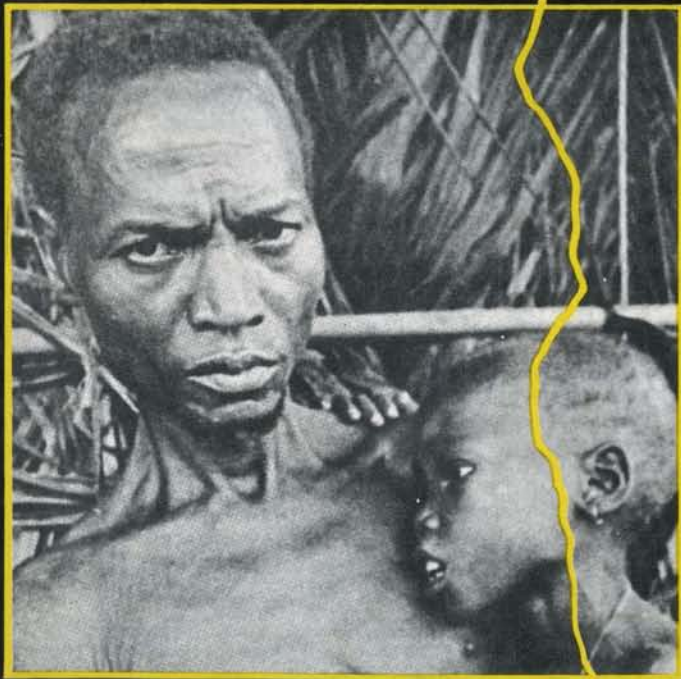


The Ecologist

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who benefits?**



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Reprocessing: Counting the cost

by Peter Bunyard

Nearly six months after Greenpeace ran into a radioactive slick close to the discharge pipe from the Sellafield reprocessing plant in Cumbria, radioactive hot spots are still turning up on the beaches. The quantity of radioactive debris flushed into the sea from the plant has not been determined, although British Nuclear Fuels claims that it was considerably less than the 4,500 curies transferred by error to a sea discharge tank. The extraordinary feature of the affair is that the total—some 4,500 curies—is a mere two per cent of the total discharges of low level beta activity waste discharged into the Irish Sea during 1975, and some five per cent of that discharged in 1983. On the face of it, BNFL appears to have been lucky that in the past its discharges did not come back in the way they did last winter. Or did they, and no one noticed?

While vigorous efforts are made to decontaminate the beaches in time for the summer tourists, the government trots out the usual assurances that the worst anyone might suffer is "localised irritation of the skin from prolonged contact with one of a number of pieces of material which have been found with much higher than usual levels of radioactivity". Indeed in his statement the Secretary of State for the Environment, Patrick Jenkin, told the House of Commons on February 14th, "there is no evidence to suggest that this contamination, although very unsatisfactory could cause significant damage to anyone's health." Perhaps he was recalling Madame Curie who suffered such irritation for years from the radium in her pocket, before she succumbed to cancer.

Alongside the beach contamination, BNFL has had to face growing fears that radiation may have brought about the unexpectedly high incidence of childhood cancers among the population in the vicinity of the Sellafield reprocessing plant. According to research carried out for Yorkshire Television, and presented in a second programme (see *Ecologist* Vol. 13, No. 6, p.198) children under 15 living near the plant have a one in 60 chance of getting cancer—11 times the chance elsewhere in Britain. That finding, based on an investigation of health records and death certificates, is very worrisome since contamination of the Irish Sea, of the silt inshore and of the Ravensglass Estuary is now more or less permanent on account of long-lived alpha wastes. Indeed, analyses carried out by the

Ministry of Agriculture, Food and Fisheries, as well as by independent scientists from the U.S. Woods Hole Oceanographic Institute, indicate that plutonium contamination of seaweed and silt along the Cumbrian coast is some 1000 times higher than it is off the Channel Islands, just over the sea from the French reprocessing plant at Cap de la Hague in Normandy.

As I indicated in my evidence given for the Stop Sizewell B Association and Ecoropa at the Sizewell B PWR public Inquiry, then into its 189th day, general standards at Sellafield have been far poorer than those prevailing at Cap de la Hague. Not only have discharges into the Channel from the French plant been lower by a factor of eight for beta emitters and a factor of more than 100 for alpha emitters—particularly during the mid 1970s—but worker exposure within the plant has been one half or less that registered at Sellafield. During 1980, for instance, the average dose to 2,671 workers at the French plant was 0.241 rem—therefore approximately two to two-and-a-half times background radiation, while in 1982, one of BNFL's better years concerning radiation exposure, the average dose for 5,223 workers was 0.64 rem.

For comparative purposes, a good way to indicate worker exposure is to assess the average radiation dose in terms of how much electricity was generated from the fuel when in a nuclear power station. Again the difference between the French and British reprocessing plants—the only two left in the Western World with any commercial pretensions—is considerable. Between 1971 and 1975 external irradiation alone at Sellafield (then Windscale) amounted to 1.2 man-rem per megawatt (electrical) year, and that for some 4171 tonnes of magnox fuel reprocessed and 120 tonnes of thermal oxide fuel. The equivalent value for la Hague was 0.51 and that for 3,944 tonnes of magnox fuel and 356 tonnes of oxide fuel reprocessed.

Since 1977, COGEMA, the operators of La Hague, has managed to bring down both individual doses to workers and the dose/energy relationship. Thus from a peak annual average external dose in 1977 of just under 0.5 rem per individual and collective dose of 714.4 man-rem, by 1980 the average annual dose had fallen to under half that, and the collective dose to 643.2 man-rem. Meanwhile the dose/energy re-

lationship had fallen steadily from a peak of over one man-rem per megawatt year in 1973 to 0.223 man-rem per megawatt year in 1981. In part that drop in exposure rate per megawatt of electricity generated was a result of reprocessing thermal oxide fuel from light water reactors, with an average burn-up of 25,000 megawatt-days per tonne compared to a little over 3,500 megawatt-days per tonne of magnox fuel. In 1981 COGEMA reprocessed more than 100 tonnes of thermal oxide fuel and 250 tonnes of magnox fuel, all in the same plant—UP 2. In 1983 the quantity of oxide fuel reprocessed had increased to 221.26 tonnes and of magnox fuel was down to 100 tonnes.

Although the contribution of each type of fuel to the external dose rate is not known precisely it can readily be deduced from the operation over two consecutive years, given that the overall collective dose is known as well as the burn up of the fuel in question and on the assumption that the same basic criteria of dose contribution from each type of fuel apply from one year to the next. My calculations for the years 1979 to 1980 indicate that the worker exposure to external radiation per megawatt year (electrical) for magnox fuel is 0.5 man-rem and for PWR fuel is 0.17 man-rem. The years 1980 to 1981 give a slightly different result: 0.56 man-rem per megawatt year for magnox fuel and 0.15 man-rem for PWR fuel. Those figures, which are for external dose alone, accord closely with the results given by the Castaing Commission—a body set up two years ago by the French Ministry of Research and Industry to investigate the management of spent reactor fuel.

According to British Nuclear Fuels in a draft note to the Stop Sizewell B Association the external dose to workers in 1982 from the reprocessing of 1212 tonnes of spent magnox fuel, with an average burn up of 4000 megawatt days per tonne, came to 0.93 man-rem per megawatt (e) year, hence nearly double that experienced in reprocessing similar fuel at La Hague.

In effect, British Nuclear Fuels has become aware that it cannot continue operating a plant where standards have been patently poor for more than a decade and where the authorisations themselves have been far too lax for the safety either of those working in the plant or living in its neighbourhood. Not that the French standards have been beyond reproach, indeed there is increasing concern over future discharges and worker safety when new plants come into operation—scheduled for the early 1990s—to reprocess the spent fuel arising both from France's own monumental PWR programme and from overseas.

BNFL has always worked, so the company claims, according to the principle that its discharges have been kept "As Low as Reasonably Achievable" (the ALARA principle). Since BNFL considers the discharge incident last autumn not to have been in breach of ALARA, the principle is clearly being used to cover a multitude of sins. Not surprisingly pressure, for once official, is growing to make the British Government impose a halt on all radioactive discharges into the Irish Sea. At a meeting in March of the Paris Commission, whose role is to give jurisdiction over sea pollution from land-based sources, various European countries affected by the Sellafield discharges, including Ireland, West Germany, Norway, Sweden, Finland and Denmark, agreed on a resolution calling for the discharges to be "As Low

as Technically Achievable"; hence virtually nil. The resolution is to go before a full meeting of the Commission in June in Oslo.

The Trade Unions too are putting strong pressure on BNFL. The National Union of Seamen, with the support of three other transport unions, has already imposed a ban on the dumping of solid radioactive waste into the Atlantic, and will consider blocking the import of spent fuel into Britain from overseas should the British Government ignore the Paris Commission's ruling, as it did that of the London Convention last year with regard to the dumping of waste off the coast of Spain.

BNFL's main response has been that it is in midst of a costly programme to reduce its discharges, spending some £500 million of which £150 million alone will be specifically aimed at reducing sea discharges. Once its 'SIXEP' treatment plant is in action, later this year, total beta discharges will be down to 30,000 curies per year, just one tenth of those being discharged in the mid 1970s, and total alpha discharges will be reduced to some 200 curies per year, down by a factor of 20 from the discharges a decade ago. While the beta discharges will be more in line with those discharged each year from La Hague—some 25,000 curies per year—the alpha discharges will still be more than tenfold higher than those from La Hague. Since the long lived alpha wastes are those causing such concern among the residents in Cumbria and the Isle of Man, and in view of plutonium levels being up to 1000 times higher there than in the vicinity of La Hague, clearly the new standards, albeit 30 times more stringent than they were, are not good enough.

Reprocessing, What For and Worth the Cost?

Ostensibly, reprocessing is a way of extracting out uranium and plutonium from spent reactor fuel, so that those elements can be manufactured into fresh reactor fuel and recycled. Spent PWR fuel, for instance, contains enough uranium-235 and plutonium to provide an additional 40 per cent of energy in the first recycling in a PWR. But that is a theory. In practice a very different situation prevails, and the recycled uranium is contaminated with neutron absorbing uranium-236 (0.57 kg per kg of uranium-235) and uranium-234 (15.3 g per kg uranium-235) both of which bring down the value of the recycled uranium to the point where it is largely worthless because of the extra enrichment costs. Another drawback is the presence in spent fuel of uranium-232, which emits hard gamma radiation. Therefore special fuel handling and fabrication facilities would have to be built for the rather limited gains that might accrue from recycling uranium.

Not that the situation is any better with the putative recycling of plutonium in thermal reactors. Spent PWR fuel, for example, contains some 11.5 per cent plutonium-241 which, with a half life of 14 years, decays into americium 241, a highly radiotoxic, non-fissionable isotope. In addition two other plutonium isotopes in spent fuel, plutonium-240 and 242, are neutron absorbers, and since both together comprise nearly 30 per cent of the plutonium derived from PWRs, their presence makes a significant difference to the fissile value of recycled plutonium. Not only would the number of recyclings with such plutonium be severely limited, but a PWR core containing plutonium would have certain technical dis-

advantages, including a more negative temperature coefficient, decreased efficiency of the control rods and the likelihood of power bursts at the interface between uranium and plutonium fuel. As with recycled uranium, the fabrication of fuel containing recycled plutonium poses special radiological problems, in particular from americium-241. Thus neither the recycling of uranium nor of plutonium or of both together in thermal reactor systems can be taken as serious propositions.

And what really is the cost of reprocessing? COGEMA in France, like BNFL, intends to build a reprocessing plant solely for thermal oxide fuel, much of it from overseas. With some 730 tonnes of thermal oxide fuel reprocessed to date COGEMA has considerably more experience of handling such spent fuel than has anyone else. Moreover its significantly better operating experience compared with others should reflect in a more realistic appraisal of performance and costs of a new reprocessing plant than might be achieved elsewhere. BNFL, on its own admission will be using similar technology and is keeping as close a look as it can at what the French are up to.

The official figure for building UP 3A, the new thermal oxide reprocessing plant with an intended throughput of some 6000 tonnes of spent fuel over 10 years, was until recently given as 11.5 billion francs in 1984 prices but has since been increased to 18 billion francs. In reality, and it is well appreciated within the industry, the cost of reprocessing is far higher. One scientist working in the French Atomic Energy Commission assesses the real figure of building and operating UP 3A at some 60 billion francs—some £5 billion. That sum is made up as follows: *Direct costs*—20 billion francs—including the cost of initial studies, some 6 billion francs for engineering and provision for a 2½ year test period; *Interest during construction*, amounting to 60 per cent of the direct costs—12 billion francs—; *Operation of the plant over 20 years*—20 billion francs—; and *Decommissioning* of the plant at a minimum of 40 per cent of the initial direct cost,—8 billion francs. (Reprocessing plants at the end of their lifetimes are basically alpha wastes and must be treated accordingly.) In all probability the throughput of the plant once in the third year of its operation is unlikely to be better than 400 tonnes per year. But in the optimistic expectation that the plant will reprocess some 15000 tonnes of spent fuel over its 20 year lifetime, then with each tonne yielding some 9 kg of plutonium which theoretically and without considering plutonium losses, would save just over a tonne of natural uranium, at a cost of £5 billion the nuclear industry could save 15,000 tonnes of natural uranium—enough to cover France's needs for a period of no more than two years. The cost of the plutonium-enriched fuel, assuming all the handling problems could be overcome would be at least three

times that of enriching and fabricating fresh uranium. In reality it is most unlikely that either the CEGB in Britain or its counterpart in France—Electricite de France—would be interested in recycled plutonium for thermal reactors. And the reprocessing problems become still more acute, and the costs more astronomical when plutonium is recycled in fast reactors.

Operational Dose

According to its evidence at the Inquiry BNFL claims that it will reprocess and manage spent thermal oxide fuel at a cost that is more than 50 per cent lower than that officially recognised in France today. It also claims that it will operate THORP with very low discharges to the environment and with low worker exposure.

Yet until THORP is actually operating it is nigh impossible to know whether its discharges will be kept down to the levels indicated by BNFL. Meanwhile BNFL reckons the total external dose to workers for a 600 tonne per annum throughput will be no more than 500 man-rem per annum. Since some 17.6 GW (e) will be generated from those 600 tonnes at an average burn-up of 33,000 MW days/tonne, the external dose per megawatt comes out at no more than 0.028 man-rem per MW (e). yr.

The best achieved in France to date for reprocessing thermal oxide fuel is 0.15 man-rem per MW (e) yr, and according to a French expert on worker safety in reprocessing plants, the best COGEMA can hope to achieve in UP 3A, or any other comparable new plant, will be just under half that, thus in the region of 0.06 man-rem per MW. year, and that only during the first years of operation, after which there may well be a deterioration in performance. Thus BNFL claims that it will achieve an operational standard with regard to its workers that is nearly ten times better than has yet been achieved in France. According to the French, such standards will be achieved, if they ever can, at the cost of an extremely expensive non-commercial reprocessing plant.

Reprocessing appears to have less and less justification, and the only possible excuse for continuing with it must be as a means of extracting out plutonium for military purposes. Both the CEGB and EDF appear to have got the message and neither is in a hurry to sign contracts for the reprocessing of their spent thermal oxide fuel. Meanwhile BNFL and COGEMA need such a commitment so as to reassure their increasingly reluctant overseas customers that reprocessing is economically a viable option and the best way of dealing with spent reactor fuel.

Reprocessing will not be the first nuclear dream to turn to ashes. I have just read an article by Charles Hollister and his colleagues in *Scientific American* that the sea-bed underlying the deep oceans is a turbulent place, wracked by powerful underwater storms that leave the bottom grooved and scoured over hundreds of miles.

So what then of assurances by government and its advisors that the sea-bed is a safe place for dumping nuclear waste?

* In my editorial (vol. 13, no.6 1983) I stated that 48,000 curies of plutonium-241 would decay to an equivalent amount of americium-241. But there is a ratio of 30 between their respective half lives, and therefore at the end of 100 years the plutonium-241 will have decayed to some 1,600 curies of americium. Thus in 1978, while the total authorised alpha wastes discharged amounted to 1,837, in reality BNFL was discharging the equivalent of 3,437 curies, and not 50,000 curies as I had indicated. Nevertheless the total alpha including americium discharged that year was more than 200 times that discharged annually at La Hague.

Protecting the Environment against the Poor

The Historical Roots of the Soil Erosion Orthodoxy in the Third World

by Randall Baker

"For the outsider who enters Africa, the governing dream has always been to change the place. The models for such change have been drawn from the North, that is, from the nations of Europe, Asia and America that lie between the 35th and 60th parallels—where the corn comes from . . .

As the North penetrated Africa, it has proved less and less capable of learning from the experience, we can only instruct. . ."
(Patrick Marnham, 1979)

This article examines the conventional perception of the land degradation problem in many Third World countries and the conventional responses made at both the state levels and the level of bilateral and multilateral assistance. According to Baker, this framework is, the *Technocratic Approach*, because it problem essentially as a physical one of energy imbalance amenable to a technical solution. This is in contrast to seeing the environmental stress as *symptomatic* of a social and political crisis usually based on: unequal control over access to, and use of, the natural environmental resource base; the 'developmental' conflict between export-based cash crops, foreign exchange and basic food security for the poor; as well as short-term asset stripping for a quick profit by those who make, or are beyond the control of, the laws.

Baker argues that the more drastic manifestations of erosion do not represent simply stress on particularly vulnerable—often marginal—physical environments, but that there is a coincidence between these areas and politically marginalised and powerless people with little to no realistic alternative to what they are doing within the existing political power structure and parameters of 'development'.

There are strong reasons why the technocratic approach exists and persists even in the face of its self-evident ineffectiveness. These are to do with the maintenance of political inequality and the ability of the technocratic approach not only to shift the blame for its own failure onto its victims but to create a serious illusion of concern on the part of those really to blame and to allow them—in the name of environmental *protection*—to tighten the screws on the marginalised poor. Thus tighter environmental control in the name of resource trusteeship goes along with tighter political control over the poor. The erosion of their political power runs in parallel with that of the soil beneath them. It is in this light that we have to examine much of the writing about 'Desertification'—which is nothing more than erosion in dry land areas—as the people in these areas are close to the 'absolute zero' category in terms of survival.

It is necessary to be aware of this technocratic paradigm, not just because it is so pervasive, but because it affords spurious validity to such terms as 'scientific objectivity' or 'neutrality' in the realms of assistance programmes and so-called 'plans of action'. Thus it is possible for technical advisors and institutions to deceive themselves and others that they operate outside the political arena and are not involved in the maintenance or polarisation of power relations. How-

ever, what should emerge from this study is that disguising politics as technology solves nothing except at a very heavy price of oppression. Ultimately, it may delay the political solution or radicalise it through frustration and hopelessness.

The process of marginalisation of people onto high-risk environments did not begin with the expansion of Europe into the tropics, but it did achieve something of a quantum jump as a result. The occupation of lowland Albania by the Ottoman Turks had the same net result of forcing people up the hillsides as did the occupation by the Spanish of much of Central America. But the process which gained such strength during the Imperial epoch has survived the transition to 'independence' in a thinly-disguised continuity.

A typical format for the technocratic approach—in this case for Kenya—is given in Figure 1, but the underlying rationale will be familiar to researchers in many countries in the Third World. Its principal characteristics are:

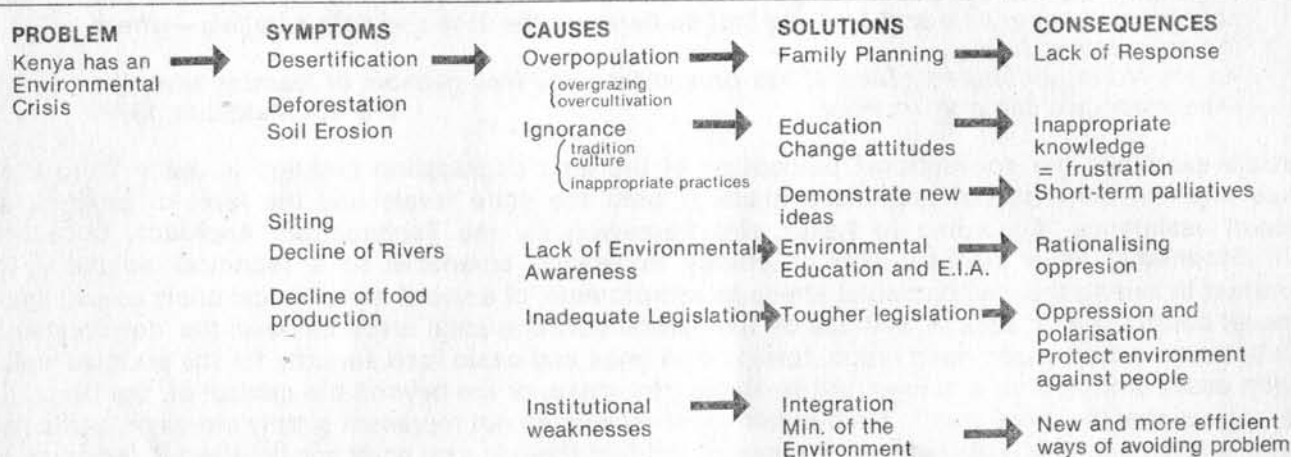
- 1 it is a-historical;
- 2 it elevates 'symptoms' to the status of 'cause';
- 3 it places environment over people in a cynical way;
- 4 it increases the polarisation of power relationships;
- 5 it maintains a facade of concern, neutrality and objectivity;
- 6 it reinforces the *status quo* and the prevailing model of development;
- 7 it uses the international scientific community and some of the major multi-lateral organisations to lend legitimacy to the existing political order by their very 'non-interference'.

Randall Baker spent six years in Uganda obtaining a PhD from Makerere University of East Africa. He has worked extensively in the Middle East, Africa and the USA and is now a reader in Development Studies (Natural Resources) at the University of East Anglia. At present he is on release to the Crown Agents in the Fiji Islands, heading a project Planning Mission on behalf of the EEC.

Although accelerated erosion in marginal areas of the Third World is not entirely or always a creation of the colonial trauma, it does seem that that period of dramatic change in world relations engendered a sharp advance in the pace and extent of the problem. This was due to the sudden incursion of European values, attitudes and technology bringing new kinds of relationships: man to man through cultural superiority; one part of the world to another unequally through the imperial economic system; one part of society to another through unequal control of, and access to, the factors of production, especially land; and man to nature through the universality of science.

the culture made it necessary for new answers to be given to new questions. . . . It was the missionaries who *taught* the Africans to read and write and thereby supplied government clerks and traders' clerks . . . and ultimately the national leaders . . . Missionaries are often blamed because they destroyed and misunderstood, and so they did. But so did everybody else. And missionaries are the only people who built below an institutional level' (author's italics).³

Such observations of local phenomena as were made were concentrated upon form rather than function, such as the obsessive preoccupation of early anthropologists with kinship structures *per se*. The missionaries then were the shock troops of the colonial dichotomy,



The Technocratic Perception: "Environmental Protection"² Fig. 1

Values and Attitudes in Conflict

The European mastery was established initially through superior technology in arms, no better example of which exists than Pizarro's dramatic defeat of the Inca by an unprovoked display of musketry when the representatives of the two cultures first met. But it would be wrong to concentrate only upon the technological superiority in arms. Just as important is the inherent perception of the European as being morally, spiritually, culturally and technologically superior to the peoples outside the European Christian orbit.

Underlying the way in which the Europeans viewed the rest of the world was the proselytising Christian ethic. A good example of the way in which this ethic could and did justify any form of iniquity and inequity in the name of eventual salvation was seen in Spain's South American empire. However, this is less immediately important than the fact that the 'missionary' has an unidirectional mind. Salvation is not based on reciprocity, but on replacement. Thus those out to save have little real interest in understanding the belief systems, life styles or environmental perceptions of the heathen. The main aim is their replacement and the acceptance of the Christian ethic and the attendant western life style. The 'job' of the missionary was described by Paul Bohannon in the following terms:

'What is a missionary's job? It turns out that, besides the purpose he goes over to achieve—the spread of his religion—he has an important secondary task. That . . . is to hold the pieces of society together when it *smashes*, and ultimately to put them back together in a new pattern. No mission has ever been entirely successful until the initial smashing of

tomy, wresting people away from their own history, consigning their belief systems and activities to the level of 'ritual', inculcating the dependent mentality and belief in the inherent superiority of the new God, the work ethic, the money market and obedience to the new order. There was no serious or systematic interest in how or why people did what they did or, as Dalton once said: 'pursued the simple business of staying alive'.

Despite the apparent paradox between blind faith and science the works of Darwin did much to reinforce the sense of superiority. Thus the crass superiority of Spain's Inquisition gave way to the subtle, but no less pervasive, superiority of paternalism. In this way there developed the attitude of 'trusteeship' for those who had not *evolved* as far as the European—or, put another way—a 'scientific justification' for regarding people of other races in other places as basically inferior. In its most subtle form it may be found in the writings of David Livingstone who writes about the Africans always as though they are children: not grown up or evolved fully. Christianity and commerce were his solutions so that eventually they will become more 'like us'. Neither Pizarro nor the average social Darwinist would have perceived any point in examining the rationale of the communities in Africa or New Spain. Thus the foundation is laid for the careless destruction of old-established and frequently subtle interlocking social and land-using systems in the face of crops and methods which are perceived, eventually by both sides as inherently superior.

Western science in the nineteenth century was full of the heady wine of self-confidence. In a tradition of free-

dom of the will released by the Reformation and boosted by Darwin (to whom Karl Marx wished to dedicate the first edition of *Das Kapital*) western scientific man had come to re-evaluate his relationship with Nature. Whatever Wordsworth might have been writing at the time in the spirit of Pantheism, the dominant concept was that of 'mastery' indicated in the heroic stature of the engineers of the time—(something we perpetuate in the ludicrous expression: 'Man's conquest of Space'). Thus we have a powerful brew:

- missionary Christianity eliminates the need for any reciprocity of values, ideas or practices;
- the cult of mastery inherent in western science drives out symbiosis or a long-evolved basis of traditional agricultural 'craft';
- whilst the pursuit of predominantly non-food cash crops for the colonial economy pushes food production and/or food producers into the wings, only to see them re-emerge now in a drastically eroded state. Mastery over minds, over Nature and over peoples. Consider this quote relative to Spanish Guinea (Equatorial Guinea) written in 1964:

'The pioneers and explorers tirelessly covered vast areas opening up the bush to modern civilisation. The missionaries . . . made selfless and fruitful attempts in the religious and cultural field . . . inspired by the Christian precept of equality of all men . . . an inevitable and tenacious effort on the part of the Spanish government . . . has brought far-reaching changes in the structure of the traditional society so that there is emerging today a numerous native elite, *intelligent* and qualified to undertake modern activities'⁴

It is interesting how the idea of equality in the above quotation very quickly reveals itself as giving others the opportunity to be as *us*, which necessitates 'far-reaching changes in the structure of traditional society'. Why, and only *now* is the elite—after induction—*intelligent*? 'Tradition' is being used here as an independent variable indicative of mindless acceptance of old practices wrapped up in ritual. These 'traditions' were often perfectly rational adjustments to the natural environment and were followed because they had proved their worth in the past, i.e. they were a dependent variable. The small quotation above seems to encapsulate the entire 'values and attitudes' syndrome which is associated with the process of marginalising the poor onto poor land: 'tradition', 'modern', 'inevitable effort' (the Spanish civilising mission it was once termed), an *emerging* elite (emerging is an evolutionary term), 'intelligent' (was there no intelligence before Spain?) and so on.

In terms of a particular form of land use, shifting cultivation ('slash and burn'), we see a specific form of this application of the values and perception problem. This system was virtually always described in the western literature as 'wasteful' because of the very considerable amount of land that was required to let the fallow run its full course. It could hardly be described as wasteful as it recycled locally almost all the energy it extracted and mimicked the natural ecosystem. It became wasteful only under pressure and that pressure, as often as not, came from outside the society not from within. In contrast to the writings about shifting

cultivation, which depicted it as an anarchic jumble, we may compare the loving affection lavished by the same writers on the terraced landscapes of the Yemen, Luzon and Java. What really appealed to the western eye and the western mind was the evidence of control or mastery over the environment. Jacks, in 1939, spoke of shifting cultivation as an example of 'Man's subordination to the vegetation'⁵. But these terraced landscapes or hydraulic systems often were the result of having to cope with pressure of population in a limiting environment. Ruthenberg has shown, however, that in terms of calories of food produced, shifting cultivation yields much greater returns to labour than does terraced rice with its endless hours spent maintaining the capital infrastructure. Ruthenberg puts the labour efficiency of shifting cultivation at three to four times that of the rice system (in terms of return per man hour)⁶.

Lastly, in this review of the clash of values, attitudes and perceptions, mention should be made about precisely *when* some of the principal actors came on the scene. In the case of Spain in the New World this does not matter so much as they had a ruthless and all-consuming passion to Christianise at any cost. However, if we take the arrival of the main missionaries, scientists and administrators in Africa then we have to remember that they were arriving at a time when the continent had been ravaged for centuries by an earlier phase of mercantilism and slavery. So they were ob-



Dr Livingstone—the missionaries get a foothold.

serving societies in ruin; but they often wrote about them as though the chaos, collapse and disorder were endemic to the African condition of barbarism, heathenism and darkness. What they should have considered was the parallel between Europe and Africa at the time of the first Portuguese voyages (c. 1500). But in a subtle and pervasive way cause and effect were reversed and the chaos of the Dark Continent engendered by the first phase of European incursion became itself a justification for the second phase: the enclosure of Africa. 'Where', some observers mused, 'were the architects of the long gone systems and structures of Zimbabwe, Engaruka, Peru, Mexico etc.'? They were right there recovering from a serious attack of cultural and physical dislocation.

The Colonial Economy

The second main thread in the explanation of the 'technocratic' approach concerns the economic basis of the colonial system, alluded to above. This was essentially—and at least in Victorian times unashamedly—unequal. Essentially the dependent territories were there to benefit the metropolitan power and along the way they would acquire the gains of 'modernisation', 'civilisation' and the fruits of western inventiveness. In earlier Spanish times the benefits were principally subsumed; for the indigenous population that is, under the heading of salvation and so the costs were passed on ultimately to the Almighty.

It is frequently stated that the coming of western medicine, as a component of benign paternalism, led to the survival of many millions who then contributed to the destruction of the land as a result of rapid 'overpopulation'. Whilst there is no doubt that rapid growth rates are being sustained now, in many cases this is far from being the true cause of localised 'overpopulation'. Frequently this resulted in the first instance from the confining of populations as a consequence of their exclusion from their traditional farming or grazing areas by the colonial requirement for land.

One of the first acts of many of the colonial actors was to seize land and alienate it. Often, as in the Pacific, the missionaries were the first in the queue to establish a firm financial base for what was to follow. Then there were rewards to Spain's captains under the *encomienda* system, the excision of land for white settlers in many parts of Africa, the taking of Crown or State lands, the declaring of reserves and the shunting of natives out of or into them depending whether they were to protect forests or accommodate those displaced by the settlers, the establishment of plantations in south-east Asia, game reserves and for many other purposes. Fairly rapidly this excised land came to be the basis for the export crop economy, the protection of fauna or simply as a hedge against inflation for the rich in South and Central America.

Reflecting the spirit of the time, most bluntly stated by Locke in his *Second Treatise* para.33 as 'God gave the world to the . . . Industrious and Rational', Napoleon III wrote to Marshall MacMahon: ". . . Africa's land is so vast and its resources to be developed so abundant that each man can find room there and give

free rein to his pursuits according to his nature, his principles and needs: for the breeding of horses and livestock and the natural cultivation of the soil; for European enterprise and intelligence (there it is again), exploiting the forests and rivers . . . and improving those industries which always precede progress in agriculture". Within a few decades approximately 20,000 farms had been opened in Algeria by Europeans settling on the best low-lying land covering more than two and a half million hectares or one-third of the cultivable land. On the other hand Algeria had five million hectares of dry, hilly terrain too sterile for profitable development to which some 630,000 peasants were confined. The wars of 'pacification' which continued until the scheme was abandoned in 1962 illustrate how one man's view of a civilising mission was another man's view of theft. Similar wars resulting from seizure and displacement may be chronicled almost wherever European settlement was significant.

The physical displacement and confinement of people by the alienation of so much land led to the pre-

"It is not technology which marginalised populations require, especially where that technology will tend to confirm them where they are. They want a share of the better resources now earmarked to feed the already overfed."

conditions for localised 'overpopulation'. Furthermore it placed the confined people at considerable risk because they were often confined to areas which were subject to serious natural hazard risk. Such was, and is, the case in much of Central America where the 'population inversion' of high pressure on the weak lands and lower pressure on the better *hacienda* lands has resulted in the weakened resilience of the slopelands to withstand the impact of hurricanes. Consequently these extreme events have a much greater impact when they arrive causing severe damage and death as with 'Fifi' in Honduras where so many died in the early 1970s from erosion-induced landslips in areas where they should not have been in the first place.

Naturally it was the better, lower-lying land which was taken first by the settlers. But even where settlers were not involved the colonial economy had a dramatic impact on land requirements and land use. This was principally through taxation and the requirement for all to produce specific cash crops (either directly as in Java, or indirectly to pay cash taxes as in Uganda).

In the early days of colonialism the Europeans were prepared to accept the contribution of the indigenous population in the form of labour. Isabella of Spain wrote in 1503 to her authorities in New Spain: ". . . compel and force the Indians to be associated with the Christians . . . and to work on their buildings and to gather and mine the gold and other metals and till the fields and produce food for the Christian inhabitants." But, as the final part of this early directive indicates, the Europeans were anxious to extract from the agri-

cultural sector not only labour but also crops to sustain the Imperial system and to meet the requirements of the colonial economy. This required the native population to extend the area of their holdings to allow for the cultivation of the cash crops or the surplus to meet taxation requirements. The colonial authorities were, in general, not anxious to see the basic subsistence economy undermined in their pursuit of commercialising the indigenous peasant sector. The subsistence sector kept down the cost of labour, helped provide a hedge against the threat of famine in the countryside and kept down the price of commodities being extracted from the peasantry. Thus the demand for land increased dramatically as a result of the colonial incursion even without the factor of increasing population which is so often blamed for the land deterioration problem.

But it was not just the land-demanding effects of the introduction of the colonial money economy/cash crop system which came to accelerate the pressure on the land: there was also the impact of the type of crop which was introduced into the local system. Alongside this was the translation to the tropics of the monoculture systems from the newly-opening plains of Russia and North America in that the same cash crop was grown year after year. The French African Empire, for instance, was divided into major crop zones specialising in groundnuts, cotton or rice. Cotton planted year after year exposed the topsoil in places such as Mali to serious erosion and depletion as the same spectrum of nutrients was extracted continually with nothing being added. Wind and water were able to work their ravages on the soil leaving the scarred and gullied landscape we see today. Continuous cultivation of groundnuts drained the soils of Senegal.

Compounding these problems was the introduction of technology from the temperate zones with their more resilient soils. Perhaps one of the best examples of this was the mould board plough brought to the New World by the Spaniards. This continued to cause destruction by turning, drying and exposing the top soil. (Its use had no small part to play in creating what later became the 'Dust Bowl' of the United States).

Lastly the colonial economy had an important impact on the local energy equation because it broke down what were essentially recycling systems. The fact that the cash crop economy was an export economy is very significant because the energy was exported with the crop. In some cases the impact of the new crops and new technology was dramatic as with cotton in Brazil or the Groundnut Scheme in Tanganyika. However, in general the pressures were less dramatic and built up gradually and inexorably to reveal the weakened condition of the countryside during some extreme event such as a drought or a hurricane.

Among the pastoral peoples who occupied some of the most marginal land in the first place the same pressures occurred. The introduction of the international boundaries by colonial governments confined them to areas which often bore no relation to their ecological need to move. Large areas of the better, moister pastures were given over to settlers as happened on the Laikipia Plateau in Kenya dispossessing the Maasai of



Tunisia: the introduction of disc harrowing has accelerated soil erosion.

some of their best dry-season grazing. Lastly the colonial authorities encouraged cultivation over pastoralism since the former was so much easier to control and regulate and was more amenable to being drawn into the market process. Earlier symbiotic relations between herder and cultivator were broken down by the seizure of dry-season grazing for rice cultivation.

So the basic task of the colonial authorities was to draw the dependent territories into the world economic system in the way which best furthered the interests of that system: the settler, the plantation, taxing the peasantry or whatever. Where alienation occurred then the pressure was transferred fairly quickly to the marginal lands. Where peasant agriculture was the means then the demand for land was quickly increased, new crops were introduced in monocultures which were ecologically destructive and the expansion of agriculture confined the pastoralists and eventually drove them to the edge of destruction and beyond in some cases.

But the breakdown which resulted from this sudden increase in pressure was not perceived officially as being attributable to the results from the colonial presence. Instead it was attributed to the inherent weakness and 'unscientific nature' of indigenous land-use systems, the uncontrolled reproductive proclivities of the indigenous populations, the dead hand of 'tradition', 'irrationality', perverseness, conservatism and so on.

The Precolonial Land Use System

It is important at this point to clarify, very briefly, the nature of what had gone before the colonial incursion to correct some of the more extreme elements in-

ternalised in the colonial perception of 'what was going wrong'. This is not all that easy to do because so many of the systems were so thoroughly wrecked by the early intrusion of Europe and so completely buried by the more formal phase which followed.

However, the myth of the 'dead hand of tradition' seems to be clearly laid by the evidence from three continents with regard to the adaptability of man to his environment on an ecologically sound basis and his adaptation of the environment on the same basis when pressure of population demanded. It is true, on the other hand, that precolonial man probably had few demands to change as thoroughly or as quickly as that change which was demanded when he ran headlong into Europe after the early fifteenth century. At one level, in precolonial times, where pressure became too great, societies would simply move and the history of Africa and the Middle East is laced with such migrations. Otherwise societies showed great adaptation to pressure by investing their labour into capital creation transforming the landscape by terracing, irrigating etc. In general, few if any societies responded to pressure by blundering to their own destruction and that of their environment—which is where they would have ended up if the typical view of tradition is accepted.

"Development for many countries appears essentially as something one buys or acquires from elsewhere, hence the importance attached to technical assistance."

Endless examples of ingenuity and industry may be produced of Inca, Pharaonic and other civilisations' forms of environmental control and harmony. But few of these systems survived the onslaught and anarchy of the European explosion. Indeed one of the first to go that we know of was the Nabataean hydraulic civilisation which was swept aside by Rome. The Third World is littered with the remains of the more monumental reminders such as the Ma'arib Dam in South Yemen—but the systems they supported have gone. More subtly the farmers and herders of those areas where monumental change was not necessary had an unwritten, long evolved and tested *ethnoscience*, but that was lost sight of in the unidirectional nature of the European contact. Now in a world of desertification, massive soil erosion, global food crises etc., we forget that these communities supported themselves for centuries. It is true that they had a much lower level of population growth but that is not the reason why these societies are in disarray now. The situation was summed up by Whitney as follows:

'One of the main organisational achievements of East Asian societies was that they were able to maintain their resource systems and population in a state of stable equilibrium with the environment over long periods of time without any widespread ecological catastrophes occurring. This achievement resulted from a common cultural heritage throughout the region which gave those who gained a livelihood from the environment a rather accurate ethnoscience understanding of the flows of energy water and minerals . . .'

Under close inspection the dinosaur argument relating to traditional societies that they groaned towards extinction because of their inability to adapt is simply not borne out by history. This particular dinosaur was brought down with a blunt instrument.

The Conventional Response

There are typically two conventional responses by the authorities to the problem of soil erosion in less-developed countries: tackle the issue of overpopulation by physically shifting people or through population control programmes and/or control the physical problem of soil erosion through conservation practices and 'appropriate' management and technology. An example of the former would be the family planning response to what is locally termed in Kenya the 'Rabbit Syndrome'² or the movement of people from the eroded and 'overpopulated' north-east of Brazil to the expanding, and also rapidly eroding, frontier of Amazonia. The first of these examples interferes with the basic security of the family in old age whilst the second merely shifts erosion around in many cases. An example of the second type of response would be the passing of tougher environmental protection laws and anti-desertification controls in Kenya.

One further observation must also be made in outlining the conventional responses to erosion problems and that is the matter of climatic change. This question was debated widely during the Sahelian drought of 1968-1973—and indeed had been looked at by the Anglo-French Forestry Commission in Northern Nigeria/Niger in the 1930s. Both in the 1930s and at the United Nations Conference on Desertification held in Nairobi in 1977 the answer was the same: there was no conclusive evidence of an underlying physical change. The cause was attributed to 'mismanagement'. The attraction of a climatic change argument is clear, of course, as it absolves anyone of blame and responsibility. However, as noted earlier, an environment weakened by overuse will be much more prone to collapse during periods of 'normal' stress⁷.

Lastly, little is made of the wholesale destruction of resources for commercial gain as occurs in Nepal or parts of Indonesia. The reason for this is usually that those responsible for the deforestation are those people who have the power to set themselves above the law.

The Post-Colonial Response and the International Scientific Community

We have demonstrated up to this point the consequences of superimposing a cultural, economic and political system from one part of the world upon another suddenly and dramatically. But some notice must be taken of the fact that virtually all of Asia, Africa and Latin America have moved out of the era of formal colonialism. Indeed, Latin America has been independent for over one hundred and sixty years. So it is necessary to examine whether there has been any corresponding change in the political factors underlying the causes of soil erosion and desertification in many of these areas.

Essentially the story is one of continuity. Virtually nowhere was there any attempt to look back into his-

tory at the rationale of the so-called 'traditional' systems of land use. This is hardly surprising as the colonial era had discredited most of precolonial history. (As a student in *independent* Uganda I pursued a history course which began with the arrival of Speke!). Those who emerged to form the elite did so within the mores of the colonial system—whatever the rhetoric leading up to independence. This elite was often embarrassed by the precolonial past since they had always seen it portrayed as barbaric, primitive or chaotic.

At the same time continuity was characteristic of the economic system and the 'development' models of most Third World countries. In the context of 'modernisation' the Third World sees itself often as engaged in a struggle with the developed world to 'catch up': to emulate the rich. Most of the Brandt literature is based on liberalising the system to allow this 'catching up' to take place. In this model the cash crop economy and the pursuit of foreign exchange is critical, especially since the oil price rises of 1974 and 1979. Development, for many countries, then appears essentially as something one buys or acquires from elsewhere, hence the importance attached to technical assistance. The faith in western methods and the necessity to close the 'capital gap' during the 1960s led many countries to focus their attention on larger, more mechanised methods of cultivating export crops—displacing labour and continuing the neglect of the food crops. Zambia is, perhaps, a classic instance of this type of thinking⁸. Thus the development parameters could all be positive at the same time as people were being dropped out of the money economy, driven off their subsistence basis and failing to find any alternative jobs or forms of security. This continued and accentuated, in some locations, the 'localised overpopulation' discussed earlier. So foreign exchange earnings were being valued over and above the worsening situation of the really poor. This is one of the reasons why 'basic needs' and 'aid to the poorest' made such a poor showing because it was in conflict with a well-established pattern from which those in authority often did very well. However, it was not possible to ignore either the desperate position of the truly marginalised—as exemplified during the Sahelian drought and 'famine', nor the rapid deterioration of the resource base. The poor themselves remained politically weak or voiceless much like the urban poor of Dickens' time. It is not that they are unaware of their plight—they know that they cannot draw attention to their plight without the threat of worsening political pressure. This way, however, lies the politics of desperation and hopelessness and it is only the difficulty of coordinating and mobilising a scattered, cynical and intimidated rural population which prevents more direct action taking place. The only option open to many is to move to the urban area and join the poor there, where at least the sheer concentration of numbers may allow some political leverage. The peripheral slums of Nairobi from which the people demonstrated their anger in August 1982 are such a pool of hopelessness. In countries such as Colombia half the population live in the capital city, often in the most degrading conditions whilst large areas of the countryside are

given over to livestock, fruits or even flowers. Soil erosion and urban crime, in these circumstances, are related phenomena with the same underlying cause.

Essentially then the unequal distribution of land and the priority given to non-nutritious export luxury crops lies at the root of the problem. I refrain from adding Lipton's term 'urban bias' since the bias is not toward the urban areas but towards a powerful group of people who generally live there. This is not something with which the international agencies may easily concern themselves. They can, and do, point out the perils of the world food situation, the growing number of food importing countries and the continuing growth of food aid. But they are powerless to point to the 'real' solutions as these are essentially political. Consequently, they adhere to the strictly neutral ground of technology. This is one of the main reasons why we hear two cries regularly. On the one hand the scientists and aid technologists complain that 'we have all the answers but are unable to apply them'. By this they mean that there is no reason for land to be lost at the rate we are losing it if better management methods were applied, tighter control effected, and more environmental awareness shown by all sides. On the other hand the representatives of governments with serious erosion problems have said at two of the major world meetings on the subject: 'Don't talk of more research, we have had too much research. What we need now is action'. The problem is that this research has been too narrow, it has given the recipient governments the various technological answers but these often meet with the sort of opposition the British found in Kenya when they were trying to terrace the Reserves thirty years ago. It is not technology which marginalised populations require, especially where that technology will tend to confirm them where they are. They want a share of the better resources now earmarked to feed the already over-fed.

A Lack of Vision

The best that the agencies can do faced with this impasse is either to continue and blame the failure on undefined 'social factors' or talk about the benefits of an 'integrated approach'. However the best that can be hoped for from the latter is the incorporation of some anthropological or sociological input which skirts the essential dichotomy. How many times have project managers had to edit out the 'politically unacceptable' comments of their statutory sociologist?

The shift of research locus from the research station to the 'systems approach' in the field naturally is a step forward but it is also evident that this is unable to tackle the main issue since the political system is excluded from both analyses. The working framework is: 'given the *status quo* how may we assist these people to improve their income, farm better, conserve resources etc.'. Indeed, progress can be made along that path and some of the worst environmental excesses may be checked—but at a price.

It is unlikely that external institutions, whether at the level of research or any other form of 'technical assistance' will contribute to a radical reappraisal of the

causes of soil erosion. Primarily assistance is something which is 'requested' by the recipient governments and so they will naturally eliminate the political variable in drawing up the terms of reference. So technical cooperation must always be the maidservant of the *status quo*. Donor governments may well have vested interests in playing this masque but how could this charge ever be levelled at the international agencies which are supposed to be above political interests? They are sucked in by their own exertions, ironically, to appear beyond politics. In effect, they accept the political order in whatever country they choose to work. The 'experts' who are provided come with a basic technical solution package for the problems with which they are presented. They have neither the time nor the training to equip them to consider the wider social and political consequences of their actions and why should they? It is not their job and no blame should attach to them. They try to do, in the best possible way, the job for which they have been recruited.

Conclusion

It is clear that the forces perpetuating the technocratic, or physical approach, to soil erosion and desertification are substantial both nationally and internationally. Such changes in treating soil erosion/land management problems among the poor in marginal environments as have occurred have been essentially cosmetic in nature. Where these topics are discussed at global conferences then they are discussed by the nominated representatives of the governments concerned and so the political dimension is, perforce, excluded. The scientific delegates will rarely touch on overtly political factors. The pressure has been to find ways to make the technocratic approach more 'efficient' and to overcome the 'social barriers' to technical improvement. Wrapped up with this sometimes has been a

well-meaning approach to 'appropriate technology' which ironically may only institutionalise and accept the underlying poverty trap. The talk of 'participation' is of little meaning if the people concerned have no power to participate in their own national economy or are powerless to seek access to the basic resources for a decent livelihood. Naturally the real problem can have only a political solution—and this article may seem rather like an argument of ecological Trotskyism saying that the conventional efforts merely put off the day. However, one of the most 'respectable' of writers on soil erosion, the American, Jacks, said in the 1930s: "Where land utilisation practices are firmly established and have become the basis of a country's economy, the adoption of a new utilisation programme conforming to the limits imposed by the natural environment may well involve a social and political revolution"¹⁵.

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Can Agribusiness feed Africa?

by Colin Hines and Barbara Dinham

The last few months have seen headlines such as 'Africa's grain food shortage' and 'Sahel faces its worst famine'. A confidential paper from the World Bank has described the region as 'almost a nightmare' and with depressing regularity television crews rush to various hunger hot spots in Africa and bring to our screens the all too familiar sight of the distended bellies and spindly legs of starving black children.

For Africa is yet again receiving the epithet 'The Hunger Continent' as it is seen to suffer from appalling droughts, particularly just south of the Sahara and north of South Africa. Although the countries in between are subject to less droughts, the high cost of oil and the effects of the recession combine to make their food situation almost equally parlous.

This onslaught of bad news can easily lead to a fatalistic despair that, if we are not careful, blinds us to the complexities behind those images of Africa and obscure the basic reasons of how the situation arose and what can be done.

Numerous African countries have chosen and been encouraged to choose capital intensive, large-scale food production schemes as a way out of their food problems. But this has contributed to food scarcity. Recent changes in the policies of the World Bank and aid agencies are likely to make a bad situation worse.

Without question most African countries face severe food shortages. Sub-Saharan Africa is the only region in the world where per capita food production has declined over the last twenty years, dropping in 1980-81 for the fifteenth time in twenty years. Per capita consumption in 1980 was 15 per cent below per capita consumption at the start of the 1970s and almost twenty per cent below that at the start of the 1960s.

Record world wheat crops are forecast for 1983. But little wheat is grown in Africa, and more and more is being imported. This year, despite mounting debt burdens, African countries will have to find around £900 million to pay for their wheat imports—and this sum after the pro-

vision of about 3.5 million tonnes obtained at concessionary terms through aid. In some African countries the demands for rice and maize imports are also rising, and are expected to increase by 1.2 million tonnes in the coming year.

Africa is becoming increasingly dependent on industrialised nations and in the process its own agricultural patterns are distorted. The continent was once self-sufficient in food stuffs, and remains a major source of supply of crops that we consume daily in the UK. These include coffee, cocoa, sugar, as well as groundnuts and palm oil for cooking, soap-making and other commercial uses. The continent is also a major producer of rubber, cotton, tropical hardwoods, and is increasingly deve-

loped as a source of cattle, vegetables and fresh flowers. Clearly, Africa is not agriculturally destitute, and the connections between export-oriented agriculture and poverty are not coincidence.

Agriculture is crucial to the economies of many African countries. Twenty-five of the 43 sub-Saharan countries are almost totally dependent on agricultural exports, and only six earn less than twenty-five per cent of their foreign exchange from agriculture. Seventeen countries derive over 80 per cent of their export income from only three or fewer commodities. The vulnerability inherent in this dependence must be set against the lack of an effective control over the commodity markets, the market structure,

world trade systems, or over the prices which must be paid for imported capital equipment and consumer goods.

Before the colonial era African agriculture was geared to food production, and most societies were self-sufficient and secure. The technology of subsistence agriculture was on a par with much of Europe, using iron tools, irrigation, terracing, crop rotation, green manuring, mixed and swamp farming. On a continent where the soils were extremely fragile and easily destroyed by intensive farming, farmers had an intimate knowledge of soil potential. All the same, surpluses were common, and were traded along the many trade routes criss-crossing the continent.

Changes for the Worse—the Colonial Take-over

By the end of the 19th century, the mining and concession companies had staked their claims to Africa, along with settlers and the colonial governments. African societies, already destroyed or weakened by 300 years of slave trade, were faced with new demands for land and labour which further shattered their economic, social and political structures.

The disintegration of African societies opened the way for the establishment of plantations by big European companies keen to secure regular and reliable supplies of materials for the companies' factories in the industrialised centres.

One of the first plantations owned by a foreign company was established in 1911 by WH Lever for his company, Lever Brothers, now Unilever, the world's biggest food business. Others moved in quickly, taking over land regardless of its value to African producers, and beginning the era of total control by big business over the food production processes.

At independence, many African governments attempted to wrest economic power from foreign companies which controlled their export crops, but experience soon showed that the companies were powerful adversaries. Most governments were compelled to adopt fairly modest legal and financial controls: measures which would not drive out big business, since those companies

had become crucial to many African economies.

In response to nationalist demands, companies moved into a network of consultancies, management companies, and technical contracts. Unilever, ICI, Shell, Tate & Lyle, Booker McConnell, the Imperial Group and Dalgety are just a few that have followed this strategy. The market is opened for company inputs, and a regular supply of quality cash crops is ensured. Plantations remain profitable, but companies derive their strength and profits from processing, trading, transport, marketing and distribution.

That is the nature of agribusiness: The integration of activities designed to make a profit out of the inputs to farming—the seeds, fertilisers, pesticides, agricultural machinery, management and consultancies, animal feedstuffs, research—as well as from the outputs of the farm.

More recently, agencies such as the World Bank and the International Monetary Fund played a crucial role in encouraging this prominence of export crops in African economies. Yet throughout the last two decades, production of food crops slumped, and prices for export crops stagnated.

In the last decade as African governments became increasingly desperate to reverse their recurrent food shortages, they embarked on a range of projects aimed at increasing their domestic food production. The most favoured approach for a growing number of countries was and is a dash for growth in food output, relying on large scale, highly capitalised and mechanised schemes.

Among the countries adopting that approach are Nigeria, Zambia, Zimbabwe, Kenya, Sudan, Ghana, Ethiopia, Tanzania, Mozambique, Togo and Benin.

Although this move represents a recognition of the importance of food security, investment into food production is invariably into those products consumed in the cities. Hence the emphasis is on wheat, rice and sugar.

Aid agencies frequently provide the guarantee of funding for those large scale food production projects, and many of the recent statements

and reports emanating from agencies such as the World Bank and the United States Agency for International Development (USAID) set the scene for grandiose schemes. USAID's 'Food Sector Assistance Strategy for the 1980s for Africa' emphasises increased production using new seeds and other technological advances, and more educated managers, technicians and administrators. The World Bank's influential report 'Accelerated Development in sub-Saharan Africa—an Agenda for Action', published in 1981, urges privatisation in such areas as the provision of seeds and basic foodstuff, and stresses the need for more middle and high-level trained personnel.

Yet African critics of the World Bank Report say that the problems lie as much with industrialised countries as with any internal planning problems. Aid projects are badly designed, being far too dependent on imported technology and equipment, laying excessive emphasis on cash crops for export or food crops for the wealthier city dwellers; and ignoring the huge difficulties of poor governments in meeting the running costs.

Time and again, the schemes developed by 'experts' and funded with aid, channel money into expensive and technically-complicated schemes. Foreign advisers, for instance, tend to favour irrigation schemes since agricultural production rises spectacularly with regular water supplies. A sceptic would point out that irrigation schemes offer more for donor countries, or agricultural consultancies, than do rain-fed agricultural projects. A typical scheme is that on the banks of the Niger River at Namarigounou with plans to irrigate 1,500 hectares of normally dusty river valley to grow food crops. Construction alone of the irrigation scheme works out at \$17,000 per hectare (\$25.5 million). Yet incredibly, only a mile or so beyond this scheme lies another—now derelict. The now unworkable irrigation scheme is a testament to the difficulties facing poor governments in meeting the running costs necessary to sustain these flash and spectacular ventures.

Other farmers in the region point to worse problems, unforeseen by

technocrats. In Mopti, since the opening of a similar capital-intensive irrigation scheme nine years ago, rice production has fallen from fifty bags a hectare to only fifteen because of infestation by wild rice, and the low resistance of imported rice seeds to irregular and inadvertent flooding.

In Tanzania, a Canadian-aided wheat scheme is causing even greater concern. Since it began in 1970, Canada has committed \$44 million to the project with the prospect of Tanzanian government being able to run it independently in the foreseeable future. Yet the prospect of that is nil, although the Tanzanian government has at least matched the Canadian's funds. In addition \$1.5 million was spent on equipment for each of the six farms in the Hanang district (totalling 60,000 acres).

The land for the wheat schemes was taken from the Barbaig, a pastoral people who both occupied and grazed their cattle on the land. They have now been forced to overgraze on the surrounding land. The

schemes themselves are far too intensive for the area, and a report on Agricultural and Livestock Production in Arusha Region noted with alarm that the "technology being applied to these large scale fully mechanised operations is alarmingly similar to the technology used in western Canada which contributed to the catastrophic soil erosions (dust bowls) of the 1930s."

The farms are laid out prairie style with no allowance for tropical downpours. Erosion is already severe as huge gullies cut through the fields; indeed £22,000 was spent on one farm trying to fill such a gully, without success. Those running the project are now having to consider practically beginning again and switching to the contoured strip farming traditionally used on small wheat farms in Tanzania.

This catalogue of disasters may be excusable if the scheme was at least producing wheat on a comparable scale. In fact, Tanzania is now estimated to be producing less wheat than when the project began, and any prospects of even sustaining

production without massive inputs are bleak.

The decision to opt for such large scale schemes is often made by bureaucrats who prefer to attribute short-falls in food supplies to inadequacies in peasant production, rather than to a more general failure to tackle such underlying causes as land reform, low farm prices, lack of support for marketing, storage and distribution. There are other pressures on governments to favour these technically advanced large-scale farms.

Firstly, there is the apparent success of modern agriculture in the West—the subsidies and inefficiencies of over-production often being obscured. Secondly agribusiness is ready, willing and anxious to advise on new schemes, and to provide the inputs required. Their profits lie there, not in peasant production.

Traditionally, big business has seen its profits only in cash crop agriculture. As the Chairman of General Foods said candidly in 1980 "It is virtually impossible for a private business establishment to

Australian Journal of Ecology

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develop, distribute and sell enough of the kinds of food poor people need and still break even, much less look for any profit."

But the financial guarantees of aid agencies have changed this prospect, and made it an extremely profitable area. World aid has risen 400 per cent during the 1970s to \$20 billion, much of which is spent on goods and expertise from the developed world. Contracts agreed through aid agencies have the advantage of being largely immune from recessions and national cut-backs.

In effect, the financial risks to agribusiness are eliminated, while an outlet for their products, agricultural inputs such as seeds, fertilisers, pesticides, tractors, harvesters, processing equipment, technical knowledge and expertise is ensured.

Large scale schemes depend heavily on these inputs and hence Africa's reliance on transnational agribusiness seems set to increase. Such schemes, however, are unlikely to solve Africa's food deficiency. They are often inappropriate and expensive and they tend to divert attention and cash from the underlying problems of rural poverty. A classic example of this process is seen in Zambia. Since independence all attempts by the government to restore and increase food production have failed. The latest policy is to concentrate resources on large-scale agricultural production rather than channel new investment into the peasant sector.

In 1981, Zambia embarked on an intensive ten-year national food production programme costing an estimated US \$500 million, largely financed with loans from bilateral aid and international organisations. The programme is intended to make Zambia self-sufficient in food by 1991 through establishing a total of eighteen mechanised State farms, two in each of the nine provinces, with each farm extending to about 20,000 hectares. These farms will make use of consultants from both foreign companies and aid agencies and all will be managed by foreign personnel.

Tate & Lyle carried out the technical study for Mswebwe State farm in Zambia's Central Province, and then won the contract to develop it

as a joint venture with the government. A number of French companies have prepared preliminary information on two farms, one in Western Province and another in Eastern Province. Lonrho—Zambia's major food producer—is expanding its interests in cattle with the help from an imaginative aid source. The Dutch government is providing the hard currency for Lonrho to import 210 Friesian cattle while the company puts up an equivalent sum from its ample Kwacha (Zambia currency) profits for further expansion of the dairy industry. On other farms experts from Bulgaria, Japan, China, East Germany and the European Economic Community are involved.

The world-renowned agronomist Rene Dumont, with over half a century of experience in Third World agriculture, is highly critical of the Zambian scheme and others like it. President Kaunda asked Dumont to analyse Zambia's agricultural strategy, and Dumont commented that Zambia is trying "to build State farms. What will these State farms be? Bureaucratic, corrupt and inefficient." The report claims that the

direction of post independence policies has "accentuated rural underdevelopment, has widened the gap between urban rich and all poor people . . . it has aggravated malnutrition." But Zambia is only one of many countries pursuing large-scale food production.

In Senegal, an agribusiness-backed scheme to grow rice is underway in the Caramance region. The technology and much of the planning and organisation of the scheme will be carried out by International Control & Systems of Houston Texas, a farm implement and agri-industrial firm. The aim is to double rice yields to 180,000 tons per annum in a highly mechanised commercial operation covering 30,000 hectares of the eastern Caramance. Senegal's socialist land reform act of 1964 legislated for communal ownership but in this scheme the development body, SODAGRI, will hire in wage labourers to work the farm. As in many such schemes, little account is taken of the effect on people already living in the area, among whom are the Balantas, renowned for their careful soil management techniques



Agro-industrial farming on a large-scale, but who is it feeding?

and sound environmental use of animals and crops. There are fears that in producing the rice, intended for the cities, the Balantas' lifestyle and independence will be eroded, their extensive agricultural knowledge and experience lost.

In Nigeria, during the second half of the seventies, the main area of agricultural investment was in large-scale irrigation schemes, with devastating effects on peasant producers. In Northern Nigeria, the Talata-Mafara project irrigated 10,000 hectares near the Sokoto River. The work was carried out by Impresit Nigeria Ltd, forty per cent owned by Fiat, and during the three year construction period 60,000 peasants were moved. They were unable to farm, were given no compensation, and finally, when they protested, the State called in armed police to put them down.

The Nigerian government itself acknowledged the failure of large scale farming to meet food needs, and in 1980 launched a new plan to increase food production called the 'Green Revolution'. The plan is to bring new land under cultivation, and the proposed investment of US \$8.24 billion has attracted agribusiness into the Green Revolution.

A US-Nigerian Joint Agricultural Consultative Committee was established in July 1980, and includes representatives from Coca Cola, Ralston Purina, the Pilsburg Company, Carnation International, Ford Motor Co, as well as large banking groups. The committee will be the principal vehicle for the transfer of US agricultural technology to Nigeria, being involved particularly in supplying fertilisers, seeds, milling and baking technologies, integrated poultry systems, and methods for the small-scale production and distribution of fresh produce. Texaco's agribusiness arm, Texagri, is involved in a 2,500 hectare scheme to produce cassava flour and Pullman Kellogg is involved in building a nitrogenous fertiliser plant. It has been suggested that US farm exports to Nigeria could reach \$1 billion by 1985, although this optimism may be undermined by the recent drop in oil revenues.

Food self-sufficiency in Africa is further undermined by the diversion

"World aid has risen 400 per cent during the 1970s to \$20 billion, much of it spent on goods and expertise from the developed world."

of investment into other massive agricultural development schemes. The Sudanese government has consistently favoured such schemes, yet the Minister of State for Irrigation, Sighairoun el Zein, recently pointed out that "Schemes are falling behind on all operations dependent on machinery". There is little evidence, however, that the experience of past failures has affected present plans. The Rahad Corporation has recently embarked on yet another mechanisation programme, spending \$3 million on 50 International Harvester cotton-picking machines, with the aim of mechanising one-third of all picking on Rahad's 300,000 acres.

Throughout the sixties and seventies, the Sudanese government poured massive resources into sugar projects, partly to meet internal demand, and with the hope of exporting sugar to its richer Arab neighbours, in all six major schemes have been launched. The most successful of these were the first two, both smaller and more modest, at Geneid and New Halfa. The history of the remaining four sugar schemes has been littered with disasters, including technical and managerial problems, and vast under-estimates of the costs involved.

The largest and most costly project is that at Kenana, probably the largest sugar scheme in the world. When Kenana was designed in 1974, the sugar price was at an all-time high (£665 per tonne) this had dropped to £93 a tonne when the project came on steam in 1979. It took a further two years for the first refined sugar to be produced.

Kenana was intended to turn Sudan into a major sugar exporter, and give a return on equity investment of around twenty-two per cent. The original cost of the project was estimated at some \$150 million—and the final bill was \$613 million. The scale was massive, and involved building a 40-megawatt power sta-

tion, a network of conduits and canals up to twenty miles long, a pumping station to lift the Nile waters 150 feet from the canals to the fields, and a factory to crush 17,000 tonnes of sugar a day. Roads and transport were needed to move the sugar the 1,000 miles to Port Sudan.

The scheme has undoubtedly benefited the foreign contractors, consultants and managers. The benefits to Sudan are not yet apparent. Power shortages hit the pumped irrigation schemes, the high cost of fuel is crippling the agricultural programmes, the road system is costly to maintain to the standard needed for heavy transport, the increasing irrigation has spread the debilitating water-borne disease schistosomiasis to many farming communities, and on the cotton-growing Gezira project, established in 1920, the disease now affects 80 per cent of children.

The formidable problems associated with the development of the sugar schemes in Sudan have meant that the government will probably end up subsidising its own food exports to much richer Arab neighbours. The government has considered growing more wheat for domestic consumption instead of cash crops, but when foreign debt problems forced it to ask for a loan from the International Monetary Fund in 1979, the IMF as usual backed export crops, and insisted that Sudan continue to grow cash crops such as sugar, cotton, groundnuts, sesame and gum arabic for export, and pressured the government to drop wheat schemes.

There is thus widespread scepticism that the agribusiness-backed schemes can reverse Africa's food deficiency. Inappropriate and expensive, western-style agribusiness diverts attention and investment from the underlying problems of rural poverty. The food produced is expensive, and the emphasis on production at the expense of distribution fails to address the problem of why people in rural areas are poor. The food produced by agribusiness is destined for the wealthier urban population.

Large scale food production bypasses the problems confronting peasant communities, who have been moved onto smaller and less

Methods of Food Production in Sub-Saharan Africa ³⁵

The most important food crops produced in Africa are maize and the root crops, such as cassava, yams and sweet potatoes. Millet and sorghum are the most important cereals after maize, since the production of wheat, rice and barley is concentrated in only a few areas.

Region	Patterns of Food Production
Sahel and W. Africa	Smallholders responsible for the bulk of food production. The subsistence sector predominates, although a few large-scale mechanised units produce rice and maize, e.g.:
Benin	Government intends to develop a series of highly mechanised State farms, 1000 hectares or more in size.
Ghana	Large mechanised estates for cash crops but also greater emphasis now being put on smallholder sector, where communal land tenure is widespread.
Guinea	Government policies emphasise collective farming, with village level production brigades equipped to cultivate communal farm units. Yields lower than on smallholdings, which account for 80 per cent of total agricultural production.
Guinea-Bissau	Government stresses the promotion of small-scale family farms, but does not exclude the establishment of State farms.
Nigeria	Government encouraging larger-scale units. The land tenure system differs among States, although it is predominantly communal. In recent years there has been a movement towards freehold tenure, mainly because rapid population growth has exerted pressure on available land and many farmers have ill-defined rights to land.
Sierra Leone	Similar to Guinea-Bissau.
Togo	Agrarian land reform is aimed at facilitating the merging of small fragmented plots and the use of modern agricultural equipment.
Central Africa	The traditional land tenure system whereby the tribal authorities allotted plots has been modified to encourage commercial rather than family-subsistence production. Attempts to organise the smallholders to produce foodcrops for sale began in the 1950s and have continued until the more recent establishment of co-operative farms in Angola and Congo, and diverse smallholder projects in Zaïre.
East Africa	Smallholders produce the bulk of agricultural products and the importance of the subsistence sector varies from country to country. There is little food production for markets in Rwanda and Burundi, but a lot in Kenya and Sudan.

In other countries large units are generally limited to some cash crops, with the exception of Ethiopia's expanding State farms and the State farms in Tanzania. Smallholders have been integrated into the market economy more through export crops than food crops, reflecting colonial priorities which have been continued since independence, e.g.:

Kenya	A continuum from small subsistence holdings to large units controlled by individuals, co-operatives and companies.
Sudan	Three distinct sectors: State-controlled, participatory irrigation schemes; large-scale private mechanised farming under rain-fed conditions, and traditional small farmers who grow about 60 per cent of total production.
Southern Africa	The control of land by white farmers and the agricultural investments of private firms has led to a sector composed of larger modern units on one hand and on the other a mainly subsistence sector, e.g.:
Malawi	Small farmers predominate in Malawi with the estate sector producing most of the cash crops.
Mozambique	A broad subsistence sector still exists but the former Portuguese commercial farms, primarily small and medium-sized, have been consolidated into State farms, along with some of the old plantations. Some 4,000 farms cover nearly 50 per cent of the farmland. Some 'communal' villages have been established and are to be expanded.
Swaziland	About 70 per cent of the population live on mainly subsistence farms covering about half the land area. A large proportion of the modern farms are owned by foreigners and private companies.
Zambia	Approximately 500-600 large-scale commercial farms, half of which are European-owned, produce one-half to two-thirds of the marketed output of maize, the staple food, on leasehold land.
Zimbabwe	Just before independence approximately 6,000 white commercial farmers and some plantations controlled almost 50 per cent of the total land area and employed a large amount of wage labour, producing most of the marketed agricultural goods. Over half the population was restricted to Tribal Trust Lands, infertile areas representing about 40 per cent of the total land area. Here farming takes place on small units with little marketed surplus produce. Farms suffer from problems of overgrazing, crowding and lack of infrastructure. Since independence, resettlement from the Trust lands to abandoned white farms has been occurring slowly.

fertile land, who are not paid a sufficient price for the crops they produce for the market, who are ill-served by distribution or storage networks, and whose needs for investment in education, health and water supplies are ill-met.

Yet peasant farmers make up 75-80 per cent of the population of most African countries and it is eventually from this source that a true solution must be based. These women and men from the backbone of Africa's food production receive few inputs, yet their work is heavy and arduous, their effort is undermined by low prices, cheap imported foods and erosion of land rights.

Africa will require increasing quantities of foreign exchange to pay for its large agricultural developments, to meet the necessary imported inputs and to repay the

loans without which the schemes could not be established. Such financing could well lock African countries into a further downward spiral whereby they find themselves forced to maintain or increase their cash crop production, both to pay for the food schemes and to keep pace with the declining terms of trade for agricultural exports. Yet such an emphasis on cash crops, linked to a dependence on large-scale food production schemes, is likely to divert further resources from the subsistence sector, which must ultimately be the major source of Africa's food production.

For the transnational agribusiness corporations the current approach to food supplies in Africa has opened up large new markets, particularly in production oriented schemes financed by aid agencies,

which appear likely to dominate the 1980s. If the trend continues, it will doubtless ensure agribusiness an increased role in Africa's food production, thus complementing its historic control of Africa's cash crop production.

Barbara Dinham, an Australian, has lived and worked in Africa for four years before working for Friends of the Earth and later for Earth Resources Research. She has been active in food politics campaigns and the women's movement. Colin Hines has been actively involved in environmental and developmental issues for the last 12 years. He was co-author of the ERR reports, Losing Ground, and Automatic Unemployment, and for the past 8 years has been a part-time lecturer in environmental studies at London's Polytechnic of the South Bank. He has been a consultant to the United Nations Environment Programme and the United States Department of Agriculture co-authoring a report on the changing structure of European Agriculture.

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GREENPEACE

Cancer and the Pill

by Ellen Grant

On the 22nd of October 1983 the British public knew at last that the pill could cause cancer. Two papers, published in *The Lancet*, were widely reported in the media. A British group led by Professor Martin Vessey¹ in Oxford had found large increases in cancer of the neck of the womb in women using the pill and a Californian group led by Professor Malcolm Pike² demonstrated a marked increase in breast cancer among young women who had started taking the pill before the age of twenty-five. *The Lancet* editorial concluded that the residual and long term effects of the pill on health needed to be taken seriously and not dismissed in an attempt to avoid the anxiety that might be created in the short term.

Such information had thus appeared and been made public more than fifty years after it was first discovered that oestrogens could cause breast cancer in male mice. Indeed, since 1932 numerous animal studies have proved that the female hormones—oestrogens, progesterone and its synthetic substitutes the progestogens, as well as the male hormones—androgens, can cause malignant growths in hormone sensitive tissues such as the breast, uterus, ovary, pituitary and testes and also elsewhere such as the brain, liver, kidney and lymphoid tissue.³

The well known facts of cancer induction brought about through the use of male and female hormones have been confused by the dual role of such steroids. Small doses can stimulate cancer, while large doses can inhibit tumour growth. This anomaly is not so strange when we think of X-rays. Small doses of radiation can cause cancer while large doses are used in radiotherapy. Thus a letter to *The Lancet* referred to a 1967 account of nine out of forty-two women with metastatic breast cancer who improved when treated with 'Lyndiol'. This pill contained the highest doses of oestrogen and progestogen used as a contraceptive pill in the U.K.

However, this high dose pill, although well tolerated by the women, was quickly discontinued because it

caused too many missed periods. The dose was thought to cause excessive pituitary suppression with an increased risk of infertility in sensitive women. Moreover women taking the pill had pregnancy-like changes in the lining of the womb and some women developed large raw areas on the neck of the womb—an early warning sign of the risk of cervical cancer. Later the Royal College of General Practitioners reported that the risk of severe cases of inflammation of the cervix increased with increasing doses of progestogen.

In 1961 I was asked to test a wide range of pills for the research body of the Family Planning Association. In 1967 I published a method for assessing the hormone balance of the various oral contraceptives by their effect on the lining of the womb.⁴ Progesterone or progestogens turn the cells in the glands—rapidly growing and dividing under the influence of oestrogens—into secreting cells. The secretion is a mixture of glycogen and fats and it normally appears at mid-cycle as a sign of ovulation in the form of vacuoles below the cell nucleus. The more progestogenic the mixture, the sooner the vacuoles appear after a woman starts taking pills—as soon as two days after the first pill.

Meanwhile the endometrium (womb lining) becomes thin and sparse if such pills also contain a low dose of oestrogen; hence the reason why bleeding is usually less than during a woman's normal period in between pill cycles. Weak mixtures, which are neither mostly oestrogenic nor progestogenic in action, give indications of vacuoles for more days than usual in the middle of the month and many women therefore bleed early—before they finish taking the pill for the stated twenty days. Because oestrogen is known to cause cancer and thrombosis, and, because of the breakthrough bleeding (BTB) problem with low dose pills, most oral contraceptives come to have marked similarities; tending to be predominantly progestogenic combined with a low dose of oestrogen and have a BTB incidence of two to ten per cent of cycles.

By the mid-sixties we had tested over sixty varieties of pills among nearly a thousand women at the headquarters of the FPA in London. Seven progestogens, synthetic derivatives of progesterone or the male hormone testosterone, and two oestrogens, ethinyl oestradiol (EO) and its 3-methyl ether (Mestranol) were tested as combined or sequential pills.

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She is a member of the American Society for Clinical Ecology, British Clinical Ecology Society and The Society for Environmental Therapy.

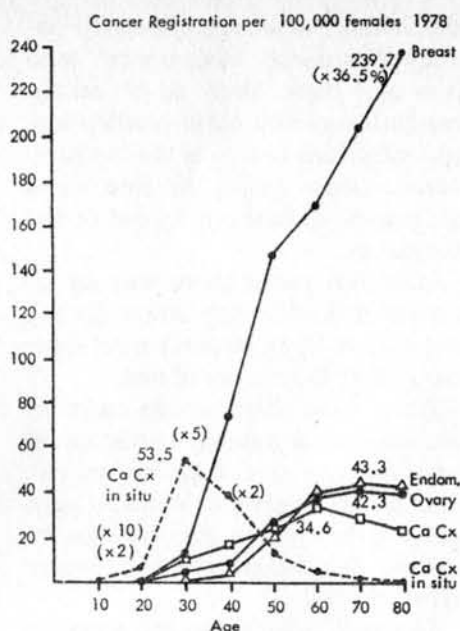
Low dose pills caused not only irregular bleeding but also too many unplanned pregnancies whether given as progestogen-only pills, sequentials or combined. The progestogens—norethisterone acetate 0.3 mg, norgestrel 0.05 mg and chlormadinone 0.5 mg—gave pregnancy rates of four, nine, and twelve per 100 women-years of use while, with megestrol acetate 0.25 mg, twenty-one out of forty-three women became pregnant in a trial of progestogen-only pills carried out in Yugoslavia in 1969.⁵ Although this very low dose of megestrol acetate had no obvious effect on the endometrium, the post coital tests gave poor results showing deficient cervical mucus. Again, an early clue that the cervical cells were to prove especially sensitive to the effects of the progestogens.

The oestrogens—ethinyl oestradiol (EO) 0.05 mg or mestranol 0.08 mg, given for the first eleven or fifteen days of a sequential regime, also allowed unplanned pregnancies.

The combined pill norethisterone acetate 1 mg plus E.O. 0.05 mg was given to twenty-two women, two of whom became pregnant; the breakthrough bleeding incidence was twenty-six per cent of cycles. That pill was therefore considered unsatisfactory for use.

Several years later, in the seventies, other pills were marketed with the same labelled doses—norethisterone acetate 1 mg plus E.O. 0.05 mg. Surprisingly these pills gave good cycle control and very few unplanned pregnancies. Since then even lower doses of the combination have been marketed. It seemed that a change in bioavailability had taken place. Pill hormones were now being micronised so that they were more efficiently absorbed by the gut with the result that apparently low doses had the same biological effect as previously achieved by higher dose pills. Obviously, women must be given large enough amounts of hormones reliably to block ovulation and to prevent endometrial bleeding. A truly low dose pill is a myth.

We found that small variations in dose of either oestrogen or progestogen could vary the side effects and the changes in blood vessels and enzymes. Very high doses of steroids could temporarily suppress 'allergic'



reactions like those evident in the premenstrual syndrome, but some lower dose pill combinations exaggerate particular aspects.

Irregular bleeding was most likely with lower dose pills which were neither mostly oestrogen nor mostly progestogenic and had a prolonged early secretory phase. Headaches and migraine affected up to sixty per cent of women within a year of taking those progestogenic pills which had both a prolonged late secretory effect, and marked development of endometrial arterioles.⁶ Vein complaints were most likely with either basically oestrogenic or progestogenic higher dose oestrogen pills, which also dilated endometrial sinusoids.⁷ Irritability, aggression and weight gain were most likely with the pills which altered both the arterioles and sinusoids. Depression and loss of libido were most likely with high dose progestogen pills containing a low dose of oestrogen, which also increased womb monoamine oxidase activity for most of the cycle, instead of for two or three days, as in a normal cycle.⁸

The switching of symptoms is not surprising as both hormones alter amine metabolism which controls blood vessel reactivity and mood and behaviour. Such changes can also alter prostaglandin synthesis and immune mechanisms. In fact, the most striking effect of the pill is variation in individual susceptibility. Some women have severe and disabling reactions to any type of pill while others remain symptom free for years.

In 1961 half of the women we enrolled already had had accidental pregnancies and all of our volunteers wanted to use the pill. By 1968, the world literature was reporting numerous pill side effects and three large prospective 'control' studies were started in which roughly half the women (the controls) used other methods.

The Royal College of General Practitioner's (RCGP) Study⁹

Forty-seven thousand women were enrolled, but ten years later 25,000 of them had been lost and only 4.4 per cent of the original takers were known to be still using the pill, probably because they had an increased chance of developing over 60 different types of illnesses. A few conditions were less common among women still taking the pill but even those ailments were slightly more common among women who had given up the pill than among women who had never taken hormones. Nevertheless it is claimed that the pill offers protection, a claim which has been reported on numerous occasions and has received widespread publicity.

One such condition is benign breast disease. High doses of progestogen and longer pill use are said to prevent lumps developing, yet sensitive women will discontinue any type of pill more quickly, especially the highest and lowest dose pills, because of side effects. Moreover doctors are less likely to give the pill to women with breast disease and more likely to advise them to stop if lumps develop.

By 1979,¹⁰ although the death rate in the study was below that in England and Wales as a whole, women who had used the pill had a 4.3 times greater chance of dying from vascular disease compared with women who had never used the pill.

By 1981¹¹ breast cancer had significantly increased among women aged thirty to thirty-four at diagnosis. There were by now twenty-two cases among users and six among controls aged fifteen to thirty-four, but that difference did not reach significance for the wider age range.

By 1983¹² there were thirty-four cases of invasive cervical cancer

among 'ever-users' and ten among controls. Some of the pill controversy has arisen because certain conditions, such as breast cancer, are rare among young women and the numbers in prospective studies may be too small to be mathematically significant in a statistical analysis. Conversely, because breast cancer is relatively common in older women a large increase in numbers may still not reach significance.

The Oxford Family Planning Association Study¹³

This study, which comprised 17,000 higher social class, well supervised women, gives a more optimistic picture of pill risks compared with those run by women in the country as a whole. After ten years¹⁴ the death rate among women using the pill when enrolled was only half that for England and Wales, although the study showed the pill increased the risk of death from vascular disease, especially from myocardial infarction. The study also had a particularly low death rate from accidents and violence, nevertheless pill users were four times more likely to be admitted to hospital for attempting suicide compared with diaphragm users.

In 1981 the incidence of breast cancer had doubled after four years of pill use and when the interval from first use was longer than twelve years, but those figures were too small to reach significance.¹⁵

Professor Vessey and his team published in *The Lancet* in October 1983 that all of the sixteen women who had developed invasive cervical cancer had used the pill. The rates for the less serious types of cervical neoplasia had increased much more rapidly among pill users than among IUD users. Unfortunately the report did not give the increase among the women who had taken the pill before having a child (nearly forty per cent of the pill users). And yet it is those youngest immature nulliparous women (who have not yet had a child) who are at special risk from changes in cell type that can lead to neoplasia.

The Walnut Creek (USA)¹⁶

For the Walnut Creek study 16.6 thousand women were enrolled and, already at entry to the study, 34

conditions were significantly increased among 'ever-users' who were also more likely to be taking tranquillisers and other medication. Incredibly one in five of the 'control' women were using or had used oestrogens as had one in ten of the pill group.

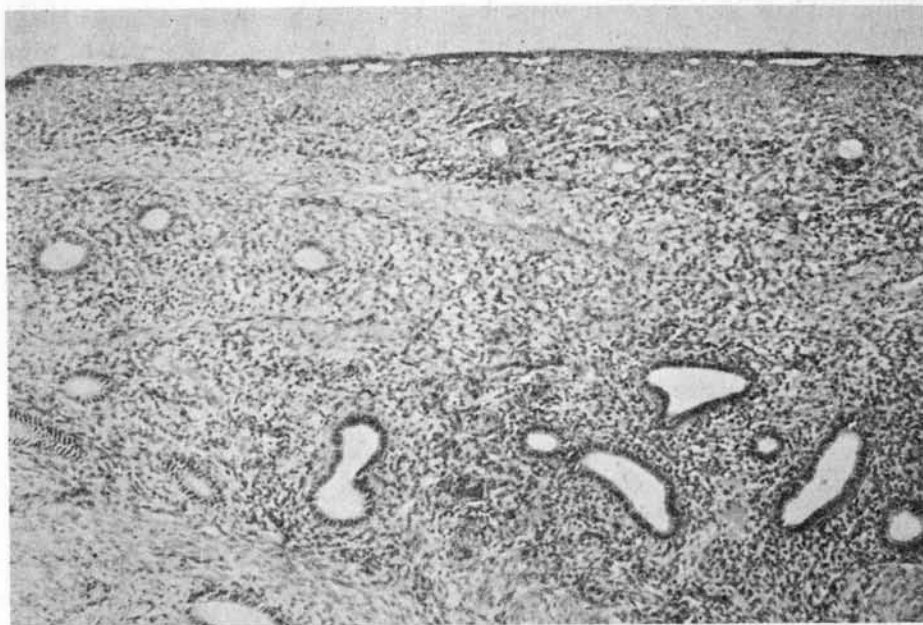
After ten years there was an increased risk of breast cancer for pill users aged forty to forty-nine especially after four years of use.

There were thirty-seven cases of cervical cancer among women under forty and one case, a heavy smoker, among the controls. Women aged forty to forty-nine also had an increased risk which rose with longer use of the pill.

The real risks of womb (cervical and endometrial) cancer must be greater than appear in the study, since the hysterectomy rate among

protected against endometrial cancer. Thus there were thirty-two cases of endometrial cancer among the controls and eleven among these older pill users. Unfortunately the control group at entry contained three times more women of which three times as many had used oestrogens. These facts could equally suggest that the combined pill may be even more carcinogenic than oestrogens given alone.

The number of women developing ovarian cancer is too small for conclusions to be drawn but we know from other studies that American women have a high ovariectomy rate. Non-malignant ovarian tumours and cysts increased among young women who had used the pill, as did malignant melanoma. Lung cancer was increased among users who smoked. All six cases of urinary



A progestogenic atrophic endometrium after a microdose of norgestrel 500 ug and ethinyl oestradiol 30 ug (ug = micrograms).

pill users is extraordinarily high, even among those under forty years old. Such operations were performed presumably because the women suffered significant increases in uterine fibromas, adenomyosis, severe bleeding and pelvic inflammatory disease. Hysterectomy is often advised to remove the risk of future womb cancer, especially likely in older women taking 'hormone replacement therapy'.

Endometrial cancer was significantly increased by current or past use of oestrogen in women over fifty despite it being claimed that pill use

tract neoplasms and six of the seven thyroid cancers occurred among users.

Breast Cancer¹⁷

Between 1962 and 1978 registrations in England and Wales increased overall by 36.5 per cent and mortality rates by 23.5 per cent with breast cancer now the commonest cause of death in middle-aged women. Oestrogens have been given to women since the 1940s although many studies indicate the increased risk of breast cancer, especially in older women. Breast cancer in males

has risen slightly, but in men over 75 years old, who are most likely to be given oestrogens for prostatic cancer, the increase is twenty per cent.

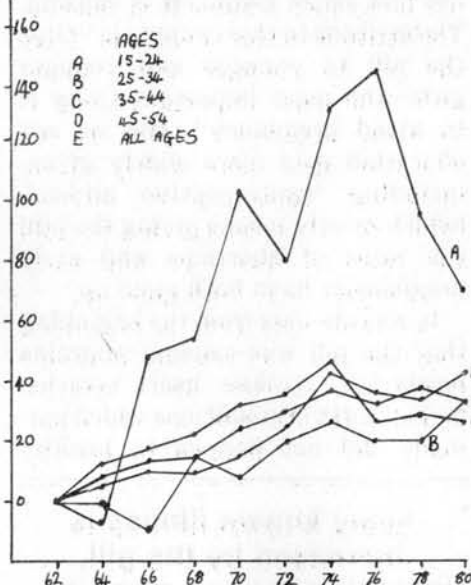
Several American studies, since 1974 indicate that pill-use significantly increases the risk of breast cancer in certain high risk groups including older women, those with a history of benign breast disease, a family history likely to affect sisters, and long term users. Most worrying of all, four studies show statistically significant increased risks, ranging from two to fourteen times according to length of pill use among women who used the pill before their first full term pregnancy compared with women who never used the pill. In 1970 it was noticed that if women had their first child before the age of twenty they had half the usual risk of developing breast cancer, while first time mothers over thirty-five had twice the risk. The pill significantly increased the 'natural' risk according to some studies.

Study expanded

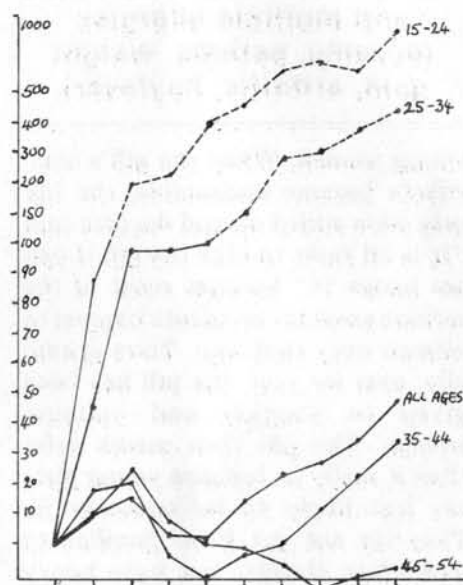
Professor Pike and his colleagues in their 1983 study, expanded on the previous 1981 findings that women who used the pill before their first full term pregnancy had an increased risk of breast cancer which went up the longer the pill had been used. The patients were Los Angeles county white women who developed breast cancer between 1972 and 1982 and were less than thirty-seven years of age when diagnosed. Of 510 eligible cases 52 were dead and the attending physicians refused permission to contact some of the others. Eventually 330 women completed questionnaires and 314 matched controls were found. They were all asked if and when they had used any type of contraceptive pill. The women with breast cancer had used oral contraceptives for an average of 49.6 months and the controls for 29.3 months. The cases averaged 16.8 months of pill use before age twenty-two compared with 10.6 months for the controls. Nearly 80 per cent of these young women had begun use of the pill before age twenty-five. The paper does not list

how many young women with breast cancer had ever used the pill at any age.

Breast Cancer
% increase/registrations 100,00 pop. OPCS



Cervical Cancer



Professor Pike divided the women according to their memory of which pills they had used, those with high and low progestogen potency. He claimed that women had an increased risk of breast cancer only if they used the 'high'—progestogen combinations. Nine women using such pills for longer than 73 months before the age of twenty-five had breast cancers. Meanwhile no one in the control group had used those pills for that length of time at that young age. Yet, the table showing the use of any type of pill before age twenty-five, indicated twenty-four women with breast cancer who had used the pill for more than 73

months compared with only seven control women, leaving fifteen cases to seven controls for lower dose pills. From such figures it is difficult to understand the conclusion that use of a 'low' progestogen component pill "appears to increase breast cancer risk little or not at all." Instead the prolonged use of any type of pill appears to increase the risk of breast cancer.

Several of the letters written to *The Lancet* following the publication disputed the method used to establish progestogen potency and one letter referred to my method of subnuclear vacuole assessment as being the most accurate. In fact little difference probably exists between the effects of norethisterone, norethisterone acetate and ethynodiol diacetate or norethynodrel as the last three are metabolised in the body into norethisterone. The commonly used progestogen norgestrel is much more powerful than the others and smaller doses can be used. I found that 0.1 mg of norgestrel plus 0.05 mg EO was progestogenic while 0.1 mg of ethynodiol diacetate plus 0.1 mg mestranol was oestrogenic in endometrial effect.

Professor Victor Wynn at St Mary's hospital in London and Professor William Spellacy in Chicago studied the effects of the different pills on carbohydrate and fat metabolism. They found that 4,000 times less norgestrel was needed to bring about a given alteration in carbohydrate metabolism—an androgen (male hormone) effect—compared with progesterone, given by injection. Meanwhile the norethisterone progestogens were four times less powerful than norgestrel but still a thousand times more powerful than progesterone.

The situation is further confused because of different techniques being used in pill manufacture during the early 1970s. The micronizing of the pill hormones meant that the particles being smaller, could be more readily absorbed by the gut. Such a change may also explain why progestogen only pills, which previously allowed conception, are now being used with impunity as contraceptives.

In a recent letter to *The Lancet* replying to questions concerning the safety of pills containing a very low

dose of oestrogen, Professor Pike and his colleagues stated that very few women in their study had used combined pills containing 35 micrograms or less of ethinyl oestradiol. Most who did, used Lo/Ovral—30 micrograms E.O. plus 0.3 mg norgestrel, and among those, four women with breast cancer had used Lo/Ovral for a total of 145 months. No controls had used that combination.

Young women taking low dose pills have abnormally high red blood corpuscles glutathione peroxidase levels after seven months. That finding suggests a disturbance in the normal, extremely important, antioxidant mechanisms. The same abnormalities have been found in older women with breast cancer. Liver clearance rates are also altered by pill steroids indicating changes in the normal detoxifying mechanisms. We found that the more liver clearance was abnormal, the more numerous were reactions to foods and chemicals, with the result that some ex-pill users had a 'multiple allergy syndrome'.

Toxic and Teratogenic Effects of Hormones¹⁸

How does pill use affect future generations? The pill has become the Thalidomide story all over again, only in some ways much worse. A recent paper gave a twenty-three times increased risk of limb deformity when hormones are taken in early pregnancy¹⁹. The effects of the pill can be very insidious and responsible for much of the ill-health among women during their child-bearing years. There has been much publicity about women with multiple allergies who seem to react to everything. All of the most sensitive women that I have seen had taken the pill before they became ill. Many also smoked, some took regular alcohol and others had taken various drugs or medicines.

As I came to appreciate after attending a clinical ecology conference in the United States in 1978, the people getting ill with severe allergies, were not old, but young women. Why were all those women getting ill in their twenties and thirties just at the time when it mattered for child bearing? The main reason, I believe, was the pill.

If something becomes common enough, popular enough, if it is given to nearly everyone (as is now happening with the pill) people accept it as normal and do not realise how much trouble it is causing. The attitude in this country is "Give the pill to younger and younger girls—the most important thing is to avoid pregnancy". But as sex education gets more widely given, including 'contraceptive advice', (which mostly means giving the pill) the rates of abortions and early pregnancies have both gone up.

It was obvious from the beginning that the pill was causing migraine headaches, strokes, heart attacks, and all sorts of conditions which normally did not happen to healthy

Every known illness is increased by the pill, including cancer, migraine, vascular and mental disease and multiple allergies (eczema, asthma, weight gain, arthritis, hayfever).

young women. When the pill's side-effects became undeniable, the figures were added up and doctors said "It is all right to take the pill if you are under 35" because most of the serious vascular accidents happen to women over that age. Thus gradually, year by year, the pill has been given to younger and younger women. The pill then seems safer than it really is, because young girls are less likely to be seriously ill. They do not yet have families to look after; they do not have heavy responsibilities. They may still be at school, keeping fit playing games. They are at the best time of their life for being healthy. Girls are being given hormones at a time when they are most likely to be able to take them without having obvious side-effects.

More women, younger women, have been taking the pill for longer, so that the cancer rate in young women between fifteen and twenty-four is rising rapidly. The rates are rising far more steeply than in the age groups which normally get such degenerative diseases. Consequently we are at the start of a very serious situation.

Many of the biochemical and im-

mune changes caused by smoking appear to be much the same as those caused by the pill. Although a campaign against smoking in pregnancy has been launched with posters, films and television advertisements, Government policy seems to be to encourage as many young girls as possible to start taking the pill while they are still at school, hoping that such action will prevent the ever-rising number of abortions and early teenage pregnancies.

Girls are encouraged to start sex early. Yet the statistics show that for every year younger than nineteen when girls start sexual intercourse, the risk of their developing cervical cancer is increased; moreover the risks for breast cancer increase too. It is only the first full-term pregnancy that protects a woman from the risk of breast cancer. In fact the younger and longer she takes hormones, or the younger she has an abortion before having her first baby, the greater is the eventual risk that she will develop breast cancer. And more young women are now putting themselves at risk.

Women have been cheated over the pill. In theory, it is the only suitable and reliable method for unmarried sex, especially when men and women have a number of different partners. Such activities are rapidly becoming normal with the result that venereal diseases have taken on epidemic proportions in America, while gonorrhoea has increased five times among young women in Britain. The increased risks of cervical cancer depend not only on how many partners the woman has had, but on how many partners the man has had. Each new partner on cervical cancer totals a greater number of partners. Venereal diseases like herpes also increase the risk of congenital abnormalities in future offspring.

The pill is much more toxic than smoking in most respects.²⁰ Although lung cancer is obviously caused by smoking and pollution, smoking women who take the pill are more likely to get lung cancer than smokers who do not take the pill.

The pill is more likely to cause illnesses of all types especially cancer, mental illness and vascular ill-

nesses, those being the commonest causes of death. With exaggerated emphasis being put on thrombosis people are unaware (as I was until I looked at the statistics), that women in their childbearing years are more likely to die from cancer, than from other causes.

In the American Walnut Creek study slightly more women died of mental deaths (i.e. suicides or accidents—women being more prone to accidents during times of hormone change)—than of vascular deaths, but cancer deaths were twice as common as either.

If a woman is suffering from the effects of toxic substances, as far as pregnancy is concerned this means that:

1. She may not become pregnant at all.
2. She may abort early, whether the foetus appears to be normal or abnormal, for instance, she may, through smoking, lose an otherwise normal baby owing to placental changes. Thus haemorrhages are more likely because of blood vessel changes. In fact women who smoke have twice the chance of an early abortion, even though many such foetuses appear to be normal. Equally, women who have stopped taking the pill, have more chance of having an abortion, especially those who have had side effects while on the pill, such as those who have had vascular changes in their endometrium and those who have become very allergic. Such women are more likely to have miscarriages and their children are more likely to be abnormal than are the children of women who have smoked but not taken the pill.
3. She may give birth to an obviously abnormal child. The abnormalities may be gross, they may be multiple, or they may consist of some small defect, such as cleft palate or club foot. An American study of severe multiple abnormalities such as those caused by Thalidomide showed that when the mothers' histories were checked for exposure to toxic substances in pregnancy—fifteen out of thirty-two had been exposed to hormones during pregnancy. Exposure to X-rays and drugs was far less prevalent. In conclusion it would seem that exposure to hormones in pregnancy is especially dangerous.

The hormone pregnancy test was banned some years ago, largely as a result of the efforts of Dr. Isabel Gal, who studied the toxicity of excess Vitamin A. She found that women on the pill had higher levels of vitamin A, which appeared to be associated with more spina bifida and other central nervous system abnormalities in subsequent pregnancies.²¹ Moreover the hormones given in the pregnancy test were the equivalent in dosage to taking the pill for several months. Although this was an almost single-handed campaign, Dr Gal managed to get the hormone pregnancy test banned in Britain. But a few years have passed, and high levels of hormones given in early pregnancy may be reintroduced in the form of the 'Morning After' pill.

Thus post-coital contraception consists of taking a progestogen and a much higher dose of oestrogen than is usually permitted in a contraceptive pill. This practice is not only dangerous for the woman, increasing the risk of thrombosis if she is sensitive, but carries a greatly increased risk of a malformed child if the pregnancy is not terminated. Doctors have been advised to warn patients of such risks. Equally, pregnancies are more likely to happen with low dose pills and progestogen-only mini-pills, as both produce more unplanned pregnancies than diaphragm use.

4. When a woman suffers a slight toxic effect she may have a child which looks normal, but which may have learning defects and behaviour problems that do not show up until years later. Learning defects can be caused by many factors including maternal smoking, alcohol, lead pollution, zinc deficiency and other vitamin and mineral deficiencies caused by taking the pill.²² Hyperactivity has been linked to lack of essential fatty acids. Normal fat metabolism, essential for the developing brain and immune system, is altered by pill hormones. Doctors involved in clinical ecology are finding that more and more women are having very allergic children; hence children with abnormal immune systems. I have seen three generations in one family; the grandmother had one or two allergies; her daughter had several; and the

daughter's baby was reacting to nearly everything.

The daughter came to me at nineteen with chest pains and migraine. I got her to give up smoking and stop the pill. She did the exclusion diet and stopped a few foods like bread. She felt so much better that she forgot to rotate her diet as advised and she even started to smoke a few cigarettes again. Two years later she became pregnant and later brought to me a very ill and allergic baby who had not stopped crying for six months. The baby also had an enlarged liver and a hereditary glycogen storage disease of the liver which was later diagnosed by a biopsy.

Although the mother tried everything she could to stop her baby crying, nothing helped. She went to the Hospital for Sick Children at Great Ormond Street; she went to one specialist after another. At six months, when she was just about to stop breast feeding, she tried cow's milk—no help. When she saw me, I told her to try soya milk but the baby still reacted, then she tried goat's milk but to no avail. The only thing that stopped the baby crying was when the mother produced more breast milk through more frequent feeds, rotated her own diet and stopped eating things she was allergic to herself. The baby began to gain weight and was very much better. It would appear that the baby reacted to the same foods as the mother.

What is actually happening? Are we getting, not only more children with learning defects, but more allergic babies than ever before? Professor Butler, who twenty years ago discovered that smoking caused learning defects has now discovered from his research in Bristol that more babies are developing eczema among those who are breast fed than among those who are bottle fed.²³ My conclusion is that mothers have become allergic, because of defects in their immune systems, having been on the pill, and that the babies are reacting to the foods to which their mothers react.

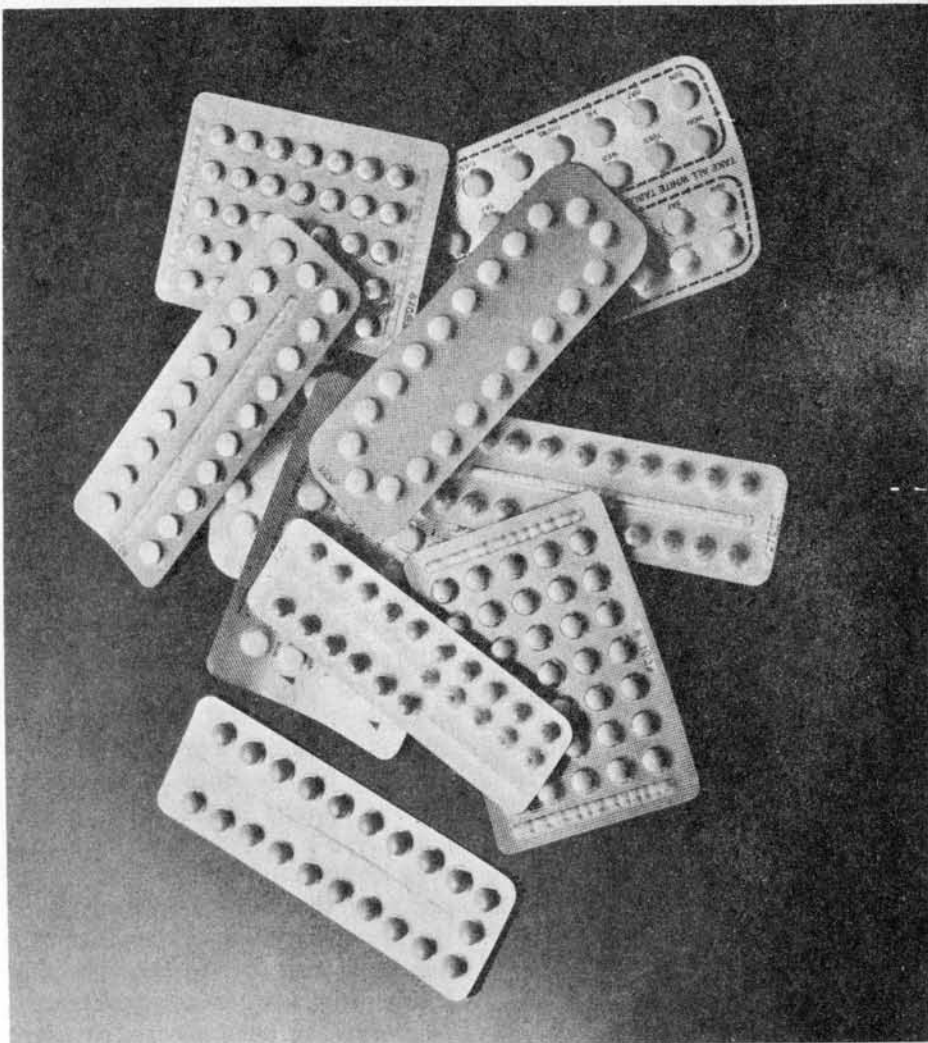
5. If a woman is exposed to toxins she may well have an apparently normal baby. Indeed most children are normal looking when they are born and even a mother who is

known to be severely alcoholic, may produce a normal looking baby. Thus, in one instance with twins, one had a full-blown foetal alcohol syndrome and the other was completely normal. For some reason, certain foetuses seem able to withstand poisons better than others.

The number of alcoholic young women has risen enormously in recent years, women being more likely to suffer liver damage than men. A woman who takes the pill increases the chances of liver damage, allergies and the tendency to become addicted to alcohol. A recent survey of British women found only 16.4 per cent were teetotal compared with 50 per cent in American studies. The Charing Cross Hospital survey found 58.1 per cent of women drank during pregnancy; 24.8 per cent were moderate to heavy drinkers with an increased risk of an abnormal baby or a spontaneous abortion.²⁴

It is known that abortions are more likely among smokers, and in women who have stopped the pill because of the side effects. The pill is likely to cause more abnormalities than smoking. The surprise finding of Vessey and his colleagues in the Oxford/FPA Oral Contraceptive Study¹³ was that if women had never taken the pill and used the diaphragm, 0.4 per cent had abnormal babies compared with 3.8 per cent of babies of those women who had taken the pill (nine and a half times as many). This result applied only to the first baby. The incidence of abnormal babies was about 5 per cent for women having subsequent babies. As women get older, they are more likely to have children with Down's Syndrome as well as other conditions; thus the difference was most marked with the first baby. In contrast, Lejeune et al³⁹ were able to show that among mothers of 730 children with Down's Syndrome, those over 30 were significantly more likely to have used the pill for longer than one year and/or to have become pregnant within six months of stopping it. This result applied only to the first baby.

The increased risk of older women having abnormal babies may be because age increases the risk of chromosome abnormalities. Neverthe-



less it has been known since 1967 that the pill increases that risk and in 1979²⁵ a paper found significantly higher rates for sister-chromatid exchanges among women taking 'low dose' pills compared with normal and pregnant women.

Once a girl has taken the pill, which is a synthetic oestrogen and a progesterone, (and most of the pills available now are nortestosterones i.e. they are the male hormone altered synthetically), she may have permanently damaged her body. Dr Kitty Little, in her book *Bone Behaviour*²⁶ stated that research on animals showed that male hormones like testosterone altered blood vessels more than female hormones did. Nortestosterones had a far larger effect on the blood vessels than did the natural hormones of either sex; a possible reason why we found the connection between the high incidence of migraine and the development of arteries in the endometrium.

When a woman is given such

drugs, her body changes in many ways. The hormones alter every cell in the body, change the blood, the red cells, the white cells, the platelets and cause immune defects. It has been known for about twenty years that platelets change, becoming stickier and clotting more easily. Changes also occur in membrane transport between the cells. Thus if the cell walls become too tight, premature-aging effects such as osteoporosis and premature senility result. If the cell walls become too loose, as happens when steroids are withdrawn schizophrenia and other mental disorders as well as headaches may be induced. Such headaches are also related to changes in the blood/brain barrier. Normally the brain is impermeable to the products of digestion such as amines, but hormones can alter the transport mechanisms so that such substances are able to pass across the barrier, bringing on headaches and other reactions.

Consequently, every known illness can be increased by the pill—including cancer, migraine, vascular and mental disease and multiple allergies (eczema, asthma, weight gain, arthritis, hay fever).

Cervical cancer has increased ten times among fifteen to twenty-four year olds since 1965. Indeed, according to a Birmingham study over ten years, nearly one in a hundred pregnant women had a positive smear.²⁷ Breast cancer has risen by about a third in most age groups, but has doubled in the fifteen to twenty-four year olds. And about one in a hundred young women each year try to commit suicide. The increase has occurred in all western countries and has been most dramatic, once again among fifteen to twenty-four year old females, especially since the use of low dose oestrogen pills became prevalent in 1969.²⁸

In America a synthetic oestrogen, Diethylstilboestrol (DES), was given to millions of women to avert miscarriages. In 1971 two papers reported that girls, born to women who had taken this synthetic oestrogen during pregnancy, were getting vaginal cancer.²⁹ Not only were the girls getting cancer, but more boys were developing cancer of the testes.

Recently it has been claimed that the pill protects against ovarian cancer, but this is unlikely to be true. Most young women developing ovarian and breast cancer have taken the pill, and the risk increases with oestrogen use. Proper control groups do not exist because of the difficulty of finding women who have never taken oestrogens or hormones. Moreover once a woman has taken hormones she is more likely to be at risk from pelvic disease and the need of a hysterectomy at an early age. Meanwhile both sexes can be affected by any hormones the mother may take during pregnancy. DES can in fact cause ovarian cancer as well as vaginal cancer after intrauterine exposure.

Hormones are given to animal livestock in many countries including Britain and Puerto Rico. The illegal use of hormones in chicken feed in Puerto Rico in order to promote growth has been blamed for an alarming outbreak of precocious puberty, breast growth in young male children and ovarian cysts in

female children. But Puerto Rico was the scene of the first large scale trials of large doses of oral contraceptives in the 1950s and it is where 90 per cent of US birth pills are manufactured today.³⁰

We are now at the second generation. Girls are being given the pill, whose mothers also took it. The most common type of cancer now appearing in young women is cervical cancer. They say it is not serious. If you find a positive smear, you cut it out, no problem. But sometimes the cancer recurs, appearing later in the vagina and in different areas. Among fifteen to twenty-four year olds the national death rate has increased four times. Some of these girls die suddenly, just months after a negative smear.

At the Margaret Pike Centre, the largest Family Planning Clinic in Europe, one in twenty-five women have an abnormal smear and the sharpest increases have been in the more serious forms.³¹ Furthermore a rapidly fatal type of breast cancer is more likely in women under 50.³²

Why does the pill cause so much trouble? One of the reasons may be that once the synthetic oestrogen is taken antibodies build up. Beaumont and his research team in Paris³³ found that such antibodies appeared two months after a woman had taken the pill and were still there years later, causing 'long-term immunological scarring' even though the pill had been discontinued. Certain women with the highest level of antibodies had had thrombosis, indicating a tie-up between thrombosis and antibodies.

Abnormal Liver

Dr Ifor Capel and his team at the Marie Curie Memorial Laboratories discovered abnormal liver metabolism in migraine patients we had sent him. It was previously known that the pill altered liver metabolism, now we found that women with severe allergies had abnormal antipyrine clearance rates and abnormal copper/zinc ratios.³⁴ Zinc deficiency is endemic in the UK and a major cause of illness and congenital abnormalities. The pill hormones cause high blood copper levels and lower body stores of zinc.

New work by Dr Ifor Capel and his team indicates that girls on the

pill have abnormally high levels of glutathione peroxidase after seven months on low dose pills. As the levels of that enzyme go up so the levels of Vitamin B2, riboflavin, go down.³⁵ Vitamin B2 is involved with antioxidant mechanisms, as are Vitamin C, Vitamin E and selenium. Oestrogens and progestogens are broken down into catechol oestrogens which can be very toxic if the antioxidant mechanisms are abnormal. Indeed the pill causes a basic change which cannot be corrected by giving extra Vitamin B2, there being a general disturbance of metabolic function, that can affect carbohydrate, fat and protein metabolism. The work on dosage by Professor Wynn at St. Mary's³⁶ and Professor Spellacy³⁷ in America showed that 300 to 400 milligrams of progesterone was equivalent to 0.75 milligrams of norgestrol in male hormone effect. Hence a so-called micro-dosage pill can still be a very powerful progestogen, especially in causing metabolic changes. The male-like effect on fat metabolism is thought to increase the heart attack risk and may also relate to the increase in sticky platelets. Meanwhile Professor Breckenridge and his colleagues in Liverpool have shown that women given the same pill can have an eight-fold variation in plasma norethisterone levels and a ten-fold variation in plasma norgestrol levels owing to variations in activity of the enzymes in the gut wall and the liver.³⁸

Conclusion

To summarise, the use of the pill and other sex steroid hormones before, during and after pregnancy interferes with basic cellular mechanisms. This interference in turn makes other toxins more likely to be toxic to eggs still in the ovary, to a foetus or to a newly born child. In view of our present knowledge, all young women should avoid taking pill steroids at any time, but especially before, during and immediately after a pregnancy.

For the sake of future generations, parents should protect their daughters from being prescribed powerful oral contraceptive hormones while they are too young to appreciate the risks involved.

The most recent advice to women

taking the pill is—don't panic. Go on taking the lowest dose pill which suits you and have frequent breast examinations and cervical smears. While it is true that cervical smear tests can detect very early signs of cervical cancer when at an easily treatable stage, nevertheless the death rate for young women with cervical cancer has increased.

Self-examination for breast lumps just before a period each month is essential for any woman today. But one in ten of those very young women in the Californian study had already died from breast cancer, long before the age when cancer becomes more likely. Surely, it would be much more sensible to avoid using such powerful hormones for sexual convenience. A return to mechanical forms of contraception, especially the diaphragm and spermicides, may not be so suitable for multiple partners but society would benefit in the long run.

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How Agrochemicals feed the Pests that destroy the crops.

by José A. Lutzenberger

A French biologist, Francis Chaboussou, has given an explanation as to why crops become susceptible to attack by pests—the theory of trophobiosis. According to Chaboussou pests can survive only on plants that have an excessive level of amino acids in their sap or tissues. The excess may be brought about through inhibition of proteosynthesis, through proteolysis being predominant over proteosynthesis or to excessive production of amino acids. Inhibition can be caused by pesticides or by unbalanced nutrition. Excessive production of amino acids comes from oversupply of nitrogen from soluble fertilizers.

The working hypothesis—indeed the very paradigm—for the practice of conventional agriculture is purely analytical and reductionist in the way it approaches the factors influencing production, such as soil, tillage and fertilizers, pests and pest control, weed competition or plant breeding. Each factor is taken independently of all the others, as if it was in a closed box, or drawer, all by itself, with practically no connection between drawers. Within each drawer reasoning is more or less linear, with few, if any, lateral branchings. When difficulties arise symptoms only are treated.

Hence, in the first drawer, the soil is seen as not much more than a mechanical substrate allowing the plant to anchor itself, so as not to be swept away by the wind. The soil is also seen as a vehicle for mineral nutrients that are either water-soluble or that can easily go into solution.

When soil is analysed for the purpose of determining the type and amount of fertilizer to apply to a given crop for maximum yield, the methods used in carrying out the analysis are given on the basis of that postulate. For instance, phosphorus is determined by leaching the soil sample with a mild acid and then analysing the leachate. Thus, the analysis may tell us that a given soil is poor in phosphorus when in fact it may be very rich, but the element is present in insoluble form. Without doubt that approach is excellent for those who want to sell the farmer expensive soluble phosphate fertilizers—superphosphate, triple super-phosphate or even complex phosphates.

In the second drawer we find the pest, all those creatures that cause damage to our crops. Plant parasites are seen as arbitrary enemies of our crops, they appear out of nowhere and they can destroy their host

plants or cause serious damage to them whenever they find them.

It is enough for the right species of aphid to be present in a potato or tomato field: it is then bound to proliferate until all the plants are affected. If we do not stop the pests in time they will continue their destructive work until the crop is lost. Such indeed is true for the blight fungus, for nematodes, for spider mites or any other parasite. Pests are thus fundamentally wicked organisms. They should be eradicated if at all possible, and when such drastic action proves impossible we should keep them away from our crops.

Once pests are found, the easiest way to fight them is by poisoning them. Consequently, an arsenal of fulminating and/or persistent biocides has been developed for use against them—the pesticides including insecticides, miticides, nematocides, fungicides, bactericides, even

rodenticides and molluscicides. Such poisons are sprayed over crops in a uniform way, preferably from a plane or helicopter. Increasingly ultra light little planes are used, and to make things easier for the farmer the poison manufacturers work out 'spraying calendars'. All the farmer has to do is follow the calendar, spray the right stuff at the right time and he will catch all the evil beasts. With some crops, apples for instance, he will spray up to thirty times in one season. Last year the guy who got the best apples in my home region of Brazil sprayed thirty-seven times: when the apples left the orchard and entered the store they were dipped in a bath of good strong fungicide, then, on the conveyor belt, they were dried and sprayed with wax. The fine wax cover will keep the fungicide in place. No fungus or bacteria will have a chance.

The person who designed the poster to induce people to buy those apples worked in a drawer of his own. He had never heard of pesticide toxicology, why should he? On the poster he shows a beautiful child eating a delicious looking apple, peel and all.

Weed Eradication

The weed is put into still another drawer. Weeds are plants that should not exist. They compete with our crops, for water, for fertilizer, for space, and they may harbour pests. Until such time as we put them on the list of extinct plants, we must fight them. Again, we have marvelous tools to hand to help us kill them—the weed killers, or herbicides which are efficient and easy to use, potent plant poisons. Some will kill everything that is green, others, depending on how they are applied, are more 'selective', they will kill some species while allowing others and especially the crop itself, to recover. Some are applied on naked soil to prevent weed seed from germinating, others kill grown plants on contact, either by killing off only those parts of the plant that they touch or by penetrating into it to kill it all. The 'defoliants' used to destroy millions of hectares of jungle in Vietnam and which are also being used in Amazonia are of the latter type.

In agriculture the aim is always to keep the soil under and between the

crop rows as naked as possible. Once a wheat field in Europe was something very beautiful to look at—an orgy of colours. Now, even along the roads and on the edges of the fields everything that flowers is sprayed away. A butterfly has become a rare sight indeed, and environmentalists have to buy up pieces of land to give natural herbs—among them all those medicinal herbs—a chance of survival.

Since, as we have seen in drawer one, the soil's function is to anchor the plants and convey soluble mineral nutrients to them, it does not really matter whether or not it is inhabited by living beings, such as by earthworms, arthropods and other animals, especially by colembola and protozoa, or by fungi, algae and bacteria. So we do not have to worry as to what our soluble fertilizers and all those downpours of poisons do to soil life. Since all those creatures are more of a bother than a discernible advantage, we might as well kill them off altogether.

I will never forget, while I was still in the pesticide business—I once received a technical paper from our research department recommending heptachlor, of all things, to eliminate earthworms. So well have some farmers been indoctrinated by now that I sometimes receive enquiries on how to kill off earthworms in orchards, ecologically, without poisons. I also remember reading papers put out by important German agricultural authorities insisting that humus is totally irrelevant for tropical agriculture; that it can all be done with chemical fertilizers. In fact, the ideal of modern agriculture seems to be hydroponics, that is, growing crops in an inert substrate bathed in a solution of soluble nutrients.

That is why, when we present a good compost or a mature biogas sludge to an agricultural laboratory, they give us a simple NPK-analysis. They do not even attempt to look into the extremely complex, and as yet mostly unknown, biochemistry of those living fertilizers in the humus that feed the life of the soil.

Let us look at the next drawer: the one that contains plant breeding. New crop varieties are selected by geneticists for maximum efficiency, that is, for maximum yield. What

really counts is so many more pounds per acre. Of course it is also important to select for good looks. The apple or potato must look attractive on the supermarket shelf.

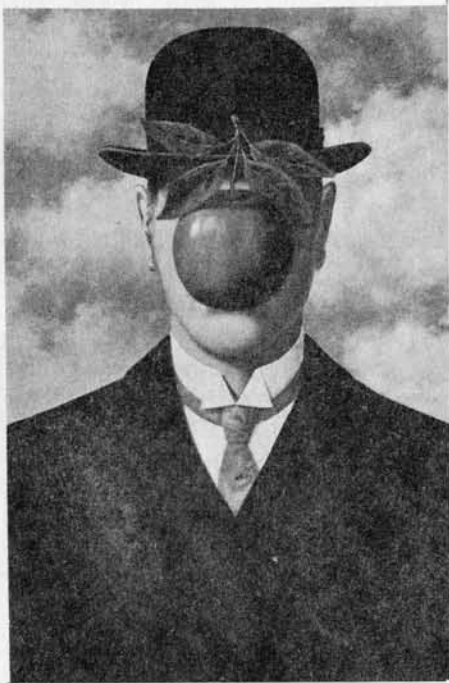
Resistance to pests must also be taken into account—apparently a cross link between this drawer and drawer two. But resistance to pests is seen only as genetically inherent to the variety itself. No attempt is made to see it in relation to the environment in which the plant will have to grow, except insofar as it relates to the environment of modern agriculture: dead soil, and plenty of chemistry.

Hence the reason why many of the giant pesticide corporations are buying up seed-producing companies and trying to monopolise the gene banks. They want to control breeding in such a way as to promote only varieties that give maximum response to their chemical inputs.

There are a few more drawers. But they are drawers modern agricultural workers hardly even think it worth-while looking into. Take the drawer ecology. Only when environmentalists make a fuss about all the dead birds and fish do they begin to look for a certain selectivity in effect, so as to kill pests without, apparently, killing other creatures. Under strong pressure they will pay lip service to 'integrated pest control', which means little other than using poisons only in emergencies, never preventively, such as in the 'spraying calendar' and then to spray at the correct time in the pest's life cycle, to minimise quantity of poison and number of applications. But since such restraint is not in the interest of turnover, it remains lip service. Recently, in the State of Sao Paulo, the poison pushers convinced the Ministry of Agriculture that it had to apply a certain insecticide on all cotton fields, from the air, on the stubble, after harvest—to 'eradicate' the boll weevil. We had to go to court to stop the action. But the Ministry had already bought the stuff, so no loss in business was involved for the poison brewers.

We might mention one more drawer—social justice. But this is not an area with which agronomists feel they should be concerned.

This brief somewhat oversimpli-



fied view is in essence the way modern agriculture sets out to overlook the relationship between pests and agricultural practices.

In many ways the paradigm is self-fulfilling inasmuch as when we pursue the kind of agricultural practices it advocates, we transform our farms in such a way as to make the paradigm come true. On most of our fields soils have become dead mechanical substrates and pests do act as if they were arbitrary enemies.

Counter-revolution—a new Perspective

A rapidly growing number—although nonetheless a minority—of farmers and workers in agriculture are beginning to see the process of agriculture from an altogether different perspective. They think not in reductionistic but in holistic terms. For them everything is connected to everything else.

They do not see the pest as an out and out enemy, neither do they want to exterminate it. The very thought that creatures deserve to be exterminated is abhorrent. For them, a process as old as organic evolution, more than three billion years old, cannot possibly produce organisms that are wrong in themselves, that should rather not exist.

If pests really were as displayed by the chemical industry in its well printed colourful folders and TV-ads no life would be left on this planet. What species of plant does not have its pests, some of which are millions,

or more than a hundred million years old. Every pest has had ample time to meet and exterminate all its hosts then dying out itself. On that premise life should have vanished from Earth.

Traditional peasants, with their ancestral wisdom, knew that pests only strike plants that are not quite healthy. Hence they strove to keep their crops healthy through proper soil management, including fallow, composting crop residues and manures, planting green manures, crop rotation, companion planting and other practices. Modern ecological farmers, with today's scientific knowledge, can do much better. Only rarely do they have to fight pests directly. Then they can resort to mild pesticides, such as rock powders, ashes, and herbal extracts.

A conventional agricultural expert confronted with an orange or peach tree covered with scales or aphids, or attacked by fungus dis-

The child eating his perfect looking apple has never heard of pesticide toxicology—why should he?

ease, looks up and tries to identify the pest species. Then he chooses what he considers to be the best and cheapest poison to free the tree from its attackers. The ecologically inclined expert, on the other hand, will look down as well as up. He will ask the farmer how he tilled his soil, whether he applied herbicides, what fertilizers were applied, what pesticides were sprayed. He will take up a slice of soil with a spade. The structure, or lack of structure and compactness he sees in the soil as well as the organisms, earth worms for instance he finds or does not find, the weeds he observes, all that will tell him much as to why pest attack occurred.

In the conventional view the factor most blamed for massive pest attack is monoculture. The argument being that, when confronted with massive and extensive stands of its host plant, the pest, whether it be animal, fungus, bacteria or virus, can really go on a spree and spread out, which it could not if its host plants were rare and interspersed

with other species on which the pest cannot thrive.

But monocultures do occur in nature too, though only under extreme environmental conditions. In a lake oversupplied with plant nutrient eutrophication ensues—one species of alga crowding out all others. Red tides are the same kind of phenomenon. In the arctic or on beach or desert ecosystems natural stands of one single plant species can sometimes be found. In some Brazilian salt marshes stands of one species of mangrove tree or fields of only one herb, *salicornia*, may be found growing. I have never been able to register serious pest attack in such ecosystems. Attack, when it occurs, is limited to a few marginal individuals. Some of them tens of thousands of hectares in one continuous piece. I know of only one pest—mistletoe, a hemiparasitic plant. On eucalyptus it occurs only on those trees that are planted on patches with a high underground water table when the varieties in question like deep, well drained soil. Neighbouring trees on adequately-drained ground are not attacked, even though birds deposit seed on them.

We also have equally large monocultures of Australian acacia for firewood and for the production of tannin for the leather industry. Here we have a very serious pest, a beautiful large beetle we call 'serrador'. The female, in the fashion of a beaver, fells trunks and cuts branches up to two inches thick, depositing her eggs on the dead wood. Sometimes a whole plantation is irreparably damaged. Here again it is interesting to observe that even though the beetle is present it attacks some plantations or parts of plantations without attacking others. I have been able to establish a correlation between heavy attack and soil type. Attack is heaviest on water-logged soils and on extremely poor sandy soils. On well-drained, fertile clay soils the beetle does not seem to like acacia. The lines that mark the limits of soil type within or between plantations also seem to be the lines that mark the limits of the areas attacked. If pest infestation was a question only of the beetle finding its host it would certainly not respect lines delimiting soil types.

The story must therefore be more complicated. Although monoculture is ecologically and socially undesirable, we can have healthy monocultures. What seems to be involved is something we might call a palatability factor. Sometimes a pest likes its host plant and sometimes it does not. The postulate of arbitrary enemy does not apply.

In more than thirty years of intensive observation of Nature (one of my superiors in the pesticide industry once contemptuously called me a 'nature lover')—I made innumerable observations of that type. As I write this, from my window I can see a colony of large, black caterpillars on a ficus tree in my back yard. They sleep at the base of the trunk during daytime, now, at dusk, they form an impressive caravan going up to feed. But they devour only the leaves on the smaller branches that have ceased growing because the canopy overhead cuts out sunshine. These are the branches that will die off anyway. It has been that way every season. Again, we have a preference for one type of foliage, on the same tree.

In addition, when we fight a pest with poison, for instance, scales on oranges with parathion, we often get an immediate proliferation of another pest—mites. We then have to use a miticide on top of the insecticide, it being said that mites are proliferating because parathion, being a 'broad spectrum' insecticide, has killed the natural enemies of the mites, leaving them free to proliferate. It is the old 'arbitrary enemy' postulate again. If the pest is not kept in check, whether by poison or predators, it will strike. Indeed the philosophy of biological control is often the same as that of chemical warfare.

But the proliferation of mites can also be triggered by modern carbamate fungicides, or by systemic insecticides. Such a phenomenon rules out elimination of predators as a cause. Furthermore, modern fungicides also often seem to promote precisely those fungi they are supposed to keep away. In our vineyards, when growers gave up the old fashioned, cheap copper and sulphur fungicides in favour of modern, expensive carbamates, they soon found themselves in a situation



A healthy crop? Or simply one that has received multiple spraying?

where they had to spray up to thirty times in one season. The more they spray, the more fungus attack they get. As if the fungicides really made the vines palatable to fungi. Now they are going for new, more potent and still more expensive poisons. Inevitably they will soon be in more serious trouble.

It is common knowledge in organic farming and gardening that pest attack has to do with the metabolic state of the plant. Susceptibility to pests, therefore, depends primarily on nutrition. Other factors, weed competition, positive or negative interactions with companion plants, and climatic conditions, also play a role. The conditions for plant health must be optimized for pest attack to be minimized. With proper soil management it is possible to have a pest-free crop even though it be surrounded by fields of the same crop infested with pests. For demonstration purposes one can easily prepare two potted plants, for instance tomato or potato, in such a way that one of them is attacked by aphids or blight, while the other one stays free of infestation. Even when foliage of the two plants is made to touch, the pest will not move from the infested to the uninfested one. But it is then simple enough to make the healthy plant become susceptible; all that has to be done is to give it an oversupply of water-soluble nitrogen fertilizer, especially ammonia fertilizer.

Natural Defence

What we do not know is what kind

of metabolic processes are involved. It is often supposed that healthy plants produce their own means of defence against pests; that they either take up from the soil or produce themselves substances antagonistic to pests—their own pesticides—or that they develop mechanical ways to defend themselves for instance through stronger cuticles.

Yet a Frenchman has now come up with an explanation that provides a plausible solution to all the above observations.

Francis Chaboussou, a researcher with INRA (Institut National de la Recherche Agronomique), in his book *Les plantes malades des pesticides—bases nouvelles d'une prévention contre maladies et parasites* (Plants made sick by Pesticides—a new basis for the prevention of diseases and pests, Debard, Paris, 1980), puts forward the theory of trophobiosis. Expressed succinctly his theory states that pests starve on healthy plants.

In essence Chaboussou claims that pests lack the enzymes to break up proteins into their constituent amino acids. That chemical process is a necessary step when one organism feeds on another; moreover foreign protein cannot be used as such since each organism must manufacture its specific proteins. Thus from the amino acids obtained through proteolysis, new proteins are synthesized in proteosynthesis. The process is like the demolition of a house to make a new one from its bricks. The theory would suggest that pests are pests, that is, they have no alternative but to parasitize plants, because of that deficiency. They must find an abundance of amino acids or they will starve.

Thus, according to Chaboussou, pests, whether they be insects, mites, nematodes, protozoans, fungi, bacteria or even virus will thrive only on plants with amebiotic imbalance that leads to abnormally high levels of amino acids. In a healthy plant those levels are low with proteosynthesis and proteolysis in balance. Indeed as soon as amino acids are formed they are used up to form proteins, or, when the plant is in repose, as in hibernation or aestivation, and proteosynthesis ceases, so does the production of amino acids. On such a plant

the blight fungus or a plant louse will simply die for lack of food; or his senses and instincts will tell the pest not to seek a plant in that condition.

But when does a plant have an excess of amino acids? Either when proteosynthesis is somehow held back or production of amino acids is too high, as can happen in old leaves from which nutrients are recycled to newer parts of the plant, and where proteolysis predominates over proteosynthesis.

For amino acid congestion to occur proteosynthesis inhibition need not be strong. The plant may still be growing vigorously. The situation can be likened to a three lane highway on which cars are cruising at seventy mph, but are suddenly confined to two lanes only. From there on cars resume travelling at seventy mph but behind, on the actual three-lane highway itself congestion builds up.

Chaboussou shows that many of the modern pesticides inhibit proteosynthesis. Even when not deliberately built into their composition, they are all to some extent systemic, thus penetrating the plant's system and circulating in the sap. Hence they all have some effect, positive or negative, on the plant's metabolism. Since most of them are biocides, negative effects should predominate. That may be the reason why, with increasing use of pesticides, we get increasing pest attack, and that not through the elimination of the natural predators of pests but through increasing crop plant vulnerability. Also, in many instances where we think the pest has become resistant to a pesticide, especially with fungi, the reason may be none other than increased sensitivity of the crop plant. That is why Chaboussou calls his book *Plants made sick by Pesticides!*

The rate of proteosynthesis depends, fundamentally, on a well-balanced nutrition. But, the way we feed our crops utilizing modern agricultural techniques and applying the methods derived from the reductionistic view, as explained above in terms of closed drawers, a plant is most unlikely to attain nutritional balance. We apply fertilizers according to empirical formulas based on an often meaningless soil analysis, in the form of concentrated soluble

salts, all at once, before or while sowing, all in the same narrow groove. Rarely do we split the application into two, the second one being a 'top dressing' or foliar spray, again of soluble salts. The plant cannot avoid bloating itself at one point and thirsting at another, when the soluble salts have been washed away, or getting too much of one element and too little of another. We do not even have to mention the problems of antagonism between the different mineral nutrients that come in to play when they are massively available.

Furthermore proteosynthesis seems to be very sensitive to deficiencies in micronutrients. But when we degrade soil structure through excessive mechanical aggression, erosion and loss of humus, and destroy soil life through chemical aggression and through eliminating food for soil life by renouncing crop rotation, composting, green manure, what can we expect? In a dead soil plants will always have difficulty taking up one or another or many of the micronutrients.

Business out of Disease

In the summer of 1982, after more than ten years' absence I revisited the vineyards of the Palatinate. I saw extensive areas where all the leaves were as yellow as sulphur, a condition known as chlorosis in which the plant is suffering an anaemia from difficulty in taking up iron. Yet there is no lack of iron in the soil. The difficulty arises from modern agricultural practices. Thus the vineyards have been highly mechanized, with the soils compacted from the weight of heavy machines, while higher doses of water-soluble fertilizers and almost continuous downpours of poison have killed off soil life. The chemical industry that caused the trouble in the first place had a ready solution—foliar application of an iron chelate! Instead of recanting it was out to make still more business for itself.

As for the increase in the production of amino acids, we have only to look at the heavy applications of soluble nitrogen fertilizers, especially those derived from ammonia, ammonium sulphate and urea. The effect is the same, whether the ammonia be synthetic or of natural origin. Ap-

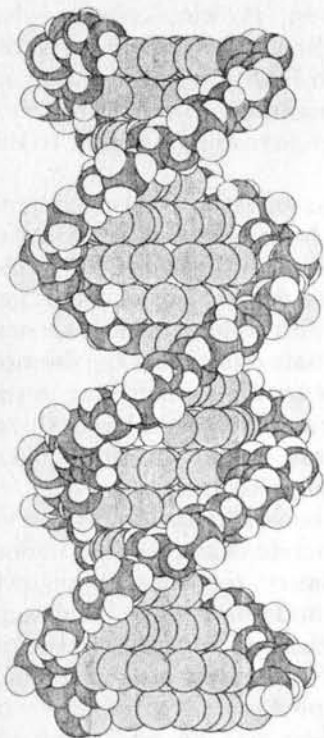
plying fresh, uncomposted chicken manure on growing plants also causes almost immediate pest attack. The high nitrogen content in chicken manure is in the form of uric acid which is readily available to the plant.

Chaboussou's theory also explains why, on the same plant, some leaves are attacked, others not. The old leaves on a cucumber plant, that get covered with mildew while the new leaves remain clear, are being drained of their nutrients for recycling to the new leaves. Proteosynthesis therefore almost ceases on those older leaves and proteolysis takes over.

In his book Chaboussou gives us many concrete examples that underpin his theory, reporting on his own research and observations over several decades and interpreting the research of others. He cites a copious bibliography; moreover his theory of trophobiosis has an added advantage, it can be easily tested in the field and checked in the laboratory. Why therefore is he simply being ignored? If he is wrong, it would be no problem to refute him. But if he is right, even if only partially, then we could be faced with a serious revolution in agronomy: which while a hard blow to modern conventional agricultural practices, especially for agri-chemical business, would be liberation for the farmer and an important contribution to the environment.

Fortunately, in my home region, in southern Brazil, we are now witnessing a reversal of trends in agriculture. A majority of our agronomists and hundreds of farmers have obtained a new level of awareness, and are convinced that the conventional ways are doomed. That new awareness is beginning to penetrate officialdom. Research and its application are beginning to take us away from the old narrow view; new horizons are looming.

José Lutzenberger is an agronomist and engineer who spent a number of years working for the large agrochemical company BASF, but who quit his job and began a vigorous and successful campaign against the activities of the agrochemical industry. In his own state of Porto Alegre in Brazil he managed to get 70 per cent reduction in the use of pesticides and herbicides and in 1978 was elected agronomist of the year by his fellow agronomists. He runs his own soft-technology landscaping company and is President of AGAPAN, the State association for the protection of the natural environment.



Molecular Biology: A Scientific Critique

by A. Sibatani

As a scientist working in the field of molecular biology, around 1969, when the student revolt had just passed its peak, I began to reappraise science as practised by myself as well as by society at large. During the several years that followed I published two books (written in Japanese) on this subject, one addressed mainly to fellow scientists, the other written for the general public.^{1,2} Both are still selling in Japan after repeated impressions. I have made some attempts to get an English edition of the second book published², but unsuccessfully, mainly because of the difficulty of finding a willing publisher.

The substance of my critique of science may be summarised as follows: science (and technology) convert social and political problems into ones of scientific expertise, thus making them inaccessible to the general public. As a result, ordinary people are deprived of the ability to design their own lifestyle and to control the factors which affect their living conditions. Instead science has become a means of political control of society and hence of manipulation of people.

My thesis, along with the critical activity of other writers, was well received in Japan, with the result that a critique of science became firmly entrenched within Japanese society. However, some Japanese scientists initially attacked my effort, although their criticism largely failed to come to grips with the problems I posed and was logically defective. In the end, my opponents simply chose to ignore my critique. At the same time, I have to admit that despite my critique having contributed to the clarification of the nature of science and technology for those who are already committed to questioning the universal validity of science, it has almost totally failed to persuade scientists with preformed ideas, already firmly committed to their scientific or technological careers and the scientific/technological ethos.

I therefore turned to a new task of criticising

science, not from outside, hence in the general context of human existence and struggle for liberation with a social and political overtone as I had done in my two books, but by using scientific logic and evidence acceptable to the scientific community.

I then realised that I wanted to write on this subject in English and therefore set out to publish articles in reputable, specialist scientific journals rather than popular or radical ones, having greater success on that score than I had with the Japanese counterparts. However, some radical Japanese critics were concerned with my attitude, fearing that the use of scientific logic for a critique of science would be interpreted to mean that scientific logic was, after all, adequate and acceptable for our critical thought. Nevertheless I was aware that the critique might also alienate the general public owing to the esoteric scientific arguments necessary in such a venture. Yet, in my opinion the use of scientific logic in formulating a critique of science does not necessarily mean that the former is appropriate in wider contexts. It is simply used as a means of persuading scientists that there are logical flaws and inconsistencies in what is practised in science, which necessitate a reappraisal of science from within. Whether this praxis of mine will ultimately prove successful remains to be seen. However, I feel that my effort in this regard is getting some tangible response from the scientific community in the West—much more so than in Japan. That difference suggests a certain peculiarity of Japanese science and technology and will form a basis for my further critique of science in its social and political context.

What follows is a revised version of my critique of molecular biology which I first published in 1981 as one of three articles on this subject. In that article I talked of the 'first coming' of molecular biology; I now hope that I can give a better perspective as to what its 'second coming' may be about.^{3, 4, 5}

Very soon after its inception, following the discovery of the double helix, molecular biology came to its golden age during the decade 1953-1963, and in quick succession saw proposals for the central dogma, the operon and allosteric hypotheses, culminating in the cracking of the genetic code.⁶

The rise of molecular biology was certainly anticipated by the participants; but it was also, in a sense, unexpected in that the triumph came so quickly and proved to be so utterly decisive. The most impressive aspect of its success was the fact that the major discoveries of this golden era were first made in the form of comprehensive theories which only later received experimental verification. It certainly was not a case of grand inductive generalisations following a slow-and-steady collection of data on every detail of the subject, as is usually assumed to be the case in the progress of science.

The promise of victory was first clearly felt in 1960 among the direct participants—members of the 'thought-collective' as Gunther Stent⁷ called them. Around this time, the concept of messenger RNA, first proposed as a hypothesis, was quickly confirmed by experiment. That fulfilment followed the latest experimental confirmation of the semi-conservative replication of DNA and the adaptor hypothesis for protein synthesis in the form of identification of transfer RNA. In the atmosphere of the period particular stress was put on the importance of theories and of using the proper method of analysis in coming to grips with the secret of life. Thus, the complexity of higher organisms compared to the relatively simple organisation of bacteriophages and *Escherichia coli* appeared only of secondary significance, in the light of the amazing uniformity of terrestrial life revealed for the first time at the molecular level. Accordingly, when Monod said shortly afterwards that what was true for *E. coli* would also be true for the elephant,⁸ such a claim was widely and easily accepted.

However, people soon wanted more from molecular biology and following the previous example of physics⁹, started to claim that, even

in biology, experimental findings were meaningful only when they found their place within the context of proper theories. It was thus hoped that through a dramatic conversion the whole of biology might be brought into a more theoretically articulated science. Indeed if the methods that had proved so eminently successful in solving the enigma of heredity could be applied in a concerted attack on the remaining outstanding problems in biology, then perhaps they too would be solved.

Thus, many of those actively involved in the rise of molecular biology—which was virtually a disentangling of the complex genetic machinery possessed by bacteriophages and *E. coli* and better called, I think, biodeciphering rather than molecular biology—decided to shift to new fields: cancer research, cell biology, developmental biology, neurobiology and the origin of life. They were probably prompted to do so by the previously successful migration of scientists from physics to biology. However, the actual achievement resulting from this new wave of conversion has fallen far short of the expectation of the participants and of their observers alike. Even worse, the whole venture has proved to be doubly premature.

DNA—still mysterious

First, the continuation of biodeciphering or molecular genetics—even with prokaryotes, and *a fortiori* in the more elaborate eukaryotes—has turned out to be much more complicated and difficult than anticipated. True enough, many new and exciting discoveries have been made by those whom we might call the second generation molecular biologists, after the original founders of the field had mostly left the scene: DNA repair; repeated sequences of DNA; reverse transcription; RNA-primed DNA replication in small fragments; phenotypic modification of DNA including amplification and splicing (switching); transposable elements of DNA; multiple reading frames for DNA; interrupted gene/RNA splicing; and non-universal genetic codes. However, most of these findings were not predicted by pre-existing theories, or alternatively the occasional right

predictions (such as those made by Howard Temin or Barbara McClintock) were almost totally ignored in the mainstream of 'molecular biology'. This was very different from the events and the major discoveries made during the golden age of molecular biology. Worse still, the real significance of some of those later discoveries such as repeated and/or intervening sequences of DNA, has remained elusive, even until today. Moreover, according to the proclaimed criterion of molecular biology, such experimental observations should be regarded as meaningless, since they have not been made within a proper theoretical framework. Thus, the real tradition of molecular biology has not been maintained. Rather, the methodology that was followed during the initial phase of molecular biology has simply collapsed.

Second, those who moved out of biodeciphering have also failed to score a success comparable to that which they had previously achieved. True enough, most of them have contributed a great deal to their new fields, but the overall results have not been as impressive or outstanding as before: only as good as in any other field of biology or science in general. Fred Sanger alone, staying within orthodox biochemistry, rather than shifting to molecular biology, and making only a switch from protein to DNA, has brilliantly succeeded twice.

In short, the golden age of molecular biology turned out to be evanescent, its development and elaboration falling far short of the expectations held out for it, both within the conventional discipline and in its wider exploitation. Worse still, that failure of molecular biology has not yet been honestly acknowledged by those who, having participated in its foundation, have attempted to use its generalities in other areas.

Thus, a realistic assessment of the recent events in molecular biology must be one of failure rather than of success. One may summarise by saying that molecular biology has succeeded in its *special*, or *elementary theory*, but so far has failed in its *general theory*. Yet it was a general theory that the molecular biologists optimistically promised at the outset of their attempted expan-

sion of molecular biology, towards the end of its brief golden age.

If the foregoing analysis is accepted, the very concept of molecular biology needs reappraisal. First, if we define molecular biology as whatever interests molecular biologists¹⁰, or whatever molecular biologists do⁴, we have to find the right definition for molecular biologists. In fact, I believe that during those early days of molecular biology one became a molecular biologist by self-appointment. Those who chose to join the then minority group and to call themselves molecular biologists were, by that very action, molecular biologists.

In that sense, as I have said, the original molecular biologists were members of a 'thought-collective', and molecular biology was characterised by a particular working style or methodology rather than by a particular area of subject matter. Thus, a considerable portion of the typical experimental work done by molecular biologists actually avoided the molecular level. Nevertheless, such scientists *thought* freely about what happened at the molecular level. It had to be like that, for only then could they escape the criticism that when molecules were examined life itself was missed; for that which one wished to examine—'life'—was thereby destroyed. In a way, it can be compared to work on brains which does not necessitate actually getting into the brain of the animal, or the human being and so damaging it. That kind of 'indirect' approach is essential to the 'thought-style' of molecular biologists, and in this respect at least a molecular biologist can remain a molecular biologist even after moving to a new field. But, and this point I would wish to stress, molecular biologists of the first generation did not work at the molecular level. Hence, the methodology of molecular biology could not be defined in terms of the ontic level with which it was concerned.

Nevertheless, the justification of molecular biology upon its 'first coming' was readily justified *a posteriori*, in that enquiries made in molecular biology, actually followed and respected the correct order in the hierarchical machinery of life. Thus even though life might be a

mystery, there was no mystery about molecules. Hence, as is often claimed, we can understand biomolecules without intervening in the unknowns of life. And having done that, we can then gradually ascend the ladder of hierarchical structure to understand more and more of the underlying complex processes. That appeared to represent the right strategy.

"The essential logic of heredity at the molecular level was first understood without knowing any detail of its molecular mechanism."

The trouble with such a notion is that the history of molecular biology does not support this rationale. Molecular biology's success did *not* depend upon such a strategy. In fact, the essential logic of heredity at the molecular level was first understood *without knowing any detail of its molecular mechanism*. Moreover the actual molecular level turned out to be very complicated, so much so that it would probably have been impossible to understand it had one tried literally to work from the molecular level upwards. The essential could not have been distinguished from the non-essential. It should be enough to remind ourselves of the riot of various natural L-amino acids that biochemists knew by the mid-fifties; while still failing to grasp the concept of only twenty amino acids being involved in protein synthesis. On the other hand, Francis Crick, a physicist by training, who had never worked directly on those compounds, was able by one stroke to deduce the existence of a set of universal amino acids and moreover to guess the right set which made up the magic twenty.

How was that done? What Crick did through discussions with James Watson was to approach the problem with a new idea.⁶ Together they envisaged protein synthesis not as a biochemical process of forming a new chemical or peptide bond through catalysis by enzymes, but as determining a sequence of ele-

mentary units, quite limited in number, which formed a biologically rather than chemically meaningful set of universal amino acids active in protein synthesis in all terrestrial organisms. Crick thus chose likely members of the set, theoretically and intuitively, excluding hydroxyproline found in collagen for its not being ubiquitous in proteins, as well as norleucine, homocysteine and ornithine, but including glutamine and asparagine as separate entities besides glutamic and aspartic acids—an admirable insight which turned out to be entirely correct. Hence they derived a round number of twenty universal amino acids.

As another example, the concept of triplet genetic code was not worked out from the molecular level. That would have involved knowing first the base sequences of the messenger RNAs and the amino acid sequences of the proteins coded by them, and finding out the regularity in correspondence between them. Without knowing the triplet rule that would have been exceedingly difficult to do, if not impossible. Although the detailed deciphering of DNA sequences is now being done in exactly that way, it was *not* the route that Crick himself¹¹ used to establish the concept and work out the nature of the genetic code. He rather utilised the approach of the original 'thought-collective' of molecular biology.

What was actually done was to conceive of four nucleotides making up a nucleic acid and then to discern that different sequences of two of the four nucleotides were not enough to specify the twenty amino acids. The logic then demanded that a certain set of twenty (and later more) out of the sixty-four possible triplet nucleotide sequences acted as ciphers for twenty amino acids, and it was on those lines that Crick explored the theoretical possibilities and implications. Experiments to prove that the genetic 'code' of amino acids was actually in the form of nucleotide triplets (or their multiples), and to assign individual triplets to each of the twenty amino acids, only followed such theoretical consideration. Hence the whole manoeuvre was anything but a groping in the dark.

What was important in this achievement was that from the moment that Crick and his colleagues had conceived of the notion of the 'magic twenty' amino acids, any amino acids, alanine for example, among the twenty would no longer be just another organic chemical, but instead a biologically meaningful entity, integrated into biological organisation or 'structure'. Such a strong assertion is not one that can be simply derived from the amino acid's physical-chemical nature. When the genetic code was elucidated, and even after it was actually cracked experimentally, the question of the code's origin remained elusive and unclear. Nor has the whole question been finally resolved. Hence the genetic code is not a chemical attribute of amino acids but inherently a concept of biological 'structure', the word structure being used here in its broadest sense.

Scientific Overview

As a consequence, the concept of genetic code, at the moment the leading principle of molecular biology, was *not* obtained by considering the molecular properties of amino acids. It was reached not from 'below' but grasped from 'above' in the hierarchy of biological concepts.¹² It was therefore not a symbol of scientific reductionism, but the reverse. A simple chemical was elevated to a part of biologically functional 'structure'. Moreover it remains a rare example of a process in which the biologically deep-seated 'structure' (usually remaining quite invisible) has been grasped through profound scientific insight. But I suspect that even Crick himself did not appreciate the full meaning of his success—for the achievement was not of a reductionist but of a structuralist approach. This point has not been well recognised, so much so that the concept and operation of molecular biology falsely has become symbolic of reductionism¹³ and a good chance of appreciating a structuralist¹⁴ approach has thereby been lost.

Hence it is a mistake and fallacy to try to correlate the success of molecular biology with a rigidly defined analytical, or even naively reductionist, method of trying to

work on everything alive from the molecular level upwards. Rather, it is my view that molecular biology should be specified in terms of its *personal* work style (see refs 4 and 6 for further detail) and of its social characteristics, rather than of the level of its subject matter in some ontological hierarchy.

Hence it looks as if what we are now observing is not really the anticipated 'second coming' of molecular biology. Although the techniques of genetic engineering and DNA sequencing have apparently removed the barrier which hindered the 'molecular biologists' of the second generation in their attack on eukaryote systems with the disclosure of many surprising facts such as: the spatial arrangement of the genes, including interrupted genes and controlling elements outside and inside the controlled genetic elements; multigene families and the ubiquity of mobile genetic elements; non-uniformity of the genetic code; and somatic switching of DNA in immunoglobulin genes; oncogenes and retroviruses; the truth is that significant and highly stimulating as these discoveries may be, they are not as successful in penetrating the depths of the theory of life as the products of the special theory of molecular biology. On the contrary these new discoveries are now, for the first time, breaking up the Mendelian and Darwinian orthodoxies of heredity and evolution in animals and plants. Yet this recent unexpected development has been obtained by orthodox methods and the orthodox thinking characteristic of biochemistry. The substance of the findings was surprising, but not the procedures by which they were found. Indeed these discoveries could have been, and often actually were, duplicated by different groups, and therefore they have less personal flavour attached to them. Hence there is greater competitive pressure among scientists. On the other hand, despite the very strong sense of competition held by the young Jim Watson¹⁵, the discovery of the double helix may be regarded as highly personal in its completeness at one stroke, instead of a series of piecemeal discoveries made by many participants over a number of years.

In this sense, the thread of molecular biology was terminated by the completion of its special theory for prokaryotes. When, if ever, it will be resumed is still unknown to us. We may believe in the 'second coming' of molecular biology with its general theory; but it may be a millennium before it arrives, because, like the 'first coming', it may depend on the existence of some similar 'thought-collective' personalities. And there are no rules for this personality game. But remember, it will have to involve more than a handful of strong but nevertheless compatible personalities. Molecular biology may recur, but then it may be in the guise of an entirely different personal style, in which case (if we may pursue this theological conceit) the 'second coming' may not be readily recognised. Rather, people may turn away from it because of its drastically novel and 'unpalatable' personal style. In this sense, the above analysis supports, in principle, the theses of Thomas Kuhn and Paul Feyerabend. Kuhn¹⁶ claimed that a scientific revolution occurs through what he called the 'paradigm change', little communication taking place between the upholders of the old and new paradigms. Feyerabend¹⁷ tells us that 'anything goes' in science, even unwarranted logic or outright fallacy, there being no fixed methodology for success in science.

"Science is often fiction or a fairy tale, remote from the real world. While it is a privilege to be a scientist, it does not entitle the scientist to forget the real world."

It is sobering to note that the 'thought-collective' which constituted the 'first coming' of molecular biology failed to grasp the reality about its subject and had a 'premature'¹⁸ illusion of the imminence of the 'second coming' in the general theory of molecular biology. It is also sobering to note that such an extraordinary group of people in science could be so mistaken. But after all, scientists can err freely

(hence we talk of science's 'objectivity' or falsification or whatever). One can only start again in science. If a religious leader admitted his/her error, it would be the end of the religion. But in a real world and in real life we may not be so free to be wrong—there may be consequences in mistakes. In a way, then, science is often fiction or a fairy tale¹⁵, being so remote from the real world. It is therefore a privilege to be a scientist, but that does not entitle the scientist to forget the real world.

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Nuclear Power— up and down like a yoyo

The economists, father and daughter Richard and Caroline Hellman, recently published *The Competitive Economics of Coal and Nuclear Power*. (Lexington). The Hellmans' pioneering work is based on an analysis of what they call the Yoyo Factor, or the inability of a nuclear plant to produce electricity reliably. *Critical Mass Energy Bulletin* editor Jan Pilarski spoke recently with Caroline Hellman, research assistant professor at the University of Rhode Island and a doctoral candidate at Harvard, about her's and her father's findings.

JP: What are some of the more significant factors affecting nuclear power's failure in the marketplace?

Hellman: The technology was prematurely rushed into mass commercialization. The nuclear industry and the government built this very novel and complex technology without going through the usual steps one goes through in dealing with a new technology. Plants were scaled up very quickly and the technology was not sufficiently refined for the scale of the industry at this point—scale in terms of size and quantity of units.

Let's look at it another way. When comparing the costs of nuclear and coal, you're looking at lifetime average cost, or mills per kilowatt-hour. In any average you have a numerator, which is the total cost, and a denominator, which is the units of output you're dividing over. And nuclear has problems at both levels. In terms of the numerator, the problems with the technology have substantially increased total costs beyond original projections. Factors affecting the total cost of nuclear power include capital costs, which are way beyond original projections, total operating and maintenance costs, waste disposal costs, and decommissioning costs. The biggest question mark in nuclear economics is waste disposal and decommissioning costs. We don't even have reliable estimates of these factors and to the extent we have estimates, they're growing all the time.

In terms of the denominator, the problems with the technology have resulted in a much lower output than predicted and therefore you're dividing a larger total cost over fewer kilowatt-hours. With the denominator, you're mainly talking about capacity factor, or the ratio of actual to potential output. Nuclear plants were designed to run at an 80 per cent capacity factor or better, and the industry is now running at about 55 per cent.

JP: What accounts for the gap between the design and performance of nuclear plants?

Hellman: Again, I would attribute it to the fact that the technology was rushed and we just didn't have enough experience with it. Problems have cropped up that weren't expected, like embrittlement and steam generator tube leaks. The technology is very sensitive and there's a lot of automatic scrambling, which shuts a plant down completely. We call this the yoyo factor because if you look at a chart of the operations of a nuclear unit it goes up and down like a yoyo. This is specific to nuclear power. Coal or fossil fuel plants do not have automatic scrambling mechanisms. When a nuclear plant scrams at its peak, as is often the case, utilities have to purchase stress replacement power. So the gap is really attributable to scaling up the plants too quickly and the problems that have resulted because of that.

Secondly, the people who are building and operating nuclear units are just not as well-trained as they should be and aren't careful to insure that plants are being operated properly. The building and managing and operating of nuclear plants is just not being done as well as is needed. But even if you have the best management, the technology simply has some problems.

JP: Has the nuclear industry exhibited learning during its years of operating nuclear plants?

Hellman: In our study, we decided to give the nuclear industry every benefit of the doubt in our comparisons of plant performance over time. The prognosis for nuclear power is very much a function of whether plants improve over time, because the industry insisted that it was on its learning curve and was going to get better if given the chance. We acknowledged that the prognosis would be better if a positive trend could be demonstrated. What we did was examine what most observers would consider to be optimal conditions for learning. That is, units operated by the same utility that are the same size and in some cases on the same site, but built at different times. So in other words, if you had anywhere from a two to three to four or five year learning period before the second unit came on line, you would expect the younger unit to do better, because that's the idea of learning. In our study we did 163 comparisons of 40 pairs of younger and older units. Each pair was compared on four different learning criteria, such as whether there was an improvement in capacity factor from the older to the younger units.

The results were amazing. Out of the 163 comparisons, performance improved significantly in 39 per cent of the comparisons, showed no improvement in 23 per cent and showed a significant deterioration in 38 per cent of the comparisons. In fact, the only learning criteria where some true improvement from older to younger units showed up was in the first twelve months' capacity factor. Utilities are somehow taking advan-

tage of plant operating experience in the first twelve months, but after that they completely lose it—and not only lose it, but do worse with the newer unit. That's one of the reasons our prognosis for nuclear power is not optimistic, because we don't see signs that the industry is improving.

JP: The yoyo factor is a new analysis, taking capacity factor one step further. What is its economic impact and how can it be used to judge a plant's performance?

Hellman: The yoyo factor is related to capacity factor but goes beyond it. If you charted a plant's operation over time and put output on the vertical axis and time on the horizontal axis, your graph would be a nice plateau for a while and then it would plummet down, because of automatic scrambling and other reasons for shutting down a unit. Because of the sensitivity of the technology, many times over the course of a year a plant's capacity factor will zoom down, because it's built into the mechanism.

You don't have this phenomenon with a coal unit. You can bring down a coal unit partially and rarely have to bring it down completely on an emergency basis. You can decrease a coal plant's output or you can plan to bring it down next week, next month, or whenever necessary. It's not such a sensitive, dangerous technology in the sense that nuclear is and doesn't require built-in automatic mechanisms.

The capacity factor tells you overall how much output you got out of the unit compared to what you should have received. The yoyo factor really brings in the idea of reliability. Because nuclear plants are built as baseload units, they had better be pretty darn reliable.

You could have a 60 per cent capacity factor and if it's reliable, it's a totally different animal from an unreliable 60 per cent capacity factor. By that I mean with a reliable plant, the operator controls when the unit is brought down. But by and large, with nuclear power, you have uncontrolled availability. When a unit scrams, it scrams. That's an automatic mechanism and it happens all the time.

Reliability is the key to the yoyo factor. Again, you could have the same capacity factor but if you have a bad yoyo factor, it's a totally different situation from a reliable 60 per cent and that's just what's been happening with nuclear plants. They've been going down at totally unexpected times at primary and secondary peaks. Now what are the consequences of that? You have to get replacement power, which because it's unplanned must be purchased at very high prices. And replacement power costs are hardly ever put into analyses of the cost of nuclear power.

A new conclusion which we present in our recent book is that with nuclear power, you need a lot of excess capacity because you need back-up units—more back-up units than are needed for a coal plant. So operators of nuclear plants are hit in two ways, because they need to prepare for occasions where they'll need either extra capacity or stress replacement power.

Three Mile Island is a perfect example of this. Its replacement power costs increased 273 per cent in the year of the accident. In the country as a whole replacement costs went up maybe 13 per cent. Once the operators realized that they had a predictable shutdown, they made long-term contracts that brought the price of power way down.

Similarly, don't forget that a plant doesn't have to be operating in order for it to require replacement power. Units that were supposed to come on-line at a certain date and whose construction was delayed are requiring replacement power. That may not be quite as distressed a situation as when the units are already operating, but that is still really a cost attributable to operating a nuclear unit. If a plant is delayed a year, then the power you have to buy to make up for that unit is really a cost of the nuclear unit.

The yoyo factor is extremely important and again, it's only a phenomenon that's come up with nuclear power—it's all a function of this technology. It's simply not a problem with fossil fuel plants.

JP: What did you discover when you compared the cost of nuclear and coal plants?

Hellman: Our economic analysis is basically a large-scale sensitivity analysis. As our basis, we used four cost studies that were the best available done by people who if anything would be biased in favour of nuclear power. The four studies were done by the U.S. Economic Research and Development Agency, the Department of Energy, the Nuclear Regulatory Commission, and Exxon. Our analysis changed some assumptions that were incorrect and left the numbers otherwise intact. We corrected the capacity factors, which in most of the studies were much too high for nuclear and too low for coal. We corrected economic life, which for nuclear was generally too high. We corrected operating and maintenance costs in most of the studies. Then we listed a number of factors, which if quantifiable, would have further increased nuclear's cost.

We found that coal basically ran at half the cost of nuclear, and that includes flue-gas desulphurization. The basic relationship holds for high and low sulphur coal.

JP: Does your analysis take into account the social risks of using coal?

Hellman: Social costs are a very tricky thing and we certainly realize that there are social costs with coal. But then, there are also lots of social costs with nuclear. We feel our basic cost ratios of nuclear to coal are valid for at least the next twenty years, and that includes the cost of flue-gas desulphurization, the basic technology at this point for controlling acid rain. Even the most drastic estimates for coal's social costs wouldn't change the basic relationship between nuclear and coal, because there are all sorts of things we haven't included for nuclear which we are even more certain about—we just don't know how big the costs are. Nuclear is so much more expensive that you could do a lot of cleaning up of coal and still be way ahead.

JP: Doesn't coal also have scaling problems like nuclear power?

Hellman: There definitely were some scaling problems with coal. The large units have had some problems. With nuclear, however, you're dealing with a totally different phenomenon. You're dealing with a tech-

nology that was commercialized before people really understood what they were dealing with. With coal there have been problems, but again, the technology of a fossil fuel unit is more readily understandable. Our state of knowledge is much more closely in line with what we're building.

But in terms of nuclear, rapid scaling is a much more major factor. It's just astonishing that between 1962 and 1967, the size of units ordered went up from 285 megawatts (the largest unit then operating) to 1170 megawatts. The industry didn't even have a 550-megawatt unit operating. Utilities did have medium-sized units that were under construction but none that were operating. In other words, the proper approach to building a novel technology like nuclear power would be to build a 285-megawatt unit, try that for a while, move up to a 500-megawatt unit and observe its operation, then try 750- and 900-megawatt plants and then build a 1170-megawatt plant. But the 1170 megawatt units were on the drawing boards being designed and ready for construction when we had only had experience with a 285 megawatt unit. That's the crux of the problem. That's the design/performance gap, that's the technological risk, that's the scaling problem.

JP: What about the industry's charge that the cost of nuclear power is so excessive because of licensing regulations?

Hellman: We think they're confusing cause and effect. To be sure, there are some inefficient regulations. There always are. We're not saying regulation is perfect and wonderful, not causing any unnecessary costs. The bulk of the problem is that the technology of nuclear power is just not performing up to par, and because of that the regulations are having to respond to those problems. The Three Mile Island accident has resulted in huge numbers of recommendations for changing regulations and the implementation of some of these suggestions. That is the direct response to an industry problem. The industry likes to hide its head in that. There is

some inefficiency, but regulation *per se* is not the problem. I think the industry has absolutely got the causality reversed. You have a Three Mile Island, a Diablo Canyon, a Shoreham, a Zimmer—I could go on and on. The regulations are responding to the failures of the industry.

JP: What about utilities pointing to the Japanese example of streamlining the licensing and construction process so a reactor can come on-line in six years, or the example of St. Lucie, built in Florida in six years?

Hellman: Japan's experience with nuclear power has been a total and unmitigated disaster. I think it's ironic when the industry brings up Japan. Japan has horrible capacity factors and can't even run their units as well as ours, and they certainly aren't a technologically unsophisticated country. Japan has certain political reasons why it might be pursuing a nuclear power programme, but from a technological standpoint nuclear power is not doing well in Japan.

As for St. Lucie, I think there are exceptions. But it's less than terrific reasoning for the industry to argue from a single plant. Their arguments are not appropriate because we're talking about ordering a new unit today. And secondly, we're looking at the industry as a whole. Our numbers are for the whole industry and not for an individual isolated unit that may be at the end of a distribution.

It's also instructive to look more closely at the plants the industry holds up as exceptions. We did an article recently for the *Wall Street Journal* which said nuclear power was not doing well as evidenced by its low capacity factors. Commonwealth Edison, the nation's largest nuclear utility came back and replied that our numbers did not square with its experience. The utility was in fact wrong. Our numbers exactly described the situation at Commonwealth Edison. For example, Commonwealth Edison argued that some of their units were operating at 80 per cent capacity factor or better. We actually went in and looked at the data for Comm Ed's large nuclear units and went back at least three to five years and there were one or two situations where one

year a unit operated at 80 per cent capacity. In fact, I think it was only one—Quad Cities 1—which in 1981 did have a capacity factor as high as 82 per cent, but the utility didn't refuel that year, which is contrary to general practice. On the other hand, the capacity factors for 1980 and 1982 were terrible, 47 per cent in 1980 and 45 per cent in 1982. There are exceptions like a St. Lucie or at Quad Cities, but sometimes if you look deeper, you find out that things are not as exceptional as they appear.

JP: What are the policy implications of your work?

Hellman: We think the country should sit down and take a hard look at what the future of nuclear is and work very hard to develop alternatives to coal and to nuclear. Glib answers won't do—the nuclear power situation is a big mess, one of the biggest financial messes we've ever been in, a big technological mess, and a big public policy mess. And I think we need a committee of people representing different interests to think about this very carefully.

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Damning Dams

LONG-DISTANCE WATER TRANSFER, A Chinese Case Study and International Experiences. Edited by: Asit K Biswas, Zuo Dakang, James E Nickum, Liu Changming. Tycooly International Publishing Ltd. Softcover £25.25, Hardback £42.00

This book is the outcome of a study, conducted by Asit Biswas and an international team of experts, of China's ambitious plan to transfer water from the Chiang Jiang River over some 800 kilometres to plains of Northern China. The study was conducted in conjunction with Academia Sinica and various Chinese water management agencies. It is, undoubtedly, the most serious and comprehensive publication yet to have appeared on the subject of large-scale water development schemes and their social and ecological implications. The main editor is Asit K Biswas, one of the leading authorities in the field.

The book is made up of an interesting foreword and introduction, both written by Biswas, which are then followed by 28 chapters, each by a different specialist—most of them Chinese but also some Americans—on different aspects of the problem. Some of those specialists are academics, others members of the Chinese state bureaucracy.

Irrigation: the International Experience

In Asit Biswas's foreword, we learn the actual extent of the World Bank's involvement in large water development schemes. Significantly, the very first loan made by the World Bank to a developing country—Chile, in March 1948—was for an irrigation and hydro-power scheme. From then, until June 1982, the Bank lent US \$26.7 billion for agricultural projects, of which \$10 billion went specifically to finance no fewer than 285 irrigation projects. The total cost of those projects was probably 2.5

times the amount obtained from the World Bank.

About 38 per cent of the money advanced by the Bank for agricultural projects worldwide has been for irrigation which represents 10 per cent of all the money lent by the bank. The rate at which those loans is increasing can be gauged from the fact that 90 per cent of all lending for agricultural projects has occurred during the last ten years.

Biswas provides other interesting statistics. According to him, the total amount of irrigated area in the developing world is in the order of 160 million hectares. The future growth rate, however, is likely to fall considerably—both because the most desirable sites will soon be developed, and also because the very high cost of irrigating land (which can range from \$2,000 to \$10,000 per hectare) militates against further development.

There is much talk in official and academic circles of plans to expand irrigated agriculture at the rate of 2.9 per cent per annum. Biswas considers that it would be more realistic to suppose that the increase would be of the order of 1.7 per cent in the next decades—not fast enough, he says, "to substantially alleviate world hunger". He also points out that, in many countries, irrigation schemes have not produced their anticipated benefits and refers to the April 1980 reports by the Club du Sahel entitled *The Development of Irrigated Agriculture in the Sahel*. The report paints "a very depressing picture; investment costs per hectare are apparently always more than \$5,000 and can reach \$15,000 and even \$20,000. They also require continuous and expensive maintenance. Without maintenance they deteriorate rapidly and their rehabilitation is even more costly than their maintenance."

What is more, the anticipated high yields and the promise of double annual cropping have not materialised. Although experts insisted that yields would reach 5-6 tons per hectare, the actual yields have varied between 1.7 and 2.6 tons. Moreover, many developed areas are, for various reasons, not being farmed, a lot of land having actually been taken out of production—presumably because of salinisation, though Biswas does not say so. To quote the Club du Sahel: "Generally speaking, during the past few years, the development of new areas has barely surpassed the surface of older ones which had to be abandoned." If this is so, then water development projects in the Sahel are clearly exacerbating food shortages in the region.

Biswas tells us that the experience in Asia may be more encouraging—though perhaps not that much more so. The main problem seems to be water-management. He points out

that 50 per cent of the world's irrigated land has, on the admission of FAO, become saline. He also notes that a 1981 study of 30 irrigation projects financed by the World Bank in 15 countries, concluded: "Overall, water management . . . was found to have received inadequate attention. Insufficient provisions for the systems' operations and maintenance were made at appraisal; insufficient action was taken during implementation. Analysis of water management issues in completion and audit reports—as well as in the appraisal reports—tended to be incomplete or superficial; quantitative data was sparse and fragmentary . . . Water supply proved inadequate in 10 cases, unreliable in 6 and inequitable in 3; water losses proved excessive in 5."

From his personal experience—and this is considerable—Biswas considers that such criticisms are "unfortunately commonplace". In spite of this, he seems to favour the further expansion of irrigated agriculture. He rationalises that conclusion by trying to persuade himself that the failures alluded to are the result of poor management and that good management is in fact possible.

So much for the Foreword. Biswas's much lengthier introduction doesn't tell us anything new, though he notes the growing opposition to large water development schemes in developed countries "on environmental and social grounds". "Many segments of society" he writes, "are no longer willing to accept such social and environmental costs as the price of progress."

Whitewashing the Aswan Experience

The first specialist paper is by Mahmoud Abu-Zeid, Chairman of the Water Research Centre, Ministry of Irrigation, Cairo, Egypt. It is largely concerned with the side-effects of the Aswan Dam and is very much the sort of paper one would expect from a government bureaucrat, politically committed, as most of them are, to grossly underplaying the social and ecological effects of these schemes and to overrating their benefits.

Abu-Zeid admits that cultivated land per capita in Egypt has fallen from 0.163 hectares in 1930 to 0.071 hectares in 1978, even though something like 0.42 million hectares have been reclaimed since 1952. He doesn't mention the equally serious reduction in the *quality* of the cultivated land—the reclaimed desert, being of very poor quality, while the land which has been lost to salinisation and urbanisation along the banks of the river, once ranked amongst the most fertile in the world. Abu-Zeid admits that, during the period under consideration, 250,000 hectares of cultivated land have been lost to industrial and urban use and that to

maintain present per-capita land availability would entail reclaiming 62,500 hectares of desert every year. On the basis of Egypt's past record, that target seems unlikely to be achieved.

In the light of those statistics, it is difficult to see how the Egyptian Government can justify the further loss of agricultural land to urban development. Yet, it is even now considering a project to build 10 satellite cities around Cairo.

Abu-Zeid lists the various features of the Aswan Dam and associated works. He tells us that "the execution of the Aswan High Dam was preceded by very extensive feasibility studies". This is totally untrue. He also tells us that, at the current rate of siltation, the dam will last 500 years. Again, this is untrue. He also tries to persuade us that the silt which used to be deposited on Egypt's agricultural land by the Nile's annual flood was not really of much use. "It was found that azote (nitrogen) did not exceed 0.13 per cent of the weight of the silt. One-third of this was found to be of value to plant nutrition." He then tells us that the loss of that silt can "be compensated by about 13,000 tons of calcium nitrate fertiliser which is now being produced in Aswan, utilizing the power generated from the dam". In fact, a more realistic figure is in the area of 100,000 tons of fertiliser, and even this would not compensate for the vast amount of organic material present in the silt which Abu-Zeid presumably does not regard as providing "plant nutrient".

Abu-Zeid also denies that the impounding of the silt behind the Aswan Dam has reduced fisheries in the Mediterranean. "Shortage of sardines has been reported during the last few years. But this variety has never constituted a major percentage of the total catch in Egypt." He tells us that the main catch was from the northern lakes, occupying an area of some 200,000 hectares, and that "these lakes are still fed by agriculture drainage water". What he does not say, however, is that this drainage water is now highly saline and contaminated with all sorts of agricultural chemicals—chemicals which have caused large scale fish kills. He then tells us that the catch in Lake Nasser more than makes up for losses elsewhere. In 1976, that catch was estimated at 20,000 tons. If it was not higher, claims Abu-Zeid, it was because of a shortage of fishing facilities; once those facilities are improved, he maintains fish catches of up to 100,000 tons a year will be possible. Such a statement is purely gratuitous.

The health impact of the Aswan Dam is dealt with in two paragraphs. The project is "believed to increase the potential for aquatic snail vectors of schistosomiasis", Abu-Zeid assures

us, but then this is not a new problem in Egypt. Indeed "parasite's eggs have been found in mummified viscera from Tutenkhamon's tomb". In any case, he goes on to claim, the problem can be solved by spending \$3.4 per hectare a year on molluscicides, by covering field drainage systems and by including "health control components" in new projects. What those "health control components" consist of and how they are to work, Abu-Zeid does not say. The problem of salinisation is also grossly underplayed. Indeed, according to Abu-Zeid, it can be solved simply by appropriate management. All in all this article is a callous and cynical piece of political propaganda, of the sort one must unfortunately expect from politicians and bureaucrats throughout the world who are desperate to justify the destructive enterprises they promote to maintain themselves in power.

Pakistan and Japan

A paper by Gaylord V Skogerboe of Colorado State University deals mainly with more recent water development schemes in Pakistan, in particular with methods of overcoming the serious salinisation problem in that country. He rightly concludes that the future lies in small scale schemes at a village level and laments the shortage of material on the traditional organisation of such schemes in Pakistan. He provides a useful bibliography on the literature that does exist on this subject.

A paper by M Okamoto of the Faculty of Agriculture, Iwata University, Japan, deals briefly, but realistically, with the Japanese experience. He points to the problems "of obtaining the consent of the people who have to be resettled in other places due to inundation, some of whom even have to change their profession since their farms will be submerged". He also notes that even after receiving compensation, such people "cannot maintain their living standard at the same level as before the inundation". Hence they lobby against these schemes. He goes on to point out that "a comprehensive and political judgement on these problems may be better than the monetary assessments that are currently conducted. It is difficult to assign monetary values to environmental impacts." Not surprisingly, people have now "begun to doubt the necessity for these large scale Interregional Water Transfer projects... Residents to be affected by the construction of reservoirs oppose the plan and so do people who fear further environmental disruption."

The Texas Water System

In another paper, Charles Greer from Indiana University, describes the Texas Water System and its possible

environmental impact. He points out that the present withdrawal of water for irrigation on the High Plains of Texas "is vastly greater than annual recharge". Indeed, he argues that without new sources of water from outside the area, "the maintenance of production in this agricultural region will not be possible a few decades in the future." Nor, for that matter, would it be possible to maintain urban and industrial growth in such centres as Dallas-Fort Worth, Houston or San Antonio. In fact, the expected increase in the population of Texas from 11 million in 1970 to an estimated 30 million by 2020—with a corresponding increase in industrial production and other economic activities—makes new supplies of water essential. Nevertheless, the Texas water plan was rejected in 1969 by referendum, and a study in 1973 showed that the conveyance of 10 billion cubic metres of water from the Mississippi River to the High Plains, though practicable from an engineering point of view, was not economic. However, a further study in 1977 predicted that, over a large area of the high plains, the underlying aquifer would be depleted by the year 2000, and that the increased price of agricultural produce might make the plan more economic.

Greer notes that few of the environmental implications of the Texas Water System have been studied. In the original study, the increased salinity of the river for export to West Texas was looked at, as was the quality of water imported from the Mississippi, though not in a detailed way. Mention was also made of the "recreational and scientific significance of impacts on freshwater fish, waterfowl and other wildlife habitats which would be affected by reservoir development in the exporting basins of East Texas". Beyond this, however, "none of the major changes in hydrobiology of these basins which could result from the proposed development were reported as having been studied". In the 1977 revised draft, environmental considerations still remain surprisingly small, and "very much secondary to the plan's main consideration of engineering and economic feasibility". Indeed, says Greer, the environmental problems are perceived largely "as political obstacles to the plan's adoption" rather than as "geographic realities in which development is to be carried out".

Interestingly enough, Greer points to the similarity between the Texas water scheme and the proposed Chang Jiang scheme in China. "Both projects involve a similar scale of transfer— $10 \times 10^9 \text{ m}^3$ conveyed annually over distances of 600 to 1,200 kilometres in the Texas case, and about $15 \times 10^9 \text{ m}^3$ conveyed some 800 kilometres in the Chinese proposal.

General environmental parameters are similar in both cases. Water is exported from a humid basin of the largest river of each continent to a region of semi-arid plains, to be used mainly for irrigation but also for municipal and industrial purposes." However, because of population density and the intensity of agricultural land used in China, the Chinese scheme is likely to have a far greater social, ecological, political and economic impact than the Texas Scheme. Greer pleads for planners to ensure that environmental systems are studied in the same detail as the economic and engineering ones. If not, he warns, "the lessons that have been learned in the US and elsewhere over the last decade will be needlessly repeated".

The Chang Jiang Project

Perhaps the most comprehensive paper on the Chang Jiang diversion project is that by Bruce Stone of the International Food Policy Research Institute, Washington DC. First of all, he describes the scheme itself in considerable detail. Apparently the idea of diverting water from the Chang Jiang area to drought stricken North China Plain and to even drier areas of the Northwest is an old one. The area south of the Chang Jiang contains one third of the total cultivated area in China and receives three-quarters of the total flow of surface water. North China, on the other hand, with half the nation's cultivated land, receives only eight per cent. Rainfall varies in China's agricultural areas from over 2000mm in the southeast to 200mm in the northwest. Moreover in the North, rainfall is not only low but uneven and unpredictable.

Three possible (not mutually exclusive) routes have been proposed for the diversion; a western route, a middle route and an eastern route. The western one has never been surveyed very intensively, the eastern route was surveyed in detail in 1978, and the middle route in 1979. Each is likely to create different environmental problems. At the moment the middle route appears to be most favoured. It would require the construction of a 1,265 kilometre canal to Beijing which would cross the Huang He west of Zhengzhou and pass through the Nanyang Basin in southern Henan. The scheme would irrigate 5×10^6 hectares and would bring an average 10 km^3 of water a year to the Hai He basin. According to Stone, there would be "a substantial risk of salinisation with the Middle Route, although probably less severe than in the case of the East Route".

The problem of resettlement will be a serious one. When the Danjiangkou Dam was constructed in the 1960s, several hundred thousand people had to be resettled. The height of the dam

would have to be raised if the middle route were adopted, which would mean displacing a further 200,000 or so people.

Apart from the social and ecological problems associated with the scheme, its cost is likely to be extremely high. Indeed, Stone asks: "In view of the immense initial costs and the substantial environmental risks and related costs and expenditures required, why is the project being reconsidered at this time?"

Inappropriate Crops

He then discusses the North's assumed need for the southern water and the possible alternatives to the proposed scheme. He argues that the Chinese diet plays a critical role in determining water requirements. At present, ninety per cent of per capita caloric intake is supplied by food grains. Stone points to the gradual displacement, over the last few decades, of coarse grains by high-yielding and high-valued strains of wheat and maize. To maintain that trend, more irrigation water is required. But is the trend desirable on social and ecological grounds? Stone argues that much of North China, especially Shandong, is characterised by low lying depressions. To grow wheat, corn or cotton under irrigation in such depressions is to favour salinisation. He suggests that sorghum and soybeans might be grown instead. In addition to being better suited to the terrain, both crops have other advantages: "They are valuable as hog feed; soybeans have a high nutritive content, improve soil fertility and are a source of oil, and sorghum stalks provide fuel and nutrients." Moreover, neither crop requires much irrigation water.

He points out too that attempts to increase grain production in unsuitable areas has generally been unfortunate. Though high yield increases have been obtained, salinisation has turned out to be a very serious problem. "Two-thirds of the 4×10^6 hectares of irrigated land in north China were threatened with salinisation in the early 1960s." Remedial action was taken and a large number of tube wells were dug in order to bring about a fall in the water table. The results were satisfactory and the area of saline farmland was considerably reduced. In spite of this, however, the cultivated area fell in the Hae He basin by about a million hectares between the fifties and the seventies. The same is true in Henan where the cultivated area fell by 1 - 2 million hectares. Stone does not make it quite clear why this should have been so if the battle against salinisation was as successful as he made it out to be. Indeed, he himself points out that salinisation "was not only the principal man-made cause of

the largest grain production setback in the People's Republic history during the Great Leap, but has been on the rise again in north China since the mid 1970s."

Although the large scale building of tube wells has resulted in the beneficial lowering of the water table in some areas, in others it has caused such a serious fall in the water table that irrigation agriculture is now itself under threat. Little data has appeared outside China on this problem, which is surprisingly similar in the American southwest (though Stone does not mention this). Indeed, if the problem is as serious as in the US southwest, then this goes a long way towards explaining the importance of the proposed water-diversion schemes. The fact that a large number of constructed wells—most notably in the provinces of Shandong, Hebei and Henan—are not actually operating suggests that it may be. This may be due to a lack of equipment and other ancillary facilities for bringing water into the fields but it may also be due to increasing groundwater depletion.

In conclusion, Stone considers that the Chang Jiang diversion is not required to bridge the gap "between supply and demand for food in China during the current decade". These schemes would undoubtedly benefit agriculture in the north but only "if the very serious risk of widespread salinisation can be eliminated"—which we know, on the basis of the total world experience, is extremely unlikely, although (again) Stone does not say this. He ends by concluding: "The mentioned costs of the projects are very large and may well be under-estimated. The implied environmental damage and associated economic loss is very substantial, at current levels of technical and administrative preparedness (particularly in the area of local water management)."

Loss of Soil Fertility

In their contribution to the book, Guo Huancheng and Xu Zhikang of the Institute of Geography, Academia Sinica, warn that salinisation and alkinisation are already serious problems in the area which will be affected by the proposed water transfer scheme. There are some 2.7 million hectares of saline soil in the region, which accounts for about a fifth of the cultivated area in the plains. They argue that there is too much monoculture in the region, and that the area devoted to multi-cropping is too large—with the result that "soil fertility is constantly dropping due to the lack of proper soil utilization or nutrient maintenance". They also point out that "a long-term one-sided emphasis on high yielding grains and on increasing the multiple cropping

index has led to a great expansion in the area devoted to maize, wheat and sweet potatoes at the cost of crops such as soybeans, sorghum and millet which are resistant to flooding and replenish the soil." Once again, the result has been a fall in soil fertility. Indeed, they tell us, "The barrenness of the soil has become an important factor limiting the region's agricultural yields and their stability".

The authors clearly have grave reservations about the scheme, although they do not say so explicitly. They recommend very thorough research into all the various environmental aspects of the scheme, including its possible effect on soil salinisation, and suggest that proper drainage be installed and that every other necessary measure be undertaken to reduce salinisation.

The Official View

A paper by Yao Bangyi and Chen Qinglian from the Ministry of Water Conservancy is also worth noting. As might be expected in a paper by two state officials, the emphasis is on the great benefits to be derived from the proposed water transfer scheme. Thus the project is expected to provide an additional 3.8 million hectares of irrigated farmland and a guaranteed water supply for a further 1.3 million hectares. The scheme is also expected to supply 2.8 cubic kilometres of supplementary water for industrial, municipal, domestic and navigational use. At the same time, large pumping stations will be able to drain up to 5,000 cubic metres/second of excess surface water away from an area of 18,000 km², which will reduce waterlogging and salinisation. A vast increase in fish production is also promised. Only in the last few lines are environmental impacts mentioned, and then it is only to suggest that "we should know what they are likely to be".

Supporting Deficiency with Deficiency?

In their paper, Xu Yuexian and Hong Jialian of the Institute of Geography, Academia Sinica, deal specifically with the likely environmental impact of the proposed 'South-to-North' water transfer project on the Chang Jiang River basin. At present, some 25 x 10⁶ hectares of the basin are cultivated, producing 40 per cent of the total national grain output and 35 per cent of the country's cotton. The area—which, in 1978, had a population of 342 million—is also heavily industrialised, "embracing over 40 large and medium-sized cities and industrial or mining bases". Indeed, according to the authors, "the total value of the basin's industrial output amounts to approximately 40 per cent of the national total". The middle and lower reaches of the basin—which will be most directly affected by the

water transfer scheme—are not only the chief grain and cotton growing areas within the basin but also the most industrialised.

It is from the Chang Jiang river that much of the water to be used to irrigate the dry northern plains is to be derived. Xu Yuexian and Hong Jialian point out that, over the last thirty years, more than 40,000 reservoirs of all sizes have been built in the Chang Jiang basin, with a total capacity of 100 cubic kilometres. The irrigated area has expanded to 6.7 x 10⁶ hectares. The demand for water for industrial and domestic purposes is constantly increasing and the availability is beginning to decline. The problem is so general that the authors conclude: "Transferring water from the Chang Jiang northwards is nothing more than 'supporting deficiency with deficiency', if we consider future increases in water use and the fact that the Chang Jiang basin is not all that rich in water resources."

Nevertheless, Xu and Hong consider that the project is feasible and that it will not prove too damaging to the area. The chief problem, as they see it, is the salinisation which the scheme is likely to cause in irrigated areas. "Over the past thirty years, the area of saline soil in the proposed water transfer region has fluctuated constantly. In the three provinces of Hebei, Henan and Shandong, there was a total of 1.9 x 10⁶ of saline soil in the mid 1950s. This area expanded to 2.3 x 10⁶ hectares in the early 1960s due to the diversion of the Huang He for irrigation and to water storage on the plain. The saline area dropped to 1.4 x 10⁶ ha by the mid 1970s, however, because of improvements in the standard of drainage with the harnessing of the Hai He and other river basins and the lowering of the water table due to the development of pump well irrigation; but the tendency to expand seems to have returned in the late 1970s. At the end of the 1970s, the area was about 1.9 x 10⁶ ha. This corresponds to the rise in the water table along both sides of certain rivers associated with the construction of water-impounding dams. At present there is a total of 2.7 x 10⁶ ha of saline soil, amounting to about 15 per cent of the total arable land from the Shaying He system of the Huai He basin in the south to Beijing and Tianjin in the north. Moreover, there is an additional 4.7 x 10⁶ ha of potential saline soil which is most vulnerable to secondary salinisation if affected by detrimental factors."

Xu and Hong appear to take it for granted that the project will be built—whatever the likely dangers—and end up suggesting that all the usual safeguards should be taken in order to reduce the damage to a minimum.

The Problems of Management

Another interesting paper is by James E Nickum from the Department of Asian Studies and Agricultural Economics, Cornell University. Like Xu and Hong, he sees the 'spread of secondary salinisation' as one of the 'likely deleterious impacts' of the proposed scheme. The threat, he argues, is particularly worrying because of the inadequacy of irrigation management in China—a problem which is, apparently, much alluded to in the national press. "There has been a long-standing criticism in the literature of 'emphasising construction to the neglect of management' and 'only grasping construction without regard for effectiveness'. A *Renmin Ribao* (People's Daily) editorial on 13 December 1963 estimated that as much as 6.7 million hectares could be added to the area irrigated and drained by existing projects. More recently, agronomists in Henan claimed that the necessary ancillary projects had not been added to 10 large reservoirs built in the 1950s or to the more recently installed 110,000 tube wells, leaving the province's irrigated acreage 2.7 million hectares below its potential."

From colleagues attending the East China Water Transfer Symposium, Nickum reports, he learnt that poor management had led to the following problems, among others:

1. Farmers in the upper reaches use too much water, while those in the lower reaches do not receive enough.
2. Though good results are achieved in experimental areas, they are nothing like as good elsewhere—largely because the peasants are reluctant to adopt the innovations proposed by government agricultural experts. Drainage, for instance, is regarded as being too expensive.
3. Poor management has led to secondary salinisation in some parts of the North China Plain. This is attributed, in particular, to seepage from canals. "Among the sites we visited, seepage rates are 40 per cent in the long-established People's Victory Canal system . . . and over 50 per cent in the channels of the Shijin Canal system." Nickum goes on to point out: "The area watered by each cubic metre is too vast, up to 2,000 hectares. This means that water is in the main canals for up to 300 days a year, keeping the nearby water table high. Some places irrigate too heavily and too often . . . (and) irrigation is emphasised to the neglect of drainage. Sometimes canals even cut off the natural drainage routes."

Nickum points out that these problems are similar elsewhere, quoting Chambers who talks of "managing those who manage the water".

Salt Water Intrusion

The question of possible salt-water intrusion in the Chang Jiang is dealt with in a paper by Shen Huanting, Mao Zhichang and Gu Guochuan of the Estuarial and Coastal Institute, East China Normal University, and Xu Pengling of the Shanghai Water Works Corporation. They point out that salt-water intrusion is already a serious problem in the Chang Jiang estuary, particularly during the dry period from December to April. It already "directly affects and threatens the water used for industry, agriculture and daily life in Shanghai and some coastal areas of Jiangsu Province", largely because of the continual deepening of the channel to the ocean in the Chang Jiang estuary in order to improve water transportation. Shen and his colleagues conclude: "If water is transferred at the rate of 1,000m³/sec along the East Route, saltwater intrusion will definitely be worsened in the Chang Jiang estuary. This will also alter the ecological environment of fishery resources. Therefore, serious attention must be paid to these effects in the planning of the south-to-north transfer." Whether the other proposed routes would have less deleterious effects is not discussed in detail. It appears, however, that they provide both advantages and disadvantages with regards salt water intrusion.

Another article which deals specifically with the likely ecological effects of the diversion is that by Zhu Shouquan, Wang Zunqin and Hseung Yi of the Institute of Soil Sciences, Academia Sinica. They describe how the high silt content of the Huang and Hai rivers, which flow through the Huang-Huai-Hai Plains, has led to the elevation of the river beds above the surrounding land surface, thereby intensifying lateral seepage and causing the water table to rise. Evaporation rates are very intense, especially in the spring when the area often suffers from drought. The summers are extremely hot and rainy—and summer flooding and salinisation is common. There is often not enough moisture in the spring for sowing; moreover, because of the soil's high

salt content, it is very difficult to cultivate cereals successfully without irrigation. Water is a critical factor. When there is too little of it there is drought, while too much in this area leads to water-logging. The high salinity of the soil, leading to the accumulation of salts on the surface of the land, is the other critical factor.

In the late 1950s a large number of reservoirs were built blocking natural drainage channels. There was considerable seepage and the water-table was raised, with the result that extensive salinisation occurred.

The critical question is whether the south-to-north water transfer "will aggravate the secondary salinisation of the soil which is a threat north of the Huang He and in coastal areas." Whichever route is adopted, increasing the water input of the Huang-Huai-Hai Plain must fundamentally alter the present water-salt balance. The authors stress the importance of taking the appropriate measures to reduce the damage. "In an engineering system . . . diversion, storage, irrigation, drainage and management of water should be regarded as a single entity, beginning with the design and installation of a drainage system prior to irrigation." Unfortunately, they go on to note, "this is rarely done in practice and therefore the soil-plant ecology has not been improved".

Conclusion

In general, almost all of the academic contributors to this book accentuate the terrible social and ecological disruption which is likely to be caused by China's proposed water transfer scheme. The bureaucrats who presented papers, on the other hand, grossly exaggerate the benefits to be

derived from the project and hardly mention the social and environmental consequences. Equally significant, none of the academics (with the possible exception of Stone) actually goes so far as to suggest that the Chiang Jiang scheme should not be built. Is this because they know, from past experience, that politicians and bureaucrats are unlikely to be moved by the dangers they highlight? Because they assume that the construction of the scheme is a foregone conclusion—and that all they can do is to try and persuade the authorities to undertake those measures which will reduce its adverse effects to a minimum?

Sadly, that conclusion is hard to resist. If the experience of similar projects in the Soviet Union, the USA and India is anything to go by, the warnings and advice of concerned academics will have little bearing on the decision to build the Chiang Jiang scheme. Indeed, that decision will almost certainly rest on purely political and economic considerations. One can only fear for the future of the tens of millions of people now living in those areas of China earmarked for development.

Edward Goldsmith

Naked Truth

VILLAGES AND FARMSTEADS. A HISTORY OF RURAL SETTLEMENTS IN ENGLAND by Christopher Taylor, George Philip, £10.95.

'By the late Iron Age there may well have been a serious shortage of timber' and 'It could well be that by the first century BC there was less woodland in England than there is now.' These astonishing statements, like so much in this absorbing and compre-

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hensive history, stop us in our tracks with a gasp of disbelief. It is not, however, Christopher Taylor's fancy, or an over-active imagination, that lead him to make these assumptions, but the result of recent research using such indispensable modern techniques as radio carbon dating, pollen counts, soil analysis and above all aerial photography. Such advances have given modern archaeologists the opportunity to make penetrating new insights into the condition of our prehistoric forebears and the country they inhabited. Forebears who were, incidentally, much more advanced and sophisticated than has been generally believed. 'Early man lived almost everywhere in England . . . he was not controlled by his environment. Indeed the reverse is true: prehistoric man actually controlled his environment most of the time.'

By the time of the Roman invasion Britain was already 'an almost totally exploited land, with a large population living in a variety of settlement types . . . At the same time there is evidence of actual over-population and over-exploitation, potentially leading to the breakdown of Iron Age society.' Is this not an unfamiliar view of AD 43? Revelations about Iron Age agricultural practices have an extraordinarily familiar ring—have we not read similar explanations for the dust bowls of America, the deserts of Africa and the floods in India? Here, in prehistoric England we find land-hungry farmers clearing woodlands, ploughing the uplands and causing erosion as the ploughed soils wash off the hillsides into the flood valleys of the major rivers. The destiny of iron age settlements is another surprise (and the author points out that thousands more exist, not yet found or lost forever beneath later shifts of soil), although they varied from district to district their proximity—about .8 of a kilometre in Hampshire, 1.3 in Cornwall and 1.5 in Bedfordshire, suggests a thriving rural population. All these revelations combine to refute the image most of us have had since we learned it at an early age, of pre-Roman Britain as a wild forested country inhabited by a few primitive people living in hut circles.

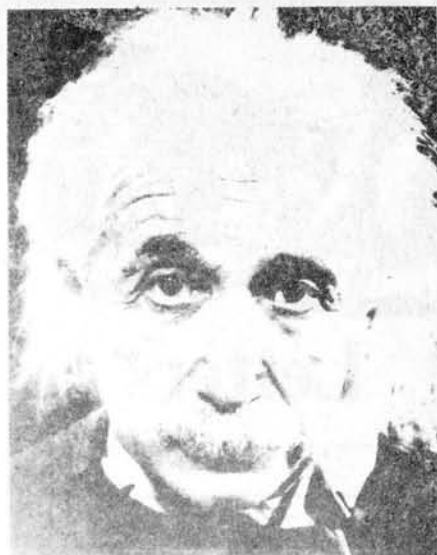
Christopher Taylor's book is full of new information which commands attention and indeed it is compulsively readable, but beyond this it is important for ecologists and environmentalists and their ilk, because the greater our knowledge and understanding of the past condition of our country, the more useful and accurate will be our assessment of the environmental threats that exist today. Is it encouraging or depressing to consider the possibility that the present day tree-cover in England is not uniquely sparse? And what should we make of the suggestion that the Saxon inva-

sion of England was not a series of violent campaigns that swept away the remaining Romans, drove the Celts into the far west and established the English village landscape of today? In this context Mr Taylor quotes Professor Charles Thomas in suggesting that no more than ten thousand Saxon settlers actually came to this country (in Roman times the population had reached about five million) and that the Saxon invasion was not so much a mass replacement of population as the political takeover of a disintegrating society.

One of Christopher Taylor's recurring themes is that the rural landscape has always changed and moved—subject to what he calls drift. Nothing is static and nothing that is revealed can be interpreted with absolute certainty. 'It is not,' he points out writing of the Iron Age, 'a simple story of steady expansion . . . but a highly complex picture of ebbs and flows, expansion and contraction, and above all of incredible variety.' It's as well to remember that when we come across simplistic generalisations about cause and effect. To show how easily archaeological evidence can be misread he cites the story of the Wiltshire village of *Snap*. In aerial photographs, as he shows, *Snap* now looks like a perfect example of a deserted medieval village. The truth is that until the beginning of this century it was a flourishing community. Early in the 1900s it was bought up by a family of butchers who wanted the land for grazing their sheep. The inhabitants, having no jobs, gradually drifted away, and by 1914 the village was abandoned—only seventy years ago. And that is not all. If you believe that traditions handed down from generation to generation are a reliable source of information, here is another illusion shattered. By 1950, when the history of *Snap* came to be written, local tradition had it that the villagers had left when their water supply failed.

I have dwelt on the prehistoric period covered in this book because that is where the more astonishing revelations are to be found, but it traces the history of rural settlements up to the present day with equal thoroughness. It is a long and comprehensively illustrated volume (how Victorian archaeologists would goggle if they could see modern aerial photographs which tell a tale so clear that even an untrained eye can extract a wealth of information from them). No one interested in our rural past could fail to find *Village and Farmstead* revealing, provocative and surely a very useful work of reference.

Ruth Lumley-Smith



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Plutonium Connection

Dear Sir,

In May 1982, in answer to a question from Lord Brockway, Her Majesty's Government said, "The possible export of civil plutonium to the United States . . . remains no more than a proposal under examination by the two Governments." In July 1982, in answer to a question from Mr Robin Cook, HMG simply said, "There have been no further developments . . ." In November 1982, HMG said "No further discussions on the proposals are planned". In the light of these Parliamentary answers, my summary of the situation would appear to be somewhat more accurate than that of Mr Lyons; if the American Government did indicate in May 1982 that it was no longer interested (as Lyons claims) then this indication had not filtered through to HMG as of 27 July 1982.

Lord Brockway's Question of 5 May asked HMG, what has been HMG's response to a communication from the EPEA (of which Mr Lyons is General Secretary). HMG replied, "My department has not received any communication from the EPEA". It would seem Lord Brockway had been misinformed.

It is true that there was large scale opposition on both sides of the Atlantic, to the 1981 proposal that the UK should sell plutonium to the US. However, Lyons' claim that the EPEA "Led the opposition" is open to serious doubt. As the Parliamentary Answer to Lord Brockway makes clear, the EPEA did not even communicate its opposition to the appropriate Government Department.

Lyons goes on to claim that, in addition, "the CEEB was also opposed to it and, to be fair to him, so was Nigel Lawson". The evidence is to the contrary. As of December 21st 1981 it was proposed that the plutonium export should be "a free standing contract between the civil nuclear industry and the United States Department of Energy". The same Government statement (Hansard, Commons, 21 December 1981, col. 738) speaks of a "commercial contract between the CEEB and the United States Department of Energy". Does Lyons now wish us to believe that in this prepared statement John Moore, Lawson's junior minister, was stating a position of which both Lawson and the CEEB disapproved? Apparently he does.

The CEEB, a commercial organisation, was free to express its opposition to a free standing commercial contract. So far as I know it never did so. By contrast, it did reprimand Dr Hesketh for expressing his opposition.

The CEEB subsequently warned Hesketh, again formally, that by taking part in the debate on the use to which civil plutonium had been put he "may create problems" for himself. It later fired him. In a letter to The Guardian (July 18, 1983) Hesketh alleged that, "It is a matter of record that the Board's several actions which led to my dismissal are strongly correlated with my writing and speaking about the use of British plutonium in American weapons." Since then, the Industrial Tribunal at which this allegation would have been examined has been called off, at the last minute, and Dr Hesketh has been re-engaged by the CEEB. Readers must therefore choose for themselves whether they accept Mr Lyons' claim that Hesketh was not dismissed for his action in regard to plutonium, or Dr Hesketh's allegation that he was.

Lyons complains that no organisation (other than the CEEB and his own EPEA) has published more than a tiny part of his Press Statement. (He has singled out The Guardian and New Statesman for especial criticism.) Readers may care to note that the Berkeley Laboratories Section Committee of the EPEA, in the light of their first hand knowledge of some of the facts, have refused to publish any part of his Press Statement.

Lyons' present letter concludes with a defence of claims made by the CEEB in its evidence to the Sizewell Inquiry. As he rightly says, this forms no part of his brief. Read in conjunction with his preceding claims, that the CEEB actually opposed the commercial contract to which, at December 1981, it was to be a party, and that Hesketh was not fired for setting out some of the facts in regard to a previous export of plutonium, one begins to wonder whether any spokesman for the CEEB could say more in its defence than has Mr Lyons.

I have not overlooked the fifty eight pages of Sizewell transcript. As my original report made clear, some of my conclusions were drawn from that transcript.

Yours faithfully
Nick Kollerstrom,
Worplesdon, Surrey.

Dear Sir,

I was surprised to read some of the things which Mr Kollerstrom wrote in his article in the last issue of The Ecologist about Dr Ross Hesketh. There is merit in some of them of course but by no means all of them.

The statement that "nothing more was heard of the proposed plutonium export (referring to the 1981 proposal from the US Government) until this year's Sizewell Inquiry" is baffling. As was reported at the time, the US administration indicated in May 1982 that the American Government was no longer interested in the proposition. The reason for this was that my own Association led the opposition to that proposal. The CEEB was also opposed to it and, to be fair to him, so was Nigel Lawson. The US Government chose the diplomatic route to a retreat.

The statement that "as a result of his action, Hesketh has lost his job" is simply untrue. So is the statement in your "Stop Press" item about the settlement we made for Dr Hesketh, that "the CEEB are keeping quiet over the reasons for the original dismissal". The reasons and the history of that particular dispute were set out in our Press Statement made at the time we concluded our agreement with the CEEB for Dr Hesketh's reinstatement. I enclose a copy of this for your information. (By agreement between the parties only my Association was to make any public comment on that agreement.) Since no other organ which has taken up Dr Hesketh's case has so far printed any more than a tiny part of this Press Statement, I wonder whether you would be willing to print it in full for the benefit at least of the readers of The Ecologist?

Finally I was struck by Mr Kollerstrom's scepticism about CEEB statements that some of their civil plutonium has been used for military purposes. "If they wish such statements to be believed, they should spell out in more detail what they are doing with their Plutonium . . . etc."

I cannot understand how Mr Kollerstrom, who elsewhere in his report refers to evidence at the Sizewell Inquiry, has overlooked the fifty-eight pages of transcript of the CEEB's cross examination by Mr Rob Edwards (CND) at the Inquiry, in which they spelled out what they are doing and how in very great detail indeed.

I mention this last point not because it is any part of my brief to do so, but because I am struck by the amount of seriously misleading information which Mr Kollerstrom managed to get into his short article about Dr Hesketh. It really is a pity since I believe that The Ecologist on some of the developments in our society has a point of view which should be taken seriously.

Yours faithfully
John Lyons
Electrical Power Engineers' Association,
Chertsey, Surrey.

Dear Friends,

I am grateful for your coverage of Ross Hesketh's case and the related concern over plutonium exports (Ecologist December 1983). However, I would like to add a couple of points.

There has been a substantial amount written about the crucial issue of the use of civil plutonium for military purposes. I would like to refer readers to just two publications which should help them understand precisely what is known, what is unknown and what is concealed. The first is Atoms for War by Howard Clark and the second is The Plutonium Connection by myself and both are available from CND.

CND is currently preparing its evidence for the Sizewell Inquiry on the assumption that we will present it sometime in June. If all goes to plan, we should be in a position to shed new light on the links between nuclear power and nuclear weapons.

Yours faithfully,
Rob Edwards
CND Sizewell Working Group
38 Fowler Terrace
Edinburgh

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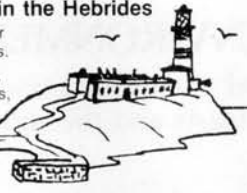
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