport systems are being improved; and there is the "Green Revolution". Attention is being given to such urgent matters as providing direct telephone links to

enable farmers in Kenya to talk to colleagues in the Central African Republic without having their calls routed through London and Paris. If everything works, whole regions of the earth will enjoy standards of living they have not known since first we invaded them.

The booklet makes no mention of the other results. The financing of development by tied aid and short-term loans will bring a quick and lucrative return to the rich nations. The more efficient the extraction of mineral resources, the more rapidly will the economies of the rich be able to expand. The greater the success of the "Green Revolution", the more business there will be for the manufacturers of agrochemicals and machinery. The world economic system being what it is, the inevitable result will be that the rich will grow richer as the poor grow poorer, in both relative and real terms.

Poverty will spread as labour-saving technologies increase unemployment without providing alternative industries to absorb workers, as resources are sold cheap that might have been used, more slowly, for the benefit of the people who would like to think they own them, as foreign exchange is depleted to service loans, and, in no small measure, as people lose their main resource, the environment in which they live. Should they succeed in producing a finished commodity for sale on world markets, they will find tariff walls erected against them and they will attract the traditional response of western industrialists to the arrival of a potential competitor. The booklet suggests that Rwanda might profit from the exploitation of its pyrethrum. In fact the collapse of the world market for pyrethrum was caused by the aggressive selling of organochlorines. When poor countries manage to produce agricultural surpluses for export they find themselves undercut by the rich. In their efforts to find a place in such a world system, the poor—who are poor, or "undeveloped" in our eyes, not their own—may accept the gross disruption of previously stable cultures. So we find subsistence farming denounced as "a precarious way of life that leaves little margin for upward movement". So it may seem in Europe, but it at least provides food for those engaging in it, which is more than can be said for the large-scale agricultural systems that have replaced it in so many areas.

One year after Stockholm, Africa and India face one of the most serious famines in history and countless millions are poorer in every way than they were thirty years ago, before aid programmes began. It is small wonder that when aid is no more than disguised exploitation it is unacceptable and the whole concept discredited. Today, if there is a way forward, it will be found by the peoples of Latin America, Africa, the Near East and Asia, without initiation from outside. If and when they need aid or advice, they will ask for it, and we must provide it—on their terms, not ours.

Michael Allaby

Odious vermin?

CONSERVATION FOR SURVIVAL, by Kai Curry-Lindahl, Gollancz, £3.25.
THE ARENA OF LIFE, by Lorus and Margery Milne, Doubleday, £5.

Has anyone noticed that the word *ecology* celebrates its centenary this year? At least, my *Shorter Oxford Dictionary*, after rather disconcertingly referring me to the more ponderous *Oecology*, dates the first appearance of the word in English to 1873. For the first 95 years of its existence, I imagine, the word was on the lips of the man in the street about as often as *oecumenical* or *odonteology*; but lately it has risen to be almost a household word. Inevitably, in the process, its keen edge of meaning has been blunted somewhat: so it is salutary to be reminded now and then of what ecology is really about—the natural world—rather than the mess we have made of it.

Both these books are based on an understanding of the wonderfully complex stability of the non-human environment. Dr Curry-Lindahl describes the various elements in world ecology, the habitats and the species which exploit them; and on this foundation builds a clear and unemotional indictment of man's interference. He shows what we are doing wrong, by first teaching us what each habitat developed to do when left to itself. His historical perspective is wide—he traces our problems not to 1900 or 1800, but to the beginning of agriculture. Before that, man was "just one member of the fauna", as a few peoples, such as the Congo pygmies, still are: but civilised man is a *disease* of the natural environment. All is not total gloom, however: he sees a chance for us, if we can learn to co-operate with nature; by, for example, making use of the enormous protein productivity of wild fauna instead of killing them off to substitute less efficient domestic species. Even in purely economic terms his "ecological strategy" makes better sense than industrial man's unthinking exploitation: and since this seems to be the only type of argument our rulers understand, we had better stress it for all we are worth. Forests and swamps, estuaries and tundra are not just beautiful: they can be made to *pay*. Wonder of wonders, they may even pay better under the natural management developed over 4,000 million years, than under the changing technological fads of the moment!

The Arena of Life shows even more clearly the beauty and balance of the world we are destroying. This book is lavishly and handsomely illustrated: but unlike the "coffee-table" volumes which it superficially resembles, it also has a meaty text. The Milnes are good educators: their book will leave anyone but a professional biologist more aware than before of how plant and animal life works. Complex subjects are not shirked: the biological conversion of solar energy, the various chemical cycles, the mechanisms of animal behaviour and reproduction. The overwhelming impression is of the *order* of the natural world—so many varied parts, yet how perfectly they all *fit*. Only man fails to fit. "Don't you find it a beautiful clean thought," says Birkin in *Women in Love*, "a world empty of people, just uninterrupted grass, and a hare sitting up?" Well, yes, very beautiful (allowing for Lawrence's ecological oversimplification): and all of us probably sympathise at times with Swift's description of mankind as "the most pernicious race of little odious vermin that nature ever suffered to crawl upon the surface of the earth." But despair is as much a sin as pride: the way of salvation for us is to recognise that we can only ultimately survive as a part of the natural order—that the laws of ecology must be obeyed, since they cannot be abolished. And that recognition will only come as a result of *education* in ecology; among other means, by books like those under review.

Nicholas Gould

Letters

Canada and the US

Sir,

I just wanted to (1) congratulate you on your magazine which I have seen for the first time today (May 1973 issue) and (2) congratulate you and Mr Mains on the article entitled "Canada and the US Energy Crisis". The article was very well-informed and housed ideas and concepts that I feel should definitely be spread throughout the Canadian consciousness.

My view of the various Canada-US problems is a little special, being a US citizen by birth and an immigrant to Canada by choice (no, I didn't *have* to desert). As a cultural heritage, I will always prize my US (the good ol' Southern States) birth and rearing. As a person looking to a sane future for the Western World, I shall hold Canada most dearly, so long as it does not go the way of the US in its thinking—meaning the "me first, and all the goodies I can collect in my back yard" philosophy of most USers. Mr Mains is more correct than he may know. Canada *can* pave the way for a new approach to resources—human and artistic resources as well as material goods. As a playwright now living in New York purely for the experience and learning I can acquire here that is not yet available in Toronto, I am very conscious of these artistic resources available to Canada. And I feel the guidelines Mr Mains sets out for the handling of material resources are equally applicable to those less tangible, humanistic quantities. The artistic brain drain is still happening from Canada to the South. New York, as a theatre industry, gobbles any Canadian talent it wants and spits it back when finished with it. The harm done to the artistic psyche is immeasurable. I am not talking from personal experience here at all, but from a viewer's outlook. But all this is possibly the subject of another paper. All I really wanted to say initially was thanks for running Mr Main's very fine and important article.

Richard Benner,
9b, 599 West End Avenue,
New York, N.Y. 10024.

Chunnellers unite !

Sir,

We enlightened *Ecologist* readers are well aware of the absurdity of the conventional "Concrete=Progress" doctrine, but we should be careful not to behave as unimaginatively as our opponents by condemning all concrete indiscriminately: some of it has a useful purpose!

One bit of concrete which I think we should support is the Channel Tunnel. Before readers disgustedly throw their *Ecologists* onto their compost heaps I want them to consider this seriously.

We agree, don't we, that railway transport is preferable to road transport, for large loads over long distances. (Sure, if we had a decentralised society, as advocated in the *Blueprint for Survival*, we would have much less need for either, but somehow we have to reach that position from where we are now.) As a result of an accounting system based on the familiar principles of Alice in Wonderland, the railways are in a dreadful mess (see *Ecologist*, Vol. 3 and Conservation News, No. 44).

The Channel Tunnel would benefit the railways much more than the roads. The ability to send freight between Britain and Europe without unloading on to ships on the way is certain to make railways much more attractive to potential users. At the same time the juggernauts would gain relatively little because they already have the advantage of "drive-on drive-off" car ferries.

Passenger traffic through the Channel Tunnel could make the airport at Foulness unnecessary (yes, I know it's unnecessary anyway, but I mean even the Government would be able to see that it's unnecessary!) because much of the expected increase in air travel is to European resorts and they could all go much more cheaply and moderately quickly by train (and far more safely!) Remember that when the Tunnel is completed (1980?) the price of aeroplane fuel will be much higher than it is now, and the Advanced Passenger Train will be in service.

Much of the very understandable local opposition to the Tunnel is on account of the enormous road terminal which is proposed to accompany it. Let's fight road developments by all means, but don't knock the poor old railways! If you stop the Tunnel you'll probably still get a new motorway, to take the expanding juggernaut traffic to the expanding ports.

Conservers of Kent argue that the Tunnel will attract unwelcome industry. I don't see why it should do so any more than the Channel ports do now: indeed it might reduce the existing attraction, because all parts of Britain would have good railway communications with Europe.

I am indebted to Peter Bromhead, Professor of Politics at Bristol University, for some of these ideas.

Yours sincerely,
Nicholas Pye-Smith,
Top Flat,
4 Cotham Park,
Bristol 6.

Larzac

Sir,

Your subscriber has had a very busy week-end, as I went around showing everyone Vol. 3 No. 6, "Larzac occupied". Thank you for, once more, being so factual, accurate and above all asking Peter Inch to devote some of his valuable time to a cause outside the UK.

We here, still hope these families will not be "repulsees"—for the sake of our out of date necessity.

Yours sincerely,
George Kamir,
Montrozier Gages,
Aveyron, France.

Conservation Society

Sir,

Readers living in the Counties of Cardigan, Merioneth, Montgomery and Radnor are invited to join the newly formed Mid-Wales Branch of the Conservation Society. Details of membership and of the meeting being held at 7.30 pm on 23rd October may be had from me.

Yours sincerely,
Basil Moore F.R.I.C.S., Chairman,
Y Felin Penpompren,
Tal y bont, Cards.

Acknowledgement

"Living off the sun" by Andrew MacKillop. Acknowledgement of the source of some of the material in this article (July issue pp 260-265) was inadvertently omitted. Table 1 on p. 262 and the equations on p. 263 were reproduced from B. J. Brinkworth, *Solar Energy for Man*, Compton Press Ltd., Salisbury, 1972 (ISBN 9001 9313 1).

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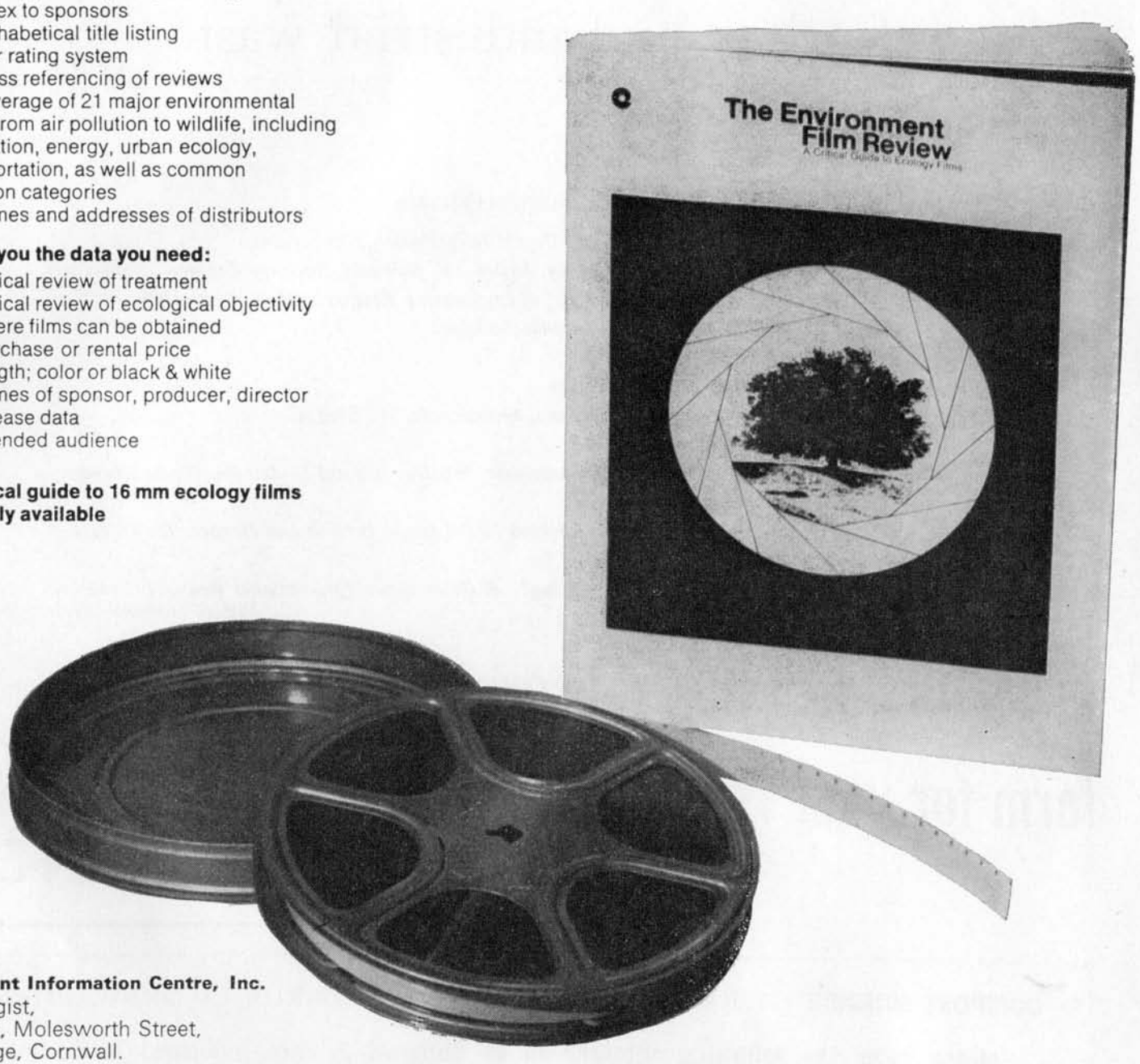

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