The Ecologist

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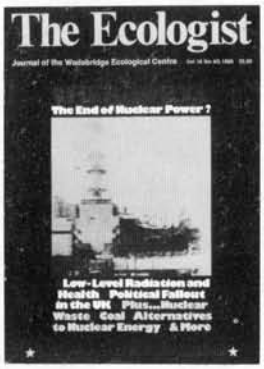
FLUORIDATION: Are we putting poison in our drinking water?



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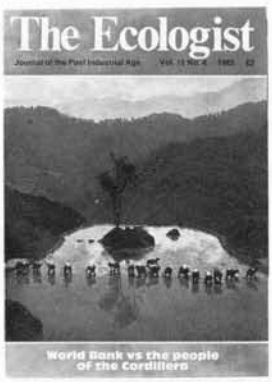

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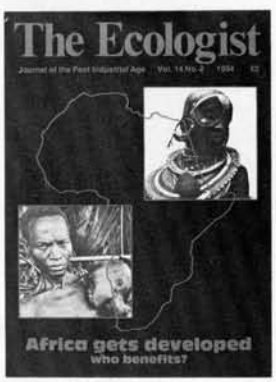

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The Ecologist

Vol. 16 No. 6 1986

Editorial

Feature Articles

Reports

Cover picture: Anneli Lerchental Bunyard, Regent's Park, London 1943

Lay-out: John McIntyre

ERRATA:

The Ecologist, Vol. 16, No. 1, 1986, p. 41, line 9 of R.P.C. Morgan's article, *Soil Erosion in Britain* should read "This is about two million hectares or about 37 per cent of the arable area of England and Wales".

The Ecologist, Vol. 16, No. 4/5, 1986, p.220, Table of M. Flood's article, *The Potential for Renewables*. The contribution from wind energy given in the table should read 650 petajoules (PJ) making a total contribution from renewables of 1,270 PJ of heat supplied or fuel saved in 2025. The total contribution from renewables, equivalent to around 45 million tonnes of coal, would be equivalent to 17 Sizewell Bs and not 35 as stated.

NUCLEAR POWER– THE HYDRA'S HEAD

It would have been too much to expect the nuclear industry and the governments which promote its activities to turn tail after Chernobyl and opt to bring the nuclear adventure to an end. Instead there has been a spate of international meetings, all designed to restore confidence in nuclear power, not least among nuclear advocates themselves. In Vienna, at the end of September, the International Atomic Energy Agency (IAEA) held its Reactor Safety Conference, by which time the delegates from some 113 member states had had time to digest the USSR report on Chernobyl, and to reiterate like Walter Marshall, chairman of the CEGB, that no such accident was ever likely to happen in their own countries. And even if it did was it really so bad? It was Three Mile Island all over again. Yes, the unthinkable had happened, but people could go on living at Harrisburg just as one day they would be back in Pripyat and other neighbouring settlements to Chernobyl.

Undoubtedly the West did the USSR a great favour in the early days after the accident with its accounts of thousands dead. By the autumn the USSR, with the nuclear industry and its advocates gladly tagging on, could point to just 31 dead and some tens of others still seriously ill. Meanwhile the tally of those likely to die of cancer through Chernobyl fall-out has been brought down and down to ridiculously low levels. Those foisting nuclear power upon us know just how difficult it will be to distinguish a Chernobyl cancer from any other.

As for the USSR, it did not take long before it was telling us that Chernobyl was hardly going to cause a hiccough in its plans for the expansion of nuclear power. Nuclear power indeed was to be brought even closer to the home with the USSR's schemes for small reactors linked to district heating. And the RBMKs? They too would all be started up again, save for the damaged number 4 Chernobyl reactor and its twin.

The Chairman of the Soviet State Committee on the Utilisation of Atomic Energy, A. Petrosyants, has been explicit in the *IAEA Bulletin* (Vol.28, No.3, 1986) on the USSR's nuclear plans. "By 1990", he stated, "we expect the country's nuclear power stations to produce 360,000 million kilowatt-hours (360 terawatt-hours) as compared with 170,000 million in 1985."

NOTICE TO READERS

As from this issue *The Ecologist* is incorporating the environment magazine *Mazingira*. In the past publication of *Mazingira* was supported by the United Nations Environment Programme (UNEP) which is no longer able to continue its subsidy. We hope that readers of *Mazingira* will find environment and development issues more than adequately covered in *The Ecologist*.

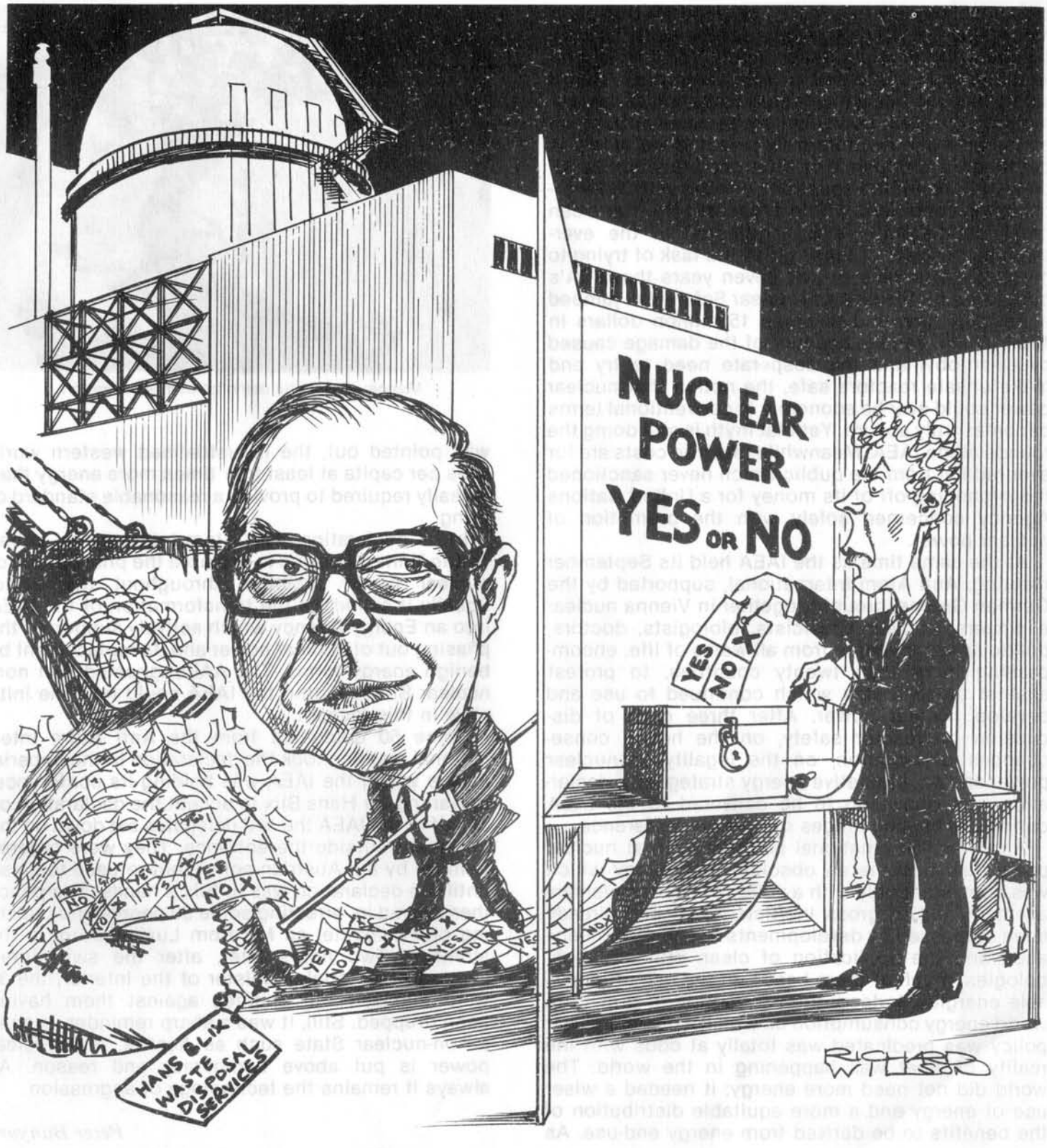
Nor was he thinking only of thermal reactors such as the USSR's pressurised water reactors and the RBMKs. "By the year 2000", he said, "fast reactors will have joined the system and will gradually supplant the thermal reactors . . . We consider that this is an inevitable process and that it will continue at a substantial rate even beyond the year 2000. Thus it will be seen that nuclear power has very good prospects in our country, particularly in the European part of the Soviet Union."

The promotion of nuclear power in the world has never been a democratic process. It has always been imposed from above, and it can be no coincidence that countries with highly centralised state bureaucracies such as France and the USSR are those most successful in today's political climate in pushing ahead with their nuclear power programmes regardless of public opinion, whether in their own countries or across the border. And Chernobyl has demonstrated unequivocally how little radiation releases respond to international frontiers. Where a better state of democracy exists, where in fact referenda are held, as in Austria and Sweden, people have chosen to do away with nuclear power. Nor did they need a Chernobyl to decide.

We can get some idea of the reactionary, undemocratic forces behind the thrust for nuclear power from statements by Hans Blix, the director general of the IAEA. He sees the drawing back from nuclear power by countries such as Holland and Finland, as signs of weakness, of pandering to voters whose fears and anxieties are hardly justified. Instead, he approves mightily of the position taken by what he terms "the world's strongest countries" which have come out "categorically to declare their continued intention to rely on nuclear power" and Britain, of course, is included in that number.

Blix has utterly failed to understand why the public is opposed to nuclear power. It is not for some ideological reason, he says, but because of a feeling that it poses unacceptable risks. The answer for him, therefore, is to demonstrate that any risk is far outweighed by the advantages. "Nuclear power is not a luxury we can drop like a garment," he states in the *IAEA Bulletin*. "Rather it is a reality we shall continue to live with. The Bhopal disaster, with some 2000 deaths, did not stop the chemical industry; it is indispensable . . ."

Here we hardly have to reiterate that pesticides, such as those manufactured by Union Carbide at Bhopal, are an unnecessary abomination which have more to do with shoddy farming practices than with some shining vision of how to feed the masses. And similar parallels are inherent in nuclear power; indeed it is telling that Blix should have talked of pesticides and nuclear power in the same breath. They



CARTOON: RICHARD WILLSON

"Only weak governments pander to the Electorate"

both generate terrible poisons and they both represent the interests of powerful industries which are actively promoted and subsidised by United Nations agencies, whether the Food and Agriculture Organisation or the IAEA. Nuclear power would not be thrust upon us and the hapless environment unless it were for active support from the State. Nuclear power is both a product of centralist State policies and an excuse for the State to broaden its powers so as to safeguard its nuclear interests from opponents. State and nuclear power are therefore interlocked and mutually self-reinforcing, and it is primarily for those reasons that nuclear power has generated such virulent opposition. Nuclear power represents the State against the people, the State against democracy, and Hans Blix should realise that ideology comes first in the implacable fight against the nuclear technocracy. Added to that is the fear of the dangers of radiation and sheer disbelief that the nuclear experts are capable of coming near to assessing the risk of nuclear accidents.

Meanwhile, the delegates at the IAEA's *Reactor Safety Conference* were no longer talking of the improbability of accidents—Chernobyl had changed all that—but instead were discussing ways to lessen the impact of accidents by sending in specially trained teams to mop up and cover up. There was talk of setting up stores of uncontaminated food—

presumably a new role for the beef, butter and grain mountains, let alone the wine lakes—and the construction of shelters, supposedly for those who would have to battle with crippled reactors. Reactor safety has become a major preoccupation of the promoters of nuclear power simply because nothing on earth can make reactors truly safe. Indeed safety is based on a confusion of different probabilities all derived from limited equations dealing with the ever-changing conditions within a reactor core. There can never be certainty, a fact reflected in the ever-swelling budgets of those given the task of trying to make reactors safe. In just seven years the IAEA's budget for its Division of Nuclear Safety has jumped more than threefold to some 15 million dollars in 1987. When we take account of the damage caused by Chernobyl and the desperate need to try and make unsafe reactors safe, the notion that nuclear power could ever be economic in conventional terms becomes truly absurd. Yet that myth is still doing the rounds at the IAEA. Meanwhile, the true costs are for ever hidden from the public which never sanctioned the syphoning off of its money for a United Nations Agency concerned solely with the promotion of nuclear power.

At the same time as the IAEA held its September meeting, Anti Atom International, supported by the German Greens, brought together in Vienna nuclear engineers, nuclear physicists, biologists, doctors, politicians and people from all walks of life, encompassing more than twenty countries, to protest against those States which continued to use and develop nuclear power. After three days of discussion on reactor safety, on the health consequences of radiation, on the legality of nuclear power and on alternative energy strategies, a declaration was drawn up to be delivered to the IAEA during the closing stages of its own conference.

Anti Atom International pointed out that nuclear power had become an obsolete technology which was consistent only with a policy of energy mismanagement and of gross inefficiency. It had already been surpassed by developments in energy conservation and the application of clean efficient technologies, much of them based on the use of renewable energies. Indeed, the very notion of growth in world energy consumption on which a nuclear power policy was predicated was totally at odds with the reality of what was happening in the world. The world did not need more energy: it needed a wiser use of energy and a more equitable distribution of the benefits to be derived from energy end-use. As

PHOTO: PETER BOSSEW

Vienna: A peaceful demonstrator is carried off

was pointed out, the industrialised western world uses per capita at least four times more energy than is really required to provide a reasonable standard of living.

In its declaration, Anti Atom International called on the United Nations to promote the phasing out of nuclear power facilities throughout the world. Equally it called for the transformation of the IAEA into an Energy Agency which actively supported the phasing out of nuclear power and its replacement by benign energy forms. The AAI suggested that non-nuclear States within the IAEA could take the initiative in this respect.

Some 50 delegates from the Anti Atom International meeting took the declaration to the Imperial Palace where the IAEA was holding its conference. In waiting for Hans Blix to accept the declaration on behalf of the IAEA the AAI delegates sat down on the pavement outside the entrance. They were ordered to move by the Austrian police, but refused to do so until the declaration was in Blix's hands. The police then moved in, arresting some 30 people and punching one delegate, an MP from Luxembourg, in the stomach. Two hours later, after the swift intervention of Austria's Minister of the Interior, the 30 were released—all charges against them having been dropped. Still, it was a sharp reminder, even in a non-nuclear State such as Austria, that nuclear power is put above democracy and reason. As always it remains the technology of aggression.

Peter Bunyard

Fluoridation—Doctoring our water supplies

In October 1985 Parliament passed a Bill allowing water authorities in Britain to fluoridate water supplies. That bit of legislation, hastily rushed through Parliament, came in response to a successful court action in 1983 that declared illegal Strathclyde Regional Council's intention to fluoridate its public water supply. One might have thought an issue as important as the doctoring of water would have brought a serious response from MPs in what was supposedly a free vote. But, 420 MPs out of a total of 650 simply did not vote at all, thus allowing the fluoridation bill to pass practically by default.

In effect, the way is now clear for the legal medication of public water and the right to choose and take responsibility for what is healthy and safe for one's children and oneself has been fundamentally eroded. It might matter less were fluoride a completely harmless substance. Yet it is an extremely potent poison, being an effective inhibitor of those enzymes associated with respiratory metabolism and the oxidation pathway in the cell. The notion too, inherent in mass medication, that what is good for

one is good for all, is belied by the facts. Individuals have very different sensitivities to different substances, fluoride being no exception. And where indeed is the evidence that fluoride added to water to give concentrations of up to one part per million is absolutely harmless? As we claim in this issue of *The Ecologist* the evidence is spurious and at best based on shoddy science.

Fluoride is found naturally in varying concentrations in the environment. But man, through his industrial activities, whether aluminium smelting, brick-making, oil refining or fertiliser producing, has added to the natural burden. The waste has to be disposed of somehow, and what better way for the industry than to find a socially acceptable disposal route. It was undoubtedly a godsend for industry, and particularly the aluminium industry, when someone noticed that children's teeth in areas where fluoride levels were naturally high appeared to be marginally healthier than those of children in other areas. From being a poison associated with such an incapacitating disease for livestock and humans as fluorosis, fluoride was suddenly and miraculously elevated to the status of an essential element.

But had those early observers of the supposed benefits of fluoride on teeth taken all factors into account? Had they considered other elements such as calcium and magnesium with which fluoride is associated in the natural environment? Could high levels of those other minerals have been the main factors in conferring healthier teeth, especially since they are known to counteract the ill-effects associated with fluoride? Furthermore, as we show in *The Ecologist,* not only have all epidemiological studies to date on the putative benefits of fluoride in water been of dubious value but, irrespective of fluoridation, children's teeth appear to have improved in terms of dental caries, over the past 30 years.

Since fluoride is found naturally in the environment, advocates of fluoridation have been quick to assume that fluoride from whatever source is the same with regard to its effect on the living environment. Yet, in the natural state fluoride is usually bound to calcium, which through powerful electrostatic forces, keeps the fluoride ion close to it. Bound to calcium in that way, the fluoride ion is not 'free' and cannot exert its toxic effects as an enzyme inhibitor. Artificial fluoride, on the other hand, usually consists of sodium fluoride, sodium silicofluoride, hydrofluosilicic acid and hydrofluoric acid. In all those forms, the fluoride ion is far 'freer' than when bound to calcium. Sodium, for instance, surrounds itself with water molecules when dissolved with its fluoride ion in water, and the electrostatic forces between sodium and fluoride are therefore considerably reduced given that the attraction between oppositely charged ions decreases by the square as the distance doubles between them.

Once in the body, fluoride can bond tightly with hydrogen, thus inactivating the active group of an enzyme, or it can replace a hydroxyl group on account of its similarity in size. It will also chelate calcium or magnesium thus removing essential components of enzyme proteins; another possibility too is the formation within the tissues of fluorinated carbon compounds such as fluoracetic and fluorocitric acid, both of which are known to be intensely poisonous. Such compounds have been found in the urine of aluminium smelter workers and of cattle suffering from fluorosis.

Whereas the benefits of fluoridation have remained in question, even after 40 years of experience, the evidence increasingly points to fluoridation as being the cause of disease. Dr Dean Burk, former head of the Cytochemistry Division of the National Cancer Institute and Dr John Yiamouyiannis, Science Director of the National Health Federation, claim that fluoride added to drinking water in the United States results in as many as 35,000 cancer deaths each year. Others are now suggesting a link between cot deaths and excess fluoride in the diet. Recent research indicates that as many as 10 per cent of babies who die mysteriously in their cots may have a defective cytochrome oxidase system and so cannot properly obtain metabolic energy. That enzyme system is the one most affected by fluoride because of its propensity to chelate with magnesium and so destroy that element's role as coenzyme in the cytochrome oxidase system. Although she made no link with fluoride at that time, in 1977 Dr Joan Cadell suggested that magnesium deprivation, in the tissues, could be a cause of "sudden unexpected infant death" (*Lancet* August 5, 1977). More recently it has been suggested that the problem of magnesium chelation may be exacerbated when fluoridated water is used to make up bottle feeds for infants, since then the intake of fluoride may be as much as 150 times greater than for breast fed infants.

Fluoridation has also been associated with arthritis and similar degenerative changes in the tissues, having been called the 'Ageing Factor' by Yiamouyiannis. The evidence against fluoridation can no longer be overlooked, and local authorities must resist any attempt by government to force them to treat water supplies with this potent poison.

Other countries seem to know better. Fluoridation has been banned in Holland and Sweden, discontinued in Yugoslavia, West Germany, Hungary and Belgium and has never been practised in Austria, Denmark, France, Italy, Greece or Norway. Just a few areas in Britain have fluoridated water, and it is time that they now abandon this medically dangerous illegitimate practice.

Peter Bunyard

The Fluoridation Campaign

By Thomas Outerbridge

The United States began fluoridating its water supplies in the 1940s. The fluoridation campaign, which involved public health authorities and industry, was based on observations that childrens' teeth appeared to be healthier when drinking water contained measurable levels of fluoride compared to fluoride-free water. Adding fluoride to water was also a convenient way of getting rid of dangerous industrial wastes, and from being considered a potent poison, fluoride suddenly acquired the status of an essential element. In fact, as Outrbridge indicates, sound scientific evidence of the benefits of fluoridation is lacking. Instead, the epidemiology on which the pro-fluoridation lobby bases its conclusions is of dubious quality.

PHOTO: ANNELI LERCHENTAL BUNYARD

From its chemical isolation 100 years ago until the 1940s, fluorine was something to be kept out of the environment. In 1925 the town of Oakley, Idaho changed its water supply in order to avoid the dental mottling caused by fluoride in the water. In 1943 the *Journal of the American Dental Association* described fluorides as "general protoplasmic poisons". How is it then that fluoride is now hailed as 'beneficial and essential', and why are there now 'fluorine deficiency areas'? What has given fluoride such a completely different image?

Fluoride As Industrial Waste

Fluorine pollution from industrial sources has a long history. Nearly all mined and quarried materials contain fluoride compounds. The extraction and refining of these materials inevitably leaves fluoride wastes.

Originally, copper and iron smelters were the worst offenders in terms of fluorine fumes and fallout. Around 1900, the very existence of the smelter industry, both in Germany and Great Britain, was threatened by successful suits for fluorine damage, and by burdensome laws and regulations.

Near Anaconda, Montana, cattle developed 'copper teeth' remarkably similar to 'Texas teeth', which was later diagnosed as fluorine poisoning. Tall stacks were built at the Anaconda smelters and those of other towns, to carry fluorine into the upper air.

Then came the aluminium and superphosphate fertiliser industries. In 1912 Bartolucci reported fluorine poisoning of cattle near a superphosphate factory in Italy. The poisoning of cattle around a Swiss aluminium plant between 1912 and 1918 was identified as fluorine poisoning by Christiani and Gautier.

During the 1920s there was growing concern about the hazards of fluoride wastes in Europe and the US. Thus, in 1933, Dr Floyd DeEds, senior toxicologist with the Department of Agriculture, published a 60 page report on chronic fluorine poisoning. He noted the poisoning of plants and animals near aluminium factories, and pointed out that the superphosphate factories were releasing 25,000 tonnes of fluorine into the air, and 90,000 tonnes onto the topsoil each year. He wrote:

> "Only recently, that is within the last ten years, has the serious nature of fluorine toxicity been realised, particularly with regard to chronic intoxication. It is from the viewpoint of chronic intoxication that fluorine is of importance to the public health. A review of the literature shows that the public health aspect of fluorine is manifested in industrial hygiene, in agriculture, and in foods. The latter aspect of the problem is particularly important because of the recommendation and increasing utilisation of fluorine compounds in agriculture."[1]

In 1933 Møller and Gudjonsson wrote of chronic fluorine poisoning among Danish cryolite workers. In

Thomas Outerbridge, *graduate of Colby College, Waterville, M.E. USA, is a writer and has worked for* The Wilson Quarterly *at the Smithsonian Institution, Washington, D.C.*

1937, Kaj Roholm published *Fluorine Intoxication; A Clinical-Hygienic Study.*

In the 1940s, as a result of World War II, there was an enormous increase in the amount of fluoride wastes being produced. "Aluminium, which had been used for pots, pans, and a few aeroplanes, was needed for an entire air fleet" with the consequence that:[2]

> "During the 1940s the Aluminium Corporation of America (Alcoa) alone faced annual claims running into millions of dollars for loss of stock and crops from fluorine poisoning . . ."[3]

In the 1940s the petroleum industry became a fluoride polluter with the substitution of hydrogen fluoride for sulphuric acid in the production of high-test gasoline. One such petroleum plant, it has been estimated, required 500-750 tonnes of hydrogen fluoride yearly.

> "How much of this goes directly into the atmosphere and how much remains in the gasoline to appear in car-exhausts, has never been told.
>
> In any case, the first such plant was put into operation in Los Angeles in 1942, and by a strange coincidence, that was the year of the first complaints of eye-irritating smog. Eye irritation is also the first noticeable effect of hyrogen fluoride for most people.
>
> For several years the Los Angeles papers told about the hydrogen fluoride in the smog; but by the time the reports reached Seattle, fluorine wasn't mentioned. Now it isn't mentioned even in LA, and we are told there is no fluoride in the LA smog. This is strange since there is fluoride in the air of every major city, with or without smog."[4]

Industries were moving into parts of the country not previously exposed to fluorine pollution. For example, steel plants were started in California and Utah, and aluminium factories were built in Washington and Oregon.

At Provo, Utah, some $30 million in damage suits were filed. "Even the deer in the hills around Provo had mottled teeth".[5] In 1950, $9 million was spent on the steel plant there, for the installation of clean-up equipment.

An aluminium plant in Troutdale, Oregon was built and operated for the government by Alcoa during the war. Five tonnes of fluorine (in the form of cryolite, aluminium fluoride, and calcium fluoride) had to be added daily to the baths of molten cryolite, in which the aluminium was made, to replenish losses. An estimated 7,000 pounds a day escaped into the atmosphere.

In 1946 this plant was rented from the government by Reynolds Metals, and in 1950, at a cost of over $2 million, emission controls were installed. In the meantime, millions of dollars in damage suits were filed, and many hundreds of thousands paid out in settlements and judgements.

US Government Response to a Growing Problem

In 1931, H.V. Churchill was able to confirm the connection between the mottling of teeth and fluorine. At this time, the US Public Health Service (PHS) (which was under the Treasury and the Secretary of the Treasury, Andrew Mellon, one time owner of Alcoa) had to recognise fluorine as a potential health hazard. Consequently, Dr H.T. Dean was employed in 1933; his job was to determine the maximum fluorine concentration which could be safely permitted in public water supplies. The PHS was not interested in other sources of fluorine ingestion; it was concerned only with fluorine taken up through drinking water.

In 1935 Dean wrote:

> For public health purposes we have arbitrarily defined the minimal threshold of fluorine concentration in domestic water supply as the highest concentration of fluoride incapable of producing a definite degree of mottled enamel in as much as 10 per cent of the group examined."[6]

Dean found that a fluoride concentration of 1.0 ppm would satisfy the 'minimal threshold'. However, by 1938 he had discovered that "where the fluoride content was just over 1.0 ppm, the examiner might find 'very mild' or 'mild' fluorosis in 25-30 per cent of the children."[7] Rather than change the allowable concentration of fluoride, Dean

> "adopted a new method of reporting in which the per cent of damage did not appear. He invented what he called the 'community index of dental fluorosis'."[8]

On the basis of Dean's work, which consisted primarily of his *21 Cities Study,* the PHS in 1942 set 1.0 ppm as the maximum tolerance for fluoride in public water systems.

The *21 Cities Study,* often referred to by fluoridation proponents, was a survey of over seven thousand children, between the ages of twelve and fourteen, from 21 cities across the US. The cities had water supplies containing naturally occurring fluoride concentrations ranging from 0.0 ppm to 2.6 ppm.

All the variations among the cities in the number of decayed, missing, or filled (DMF) teeth were attributed to the varying fluoride concentrations in the water. In nine of the 21 cities, with fluoride concentrations from 0.0 ppm to just 0.2 ppm, the number of DMF teeth per 100 children ranged from 1037 to 673. Meanwhile the DMF teeth per 100 children in the remaining 12 cities, where fluoride concentrations ranged from 0.3 ppm to 2.6 ppm, were correspondingly lower, lying between 652 to 236.

At the 1951 Delaney Committee hearings to Investigate the Use of Chemicals in Food and Cosmetics, Dean was questioned about the *21 Cities Study.* Under cross-examination:

> Dean explained the embarrassingly high incidence of mottled enamel at Maywood, Illinois, where the DMF teeth per 100 children was 258, (1.2 ppm) and at Marion (0.4 ppm) on the grounds that there had been changes in their water supplies during the lifetime of the group examined. This, however, had not prevented their being retained as a part of the study.[9]

Dean did not mention that similar changes had occurred in Galesburg, Elmhurst, Aurora, East Moline, Joliet, and Elgin, and probably at Lima. This reduces the 21 cities to twelve, nine of which had fluoride concentrations of 0.2 ppm or less, and one, Colorado Springs, with 2.6 ppm. The *21 Cities Study*—the principal study by which the 1.0 ppm fluoride concentration was established by the PHS as acceptable for

all public drinking water—reduces to two cities, Kewanee, Illinois with 0.9 ppm, and Pueblo, Colorado with 0.6 ppm.

A Market for Industrial Waste

Growing public awareness of, and concern over, fluorine pollution, and growing industrial fluorine wastes, could not both continue forever. As well as all of the studies on the ill-effects of fluorine; during the 1930s research was begun into how fluoride waste could be incorporated into the environment.

Dean's work had been on naturally fluoridated areas, and was designed to see what was a permissible fluoride concentration for water supplies. Dr Gerald Cox, working at the Mellon Institute on industrial grants, was looking for a market for industrial fluoride wastes. The connection between mottled enamel and small reductions in caries had already been made. In 1916, G.V. Black and F. McKay claimed that on the evidence available mottled teeth may display an absence of caries, and in 1939 Cox suggested that "the present trend toward complete removal of fluoride from water and food may need some reversal".[10]

The same year a paper appeared by Cox which proposed artificial water fluoridation as a means of reducing tooth decay. Cox was supported by Oscar Ewing, former counsel to Alcoa, who later became Director of Social Security of the PHS. Ewing was instrumental in persuading the PHS to endorse artificial water fluoridation, which it did in 1950.

Fluoride in the water as a caries prevention measure, was given great publicity when, in 1943, *Reader's Digest* published an article called "The Town Without a Toothache". The town was Hereford, Texas, with a water supply containing a natural fluorine concentration of 1.5 ppm to 2.5 ppm. Dr C.W. Heard, the dentist whose report started the publicity, accepted that fluorine might be responsible for the relatively low caries rate in Hereford. But he also suspected other factors, such as the high mineral content of the water and soil, and the food grown on that soil. All of the locally produced foodstuffs were found to be high in phosphorus, calcium, iron, magnesium, and trace minerals. However, the picture in Hereford changed, and in 1951 Dr Heard wrote:

> "It is not true that Hereford, Texas, is a town without toothache. This phrase has been used effectively by people interested in marketing sodium fluoride all over the country.
>
> I have practised dentistry here for years and incidence of tooth decay originally was very low. Considerable research by some dental authorities brought the suggestion that the relatively high content of natural fluorine might be the reason. I accepted this conclusion for a time.
>
> However, as the town grew, and people began to live on processed food . . . tooth decay increased by leaps and bounds. The increase persisted in spite of the fact that people were drinking the same water they drank when they were eating natural and unadulterated foods.
>
> The dental investigators made a serious mistake when they gave fluorine the credit for our good teeth. They overlooked the food grown in our rich, well-mineralised soil . . ."[11]

By the time Heard wrote this, the 'Fluoridation Campaign' had been under way for several years and already had the approval and support of the USPHS, the American Dental Association (ADA), the American Association of Public Health Dentists, State and Territorial Dental Health Directors, the American Public Health Association, the American Water Works Association, the National Research Council, and the American Medical Association (AMA) (the latter limiting its approval to endorsement of the 'principle' of fluoridation).

Artificial Water Fluoridation

The idea of artificial water fluoridation was first put into practice in 1945. Ten-year pilot programmes were begun at Grand Rapids, Michigan and Newburgh, New York. Studies were also begun in Evanston, Illinois, and two in Brantford, Canada. It is on the basis of those studies that the 'Fluoridation Campaign' gained "unqualified endorsement" from the PHS in 1950.

The scientific validity of these studies is questionable in that respect. The control, fluoride-free city to be compared with Grand Rapids over a ten-year trial period was Muskegon, Michigan. Grand Rapids began artificial fluoridation of the water supplies in January 1945. However, five years later, in June 1950, Dr Leonard Scheele, the US Surgeon General, declared before the Congressional Committee that the US Public Health Service gave an "unqualified endorsement" to water fluoridation (HR74 page 1500).[12] Furthermore Muskegon's water supply was fluoridated in July 1951, half way through the trial. The reliability of a mean rate depends on the number of subjects included in the study. Yet,

> "Because of the small number of subjects included in some age groups in some years in Muskegon, little relevance can be placed on the values stated. In twelve categories fewer than twenty children were examined. One 'group' consisted of only one child, whereas the largest contained 462. In the test city the variation in sample size was even greater, from 1,806 to 3 subjects."[13]

Meanwhile, the Evanston study was described as "one of the most elaborate investigations" by the United Kingdom Mission, which came to the US in 1952 to witness the effects of artificial fluoridation.[14] The researchers, Hill and his colleagues, asserted that they had planned the study so as "to measure every variable that might influence and obscure the findings."[15] However as Philip Sutton pointed out:

> "It soon became apparent that Oak Park could not be called the 'ideal control community', for Hill et al (1951) stated that 'Comparison of the caries rates of all children in the study area (Evanston, Illinois) and the control area (Oak Park, Illinois) prior to the addition of sodium fluoride to the communal water supply of the study area indicated a lower caries rate for school children of the control area'."[16]

In addition the UK Mission had to admit that, compared with Oak Park, the economic and dental care level in Evanston was very high. It also stated that:

> "Before fluoridation started a dental survey was made of 4,375 children in the selected groups in Evanston and of 2,493 children in Oak Park. Further examinations have been carried out each year since 1947 and will continue until 1962."[17]

However, the examinations in Oak Park did not begin until after the Evanston water supply had been fluoridated in February 1947. After the initial 1947 examination, no further Oak Park examinations were conducted until 1956, 9 years later.

An example of how the authors of the studies were able to affect the results is seen in the 'weighting' of results. In the 1946 and 1948 Evanston examinations, the six, seven, and eight year old age groups were combined to give a caries rate for the children ranging from six to eight years. In Evanston in 1946 the DMF rate for these age groups was 46.85, 153.49 and 249.93 respectively. Thus clearly, depending on the number of children taken from each group, the average caries rate will be lower or higher than it would be if each group had been equally represented. In 1946, from the age groups of six, seven and eight years, 461, 759 and 771 children respectively, were examined. The corresponding numbers in 1948 were 756, 838 and 440.

Sodium fluoride was added to the Newburgh water supply in May 1945. D.B. Ast wrote in the *American Journal of Public Health* (1950) that with regard to Newburgh and the control city, Kingston, "water supplies at the outset of this study were comparable and have remained so, except for the addition of sodium fluoride to Newburgh's supply."[18] But in fact, both the source and the composition of the two water supplies were different. Especially important were the differences in composition. A 1952 analysis by the US Geological Survey found that for each of the items:

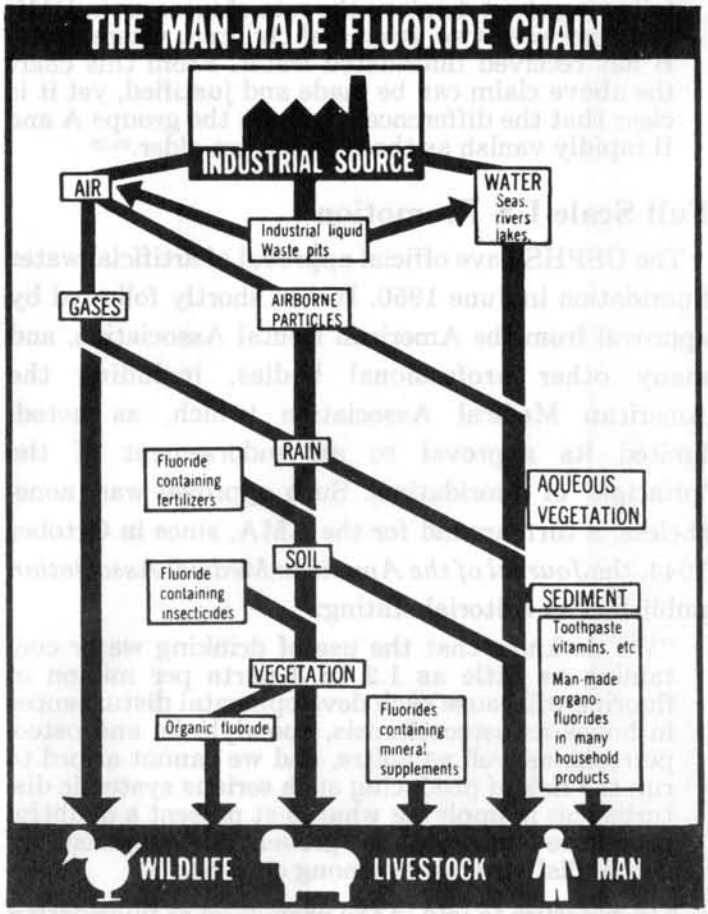
> "magnesium, sodium, dissolved solids, specific conductance, hardness, and alkalinity—the values for the Newburgh water were at least four times as great as those obtained from analysis of the Kingston supply. In the very important matter of calcium content, the Newburgh value of 35 ppm (Ca) was more than five times as large as that of the Kingston one of 6.6 ppm (Ca)."[19]

As with the Evanston study, weighting occurred at the Newburgh trial. Although the authorities stated in 1951 that the DMF rates in the control city of Kingston showed no changes, each of the six, seven and eight year old groups studied showed a decrease in the caries rates between 1946 and 1949.[20] This occurred despite the fact that Kingston "remained fluoride deficient throughout the study period".[21] Meanwhile the claim for no change in the Kingston rates had been based on a method which computed a caries rate for the combined age groups of six to twelve years.[22]

In Brantford, Canada, two independent trials were conducted. In one of these there was no control group. Instead, two pre-fluoridation surveys were carried out by the school dental officer and his assistant.

The other study, carried out by the Canadian Department of National Health and Welfare, was begun in January 1948, nearly three years after fluoridation of the Brantford water supply. Brantford's "dental care was outstandingly good", according to the UK Mission Report (1953). H.K. Brown, one of the authors of this study, wrote in the *Journal of the Canadian Dental Association* (1952) that:

> "the recordings so far obtained indicated both a high treatment and an apparently better oral hygiene status of the Brantford children when compared with the controls, and it is therefore suggested that caution should be exercised in the interpretation of the rates shown. The lack of a prefluoridation survey on a comparable basis is a further limiting factor in interpreting the results."[23]



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The control towns were Sarnia, a 'fluoride-free' city, and Stratford, a city with water containing a natural fluorine concentration of 1.3 ppm.

In the 1955 Division of Medical Statistics, Ontario Department of Health, Report to the Minister of Health, Province of Ontario, Canada, any fall in the dental caries rates of deciduous teeth in the control city of Sarnia was omitted, yet the percentage reduction there was 16 per cent, as compared with 18 per cent in the test city.[24]

Average DMF Per Child

Age	6	7	8	9	10
Group A	0.5	2.0	3.5	5.0	6.5
Group B	0.0	0.5	2.0	3.5	5.0
Difference	0.5	1.5	1.5	1.5	1.5
'Reduction' %	100	75	43	30	23

54 per cent Average

K.K. Paluev, a Fellow of the American Institute of Electrical Engineers and an analyst of experimental data, describes how misleading the whole method of expressing 'reductions' in percentages is. He gives the following example:

> In the words of the PHS and the American Dental Association, "reduction up to 100 per cent with the average of 54 per cent is demonstrated." The

following chart displays the rate of increase in DMF teeth between two groups of children, where group B has received fluoridated water. From this chart the above claim can be made and justified, yet it is clear that the differences between the groups A and B rapidly vanish as the children get older.[25,26]

Full Scale US Promotion

The USPHS gave official approval of artificial water fluoridation in June 1950. It was shortly followed by approval from the American Dental Association, and many other professional bodies, including the American Medical Association (which, as noted, limited its approval to an endorsement of the 'principle' of fluoridation). Such approval was, nonetheless, a turn around for the AMA, since in October 1944, the *Journal of the American Medical Association* published an editorial stating:

> "We do know that the use of drinking water containing as little as 1.2 to 3 parts per million of fluorine will cause such developmental disturbances in bones as osteosclerosis, spondylosis, and osteopetrosis, as well as goitre, and we cannot afford to run the risk of producing such serious systemic disturbances in applying what is at present a doubtful procedure intended to prevent development of dental disfigurements among children."[27]

Yet, pressure to join in the promotion of fluoridation was coming from high places, and in a paper read before the Massachusetts Dental Convention in 1952, Assistant Surgeon General Knutson demanded to know "why are we quibbling, delaying, pigeon-holing, in the face of exhaustive research and overwhelming proof?"[28]

This was at a time when the outcry against sugar and sugar products was growing within the ADA and the American public. The research and propaganda arm of the sugar industry, the Sugar Research Foundation, was one of the earliest advocates of water fluoridation. It gave generous support for research designed to show that America's annual average 100 pound-per-person consumption of sugar was not excessive. In 1949 the Foundation's scientific director, Dr Robert C. Hockett, acknowledged that the dental-caries research was designed "to find out how tooth decay may be controlled effectively without restriction of sugar intake."[29]

As potential suppliers of the fluoride wastes used to fluoridate water supplies, the aluminium industry was an eager promoter. At one point in the 1950s the Aluminium Company of Canada printed a full-page advertisement, recommending the use of 'Alcan sodium fluoride'. The adverts stopped when fluoridation opponents began to use them as proof of commercial involvement.

The 'Fluoridation Campaign' was under way, with millions of dollars and many reputations resting on its success. Professor Albert Schatz of Temple University, a leading researcher in dentistry as well as in cancer, who claimed to have lost his share of the Nobel Prize as co-discoverer of streptomycin because of his outspoken opposition to fluoridation, had this to say about the fluoride controversy:

> "Ever since US dentistry 'created' fluoridation it has been forced to defend it in the face of increasing worldwide opposition from many responsible scientists . . . As a result, the reputation of US dentistry has become irrevocably bound to the fate of fluoridation. A stage has now been reached where the rejection of fluoridation will irreparably discredit the American Dental Association and the National Institutes of Dental Research of the US Public Health Service."[30]

That may not be far from the truth. After the 1950 endorsements of fluoridation, "state and local dental societies were mobilised in support of fluoridation, and dissenters were silenced by an unprecedented gag rule that penalised by expulsion any public criticism of fluoridation.[31] The House of Delegates of the ADA had to invoke Section 20 of its Code of Ethics in 1951 to prohibit dentists opposing fluoridation, on pain of loss of licence to practise."[32]

W.B. Hartsfield, Mayor of Atlanta, Georgia, merely noted in 1961 that "the general public does not realise the gigantic power structure which is pushing fluoridation."[33]

Instances of the professional community's commitment to, and enthusiasm for, fluoridation abound. *National Fluoridation News* published this description of a 'Fluoridation Campaign' effort:

> "Mason City, Iowa . . . was the scene of an interesting fluoridation campaign . . . The fluoridation drum beaters descended on Mason City with the usual misleading literature. The hometown paper was enlisted in the crusade. Endorsements by experts were introduced. Civic groups joined up with the parade. Local doctors issued statements about the deplorable state of children's teeth. The decay rate was so appalling that the local dentists couldn't handle the terrible situation. Dr Charles Henshaw, employee of the Iowa Department of Health came to town to display his charts and graphs to show how 1 ppm could lower the decay in Mason City children's teeth by 65 per cent.
>
> Then someone tested the Mason City water supply and found that it already contained 1.25 ppm—a little more than the magic amount of fluoride. Almost the same thing happened at Ottawa, Illinois, only the water there contained 1.3 ppm of natural fluoride."[34]

By 1967 six million in Canada and 72 million in the US were drinking fluoridated water, "and in the latter country a further ten million people were living in areas where the natural water contained sufficient fluoride."[35]

United Kingdom Joins the Campaign

In 1953 the UK Mission to the US returned and reported on the benefits of fluoride, and made their recommendation to begin pilot programmes in the UK.

> "The mission found no scientific evidence of danger to health from the prolonged consumption of water containing fluoride in low concentration . . .
> The mission concluded that fluoridation of water supplies was a valuable health measure through its effect in reducing the incidence of dental caries . . ."[36]

It was decided that three communities should be fluoridated as trials. Fluoridation began in Anglesey in 1955, in Kilmarnock in 1956, and in Watford the same year. Fluoridation was terminated in Kilmarnock on

October 10, 1962. Prior to the Town Council vote, which brought it to an end, the Medical Practitioners' Union, in London, wrote to express its support for continuing fluoridation. "We believe," it said, "that any change in policy in Kilmarnock could seriously prejudice the Government's decision on a national policy. This is our only reason for intervening."[37]

Town Treasurer, W. Wallace, an opponent of the experiment, had this to say:

> "In the three British study areas—Anglesey, Kilmarnock, Watford—on the figures given, it is claimed that at age three dental decay is reduced by 66 per cent. It is also admitted that at age seven the reduction is only 14 per cent. In plain English, at age seven before fluoridation the average child had seven bad teeth whereas, after five years of fluoridation, six bad teeth. Does any member here consider that achievement of fluoridation outstanding or worthwhile?"[38]

Wallace had also been put off by a remark in the Medical Officer's Report of 1957 (page 42); it read: "As far as possible the same children are examined every year."[39]

Meanwhile the Department of Health and Social Security gave full backing to fluoridation in 'Report No. 105' and did so again in 'Report No. 122', published in 1969.[40]

The 'Fluoridation Campaign' was under way in the UK, and soon had professional support equal to that in the US and Canada. In the October 1970 issue of the *British Dental Journal*, Gordon M. Williams, chairman of the British Dental Association Dental Health Committee, wrote:

> "As soon as dentists recognise their responsibility to the politics of fluoridation, their performance will be outstanding. In politics, the emphasis is on propagandising rather than on educating. In politics, the emphasis must be on commitment rather than detached objectivity . . . In other words, a dentist does not need to know all the vast scientific background to fluoridation—all he needs is the knowledge that fluoridation is safe, effective, and practical, and enough enthusiasm to convince other people that this is so."[41]

In fact, the difference in decay associated with fluoridation is one, or less than one tooth per child. 'Report No. 122' claims that decay of the permanent teeth had been reduced by 43 per cent at age 8, by 36 per cent at age 9, and by 31 per cent at age 10. When improvements in the control areas are deducted, the percentages become 35, 33 and 26 respectively. The reductions claimed represent one or less than one tooth per child.

By 1980, approximately four and a half million people in Britain were receiving artificially fluoridated water.

The United Kingdom's Royal College of Physicians (RCP) took up the question in 1976, and published its findings in a booklet entitled *Fluoride Teeth and Health.*

In placating those who fear the environmental consequences of adding fluoride to the water, the College asserts that "most of the fluoride used would be derived from sources that would otherwise have been discharged to the sea as waste. Fluoridation does not harm the environment."[42] It has been suggested that this explains "why fluoridationists do not carry their efforts to replicate nature to the extent of using calcium fluoride for the process of fluoridation. Calcium fluoride is not, of course, a waste product of industry."[43]

On the basis of past data such as that described here the RCP came to the conclusion that:

> "The statement is sometimes made that fluoridation merely postpones and does not prevent caries. Several factors contribute to the development of caries and the removal of one factor (a relative lack of fluoride) cannot be expected to prevent the others from having an effect in the course of time. This is the case in many diseases. The elimination of one factor among several may, nevertheless, be worthwhile. It is certainly so in the case of fluoride intake and dental caries, since adequate provision of fluoride reduces the prevalence of the disease throughout life."[44]

The report cites the support of the World Health Organisation (WHO) Expert Committee on Trace Elements, and states that this committee has included fluorine in their list of trace elements believed to be essential for animal life. The WHO report states:

> "Since only trace amounts of the element are required by the organism . . . animals and human beings are probably rarely in acute need of it. It is also possible that our present state of knowledge concerning optimal levels and essential functions may be quite inadequate."[45]

Nevertheless, the WHO report does support fluoridation in the areas where fluoride concentration is below the 'optimal level' of 1.0 ppm. We may note that no scientist who spoke out against fluoridation was asked to contribute, and the report's editor, Yngve Ericsson, is well known for his pro-fluoridation stance.

The RCP report makes several references to Dean's work, and to the original US and Canadian studies. All of these references seem to ignore any evidence which might question the validity or conclusions of these studies. The report cites the US Food and Drug Administration as listing fluorine among the essential nutrients. This may have been the case in 1976, but in March 1979, fluorine classification was changed from 'Essential' to 'Non-essential' and now rests in the FDA category of "not generally recognised as safe".

Today we are faced with growing quantities of fluoride in the environment regardless of whether it is added to the water supply. Sodium fluorosilicate is a component of chemical fertilisers, whose use is on the rise. Fluorides are used in insecticides, pesticides and herbicides. Fluorides are still released into the air by the steel, ceramic, superphosphate fertiliser, aluminium, copper, coal, oil and atomic energy industries.

In the US, after over 25 years of fluoridation, Grand Rapids, Newburgh and Evanston have almost twice as many dentists per unit population than the average figure for the whole country. Granted this proves very little; but maybe Professor J.C. Muhler of the University of Indiana was more than pure cynic when he said in 1963 that "the great benefit of fluoridation to dentists was the fact that the enamel became so brittle that dentists needn't waste time on ordinary fillings but could concentrate on the more profitable work of fitting crowns."[46]

In the UK the British Dental Association now suggests that pressure be put on education authorities to include pro-fluoridation projects in school. In the US, sugar and sugar products account for more than $8 billion in sales annually. In 1985 the Sugar Association sponsored a $2 million sugar campaign. Per capita annual consumption in the US is up to 118.1 to 126.8 pounds.

None of the professional endorsers of fluoridation, not the AMA, ADA, USPHS, BMA, BDA or RCP have done any comprehensive research into the safety of the free fluoride ion in a living organism. Fluoride is everywhere in our environment. It is in the food, air and water, and now in gels, toothpastes, tablets and other drugs. Today fluoride has a positive image, built up over just a few decades; to oppose artificial fluoridation is to attack the health of our children's teeth, and to raise objections by bringing in any other considerations is to be guilty of layman ignorant stubborness.

Arguments against artificial water fluoridation can come from several angles. The economic argument: the small decrease in decay does not warrant the cost of fluoridating an entire water supply, especially when fluoride has no effect after the teeth have formed. The moral argument: Fluoridation is a form of compulsory mass medication. The health argument: The safety of artificial fluorides has in no way been proven, and there is increasing evidence to the contrary.

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Fluoride: New Grounds for Concern

By Mark Diesendorf and Philip R.N. Sutton

The sugar industry and the aluminium industry have benefitted from the fluoridation campaign, the sugar industry because of claims that fluoride will prevent decay, even with the consumption of sugary foods, and the aluminium industry as a means of getting rid of fluoride wastes. But what are the health consequences of consuming fluoride-enriched produce? As Drs Diesendorf and Sutton point out in this article, evidence is now accumulating that fluoride from fluoridated water supplies is leaving in its wake a host of chronic disease, from fluorosis of the skeleton to genetic effects. Excess fluoride may also be responsible for cancers. If fluoride does have any beneficial effects, it has become clear that they are far outweighed by the damage it causes.

The intake of fluorides, salts of the element fluorine, has increased markedly over the past quarter century. Fluorides are added to a number of consumer products, such as toothpastes, mouth-rinses and gels, in order to try to reduce tooth decay in children. Moreover, fluoridation, the addition of fluorides to town water supplies, contributes to human fluoride intake a considerable involuntary component, a large part of which is derived from foods processed in, and drinks reconstituted with, fluoridated water.

Even very low levels of fluoride in water and air are damaging to certain species of plants. High doses are well known to be poisonous to animals and humans—indeed, sodium fluoride is used as a rat poison.

How safe are fluoride products and fluoridation for people? Are they really as beneficial for children's teeth as dental and medical associations in extensively fluoridated countries, such as Britain (10 per cent fluoridated), the USA (50 per cent) and Australia (67 per cent) claim? Should people be, in effect, compelled to drink fluoridated water? Who profits from the marketing of products which are supposed to reduce tooth decay,

even though children continue to eat junk food? Fluoridation, and the marketing of other fluoride products, raise scientific controversies, unresolved ethical issues and political questions. They are matters worthy of serious scrutiny.

On the world scene, there are considerable divisions of opinion. In continental western Europe, fluoridation was introduced beyond the pilot plant stage only in Sweden, the Netherlands and West Germany. In each of these countries, after trials lasting many years, it has been terminated on health and/or ethical grounds. In contrast, Australia, is one of the most extensively fluoridated countries in the world. In some circles in Australia, those who question fluoridation are branded as "ignorant cranks".

Nevertheless, in this article, we attempt to draw attention to scientific evidence, published in international journals over the past five years, which indicates new grounds for concern about potential health hazards from low doses of fluorides. We also explain why the claims that fluoridation is responsible for the substantial reductions in tooth decay observed in developed countries, are being examined with growing scepticism by scientists.

On the question of risks, some dental and medical authorities have somehow managed to convey the incorrect impression that, apart from strengthening teeth, fluoride is inert in the human body and is therefore harmless. The biochemistry and physiology of fluoride in the human body contradict this notion. Not only is fluoride incorporated into teeth, but also into bone and many soft tissues. On account of its small size, the fluoride ion is very active

biochemically, possibly only exceeded in activity by the hydrogen ion. It is therefore not surprising that a wide range of adverse effects on biological systems and on human health have been reported in the scientific literature. We first draw attention to a group of people who may be at particularly high risk.

Bottle-fed Infants

Infants who are fed with milk formulae prepared with fluoridated water take in about 100 times the amount of fluoride which they would receive from breast milk. This is because there is a kind of physiological "barrier" which largely prevents fluoride from entering breast milk, even when the mother is on a relatively high fluoride diet. This barrier could have evolved to protect the developing infant in environments which have naturally higher than average fluoride levels. It is widely accepted by nutritionists that breast milk contains the optimum amounts of all nutrients required for the proper development of the infant, at least for the first few months after birth. One wonders what the massive unnatural overdose of fluoride is doing to bottle-fed infants, particularly since it is now known that breast-fed infants remove fluoride from their bones and excrete more fluoride than they ingest.

Genetic Damage

Genetic effects are inherited effects. They are known to be produced by quite a large number of chemicals in the environment and by ionising radiation. In the 1970s, several scientific papers reported that fluoride causes genetic damage to some plants and animals, and to animal cells grown in tissue culture on suitable nutrients in the laboratory. At that time there were some contradictory reports and the situation was unclear.

However, since 1980 several scientific papers have been published in major international journals showing clearly that, under certain conditions, fluoride damages the DNA molecule, hence the primary genetic material which contains the genes.

In particular, a group at the Nippon Dental University in Tokyo has shown that fluoride disrupts the DNA in cells taken from the human mouth and from the human foreskin, and grown in tissue culture. Although the fluoride concentrations used in these experiments were much greater than that recommended by the pro-fluoridation dental associations for fluoridated water (about 1mg fluoride per litre of water), the concentrations were comparable with those existing in people's mouths, following teeth cleaning with fluoridated toothpaste, mouth rinsing with a fluoridated rinse, or application of a fluoridated gel to the teeth.

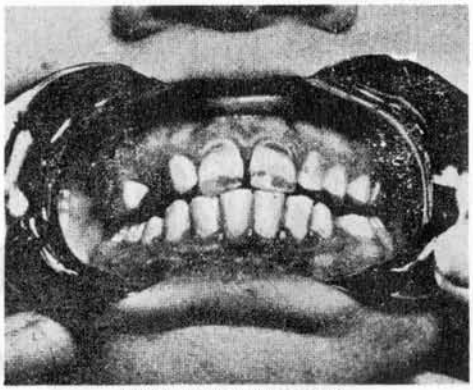
The observation of genetic damage raises the question as to whether consumers should continue to use these fluoridated products. It also suggests the possibility that using fluoridated water may produce genetic effects; to elucidate this, more experiments are needed at lower fluoride concentrations. It should be noted that some genetic effects, such as changes in mitosis and DNA synthesis in cell cultures, have been reported at fluoride concentrations as low as 1.5mg/litre.

Cancer?

Chemicals which are mutagenic are also often, though not always, capable of inducing cancer in humans. Some of the experiments mentioned in the previous section provide strong evidence that fluoride is a mutagen. But is it also a human carcinogen?

So far, epidemiological studies do not seem to have established a higher cancer mortality rate in general in fluoridated cities compared with unfluoridated cities. However, it should be borne in mind that epidemiological studies generally contain a number of untested assumptions, such as the selection of data and procedures for analysing that data, and so a clear-cut answer cannot be given at this stage. If there is a cancer risk, it is possible that it mainly occurs at the higher levels of fluoride exposure corresponding to the use of toothpastes, gels and mouth-washes.

Nevertheless there are genuine grounds for concern. Experiments carried out in 1984 indicate that at least one type of mammalian cell, grown in fluoride-treated culture, induces tumours when injected back into the living mammal. Untreated cells do not have this effect. While there is still a big gap between the result of this kind of experiment and the direct induction or the acceleration of the development of cancer by fluoride in humans, the evidence remains worrying.



Mild dental fluorosis.

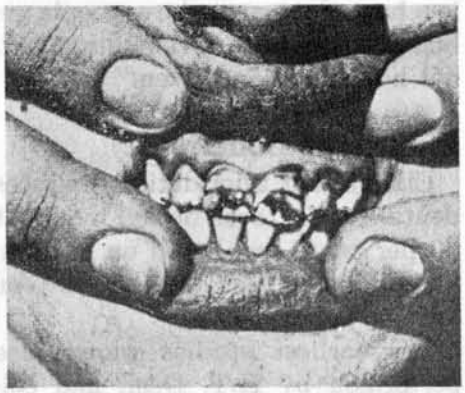
Enzyme Inhibition

Enzymes are proteins which act like catalysts to facilitate and control chemical reactions in living creatures. For many years, it has been known that fluoride interferes with the action of a number of enzymes in the human body. The health implications of these changes are still unknown, but the possible damage is profound and diverse.

One of the main research advances in this area in the 1980s has been to shed light on the mechanism by which fluoride inhibits enzymes. Fluoride can interfere with an important chemical bond, known as the hydrogen bond. This results in changes in the shape of enzyme molecules, effecting their ability to fulfil their functions. With regard to DNA, which is like a spiral staircase consisting of two bannisters held together with hydrogen bonded steps, fluoride, by affecting those hydrogen bonds, can completely disrupt the molecule, readily accounting for the genetic damage mentioned earlier.

Well-known Health Hazards

Prior to 1980, evidence for the existence of a number of other ill effects from ingesting fluoridated water, fluoride toothpaste and tablets was reported in the scientific literature but ignored or denigrated by the promoters of fluoridation. We mention here only those hazards which are well documented. However, these could be just the tip of



Moderate dental fluorosis.

the iceberg. The problem is that Australian, British and USA doctors are incorrectly led to believe by their professional associations that there are no adverse effects from fluoridation and the use of fluoride-containing products, apart from the mottling of teeth. Even this effect is stated to be so slight that it can be detected only by experts.

■ **Dental fluorosis**

Dental fluorosis (mottling of teeth) is not just a "cosmetic" problem. Amongst fluoride researchers, it has been recognised for many years as the first visible sign of chronic fluoride poisoning. It used to be considered that mottled teeth would occur in about 10 per cent of children who drank water with fluoride concentrations at or near the level recommended by fluoridation promoters. Recently, evidence has been published that this percentage has risen substantially in some fluoridated areas, such as Auckland, New Zealand, where about one quarter of the children are affected. A contributing reason for this increase must be the substantial increase in the fluoride dose which is now ingested from numerous sources by many populations (see below).

■ **Skeletal fluorosis**

A bone disease called skeletal fluorosis is prevalent in several parts of the world (e.g. India, Qatar and Japan) where drinking water naturally contains fluoride in concentrations equal to or slightly above that recommended for fluoridation. Skeletal fluorosis involves changes in the bone structure which are generally detectable on x-rays. Extreme cases (such as those often seen in India) have readily visible symptoms and include crippling of those affected. These extreme forms have not been reported in Australia, probably because other factors are important, such as nutrition which may be inadequate in those with symptoms. It is now increasingly recognised that the nutrition of many Britons, Americans and Australians falls far short of being adequate. To date no scientific study has been carried out in those countries to identify the extent of skeletal fluorosis.

■ **Haemodialysis**

In the 1970s, several major overseas hospitals, such as the Mayo Clinic, Ottawa General Hospital and Montreal General Hospital, reported cases of serious bone diseases in patients undergoing long-term treatment on kidney machines which used fluoridated water. Nowadays, many (but not all) kidney machines have a "filter" to remove fluoride from the water.

■ **Intolerance to Fluoride**

In a small fraction of people, fluoridated water, fluoride toothpaste and fluoride tablets produce a variety of intolerance effects, including skin eruptions, gastric upsets, headaches, increased desire to urinate and, in the case of toothpaste, mouth ulcers. All of these effects have been reported by clinicians in the medical literature. Some have been confirmed by a "blind" and a "double blind" controlled trial.

Fluoride Dose

The fluoridation of water supplies is called "controlled fluoridation" by proponents because the aim—often not achieved—is to add fluoride to town water supplies at a fixed concentration: namely, about 1 mg of fluoride per litre of water in temperate climates. However, the term "controlled" is misleading because the individual dose of fluoride depends not only on the concentration in the water but also on how much water (and tea, beer, soft drink, reconstituted fruit juice, etc), people drink, and on how much food processed with fluoridated water they eat.

As recently as 1971, leading proponents of fluoridation from the dental profession and even the US National Academy of Sciences stated that the total average daily intake of fluoride from fluoridated water, from both direct and indirect pathways, was only about 1 mg for an adult. These authorities seemed unaware that measurements had already been made on sedentary people yielding daily intakes of 2 to 5.5 mg. In manual labourers, these intakes may be doubled. To these figures must be added the intake from atmospheric pollution and from natural sources (e.g. strong tea made with water originally having a negligible fluoride content contains about 2 mg per litre) and consumer products (e.g. dentifrices and some medical drugs).

Recent studies have shown that young children (ages 2-6) swallow about one-third of the toothpaste applied to the brush, producing a substantial peak in the fluoride concentration in the blood plasma. Since the concentration of fluoride in toothpaste is about 0.1 per cent, daily doses of fluoride of 0.5mg from toothpaste are likely.

We believe that the current practice of marketing fruit-flavoured fluoride toothpaste is dangerous. A single 75gm tube contains about 75mg of fluoride. There is no doubt that this is a toxic dose, which could even be fatal for some children. How is it that our medical and dental authorities have allowed fruit-flavoured fluoride toothpaste onto the market without making a public protest? The answer, we suggest, lies in the close relationship between some of these authorities and commercial interests, and in the perceived requirement not to shake public confidence in the safety of fluoride, even to the extent of suppressing information about its well-recognised dangers.

In heavily fluoridated countries such as Australia, it is not uncommon for children to receive fluoride not only directly and indirectly from the water supply and from natural sources, but also from atmospheric fluoride pollution, fluoride tablets, toothpaste, mouth-rinses and gels (about 1 per cent fluoride). In our experience, when medical and dental authorities campaign for the fluoridation of a town water supply in Australia, they make no serious attempt to assess the total fluoride intake which citizens may already be receiving.

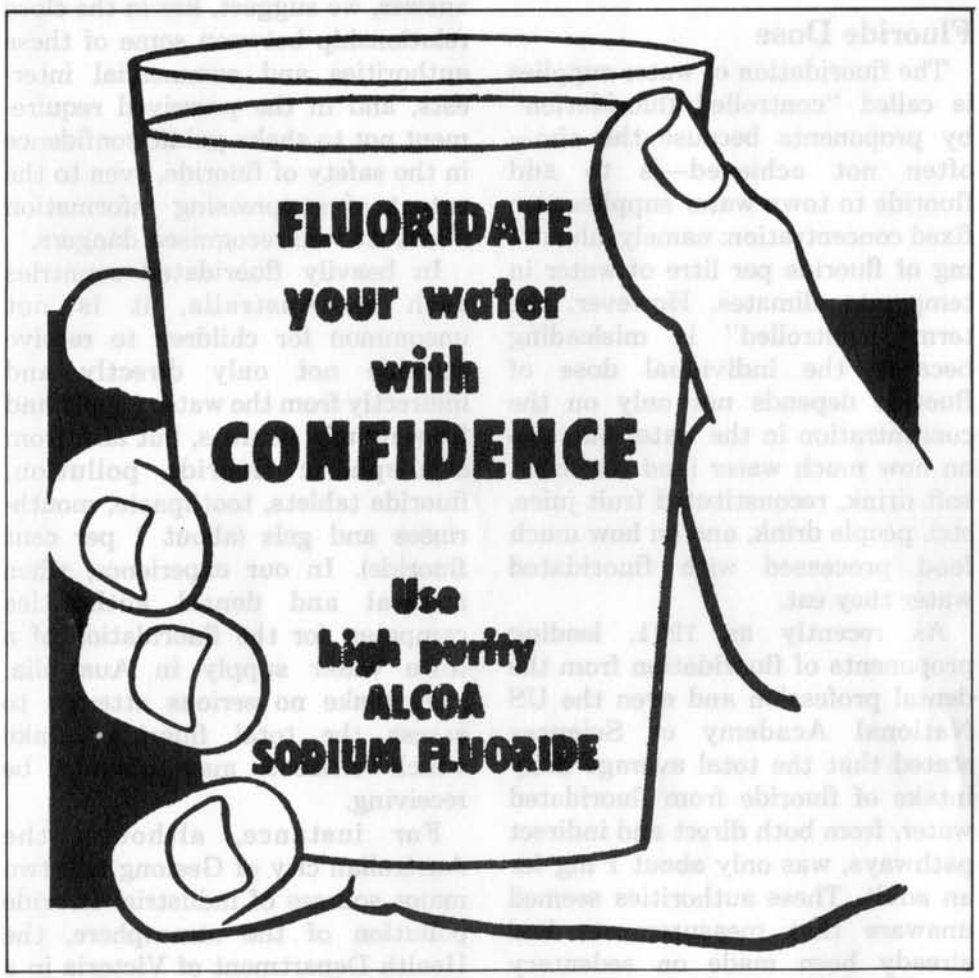
For instance, although the Australian city of Geelong had two major sources of industrial fluoride pollution of the atmosphere, the Health Department of Victoria in a recent letter to the Geelong Water

Trust admitted that it had not determined the fluoride levels in the population of any Victorian town before advocating fluoridation. The Department had, therefore, disregarded the resolution of the World Health Organisation which specified that fluoride intake from other sources must be taken into account when considering the introduction of fluoridation.

Readers may be surprised to learn that there is no official "safe" daily dose of fluoride expressed in mg per kg of body weight per day. Dentists and state authorities seem to think only in terms of fluoride concentrations (in mg per litre) in the water supply which, as the volume drunk is not considered, bear little relation to doses ingested by individuals. For the one ill effect of fluoridation which is generally conceded even by proponents, dental fluorosis, we cannot find even one study of its dependence on dose. This is just one indication of the inadequacy of the research done to back up claims for the safety of fluoridation and fluoride products.

The incomplete data available suggest that the total daily fluoride dose in fluoridated areas is likely to average at least several mg and, for physically active people, could be over 10mg. For comparison, the controlled trials in which intolerance reactions to fluoride were observed, delivered just 1mg of fluoride per day. Even the profluoridation British Royal College of Physicians admits that some patients, when given as little as 9mg per day fluoride in tablets, with the aim of treating osteoporosis, experience nausea, gastric upset and sometimes vomiting. Clearly, if there is a margin for safety for the "average" person, it must be very small. Because of human variability and because of the lack of a controlled dose, it is inevitable that for some individuals there can be no margin of safety.

Nearly 30 years ago, B.C. Nesin, the Director of Laboratories of the New York Water Supply, said that the minimum safety factor is 10mg for substances which are admitted to a water supply, and that such a factor cannot be established with fluoridation at 1mg per litre. He added: "It must be concluded that the fluoridation of public water supplies is a hazardous procedure, people are bound to get hurt, it remains to find out how many and when."



A 1950s US aluminium industry advertisement.

Enormous Benefits?

Claims that fluoridation "reduces dental caries (tooth decay) by about 60 per cent" are based on studies, "trials", or "demonstrations" on various populations.

The earliest studies were those performed by H.T. Dean and colleagues in naturally fluoridated regions of the USA. It is claimed that these studies demonstrate a reduction in tooth decay proportional to the concentration of fluoride in the water supply. Unfortunately, from a scientific perspective, the fact that these studies were qualitative rather than quantitative in nature, the non-random method of selecting data and the high sensitivity of the results to the way in which the study populations were grouped, all show that no firm conclusions can be drawn from these early studies. Indeed, Ziegelbecker, a mathematician, analysed a much larger data set which included that considered by Dean and could not find any relationship between fluoride concentration in drinking water and tooth decay.

The next set of studies, which were used to justify the extensive fluoridation programme in the USA (and subseqently in Australia), took place in several artificially fluoridated towns in North America. These "demonstrations" have been criticised rigorously in a book by Sutton, on the grounds of inadequate experimental design and inadequate statistical analysis. Sutton's critique is generally not cited in the pro-fluoridation literature, despite the fact that it has never been refuted.

Notwithstanding the poor scientific status of the above-mentioned studies in both naturally and artificially fluoridated regions, these studies are still cited as the basis for fluoridation in many pro-fluoridation reviews and reports, including the 1976 report of the British Royal College of Physicians.

"Demonstrations" of the alleged benfits of fluoridation have been performed in several other countries. A few of these, such as some of

the early studies in Britain, were better designed experimentally, to the extent that they had unfluoridated control populations and the dental examiners did not know which children came from the control population and which came from the fluoridated test region. (This elementary precaution against bias was not taken in the North American trials.) The selected data from these studies published by the UK Department of Health in 1969 suggested a modest contribution from fluoridation: a reduction in tooth decay of about one cavity per child in fluoridated regions compared with unfloridated controls of the same age. However, the rate of increase in tooth decay with age was the same in both fluoridated and control cities. A possible interpretation of the data is that there is a delay of 1-2 years in the onset of tooth decay in the fluoridated cities.

The vast majority of the fluoridation "demonstrations" have been no better in scientific standard than the North American ones. Some have even been worse. For instance, none of the Australian studies on permanent teeth had a genuine control population. Moreover, it appears that only one study had adequate baseline data that is, a series of examinations of tooth decay over several years before a population is fluoridated.

It is important to have a control population and to have sufficient baseline data to obtain the time trend in tooth decay before fluoridation so as to find out whether the observed reduction in tooth decay over a period of years is caused by fluoridation or by other environment and lifestyle factors.

There is now growing evidence that tooth decay has greatly decreased in a number of developed countries in *both* fluoridated and unfluoridated regions. For example, in Sydney, Australia, the Health Commission of New South Wales has reported that the proportion of children with "decay-free" teeth increased from 8 per cent in 1961 to 58 per cent in 1967. However, Sydney was only fluoridated in 1968, and the Health Commission has not published any evidence to support the notion that fluoride tablets and fluoride toothpaste were widely used in Sydney in the above period.

Furthermore, the maximum possible benefit (if any) from fluoridation would surely be achieved for children who have consumed fluoridated water from birth. Yet there is a growing body of evidence which suggests that such "optimally exposed" children have much less tooth decay today than "optimally exposed" children of the same age several years ago.

So it is likely that fluoridation plays a minor role in reducing tooth decay. By pushing strongly to achieve total fluoridation in Britain, the USA and Australia, the promoters are in effect destroying scientific evidence which is unfavourable to their policies.

Misleading Statements

It is not often that State and Commonwealth Departments of Health, and a leading consumers' organisation, publish information which is misleading and, in some cases, demonstrably false. Unfortunately, this has been the situation with regard to the issue of fluoridation.

Two examples of such publications are:-

1. The anonymous article originally published in the USA magazine, *Consumer Reports*, and reprinted verbatim in the August 1979 issue of the Australian consumers' magazine, *Choice*;
2. The introduction to the 1978-79 Annual Report of the Australian Director-General of Health.

A complete analysis of the misleading information in these two articles would require a whole paper in itself. Yet it is important to try and set the record straight. Therefore, we shall mention only some of the basic misleading

Who profits from Fluoridation

Fluoride is promoted as a kind of "magic bullet" which is supposed to prevent tooth decay harmlessly whatever junk food children may eat. Clearly the promotion of fluoridation and other fluoride products assists the manufacturers of foods containing large amounts of sugar and other refined carbohydrates to prosper.

One of the principal fluoridation-promoting bodies in Australia, the Dental Health Education and Research Foundation (DHERF), is associated with the University of Sydney. The 1979 Annual Report of the DHERF contained a list of financial donors, the "Honour role of contributors". These included the Coca Cola Export Corporation, the Wrigley Co., the Australian Council of Soft Drink Manufacturers, the Colonial Sugar Refining Co., Arnotts Biscuits, Cadbury Schweppes, Kelloggs and Scanlens Sweets.

From the DHERF's total expenditure of $199,000 (Australian dollars) in 1979, $43,000 was explicitly designated for "Fluoridation promotion". Out of $97,000 designated for "Research and educational programmes" and "Publications and films" a large part was also devoted to fluoridation. The promotion of good nutrition including the avoidance of sugary foods, appears to play a very minor role in DHERF's educational and reserach programmes. Yet it is just these foods, not a so-called "fluroide deficiency", which comprise the principal cause of tooth decay.

Another likely beneficiary of the public health image of fluoride is the aluminium industry, which funded some of the early American research on the alleged relationship between tooth decay and the natural levels of fluoride in town water supplies. Subsequently the industry advertised its fluoride for use in water fluoridation programmes in the USA. However, the indirect financial gains to the industry from fluoridation may be considerably greater than those from selling the fluoride. Indeed, it is only in the past six years or so that discussion of fluoride pollution from aluminium smelters has started to become "respectable" in Australia.

Not that this is a deliberate conspiracy between dentists and big business. Most people have the best of motives, and there is no reason to question that bodies such as the DHERF and their donors wish to improve children's teeth. It is sufficient to identify the links between elite dental researchers on one hand and the sugary food and aluminium industries on the other, and to point out that the dental researchers may be in a position of inadvertent conflict of interest. The existence of innocent participants does not weaken the hypothesis that the primary pressure for fluoridation originates from the sugary food and aluminium industries. Dentists and to a lesser extent doctors and health administrators play the role of unwitting "cadres" who perform both the research and the promotional campaigns for fluoridation. These activities are funded in part from the additional profits which fluoridation brings to the primary pressure groups.

Mark Diesendorf and Philip R.N. Sutton

terminology in these and other profluoridation articles, and give just one example of a false statement.

The *Choice* article implies wrongly that fluoride has been shown to be an "essential nutrient". However, fluoride, at the levels recommended by pro-fluoridation dental associations, is neither "necessary" nor "sufficient" for sound teeth. In other words, people can have sound teeth without fluoridated water, toothpaste, or tablets and people can have very decayed teeth even though they use all the fluoride paraphenalia. The quality of your teeth depends on a broader range of factors than the presence of virtual absence of fluoride. But, are traces of fluoride, much smaller than those considered above, necessary for life? This has never been established scientifically. Indeed, in 1979, the USA Food and Drug Administration ceased listing fluorine as "essential or probably essential" in human nutrition. In any case, the question of the essentiality of fluorine is irrelevant to the issue of fluoridation and the use of fluoridated products, because minute traces of fluoride are always present naturally in the diet.

The Australian Director-General of Health referred to a "deficiency of fluoride", but there cannot be any such condition. How can there be a deficiency of something which is not even necessary?

The use of the above misleading terminology—"controlled fluoridation", "essential nutrient" and "deficiency of fluoride"—by the promoters of fluoridation and fluoride products is not the language of science but rather that of advertising and public relations masquerading as science.

An example of a statement in the *Choice* article which is factually false, rather than just misleading, occurs in the section headed "Claim: fluoride is a poison". In speaking of chronic fluoride toxicity in India (where skeletal fluorosis is a major manifestation of such toxicity), a paragraph in this section creates the false impression that such ill effects "are associated with water supplies that contain at least 10ppm of natural fluoride". In fact, in India a number of cases of skeletal fluorosis have been found in several regions where water supplies contain concentrations around 1ppm (1mg per litre). Indeed, it is for this reason that the Indian scientist, S.G. Srikantia, has recommended that the upper limit for fluoride in drinking water be set around 0.5ppm.

The existence of many uncorrected false and misleading statements in apparently authoritative articles promoting fluoridation can be understood in the light of our experience that until the 1980s it was almost impossible to publish or broadcast articles, letters and radio talks which raised awkward questions about fluoridation. Such was the power and influence of the profluoride lobby. In fact very few fluoridation proponents have actually studied the original scientific literature. Organisations which have endorsed fluoridation have done so on faith, relying on the opinions of a small core of active promoters, on the basis of a detailed study of the issue.

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Philip R.N. Sutton DDSc FRACDS *was appointed senior lecturer in Dental Science in 1963 at the University of Melbourne's School of Dental Science, but resigned in 1974 to have more time to extend his studies on dental conditions in Polynesia and Micronesia. In 1959, Melbourne University Press published the first edition of his monograph, "Fluoridation: Errors and Omissions in Experimental Trials", which he updated in 1980.*

The Hastings Fluoridation Experiment: Science or Swindle?

By John Colquhoun and Robert Mann

Those in favour of fluoridation have hailed the Hastings Fluoridation Scheme in New Zealand as valuable evidence of the benefits on children's teeth of fluoride. However, studies of the Scheme, such as by the authors, show it to be seriously flawed from a scientific point of view. In fact, the data reveal no positive advantage to children's health as a result of being exposed to fluoride in water.

The controversy over fluoridation of public water supplies is normally seen as a weighing of costs against benefit. The costs, apart from financial inputs, are claimed to be various illnesses which have proved difficult to quantify or even to attribute to fluoridation. The benefit is taken to be causation of major decreases in tooth decay. One of the surveys usually cited as showing this benefit has now been found to show no such thing.

The Hastings fluoridation study in New Zealand, 1954-1970 (*New Zealand Dental Journal* vols 54, 55, 58, 59, 61, 67) is listed in textbooks throughout the world as an important study confirming the effectiveness of water fluoridation (e.g. J.J. Murray *Fluorides in Caries Prevention.* Wright, Bristol, 1982). Data from the study were used by O. Backer Dirks, the distinguished European researcher and advocate of fluoridation, in one of his better known and oft-cited published papers (*Caries Research,* vol. 8 suppl. p2). Professor Murray's book, after reviewing the famous United States' trials, saying of the Backer Dirks and Hastings studies that they reinforced the European finding because "free smooth-surface caries was reduced by 87 per cent . . . approximal caries by 73 per cent . . . and occlusal surface caries by 39 per cent . . ." The greatest reductions were among 6-year-olds—74 per cent by 1961 and 87 per cent by 1964—but the greatest part of these had occurred in the first few years of the project: 42 per cent by 1957 and 61 per cent by 1959. These spectacular reductions, following a Commission of Inquiry report in favour of fluoridation, (Government Printer, Wellington, 1957), led to acceptance of widespread fluoridation in New Zealand.

Hastings was chosen for such an experiment because its Council had already decided to fluoridate its water supply, the first to do so in New Zealand, following an approach from the local branch of the Dental Association. It was considered to be a 'typical' New Zealand population, and therefore ideally suitable. At first described as an 'experiment' with a neighbouring town, Napier, using essentially the same groundwater unfluoridated (0.15 ppm), as "an ideal control" (Cabinet decision, March 1952, National Archives), the project was later changed to a before-and-after 'demonstration' (*NZ Dental J,* vol. 58 p219).

The study's initial dental surveys of children in the two towns were not carried out until late 1954, almost two years after Hastings was first fluoridated. The follow-up survey in 1957 was reported to show a dramatic reduction in dental decay in Hastings after only 27 months of 'continuous fluoridation'. However, both the first and follow-up surveys had shown that the younger (under 10-year-old) control children had significantly less decay than the children of the same age in Hastings. It was said that a special protective factor—the trace element molybdenum in recent marine soil—had caused Napier decay rates to be below the average for the country. Because of that difference, the decision was made to discontinue the use of Napier as a control. Child dental decay rates being very high in New Zealand, it was reasoned that further continuous and marked reduction of dental decay among Hastings children would establish the effectiveness of fluoridation.

The Hastings study was carried out by Mr (later Dr) T.G. Ludwig, who replaced Dr R.E.T. Hewat as Dental Research Officer of the New Zealand Medical Research Council. Both have since died. Ludwig worked under the direction of the Fluoridation Committee of the Department of Health in Wellington. Most members of that Committee were officers of that Department. Co-opted on to it was a representative of the New Zealand Dental Association, Colonel (now Brigadier) J. Ferris Fuller. The latter became its chairman, and soon assumed a major role in direction of the Hastings operation. Ludwig's work also required the approval of the Dental Research Committee of the

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Medical Research Council, centred in Dunedin with the University of Otago's Dental Faculty, which followed the project closely. Colonel Fuller later became chairman of that Committee as well.

The New Zealand Official Information Act 1982 has made available for public perusal the archives of government departments. Department of Health Head Office files (nos 125/299, 125/299/1, 2 & 3 and 124/30/31 & 33) now held in National Archives, Wellington, and other official and professional sources reveal a considerable amount of information not in agreement with the currently accepted published version of the Hastings fluoridation study:

1) The claimed reductions in decay, which were greatest for the younger children, were brought about partly if not mainly by a local change in diagnostic procedure following the introduction of fluoridation.
2) Reductions over such short periods are, by today's statistical standards, beyond the "limit of credibility" for genuine decay reductions.
3) A reduction in dental decay occurred in other, non-fluoridated, places throughout New Zealand during the time of the study, making it difficult for public health officials to present convincing statistics showing that the claimed reductions were related to fluoridation. The reduction occurred in the control town as elsewhere.

Change in diagnostic Procedure

Most of the younger children involved in the experiment received their dental treatment regularly at school dental clinics, staffed by the then unique New Zealand grade of dentist called "school dental nurse". In a 1957 report to the Fluoridation Committee, entitled "Investigation of diagnostic standards of dental nurses in Hastings and Napier" Ludwig expressed concern that "the meticulous diagnostic standards of the dental nurses in Hastings might overshadow any improvement in the caries prevalence resulting from fluoridation". During the latter part of 1955, he wrote, he met each nurse and explained to her the diagnostic standards required by the study and illustrated these standards by examining a number of children in company with her. "While this procedure enabled one or two nurses to cooperate effectively by taking a more lenient view of possible very early carious lesions it did not seem to be successful generally . . ."

The report continued: "To determine the actual extent of the problem the following course was adopted. Each dental nurse operating in Hastings and Napier was asked to examine twenty children, record her findings and then to leave these children untreated until further notice. The nurses were not informed of the purpose of the examinations. The dental research officer and the Principal Dental Officer for Hawke's Bay then visited the Hastings and Napier clinics and examined suitable children previously examined by the nurses. The results of the three examiners were then compared and those for Hastings are given in Table 1. The results for Napier are given in Table 2 and include the results of the nurses and of the dental research officer only. The findings tabulated apply only to carious lesions upon the occlusal surfaces of molars . . ."

These tables summarised the results of the dental research officer for 7 Hastings and 4 Napier school dental nurses. They show that on average the dental nurses, even after two years of persuasion to alter their earlier standards which were still maintained in the rest of New Zealand, were still finding almost four times as many cavities requiring fillings as the new diagnostic standards required. Subsequently Ludwig reported to the Department on which dental nurses were and were not 'co-operating'. The problem was also discussed with private dental practitioners in the two towns.

Most of the permanent tooth fillings for 6- and 7-year-old children were in the "occlusal surfaces of molars" mentioned above. This change in diagnostic procedure followed much discussion within the Fluoridation Committee. In 1954, it had been agreed to instruct school dental nurses in Hastings and Napier to cease inserting 'prophyl-

Tables 1 and 2. Reproduced exactly from T.G. Ludwig's report to Fluoridation Committee: "Investigation of diagnostic standards of dental nurses in Hastings and Napier." The "diagnostic standards required" after the experiment's initial dental examinations called for a reduction in the number of cavities requiring filling to almost a quarter of the number found by the dental nurses using their earlier standards.

TABLE 1

Comparison of Diagnostic Standards of Hastings Dental Nurses, T.G. Ludwig and Principal Dental Officer (Gisborne).

	Hastings Nurses	T.G.L.	P.D.O.
No. of Patients Examined	51	51	51
No. of Lesions Diagnosed as Carious	77	20	22
Average Number of Lesions per Child	1.51	0.39	0.43

TABLE 2

Comparison of Diagnostic Standards of Napier Dental Nurses and Dental Research Officer

	Napier Dental Nurses	T.G.L.
No. of Patients Examined	32	32
No. of Teeth Diagnosed as Carious	75	23
Average No. of Teeth Carious per Child	2.34	0.72

Source: Department of Health file: Fluoridation, Hastings Study 1956-70, National Archives, Wellington.

actic fillings'—that is, small fillings placed, as a preventive measure, in pre-carious (not decayed but considered likely to decay) fissures on the occlusal (biting) surfaces of permanent molar teeth—and also to discontinue applying fluoride solution topically. In a report sent to the Committee in 1957 entitled "Effect of prophylactic fillings and examination criteria on the results to be expected from fluoridation" a Dental Faculty member recommended "a re-evaluation of the criteria now used in deciding when a cavity should be filled" and "that no cavity should be filled until the lesion has penetrated the enamel." It was originally intended to record changing decay rates in both Hastings and Napier, so that the difference between them would show the fluoride effect.

There can be no doubt that Ludwig and the Committee members sincerely believed, in the authors' view correctly, that dental nurses and private dentists were filling many teeth which should not definitely be classed as 'carious'. They also believed that such a meticulous filling practice could prevent a fair test of fluoridation in Hastings. But the change in diagnostic standard which they implemented must have contributed substantially to the reductions reported. Ludwig measured caries prevalence using the 'DMF' measure (average number of decayed, missing and filled teeth). Because the children examined, like all children in New Zealand at that time, had been receiving regular six-monthly dental treatments, the measure was largely of the number of fillings. Thus the first recorded DMF scores consisted largely of a count of fillings which had been inserted using the earlier criteria for finding cavities.

It is clear that the results eventually published, for Hastings only, claiming to show the effect of water fluoridation, were partly if not mainly the result of the change in diagnostic procedure. The 6- and 7-year-olds, whose occlusal surfaces of molars were in 1954 filled much earlier and more often, would be the most affected by the change and showed the greatest reductions. Also smooth tooth-surface cavities ('approximal' or between-teeth and 'gingival' or near-the-gum) reported by Ludwig and later by Backer Dirks to be the most reduced by fluoridation, were similarly in 1954 filled much earlier than the stage of "penetration of the enamel" described above. In none of the published papers on the Hastings study was the change in diagnostic standards reported. No explanation has been offered for that omission.

Limit of Credibility

The claimed large reductions in Hastings are beyond what is today regarded as the "limit of credibility" for genuine reductions in decay prevalence. According to Alman (*Journal of Dental Research* vol. 61 special p1361) an annualised reduction rate of 10 to 12 per cent becomes an "upper limit of credibility" and rates well above ten per cent suggest that we may be looking at a data-set-dependency, where the high level of change may combine true changes in caries prevalence with factors relating to changes in the population sampled or with inadvertent changes in diagnostic standards". The annualised rate is not the percentage over a period divided by the number of years, but is the rate for each single year which would result, when calculated like compound interest, in the percentage reduction over that period. In the Hastings study the spectacular reductions, for 5- to 7-year-olds, were mostly beyond the limit of credibility, annualised rates varying between 13 per cent and 20 per cent.

Ludwig reported, in each published part of his study, the total reduction since 1954 for each age group, which was very impressive expressed as a percentage. Thus in each later report it was not clear that many reductions since the previous report were quite small, after the first big ones (Figure 1). These large reductions carried through to some extent as the children grew older. The effect is shown in Figure 2. (In Figure 1 the 6- to 8-year-olds in the first stage became the 8- to 10-year-olds in the next stage, 2+ years later.) A part of the carried-through difference must have been due to a real decay decline, now known to be occurring everywhere. The change in diagnosis, rather than

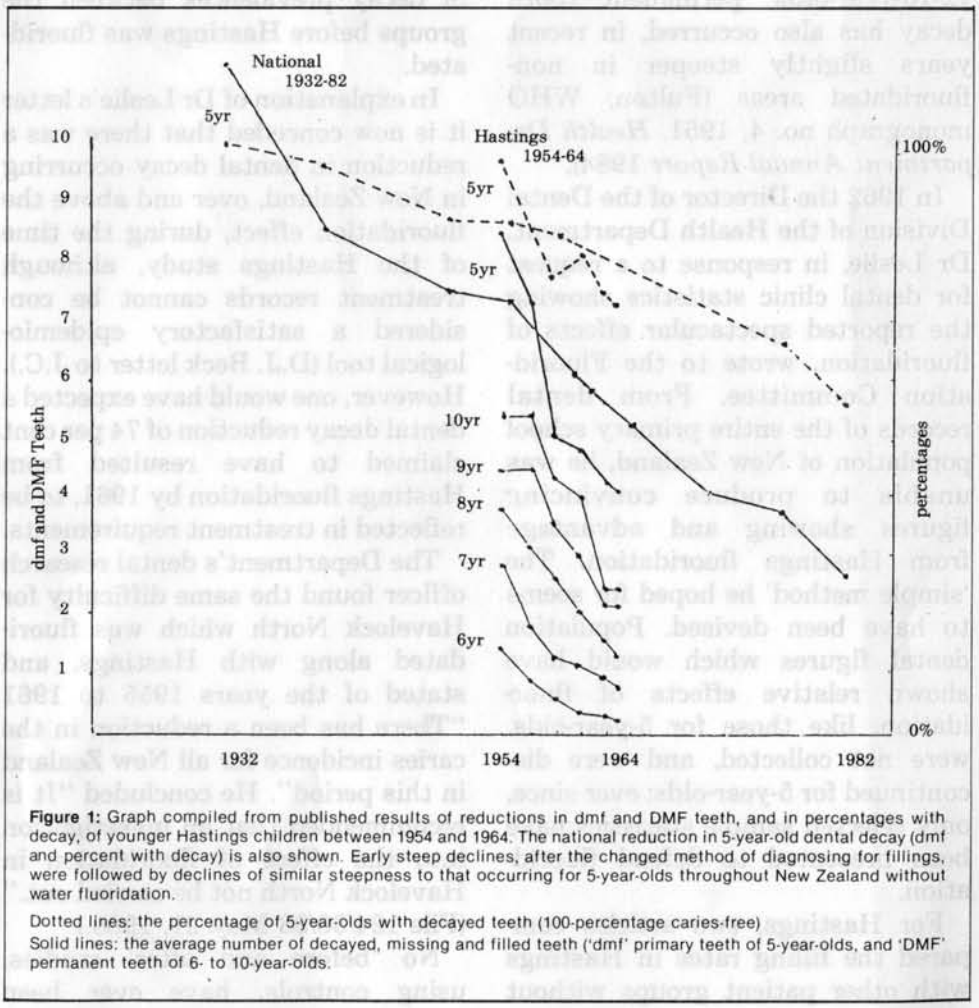

Figure 1: Graph compiled from published results of reductions in dmf and DMF teeth, and in percentages with decay, of younger Hastings children between 1954 and 1964. The national reduction in 5-year-old dental decay (dmf and percent with decay) is also shown. Early steep declines, after the changed method of diagnosing for fillings, were followed by declines of similar steepness to that occurring for 5-year-olds throughout New Zealand without water fluoridation.

Dotted lines: the percentage of 5-year-olds with decayed teeth (100-percentage caries-free)
Solid lines: the average number of decayed, missing and filled teeth ('dmf' primary teeth of 5-year-olds, and 'DMF' permanent teeth of 6- to 10-year-olds.

fluoridation, explains the big early reductions.

Those big reductions were rather deceptive. Obviously, delaying one filling in a 6- or 7-year-old, whose DMF has reached only 2 or 3, can result in a 30 to 50 per cent reduction. But by the time the child is 15 or 16, with a much higher DMF, the reduction carried through was a much smaller percentage. Thus the difference between the 6-year-old DMFs in Figure 2 is 74 per cent, while the carried-through reduction in the two DMFs by the time the children reached 15 is only 13 per cent for the 6½ year period—an annualised decline of 2 per cent.

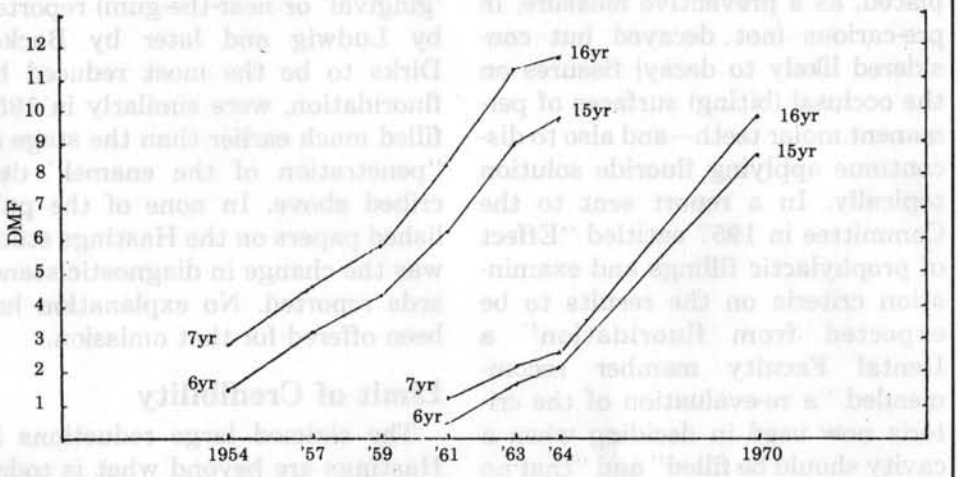

Figure 2: The increase in mean DMFT (decayed, missing and filled permanent teeth) of groups of children as they grew older after their first examination in the study. The suddenly lowered DMFT carried through and 9 or 10 years later was similar to the gradual 5-year-old decline everywhere.

Subjects for the study were all available Hastings schoolchildren of European extraction aged 5 to 16 years (except in 1970) who had lived in the city and consumed fluoridated water throughout life. Number in each age group varied from 259 (5-year) to 24 (16-year). The groups were thus approximately the same children between 1954 and 1970, though reducing in number with some overlapping of content of the groups in intervening years. Figure 2 is compiled from the published results for those children who were examined at age 6 or 7 years and again at 15 or 16 years.

Source: Ludwig, op cit.

Decay reduction in non-fluoridated Places

A reduction in dental decay of primary teeth at an annualised rate around 4 per cent, shown by continuously collected statistics for 5-year-olds (*Health Department Annual Reports* 1956-1971 and *NZ Dental Journal* vol. 48 p160, vol. 80 p14), has occurred throughout New Zealand over the past 50 years (see Figure 1). An equally steep though less continuously recorded decline in 12-13-year-olds' permanent tooth decay has also occurred, in recent years slightly steeper in non-fluoridated areas (Fulton, WHO monograph no. 4, 1951. *Health Department Annual Report* 1984).

In 1962 the Director of the Dental Division of the Health Department, Dr Leslie, in response to a request for dental clinic statistics showing the reported spectacular effects of fluoridation, wrote to the Fluoridation Committee. From dental records of the entire primary school population of New Zealand, he was unable to produce convincing figures showing and advantage from Hastings fluoridation. The 'simple method' he hoped for seems to have been devised. Population dental figures which would have shown relative effects of fluoridation, like those for 5-year-olds, were not collected, and were discontinued for 5-year-olds; ever since, only selected sample statistics have been presented to defend fluoridation.

For Hastings, two articles compared the filling rates in Hastings with other patient groups without fluoridation experience (*NZ School Dental Service Gazette* vol. 24 p55, *NZ Dental Journal* vol 62 p32). In these studies there was no consideration of socio-economic or ethnic differences between the Hastings and the other groups, nor of differences in decay prevalences between the groups before Hastings was fluoridated.

In explanation of Dr Leslie's letter it is now conceded that there was a reduction in dental decay occurring in New Zealand, over and above the fluoridation effect, during the time of the Hastings study, although treatment records cannot be considered a satisfactory epidemiological tool (D.J. Beck letter to J.C.). However, one would have expected a dental decay reduction of 74 per cent claimed to have resulted from Hastings fluoridation by 1961, to be reflected in treatment requirements.

The Department's dental research officer found the same difficulty for Havelock North which was fluoridated along with Hastings, and stated of the years 1955 to 1961 "There has been a reduction in the caries incidence for all New Zealand in this period". He concluded "It is recommended that an investigation into the effect of fluoridation in Havelock North not be carried out." (File 124/30/33 May 21, 1965.)

No 'before and after' studies, using controls, have ever been carried out to demonstrate the effectiveness of water fluoridation under New Zealand conditions.

Napier Reduction

According to Fuller, (Letter to J.C.), surveys by Ludwig of Napier children in 1957 and 1961 showed that the change in diagnostic criteria had reduced filling rates only slightly there, indicating that the Hastings reductions were due mainly to fluoridation. Only the 1957 results of those surveys seem to have been published (*Soil Science* vol. 92 p359). Abandonment of Napier as a control after 1957, and consequent lifting of pressure on school dental operators to delay fillings, would have resulted in the national reduction being less evident in Napier between 1957 and 1961. Dental clinic records examined by one author (National collection of School Dental Service patient history charts, Department of Health, Wellington) suggest that the overall Napier reduction, over a longer period than the brief one observed by Ludwig, was comparable to the national one (see Figure 3).

Who was Right?

The discovery revealed by Ludwig's initial dental surveys in the two towns—that younger children, the ones expected to show the

greatest benefit from fluoride, had up to 58 per cent less decay in the unfluoridated control town—caused considerable embarrassment. The explanation—a trace element in Napier soil, causing below average decay there (*Nature* vol 186 p695)—was simply not believed by the opponents of fluoridation. The discovery of the decay difference was not made until well after fluoridation had commenced. It was alleged by opponents that fluoride must have damaged Hastings children's teeth. The subsequently published figures on the dental status of virtually the entire 5-year-old population of New Zealand show that Ludwig's published figures for Napier 5-year-olds' dental health at that time (*Soil Science* vol 92 p359) were not below the national average. But the decay prevalence of Hastings 5-year-olds was well above average.

Early Doubts

The reason for the initial surveys being undertaken after fluoridation had commenced was the replacement of Hewat. The experiment had been commenced by him in 1952, when he carried out pre-fluoridation dental examinations of Hastings children. The results were not published. They are not in Department of Health files. Fuller, when he sought to examine them years later, found they had been destroyed in one of the Department's "periodical purges of records" (Letter to J.C.). The Medical Research Council, whose records at that period were held by the Department of Health, has none on the Hastings experiment. As well as the rather crude and subjectively influenced DMF measure, used in United States studies and later by Ludwig, Hewat used a more precise and complex 'caries index' and 'annual caries attack rate', based on the proportion of tooth surfaces diseased after allowing for their period of exposure since eruption (Hewat and Eastcott, *Dental Caries in New Zealand*, Medical Research Council of New Zealand, 1955). Following the replacement of Hewat, there was in 1954 a complete new start. According to Fuller, Ludwig "simply could not calibrate against Hewat".

Although willing to submit fluoride to a fair trial, Hewat had doubts. In private memoranda he pointed out to his colleagues that an earlier survey had shown that children residing in natural fluoride areas of New Zealand (0.2 or more parts per million) did not have significantly less dental decay, and sometimes had significantly more. He stated "In spite of the fact that there is a steady increase in the number of communities in USA which are adopting fluoridation (over 400 recently), there is still doubt in my mind whether the benefit claimed to result from this measure is fully supported by scientific evidence. In New Zealand we have found that many factors are interrelated with the caries rate, and I am not aware that any consideration has been given to such influences in the published data on caries and fluorine" (Memo. Mar. 14, 1953 on file 125/299).

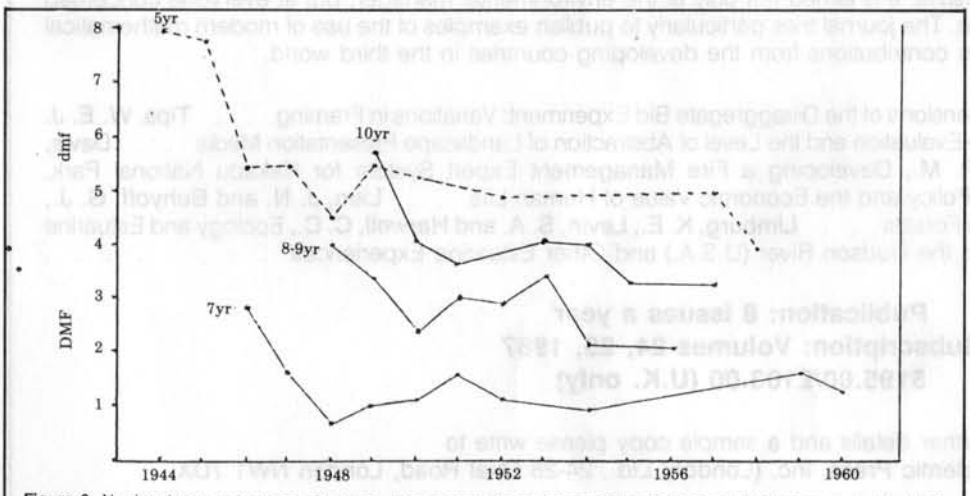

Figure 3: Napier decay reductions. Declines in mean number of decayed, missing and filled primary teeth (dmf 5-year-olds, broken line) and permanent teeth (DMF 7- to 10-year-olds, solid lines) between 1944 and 1960. The overall downward trends are similar to the national decline in dmf of 5-year-olds.
Source: 259 dental history charts from Napier school dental clinics. In later part of the period older children were treated by private dentists.

Professional Behaviour

The obvious possibility jumped at by opponents, that fluoride had actually damaged teeth of younger children, seems never to have been entertained by those conducting the experiment. They had faith in their theory that fluoridation would provide an immense benefit, based on their acceptance of evidence from the United States. The experiment was conducted in an atmosphere of intense public debate. Sir Dove Myer Robinson, for many years Mayor of Auckland and a prominent opponent of fluoridation, described the Hastings experiment as a 'swindle'. That view is understandable. But there is no doubt about the good intentions and sincere commitment of the professionals who conducted the experiment. Their ways of thinking and behaving are shared with other professions and have been the subject of sociological inquiry in other contexts (e.g. "Professional Networks and the Institutionalisation of a Single Mind Set" *American Sociological Review* vol. 50 p639). There was no conscious effort to deceive, because the first deception was of themselves. Some of their actions are difficult to explain or condone. One was the calling in of the police to investigate secretly the backgrounds and political affiliations of persons organising opposition to fluoridation. Apparently the professionals on the Fluoridation Committee were unable to understand that their opponents could have other than sinister motives. The result of their inquiry, in a letter from Head Office, no doubt left them mystified.

When the 1963 Hastings results were announced they drew comment from Hewat, then living in retirement (File 124/30/33, Apr. 27, 1965). He agreed, with the retired High School principal who had vigorously opposed Hastings fluoridation, that the results as presented could be interpreted differently, to show only a temporary delay in the onset of decay, with no reduction in the progress of the disease. Fuller and Ludwig, supported by the Government Statistician, rejected such an explanation (same File, May 19, 1965). The information now available, presented in this study, reinforces Hewat's assessment, which

could explain why by 1962 Hastings children, as Dr Leslie had discovered, were receiving as many fillings as in other places where overall prevalence of the disease was also declining.

At the time, Fuller commented "I think we all realise this is largely a question of point of view and unfortunately Dr Hewat does not see it from the viewpoint of a fluoridationist" (same File, Apr. 30, 1965). Those who are committed to strong belief in a theory can interpret data and arrive at conclusions quite opposite to the conclusions of those who are not so committed. The history of science has repeatedly demonstrated that more than one theoretical construction can usually be placed upon a given collection of data. It is apparent that belief in, and commitment to, the fluoridation paradigm strongly influenced New Zealand health professionals in their interpretation of the Hastings data. Many of the participants in the above events are still living. They have been invited to comment on this new information.

The obvious possibility jumped at by opponents, that fluoride had actually damaged teeth of younger children, seems never to have been entertained by those conducting the experiment.

Conclusion

From the above considerations it seems clear that the Hastings fluoridation study did not, as it was purported to do, demonstrate the effectiveness of water fluoridation in reducing dental decay in a typical New Zealand population. The reported reductions were at least partly, if not wholly, the result of factors other than fluoridation. Today proponents of fluoridation will concede that there were other factors operating to cause the reductions, over and above any fluoridation effect. But that fact, although known to those responsible for the study, was never mentioned in official and scientific published reports on it. The study was, it seems, more a public relations exercise than a scientific one. Nonetheless, it is still cited in dental scientific literature, and in textbooks like Professor Murray's, as being the latter. We suggest closer examination of past fluoridation studies in other countries, as begun by Diesendorf (*Nature* vol. 322 125-129, 10 July 1986).

FLUORIDE—The Poison in our Midst

By Doris Grant

In October 1985, after a mediocre debate and abstentions by two-thirds of the MPs, Parliament passed the Water (Fluoridation) Bill, by which it became legal for local authorities to fluoridate public water supplies. Doris Grant presents compelling reasons why both on health, as well as on moral grounds, we must vigorously resist fluoridation.

It is both tragic and ironic that the very section of the community which the Government's controversial Water (Fluoridation) Bill is alleged to benefit—children—is the one most likely to be harmed by fluoride.

As far back as 1952, at the hearings on Chemicals in Food and Cosmetics, Dr John Knudson of the United States Public Health Service, although pro-fluoridation, frankly admitted that no research had been done on the possible effect of artificial fluoridation on children suffering from malnutrition. The same year, the *Journal of the American Dental Association* published a warning by two investigators, Drs Massler and Schour, that "low levels of fluoride ingestion which are generally considered to be safe for the general population may not be safe for malnourished infants and children because of disturbances of calcium metabolism." In 1977, in *The Total Science of the Environment*, John R. Marier, Canadian National Research Council scientist, warned that "people with inadequate dietary intakes, particularly of calcium and/or vitamin C, are likely to be more 'at risk' as a consequence of long-term low dose fluoride ingestion."[1]

These warnings are of the gravest significance for Britain in the light of a shock report by Geoffrey Cannon and Caroline Walker which appeared in *The Observer* of January 27 and February 3, 1985. It revealed that Britain is "The sick man, woman and child of Europe" and warned that the state of health of Britain's infants and children is deplorable, citing recent medical research showing that during the past 25 years childhood eczema has doubled[2] and childhood insulin-dependent diabetes has increased sixfold.[3] Adolescent obesity is also a problem and, according to Dr Walter Barker, director of the Child Health Development Programme at Bristol University, there is "a tremendous amount of minor recurring illness, like diarrhoea and chest infection that just shouldn't be there."

In the Government's own report, *Fit For The Future* (1976)[4], it frankly revealed that child health among the under-nourished in Britain is causing "profound anxiety", with an alarmingly high infant death rate compared to other countries, and much acute illness in childhood.

Particularly shocking is the state of health of infants and children in Scotland. According to *The Observer* report, more Scottish infants die in the first year of life of congenital malformations than in 17 other developed countries, and the incidence of foetal defects, including spina bifida, is much greater in Scotland (and in Northern Ireland) than in Portugal or Spain. It is also much higher than in other UK areas, so much so that the incidence of serious deformities of the central nervous system is known, emotively, as "The Celtic Curse". Arthur Wynn, scientist and statistician, and his wife Margaret, co-authors of *Prevention of Handicap and the Health of Women* (1979), found that women in Scotland, Northern Ireland and Wales—though not going hungry—have the worst diet in terms of nutrients than any other developed countries. Their offspring, inevitably, are also badly nourished.

The Water Bill

The Scottish diet of white bread, cakes, pastries and refined sugar, with insufficient fresh fruit and leafy vegetables is deficient in a highly essential trace element—magnesium, until the past few decades "the forgotten mineral".[5] A paper published in *The Proceedings of the Finnish Dental Society* (1980)[6] revealed just how deficient in magnesium our diet has become. The author, John R. Marier, showed that the magnesium content of food has been falling since the first decade of this century and can be as much as 50 per cent lower than required. He also warned that the more severe the

Doris Grant, *author of books on Nutrition is in the forefront of the anti-fluoridation campaign in Britain.*

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deficiency of magnesium, the greater the toxic effects of fluoride, "very low levels of dietary fluoride are toxic at ultra-low levels of dietary magnesium, whereas much higher levels of fluoride are innocuous when dietary magnesium is increased".

Marier's warnings have particular significance regarding the Water (Fluoridation) Bill. As well as tying up calcium, zinc, iron and other important minerals, fluoride 'locks-up' magnesium,[7] forming near insoluble magnesium fluoride which the body cannot use. Fluoridation will therefore increase the already serious magnesium deficiency in the modern diet. This deficiency has detrimental effects on every cell in the body because magnesium is required for the work of some 200 enzymes.

Moreover, its removal by fluoride inhibits the cytochrome, oxygen-carrying enzymes which are of particular importance to the unborn and the very young. A deficiency of these enzymes—cytochrome C oxidase in particular—causes oxygen starvation in the cells, acknowledged as one of the major causes of birth defects, Down's Syndrome, infant mortality, and cot death.

Magnesium is also involved in biochemical processes such as the structure of nucleic acids—the genetic substance which transmits normal hereditary traits from one generation to another. This deficiency, plus excess of fluoride can therefore increase the risk of bearing a malformed child. There are 30,000 malformed children born annually in Britain, Fluoridation could increase this number considerably, especially in Celtic Curse areas.

In June this year, in an open letter to John Mackay, Minister of Health for Scotland and George Younger, Secretary of State for Scotland, I drew attention to the shocking ill-health record of Scotland's infants and children, and the appalling extra risks to these children inherent in the Water (Fluoridation) Bill and its likely effect of fluoridation of their drinking water.

Their reply stated, "the safety of water fluoridation has been confirmed repeatedly by groups of scientific experts". In support of this affirmation a number of 'major reviews' were cited which were undertaken by associations such as the World Health Organisation and the Royal College of Physicians.

Apart from the Knox Report,[8] published at the end of 1984, these 'major reviews' were undertaken in the 1970s; they mainly consisted of endorsements rather than original research. They have now been invalidated by new research in the 1980s proving serious harm from fluoride at the molecular level. As for the Knox Report, an eleven page review of it, *The Knox Report on Fluoridation and Cancer* was published by the National Anti-Fluoridation Campaign. Its author, George Stern, MA, MSc, Fellow of the Royal Statistical Society, trenchantly reduces its arguments to absurdity and reveals it as merely "a lengthy report which slightly and insignificantly alters what has been said before, and presents this as the answer". Mr Stern's chief criticism is Knox's omission of much pertinent scientific data—*data which contradicts himself.* As Stern points out, "Knox *does* tell us that in the Scottish case, the judge accepted that fluoridation did not increase cancer deaths. He does *not* tell us that three out of four judges in the USA ruled the other way"—*on the same evidence.* As Dr George Waldbott has observed, "Omission of pertinent scientific data is at best a demonstration of poor scholarship; when the health of millions is at stake, however, it is intolerable."

Compelling Evidence of Harm

In 1981, research by John Emsley and his team at King's College, London, reported in *New Scientist* of January 22, 1981, revealed that they had found a mechanism at the molecular level whereby the allegedly 'chemical inert' fluoride ion could disrupt enzymes and DNA. It could thus be "responsible for the serious charges being laid at fluoride's door: genetic damage, birth defects, cancer and allergy".

Later in 1981, two Soviet researchers provided independent support for the validity of John Emsley's findings. In the October issue of *Fluoride* they reported fluoride interference with RNA (a close relation of DNA).

In 1982, Japanese researchers at the Nippon Dental College, Tokyo, provided still more independent support for John Emsley's findings. In *The Japan Times* of August 24, they reported studies showing that fluoride, as used in topical applications to teeth, induced genetic damage and irregular synthesis of DNA in mammalian cells.[9] A leading opponent, Professor Martin Smellie, promptly dismissed these highly disturbing findings because "the doses of fluoride used in the Japanese tests were too high—at least 70 times higher than what is proposed to add to drinking water".

The Japanese tests, however, were undertaken to investigate the potential hazards of high doses of fluoride used in topical applications (9,000 ppm) to teeth, and in fluoride rinses (250-500 ppm). The highest dose of fluoride used in the tests—57 ppm—was nearly *158 times less* than that used in topical applications to teeth, and nearly *nine times less* than the highest dose used in mouth rinses!

In 1985, a new study by three scientists at the Department of Chemistry of the University of California, San Diego, provided the first ever solid evidence of the mechanism by which fluoride can inhibit enzymes and wreak its harm on health.[10] This study, reported in *New Scientist* of February 28, used X-ray analysis to compare the structure of a fluoridated enzyme with that of a normal one. According to the *New Scientist* report, "A disturbing picture emerges. Fluoride switches off the enzyme by attacking its weakest links—the delicately balanced network of hydrogen bonds surrounding the enzyme's active sites."

It is of special significance that the enzyme featuring in the San Diego study is cytochrome C oxidase—the same oxygen-carrying respiratory enzyme a deficiency of which is linked to cancer and to cot death and other tragedies of babyhood. This American study therefore provided incontrovertible confirmation of the fluoride/cot death hypothesis put forward in 'Fluoride The Threat To Your Children' in *Here's Health* (April, 1984).

The reply to my open letter to the Minister of Health and the Secretary of State for Scotland insisted

that there was nothing in the San Diego study "which would change the Government's conviction that fluoridation is safe". The reason given was that, "It has been known for many years that fluoride at very high concentrations can inhibit or enhance the action of many enzymes. Direct enzyme inhibition in humans has never been shown to result from the low levels of fluoride ingested from fluoridated water"—a statement virtually denying the well documented fact that many essential enzymes in the body are inhibited by a concentration of fluoride greatly below that used for fluoridation. For instance, enzymes such as lipase, esterases and phosphatases are inhibited by as little as 0.2 ppm![11]

Danger of Overdosage

In their enthusiasm for fluoridation and in their unshakeable conviction of its absolute safety, proponents are blinding themselves to its side-effects or refusing to acknowledge them. One overlooked side-effect of serious consequence for the very young infant, is the enormously-increased fluoride dosage which bottle-fed babies receive when their artificial feeds are reconstituted with fluoridated water. The danger of this overdose was highlighted by Dr J. Cuthbertson in a letter to the *Lancet* in 1976, warning that because babies consume a high level of fluid in relation to body weight, the infant's dose of both sodium and fluoride could be *eight* to *ten* times the proportionate adult one.

In a 1979 publication by the University of Goteborg, Professor Arvid Carlsson expressed great concern over the massive overdose received by bottle-fed infants.[12] *Though producing no obvious effects on the child's bodily development, it might damage the developing brain and permanently affect learning ability.* Now Professor Jan Ekstrand and his team have found that when fluoridated water is used to prepare mixtures for bottle-fed infants they receive 150 times as much fluoride as breast-fed infants.[13] It is therefore of special interest that cot death was described in 1965 by Dr R. Coombs as "preponderantly a disease of the bottle-fed infant".

In view of these alarming facts about fluoride and bottle-fed babies it is now imperative for the Department of Health to ensure that supplies of fluoride-free or low-fluoride bottled water are delivered to the home of every mother in a fluoridated area who is bottle-feeding a child.

Bottle-fed infants are vulnerable to fluoride overdose.

Also imperative should be the banning in all national health baby clinics of fluoride tablets for pregnant women. *Drug News Weekly,* October 24, 1966, reported that the FDA had consulted leading dental authorities who agreed that taking fluoride tablets before a child is born will not mean stronger teeth or prevent decay. Moreover, the FDA had admitted that scientific studies suggest possible harm to the foetus from fluoride. The advertising of fluoride tablets to women during pregnancy was banned by the FDA in 1966. It is therefore unforgiveable that no studies have been undertaken into the effects of fluoride ingestion on pregnant women. This was admitted by an official of the American National Cancer Institute at the famous Delaney Hearings in 1952.

That many baby clinics in Britain are nevertheless still advising fluoride tablets for pregnant women is dangerously irresponsible. That they are also still advising fluoride tablets for very young children could well be a contributory cause to the increased incidence of acute illness in children today, especially in cases of kidney failure. "In the human body, the kidneys are probably the most crucial organ during the course of low dose, long term exposure to fluoride"—warned National Research Council of Canada scientists, Marier and Rose, in *Environmental Fluoride, 1977.*

In Britain, especially in the fluoridated Birmingham area, there appears to be a significant increase in chronic renal failure in young children accompanied by acute thirst (polydipsia)—both classic symptoms of chronic fluorine poisoning.

A report from Victoria, Australia (now the most fluoridated country in the world) has revealed that the incidence of chronic renal failure in Australian children is increasing and is now so high that a child kidney transplant and dialysis unit has similarly had to be established. A report of the Australian Kidney Foundation in 1982 made it abundantly clear that there had been a 63 per cent increase in the incidence of renal failure since 1977—*the date when fluoridation was introduced into Victoria's water!*

Harm From Fluoridated Toothpastes

There are now widespread and serious reports of harm from the use of fluoride toothpastes. Mouth ulcers, stomach and bowel disorders, vomitting, abdominal cramp, diarrhoea, facial spots (bullous eczema), have all been experienced by fluoride toothpaste users.

Children, especially, swallow toothpaste, far more than is generally realised. An editorial in the *Lancet* of September 18, 1971, reported that fluoride toothpaste could deliver a dose of approximately 1mg of fluoride per squeeze, and a proportion of children in one study occasionally consumed as much as 2.4 to 2.6mg by this means. Where the water is fluoridated this could result in a daily intake three times higher than the so-called safety dose of 1mg. Even the pro-fluoridation British Dental Health Foundation's publication, *Facts on Fluoride,* admitted that fluoride toothpaste should not be swallowed in large quantities because of its toxicity!

As well as swallowing some, or all, of their toothpaste, children have been reported making "toothpaste butties".

Fluoride is one of the industrial poisons that can depress the immune system (even at the 1mg fluoridation level).[14] Fluoride tablets and toothpastes could therefore be a largely contributing factor to the increasing incidence in Britain today of childhood diseases.

The Antidote

The reduction of environmental fluoride pollution—especially in the form of 'acid rain', and the prevention of fluoridation of drinking water, is imperative. Also imperative is preconceptual dietary advice to both husbands and wives such as that given by Foresight, The Association For The Promotion of Preconceptual Care.[15] The diet during pregnancy must be rich in all the necessary vitamins and minerals, especially in magnesium which helps to buffer fluoride's toxicity. Such an antidote could prevent thousands of baby casualties.

It should constitute a salutary warning for Britain that Holland banned fluoridation in 1976, by Royal decree, on grounds of health hazards exposed; that Chile stopped fluoridation after 23 years of trial in 1977, mainly because of its harmful effects on children; and that Sweden banned fluoridation in 1971, because of concern that fluoride might be harmful to the unborn and very young children.

In conclusion, it is now known that there has been a substantial decrease in dental decay in children during the past 20 years in both fluoridated and unfluoridated areas. This makes a nonsense of the fluoridation argument, especially as no evidence has ever been produced anywhere in the world which proves that fluoride in any form has prevented tooth decay and that prevention has not been due to other factors (such as, for instance, the Department of Health's withdrawal in 1971 of sweetened orange juice—an acknowledged cause of tooth decay in infants—from National Health Clinics).

Patrick Clavell Blount, honorary chairman of the National Anti-Fluoridation Campaign, considers this the most important argument against fluoridation.

As Dr Alan B. Shrank observed in *Hospital Doctor* of January 13, 1983, "Now that it is clear that dental caries in children is falling without fluoridation and that there is strong evidence that it might be harmful, only the incautious and the arrogant would continue to promote fluoridation."

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PHOTO: BRIAN MORRIS

A typical Hill Pandaram family outside their leaf shelter, Kerala, India

Deforestation in India and the Fate of Forest Tribes

by Brian Morris

Having exploited the forests successfully for thousands of years without causing ecological damage or threatening their survival, India's forest people are being made the scapegoat for the destruction to the country's tropical forests. Their land rights are being taken away from them and their harvesting of the forest's natural products banned on pain of a fine or even imprisonment. Instead the exploitation of the forests is being taken over by industrial, money-making interests.

In the famous Tamil epic poem *The Silappadikaram* (The story of the Anklet), we hear that: "The King, with his suite reached the bank spread with fine sand dunes from the Periyar river, which falls from the great mountain. Its flowing waters were covered with fully blossomed kongu, vengai, konrai (trees) in overhanging clusters, as well as with nakam, tilakam, and the fragrant aram around which swarms of bees were murmuring their sweet songs. Here he stayed at ease . . .

"Then there appeared before him the hill-folk like vanquished kings, laden with tribute. They came carrying on their heads such presents as: the white tusks of elephants, whisks of deer hair, pots of honey, chips of sandalwood, loads of anjana and beautiful aritara, cardamon stalks, pepper stalks, luxuriant kavalai, ripe coconuts, delicious mangoes, garlands of green leaves (paccilai), jack fruits, flowery creepers, rich bunches of arecanut from luxuriant palms, fawns of the musk deer, harmless little mongooses . . ."[1]

Contrast that with a report by H.R. Pate, a colonial administrator, who relates: "The prosperity of the river-irrigated section of Tinnevelly, extending from the Western Ghats to the sea, is dependent on the continuous flow of water in the rivers that rise on the Western Ghats. Now this continuous flow has notably decreased of late years, and the decrease commenced with the destruction of much of the forest that formerly clothed the Ghats and protected the heads of the streams: the rich shola land in the ravines down which the streams descend, attracted coffee planters, who destroyed the magnificent timber and thus let in the wind, which has extended the mischief done by the axe. Thousands of trees lie prostrate, and the coffee gardens, as might be ex-

pected, are mostly wind blown and useless . . . The mischief, however, is done so far and cannot now be repaired, but what we can do is to conserve the remaining forest most carefully and see if one cannot increase the volume of water in the streams . . . The people themselves are unanimous in their wish for conservancy, as even at the foot of the hills they now begin to suffer, and lower down the streams there is always an outcry for water.''[2]

With regard to Indian forests and the welfare of tribal peoples intimately associated with them, these rather obscure sources are highly informative and should help dispel two myths generally used by those who seek to exploit the resources of the forested regions.

The first is that the tropical forests are uninhabited: that they are wilderness areas untouched by human kind. There is even the suggestion that they are a kind of 'last frontier', a pristine domain of nature awaiting conquest. Indeed the ideology of development invariably invokes the 18th century imagery of a natural world simply waiting to be subdued, dominated and exploited. That there might be people living in the forests is simply ignored, or else they are treated as some exotic relic of a bygone age. One publisher approached me recently with the view to my writing an illustrated book on one South Indian tribal community, the Hill Pandaram: but when he discovered that they wore clothes like other people in India he lost interest in them, as they were not considered 'genuine' primitives of a 'disappearing world.' To see forested regions as being devoid of real people, and as a kind of 'exotic, natural object' is particularly evident in discussions of Amazonia, where the needs and interests of both the peasants and tribal peoples who have long lived in the region, have systematically been ignored.[3,4,5]

One only has to read the early Spanish chronicles or the writings of such naturalists as Wallace[6] (1853) and Bates (1864)[7] to realise that the Amazon region has never been an 'empty land'. What then is significant about the extract from the Tamil epic poem quoted above, which was written almost two thousand years ago is that it indicated that the South Indian forests have long been inhabited by tribal peoples, that these people had a viable and sustaining relationship with the forest environment (growing a wide variety of agricultural produce) and that they were not social isolates but had structured relationships with the wider Indian society.

PHOTO: BRIAN MORRIS

Young Malapantaran woman beating palm stems to collect palm flour.

The second assumption which the ideology of development invokes, is that the widespread deforestation and the impending ecological crisis is largely due to the malpractices of the indigenous peoples themselves.[8] Development agencies, including the FAO and even the World Conservation Strategy—as outlined by Robert Allen[9]—all tend to see as the primary factors in creating this crisis, poverty, population growth and shifting cultivation.[10] The blame is thus largely placed on the peasant and tribal communities of the Third World, who, because of their growing numbers and poverty, strip the land of its trees and cultivate steep and unstable slopes. What they need, according to Allen, is conservation-based rural development schemes to help them survive—no doubt advised by FAO Technical experts. Allen admits that the affluent should also ''constrain their demands on resources'' or ideally reduce them, and that there should be some controls over the timber companies. But like the Brandt report, Allen fails to explain why poverty exists in the first place, misleadingly links poverty to environmental degradation, and thus fails adequately to examine contemporary economic structures and the role that timber companies, ranching syndicates and multinationals have had both in creating and maintaining social inequalities and in the degradation of the tropical forest environment. As Plumwood and Routley[11] argue, the destruction of tropical forests, specifically in Amazonia and in Indonesia, is largely the result not of the activities of shifting cultivators and landless peasants, even less of population pressure, but of the present economic system, and of the unholy alliance between Third World political elites and western corporate interests. In regions where privilege, inequality and subsequent poverty are rife, and where repressive regimes are continually supported by the American administration[12], western corporations virtually have a freehand in implementing 'development' projects that are causing widespread forest destruction. Needless to say, as Eckholm writes[10]; the economic benefit of those projects goes to the importing countries (the 'north') and to the wealthy elites within the timber-exporting countries and not to the people of the forested regions who become even more impoverished.

What is then significant about the second quotation which was written

by a certain Mr Puckle as long ago as 1857, was that in advocating forest conservation he not only saw foreign plantations as a major factor in the forest destruction that was then taking place in South India, but realised, with commendable insight, the ecological importance of the forests.

Until about forty years ago almost a third of India's land surface was covered with luxuriant tropical forests that contained priceless hardwoods. It was still, as one correspondent noted[13] the India of Kipling's *Jungle Book* and Jim Corbett's unforgettable accounts of the wildlife of the Kumaon hills. Those forests were still replete with animal life, with herds of elephant, bison and black buck, as well as many other species of mammals—sambar, chrevotain, leopard, several species of mongoose and squirrel, sloth bear, black monkey, and the occasional tiger. The forests were, as the anthropologist Ehrenfels remarked, a 'botanist's paradise': in fact, like the Tamil poets, one could easily become lyrical about them.[14]

Tribal Man

Associated with the forested regions are more than 400 different ethnic communities, designated as 'scheduled tribes'. Often with distinct languages or dialects, and in many important respects culturally distinct from the dominant Hindu population, tribal people number about forty million, constituting around seven per cent of the Indian population. But inhabiting 'the fringes of civilisation', as one writer expressed it, their location tends to be concentrated: thus in those regions where forests still predominate, Orissa, Madya Pradesh and the Himalayan frontier, tribal people constitute around twenty per cent of the population, while in Arunachal Pradesh they form the majority.[15] In Southern India tribal communities are associated with the remaining forested hills, the Western Ghats and the hills of the Deccan. Several of these communities, like the Kadar and Chenchu, are still essentially hunter-gatherers, but the majority practise shifting cultivation (although plough agriculture is common) and the most important of these communities are the Gonds of Andra Pradesh who number around four million.

Personal Experience

For nearly a year I lived with one foraging community, the Hill Pandaram. Such tribal peoples, as Eckholm indicates, have lived in harmony with the forests for thousands of years, despite harassment and exploitation experienced from the neighbouring Hindus. But such communities have never been isolated from the wider culture, and trading relationships, either of a symbiotic kind or organised through a contractual system have long been in existence. In fact tribal communities have never been completely free of exploitation, for even in the precolonial period (as the above quotation denoted) kings and petty chiefs in the plains area claimed sovereignty over the forested regions and exacted tribute. But the forest nonetheless offered such communities a certain security and independence.

Around the middle of the 19th century the British administration, following the advice of men such as Mr Puckle, established forest departments in all the States of southern India. Various legislation was enacted to control the cutting of timber and bamboos, and the gathering of the minor forest produce: extraction although deemed to be an important source of state revenue was only to be done under licence. The administration assumed that the tribal peoples, whether shifting cultivators or food gatherers, were not the rightful owners of the forest tracts that many had inhabited for centuries. Not that the government was unaware of the rights of the hill tribes, but considered that they were clearly subordinate to the fundamental premise that the forests belonged to the 'state', the latter reflecting the interests of overseas capital and the high castes and propertied groups of the plains. The forest regulations included a 'Rules for the Treatment and Management of Hillmen', and these stipulated that the tribal people were to be "under the control of the forestry department" and to be located in permanent settlements. The tribal communities were thus seen as essentially 'wards' of the forest department, and denied any land rights. The collection of minor forest products, which the tribal communities had traditionally gathered for trade, was systemised, and the rights to those products (as with timber extraction) were leased out to merchant contractors. Through a system of indebtiture such contractors attempted to both induce the tribal peoples to gather the forest products, and to control them. Although the forest regulations attempted to some extent to protect the interests of the tribal communities in that traders were forbidden to give them credit, sell them intoxi-

PHOTO: BRIAN MORRIS

Hill Pandaram collecting Dammar Resin.

cating liquor or ill-treat them, this mercantile system was essentially exploitative and involved a good deal of harassment of the tribal people.[16] The products involved—cardamon, honey and wax, ginger, myrobalam, various medicinal plants, dammar resin, turmeric—had long been important to the local economy, and there are records of these commodities being exported from the Malabar coast even in Roman times.

Although the forest departments attempted to 'settle' the nomadic forest tribes and induce them to take up permanent agriculture, they always recognised the right of such tribes to live within the reserve forests—even though under the control and jurisdiction of the department. Yet as they were drawn more and more into the market economy, and as a growing number of non-tribal peoples immigrated into the forested areas so the tribal peoples were subjected to increasing exploitation. With the connivance of forest officials and through patterns of indebtiture, the tribal communities were fragmented and their lands alienated to outsiders. Thus the Gonds and other tribal communities of Andra Pradesh have been reduced in recent years from independent subsistence farmers to virtually landless labourers. Furer-Haimendorf, an anthropologist who has spent more than forty years studying the tribal peoples of South Asia, suggests in his recent important study on the *Tribes of India*[17], that the situation of the tribal communities in Andra Pradesh "has all the elements of a collective tragedy". But the trials and tribulations of the tribal communities have not ended there. For a new Forest Act (1980) is being implemented which will not only deny the tribal peoples any right to collect resources from the forests in which they live—and this includes the gathering of firewood for fuel, food plants and medicines for personal use, and the minor forest produce for their own trading purposes, as well as the grazing of livestock in forest areas—but makes the collection of any forest product for their own use a criminal offence. To make matters worse, forest officers are to be given the powers of a magistrate, and can summarily try anyone for any offence against the forest code, with penalties of up to three years imprisonment or a 1000 Rupees fine (£66). He is also to be given discretion in the collection of fines, the calculation of compensation for damage, and the powers to seize property. All this has implied the continuation of—or return to—the old colonial forest policies, though in a much harsher and repressive form. In many states the tribal occupation of forest land has thus been declared illegal, and thousands of tribal people have faced mass evictions. Ironically (or with callous deception?) this legislation has been done on the grounds of national interest, and as a response to the impending ecological crisis, given that the Indian forests have shrunk alarmingly in recent decades, with around 4.2 million hectares reported to have been lost since 1947. A recent U.N. study even suggested that in less than twenty years, given the current rates of deforestation, there will be no natural forests left in South Asia.

A Collective Tragedy

But as many writers have insisted, such as Manohar and Wilson,[18,19] it is not the tribal peoples themselves who have been responsible for this widespread destruction of the forests, but rather, as in Brazil and Indonesia, the outcome of an unholy alliance between state governments and commercial timber interests. Despite humanistic rhetoric about concern for the social 'welfare' of the tribal communities, state policies combined with local pressures have taken an oppressive form, to the social detriment of the forest people. In essence the forests have been destroyed by the State governments themselves: for as Shankar Jha points out, they have leased out commercial rights to private contractors[13] who with the connivance of the policy and the forest guards and the local politicians, have tended to fell timber well beyond what is legally permitted. Under the present oppressive situation, while timber merchants carry on their illegal activities unhindered, a tribal woman carrying a bundle of firewood is liable to be caught and punished.[20] Rather than curbing the widespread destruction of forests, current legislation will only exacerbate the problem, and as well as making thousands of tribal people destitute, will facilitate the syphoning off of capital to the west. Yet as Amrit Wilson states, while the tribal peoples are being evicted from their land, development agencies like the World Bank and UNDP are promoting afforestation programmes. "Afforestation is something of a euphemism for what these projects entail is the conversion of the natural forests into single-species plantations—teak, eucalyptus or pines according to the locality. Such projects are invariably linked to multinational companies. The possible long term effects of this widespread deforestation is now widely discussed and debated."

"No one even dares to think", says Jha, "of the climatic changes this will cause, but the spectre of the entire sub-continent turning into a vast dustbowl within the lifespan of those already born stares us in the face."[13]

Alienated from their tribal lands, harassed and exploited everywhere by state officials and non-tribals, and now facing destitution, the tribal peoples have responded in various ways to those adverse conditions. Reform movements and millenial cults have long been a feature of tribal life, and during the colonial period there were a number of so-called "tribal rebellions". These uprisings were essentially, as Furer-Haimendorft stated, defensive movements, they were the last resort of tribal people driven to despair by the encroachment of outsiders on their land. More recently there have been organised political movements which have attempted to defend the rights and interests of the tribal peoples, and often, as with the well-known Chipko movement, have attempted to halt the deforestation, defending the interests of local people against the timber interests. Invariably this has led to increased repression by the state, and acts of violence against the tribal people. A postscript to Furer-Haimendorf's study reports an incident in the Adilabad district of Andra Pradesh in April 1981 when police indiscriminately opened fire on a group of Gond villagers, killing more than two hundred people. Protesting at the alienation of their

land, which the new Forest Act now justifies in the name of progress and conservation, this kind of incident is becoming increasingly common. The Indian government seems intent, as Wilson writes, to indicate to the I.M.F. that it is ready to provide an "investment environment unruffled by civil liberties". Yet such a colonial forest policy, even if backed by repressive measures, is no answer to the ecological crisis—in fact such a policy is the major cause of the forest destruction that has taken place in the last two decades. Only measures that stop the exploitation of the forests by timber corporations, that tackle the problem of fuel scarcity, and provide genuine support for the tribal communities, can save India's forests. And to curb the deforestation is not something that is only in the interest of the tribal peoples—India's whole future is at stake.

In Anton Chekhov's play *Uncle Vanya* a country doctor Astrov speaks: "The (Russian) forests echo with the sound of the axe, millions of trees are perishing, the homes of wild animals and birds are being laid waste, the rivers are growing shallow and running dry, exquisite scenery is disappearing forever, and all because men are too lazy and too stupid. . . Isn't that so madam? One has to be a barbarian to burn this beauty in one's stove, to destroy what we cannot create. Man has been endowed with reason and creative powers to increase what has been given to him, but so far he has not created but destroyed. There are fewer and fewer forests, rivers are drying up, the game birds are becoming extinct, the climate is ruined, and every day the earth is becoming poorer. Here, you're looking at me ironically, and you don't think what I am telling you is serious—and perhaps I really am a crank, but when I walk past the woods I have saved from the axe or when I hear the . . . wood planted with my own hands rustling over my head, I realise that the climate is to some extent in my power and that if in a thousand years men are happy and contented I shall have done my bit toward it . . . However it's time I was going."[21]

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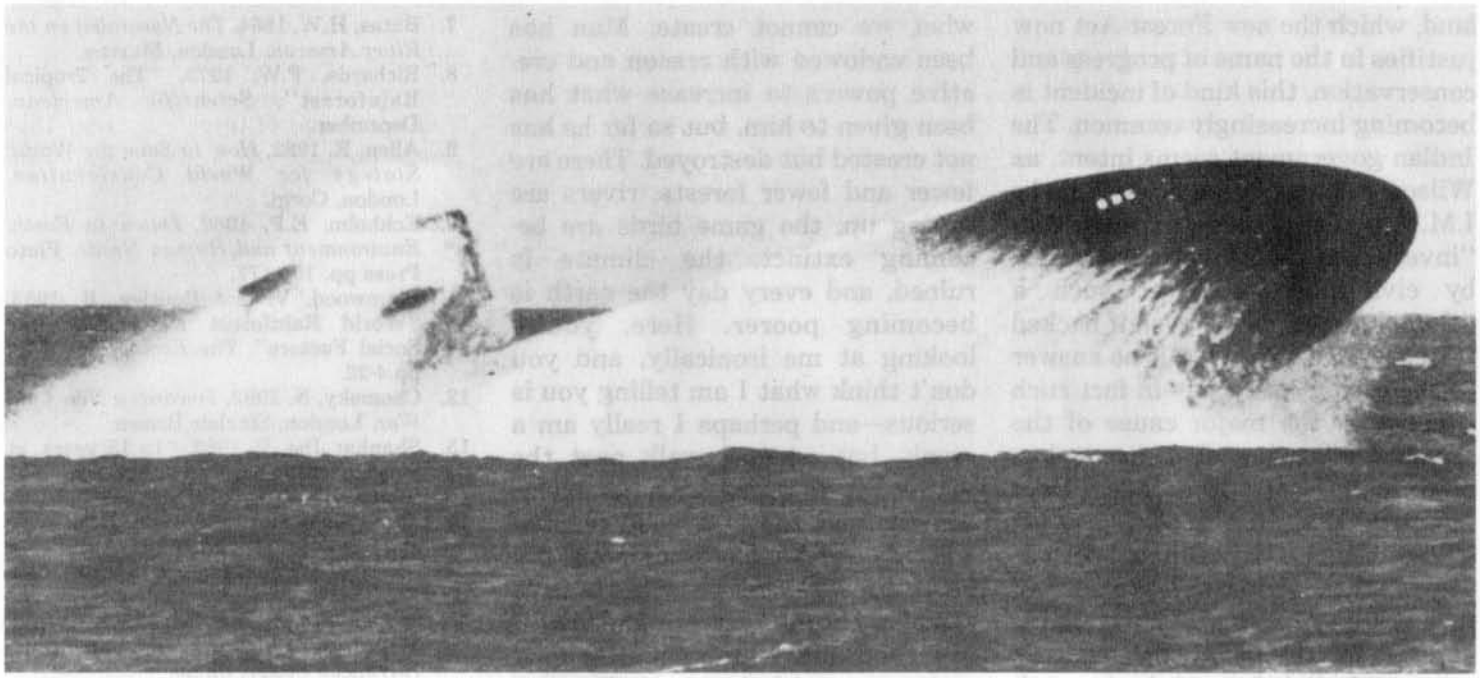
This extraordinary advertisement clearly illustrates how the economists' view our planet as something to be squeezed until there is nothing left.



A US Nuclear Submarine breaking through the surface.

The Spirit of Thoreau in the Age of Trident

by Richard Falk

Thoreau in his time was prepared to go to goal rather than to support an unjust war. Today protesters against weapons systems such as Trident have harsh sentences meted out against them as the State tries to stifle all opposition. In fact the US government, the USSR and others with first-strike aggressive capabilities are behaving in direct contravention of the principles which were laid down during the judgement of Nazi war crimes at the Nuremberg trials. According to Falk such governments should be arraigned for the current war crimes against humanity. Democracy, he says, lies not with such governments but rather with the protesters struggling against the arms race.

Henry David Thoreau went to jail in 1842 rather than pay a poll tax whose revenues were used, in part, to pay for President Polk's colonialist war against Mexico. That long ago Thoreau insisted that a citizen had a civic responsibility to oppose an unjust war: "The soldier is applauded who refuses to serve in an unjust war by those who do not refuse to sustain the unjust government which makes the war." His more general counsel was to "Let your life be a counter friction to stop the machine. What I have to do is to see, at any rate, that I do not lead myself to the wrong which I condemn."

These days, rarely noticed except when prison terms are announced, there are a growing number of Americans who are dedicating their lives to stopping the machine. Now the machine has become nuclearised, and threatens, at least in our imagination, the ultimate human crime of omnicide, not an idle threat, given the validating findings of several groups of scientists about the prospects for "nuclear winter" in the aftermath of nuclear war. Unlike Thoreau who lives on in our tradition for his single night in a comfortable Concord jail (a friend paid his overdue tax to obtain his release), these unsung Americans, our contemporaries, are receiving longish prison sentences, are remaining for years behind bars away from family, freedom, and work and they are returning over and over again to put their bodies in the way of the machine. Their lives have become haunted by the darkest shadows of nuclearism.

A particular focus of these resistance activities has been "first-strike" weapons systems. It is important to understand why. As moralists, legalists, and strategists have argued ever since Hiroshima, with nuclear weapons in existence, there is no way to disinvent them or to be sure that if we renounce them we won't tempt others to engage in nuclear blackmail, or even surprise attack. Whether deterrence or disarmament is safer, saner, more moral is arguable in a world of hostile states and widespread conflict. Most radical peace activists tend to respect this tragic circumstance, although their definite preference is to take the risks of vulnerability connected with disarmament.

What they refuse to tolerate, however, is the use of nuclear weapons, not for war avoidance roles (deterrence), but for geopolitical power plays. The construction of first-strike weapons systems is so objectionable because it strips away the masks of inevitability from the so-called nuclear dilemma, and

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makes it clear that our leaders have become hypocrites of the most fundamental kind. In essence, a first-strike weapons system is one that is designed to be used to attack, not retaliate. For instance, submarines with many nuclear warheads on their missiles having high degrees of accuracy, yet relatively vulnerable to attack by others, or cruise missiles that are easy to destroy while still on the ground, but hard to stop once launched because they elude radar. If retaliation was the purpose of these systems, then weapons designers would emphasise survivability of their missiles, above all. As well, strategic doctrine would be clear that the only mission of nuclear weapons was to deter others from using them.

Resisters have been persuaded that the United States Government is building first-strike weapons systems at the present time. Robert Aldridge, a former Lockeed engineer, has been important in confirming these suspicions. He had been in charge of the Lockheed unit charged with designing the Trident submarine. He quit an important job and gave up a successful career because he became convinced that the United States was building weapons for a possible war of aggression in the future that might rely on the system he was designing. Aldridge has written a careful book entitled *First-Strike: The Pentagon's Strategy for Nuclear War* that summarises the technical arguments for so regarding the Trident Submarines*. He has also lectured widely and given his entire life over to informing people about these developments. Aldridge is not a political person in the normal sense. He is a devout Catholic, a family man of quiet ways, and someone who conveys the utmost integrity and credibility. To those already concerned about the menace of nuclear weapons, and their role in our foreign policy, the life and testimony of Robert Aldridge sweeps across their lives like a tornado.

Those who have been especially activated seem, especially, participants in Christian faith communities with a special concern for bringing justice into the world on a personal and daily basis. They regard the gospels as a call to action, and view Jesus as a divine person who gladly gave his life rather than submit to unjust authority. There are many variations on tactics and outlook, but two clusters of tendencies stand out. One can be associated with Seattle near where the naval base for the Trident submarine is located, but it has had a widening arc of ripple effects. The resolve to resist is centered around Ground Zero (the name given to the place of maximum blast effect at the time of a nuclear explosion), a small group of devoutly religious persons whose efforts are known more widely as a result of their excellent newsletter, sympathetic media coverage in the area, a supportive Catholic Archbishop, and the writings and inspiration of James Douglas. Their tactics have been non-violent, influenced by Martin Luther King, Jr's civil rights movement and even more, by the theory and practice of *satyagraha* in India under the guidance of Gandhi.

They have organised blockades of sailboats to prevent the entry into port at the Bangor base of the first Trident class submarines and they have on six or more occasions blocked "the white train" that carries the missiles and warheads for Trident subs from their place of assembly at a Pantex plant in Amarillo, Texas. A monitoring and solidarity network has grown up along the route of the train suggesting the birthing of a movement at the grassroots. For instance, two years ago a half dozen residents of Fort Collins, Colorado, blocked the white train as it passed through their city. They were dragged by police from the tracks and charged with criminal trespass, but in the end considerable community support and policy divisions in the local DA's office led the case to be dropped.

These activities are ongoing and continuing, although the government has tried to adjust by repainting the train a neutral colour and sending it as covertly as possible by a variety of alternate routes. By now several dozen resisters have been arrested, prosecuted, convicted, on various occasions, and have returned to repeat their "crime". There are also physical risks undertaken. The engineers on the train are apparently under orders not to stop even if the tracks are obstructed. This means that if the police fail to remove the protesters from the tracks they could be crushed. So far, no incident of this sort has occurred. Perhaps the engineers have secret orders, or themselves harbour a grain of disobedience, and would brake the train at the last instant. Yet, from the protesters perspective they are putting their bodies directly in the way of the machine. They are expressing a commitment unto death, that is of the utmost seriousness.

Similarly, in the Eastern portion of the United States there are comparable activities similarly motivated. These activities, because of the character of the operations located in the region, are directed at the weapons themselves rather than at their deployment. The most prominent of these protesters are the Berrigan brothers, Daniel and Philip, who with close associates,

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*The idea of "first-strike" is a complex one. In essence, a combination of missiles, navigational aid, and operational plans provides war planners with the confidence that it is possible to threaten or actually initiate nuclear war in such a way as to disable, at least in large part, the capacity of the other side to retaliate. One effect of such a first-strike posture is to create pressure on the threatened society to attack first in a period of rising tensions or crisis to avoid the adverse effects of vulnerability to a first strike. Aldridge anticipates on the basis of present projections that the United States will achieve a first-strike posture in 1988 when 18 Navstar satellites will be placed in orbit to provide in-flight guidance for missiles assuring greater accuracy for a strike aiming at Soviet "hard targets" such as silos or command centres.

Trident itself refers both to a new superclass of submarines and to a type of missile that can be also retro-fitted into earlier classes of nuclear submarines. By 1988 there are expected to be nine Trident submarines each carrying 24 Trident missiles, with each missile having eight 100-kiliton warheads (about 8 Hiroshima equivalents), for a grand total of 1,728 warheads capable of being separately targeted. It is not surprising that a Trident commander has been called "the third most powerful man in the world." In addition, of course, are the other classes of submarines, land-based missiles, and the strategic bomber fleet. Anti-nuclear resisters regard any element of this array of weaponry to be part of the first-strike capability and a fair focus for action. Aside from the Trident submarines, a favoured target for protest is the Mark 12 or Mark 12-A warhead intended for Minuteman-3 and MX land-based missiles. The material in this note is largely drawn from Aldridge's article "First Strike Breakout in 1988," published in *Ground Zero*, Dec '83/Jan '84, pp. 1, 3.

have engaged in a series of Plowshare activities, such as entering a GE plant, where the Mark 12-A missile is assembled or Griffiss Air Force Base in upstate New York where B-52s are being retrofitted for cruise missiles, done some damage to the missiles themselves, sang religious songs at the site of their trespass, and waited until the police came to arrest them. Others have gone to the sub base at Groton, Connecticut or to defence plants in the region, such as AVCO and Electric Boat Company, to enter and do some physical damage, "disarmament" as they call it, to the weapons themselves. Again there are serious risks taken whenever citizens enter top-secret defence related facilities without authorisation. Furthermore, when property is destroyed, especially if it relates to "national security", judges tend to become harsh, even vindictive. Sentences of more than five years in jail are common in such cases, and there are a few recent cases where terms of more than ten years have been imposed. In other words these activists are as serious as it is possible to be in civil society.

Thoreau and Morality

"No truer American exists than Thoreau," Emerson said of his friend in the course of a eulogy. It remains to this day a puzzling tribute to someone most renowned for his stubborn defiance of authority. For most, to be a true American is to be obedient to the laws and deferential to the government. Patriotism is associated in the popular mind with supporting the foreign adventures of the state, dying for the sake of the flag no matter what moralists might say about the cause at stake.

Yet, surely Emerson knew what he was saying. There has been another idea of America all along, one that is expressive of a different vision of national destiny and another conception of perfect citizenship. This is an America that started out, above all, as the endpoint of pilgrimage, a place of sanctuary for the individual conscience. This is also the country that reveres the natural and innocent as qualities that have made America appear as a promised land.

Britain, January 1st, 1983, women dance at dawn on a Cruise Missile silo site at USAF Greenham Common.

It is not generally appreciated that Thoreau linked his defence of civil disobedience with his retreat to the rustic simplicity of Walden Pond from emerging industrial society in nineteenth century New England. Toward the end of *Walden* there is a passage that expresses Thoreau's attitude toward law and governmental authority; the great aesthetic naturalist there insists that, above all else, an individual is "to maintain himself in whatever attitude he finds himself through obedience to the laws of his being, which will never be one of opposition to a just government, if he should chance to meet with such." Remember that given Thoreau's scepticism about government, to posit a just government was to enchant the mind with a kind of political oxymoron. The proper citizen, then, is the morally activated individual assuming some sort of oppositional stance. Such a credo has many resonances in the American experience including the rags-to-riches saga of Horatio Alger, the often lethal glory of pioneers and cowboys who pushed the frontier into the wilderness, and the dark metaphysical journey of Ahab and Ismael into the lawless watery wilds.

Thoreau's specific originality was to turn his grasp of this heroic side of American character into a moral questioning of the state, and then to act accordingly. In this regard, Thoreau gives conscience priority in his arrangement of virtues: "I think we should be men first, and subjects afterward. It is not desirable to cultivate a respect for law, so much as for right." At the end of this seminal essay Thoreau asserts, "there never will be a really free and enlightened State, until the State comes to recognise the individual as a higher and independent power, from which all its own power and authority are derived . . ."

Along with the Mexican War, Thoreau was also deeply troubled by the persistence of slavery as a legitimate social institution. His insistence on a moral course was uncompromising: "This people must cease to hold slaves, and to make war on Mexico, though it cost them their existence as a people." He thought these failures of the republic serious enough to warrant revolution: "I think that it is not too soon for honest men to rebel and revolutionise." This kind of clarity about what the citizen should demand from his government contrasts with the mainstream criteria of victory and wealth: To win is to be vindicated, to lose is to be condemned. Politicians in the United States have received and acted on this message from civil society almost from the beginning. The Vietnam experience reinforced this central understanding. On a more intellectual plane, apologists have rationalised the pursuit of

national interests in world affairs by a biblical invocation of the fallen condition of humankind, a kind of tarnished golden rule, that overlooks the evil done unto others because it is the only alternative to their doing it unto us.

At the same time, there was an underlying political forbearance in Thoreau's stance. He seemed concerned, in the end, more with the significance of moral purity to fulfill the individual life than with activating a collective process that might overcome the injustice or transform the governing process in directions more to his liking. The essence of what Thoreau demands of a citizen is this: "What I have to do is to see, at any rate, that I do not lend myself to the wrong which I condemn!" To be sure, there is attached to this injunction a kind of absurd confidence in the social consequences of a symbolic act of disobedience:

> I know this well, that if one thousand, if one hundred, if ten men whom I could name,—if ten *honest* men only,—aye, if one HONEST man, in this State of Massachusetts, *ceasing to hold slaves*, were actually to withdraw from co-partnership, and be locked up in the county jail therefore, it would be the abolition of slavery in America.

Underneath this rhetorical extravagance is an all-too-American individualism, a wish to be left alone to retreat from society, come what may with respect to slavery.

Of course, also, it is not possible, or useful, to conjecture how Thoreau might have altered his position if trainloads of Trident missiles were passing through his beloved Concord. What continues to matter to us today is that learning to say "No" to the state seems decisively relevant to our prospects as a people.

Civil disobedience and the State

Thoreau in his famous essay on civil disobedience centres his concern on the militarism of the organised state: "Government is at best but an expedient; but most governments are usually, and all governments are sometimes, inexpedient. The objections which have been brought against a standing army, and they are many and weighty, and deserve to prevail, may also at last be brought against a standing government." If Thoreau thought so in 1846, one wonders what drastic response he might advocate and undertake in 1983 when billions and billions of dollars are devoted to weapons of mass destruction, when military might is used at the sole discretion of the President to impose America's arbitrary will on a helpless island people of a Carribean micro-State, when American weapons of mass destruction are deployed throughout the entire globe and American strategists and officials talk grotesquely, but solemnly, about *prevailing* in nuclear war, and prepare in surreal spirit for "victory" and "recovery".

"As for adopting the ways which the State has provided for remedying the evil, I know not of such ways".

The situation today is, of course, far, far more extreme than anything in Thoreau's reality, so much so that it exceeds our imaginative capacities to compare the circumstances. Since Thoreau's time history has lost its moorings, making all of human society ridiculously dependent on the whims and wisdom of its main rulers. In the TV docudrama, "The Day After", the likely severity of nuclear war had to be understated to make it even possible to present it as a potential reality, and even then, war thinkers such as Henry Kissinger complained about scaring the American people into a posture of submission by presenting the future in such horrific terms. Power-wielders don't want the reality of our situation to get in their way, no matter what the eventual costs.

Prophetically, Thoreau raised the question of citizen responsibility to oppose an unjust war: "The soldier is applauded who refuses to serve in an unjust war by those who do not refuse to sustain the unjust government which makes the war." The minimum obligation of citizenship in a free society is to separate oneself from supporting those aspects of state power that are destructive and exploitative. Thoreau demands nothing necessarily more, but also nothing less.

But many continue to say, however implausibly, it is not necessary to resist, but merely to register disapproval, to vote, to petition representative in Congress, to write letters, and to wait for the procedures of constitutional government, to make the needed adjustments and achieve the necessary reforms. Thoreau gave an answer to these disciples of normalcy that is more apt than ever: "As for adopting the ways which the State has provided for remedying the evil, I know not of such ways". When our conscience is appalled, then some response by way of non-violent defiant action is required as a message, an appeal, a warning. It is also a weapon available to society in its struggle to preserve the honour and integrity of its traditions against the menace of the state.

It is interesting to realise that Thoreau called his essay, originally given as an oration at the Concord Lyceum, "Resistance to Civil Government", not "On the Duty of Civil Disobedience", a title later invented by the editors of Thoreau's collected works. The distinction between "resistance" and "disobedience" is subtle, yet profound. Disobedience, as a stance, acknowledges the authority of the state and submits to the logic of imprisonment, while resistance raises the question, it seems to me, of who it is that belongs in prison, the officials who are acting on behalf of the state or those who resist.

True, Thoreau's resistance was based on conscience, not law. Courts have the obligation to enforce the law, and cannot bend the law to accede quixotically to the subjective prescriptions of dissenting citizens. But even here, the case has always been cloudy, especially with respect to criminal law. The underlying idea of trial by jury was to bring the conscience of the community to bear upon the application of the law. Thus, when the conscience of citi-

zens is the essence of an alleged crime, there is a role for what is called "jury nullification", nullifying the law and acceding to claims of conscience. Our courts have generally tried to shut down this function of the jury, and to tie jurors hands by legalistic instructions by judges that disallow conscience to be taken into account, even in situations of symbolic criminality where the actions of those accused of lawlessness are motivated by citizen fervour for a better society.

In the anti-nuclear context, even the "law" is in doubt and, further, the role of community conscience seems plain enough for even the most legalistic sensibility to grasp, but judges find their primary identity as officers of the state as well as men of the law, and seem more likely to serve as guardians of the state than as intermediaries between mandates of the state and challenges from the citizenry.

Perhaps, in the end Thoreau is *only* a literary figure. His political acts were so puny and episodic compared to the gravity of the evils addressed. What lives is the rhetoric and the posture, and a vague understanding that Thoreau was willing to become an outlaw to underline his point. No one credits Thoreau with doing anything significant to stop the Mexican War or slavery, or even with persevering. A single night in jail is hardly a struggle to the end. In this sense, too, Thoreau seems very American, honoured as a great rebel in our tradition without having really done too much to deserve the status. Ye the honouring achieved something inspirational for others—for instance, Tolstoy, Gandhi, Martin Luther King—it has lent legitimacy to their defiance, and established the importance of the non-violent path.

The Nuremberg Trials

There have been some significant changes since the mid-nineteenth century in the legal relationship between citizen and the state. After World War II the victorious powers, led by the United States, established a judicial framework to assess the criminal liability of the defeated leaders of Germany and Japan. The most important of these trials were those held at Nuremberg upholding the basic idea that in the war/peace area leaders of governments were individually responsible for violations of international law even if they were themselves carrying out the policies of superior officials. At Nuremberg "the supreme crime" was held by the tribunal to be planning or waging "aggressive war" (that is, war as an active instrument of foreign policy beyond the circumstances of self-defence).

Ever since the Nuremberg proceedings there have been discussions about its quality as a legal precedent. The main criticisms have been associated with its character as victors' justice. In relation to the conduct of the war, the victorious powers engaged in behaviour that appeared "criminal" from the perspective of the laws of war. For instance, the strategic bombing of cities in Germany and Japan, the use of atomic bombs, and the wholesale murder of European prisoners of war by their Soviet captors.

At the time, the prosecuting governments, especially the United States, emphasised that the effort at Nuremberg was to build a legal structure of accountability for the future. The American prosecutor, Robert Jackson, who took a leave from the US Supreme Court to play his historic part at Nuremberg, stated with eloquence that the principles used to assess the responsibility of the German defendants would serve as a basis to judge the victors in the future. Steps were taken to implement this conception of building a reliable legal order. At the United Nations General Assembly the essence of what was achieved at these proceedings, the Nuremberg Principles, were adopted at its very first session in 1946 by a unanimous vote of the states then members of the form of General Assembly Resolution 95(I). Later on in 1950 these Nuremberg Principles were reformulated in authoritative form by the International Law Commission, a UN body of legal experts that enjoys prestige because it has operated at a technical level without getting drawn into the East-West ideological struggles of the postwar world.*

Throughout this process, it was the United States Government that was the most ardent champion of the effort to extend the Nuremberg concept from the context of World War II to serve the international community permanently as a framework. Most international law specialists regard the Nuremberg Principles as forming a part of international law that is binding on all governments.

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*The 1950 ILC text of the Nuremberg Principles follows:
As formulated by the International Law Commission, June-July 1950.
Principle I
Any person who commits an act which constitutes a crime under international law is responsible therefore and liable to punishment.
Principle II
The fact that internal law does not impose a penalty for an act which constitutes a crime under international law does not relieve the person who committed the act from responsibility under international law.
Principle III
The fact that a person who committed an act which constitutes a crime under international law acted as Head of State or responsible government official does not relieve him from responsibility under international law.
Principle IV
The fact that a person acted pursuant to order of his Government or of a superior does not relieve him from responsibility under international law, provided a moral choice was in fact possible to him.
Principle V
Any person charged with a crime under international law has the right to a fair trial on the facts and law.
Principle VI
The crimes hereinafter set out are punishable as crimes under international law:
a. Crimes against peace:
(i) Planning, preparation, initiation or waging of war of aggression or a war in violation of international treaties, agreements or assurances;
(ii) Participation in a common plan or conspiracy for the accomplishment of any of the acts mentioned under (i).
b. War crimes:
Violations of the laws or customs of war which include, but are not limited to, murder, ill-treatment or deportation to slave-labour or for any other purpose of civilian population of or in occupied territory, murder or ill-treatment of prisoners of war or persons on the seas, killing of hostages, plunder of public or private property, wanton destruction of cities, towns, or villages, or devastation not justified by military necessity.
c. Crimes against humanity:
Murder, extermination, enslavement, deportation and other inhuman acts done against any civilian population, or persecutions on politicial, racial or religious grounds, when such acts are done or such persecutions are carried on in execution of or in connection with any crime against peace or any war crime.
Principle VII
Complicity in the commission of a crime against peace, a war crime, or a crime against humanity as set forth in Principle VI is a crime under international law.

Without attaching weight to the observation, it seems probable that Thoreau would have been disturbed by the hypocrisy of Nuremberg, but would have applauded the determined effort to make governmental leaders personally accountable for initiating and waging war, as well as for gross abuses toward people under their control (what was called at Nuremberg "crimes against humanity"). It is also probable that Thoreau would not have expected too much to come from Nuremberg, given the way governments behave toward one another and their tendency to impose their will on the weak. He would not have been wrong. Each of the governments that sat in judgment at Nuremberg has subsequently engaged in one or more instance of aggressive warfare. There have been no subsequent prosecutions. In retrospect, it would seem that from a governmental perspective Nuremberg was "Victors' justice", nothing more.

Yet, from a citizen's perspective something new was added to political reality, something not intended by the architects of Nuremberg. The Nuremberg Principles provide a valid set of yardsticks by which to appraise the legality of governmental conduct on the most vital aspects of human affairs. What is more, the Nuremberg Principles set standards that are designed to guide and determine individual conduct. The underlying idea is that each person in whatever societal position is called upon to avoid complicity in the crimes punished at Nuremberg even if it means violating normal domestic laws. This wider pattern of responsibility has been called "the Nuremberg obligation".

One thing all the anti-nuclear protesters have in common is an awareness and acceptance of the Nuremberg obligation. Over and over again in trials across the country, the defendants explain, and seek to justify, their conduct by claiming its validation under the Nuremberg obligation. Here again, the link with first-strike weapons systems, such as Trident is alleged to be, is quite central. The essence of this first-strike identity is to be shaped for the initiation of nuclear war, and hence, the construction of such submarines is itself "criminal" as it contemplates waging the most destructive aggressive war in all of history. And it relies upon weapons of mass destruction to carry out these aggressive designs, which seem invalid as weapons of warfare and violations of the laws of war, the second category of Nuremberg crimes.

These legal arguments have not been accepted by domestic courts in the United States, although there has been some acknowledgement of their relevance. Experts have often been allowed to testify about the Nuremberg Principles despite vigorous objection by the prosecutor. Juries have evidently been impressed by the line of reasoning, but have generally been instructed in such a constraining way by the presiding judge as to feel that they had no option other than a verdict of guilty.

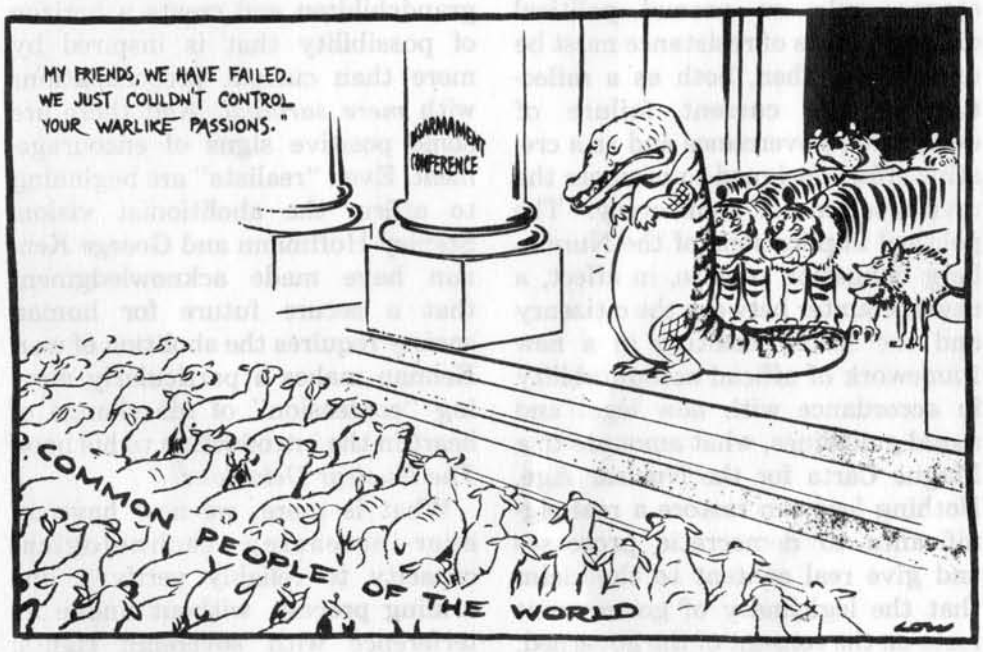
Yet, the overall effect of the Nuremberg obligation is to change the character of the action from Thoreau's symbolic refusal to pay the poll tax. For Thoreau his stand was rooted in conscience, and the moral responsibility of an individual to act on this basis. Thoreau accepted "law" as an expression of the state to be resisted, as necessary, by "morality". As a result, an opposition between law and morality will inevitably arise whenever a government acts unjustly.

For the Trident protesters the priority of morality is also central to their stand, and is their starting-point. At the same time, by invoking Nuremberg, the protesters are claiming that law, properly applied, is on their side. In fact, that upholding the Nuremberg obligation is the paramount legal duty in the context, and that the true law-breakers are those leaders of government who are building Trident submarines with first-strike missions in mind.

From this outlook, then, it is the institutions that are tainted, not the law. What is more, to oppose the results reached by those tainted institutions is not really "civil disobedience" in Thoreau's sense. It is rather an insistence that citizens have become law enforcement agents in relation to the government. My guess is that Thoreau would have approved, although he might not have been out there in the tracks.

Thoreau, as we have said, was a supreme individualist. He was in retreat from the clamouring demands of modern life. He wanted, above all, to be left alone to grow intimate with his natural habitat, to explore the countryside and know its ways. As Emerson gently notes, "I think the severity of his ideal interfered to deprive him of a healthy sufficiency of human society".

The Trident protesters are not so deprived. Their strength comes from community rather than individu-



"And we like sheep . . ."

Little has changed—a cartoon of the peace moves and disarmament conferences of 1933.

ality. The prophetic witness is directed toward others in the spirit of love, not judgement. In this sense, their action is not symbolic as a gesture is symbolic. They are, as actors, closer to Gandhi than Thoreau. Their search is for symbolic actions that will mobilise others to join them on the tracks or in "disarmament" actions at defence plants.

Beyond opposing nuclearism their strongest commitment is to renounce violence. Under no conditions will they act violently against another person. Their principled non-violence draws on early Christianity, as well as the call of Jesus not to resist evil. It also follows from Gandhi's and King's success in building movements of opposition. The Trident protesters are in the world to change the world.

The Threat of Ultimate War

It is important, as these particular defendants propose, to give the courts and juries an opportunity to fulfil the Nuremberg obligation, but it would be foolish and naive to expect dramatic results, although not nearly as foolish as a few years ago. In addition to mushrooming resistance from below, there are important defections from nuclearism at high levels of political leadership, and there exist important statements presenting an emerging societal consensus on nuclearism, statements such as the Bishops' Pastoral Letter on War and Peace and the legal analysis of the Lawyers Committee on Nuclear Policy. These formulations definitely validate the reasonableness of non-violent, symbolic resistance which points to governmental illegality and immorality, as well as the emergency hazards posed by the latest phases of the arms race.

These interpretations are strengthened by the paralysis of representative institutions and elective procedures when it comes to the national security policy. The situation has regressed from the time of Thoreau's complaint that conscience cannot wait on the rhythms of constitutional government. Today, we are faced with something far more menacing than the encroachment on democracy caused by "a standing army", which was the specific object of the anxiety of anti-militarists in the early life of the Republic. Today, our society has become permanently galvanised to carry out an ultimate war at a few minutes notice.

Furthermore, the global stance of the United States calls for wide-ranging interventionary capabilities and campaigns to be mounted on the sole basis of a general Presidential mandate. The procedures of representative democracy have been severely compromised and fundamentally inhibited. Congress has played virtually no role in questioning the moral, legal, and political policies of nuclearism. The courts have been evasive and passive, and have done their best to avoid "embarrassing" results caused by juries doubtful about their restrictive conceptions of legality. Presidential elections are a mockery when it comes to these security concerns. No major candidate can remain "credible" with the media, and hence with the public, if he or she is seen in any way to question the national security consensus that is held by "the state within the state", that is, by the sectors of the Federal bureaucracy associated with war/peace issues, especially the Pentagon, the State Department, and the intelligence agencies.

Representative democracy is now virtually dead when it comes to nuclear national security. Citizens conscious of the Nuremberg obligation cannot in these circumstances rely on normal political channels. Acts of resistance must be understood, then, both as a reflection of the current failure of democratic governance and as a creative effort designed to promote the revitalisation of democracy. The political implications of the Nuremberg obligation require, in effect, a new encounter between the citizenry and the state, resulting in a new framework of official accountability in accordance with new legal and moral guidelines, what amounts to a Magna Carta for the Nuclear Age. Nothing less can restore a real significance to democratic processes and give real content to the claim that the legitimacy of government rests on the consent of the governed. Citizenship and patriotism in the nuclear age must be increasingly understood as requiring participation in this struggle, to revitalise democracy and to dismantle the nuclear national security state.

With characteristic prophetic power, Leo Tolstoy commented in his old age on "the two wars", that of the state, illustrated by the then contemporaneous Spanish-American War (1898) and that of the war against war, illustrated by the struggle of the militant and persecuted pacifist sect of the Dukoboors in Czarist Russia. It is not enough to be sensitive to the peculiar menace of nuclearism. War itself has become a scandal and an obscenity in a world of mass misery and fairly widespread education. The technology of non-nuclear warfare is becoming increasingly capable of levels of mass, indiscriminate destruction comparable to that of nuclear weapons. Even as early as World War I the mutually destructive character of war led to widespread public questioning of the continued acceptability of war in organised political life. Until fairly recently, the United States played a leading, if somewhat hypocritical, role in working for the prohibition of non-defensive warfare.

It is foolhardy to look to the modern state, here or elsewhere, to further the goals of the abolition of war. At the same time, such a project, however remote its prospects may seem in our militarised, wired world, is essential if we are to build a hopeful future for our children and grandchildren and create a horizon of possibility that is inspired by more than current preoccupations with *mere survival.* And there are some positive signs of encouragement. Even "realists" are beginning to affirm the abolitionist vision. Stanley Hoffmann and George Kennan have made acknowledgment that a secure future for human society requires the abolition of war. Kennan makes a particularly moving "confession" of his change of heart in the introduction to his book *The Nuclear Delusions.*

What is more, we now have an ever-increasing technological capacity to reliably verify a disarming process, without undue interference with sovereign rights; new information technologies, combined with sensing and monitoring

The true lawbreakers are those leaders of government who are building Trident Submarines with first-strike missions in mind.

capabilities, can create confidence that distrust, can be reconciled with deep levels of disarmament. And finally, a wider sphere of the public is becoming convinced that "national security" can be upheld by non-violent means, and that responsibility for its discharge needs to be reclaimed, taken away from the exclusive control of the centralised state, with its dependence on bureaucratic methods and its confidence in technology and violence.

Let me revert, in closing, to Tolstoy's war on war. He rests his faith on those who act without limit on the basis of their conviction, those who the mainstream refuses to acknowledge; in Tolstoy's words, ". . . no one speaks or knows of these heroes of the war against war, who are not seen and heard by anyone." He tells, in particular, of a peasant, named Okhook, who refused military service and while being transported to jail managed to convert to his cause his guard Sereda, and whom Tolstoy quotes as saying "I do not want to be with the tormentors, join me to the martyrs." Many more of us are open to this alliance, within the societal struggle at this stage.

In this sense, it is important at this time for us to question the technocratic definitions of "useful", "practical", and "realistic" which we are given. These definitions are deeply tied to the technologies of violence, to the computerisation of decisions, and even the robot as an advance on human nature. Under much less critical circumstances, Tolstoy commented in a manner that remains illuminating:

> The people of our time, especially the scholars, have become so gross that they do not understand, and in their grossness cannot even understand, the significance and the influence of spiritual force. A charge of ten thousand pounds of dynamite sent into a crowd of living men—that they understand and in that they see strength; but an idea, truth, which has been realised, has been introduced into life to the point of martyrdom, has become accessible to millions—that is to their conception not force, because it does not boom, and you do not see broken bones and puddles of blood.

I honestly believe we are reaching the stage where honouring the Nuremberg obligation becomes a spiritual weapon with which to fight against the violence-drenched orientations of the modern state, whether East or West. And I believe that these defendants who are facing trial these days are "martyrs" in Tolstoy's sense; they are teaching us how to be citizens in the nuclear age.

In the end, negating nuclearism is not enough. We also require a wider vision of a human community that handles conflict non-violently, that harnesses production to human needs, and that uses far more of the resources of the planet for the benefit of all. It may seem an impossible journey, but our only solid hope as a species is to muster the courage to get on with it. As W.H. Auden once wrote "We who are about to die demand a miracle." But this time the miracle will not come from without, if it comes, but from within.

Colombia—Hydro-electric Schemes on the Rio Sinu

As a result of the 1973 energy crisis, Colombia decided to embark on a massive electrification programme based primarily on the development of hydropower and to a lesser extent on coal. In fact, Colombia is estimated to have nearly 40 per cent of the coal reserves of all Latin America and 20 per cent of the hydro-electric potential, one study assessing the hydro-electric potential of Colombia as being as great as 93 GW (1 GW = 10^9 watts). Furthermore the growth in electricity demand between 1964 and 1978 was 10.7 per cent per annum, with demand therefore doubling in less than seven years. To supply that demand and meet future growth, which was assumed to continue during the 1980s, ENE—the National Energy Study of 1982—recommended that more than 300 hydroelectric schemes should be realised, 79 of them in the Orinoco region bordering on Venezuela and 33 in the Amazon. Another 132 schemes were to be on the large Magdalena and Cauca rivers running northwards in the valleys between the eastern and central Cordilleras, and 44 on Colombia's Pacific side, affecting the Choco region. Ten dams each were suggested for the Sierra Nevada—Guajira and Atrato-Sinu regions.

Of the total 308 dams, 22 are at present in operation, 6 under construction, another 6 on the drawing board and 21 others at the stage of feasibility studies. So far none have been developed in the Amazon and Orinoco regions. ENE came to the conclusion that the costs of nuclear power, as an alternative, would far exceed those of either coal or hydro-electricity generation, and therefore nuclear power was not seen to be a reasonable option. The final decision about any future development of the electricity sector was to be taken by CONPES, the National Council for Socio-Economic Policy.

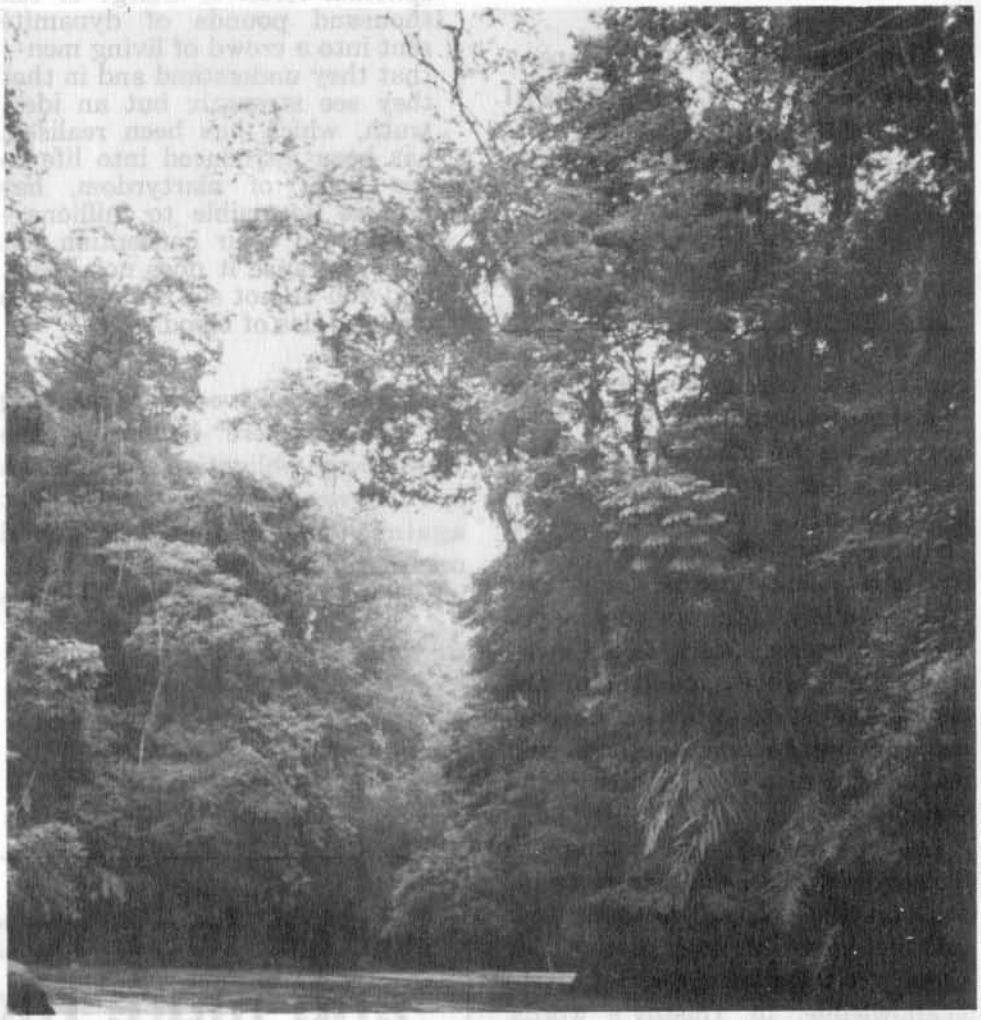


PHOTO: JUAN PABLO RUIZ

Tropical forest in the Paramillo National Park, Colombia.

Like other Latin American countries, Colombia has severe economic problems and growth has fallen, including in the electricity sector. Indeed by 1984 growth in electricity demand had fallen for the year to 6.5 per cent and is now down to 5 per cent, where it is expected to stay for the rest of the decade. A fall in population growth, as well as sharply rising tariffs are given as reasons for the decline in growth. Yet in its new 'expansion plan' the Colombian electricity supply industry decided to programme for a growth rate of 7.7 per cent rather than for the 6.7 per cent of its low-growth scenario. Even so, the reduction in the planned growth rate has led to a postponing of all projects at the pre-construction phase, in some instances by up to seven years. Yet, although the coal-fired stations have either been postponed indefinitely or scrapped from the plan, all the hydroelectric schemes under development have been kept, officially at least, with set times given for their coming on 'stream'. Consequently, the Colombian electricity supply industry expects the hydroelectric component of the generating system to increase from 71 per cent in 1984 to over 83 per cent by 1995, with coal-fired generation dropping from a 1984 contribution of 29 per cent to 16.6 per cent in 1995. Total installed capacity meanwhile will have increased some 2½ times, from 5.7 GW (gigawatts) to just under 14 GW. By the year 2000, the plan is that nearly 90 per cent of electricity generation will be hydroelectric. No consideration at all has been given in ENE to the environmental impacts of large dams. Meanwhile the debt incurred by the electricity sector comprises one third of the entire Colombian debt.

URRA I and II—Rio Sinu

A relatively large hydroelectric scheme totalling 1.2 GW, hence one-fifth of today's total installed cap-

acity and involving two dams, Urra I and II, is in the planning stage for the Rio Sinù and its tributaries which run down from the north end of the western cordillera to the coastal plain and the Atlantic. The rivers originate in the mountains and altiplano of the Paramillo National Park which at its highest point reaches almost 4000 metres. Designated a National Park in 1977, El Paramillo extends for some 4,600 square kilometres, therefore covering an area which is at least one-third larger than Cornwall in the UK. Should the construction of the two dams, Urra I and II go ahead, an area will be flooded encompassing some 600 square kilometres, most of it within the National Park. In fact the turbines for the project were bought in 1976 from the Soviet Union—Energo Mach Export—even before the feasibility studies were finished. The Urra I dam is to be built by Skanska—a Swedish Company—according to a contract signed in 1985. Funds are not yet available for the second dam, Urra II, and the largest part of the scheme.

A Biological Refuge

El Paramillo National Park is exceptional for its range of habitat, from the cold (3-4°C) extremely wet (4000 mm) summit area and serrania, to tropical rain and deciduous forest, as well as for the richness of endemic species. Indeed, the forest contains a unique mixture of species from the Pacific Coast region, with links to Ecuador, from Central America and from the Orinoco and Amazon. The forest survived glaciation during the Pleistocene and therefore ranks as an important 'biological refuge'. It is the only forest known to have three species of tapir, one of Panamanian origin, another of the Amazon and the third a highland species, *Tapirus Pinchaque*. To date some 150 species of mammal have been classified and at least 500 species of bird. The forest too has a rich diversity of trees, those in the upper reaches of the rivers, but at relatively low altitude being rainforest proper, and those further downstream and away from the river banks being deciduous on account of the long summer season (December to March). Already the lower reaches of the river Sinù and much of the land stretching some 200 kilometres to the Atlantic have been deforested. The Paramillo Park is also being 'nibbled away' by Colonos (colonisers) who take out wood and convert the land to pasture for cattle. The entire area down to the coast has some 2½ million head of cattle.

PHOTO: JUAN PABLO RUIZ

The colonisers move in along the Manso River.

The task of building the dams has been given to CORELCA—Corporacion Electrica de la Costa Atlantica—a move that has been criticised by the World Bank both on the grounds of the limited financing capability of the company and equally because of inadequate feasibility studies. Indeed, at least 80 per cent of the original estimated $US 1.2 billions will have to be borrowed. A loan has been sought from the World Bank and the InterAmerican Development Bank, but confirmation of the deal has not yet been received. On the contrary, as indicated in a telex to the Colombian Ministry of Mines and Energy (April 9th, 1985) the World Bank is concerned that projected electricity demand in Colombia has been exaggerated, and therefore that the first unit at Urra will not be required at the earliest by 1994 and more likely by 1997. That being the case, rather than work commencing as originally envisaged in 1985, the project should be begun no earlier than 1989. Nor does the World Bank believe that the ecological problems associated with the project have been adequately catered for. It recommends that no major work be undertaken that will compromise future decisions. Meanwhile, a senior official from the Inter-American Development Bank, Rene Costales, told me in Colombia that there was a 50/50 chance that Urra I and II would be built. CORELCA, meanwhile, is determined to proceed with Urra I, even though the project only makes economic sense with both dams being built. From the environmental point of view, the lake formed by Urra II will be far more devastating than that caused by the smaller Urra I dam downstream.

The development to date consists of a dirt-track road from the town of Tierralta to Urra I, a distance of some 35 kilometres, and then on towards Urra II, again a comparable distance. However, with 7 kilometres to go, that final section has been abandoned for the time being. Two base camps for the road construction workers, one at the site of Urra I and the other at Urra II have also been established. Without question, the building of the road has accelerated the influx of colonisers into the National Park area. There is no policing of the area, nothing to deter them from cutting out the wood and putting in their cattle. Travelling up the Rio Sinù and its tributaries (Rio Manso and Verde) we saw a number of large rafts of cut logs, lashed together, on their way to Tierralta some 100 kilometres downstream. Other roads are planned by the Ministry of Public Works that would go into the National Park from Antioquia towards the Rio Verde and from the San Jorge river to the Rio Manso. All these roads are against the National Park laws of 1977 (Decree 622).

The Ecological Consequences of Building the Dam

The loss of one-sixth of the area of the Paramillo National Park in the reservoir, and an even greater proportion of humid tropical forest will put considerable pressure on the remaining forest area and lead to the loss of irreplaceable wildlife.

The general opening up of the area during the construction phase will

undoubtedly hasten the devastating effects of illegal immigration into the forest and up into the serrania of the paramo. Evidence of such colonisation is clearly visible and already increased sedimentation has been noticed in the rivers.

On its way to the coast the Rio Sinù, like the Rio San Jorge to the east, breaks into enormous swamps, covering altogether some 600 square kilometres. The Rio Sinù has some 150 species of fish, half of them marine, and of the 68 remaining species, at least eight are endemic to the Sinù. Fishing plays an enormous role in the local economy as well as providing essential protein in a subsistence diet. As many as 20,000 people are dependent on the fish from the swamps (Cienagas) and rivers, indeed there are some 10,000 commercial fishermen and 10,000 subsistence. During the filling stages, reckoned by CORELCA to take some four to five years, the level of the Sinù river will drop by at least 3 metres. That fall will lead to a drying out of much of the swamp area and the question arises, what will happen to the fish? Most of the fish species are migratory, depending for their reproduction on free passage from the Cienagas up the river. Any decline in fish numbers will be catastrophic for much of the rural population (some 60 per cent of the whole). At the same time, the larger landowners (who have been acquiring most of the land) and who are mostly cattle ranchers, welcome the drying out of the marshes, but they have not fully taken into account the effects on pasture and on the provision of drinking water, of a fall in groundwater level. Another potential problem brought about by the fall in groundwater will be soil salinisation and salt water intrusion from the coast. Such intrusion will lead to a killing of the mangrove swamps close to the coast, with consequences on the shrimp industry of the area. Salt water intrusion will also affect irrigation farming in la Doctrina. CORELCA meanwhile claims that the dam projects will enable 'a management' of the river system with an evening out of the flow during the dry and wet seasons. Again, how important such seasonal changes are for river and forest life is hardly known at all.

A number of people presently live in the areas to be inundated. Some 1,200 Katio-Embera Indians live along the banks of the Upper Sinù and San Jorge rivers, their ancestors having migrated there from the Choco region in Colonial Spanish times after the eradication of the original Sinù Indians. The Embera-Katio Indians live in small family groups in round houses on stilts called Tambos. They survive through hunting, fishing, gathering and horticulture, growing rice, maize, plantain and yucca. They keep pigs, turkeys and a small number of cattle. They are basically self-sufficient, but carry out some trading to buy in fuel for such items as outboard motors. They retain many of their traditions, carrying out religious rites involving their Shamans who are called Jaibanas. They will lose much of their land, and they cannot be adequately compensated since the alluvial lands now available to them will be lost under the floodwaters. The area too is rich in archaeology dating back several thousand years. CORELCA, meanwhile, has no plans for resettling the Indians.

PHOTO: JUNA PABLO RUIZ

When the floodwaters come she'll have to go.

The population of colonisers in the areas to be flooded amounts to some 7,500 people. They too will have to be moved and provided with a basic infrastructure for survival. The colonisers are less dependent on the intact forest for their survival than are the Indians—indeed they are largely responsible for the present destruction of the forest—hence their way of life is less likely to be destroyed by the translocation; their culture such as it is, will survive. On the other hand, the colonisers too have been victims of violence and conflict elsewhere in Colombia and have sought refuge along the Sinù river.

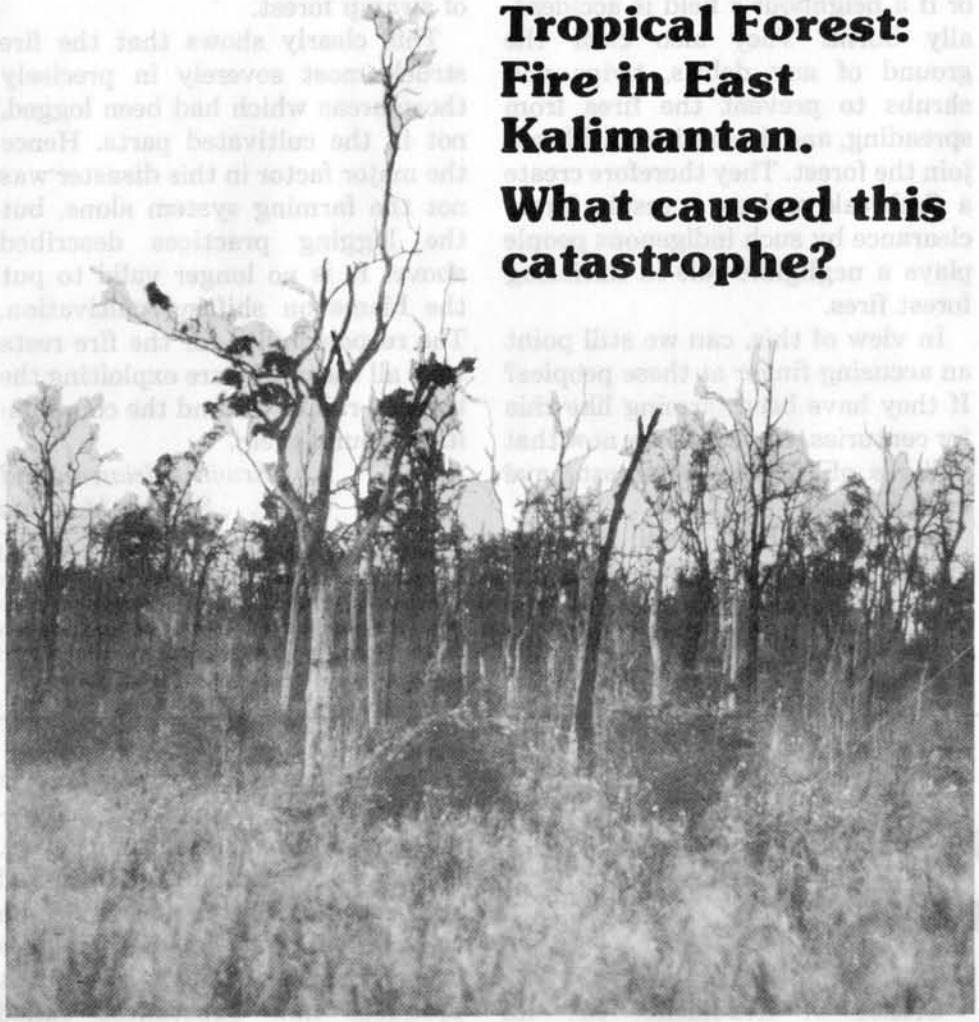
Action

The Institute for Natural Resources and the Environment in Colombia—INDERENA—while under the directorship of Margarita de Botero carried out an ecological evaluation of the threatened area. INDERENA's conclusions were that the hydroelectric scheme would be environmentally and socially disastrous. Meanwhile, given its responsibility for the National Park, INDERENA was concerned at the lack of any control over the activities of the colonisers. and was setting up links with international groups and organisations to focus attention on the National Park and to help bring about a cancelling of the dam project. After the 1986 elections in Colombia, Margarita de Botero resigned as head of INDERENA. It remains to be seen whether INDERENA will continue the fight against the Urra scheme. The outgoing President of Colombia, Betancur, had called for a halt: the new President, Barco, has worked for the World Bank and is under pressure to reopen the issue, particularly from his Minister of Communications who comes from the Caribbean region of Colombia through which the Rio Sinù flows. Typically politicians see large dam projects in their area as conferring prestige both to the region and on themselves. The Minister of Communications is no exception. Given the World Bank's statement that no work should be carried out before 1989, we have three years in which to save the forest.

Peter Bunyard

For a useful guide to hydroelectric schemes in Colombia see: Hernando Roa Suarez and Astrid Blanco Alarcon, Hidroelectricas en Colombia: Impactos Ambientales y Alternativas, FEN Bogota 1986.

The Burning of a Tropical Forest: Fire in East Kalimantan. What caused this catastrophe?



Some 3.3 million hectares of forest were destroyed in the fire which raged in the forests of East Kalimantan during 1982-3, making it one of the worst natural disasters this century. Of the affected area, 22.86% was primary forest; 21.43% secondary forest, land cleared by shifting agriculture and settlements; 15.71% swamp forest; and 40% forestry concessions.

The fire caused havoc to the ecology and economy of the region, disturbing soil and water conservation and wiping out germplasm resources; including plants and animals useful to mankind. In economic terms, timber and non-timber forest products represent an important source of income for the government, second only to oil and natural gas.

Until now, estimates of the losses incurred through the fire have, for the most part focused on the destruction of timber in areas allocated to logging concessions. However, the true losses far exceed those. The most obvious are the effects on the local people, to whom little attention has been paid by researchers and those in position of authority. And little investigation has been carried out on the extent of damage to genetic resources, nor on the adverse effects to the physical environment.

Why did this fire start and then gain such a terrifying hold? We found that areas where logging had taken place were fire risks with dead wood lying scattered over considerable distances. Such debris consists of branches, roots and other remnants of felled trees that are considered as having no commercial value. At the same time dead wood often piles up in small rivers that would otherwise serve as natural firebreaks. Such obstructions may result from the construction of slipways for logs whereby tree trunks are laid parallel to rivers along the sides of valleys. When these fall into disrepair and are no longer used, the logs slide into rivers and block them.

This practice is common in many logging zones. Furthermore, once access along a logging track becomes difficult, new bridges are immediately constructed, taking some 5 to 6 hours to build one—just half a day's work for local labourers.

The first stage is to make a pontoon to get the heavy machinery across. Nearby trees are felled and their trunks dropped across the river bed so that they form a sufficiently large pile. Once the heavy equipment can go back and forth, the process of constructing a proper bridge begins. These are about 5 to 6 metres wide, the length depending on the width of the river. Thus bridge construction requires a large quantity of timber.

Usually the branches and twigs trimmed off are simply left *in situ* or heaped into the river in the hope that the current will carry them away. In the dry season this wood dries out and the rivers dry up, enabling a huge forest fire, such as occurred, to break out.

In addition, opening up the forest stimulates the growth of shrubs and scrub which quickly die down in the dry season, forming ideal kindling material. Both a search through the literature and interviews with local people revealed that no serious forest fires had occurred before the forest was opened up by logging companies. There had always been fires in the dry season, but never on the scale of the one in 1982-3. According to rainfall figures and the evidence of local people, approximately every ten years the dry season was likely to be a particularly long one. For example, the last drought before 1982 was in 1971. At that time the forest was sufficiently intact to prevent the fires from spreading over a large area.

Shifting Cultivators: The Scapegoats

The Dayak tribes of Uma Kulit and Kenyah Kayan living in the village of Long Noran and Marah Kenyah have settled all along the rivers Telen and Marah, having practised shifting cultivation for countless generations. Yet some people have tried to blame shifting cultivation for the 1982-3 East Kalimantan fire. Compared with the estimated total area of destruction, the

percentage under such cultivation was extremely small, only 7.14 per cent (source: Mulawarman University). What real grounds are there for claiming that these people were responsible?

Along the banks of the river Marah (a tributary of river Telen) to Batu Dinding are many newly established fields together with patches of young forest, indicating once cleared land. The land on both sides of the river is farmed by Dayaks, who use the river to transport their crops by canoe. They also believe the land to be more fertile compared with that further from the river.

Usually the first step in preparing fields entails cutting down trees and the herb layer. The shrubs are left until the land is dry enough to burn. All the fields are fired at the same time to prevent the fire spreading between them.

Under traditional Dayak law, sanctions are imposed on people who do not follow the correct procedure, or if a neighbour's field is accidentally burnt. They also clear the ground of any debris, twigs and shrubs to prevent the fires from spreading, and do so where fields adjoin the forest. They therefore create a firebreak and as a result forest clearance by such indigenous people plays a negligible role in initiating forest fires.

In view of this, can we still point an accusing finger at these peoples? If they have been farming like this for centuries, why is it only now that millions of hectares of forest have been burnt?

An official, Dedi Hadi, has provided the following data about the area of forest destroyed in the 1982-3 fire: 800,000 ha of virgin forest; 1,400,000 ha of forest logged by timber operators; 750,000 ha of secondary forest, settlements and shifting cultivation; and 500,000 ha of swamp forest.

This clearly shows that the fire struck most severely in precisely those areas which had been logged, not in the cultivated parts. Hence the major factor in this disaster was not the farming system alone, but the logging practices described above. It is no longer valid to put the blame on shifting cultivation. The responsibility for the fire rests with all those who are exploiting the tropical rainforest and the communities around them.

Erwin Adriawan and Sandra Moniaga

This is an extract from a document prepared by participants of a field course on forests which was organised by SKEPHI—a pressure group concerned with the exploitation and destruction of tropical rainforests in Indonesia.

Irradiated Food— Who wants it?

An important new weapon in the battle to end world hunger, say its promoters. A dangerous fraud, whose real purpose is to provide a socially acceptable use for the nuclear industry's biggest liability, radioactive waste, say its opponents. The subject is food irradiation, a controversial technology on the verge of a dramatic expansion throughout the world.

Irradiation involves subjecting food to massive doses of gamma radiation in order to kill bacteria and insects that destroy or contaminate produce and meats. The potential benefits are obvious, especially in the developing countries where post-harvest losses are a major cause of food shortages, and where refrigeration and other methods of food preservation are not readily available. With irradiation, it is said, a raw steak could be kept on a shelf, unrefrigerated, for several years; fish could be shipped around the world without being frozen; strawberries and bananas could be stored for weeks or months without going bad.

Critics of irradiation say its proponents are giving the false impression that it is a miracle cure-all, and the only alternative to dangerous chemical treatments. Dr Noel Sommer, of the University of California at Davis, who has conducted food irradiation studies since the early 1960s, contradicts that notion: "These people just don't know what they're talking about. For irradiation to work, fruits and vegetables would have to be much more resistant to radiation than the pathogens we want to kill, but our work has suggested that that is not the case." Other treatments, such as fumigation with carbon dioxide, which is already widely used in Europe and Asia, might be safer and more effective than either irradiation or chemicals. The citrus growers' associations of Florida and California have asked the FDA to ban irradiation of citrus fruits because, according to the US Department of Agriculture, irradiation makes them tasteless, causes the skins to pit and turn black, and hastens decay.

One thing everyone agrees upon is that irradiation at the levels suggested does not make food radioactive, anymore than standing in front of an x-ray machine makes a person radioactive. But irradiation does cause chemical changes to food; it produces new substances called *unique radiolytic products* (UPRs) in exposed foods. There may be hundreds or even thousands of these compounds; no one knows what they are or what the effects of eating them are. In 1980 the Food and Drug Administration (FDA) said that there should be a study of the possible toxic effects of UPRs, but no such study has yet been commissioned.

Irradiation also destroys or depletes essential nutrients, such as vitamins A, E, C, and the B complex, and certain amino acids. Supporters say that the losses are on a par with those caused by other processing methods. But Jeff Reinhardt of the San Francisco-based Coalition to Stop Food Irradiation (CSFI) says that irradiation destroys nutrients that the body needs to cope with the very chemicals that irradiated food contains. "This is another toxic time-bomb, like asbestos. You're going to see an increase in liver cancer, in gastro-intestinal diseases

Irradiating Food—A new role for radioactive waste

Food gets irradiated in the Netherlands

A food irradiation plant consists of an irradiation room, where the gamma ray source is housed, and a system for moving food in and out of the irradiation room. Operators control everything from outside the irradiation room, which is entered only for maintenance. The walls of the irradiation room are usually made of concrete and are 6 or more feet thick. The most common source of gamma rays for irradiation is cobalt-60 from Canadian nuclear reactors. Caesium-137 from US nuclear weapons facilities may become more widely used now that the US Department of Energy is preparing to lease it for 10 cents a curie, one-tenth the price of cobalt. Some irradiators use machine-produced gamma rays or X-rays. If the gamma ray source is a radioisotope such as cobalt-60 or caesium-137, it is usually lowered into a water pool when it is not in use.

The structure in which the gamma source is embedded, called the plaque, is about the size of an ordinary door, much smaller than for medical products, which must be completely sterilised and can tolerate very high levels of irradiation. As in ordinary doors, the plaque has panels, but they are made of stainless steel. Each holds several "pencils", thin 18" long rods of caesium-137 or cobalt-60 wrapped in a double shell of stainless steel.

Food, in the containers in which it will be transported and sold, is sent into the irradiation room on monorail-type conveyors. In Hawaii, for example, where International Nutronics is building an irradiation plant, papayas in cardboard boxes will be stacked on wooden pallets, which are hung from the conveyor track with steel cables. With the source lifted from its storage pool, the food moves in on the conveyor belt, entering the irradiation room through a mesh door and turning through several corridors, whose walls block the gamma rays and prevent radiation from escaping through the mesh doors. Each load travels around the source, stopping at different points to expose all sides of the load. The whole thing takes only a few minutes per load, although the exact time varies with the type of food being exposed.

including cancers of the colon and rectum, and possibly exacerbations of various kidney diseases."

By killing certain insects and disease-carriers, irradiation alters the balance between insects, bacteria, and the foods they prey upon. Just as the introduction of DDT led to an increase in the number of DDT-resistant mosquitoes, as well as a decrease in the number of natural predators on mosquitoes and other harmful insects, irradiation will lead to unpredictable and possibly harmful changes in the present balance between insects, bacteria, and the foods they prey upon. Botulism, for example, which is caused by radiation-resistant bacteria, could thrive when its natural competitors have been killed by irradiation. Radiation-resistant strains of Salmonella have already developed in irradiation experiments. Irradiation is also known to stimulate the production of aflatoxin, a naturally-occurring fungus that the EPA says is 1,000 times more likely to cause cancer than ethylene dibromide (EDB), which the goverment has banned for use in food. The fact that aflatoxin thrives in hot, humid climates and is already a major public health problem in developing countries casts doubt on irradiation being the ideal solution to Third World food shortages.

Irradiation is one offshoot of the "Atoms for Peace" movement that launched the International Atomic Energy Agency. The IAEA, and its sister United Nations agencies, the Food and Agriculture Organisation and the World Health Organisation, have worked together to promote the use of irradiation, as a solution to the food shortage in developing countries. In 1980 the three bodies jointly declared that food irradiated with up to one million rads, ten times the proposed US legal limit, is safe for human consumption. Some 25 countries have approved irradiation on a limited or provisional scale. Some hospitals in the US and Europe irradiate food for patients who require a sterile diet; NASA sends irradiated steak and corned beef into space for its astronauts. But the technology has never broken through to the marketplace on a large scale. Last year a mere 7,000 tons of irradiated food was sold worldwide, and most of that consisted of Japanese potatoes treated to prevent sprouting. Most developing countries are waiting for the United States to take the lead in the field.

WHO's 1980 imprimateur on irradiation was one of several fac-

tors that have fueled the current push for expansion in the US. Another was the recent banning of ethylene oxide and EDB, which sent industry looking for some other way to protect citrus fruits and grain from insects, and may have made irradiation, for some foods at least, commercially viable. A third is the nuclear industry's eagerness to find a "positive" use for nuclear waste, especially the type produced in weapons facilities. The Department of Energy (DOE) is encapsulating caesium-137, radioactive waste from the Hanford nuclear facility in Washington State, into a form appropriate for food irradiation, ready for sale as soon as irradiation is approved. The DOE, which runs Hanford and the country's other nuclear weapons plants, has already awarded a New Jersey firm a $273,000 contract to build a mobile irradiator, which will be used to give demonstrations in farm areas. By the end of 1986 the DOE plans to be operating a $3 million irradiation plant somewhere in California, to encourage private companies to adopt food irradiation. "This is a capital-intensive technology and we don't know if it's going to work," said Jack Sivinski of CH2M Hill, the Albuquerque engineering firm that is designing the plant. "The risk is more than a private person would want to assume on his own, so government develops the technology, to encourage industry."

Two Republicans from Washington State, Representative Sid Morrison and Senator Slade Gorton, have introduced bills that would remove the existing requirement that irradiated food be clearly labelled as such, and set up a federal group to promote food irradiation to the public and the food industry. "If food irradiation is such a good idea," Kathleen Tucker, a lawyer and director of the Health and Energy Institute in Washington, DC, said in a telephone interview, "the industry would take it up. Morrison's bill is attempting to shove it down the industry's throat—at the taxpayer's expense."

Tucker is also worried by the prospect of having large amounts of highly radioactive materials in private hands. Food is treated with from 30,000 to several million rads; a typical chest x-ray, by comparison, delivers less than one-tenth of a rad. Because radioactive materials are always decaying (caesium-137 has a half-life of about 30 years), there must be steady replenishment to maintain a constant level of irradiation. The head of the United Nations food irradiation programme explaining the UN's decision to recommend against mandatory labelling, recently warned that "any word or statement containing the word "irradiated" . . . may cause the consumer to avoid the product".

Over the past 30 years there have been hundreds of tests of the health effects of irradiated food; the United States alone has spent $80 million on irradiation research. Many studies were commissioned by the US Army, at the Natick Army Base in Massachusetts, located in Heckler's former congressional district. A review of the army's and other studies raises some disturbing questions, and casts doubt on Heckler's statement that "thirty years of research . . . have shown that the proposed levels of irradiation are safe and nutritious". An FDA review in 1982 found, according to an internal memo, that 344 of 413 studies on the toxicity of irradiated foods were either inconclusive or inadequate. The memo goes on to say that on "detailed examination of the (remaining) 69, five studies (1 per cent of all studies reviewed) appeared to support safety."

A US government-sponsored study published in 1975 in the *American Journal of Clinical Nutrition* found that malnourished children in India who were fed wheat irradiated with 75,000 rads had an increase in abnormal white blood cells, a condition associated with leukaemia. A control group eating non-irradiated grain, did not develop blood irregularities. In another study the same effect was noted in monkeys fed similarly irradiated wheat. Recently the US Department of Agriculture commissioned the largest food processing study ever, on the effects of eating irradiated chicken. Researchers found many problems in mice fed irradiated chicken, including cancerous lesions, kidney disease, and a statistically significant increase in testicular tumours. These problems did not appear in a control group. The report concludes that although the irradiated diet was not "highly toxic . . ., the preponderance of evidence suggests some degree of toxicity was present." But the government's National Toxicology Programme, which reviewed the study at the FDA's request, recently declared that the ill-effects observed in the experimental animals were not the result of eating irradiated food.

That leaves the way clear at last for the FDA to officially adopt its draft regulations. Staff members sent the FDA commissioners a finalised version during the first week of June. The commissioners will seek the approval of the Public Health Service and other government agencies before formally adopting the regulations, probably later this year. With the FDA and the DHSS apparently committed to food irradiation, other countries are likely to follow.

Catherine Caufield

Catherine Caufield *scholar and journalist, writes articles for the New Scientist on development issues, is author of In the Rainforest and currently working on a book on low-level radiation.*

THE UNACCEPTABLE FACE OF C.E.R.N.

CERN, the European Centre of Nuclean Research, has a reputation that other laboratories can only envy. And it is acclaimed for much more than scientific excellence alone. It is, we are told, a paragon of efficiency, consistently accomplishing its projects on time and within budget; it is a "European MIT", offering advanced courses in science and engineering to some 140 undergraduates each year; and it is a model of courtesy to the taxpayers who fund it, gladly opening its experimental control rooms to visits by parties of inquisitive French pensioners. Above all, it is wholly consecrated to the purest pure science conceivable—in the words of a 1982 publication, "it is not concerned with atomic weapons, nor with nuclear power stations". Such is the image that the Centre has assiduously cultivated. But does the reality of CERN match the myth?

Supporters of CERN are fond of comparing its work to the 19th century's researches into electromagnetism. Like the investigations of Michael Faraday and James Clerk Maxwell, they suggest, CERN's activities may not yield tangible benefits in the short term, but eventually they will lead to a myriad technological developments as marvellous and diverse as they are inherently impossible to foresee. Yet the analogy is misleading. The reason that an improved understanding of electromagnetism brought so many everyday benefits is that electromagnetism is the force that dominates nature at the level of everyday life. Faraday's experiments were, after all, performed with human-scale technology, so it was all but inevitable that human-scale technology should have profited from what he learned. But there is nothing human-scale about experiments performed at CERN. Particle physicists' studies of the nuclear processes of the microcosm, like astronomers' studies of the gravitational processes of the macrocosm, are essentially concerned with problems that are progressively further and further removed from the plane of daily existence, and therefore—again like astronomical researches—require apparatus that is ever more costly and colossal. It is overwhelmingly improbable that such work can ever bring practical benefits that are not equally megatechnological. Moreover, history makes it painfully clear what form such "benefits" must generally take. Not without good reason did H.B.G. Casimir, then President of the European Physical Society, warn in 1972 of the dangers that would arise if particle physics ever found a technological role.

In fact Casimir's words were already 30 years out of date when he wrote them. As early as the Second World War, it had become apparent that the particle accelerator was of the utmost military significance: from 1941 until the fall of 1943 accelerators were the sole source of plutonium, and it was research with an accelerator—the 184-inch cyclotron at Berkeley—which permitted the perfecting of the "calutron" isotope separation technique that supplied uranium-235 for the Hiroshima atomic bomb. And today the accelerator is regaining its old importance as a tool of fissile-material engineering. The superconducting magnets developed for it are also well adapted to the laser-electromagnetic enrichment of fissile isotopes, or to the magnetic-confinement fusion reactor; and in the form of the accelerator-breeder, it offers an inceasingly attractive route to the manufacture of plutonium. Already CERN has collaborated with West German scientists in experiments ultimately geared towards the construction of such new generation plutonium-breeders. This is merely one of several ways in which CERN is fostering nuclear proliferation.

No less disturbing are CERN's contributions to the post-nuclear technologies of the fast-dawning era of "Star Wars". Some will probably not bear fruit until the next century: CERN's invention of antiproton cooling, for example—the work which won Carlo Rubbia and Simon van der Meer the 1984 Nobel Physics Prize—has not "domesticated" antimatter sufficiently to allow the building of the long-awaited antimatter-triggered thermonuclear bomb without substantial further technical progress. But other research carried out at CERN will find military uses much sooner. Various types of beam weaponry, neutral hydrogen beams and free-electron lasers for instance, heavily rely upon precisely the accelerator technology which is actually CERN's principal sphere of activity. Most of the help CERN has given to beam weapon researchers has so far been only very oblique; but documents published by Los Alamos reveal some exceptions to the general rule. For instance the ray-tracing computer programme TURTLE, devised with CERN's assistance, has been used at Los Alamos in studies of the feasibility of focusing particle beams on very distant targets with arrays of magnetic lenses, while scientists at Los Alamos have been given pre-publication access to data concerning CERN's new proton linear accelerator—in effect a prototype of the kind of high beam-intensity linac that would be at the heart of an orbiting missile-killer. Givern that CERN and Los Alamos are obviously on such cordial terms with each other, it comes as no surprise to find them collaborating in the building of a radio-frequency quadrupole particle injector of essentially the same type as would load such a missile-killer's "ammunition".

To be fair, it must be emphasised that there is little clear awareness within CERN that its work has any military importance whatsoever. Equally, though, it cannot be denied that CERN's blindness is occasionally reminiscent of Admiral Nelson's. Clinging to an extreme—and arguably excessive—belief in particle physics's intellectual worth, CERN is unwilling to entertain any consideration that might in any way come to inhibit it; and this tends to make it overlook both the social implications of its researches and

their social context. Its disregard of the military significance of its activities is, unfortunately, only one manifestation of a strangely child-like single-minded ruthlessness. Another is its building of the new Large Electron Positron Collider without more than token, not to say cynical, consultation of the views of people in its host region; yet another is its abuse of its unique, quasi-diplomatic legal status to allow the contract workers on its sites to be paid less than France's statutory minimum wage. CERN's renowned efficiency of operation takes on a decidedly ironical aspect when, listening to the complaints of a local resident, one hears its behaviour being bitterly likened to that of a multinational on the Ivory Coast.

The angry frustration implicit in that simile is a feeling that many of CERN's critics must share. If objections to CERN's work are answered at all, it is often merely with a sullen resentment that they should ever have been framed in the first place. Nor can disquiet about CERN always be articulated through the normal channels of democracy: in securing executive approval for the LEP, for example, CERN largely succeeded in avoiding the project's submission to what Jean-Marie Dufour, its legal adviser, described as the "long and hazardous" process of parliamentary debate. And this is typical of the manner in which CERN is administrated. In effect the Centre is run not by its member nations' representative assemblies but by their ministers for science and foreign affairs, who, in practice, delegate their authority to committees of assorted "experts". The "experts" are generally so prejudiced in CERN's favour as to grant it more or less whatever it wants; and the ministers are generally so scientifically illiterate—or simply so busy with other matters—that they are seldom able to do much more than rubber-stamp their appointees' recommendations. CERN could not better illustrate the meaning of technocracy if it had been created for no other purpose.

The time is now surely long overdue for CERN to be brought under proper democratic supervision and control. A good beginning might be the convening of an international parliamentary committee of enquiry to seek answers to the questions raised in this article. Is CERN truly acting in the best interests of the people of Europe? Is it not riding roughshod over the rights of its workers and of its host community? In promoting both nuclear and post-nuclear strategic technology, is it not fuelling an ever-accelerating arms race towards a third (and final) World War? That CERN might be reluctant to face such questions is merely a reason for asking them all the more insistently. If CERN is indeed a "European MIT", it is helping to shape the minds of the coming generation of physicists; and we cannot allow these young people to be educated in an atmosphere of introverted social indifference, still less one of an amoral readiness to sacrifice all other human values to the gratification of academic curiosity. We can no longer afford to breed the kind of scientist who, in withdrawing ever further from the world of humble human reality, threatens to become the inadvertent instrument of that world's absolute destruction.

Andre Gsponer

Dr Andre Gsponer *was formerly a physicist at CERN but resigned from it in 1980 because of his disquiet at the military implications of its research. Together with Jacques Grinevald, Lucile Hanouz and Pierre Lehmann he wrote the book* La Quadrature de CERN *(Editions d'en bas, case 107, CH-1017 Lausanne, 1984) upon which this article is based.*

Books

Symbiosis Evolution

MICROCOSMOS. FOUR BILLION YEARS OF EVOLUTION FROM OUR MICROBIAL ANCESTORS, by Lynn Margulis and Dorion Sagan. Summit Books, New York, $17.95 and Allen and Unwin 1986.

Microcosmos is a book for all to read. Although the ideas expressed with such clarity and enthusiasm in this enthralling volume are soundly based on current scientific research they are couched in language that anyone with a smattering of biology can easily grasp. And it is more than likely that some fondly held convictions about the distinction between 'higher' and 'lower' forms of life will receive a severe shaking. For it is the thesis of Margulis and Sagan that we basically owe our existence to the extraordinary activities of bacteria which not only have transformed our planet over aeons of time into a place hospitable for the entire community of living organisms, but equally have provided us 'higher' organisms with the biochemical equipment to function.

In taking us at breathtaking pace through the origin of life until we arrive at our own epoch, the authors stress that community and cooperation have been the handmaidens of evolution rather than "nature, red in tooth and claw". Indeed, *Microcosmos* has re-established the notion that *symbiosis*, for long held in disrepute as an evolutionary mechanism, is a powerful tool in the struggle for existence. As Margulis and Sagan tell us ". . . the view of evolution as that of mortal competition among individuals and species, a popular distortion of Darwin's notion of 'survival of the fittest', dissolves before a new view of continual cooperation, cohabitation, strong interaction, and mutual dependence among life forms."

Margulis and Sagan are not troubled about the actual origin of life on earth; they do not believe it necessary, as Francis Crick, Fred Hoyle and others have done, to involve a panspermic extra-terrestrial source of living material brought in from space by a crashing meterorite.

As a number of experiments have now shown, temperatures and the energy-rich conditions on the young cooling planet, some 3,900 million year ago, were obviously ideal for the synthesis of many of the chemical forms that are now part and parcel of all living creatures, for instance amino acids, and the nucleotide bases that provide the coding letters for DNA and RNA, including ATP itself which is the energy carrier in metabolic processes.

"There was sufficient time and energy available", say the authors of *Microcosmos* "for life's molecular combinations to arise from chemical alliances encouraged by the cyclically changing, energy-charged environment . . . There is no need to postulate the unlikely when the likely abounds."

Clearly life arose and could arise because conditions were uniquely favourable for such happenings. For one, there was no oxygen around in that early atmosphere to destroy through oxidation the newly synthesised organic compounds. In time certain compounds would have been produced with catalytic powers and in time an 'autopoietic' entity which by possessing the ability to sustain and actively maintain itself against external conditions would have the attributes of a living organism.

Today we recognise life as a phenomenon associated with living cells, and we tend to divide the world up into plants and animals, suggesting a fundamental difference between the two. But the real division is between the prokaryotes, encompassing all the bacteria with no nucleus, and the eukaryotes which includes all other life forms that have a membrane-bounded nucleus. And what an extraordinary story Margulis and Sagan have to tell us. From the fossil record, as left in the most ancient rocks on earth, bacteria in one form or another appear to have their origin closely connected with the origin of life itself. Moreover, in the ability of bacteria, as shown by modern research, to exchange chunks of genetic material whether within species or even to bacteria of other species, lies a foundation stone for evolution which far exceeds in importance the spot mutation and chromosome rearrangement mechanisms that underlie the Mendelian laws of inheritance.

"These exchanges are a standard part of the prokaryotic repertoire. Yet even today," say the authors, "many bacteriologists do not grasp their full significance: that as a result of this ability, the world's bacteria essentially have access to a single gene pool and hence to the adaptive mechanisms of the entire bacterial gene pool. The superior speed of gene recombination over that of mutation is obvious: it could take eukaryotic organisms a million years to adjust to a change on a worldwide scale that bacteria can accommodate in a few years."

Bacterial sex may be the means by which considerable pieces of valuable biochemical information can be interchanged, but it is the biochemical repertoire of bacteria which in itself is staggering. Bacteria invented all manner of fermentation processes, and discovered the fixation of nitrogen, thus making nitrogen-rich compounds available to the rest of the biota. Bacteria also created all kinds of photosynthetic processes, and finally, once oxygen—a bacterial waste product—was on the scene, developed the powerful electron transport system associated with the cytochromes of the mitochondria, and so gave us respiration.

By the Proterozoic Aeon, some 2,500 million years ago, according to Margulis and Sagan, bacteria had invented thousands of metabolic devices, including all the major ones known today. But how did they come down to us? The evidence suggests increasingly that the eukaryotic cells of animals and plants were originally derived from symbiotic associations of different species of bacteria, each of which could bring into the relationship new attributes, whether it be biochemical pathways for utilising energy or even a motile structure such as cilia. For instance, both chloroplasts, the organelles responsible for photosynthesis in green plants, and mitochondria, the organelles in which the major metabolic pathways of respiration take place, have genetic material which reflects a bacterial origin. Moreover the division and therefore reproduction of these organelles takes place separately from the division of the cell in which they are found. In recent years too, the discovery of a robust chloroplast-like bacterium named *Prochloron*, living symbiotically in association with a sea squirt, would appear to clinch the argument of the bacterial origin of plastids.

"As you look around beyond the human artefacts you cannot fail to see the tremendous success of *Prochloron's* descendants:" say Margulis and Sagan. "Jungles, gardens, house plants, and grassy hills, all of them testify to the success of plastids. Eaten, but not digested, they have insinuated themselves into every corner of the world, hitchhiking as

part of a cooperative partnership called the eukaryotic cell."

While biologists have come to accept that mitochondria and plastids were probably of bacterial origin, they are less enthusiastic over the idea, put forward particularly by Lynn Margulis, that the microtubules associated with cell secretion, cell division, nerve cell formation and the manufacture of whip-like flagella or beating cilia have a common origin —of course bacterial. The reasons for her contention are not necessarily far-fetched, since microtubules from all manner of species and phyla, from slime moulds to the axons of neurones in the human brain, have a similar structure and nearly identical tubulin proteins. Indeed, all cilia and flagella (collectively "undilipodia" because they are identical), associated with whatever organism, have what is known as a 9 + 2 array of pairs of microtubules, nine pairs in a ring around a single pair of microtubules in the centre. Equally the *kinetosome* out of which each undulipodium forms, has nine triplets of microtubules arranged in a circle. But the connections go further, and the centrioles, which in eukaryotic cells organise the spindle structure that pulls the chromosomes into what will become the new nucleus during cell division, have exactly the same structure as kinetosomes. The spindle, meanwhile, is made up of hundreds of microtubules. Sperm tails, which drive the sperm to fuse with the oocyte structures in the rod and cone cells of the retina, the axons and dendrites of the brain, are all microtubular structures, some with the 9 + 2 array.

So what indeed is the bacterial candidate for this extraordinary repertoire of functions? In fact the tiny corkscrew-like spirochaete would appear best to fit the bill. It is highly motile, its entire body whip-like, and some species have microtubules, although none so far found with the 9 + 2 structure. Moreover certain species of spirochaete have a great propensity for forming symbiotic alliances in which they act as the motile power, driving their partner along to where there is food. An incredible example of such symbiosis is to be found in the termite hindgut, where the protist, *Mixotricha paradoxa* is propelled along by some half million attached spirochaetes, all their bodies waving in unison. As it happens, the termite needs its gut micro-organisms to digest wood cellulose, termites lack enzymes to break down. Hence symbiosis is to be found at every level within the insect, and to insist that the animal is a single individual is patent nonsense.

Microcosm is a book packed with information and fascinating detail, but all of it to the purpose of demonstrating how life forms are interwoven with each other. Lynn Margulis too is the other partner in Lovelock's Gaia hypothesis, and it is not surprising to find her and Dorion Sagan discussing in their book the way in which micro-organisms—and bacteria in particular—established the means by which atmospheric gases and ultimately the Earth's temperature could be regulated. There are undoubtedly some extraordinary, nigh mystic-making elements in the story of life over its evolutionary history. Oxygen for instance, when released to the point where it built up in the environment, was a powerful destroyer of life, yet by adapting to it and evolving ways not just to live with it, but how to use it, organisms gained an energetic metabolism that enabled swift locomotion, flight and warm bloodedness. And if the Gaia hypothesis is soundly based, then it would have been essential for life to have found a means of metabolising carbon dioxide out of the atmosphere and to have replaced it with a gas that did not possess carbon dioxide's greenhouse properties. Meanwhile ozone, formed from oxygen, acted as an ultraviolet shield, protecting the new colonisers of terrestrial and marine environments from chromosomal damage. In looking back over evolutionary history it is sometimes hard to escape the conclusion that each new major metabolic achievement, whether photosynthesis, respiration, the manufacture of steroids, all desperate responses to life threatening situations, form part of an ordered sequence of events. Indeed if it were not for that tautology we would not be here.

One can hardly expect to find better advocates for the essential role of bacteria in the earth's history than Margulis and Sagan. In the end they challenge us with the idea that we human beings as a sort of ultimate creation of bacteria with our extraordinary nervous system, may indeed be taking on where bacteria so far have left off. From bacteria, although hardly crediting them, we have discovered how to snip off bits of genome and by biotechnology to create new chimaeric strains, and if we use our intelligence we can learn to colonise new environments with autopoietic communities. On the other hand we may destroy ourselves and some of our eukaryotic partners like forest trees and leave the world once again to the *Microcosmos*. It is all there to be read in what must be a landmark in biological conception.

Peter Bunyard

Radiation Guide

RADIATION: DOSES, EFFECTS, RISKS United Nations Environment Programme (UNEP); distributed by United Nations' sales offices at Geneva, Switzerland and New York, USA; Price US$10.

A clear and timely booklet which sets out to present the findings of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) to a broad audience, and to explain some of the basic facts on radiation and its related hazards. So much of the information available to the general public is coloured either by emotion from the anti-nuclear lobby or by bland reassurance from the exponents of nuclear energy that it is refreshing to have to hand a full but easy-to-read exposé of what it is all about.

The booklet starts off by explaining radioactivity, and in particular the important fact not always understood that the principal amount of radiation received by the world's inhabitants comes from natural sources, be they terrestrial or cosmic. In fact, less than a quarter of the radiation we receive comes from man-made sources and, of these man-made sources, medical radiation is by far the most common cause, whether for diagnosis (X-rays) or for treating disease (radiotherapy).

The effects of radiation on mankind are then examined, and a final chapter looks into the acceptability of risks. This final chapter, unlike the rest of the book, is not based on UNSCEAR reports and findings; rather it looks at the subjective perception of radio risks and comments upon salient features, for example how almost all public attention and apprehension is focused on nuclear power, the imprecision of the methods of assessment of the effects of exposures, and the health benefits of therapeutic exposure.

The book concludes on the statement 'a little learning is a dangerous thing'; as the industrialised nations of the northern hemisphere reel back from the impacts of the Chernobyl catastrophe, and with Three Mile Island still fresh in our memories, this short book will be useful for the man in the street to increase his understanding and awareness of radiation and related issues.

The book is amply illustrated with drawings and diagrams, which highlight the principal facts and arguments of the text and lend clarity to the explanations.

Francis O'Kelly

Transformation into Life

THE BIOSPHERE By Vladimir Vernadsky. An abridged version based on the French edition of 1929. With a preface by Evgenii Shepelev, Synergetic Press, Inc.

The republication, for the first time in English, of Vladimir Vernadsky's 1926 Russian manuscript, *The Biosphere*, is a welcome effort. Published in French under the title "La Biosphere" (Paris Alcan), the French version has served as the basis for this 1986 English translation. Apparently the manuscript had been hiding in the attic of an English translator for years when Synergetic Press got it. Despite the slimness of the volume (abridged in part to be rid of outmoded scientific results), and despite the somewhat idiosyncratic efforts of the publishers to create an historical context (they rank Vernadsky with Newton), the book is elegant and illuminating.

Vernadsky, though he did not coin the term, is nonetheless responsible for bringing the interdisciplinary term *biosphere* into common scientific parlance. With this translation we can see that Vernadsky's concise language reflects his gift of seeing that masses of organisms produce unitary forces with distinct physico-chemical effects. Life's geological impact has been massive on the earth as a whole, as well as on major parts of it. In keeping with such a vision Vernadsky considers cyanobacteria, algae and, plants—all photosynthetic life—together as "green living matter". Since they directly transform the energy of the sun, they are "organisms of the first order," what, in modern biological jargon would be termed "autotrophs" or "primary producers". Likewise, heterotrophs such as carnivores are referred to as "organisms of the second order." The insightful, simplifying language of Vernadsky reflects his vision, his desire for profound generalisations and treatment of life as only a special form of matter. Vernadsky, originally trained as a geologist, and specialised in mineralogy and crystallography; it is in part for this reason that he was able to perceive life neither as matter imbued with a vital force nor as a simple concatenation of atoms, nor even as a Darwinian collection of ever-battling individuals. For Vernadsky life was not so much life as "living matter", a peculiar form of moving mineral. He was keenly aware of the chemical composition of organisms, of the location and transportation of their aggregate atoms. Without knowing the details of micro-organisms he knew of their aggregate effects on nature; for this reason he spoke of "films" and "layers" or, if more finely dispersed, of "rarefactions" of living matter. For Vernadsky the process of life, the accumulation and migration of biogenic matter at the surface of the earth, was a permutation of the energy of the sun. The biosphere was not simply the domain inhabited by life, but a region of transformation of solar into "geochemical" energy. It is rather remarkable that before anyone had so much as seen the earth from space, Vernadsky not only envisaged life as primarily a geological or planetary phenomenon, but saw reproduction, the tendency of organisms to grow and multiply, and the movement attending such reproduction, as essentially cosmic phenomena. Life is matter that traps and changes solar energy. In a sense, Vernadsky did for biological space what Darwin did for biological time: he showed that the main traits, the scientific character of life as a whole, could be grasped only in a global context, one which encompassed space and radiations from the sun. After contemplating the biosphere Vernadsky comes to two conclusions, which he raises to the level of "biospheric principles". The first principle is that "The biogenic migration of atoms in the biosphere tends towards a maximum of manifestation." Vernadsky's mineralogical view of evolution largely ignores the changes in shape and size of organisms as individuals and focuses rather on an overall increase in the circulation of atoms in the biosphere. Indeed, this is explicitly summed up in Vernadsky's second biospheric principle, that "The evolution of species, in tending towards the creation of new forms of life, must always move in the direction of increasing biogenic migration of the atoms in the biosphere." In Vernadsky's view the tendency of increasing atomic migration through time had reached a new peak with the appearance of humans, who, wittingly and unwittingly, release all sorts of new chemical compounds into their surroundings. Part of man's challenge is to involve these new compounds in the biotic circulation, so they do not stagnate and build up as global environmental poisons.

Vernadsky's view of the biosphere is his own and differs from the more modern scientific formulation of Gaia as developed by atmospheric chemist James Lovelock. Far from seeing the earth as a living organism, he saw life as a geological force. There is no evidence that Vernadsky perceived—as does Lovelock—that life itself is a powerful environmental regulator. In the Gaian view life is actively involved in the maintenance of its chemical and thermal environment at livable values through naturally evolving (yet so intricate as to seem almost designed) mechanisms of homeorrhesis. Vernadsky speculated that the hydrogen-rich composition of life derived from solar radiation and the interchange of matter between the surfaces of celestial bodies, his concept of "geothermal energy" may therefore be too general to be of scientific use. Yet there is much here that is philosophically alluring and valuable: the republication of *La Biosphere* allows us to glimpse the vision of a truly global polymath, an interdisciplinarian who combined scientific fields to gain fresh insights, and a pioneer whose legacy was in seeing life from a global viewpoint that far transcended normal organismic biology. By treating life as a sort of hyperactive cosmic mineral, Vernadsky, who died in 1945, made a worthy contribution to modern science. Whereas in the USSR a main biogeochemical institute has been named after him, and he is widely seen as the father of biogeochemistry, his work has gone too long unnoticed in the west. Hopefully this graceful reprint signals an end to our ignorance in the West of Vernadsky, who was a major and original ecological thinker.

Dorion Sagan

Recreating the Countryside

A RURAL POLICY FOR THE EEC? Hugh Clout. Methuen. Paperback £5.95.

Few of us have the time, the ability or the patience to master and summarise the copious and complex documentation from the EEC Commission and other EEC institutions as well as the relevant books and articles on the theme of rural policy as Hugh Clout has done. His sure touch arises from the fact that he is a geographer with a lifetime's experience of European rural communities and he has also served as rapporteur for an important working party organised by the *Institute for European Environmental Policy*.

The interrogative title has three implications: Is there a coherent rural policy in the EEC?—the answer is No. Is such a policy possible?—Yes, but very difficult to devise. Are the recommendations at the end of this book practical and sustainable?—probably Yes, but to implement them requires a great deal more research and experiment than is being projected, despite the fact that the guidelines are by now generally accepted in a vague way by the EEC and its sovereign states.

The changes in the countryside since the mid-century as statistically described by Clout are truly astonishing and hard to grasp even by somebody who has lived through them. In order to industrialise agriculture on a mass production, specialist basis, European governments had to subsidise it in various ways on a massive scale (so that its actual profitability in a free market is dubious despite its boasted efficiency) leading to the ultimate crisis produced by high guaranteed prices which, ostensibly intended to protect the small farmer, have made millionaires of the big ones.

It is this concentrated wealth, an inevitable vested interest, which has paralysed reform and made rural policy a chaos of conflicting intentions unable to harmonise agriculture with the needs of the rural community. Productivity, as conceived in economic terms, and conservation—the sustenance of soil fertility, the nutritional quality of food and the interrelationship of farm animals with the landscape—have divided into separate issues instead of remaining indivisible as they were in the past. Two conflicting policies are therefore pursued instead of one coherent policy. The primary policy is to support productivity; the second—and very secondary one—is to aid conservation. A coherent policy has been sabotaged by the agro-industrial lobby because it does not want public money channelled from productivity to conservation. Conservation means much more than the conservation of the soil and the nutritional quality of food; we have reached such a pitch of social degradation that it also means the conservation of the small farmer, the part-time farmer and the village and hamlet. None of this will be possible until we have a reformed agriculture that can serve as the sustainable basis of an enduring rural community.

Nevertheless, even if this were achieved, we should still have to decide what kind of a rural society we want. Modern communications have made the interpenetration of town and country inevitable—which in many ways is a good thing if we could learn to harmonise the virtues of both, instead of allowing urban ambitions and urban ecological ignorance to dominate. The countryman and the townsman must listen to each other, a process which Clout shows to be slowly taking place. At the moment the most significant issue is that the old rural society had values, which it would be fatal to lose, that are being destroyed but which could be revived within a new framework. We do not yet know how this will ultimately be achieved; yet, as 80 per cent of Britain is still rural, there is immense scope for devising a new pattern of country life, based upon a love of place and a sustainable agriculture.

Clout tells us that the French are the most advanced in this kind of experiment and we should take note of what they are doing—including, in some regions, limiting the size of farms. There are some European paradoxes too. The Dutch who have the most intensive and polluting agriculture are now financing some of the most advanced research into more conservational farming and have some of the most strictly controlled national parks. The whole of the EEC is, however reluctantly, trying to solve the rural problems caused by progressive agriculture and modern communications—indeed they are now worldwide problems. Every generation has to correct the errors of its parents, an infinite process. Britain unfortunately is failing to measure up to the challenge from false notions of economy—rural and ecological reforms in common with justice, equity and education must bow down before the ill-conceived exigencies of the public sector borrowing requirements. What can we say of a government that, when soil erosion is perceived to be a serious problem, halves the funding of the *Soil Survey* and which refuses to establish a research station for studying the relative merits and environmental effects of different forms of husbandry when this is an absolute for determining the future of agriculture? As we are too mean to save ourselves, perhaps the EEC will do it for us.

All this is implicit in Hugh Clout's comprehensive survey, which might, in my view, have been more explicitly underlined.

Robert Waller

LETTERS

Cancer Risk

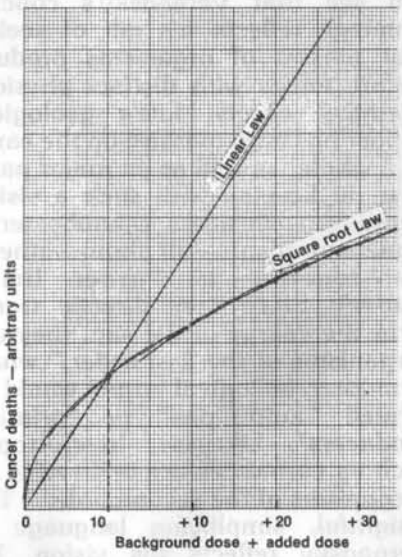
Dear Sir,

Peter Bunyard and Graham Searle in your Chernobyl issue (No.4-5, 1986, p181) support the idea that a square root law curve fits the facts better than does a linear law for the production of cancers at low levels. This does not seem physiologically probable, but if true would mean that the natural background is more important and additions from the nuclear industry less important than would be the case for a linear law.

Suppose as you suggest that at low levels of radiation the effect varies with the square root of the dose, i.e. the cancer mortality is $k\sqrt{D}$. Then with no background dose, the mortality due to 15 rem alone will be $\sqrt{15}k$, i.e. 3.873k. With 10 rem lifetime background dose alone it will be $\sqrt{10}k$, i.e. 3.162k. With both it will be $\sqrt{25}k$, ie. 5k. The increased effect due to the extra $\sqrt{15}$ rem will therefore be only 1.84k, less than half the effect that the $\sqrt{15}$ rem would have alone.

Speaking more generally, *any* relation between cancer initiation and radiation dose that gives a smaller than linear fall in cancers with fall in dose at low levels will make the importance of the background greater and the importance of any additional dose less.

Yours faithfully
Emeritus Professor J.H. Fremlin
Birmingham, UK.



Dear Sir,

The point overlooked by Fremlin is that 10 or 15 rem from background radiation would have been *received* as repetitions of much smaller doses (millirems infact). Therefore the risk of each exposure would come much nearer to the vertical take off of a square root curve than is suggested in his letter.

Note the vertical take off implies an *infinity effect* at this point which is nonsense. Therefore all these risk curves are approximations to reality.

Regarding Fremlins last paragraph this is only true if the additional dose is a single large one, (as in the case of A — Bomb victims).

Yours faithfully
Dr Alice Stewart
Queen Elizabeth Medical Centre
Birmingham, UK.

Chernobyl Mortality

Dear Editors

The Chernobyl issue of *The Ecologist* (Vol 16, No 4/5, 1986) contains three "extracts" of my Chernobyl analysis report, which are very well edited from my report (I want to emphasize this), except for one error. The third extract, on the theme "The Health Consequences of Chernobyl", contains a paragraph which was not extracted from my report, but instead was written and put in by the editors in conjunction with FoE without my knowledge, nor consent, and gives an estimate of the projected number of cancer deaths resulting from the accident. The estimate given is 280,000, which is based in part on a cancer probability value for radiation health effects that is 20 times the 0.0001 per rem probability value assumed by the International Radiological Protection Commission (ICRP). The editor's value is characterised as a value "which more closely fits the facts", referring to another article in that issue, "The Effects of Low-Dose Radiation" which reviews other analyses of the cancer probability. In fact, however, my Chernobyl report asserts that no cancer probability value has been established, and that based on statistical uncertainties, one cannot presently exclude a value of 0.005, or 50 times the ICRP value. On this ground I estimate in my report that the possibility of 720,000 cancer deaths cannot presently be excluded, based on my estimate of the projected external radiation dose to the human population affected by the accident.

To correct the record, the printed text of the "extract" which was not taken from my report begins with "This being so . . .", and ends with ". . . 288,000." (Page 170.) The corresponding paragraph in my report is as follows:

I have studied many analyses of the cancer probability per unit of radiation dose and find them essentially speculation or based on meagre and hard to verify statistics or incomprehensible esoteric analyses. I think that we just do not know the actual cancer risk of radiation, much less more subtle health impairments. It would take a controlled experiment of a very large population to establish the health injury rate of radiation exposure. In the absence of such, one can estimate on the basis of statistical arguments (statistical uncertainties) that a cancer probability of 0.5% per rem of whole-body dose is possible, since it presently cannot be excluded. This view has been concurred in by the US Nuclear Regulatory Commission's expert for biological effects of radiation, Dr Jerome Puskin. Remember, one rem is a strong dose of radiation. With this figure one can make an estimate of the projected (future possible) number of cancer deaths caused by the Chernobyl accident fallout over the above-stated estimated 600,000 sq kilometres zone. The result: 720,000 cancer deaths cannot be excluded! *This assumes a population density of 120 persons per sq kilometre: 600,000 x 120 x 2 rems x 0.005 = 720,000.* (pp 31-32)

I should add that my forthcoming revised report, to be published by the Wadebridge Ecological Centre, will include an extensive analysis of this cancer probability question, thanks to the helpful scientific materials supplied by and discussions with *The Ecologist* editor, Mr Peter Bunyard, and others. My latest research of this question so far confirms my previous conclusion.

I would like to add that my analysis of the consequences of the Chernobyl accident given in my report is not based solely on an upper-bound-like estimate of the possible number of cancers which might result from the Chernobyl radiation releases, as one might gather from the extracts, but also, and primarily, on comparisons of estimated projected radiation doses to individuals with the natural radiation exposure values, which I think is a more tangible ground for assessing the health risks consequences of the accident.

Richard E Webb, November 12, 1986.

Fast Reactor Explosions

Dear Editor

The military want more than 90% of the fissile plutonium isotope in their bombs, and an Amory Lovins *Nature* article estimated that, with but 70% in, bombs would give a phut of some kind; but Dr Richard Webb (*Ecologist* Vol 16) asks us to believe that a mix with only 20% in can go bang. For that is what the Dounreay Breeder reacter core contains. He gives no evidence to support this conclusion, nor references. The latest Ecoropa factsheet also makes this claim, perhaps having heard it from Dr Webb.

Were this true, it would be a sufficient argument to halt the nuclear industry worldwide; for without the development of fast reactors, the present generation of thermal reactors are but a flash in the pan. And the prospect of them blowing up not chemically as Chernobyl but in a nuclear reaction is not a risk to be contemplated under any circumstances at all.

My feeling is that there are enough sound arguments against nuclear power without introducing a sensationalist claim probably not sustainable. Uranium-238 of which some 80% of the Dounreay PFR core is composed, absorbs neutrons, and further has the property that it absorbs them better at a higher temperature, one gathers, and this is what is customarily taken as fixing an upper limit to the neutron flux energy; i.e. after a meltdown it would be hot but could not go supercritical. Dr Webb, I don't believe you.

Yours truly
Nick Kollerstrom
Worplesdon, Surrey, UK

Dr Webb replies:

It is frustrating how people quickly draw conclusions about their safety in the technical field on the basis of their own limited knowledge without bothering to inquire into the matter. *The Ecologist* "extract" from my Chernobyl report (my analysis of the Chernobyl accident with a comparative analysis of the accident hazards of western reactors), which Mr Kollerstrom disbelieves, cannot in such a short space prove the A-bomb size explosion potentials of fast breeder reactors (FBRs), but can only inform the public of my research finding, give the basic postulated mechanism for plausibility, and urge an investigation by the public authorities and scientific community. Why prejudice it?

Consider the points made in the Extracts:

1. There is a great quantity of plutonium (fissionable material) in a fast breeder reactor. I could have added that there is 1450 kilograms of plutonium in the SNR-300 reactor (a small fast breeder reactor) versus only about 10 kilograms of plutonium needed to make a bomb, or enough reactor fuel to make 12 to 15 separate critical masses, if the reactor core (fuel rod bundles with 50% void space between fuel rods for coolant flow) should melt and the fuel material compact (fill the void space). In a larger FBR, 1 to 3 tons of Pu are used.

2. The mechanism: In a core melting accident one small critical mass forms (compacted fuel mass) and explodes, which in turn drives a second nearly critical mass toward a third mass, to assemble a secondary super-critical mass. The mechanism is like the Hiroshima atomic bomb mechanism. Driving enough fissionable material together produces explosive atomic chain reactions.

3. One to three kilotons of TNT equivalent explosion potential (Hiroshima was 13 kt) was *calculated*, not merely guessed. (I assumed SNR-300 fuel compositions.) The theory which I have developed predicts the observed 13 kilotons explosion energy yield of the Hiroshima bomb; so the theory is verified.

4. There is furthermore the possibility of an augmentation of the explosion energy yield, as the extreme pressures of the secondary reaction could compact or even compress other fuel material in the reactor vessel to generate a tertiary reaction, and so on. No limit has yet been calculated.

5. My background: doctorate with dissertation on the explosive excursions of the atomic reaction in fast breeder reactor accidents.

Are these points not enough to warrant an enquiry?

Mr K. says that I give no evidence. On the contrary, I cited the opinion of Dr David R. Inglis, who was one of the original 40 physicists who developed the atomic bomb at Los Alamos, and whose work in that project was precisely the kind of theoretical analysis that I have done on the subject explosion mechanism. Dr Inglis stated that the mechanism is credible and needs to be examined. The Extract also cites the report of the official history of the Los Alamos project, which reveals a third possible mechanism for producing atomic bomb explosions besides the Hiroshima "gun-type" and Nagasaki "implosion" type mechanisms, and that is, "autocatalytic assembly" of fissile material, which is precisely the mechanism which I have analysed for the SNR-300 reactor case.

Mr K. says that I give no references. If he had inquired, by obtaining my whole report, he would have learned that I have issued a separate, specific report of my analysis and calculations of the atomic bomb size potentiality, dated April 4 1986. This separate report was sent to the responsible ministers in the Nordrhein-Westfalen and federal Governments in West Germany for consideration in the licensing question of the startup of SNR-300. (Incidentally, the NRW minister has recently announced that a decision on a licence for SNR-300 has been deferred pending a new investigation of the safety of the SNR-300 reactor and other reactors in NRW.) Unfortunately, my April 4 report must be given a selected distribution, because it gives some information on how to design atomic bombs; so it obviously

cannot be published. Consider also this: the US Government and its laboratories have never made a statement that nuclear power plants cannot explode like atomic bombs.

Now about Mr K's 90%, 70% and 20% figures on fissile enrichment. Yes, we may assume that atomic bombs use over 90% fissile plutonium, to maximise what the Los Alamos project called "the efficiency". But the fact of the lower enrichment for FBR fuel of itself does not preclude an A-bomb-like explosion potential by the proposed mechanism. My analysis model assumes 31%—the SNR-300 outer core zone fuel. I cannot vouch for Mr K's 20% figure for the Dounreay reactor, because the data on fissile enrichment for the British and French FBRs are not given in the literature that I have been able to acquire. My Chernobyl report specifically mentions that I plan to offer my April 4 report to the French and British authorities. I specifically had in mind to propose to the British and the French Governments that I investigate their FBR reactor fuel design (e.g. enrichments) for a possible A-bomb explosion potential; for in my October 28 1985 letter to the pertinent Ministers of West Germany, which introduced my research of this question, I stated: "My analysis presently applies to SNR-300, as the value of the plutonium concentration (enrichment) assumed in my analysis so far is that which applies to SNR-300. I have not yet investigated the fuel compositions used in the French Super-Phenix reactor design, nor in the US FFTF reactor design."

The key point to make here is that whatever the FBR loses by a reduced fissile enrichment, it makes up for it in spades by having a much greater total "loading" of fissile material (plutonium). Professor Eugene Wigner, one of the original group of five scientists in the United States who in 1939-40 pressed the Government to develop an atomic bomb, and who is co-author of the classic treatise *The Physical Theory of Neutron Chain Reactions*, told Professor J. Benecke of University of Munich, that he (Wigner) is worried about the hazards of the FBR because "of all those kilos of plutonium" in the core.

As for Mr K's vague, oblique reference to Lovins' article, it proves nothing. It needs to be said that one cannot really evaluate the explosion hazards of fissionable material without developing thoroughly rigorous theoretical models and mathematical methods, and making authoritative calculations. Writers of popular physics articles can study a few limited published works in this field to look for hints of possible explosion potentials or fizzles (phuts), but that is all.

Finally, Mr K. asserts the property of Uranium-238 (the rest of the material in the fuel) that it absorbs neutrons better at higher temperatures; and that this limits the "neutron flux energy", and thus prevents the fuel from going "super-critical" upon a meltdown of the fuel. This statement reflects a total ignorance about reactor physics. Firstly, there is no such physics concept as "neutron flux energy". The neutrons, which cause the atomic fission, have a spectrum of energies (speeds). The flow of the neutrons across a unit area is called the "flux" of neutrons. The total flux is distributed over the energy scale —the flux spectrum. The U-238 elevated temperature property, to which Mr K. refers, and which is called the "Doppler effect", does not fix any limit on the neutron energies nor the flux. His statement reads like a science fiction book, where an author lets his imagination soar.

As for his statement that the Doppler effect precludes a super-criticality when the fuel heats up and melts, this is more such fiction. Any cursory reading of the literature on FBR "safety" will inform one that the fuel melting in an FBR is the prime mechanism for potentially causing super-criticality, by inducing fuel compaction (e.g. slumping). See for example *Fast Breeder Reactor*, by Waltar and Reynolds (Pergamon Press, 1981), which is an authoritative reference book on FBRs commissioned by the US Department of Energy. The classic Bethe-Tait theory of nuclear explosion potentials of FBRs, which was published by none other than "Her Majesty's Stationary Office", assumes core compaction upon a meltdown of a FBR core, in order to model a super-criticality and calculate estimates of the consequent nuclear excursion/explosion potential. (Dr Bethe led the theoretical division of the Los Alamos project.) Incidentally, Bethe and Tait's analysis assumes merely a mild mechanism (gravity driven collapse of the core), and neglects the more serious mechanism, such as the proposed one of a small compacted mass being blasted toward another mass by an initiating small excursion/explosion—an autocatalytic assembly mechanism.

It is fairly known that the fission excursion energy yield (explosion energy) of FBR fuel compaction supercriticalities is roughly proportional to the 3/2 power of the "velocity of assembly" (rate of compaction). A slow fuel assembly gives more time for the vaporising fuel material to expand and "disassemble" itself (by vapour pressure driven outward accelerations of the material as the fissioning multiplies), before the fission multiplication can grow to extreme A-bomb levels. The result is a weak explosion or fizzle. A rapid assembly on the other hand allows more fuel to be assembled before the fuel can blow itself apart and stop the fissioning, hence a stronger supercriticality is achieved, hence a greater energy yield, hence a stronger explosion. Since a gravity-driven collapse or assembly of fuel can yield a nuclear explosion, as Bethe and Tait calculated, one can imagine what a blast-driven assembly would yield, as in the subject mechanism (model).

Also, since the disassembly process is retarded by the inertia resistance of the fuel mass, a larger fuel mass means a slower rate of disassembly, hence a greater energy yield, everything else equal. This partly explains why 31% fissile enrichment can still admit a theoretical A-bomb-like explosion potential, because more fuel mass is present in a criticality than in an atomic bomb, since it takes more fuel mass to make a critical mass for a lesser plutonium enrichment. Likewise, I see no reason why 20% enrichment could not have such explosion potentials, perhaps somewhat less. Also, it does not have to be one kiloton TNT to be catastrophic: just one thousandth of the value would destroy the reactor containment and release the deadly fission products and plutonium radioactivity into the atmosphere. Moreover, there are other mechanisms for producing catastrophic nuclear explosions short of atomic bomb size, which are treated (analysed and calculated) in my other SNR-300 treatises mentioned in *The Ecologist* extracts, but which Mr K. ignores. These explosion potentialities would be a "sufficient argument to halt the nuclear industry worldwide", by Mr K's criterion, since the fast breeder can "blow up" by these less severe mechanisms but still involving "a nuclear reaction".

It is true that U-238 absorbs neutrons more at higher temperatures. But the key factor is the *magnitude* of the effect. For a FBR core near its original design configuration, a slight, slow slumping of the core can cause a super-critical runaway atomic chain reaction. In this case the Dopper effect is predicted to limit substantially the initial excursion/energy yield (a relatively weak explosion). (Although one has to examine the follow-on possibilities for re-compaction.) But the total potential Doppler mitigating effect is limited to a low magnitude. For a stronger and more rapid assembly (compactions of fuel material), the Doppler effect on the energy yield is minor. For the mechanism of present interest, highly compacted, small fuel masses, the Doppler effect is negligible.

My April 4 analysis report discusses the Doppler effect in detail. The neutrons fly around inside the core to cause fissions, which emit more neutrons to cause more fissions—the chain reaction. The neutrons vary in their energy (speed)—a spectrum distribution from a peak of 1 to 2 Mev (million electron volts), an average or median of about 0.4 Mev with a small "tail" less than 0.1 Mev. The neutrons born at very high energies by atomic fissions are slowed down somewhat by collisions with the atoms of the fuel material, namely, uranium, plutonium, and oxygen, and of the steel and liquid sodium coolant. The more of this material means the more slowing down of neutrons. The Doppler effect occurs in the low energy tail region of the neutron energy spectrum, where U-238 happens to have a strong neutron absorber propensity. In the conventional water-cooled reactor there are also the hydrogen atoms of the water, which greatly slow down the neutrons to 1/40 ev (0.00000002 Mev). So in a water-cooled reactor almost all the neutrons produced by fissioning pass through the U-238 high neutron absorption region of the neutron energy spectrum when slowing down by collisions. Consequently, in a water-cooled reactor (and in graphite ractors too), the Doppler effect is relatively large. But in a FBR there is no water nor graphite, so the neutrons are not slowed down very much. Consequently, the Doppler effect is small for FBR fissioning excursions. In the assumed explosion mechanism—small compacted fuel mass with no steel nor liquid sodium present (melted away and boiled out), there is even less slowing down of the neutrons, thus moving the tail of the neutron energy spectrum up the energy scale, further away from the U-238 Doppler zone. (We say the spectrum is "hardened".) By the Doppler theory, the effect should be negligible, if anything, according to my calculation. Incidentally, my April 4 report discusses this and many other considerations and factors as well.

I urge Mr K. to keep an open mind and inquire in the matter, as he wisely is addressing its seriousness.

Richard E. Webb, November 21, 1986.

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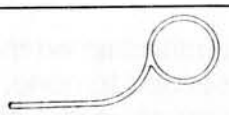

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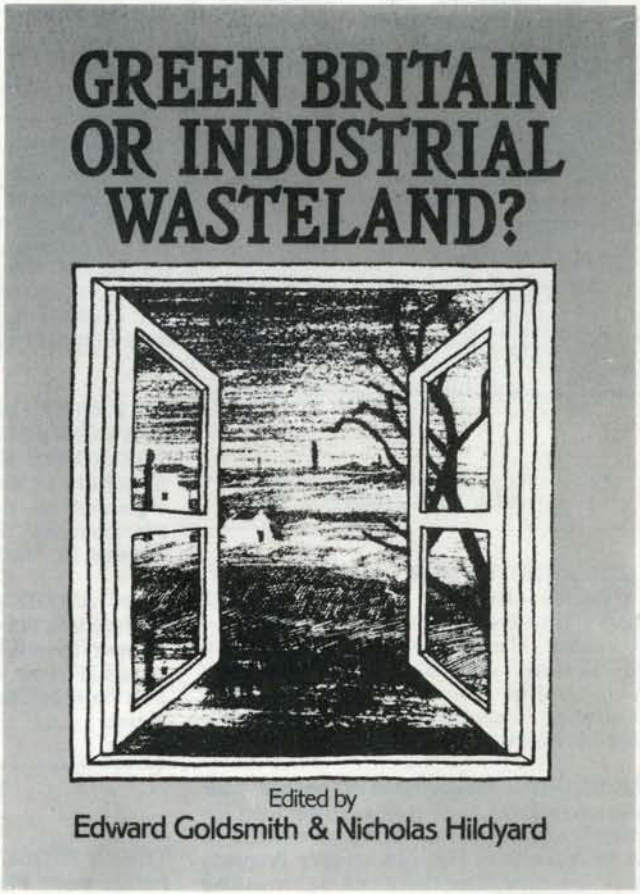

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