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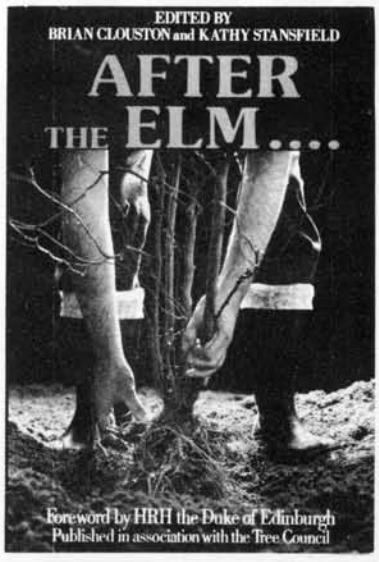

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The Ecologist

Vol. 9 Nos 8/9 Nov/Dec 1979

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Cover by Mike Frost
Photo of Karen Silkwood by Critical Mass

Published by Edward Goldsmith, Ecosystems Ltd, 73 Molesworth Street, Wadebridge, Cornwall PL27 7DS, UK.
Editors: Edward Goldsmith, Nicholas Hildyard. Managing Editor: Maria Parsons.
Book Review Editor: Ruth Lumley-Smith.
Associate Editors: Robert Allen, Peter Bunyard, Brian Johnson, Bernard Gilbert, Jimo Omo-Fadaka, Andrew MacKillop, Robert Waller, Lawrence Hills, John Papworth, Nicholas Gould, Raymond Dasmann, Richard Wilson, John Milton (USA), Henryk Skolimowski (USA), Manfred Siebker, Sigmund Kvaløy (Norway).

ISSN 0141-6952

Advertising: Maria Parsons, 73 Molesworth Street, Wadebridge, Cornwall.
Tel: 020-881-2996

Printed by: Penwell Ltd, Parkwood, Callington, Cornwall.

Editorial

Sir Frank Fraser Darling

Sir Frank Fraser Darling who died last month, was one of the very greatest figures in the ecological movement.

I first met Sir Frank towards the end of 1971. Robert Allen and I were finishing our *Blueprint for Survival* and were seeking to persuade as many eminent scientists as possible to endorse it. He very much liked the document and it was largely due to his influence, as well as that of Sir Julian Huxley, that so many eminent scientists featured among the signatories.

Sir Frank also chaired the press conference organised for the launching of *The Blueprint* in January 1972 and it was his eloquent presentation more than anything else that influenced the journalists present to give it the massive coverage in the popular press that it obtained.

Most people, including the bulk of the scientific community, regarded *The Blueprint* as representing an extremist position, not so Sir Frank. He was one of the few eminent scientists, in this country, to realise that it was in fact a very conservative document. His pessimism regarding the future of our industrial society was even deeper than our own. At the Stockholm conference he said to me in private "I think that we are doomed."

Recently Professor Ray Dasmann and his wife Beth made a pilgrimage to Forres to visit Sir Frank and his wife in their retirement. They later passed through Cornwall and suggested I write to ask him to join the Ecology Party. With Lady Fraser Darling's permission, we are publishing his reply. Significantly she asked me to publish it in toto as she felt that it faithfully reflected his views on the Human Prospect.

15 October 1978

Dear Edward,

I appreciate your letter. Ray Dasmann came one day this summer with Beth. Above their bed was a picture painted by Beth a good ten years ago which I had admired in Washington and which they sent to me. I am still alive in the mind but the body is a poor show — balance gone, eyes all squiffy and one ear dead, hair still dark, which looks silly in a man of seventy-five. My writing is well on the way to being illegible. Once I wrote books so that the outside world should or might read them: now the mountain has to come to Mohammed, which sounds a bit silly and conceited. So like the villager in *Punch*, "Sometimes I sits and sometimes I sits and thinks — but mostly I just sits." Sometimes I talk, especially when folk come and see me. Strokes are not helpful to an active life, so I have closed up as far as writing is concerned. I suppose you would say I could talk with a recording machine but when I wrote the pen was an extension of my mind and as I did not revise, there was a spontaneity. Dictating hasn't got this with me.

Sorry your Movement seems to be not so good. I think one of your shortcomings is that you are not pessimistic enough, and perhaps you are in too much of a hurry. To change Man is going to take more time than we have. One can tell the world this — in some ways I have tried to for forty years — but despite small strugglings, such as your own and mine, Man goes on his own way. My only hope is in what we have recently glimpsed, that life has happened elsewhere (*vide* the probable organic nature and origin of some molecules in meteorites). If evolution is cosmic rather than planetary, well God has all the time in the Universe and Man is rather small beer (as he has long appeared to me, despite my admiration for some individuals). Did God evolve? This seems to me very possible and he isn't finished yet. So far I would say Man is his biggest mistake. God gave Man freewill too soon, along with his inordinate capacity to reproduce. *Your* mistake, as I see it, is in your capacity to ignore the existence of two thirds of humanity. Having got this gift of God, compassion, we can't brush off these two thirds, despite earthquakes and floods (like Persia and the Indian Valley — the latter exacerbated by economic exploration of sub-Himalayan forests) because we are in some ways growing more humane. We continue to fell the Mato Grosso and kill the indigenous Indians, but we subscribe to the notion of the 'sanctity of human life'. (This phrase seems to mean less and less when applied to some poor child whose cry we don't hear). It seems to me that Man is going to kill himself as a species, along with whales and lions and tigers and those thousands of species of mites and things which perform necessary jobs of conversion. (You can't make much of these in a World Wildlife poster), so if snow leopards and pandas look well in posters which folk can see with our conceptions of beauty, they are doing a good job in helping to preserve those lesser creatures which are not photogenic, nor their functions scarcely observed as yet.

I believe that we must examine our own individual behaviour *all* the time and behave according to our vouchsafed enlightenment. Even so we shall often be wrong, obviously, but there is a lot of cosmic time. I just missed Pierre Teilhard de Chardin in New York in 1955, for which I have continued to be sorry, but his noosphere was, and still is, utterly beyond me.

So am I without hope? Not really. We can be learning all the time. Pierre Teilhard might say there is hope for me yet! For life to have reached literacy, abstract thought and the concept of evolution has been a considerable breakthrough. May compassion stay with us, despite our apparent human determination to cut it in two.

Yours ever,
Frank

Edward Goldsmith

Cultivation and Culture

by
Gary Nabham
Department of Plant Sciences
University of Arizona

Traditional crops are part of a culture's heritage. Their destruction not only causes a loss of genetic diversity but in many cases social impoverishment.

Cynthia Anson

Crops are part of the material assemblages which cultures acquire and develop. As cultures change, crop varieties may either be adapted to new cultural needs or abandoned. Additionally, exotic crop varieties are voluntarily recruited, or sometimes imposed upon cultural communities. Although it can be argued that crops, as organisms, have "lives of their own," in a sense their lives are dependent upon the cultures which nurture them. Actually, the relationship between domesticated plants and humans is symbiotic; cultures also become somewhat dependent upon selected crop species or varieties for their sustenance (Bates 1961).

Traditional or "folk" crop varieties are plant selections that have been adapted over centuries to localized climatic and soil conditions, and to the nature of use by particular cultures. Traditional crop varieties are largely functions of environments and cultures that have been relatively stable or slow-changing. It takes considerable time to select varieties for adaptiveness to local soil and weather.

After Columbus

What then happens to these plants when suddenly, a relatively rapid, disruptive period of culture change occurs? First, consider the consequences of the Columbian exchange, the period of biological and cultural dispersals that took place at blinding speed after 1492 (Crosby 1972). It is well known that certain crops such as maize and wheat were introduced to other continents and contributed immeasurably to food production beyond their centres of origin. We know less of the immediate post-1492 impact on indigenous gene pools within these centres. There are records, however, of conscious suppression of crops such as Mexican grain amaranths which played key roles in social and religious activities that colonists wished to discourage (Sauer 1950). Overall, agricultural anthropologist John Carr (personal communication) estimates that over 70 per cent of the "vegetable strains" or folk varieties available in the Americas at the time of Columbus are now extinct.

A second period of rapid agricultural change has occurred within the last two generations. An ancient pattern of local seed saving and slow selection has been disrupted on a global scale (Nabhan 1979). The products of modern plant breeding and promotion are rapidly replacing folk varieties; farmers are buying higher yielding F_1 hybrid seed every year rather than saving their own seed. U.S.Agriculture Secretary Bob Berglund recently acknowledged that "the prediction that by 1991 three-fourths of all vegetable varieties grown now will become extinct may prove to be correct. Obsolete varieties are being replaced by improved varieties adapted to extended areas of agriculture" (Hornblower 1979).

Such statistical predictions are provisional, and geneticists are working toward more refined calculations of the amount of genetic diversity being lost (Vida 1978). Yet it has largely been plant breeders who have been alarmed with these trends, because they indicate a loss of genetic resources available for future breeding work. Some critics (Harlan 1971; Eckholm 1978) have stressed that the old varieties may not be of much value, but their genes have potential economic value via plant breeding for new varieties.

Social Loss

Another concern has been discussed less. If cultures are dependent to some extent on existing traditional crop varieties, how does the loss of genetic diversity within their fields affect them? There is no single suitable answer to this question, since it requires a case by case analysis. I would like to offer some examples from the Western hemisphere which may represent instances of cultures being affected by the quantity and quality of traditional crop varieties available to them. Since I have been documenting the "drying up" of gene pools with American Indian communities near the U.S. Southwest/Mexico border (see box), many of the examples I cite come from this geographic area.

The Mayas and Crops

One difficulty in assessing the cultural impacts of genetic diversity loss is that there are few good "before and after" studies. Perhaps the best historic perspective on species diversity loss and its toll on native economy and nutrition comes from the tropics of Mexico. Nations and Nigh (1978) have documented the demise of native food production among the Lacandon Maya of Chiapas as intensive forage and cattle production have come to replace it.

The Lacadones have traditionally grown up to 79 varieties of food and raw material crops in a single one hectare area (Nations and Nigh 1978). Yet today fewer than 15 per cent of the Lacadon families subsist on their

CULTIVATED CROPS OF NATIVE CULTURES IN SOUTH

Agave augustifolia Haw.-BACANORA, CENTURY PLANT. Occasionally cultivated in Sonora and Chihuahua, it is likely that human selection for taste and more active vegetation cloning has occurred in certain localities. On the other hand, numerous wild populations have been depleted from large areas by alcohol distillers. This is the closest desert-dwelling relative to TEQUILA AZUL, *Agave tequilana.*

Amaranthus cruentus L.-COCKSCOMB, GRAIN AMARANTH. Found among Warihio, and among the Mountain Pima by Faubert. Known as a dye plant among the Hopi and other Pueblos via collections by Sauer and Nabhan.

Amaranthus hypochondriacus L.-GUEGUI, GRAIN AMARANTH. Recently rediscovered among the Tarahumar by Bye, and among the Warihio and upper Rio Grande Pueblos by Nabhan. Limited to a few villages, where it was once extensive. On its way to seed banks.

Canavalia ensiformis L.-JACK BEAN. Found in diverse forms in the region prehistorically, jack beans have been collected from the region's natives only twice in historic times. Viable seed collections of native cultivated varieties are unknown. Has this regional pool gone dry?

Capsicum annum L.-CHILES. Not yet recovered archaeologically from the region, chilies made a major impact historically. Wild chiltepines (var. *glabriusculum*) are being overharvested in the region. Old cultivated varieties are difficult to sort out from newly diffused ones, and hybridization may be diluting the more antiquated gene pool.'

Cucurbita mixta Pang.-CALABASA VERDE, GREEN STRIPED CUSHAW. Reaching the region prehistorically, this squash is relatively resistant to drought and to stem borer. Few viable collections of indigenous varieties are available now, although its demise is serious only among the Rio Grande Pueblos. Whitaker is actively collecting *Cucurbita* germplasm for the USDA.

Cucurbita moschata Duch.-SEGUALCA, BIG CHEESE PUMPKIN. This winter squash has thrived in the Sonoran Desert, but is limited north of there. Poorly collected in the region.

Cucurbita pepo L.-CALABASA DEL VERANO, PUMPKIN. This summer squash is the earliest and most widespread *cucurbita* in the region, and is likely better represented in seed banks.

Distichlis palmeri (Vasey) Fasset ex I.M. Johnston-PALMER'S SALTGRASS. Felger has suggested that ethnohistoric sources indicate management and selection of this species for larger-grained phenotypes. This selected stock, known from one historic collection, likely no longer occurs among the Yuman people.

Gossypium hirsutum L. var *punctatum-* ALGODON INDIGENA, HOPI COTTON. Distinct enough to have been described as a separate species (*Gossypium hopi*) at one time, this fine-spinning quality short staple cotton was abandoned among the Indians by the 1940's. Plant breeders have maintained at least 2 collections in seed banks; they are among the most widely used stocks for breeding, and have just been reintroduced to the Hopi.

Helianthus annuus L. var *macrocarpus-* GIRASOL NEGRO, BLACK DYE SUNFLOWER. Recently rediscovered archaeological artifacts suggest that this domesticate was in the region longer than the literature assumes. Formerly found among more than a dozen native cultures, indigenous varieties persist only among a few of the Hopi, Havasupai, Laguna, and possibly, Navajo. At Hopi, they are losing their genes via inadvertant hybridization with Mammoth Russian sunflowers growing in nearby gardens. Remaining germplasm has been collected by Heiser and Nabhan.

Hyptis suaveolens Pot.- CONIVARI, CHIA GRANDE. Collected in the 1930's by Gentry, and recently recollected by Bye and Nabhan in the Chinipas, Chihuahua vicinity. A garden seed used in the preparation of refreshing beverages, its origin, distribution and status are poorly known.

Lagenaria siceraria (Mol.) Standl.-GUAJE, BULI, BOTTLEGOURD. Heiser has suggested that folk varieties in this region are atypical

indigenous agricultural ecosystem, as expanding human and cattle populations have altered the economics and carrying capacity of the tropical landscape. Whereas the Lacadones customarily burnt only secondary vegetation to plant their fields, recently immigrated ranchers are converting irreplacable primary forests to new forage fields, and mining their soils through intensive monoculture. With surrounding watersheds destroyed and the alternative of wage work available to them, many Lacadones have accepted the cheap labour jobs which ranchers have offered them. The nutritional status of the Lacadones has suffered as they give up multicropping for livestock work, since less plant foods are available to them, and meat prices restrict its frequent consumption. Nations and Nigh (1978) have observed that "beef consumption declines (locally) as beef production increases because cattle produced in the Chiapas jungle are exported to Mexico cities where they replace northern Mexican beef that is frequently exported to the United States." Thus rapid economic change has resulted in less food diversity and poorer nutrition among the native people.

Crops and Agricultural Stability

The loss of crop varieties not only reduces the variety of foods available — it also could affect the stability of the agricultural system. Current studies by Stephen Brush in the Peruvian Andes document the role of

WESTERN NORTH AMERICA — THEIR CURRENT STATUS

for this species as it is otherwise known in the Americas. Nabhan has recently provided Heiser with additional viable seed. Patchy distribution of survival.

Nicotiana rustica L.- MAKUCHI, TOBACCO. Although occurring prehistorically in the eastern U.S., this tobacco of South American origin diffused into the Southwest in early historic times. Already lost from many tribes, it persists among the Tarahumar, Warihio, and some New Mexican Pueblos. Collections from the latter two are on their way to seed banks and to other Indians.

Panicum sonorum Beal.- SAGUI, SONORAN PANICGRASS. Gentry's 1930's collection of this cereal suggested that there was a true domesticate of this species in the Sierra Madre; seeds of unknown status were formerly collected among the Yuma and Papago. It is mentioned as a cultivated plant in documents from the 1700s. Recent collections by Aguirre, de Wet and Nabhan allow the comparison of wild and cultivated phenotypes. Now extinct at the locality where Gentry originally collected the Warihio domesticate.

Phaseolus acutifolius Gray- TEPARI, TEPARY BEAN. Until recently, only a few seed lots were in world collections, poorly representing the many locally adapted populations of 8+ races. Collections by Waines, Nabhan, Freytag and DeBouck have suddenly improved the representation of this arid-adapted species in international seed banks. In Indian communities, teparies are rapidly being abandoned.

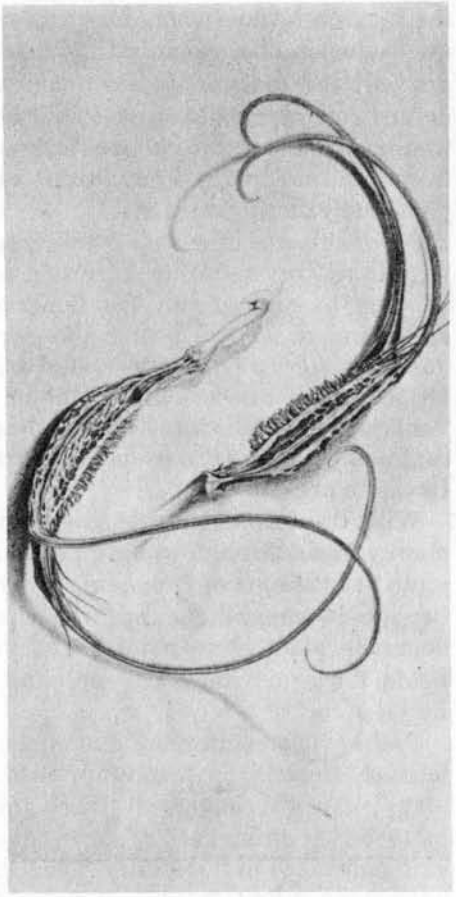
Phaseolus coccineus L.- AYECOTL, RUNNER BEANS. Although doubtfully occurring prehistorically north of the U.S./Mexico border, the Tarahumar and other northwest Mexican tribes may have cultivated this species for centuries. At least 3 races have been cultivated historically in the region; they are poorly understood geographically, and have not been collected often.

Phaseolus lunatus L.- SIEVA, LIMA BEAN. At least 6 races have been grown in the region historically; several were widely distributed prehistorically. Hopi selections are best represented in collections.

Phaseolus vulgaris L.- FRIJOL COMUN, COMMON BEANS. Best represented of the beans in seed banks, 35+ races of this species have been grown in the U.S. Southwest and Mexico. Basic collections have been made in the region, but there has been no comprehensive effort yet to collect remaining folk varieties from all Indian communities.

Proboscidea parviflora (Woot.) Woot. and Standl.- TORITO, DEVIL'S CLAW. Domesticated for its fiber useful in basketry, this cultivated plant has spread from the Sonoran Desert tribes to other Indians in the Colorado Plateau, Mohave and Great Basin Deserts. Although domesticated devil's claw already appears locally extinct among some Indian communities, Whiting and Nabhan have preserved viable seed from many of the remaining populations.

Zea mays L.- MAIZ, MAIZE, CORN. Over 200 races from the Americas are in germplasm collections, but many others were abandoned prior to active conservation efforts beginning in the 1940's. Except for basic collections made by Edgar Anderson, and recent additions from Miksicek and others, folk varieties from the North American deserts are poorly represented in seed banks.



Tiewes, Arizona State Museum

A wide variety of crops are cultivated in these Pueblo 'Waffle Gardens'. The survival and continued evolution of finely-adapted folk varieties depends upon the healthy continuation of indiginous agriculture - seed banks are at best a slim buffer against disaster.

genetic diversity in buffering local farmers from crop failure and starvation in an unpredictable environment (Brush 1977). The Andean farmers' folk classification of tubers not only recognizes fine distinctions between potato varieties; these varieties have evolved differential responses to frosts, blight, and insects. When as many as forty-six varieties of potatoes are grown together in one 1/2 hectare Andean field, they protect the human community from crop failure in a way that monoculture cannot (Berry 1979; National Academy of Sciences 1972). This area in the Peruvian Andes has seen the introduction of mechanized grain production, with the promotion of modern wheat varieties. Iltis (1974) has recommended that the genetic landscape in the Peruvian Andes should be frozen, by the "deliberate exclusion of agricultural improvements . . . Here, not only the Indians' potato fields with their 500-odd named cultivars could survive, but also their adjoining weedy and wild potato populations would be protected from well-meaning agricultural experts and their genetically uniform strains."

Other cultures may have fewer crop varieties in their repertoire, concentrating on certain selections uniquely adapted to coping with the limiting factors of their environment. Tepary beans, the principal crop of the Papago historically, is more suited to desert flood-water farming than other beans (Nabhan et al., in press). Teparies are much more heat and drought tolerant than common beans (*Phaseolus vulgaris*) (Parsons and Davis, in press).

With the introduction of government surplus commodity foods through welfare programmes, non-native pinto bean strains of *P. vulgaris* became available to the Papago in superabundance. As the Papago farmers began to plant more pinto beans in their floodwater fields, it was inevitable that more frequent crop failures would occur.

Rather than reinforcing a tendency to plant teparies instead of pintos in floodwater fields, it appears that many Papagos began to take government surplus pinto beans as an easier, surer bean supply than *any* kind cultivated in floodwater fields. Ironically, teparies are higher in protein and mineral content than surplus commodity pintos (Calloway, Giaque and Costa 1974). Papago tepary selections and floodwater fields have been abandoned as the tribe's economy has become highly subsidized. Since these food subsidies are in turn dependent upon the now-tenuous status of fossil fuel-based agriculture and transportation, as well as taxpayers "good will", the Papago have been left vulnerable.

Food and Culture

Native foods sometimes play a role in what Spicer (1971) terms the "persistent identity systems" of a culture. For instance, several folk varieties used in Hopi ceremonies have persisted much longer among the Hopi than have other crop varieties (Whiting 1939). Additionally, Hopi ceremonialism has aided in the maintenance of folk varieties long since gone from other neighbouring cultures. Maize varieties and certain other crops are obvious "identity symbols" (Spicer 1971) for the Hopi, even when the variety is not culture-specific (Whiting 1939). Hildyard (1978) reminds us that cultural and social factors are as important as nutritional and yield factors in the selection and maintenance of a food or a crop. The loss of a symbolic crop may give a community less to rally around, resulting in some deterioration of cultural cohesion.

At the same time, it is true that individuals within a cultural system may opt to abandon a traditional crop variety for other, exotic cultivars with no apparent sense of loss. The cumulative effect of numerous "independently acting" individuals abandoning the same folk variety is seldom recognized until some time after the variety has become unavailable.

When I sense that such a simultaneous abandonment of a rare folk variety is occurring within a cultural community, I feel a responsibility to obtain and conserve a portion of the viable seed that is still available. Many biologists attempt to "head-off" the possible extinction of any taxon because of the "ecological belief" that each species or variety functions as evolutionary "information" which enriches the biosphere (Bunnell 1978).

I suggest that much cultural as well as genetic infor-

mation is "alive" in traditional crop varieties; they are part of ethnic heritages. After the publication of a popular article on American Indian crops (Nabhan and Felger 1977), I received several letters from young native Americans requesting the seed of traditional varieties which their families remembered but had lost. Nativistic revival movements cannot bring a culture back to its conditions prior to disruption, but they do impede further disruptive change. In addition, the oral history recalled upon viewing the seeds once again allows the elderly to transmit certain values to the younger generation, and aids in cultural continuity.

Seed Banks

It is regrettable to find in a museum or herbarium collection a specimen of a traditional crop variety now extinct — an ethnobotanist's voucher from an earlier time. This has in fact occurred with Sonoran Desert jack beans (Sauer 1964). Although the region's natives once maintained a greater varietal diversity of the jack bean (*Canavilia ensiformis*), than anywhere else in the world (Sauer and Kaplan 1969), only two voucher specimens were collected historically. The Sonoran Desert gene pool of this species no longer exists. Southwestern Indian cotton, too, was abandoned by all Indian farmers in the region by the 1940s, and survives today in the form of just two collections. Considerable genetic variability in traditional crop varieties has already been lost (Galinat 1974). Genetic drift and gene loss can occur even after folk varieties are placed in seed banks, so that genetic diversity decreases despite current conservation efforts (Roos 1977).

Despite inadequate funding and other problems limiting the current efficacy of seed banks (Harlan 1972), they remain important in the efforts to arrest possible extinctions and conserve folk varieties. Seed banks such as the *Centro Internacional de Agricultura Tropical* (CIAT) have as standard policy, an agreement that any ethnic community or individual who has provided seed may request the return of a portion of that seed at any time in the future.

Clearly, the survival and continued evolution of finely-adapted folk varieties depends upon the healthy continuation of indigenous agriculture — seed banks are at best a slim buffer against disaster. Wilkes (1977) and Iltis (1974) have gone so far as to propose reserves of indigenous agriculture protected and subsidized by international organizations. Others have speculated that folk varieties and agricultural techniques will be maintained by a culture only if the incentives come from within the ethnic community, and that conservation brings rewards in the culture's own terms. Native cultures may also resent the imposition by outsiders that exotic or modern hybrid cultivars should not be introduced into their territory.

The Right to Choose

Cultures around the world need to practice their right to choose from many agricultural options. I have elsewhere argued that "not every region can or should take the Green Revolution path. Many communities may want to continue with or renovate their traditional crop varieties, but this will be impossible in the future if conservation is not insured now" (Nabhan 1979). Taking the option of revitalizing traditional crop varieties results in many positive feedbacks within a culture. With crop varieties that are finely adapted to local conditions, a self-sufficient agriculture system is possible. Just as important are the ways in which a culture is strengthened by accepting and continuing its own heritage of symbols rather than adopting those of a colonial culture. Nicholas Hildyard (1978) is correct in suggesting that the solution to the world food crisis lies not in destroying cultures but in re-establishing them. Any effort to restore the agricultural base of a people has its benefits. The rewards are much richer when a genetic and cultural heritage are preserved through that revitalized agricultural base.

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Polluted Data

by Samuel Epstein

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La Recherche

Are scientists rigging the tests that should alert us to the hazards of chemical pollution?

Information is the currency of economic and political power. Decision-making at all levels of government presupposes the availability of a body of information, on the basis of which the relative merits of alternate policies can be analyzed and considered. If this information or data base is tarnished or invalid, then whatever decisions are reached must also be suspect or invalid, threatening the fabric of democratic government.

The overwhelming bulk of all benefit and risk data, on which most regulatory decisions are based, comes from the industries themselves being regulated. These data are either generated and interpreted by in-house scientific staff or by commercial laboratories and universities under contract to industry.

In-house scientific staff are not immune to conscious and subconscious pressures from research and development and marketing departments, anxious to hurry their product or process into commerce. Industrial contracts are usually awarded secretly to commercial laboratories and universities, without bids having first been solicited on the open market, a practice hardly consistent with the ethos of competitive capitalism.

The contractee, eager for the award of future contracts, is also not immune to unspoken pressures and may produce information or interpretations consistent with what are perceived as the interests of the contracting industry, even though this limited perception is more likely to reflect short-term, rather than long-term, interests and values.

Built into this process is a cadre of consultants, generally from prestigious universities or research institutes, whose stamp of approval provides the data with an additional mantle of authority. The identities of these consultants are often hidden not only from the public but also from their own universities or institutions. The industrial interests of these consultants are either not disclosed to the agencies on whose advisory and expert committees they sit, or if disclosed are usually maintained in confidential files. Let's look at a few case histories drawn from the field of occupational and environmental cancer.

Constraints in the Generation of Data

The most common problem with industrially generated data is its poor quality. Deeply concerned by the inadequacy of data submitted in 1967 to the Food and Drug Administration (FDA) by industry in support of food additive petitions, then Commissioner Herbert Ley complained: "Almost half of the food additive petitions originally submitted to the Food and Drug Administration have been incomplete or have not adequately supported the regulation requested and, therefore, have required subsequent supplementation, amendment, withdrawal or denial. Scientific review of deficient and poorly organized petitions is an unnecessary burden that wastes the time and effort of both Administration and industry scientists . . ."

There is no evidence that the situation has improved at all in the last decade, particularly with regard to faults of design and performance of carcinogenicity tests.

Cancer Testing

Consider those examples which illustrate common patterns of experimental misconduct: A 1969 review of seventeen industrially sponsored studies on the carcinogenicity of DDT by the Carcinogenicity Panel of the Mrak Commission on Pesticides concluded that fourteen of these studies were so inherently defective as to preclude any possible determination of carcinogenicity.

*This autumn Anchor Press/Doubleday, New York, will publish a revised and expanded paperback edition of Professor Epstein's book *The Politics of Cancer*, further documenting his position.

From 1965 to 1970, Allied Chemical Company spent $500,000 on carcinogenicity and toxicological testing of the cosmetic food additive Red Dye No. 40 which was undertaken by Hazleton Laboratories. Based on Hazleton's conclusion that the additive was safe, Allied confidently submitted these data to FDA in 1970, and embarked on an ambitious advertising and marketing programme. However, not only had Hazleton failed to perform the customary mouse carcinogenicity test, but their rat test was of little value: most animals died from intercurrent infection early in the test, leaving so few alive that only a massive carcinogenic effect could have been detected.

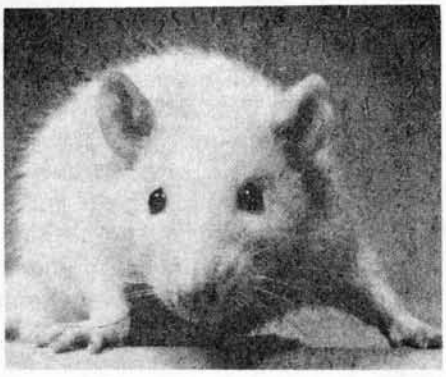
Carcinogenicity tests in rats of aldrin/dieldrin, sponsored by Shell, and of chlordane/heptachlor, sponsored by Velsicol, produced results that were claimed as negative by the industry. In fact, these results were hardly interpretable because such high and toxic doses of both pesticides were fed the animals that many died early in the experiments before they could have developed cancer.

Other data submitted by Shell and Velsicol were used to claim that their pesticides were not carcinogenic in mice, and that the liver lesions induced in them were not really cancers, but just nonmalignant hyperplastic nodules. Review by independent experts, however, proved just the contrary. Faced with such major discrepancies and under pressure from Senator Edward M. Kennedy of Massachusetts, the Environmental Protection Agency (EPA) reviewed other industry data on pesticides. Twenty-four pesticides were selected on the basis of their highest tolerances on common foods, and their extensive toxicological files, which had been previously submitted by a wide variety of manufacturers, were then independently reevaluated by Melvin Reuber on behalf of EPA. In a report of April 9, 1976, it was concluded that with the possible exception of one pesticide, all these data were so inadequate that it was not possible to conclude whether the other pesticides are safe, and whether any carcinogenic or other hazard is involved in eating common foods with now legal residues.

These and other equally grave deficiencies in the EPA data base on pesticides were discussed in a 1976 congressional staff report: "EPA almost exclusively rules upon data submitted by the pesticide companies. This data is the informational linchpin in the Agency's regulatory programme. Yet in spite of repeated warnings, beginning at least five years ago, EPA has failed to take corrective action designed to discover and supplement further data."

Manipulation

More serious than inadequacies of data are the numerous examples of manipulation. Fraudulent manipulation of data has been established with such drugs as MER/29, for which officials of Richardson-Merrill Company were criminally convicted; Dornwall, for which Wallace and Tiernan Company were found guilty of submitting false data; Flexin, for which McNeil Laboratories pleaded *nolo contendere* to charges of willfully concealing information; and Panalba, information on whose lack of efficacy, compared with its individual ingredients, was accidentally discovered by an FDA inspector in Upjohn files in March 1968, resulting in the subsequent withdrawal of this drug from the market.



The ingenuity of practitioners of the art of explaining away awkward data knows no bounds

On January 20, 1976, then FDA Commissioner Alexander Schmidt testified before Senator Kennedy that Hazleton Laboratories, under contract to G.D. Searle Company, reported on nonexisting histological findings in carcinogenicity tests on the drug Aldactone. Hazleton was also charged with falsifying data on the artificial sweetener, Aspartame.

Even worse than these examples of improper or inept design was the fiasco of nitrilotriacetic acid. In 1970, Monsanto and Proctor and Gamble were poised to launch a new type of detergent onto the market, based on nitrilotriacetic acid instead of phosphates. This would have resulted in the annual discharge of approximately five billion pounds of the new detergent into the surface waters and ultimately the drinking waters of the U.S. The industries concerned had spent about ten years investigating the toxicological and ecological effects of nitrilotriacetic acid, concluding that it was noncarcinogenic and that it degraded in water into harmless constituents.

In fact, the industries had not done a single test on the nature of the intermediary degradation products of nitrilotriacetic acid, nor of the possible interaction of such products in water. The industry had also failed to appreciate that degradation was incomplete over a wide range of operating conditions with the resulting likelihood that drinking water could become contaminated with the detergent. These and other considerations led to the withdrawal of nitrilotriacetic acid from the market, with a loss of some $300 million to the industries concerned. The detergent builder was subsequently shown in studies sponsored by the National Cancer Institute and the National Institute of Environmental Health Sciences to produce cancer of the kidney and ureter in mice and rats.

Similar examples are endemic to the whole field of safety testing, whether of drugs, pesticides, food additives, industrial chemicals and even motor cars. For instance, in 1972, Ford Motor Company massively cheated on emission control certification tests on their new fleet of cars. With approval of the Nixon administration and the Department of Justice, the industry managed to ward off a subsequent criminal prosecution and jail sentence by paying a seven-million-dollar fine.

Economic Impact

Industry has manipulated economic as well as scientific data. It is now common practice for any industry when "threatened" by an impending regulation or standard designed to protect against occupational cancer, environmental pollution or some other adverse effect, to protest that this measure is unnecessary, and so expensive that it will put them out of business (see *The Ecologist*, Sept/Oct 1979). In this, they are supported by commercial consulting laboratories who prepare economic analyses apparently confirming the industry contention. For example, the economic impact analyses of the anticipated costs of meeting the proposed one part per million vinyl chloride standard in the workplace undertaken by the consulting firms Foster D. Snell and Arthur D. Little in the summer of 1974, supported industry's claim that the standard would be too expensive and impractical. Their estimates of $65 billion in costs and job losses of more than a million and a half have turned out to be exaggerated, quite apart from neglecting savings to industry from recovery of vinyl chloride that would otherwise be lost to the outside air and, also, major costs to society from vinyl chloride-induced cancer and other diseases in the workplace and surrounding areas.

The Manufacturing Chemists Association and Dow Chemical Company spearheaded a strategy to block toxic substances legislation which had been languishing in Congress for six years prior to its passage on October 11, 1976. Industry claimed that it would cost too much. In 1975, industry asserted that the costs of implementation would be in the range of two billion dollars a year. In contrast, EPA and the General Accounting Office estimates ranged from $80 to $200 million, costs which are now seen to be much closer to reality. Industry has similarly exaggerated cost of the new "generic" regulations on occupational carcinogens proposed by OSHA.

Myths and Realties

The ingenuity of practitioners of the art of explaining away awkward data knows no bounds. Experimental and epidemiological carcinogenicity data are often denigrated or dismissed with equal aplomb. Over the years, the industry position on carcinogenicity data has been crystallized, if not caricatured, into a set of self-serving pseudo-scientific dogmas which have been repeated in public forums so often that they have become dignified in the reiterative process.

These myths have been aired on two major occasions: at the 1973 Department of Labor Advisory Committee on Occupational Carcinogens, by industries including Dow, Du Pont, Rohm and Haas and Esso Research, in addition to the Manufacturing Chemists Association and the Synthetic Organic Chemical Manufacturers Association; and at the cancellation/suspension hearings on aldrin/dieldrin, by Shell Chemical Company, and on chlordane/heptachlor, by Velsicol Chemical Company. These myths contain the following propositions which the independent expert scientific community overwhelmingly rejects:

☐ *Tumorigens are Less Dangerous Than Carcinogens*

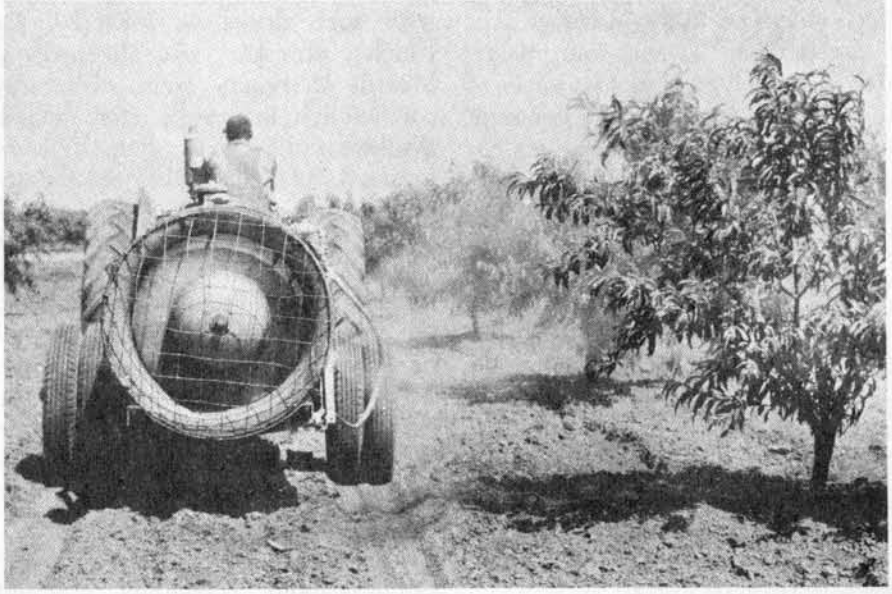
This argument was used at the pesticide hearings to explain away the allegedly "benign liver tumors" induced by DDT, aldrin/dieldrin and chlordane/heptachlor which were claimed by industry to be just tumorigens as opposed to carcinogens. Apart from the fact that independent review established that these "tumors" are frankly cancers, which in some cases metastasized to the lungs, they also produced cancers at a wide range of sites other than the liver and hence are clearly carcinogens. There is no conceivable basis for drawing any scientific and regulatory distinctions between allegedly "benign tumors" and cancers induced by administration of carcinogens.

☐ *Animal Carcinogens are Less Dangerous Than Human Carcinogens*

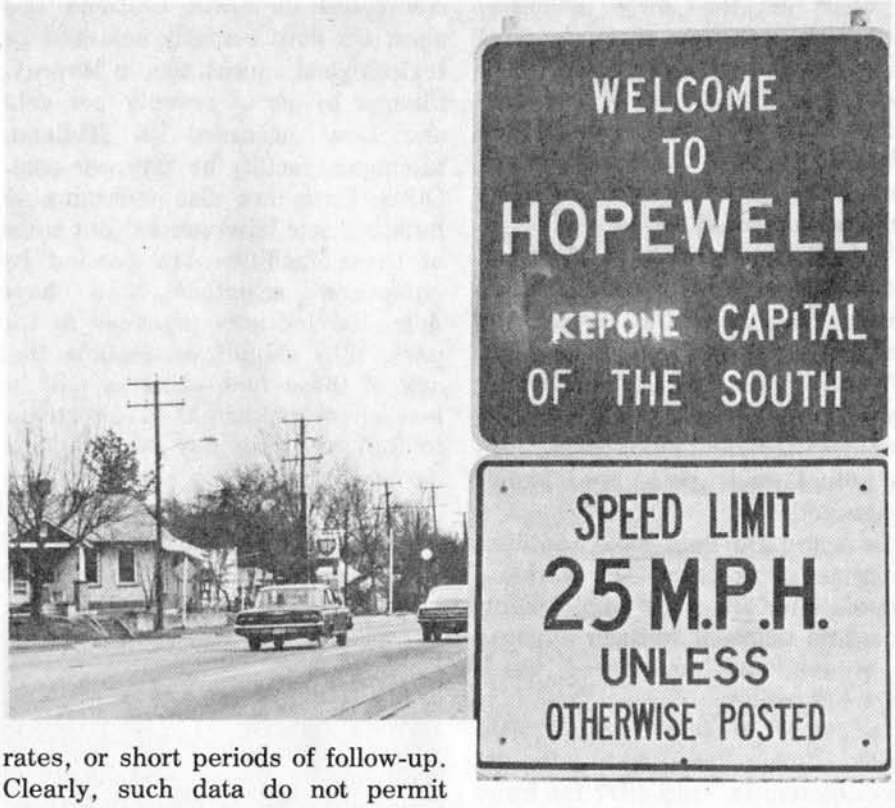
In other words, the results of animal tests have to be validated by human exposure in the workplace before rigorous controls need to be instituted. This argument was vigorously proposed for various occupational carcinogens, such as dichlorobenzidine and ethyleneimine, for which there are as yet no human data. The argument is still pressed even though the activity of many recently recognized "human" carcinogens, such as diethylstilbestrol and vinyl chloride, was first demonstrated in animal tests.

☐ *Most Chemicals Are Carcinogenic When Tested at Relatively High Concentrations*

This is inconsistent with available information. Mice or other animals can be fed with massive doses of most chemicals and will not develop cancer. For instance, in a National Cancer Institute (NCI) contract study by Litton Bionetics from 1963 to 1969, approximately one hundred and forty industrial compounds and pesticides, selected because of strong suspicions as to their possible



Data that can't be designed out of existence is suppressed or even destroyed.



K. Weigel. Hopewell. News Photo

carcinogenicity, were tested at maximally tolerated doses in two strains of mice. Less than ten per cent of these compounds were found to be carcinogenic.

What's more, of a total of some six thousand compounds listed in an NCI survey only approximately one thousand have been reported to be carcinogenic. However, by current standards, only half of those tests are considered valid, and a total of about five hundred compounds are now accepted as carcinogenic. The compounds on the NCI list were selected on the basis of known similarity to proven carcinogens.

☐*Safe Levels of Exposure to Carcinogens Can Be Determined*

It is alleged that no (or negligible) risks result from exposure to "low levels" of occupational or environmental carcinogens. These low levels are generally determined on the basis of the sensitivity of available monitoring techniques, technical expediency or other poorly articulated concepts. For example, the American Conference of Government and Industrial Hygienists has in the past assigned acceptable "threshold limit value" levels for carcinogens such as asbestos, BCME and nickel carbonyl. Expert national and international scientific committees and regulatory agencies are, however, agreed that there is no known mechanism for setting thresholds or safe levels for any chemical carcinogen.

☐*Human Experience Has Demonstrated the Safety of Occupational Exposure to "Animal Carcinogens" or to "low" Levels of Human Carcinogens*

These claims are generally based on a lack of positive evidence of excess cancer deaths, or on the basis of undisclosed or partially accessible records covering small working populations at risk, undefined turnover rates, or short periods of follow-up. Clearly, such data do not permit development of valid inferences, and fail to recognize inherent limitations of epidemiological techniques.

Dow and Du Pont were insistent at the 1973 Department of Labor Advisory Committee meetings on occupational carcinogens that their own experience had proved the safety of use of two widely used "animal carcinogens," ethyleneimine and methylene-2-bischloroaniline. After repeated challenge to produce the underlying epidemiological data, the industries finally admitted that they had destroyed the workers' records after ten years exposure as a matter of standard company policy, thereby making it virtually impossible to detect a human carcinogenic effect.

Apart from explaining away carcinogenesis, attempts have also been made to explain away other chronic toxic effects including birth defects. An example of this is a 1971 Dow publication on the teratogenicity of the herbicide 2,4-D in rats. Dow claimed that it was tested in pregnant rats and found to be nonteratogenic, although tabular data indicated the production of a wide range of congenital defects. But since the affected progeny were shown to be capable of surviving in early infancy, Dow decided that the birth defects were of no particular consequence and should be ignored. To bolster this position, Dow redefined the standard term teratology, as congenital defects inconsistent with survival or optimal function. Under this definition Thalidomide-type defects and most congenital heart defects would be excluded.

Suppression and Destruction of Data

Data that can't be designed out of existence or interpreted away can be suppressed or even destroyed. Known instances of this are legion, and probably exceeded in number only by instances that have not yet been discovered. The carcinogenicity of the organochlorine pesticide kepone, besides its toxic effects on the reproductive and central nervous systems, was discovered by studies sponsored by the manufacturer, Allied Chemical, in the early nineteen-sixties. Allied suppressed this information for about a decade until workers at Life Sciences, an Allied spin-off corporation in Honeywell, Virginia, developed crippling neurological and other diseases from exposure to very high levels of kepone in grossly deficient working conditions.

In December 1972, Velsicol was informed by its own consultants that chlordane/heptachlor was carcinogenic. However, the company suppressed this information, resulting in their criminal indictment in December 1977 by a federal grand jury.

Reserve Mining Company testified

in court in the early seventies that there were no alternate sites which could be used for the daily disposal of 67,000 tons of asbestos-laden taconite tailings into Lake Superior. In fact, the company had previously developed detailed plans for land disposal sites.

The carcinogenicity of vinyl chloride in rats was rediscovered by Cesare Maltoni of the Institute of Oncology in Bologna, Italy, in 1973. However, the Manufacturing Chemists suppressed this knowledge for more than eighteen months, until the human evidence could no longer be ignored.

Dow and Du Pont have admitted "routine destruction" of workers' records after ten years employment, including those of workers exposed to occupational carcinogens, as a matter of policy.

Industrial Biotest Labs, Northbrook, Illinois, faced with a federal investigation in April 1977 for fraud and submission of questionable test data, destroyed files dealing with toxicological and carcinogenicity testing of thousands of federally approved products including drugs, pesticides, food additives and industrial chemicals. The president of the company, A.J. Frisque, has admitted that he ordered the shredding of laboratory documents, but claimed that this was because of a "misunderstanding."

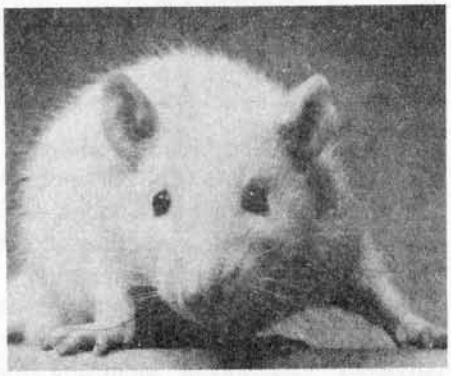
Industrial Biotest has also been charged by Representative Thomas Downey of New York with having mismanaged toxicological tests by "shoddy amateurish" laboratory practices on irradiated food in a U.S. Army project dating back to 1953, which has so far cost the taxpaper about $51 million. Industrial Biotest has also been one of the main contractees of the Chemical Industry Institute of Toxicology.

Industry's Reaction

Industry first reacted by angrily denying that it was guilty of falsifying and manipulating its data base. Later it grudgingly accepted the possibility of an occasional, unfortunate "slip-up."

Now industry responds by increasing its toxicological and carcinogenic testing capabilities, such as the creation, in 1974, of the Chemical Industry Institute of Toxicology. A new industry-wide facility is to be completed in North Carolina this year. Du Pont recently enlarged its toxicological capabilities in Newark, Illinois, by about seventy per cent and Dow increased its Midland, Michigan, facility by fifty per cent. Other firms are also enlarging or building new laboratories. But some of these facilities are headed by outspoken scientists who have defended industry practices in the past. Why should we assume that any of these new ventures will be less constrained by their direct link to industry than any of their predecessors?

The FDA, EPA and other federal agencies are now developing plans which would include formalized inspection, selective auditing, monitoring and licensing of testing laboratories. Some have also recommended increased penalties for manipulation or suppression of data. Over the years, Senator Gaylord Nelson of Wisconsin has proposed the concept of a "third party testing," particularly of drugs, by federal laboratories. Congress, too, has just recognized the need to insure quality control of the data submitted to the FDA in support of the products it regulates and has allocated an extra $16.6 million to the agency in 1977.



Faced with a federal investigation for fraud and submission of questionable data, one Illinois company immediately destroyed its files . . .

Clearly more radical approaches are required. One proposal would introduce a neutral "buffer" zone between those who test and those whose product is being tested. At a congressional hearing five years ago, I recommended "the introduction of a disinterested advisory group or agency to act as an intermediary between manufacturers and commercial and other testing laboratories . . . Manufacturers would notify the advisory group or agency when safety evaluation was required for a particular chemical. The advisory group would then solicit contract bids on the open market. Bids would be awarded on the basis of economics, quality of protocols and technical competence. The progress of testing would be monitored by periodic project site visits, as routine with federal contracts. At the conclusion of the studies, the advisory group would comment on the quality of the data, make appropriate recommendations and forward these to the regulatory agency concerned for appropriate action."

Industry could be protected from the possibility of incompetent work by requiring the contractee to post an indemnifying bond should the tests have to be repeated because they were bungled or for any other reason. And some form of limited liability provisions could be built into such a buffer system. This could insure that industry complying with these requirements would be protected from possible open-ended future testing needs, and possibly also from legal responsibility from future adverse effects not disclosed by properly conducted tests.

There must be greater appreciation of the enormity and public health consequences of the manipulation or suppression of toxicological, epidemiological and other data on health, safety and exposure. Americans have come to accept medical malpractice suits; laboratory and professional malpractice suits are clearly needed to police the practice of toxicology, epidemiology and safety assessment. The concept of homicide or assault by toxic chemicals is a variant of white-collar crime. Maximum legal and criminal penalties, extending to manslaughter charges, should be directed against all directly or indirectly involved in these practices.

The Polluters Hit Back

***Polluted Data* prompted an immediate reaction from those chemical companies attacked by Professor Epstein. We reprint their apologia and his reply . . .**

Samuel S. Epstein makes some very serious charges about the integrity of scientists in the drug and chemical industries and the contract labs which serve them. He implies that none of us can be trusted because it will be in our organizations' interest to deceive the public and its protectors.

In this he is wrong. Monsanto employs more than seven hundred people, working full-time to ensure worker, product and environmental safety. Last year alone we spent more than $160 million in this effort. This money is not being spent frivolously. Among the people employed are scientists who stand with the best in academia or government labs. They will not compromise their personal ethics nor endanger their scientific standing to participate in deception. They set the standards the rest of us live by. Neither is it in Monsanto's interest to practice deception. Ultimately our survival is tied to our credibility — in the trust customers and the public place in our word.

Nevertheless, sometimes misguided people will shade data, or falsify it, to give results they believe their bosses or customers want. And sometimes scientists make honest errors of fact or judgment. Monsanto guards against this by appropriate review procedures, good laboratory practice codes and the like and by employing good scientists, proud of their scientific credentials. They know that their work will be judged by their peers in the scientific community, and they act accordingly.

JAMES D. WILSON
Monsanto Industrial Chemicals Co.
St. Louis, Missouri

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Samuel S. Epstein claims that Dow scientists redefined teratology to avoid calling 2,4-D a teratogen. We, the accused, deem this accusation to be "polluted opinion." For the benefit of scientific integrity, we would like to examine our definition in the light of others expressed in the literature by recognized experts and in relation to Epstein's own definition. Consider our definition in *Food and Cosmetic Toxicology* (Vol.9, 1971, page 811):

"Embryotoxicity is the toxic effect on an embryo caused by treating pregnant females during that period in which actual tissue differentiation and organogenesis occur. Fetotoxicity is the toxic or degenerative effect on already formed fetal tissue and organs. Embryo-and fetotoxicity include a range of responses which extend from those of no functional or morphological significance to death of the embryo or fetus. Teratogenicity is that degree of embryotoxicity which seriously interferes with normal development or survival of the offspring."

This definition was developed in order to permit judgment of the significance of delayed ossification since many forms of stress including maternal toxicity, water deprivation, plane rides, etc. cause such effects. Some teratologists were making a personal judgment at the time of observation whether the delay of ossification was insufficient to report. Our intent was to report all observable findings and judge later. Incidentally, all findings were accurately reported in the article, thus allowing peer and public scrutiny of our observations, and thereby making it possible for those knowledgeable in the science to assess independently their significance. We made our assessment and published it.The definition we set forth obviously does not exclude thalidomide-type defects and most congenital heart defects, as claimed by Epstein.

For further objective evaluation of the quality of this definition, we refer readers to other definitions by experts. Consider these:

The French teratologist H.Tuchmann-Duplessis, in *Drug Effects on the Fetus* (ADIS Press, 1975),defines a teratogen as: "An agent which produces major anatomical abnormalities such as cleft palate, phocomelia or anencephaly, is a true teratogen (i.e. monster-producing), a word derived from the Greek term for monster. Less obvious congenital abnormalities can also occur, hence use of the general term dysmorphen to describe functional abnormalities or structural abnormalities of either a minor or major degree. The term teratogen has therefore been reserved for major or gross abnormalities."

Numerous other definitions have also appeared, including one by David J. Clegg of the Canadian Food and Drug Directorate in his chapter, "Teratology," (*Annual Review of Pharmacology 1971*), and another by M.E.Sucheston, M.S.Cannon and G.A.Palkuti, editors of *Congenital Malformations* (F. A. Davis, 1973). The reader should also consider the definition proposed by Robert E.

Stamples, of the National Institute of Environmental Health Sciences, in the *Proceedings of the Guadaloupe Conference* (sponsored by L'Institute de la Vie), and Harold Kalter and Josef Warkany's definition which appeared in *Physiological Reviews* (Vol.39, 1959).

Epstein, of course, is entitled to his opinion but it is difficult to understand his disagreement when he states, in his earlier paper published in the *Review of Environmental Pathology* (Vol.66, 1972), "Teratology is generally defined as structural abnormalities that can be recognized at or shortly after birth and which cause disability or death."

Most will quickly detect which definition — ours or Epstein's — is most rigorous, restrictive and descriptive.

P. J. GEHRING
Director, Health & Environmental Research
B. A. SCHWETZ
Director, Toxicology Research Laboratory
Health & Environmental Research
Dow Chemical U.S.A. Midland, Michigan.

"Polluted Data" by Samuel S. Epstein contains misleading and erroneous statements. For example, Hazleton Laboratories did not perform the mouse carcinogenicity test on Red Dye No.40 because they were not contracted to do so at that time by the manufacturers of the material. Additionally, it is not true that this was a "customary" test prior to 1970 for food and color additives. Subsequent to 1970, additional long-term studies were carried out by Hazleton Laboratories on Red Dye No.40 involving *in utero* exposure to both rats and mice. These studies were designed to fill scientific data gaps and satisfy other regulatory agencies outside the US.

The author also makes the statement that in the rat study "most animals died from intercurrent infection early in the test." In fact, less than one-half of the animals in any group died from intercurrent infection or any other natural cause. More than half the animals starting the study can be readily accounted for by adding the animals sacrificed at the intermediate intervals to those sacrificed at termination. Hence, the statement made by the author is not true, irrespective of the subjective nature of the phrase "early in the test."

It is also stated in the article that "Hazelton was also charged with falsifying data on the artificial sweetner, Aspartame." Again, this is not true and at no time have any such charges been made by anyone except Epstein in the article in question.

Lastly, I am aghast to note that the author was not even able to spell "Hazleton" correctly.

ROY M. DAGNALL
Vice President and Director of Research
Hazleton Laboratories, Vienna, Virginia

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The environmental health hazards issue illustrates that the hazards to logical discussion in this area may exceed the hazards to health. The Delaney clause of the Food, Drug and Cosmetics Act is a prime example. Many toxicologists — and the majority of the public — question the relevance of highly exaggerated feeding studies, such as the saccharin tests, to human experience.

Twice in this issue — in Samuel S. Epstein's "Polluted Data" and in Richard D. O'Brien's "Pest Asides" — the authors refute the "myth" that most chemicals could be found carcinogenic under some exaggerated test condition by referring to a 1963-69 Litton Bionetics study of about one hundred and forty chemicals — chiefly pesticides and other economic poisons — in which less than ten per cent were found to be carcinogenic. The remarkable thing is that a few of these poisons could actually be fed long enough for the animals to develop cancer. Saccharin and other food additives are used in foods precisely because they are *not* toxic. The maximum tolerated dose for many food additives is enormous, hence the feasibility of running such ludicrous feeding levels as five per cent saccharin throughout two consecutive lifetimes. Nothing remotely resembling the saccharin tests was possible in the Litton study.

The irony, of course, is that the *less* toxic a substance is, the more readily you can run long-term, highly exaggerated feeding studies on it and eventually "prove" that it should be banned. Even the most harmless substance at some point becomes harmful, if taken in a large enough amount. It is curious that this fundamental truth, so readily perceived by the great majority of people, continues to elude Mr. Delaney and much of the Congress.

ANTHONY FILANDRO
Virginia Dare Extract Co., Inc.
Brooklyn, New York

*

Samuel S. Epstein does a great disservice to science and industry. He would have us believe that we are suffering an epidemic of cancer and other equally serious diseases caused by an industry without a conscience. Government statistics for the US clearly show that the incidence of cancer is not increasing, if we adjust the rates for longevity and for cigarette-smoking. Industrial chemicals may contribute one to five per cent of the cancer in the US. I question whether the public is well served by being led to believe that industrial chemicals are the dominant *cause* (we still don't know what causes cancer) of cancer in this country. I take particular issue with Epstein's thesis that industry is unethical, self-serving, and suppresses or destroys data. He loses sight of the fact that industry is what has made our country great.

STANLEY R. NEWMAN
Fishkill, New York

Samuel S. Epstein replies:

None of these responses substantively challenge my overall conclusion that the track record of the chemical industry "now justifies strong reservations as to the validity of any data developed by any institutions or individuals whose economic interests are directly or in-

directly affected."

It is not just a question, as James D. Wilson of Monsanto suggests, of the occasional misguided industry scientist shading or falsifying data. There is, instead, a fundamental conflict of interest inherent in present standard modes of generation and interpretation of product safety and related data by scientists employed directly or indirectly by the same industry which manufactures the particular product. On economic grounds alone, this system has served industry badly on a long-term basis, as illustrated by the nitrilotriacetic acid example, which cost Monsanto and Procter Gamble about $300 million, because of their inept studies which, over some ten years, failed to recognize and detect the serious public-health hazards posed by the use of the detergent-builder. The public may further judge Monsanto's credibility on product and environmental safety by their rush to market acrylonitrile plastic bottles (Cycle Safe) in the absence of adequate pre-market testing (in spite of the close structural similarity of acrylonitrile and vinyl chloride), and their legal challenge in November 1977 to the Food and Drug Administration's (FDA) banning these bottles because of the leaching of the carcinogenic acrylonitrile into their contents. Rather than stress the need for improved pre-market testing, to avoid future nitrilotriacetic acid and acrylonitrile-type problems, Monsanto has recently embarked on a multimillion dollar national advertising campaign designed to persuade the public of the essential safety of synthetic chemicals unless misused. Interestingly, one of the chemicals featured as essentially harmless in a Monsanto TV spot, later withdrawn, was Vegadex (sulfallate), a herbicide reported by the National Cancer Institute in March 1978 to be carcinogenic to both rats and mice.

Dow Chemical has labored mightily over the last decade to disprove or explain away the escalating data on the teratogenicity of phenoxy herbicides, 2,4,5-T, 2,4-D and their derivatives quite apart from questions of carcinogenicity of 2,4-D and of the dioxin contaminants of 2,4,5-T and its derivatives. The 1971 Schwetz paper confirmed earlier Canadian reports on the teratogenicity of 2,4-D, in that it induced a wide range of dose-related skeletal and other anomalies, but Dow nevertheless concluded that 2,4-D was non-teratogenic. Dow's semantics justifying this anomalous conclusion have been examined in Nicholas Wade's *Science* article, "Dow Redifines Word It Doesn't Like" (April 21, 1972). The definition of teratology that P.J.Gehring and B.A.Schwetz of Dow attribute to me is misleadingly incomplete. In the following sentence I wrote: ". . . teratology also includes microscopic, biochemical and functional abnormalities of prenatal origin."

Roy M. Dagnall of Hazleton claims that it was not "customary" to test food additives for carcinogenicity in mice as well as rats prior to 1970. That conclusion is inconsistent with the record. Some twenty years ago, a National Academy of Sciences committee report recommended "continuous feeding of various levels of the test substance (food additives) to rats and mice for their normal life span . . ." About the same time, an FAO/WHO committee similarly recommended lifetime feeding for carcinogenicity testing of food additives. The latter report also emphasized what should be patently obvious, that a minimum number of animals of each sex (the report recommends twenty) must survive until the end of a test for this to be accepted as valid. Not only did Hazleton initially fail to test Red No.40 for carcinogenicity in mice (or apparently fail to insist to Allied that such tests were necessary), but their conduct of the rat test was unimpressive. The test had to be prematurely terminated at 21 months, in view of major mortality from intercurrent infection commencing early in the test (these losses were further compounded by deliberate sacrifice of animals for interim histological study). Of an original three hundred rats, comprising control groups of sixty animals of each sex and three test groups each of thirty animals, a total of only 59 rats survived until the end of the test, when the number of rats in each group ranged from only five to ten. The only finding of note recognized by a Hazleton pathologist was kidney damage in some of the higher dosed animals that died at six months. This was, however, subsequently discounted by senior Hazleton staff, who, on the basis of "retrospective histopathological analysis," omitted all reference to such toxic effects from their final report to the FDA. On the basis of these and other Hazleton data, Allied claimed in early 1971 that "Allura red (Red No.40) has undergone one of the most extensive batteries of testing ever used for food colorant." In spite of these unfounded claims, an expert WHO committee in 1974 refused to grant even temporary approval for Red No.40, "as only very limited information is available." Most countries other than the US do not use it and even here it is now under suspicion on grounds of carcinogenicity.

Hazleton's flat denial of charges of incompetence and falsification of data further damages its credibility, as this is at variance with the record. At hearings before Senator Edward M.Kennedy on January 20, 1976 and on April 8, 1976 at joint hearings before two subcommittees of the Senate Judiciary Committee, then FDA Commissioner Schmidt announced that serious deficiencies had been found in Hazleton's carcinogenicity tests, under contract to G.D.Searle Company, on the drug Aldactone and on the sweetener Aspartame. During the April 1976 hearings, Schmidt testified that FDA investigation of both Hazleton tests demonstrated a wide range of problems. These included: ". . . large numbers of autolyzed tissues; failure to assay test substances; failure to assay treatment-diet mixture; failure to adequately review records and verify their accuracy; the use of statistical methods which included autolyzed tissues, on which no observation had been made, in

the denominator for determining the number of lesions found; lesions reported at necropsy for which slides had not been made; tumours reported microscopically for which slides had never been made."

Anthony Filandro's challenges to the scientific basis of the Delaney clause and to the need to test for carcinogens in animals at levels in excess of human exposure are now familiar elements of the standard industry mythology on carcinogenesis. These self-serving postulates have been unequivocally rejected by the independent scientific community and by the conclusions of an array of expert government and independent non-government bodies over the last two decades.

Stanley R. Newman is equally uninformed on problems of cancer incidence which, however, were not discussed in "Polluted Data." In fact, there has been a major and absolute overall increase in cancer incidence and mortality during this century, and even more strikingly in the last decade, which is even more marked for certain organ sites. This cannot be explained away by increased lifespan or by smoking.

Rather than deny or minimize the now overwhelming evidence on the serious limitations of industry data, top management would do better to accept these realities and examine new approaches for the development of valid data more consistent with their own long-term economic interests and with public health and safety.

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Can We Control Pollution?

by Edward Goldsmith

Several million pollutants have been introduced into our environment. It is impossible to establish safe levels of exposure for any of them. Even if it were, it is equally impossible to ensure that those levels are not exceeded.

At the Stockholm Environmental Conference, in answer to environmentalists' demands for the banning of supersonic aircraft, Lord Zuckerman, ex Chief Scientist to the British Government, answered that "if it were an ineluctable conclusion that the use of supersonic civil transport would irrevocably wreck the ozone layer which overlies our atmosphere, can we seriously imagine that we would not find ways of inhibiting the use of such aircraft, as our knowledge of their secondary effects, if any, become more apparent? What are we: ants, lemmings or rational human beings?[1]

Zuckerman as usual was talking through his hat. The experience so far has been that very harmful pollutants have often been produced for a very long time, even before their harmfulness has been established, during which time they have entered into so many different manufacturing processes that they have become general environmental contaminants.

Even then efforts to introduce any controls at all have been so feverishly opposed by industry and government with the aid of the scientific experts whom they employ that still more time has elapsed before they have met with any success however limited.

Thus PCBs are today regarded as known carcinogens, also ones that appear to be toxic at much lower levels than previously thought. They were first brought into use in 1929. It was nearly forty years before they were recognised as dangerous. By that time about 30,000 tons had been dispersed in the atmosphere, 60,000 tons into water systems and 300,000 tons had been dumped.[2] If DDT, of course, can be transformed into PCBs under the action of ultra-violet rays, then the quantities are much bigger still. What is certain is that PCBs are now a general contaminant of our environment. They are present in water, air, soil and sediment, and tend to accumulate in the fatty tissues of animals.[3] DDT is now also recognised as causing serious biological damage to biological organisms and is a suspected carcinogen.

Since it first entered into use the total amount produced by man is somewhere in the area of two million tons, and, like PCBs, it is now a general environmental contaminant. Though its effects were revealed over twenty-five years ago with the publication of Rachel Carson's 'Silent Spring', no real action was taken until 1972. Today, even though it is no longer allowed to be sold in the US, exports are unaffected and it

continues to be produced at the rate of 100,000 tons a year.

P.V.C.

Another general contaminant of life on this planet is PVC, polyvinyl chloride, which is now a recognised carcinogen. Prior to the discovery of its hazards however, an estimated 100 million pounds a year were being lost to the environment during manufacture and two per cent of the US output of five billion pounds were being released 'through deliberate dispersive use', though the most hazardous of these uses, as a propellant in aerosol spray cans, was banned in 1974.[4] The use of this pollutant is now subject to certain controls in many countries, however, its production in total terms has not been affected. In particular it is still used as a plasticiser for wrapping materials and is known to leach in small but significant amounts into the food-stuffs contained.

Asbestos

The carcinogenic effect of asbestos has been known at least since the early 1930s. The time lag between first reports of asbestos related disease and control measures to reduce the risk was about thirty years. During this period to quote Lawrence McGinty[5] "The toll of death from cancers and lung disease caused by asbestos will never be counted. Some are buried with conveniently incorrect death certificates, others died from lung cancers indistinguishable from those caused by smoking cigarettes. Although asbestos is far from the most potent toxic substance used industrially, its very pervasiveness means that the number of people exposed to it — workers, consumers, and those living in cities — is enormous. It would be quicker to count those who haven't been exposed."

According to Irving Selikoff[6] of the Environmental Sciences Laboratory at the Mount Sinai Medical School in New York, of the one million Americans who have been exposed to asbestos forty per cent are likely to die of cancer over forty-five years, 200,000 of lung cancer and 50,000 of mesothelioma.

One type of asbestos Crocidolite (blue) has now been banned but other types are still in current use and efforts to reduce the levels to which people are exposed continues to be combatted by industrialists, some trade unionists and politicians.

Fibreglass

Fibreglass appears to be as hazardous as asbestos. It was first produced on a commercial scale in the late 1930s. By 1967, Americans were using 308 million pounds of textile-type fibreglass per annum and another 500 million pounds of loose fibreglass materials, in more than 33,000 different consumer products including building insulations and household curtains. They all tend to end up on some dump, where "they become a reservoir of potentially toxic material which will leak into the atmosphere for centuries or aeons to come."[7]

HSE

Other carcinogens such as red dye no. 2 or amaranth, another established carcinogen, have entered into an astonishing variety of processed foods. In the US each year about nineteen million dollars worth of it is produced and added to between nineteen and twenty-five billion dollars worth of food. According to the FDA it is used in "ice creams, processed cheese, luncheon meat, frankfurters, fish fillets, shell fish, cornflakes, shredded wheat or wheat cereal, rice flakes or puffed rice, rolls (sweets, cinnamon, Bismarcks etc.) snack items (spretzels, corn chips,

crackers etc.) cookies, pie crust, cake mix, pickles, peaches, citrus juice and fruit juice (canned) canned apricots, cherries, pears, pineapple, fruit cocktail, salad dressings, jelly, pudding mix, syrup, jam, candy bars, vinegar and cola drinks.''[8] Americans are said to be ingesting about 500 tons of it a year. The FDA attempt to ban it was delayed fifteen years. It has now been banned in the US, but is still in general use in other countries.

HCB

Hexachlorophene is also a highly toxic chemical. In the summer of 1972, thirty-nine infants in a French hospital died from being rubbed with a baby powder containing six per cent hexachlorophene. It was banned by the FDA in January 1972, but only after being used for thirty years in a host of non-prescription products including 400 categories of deodorants, soaps, shampoos, toothpastes, cleansers, and cosmetics, involving thousands of brand names and hundreds of millions of dollars in retail sales.[9]

Hexachlorbenzene (HCB) has been widely used as a fungicide for seed protection. World production is thought to be four million pounds a year. It was found to be highly toxic as early as 1955 when grain seed in Turkey treated with HCB that was intended for sowing was used instead for bread production. Five thousand people were affected and between 250 and 500 died. WHO has shown that children under the age of two taking HCB via their mothers milk suffered a ninety per cent mortality rate. In the US, HCB is a trace contaminant of human milk and levels are also to be found in other food stuffs including butter. So far efforts to ban this substance have failed.[10]

Chloroform

Chloroform was shown to cause liver cancer in small animals over thirty years ago.[11] Yet it is still used in cough mixtures, mouthwashes and toothpastes. It is also used as a preservative, in fact it is now in such general use that when it was suggested to a UK expert that this substance might be banned he answered ''it would be like trying to get rid of alcohol — there is a little bit everywhere.''[12]

5 million chemicals

It is important to realise that I have named but a handful of the four million chemicals which, according to OECD[13], we have introduced into our environment 563,000 of which are thought to be in common use and 100 of which are produced in excess of 50,000 metric tons a year. It is also important to realise that very few of these chemicals have been properly tested — a question I shall examine in greater detail further on in this essay.

It should thereby be fairly obvious that we live in a highly contaminated environment — and when we consider that possibly a thousand new chemicals are introduced every year — some say 3,000 — and that the quantities of the existing ones generated by our industrial activities continue to increase with the growing world economy, our environment is clearly becoming more highly contaminated every year — which explains the current and growing epidemic of pollution-induced diseases in particular cancer.

Celia Perkins

The Excuses

When the pollution caused by a particular activity or set of activities is pointed out to the polluters or to the authorities and it is suggested that something be done about it the answer is nearly always the same. We are told that this is not possible until further scientific research be undertaken in order to obtain ''the hard scientific evidence'' required to determine the exact effects of the pollutants on living things.

Consider in this context the efforts made by Chemie Grunentaile, (the firm responsible for making and distributing thalidomide) to avoid the banning of this product. Among other things a famous expert, Professor Eric Blechshmidt, Director of the Institute of Anatomy of Göttingen University was prevailed upon to state in a Court of Law that ''so long as there is no complete certainty about how the thalidomide might execute its effect on any embryo, theories about the drug's detrimental quality are premature and represent no more than pure speculation. Any binding thesis about a causal link between thalidomide and deformities does not yet exist.''[14]

The Mediterranean

Consider too the case of the grossly polluted Mediterranean[15]. The United Nations Environmental Programme has sponsored a series of international meetings to try to reach agreement on actions required to prevent this sea from becoming a lifeless waste but so far these have been in vain. The excuse for inaction is as usual ignorance as to the exact nature of the pollutants that are causing all the damage. ''We do not have enough evidence yet,'' said Dr. Keckes,[16] the scientist in charge of 'the scientific assessments' of the state of this highly polluted sea. ''The rate of implementation of the Treaty'', he states self-righteously, ''will depend on how fast we can define the standards scientifically.'' We can predict in advance that these standards, even if they are established, will never be accepted by all the polluting nations involved. In any case, as we have seen, they can only be arbitrary ones. It means that whatever happens, the pollution levels in the Mediterranean will continue to increase just as they are in other European seas and inland waterways.

Of course one reason why such evidence does not exist, as I pointed out in my article 'Blind man's Buff'[17] is that no-one has looked for it — nor very often does anyone intend to do so.

Thus the National Cancer Institute has recently demonstrated the

carcinogenicity of trichloroethylene which is used as an industrial solvent particularly for degreasing machine parts, it is also used in foodstuffs, for decaffeinating coffee for instance. In the UK The Health and Safety Executive (HSE) however refuses to reduce existing safety levels which are at present 100 ppm. One reason is that the NCI tests were on animals and not humans. This is a weak excuse since substances which are carcinogenic in one form of life tend to be carcinogenic to others — the informational medium contained in the genes and in the nucleus of a cell, which is affected by a carcinogen, being expressed in the precisely same medium — DNA. Tighter controls they insist would have to await the result of surveys of workers exposed to this chemical. A spokesman recently admitted that the government Employment Medical Advisory Service *had no immediate plans for such a survey.*[18]

The question we must ask is how much can the government justify allowing several million chemicals to which organisms and ecosystems have never been exposed during the course of their evolution, to be released into our environment without these tests being carried out? Greater irresponsibility is hard to imagine. But would carrying out such tests serve any real purpose? Would they yield serious information that could really be of use in determining an effective strategy for controlling offending chemicals? As I shall now attempt to show, the answer is undoubtedly not.

Celia Perkins

Acceptable Levels

The theoretical possibilities of pollution control is based on the principle that dangerous chemicals are only dangerous when used at sufficiently high levels, and that there must be a level at which concentrations of the chemical are biologically harmless. If this is so then it suffices to assure that these levels are never exceeded for no biological damage to occur. The more we know about the biological effect of chemicals, however, the more it becomes apparent that this is simply not true. Serious efforts have been made to establish safe levels of different pollutants, but these studies have always proved to be in vain. This is the case for instance with radiation. It is now generally accepted that any increase in radiation levels over and above that to which we have adapted during the course of our evolution must be reflected in some biological damage. The same seems to be the case with asbestos. The US National Institute of Occupational Safety and Health (NIOSH) has stated quite explicitly that "excessive cancer risks have been demonstrated at all fibre concentrations studied to date. Evaluation of all human data available provides no evidence for a threshold or for a 'safe' level of asbestos exposure."[19]

No Means of Determining Safe Levels

In general this is true for all carcinogens, a principle that is accepted by the Health Education and Welfare (HEW) in the US. As its former secretary Arthur Flemming has said "Scientifically there is no way to determine a safe level for a substance known to reduce cancer in animals." It is this principle that provides the rationale for the famous Delaney Clause which makes it illegal in the US to add any chemical to foodstuffs that can be shown to be carcinogenic even in very small amounts. Since the Delaney Clause was passed no significant progress has been made in our ability to determine a safe level of a cancer causing chemical. On the contrary, according to Anita Johnson[20] "recent evidence suggests that estimating a safe dose is more difficult than was previously thought."

For instance the Federal Drug Administration (FDA) conducted a massive 'megamouse' study at a cost of more than five million dollars to determine if very low doses of a known carcinogen over a period were in any way safer than high doses as is generally maintained by the chemical industry. Twenty four thousand animals were used in this study and the results showed that low doses were not safe at all. Liver cancers were produced at the lowest dose as well as at the highest.

Set for Economic Reasons

If this is so then the acceptable levels fixed for potentially dangerous chemicals released into our environment have no scientific basis whatsoever. In fact, it is very easy to show that they are simply *the minimum levels that can be achieved without compromising economic priorities.*

Thus the WHO standard of 0.02 to 0.05 ppm mercury in food "is simply the practical residue limit, the concentration of mercury expected in the diet from natural background and environmental contamination."[21] In Sweden, the maximum permissible level was maintained at 1.00 ppm for a very long time. The reason is that if the limit of 0.5 ppm had been adopted in the late sixties as was then proposed, it would have become necessary to close down more than forty-five per cent of Sweden's inland fisheries.[22]

The acceptable level of lead in drinking water is above all that which tends to be present today. When WHO recently raised it from fifty microgrammes to a hundred microgrammes per litre, this was not the result of the sudden discovery that man was less sensitive to lead poisoning than was previously thought, but to *the fact that few water authorities could provide water to this standard.*

Indeed the Cox report, drawn up with the aid of experts from twenty-four countries established that toxic effects are noted above fifty microgrammes per litre — while Kehoe who, according to Bryce-Smith "has probably carried out more studies on lead than almost any other authority living", had argued very strongly that the level should be set as low as

twenty microgrammes per litre.[23]

The level fixed by the Federal Drug Administration (FDA) for aflatoxins, a highly carcinogenic substance produced by certain moulds left on improperly dried crops such as peanuts and cereals, is twenty ppb. Yet we know that aflatoxins can cause cancer in animals when fed at levels of .45 ppb to fish, 1 ppb to rats; at 15 ppb aflatoxin, 100 per cent of rats get cancer. As Anita Johnson points out, these very high tolerances are an indication of the commercial pressures felt daily at the FDA.

In the same way, the level set by the FDA for PCBs which is now a general environmental contaminant, is 5 ppm in fish and poultry in spite of the fact that PCBs are so toxic that they have been shown to suppress reproduction in animals at a dose of 2.5 ppm. To quote Anita Johnson, "The FDA appears to have chosen 5 ppm simply because it would permit the vast majority of PCB-contaminated products to be marketed as usual."

Commercial Pressures

Efforts to reduce levels by various government agencies are consistently being thwarted by commercial pressures. Last year the Department of Labour was expected to announce a reduction in the acceptable level for occupational exposure to lead in the air by fifty microgrammes per cubic feet of air. This would have reduced the existing level by four times. The Regulatory Analysis and Review Group opposed this on the grounds that the cost to industry of maintaining these levels would be in excess of a billion dollars. New levels for exposure to benzene proposed by OSHA were also successfully quashed in the Federal Appeal Court in New Orleans last year on the grounds that the agency had failed to demonstrate 'a reasonable relationship' between anticipated benefits and costs.[24]

International Variations

Needless to say, acceptable levels vary considerably from one country to another, largely because of the relevant pressures exerted by government departments, commercial interests and trade unions.

Thus, if the acceptable level for PVCs was for a long time 550 ppm in the US whereas it was only 100 ppm in West Germany and only 10 ppm in the USSR this seems to have been largely because of the pressure applied by Goodrich, the principal manufacturer in the US, who strongly opposed the necessary standard. (It has now been reduced to 1 ppm over an eight hour period with permitted excursions of up to 5 ppm over and above which respirators must be worn.)

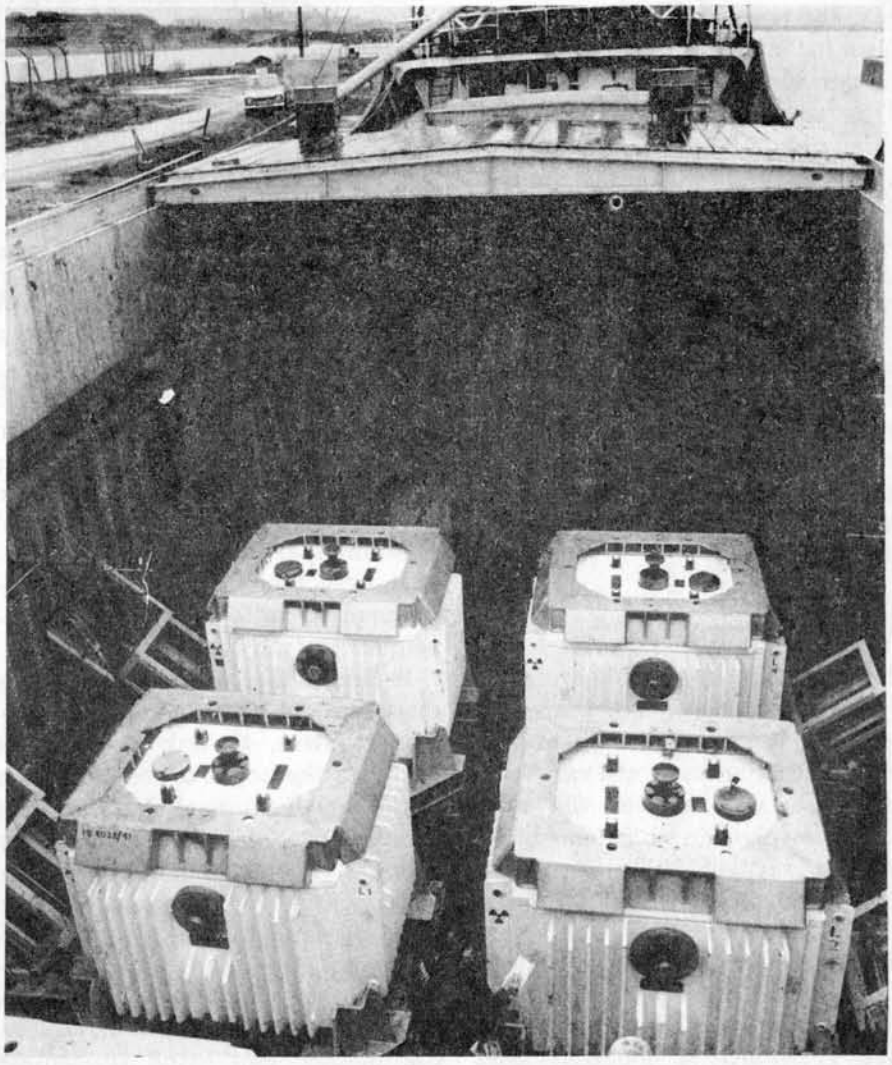
This refusal to take any real action to ban carcinogens reflects overt government policy. Indeed the government boasts of its 'flexible and pragmatic approach' whereby polluters are simply asked to keep pollution levels down 'by the best practical means' which, in practice means — in that way that interferes as little as possible with the far greater priorities of maintaining employment and economic growth.

Thus the ICRP recommends that all exposure to radioactivity "be kept as low as reasonably achievable, economic and social factors being taken into account; and . . . the dose equivalent to individuals should not exceed the limits recommended by the appropriate circumstances by the Commission."

Reasonably Achievable?

As Professor Athersley pointed out at the Windscale Inquiry it depends on how reasonably achievable' is interpreted."[25]

At Windscale, where levels of caesium and alpha emitters such as plutonium and americium to the Irish Sea are very much higher than they are from any other similar reprocessing plant, and where no efforts whatsoever are made to contain emissions of Krypton 85 and Tritium to the atmosphere (which is also contrary to practice in other countries), the term 'reasonably achievable' is clearly interpreted in such a way as to make it unnecessary for British Nuclear Fuels to incur any additional costs that might reduce this state-owned company's economic viability. This attitude is reflected in all our Government's pollution control policies. Thus the



Press Association

UK representatives at the EEC discussions on the control of pollutants released into European rivers refused to accept the controls proposed on the grounds that our rivers were faster flowing and could therefore absorb more pollutants than could those on the Continent. This is an absurd argument since the levels of pollutants entering our grossly polluted seas from our rivers, is in no way affected by the river's rate of flow.[26]

Individual Variety

The most obvious problem involved in fixing an acceptable level for any pollutant is that susceptibility to different chemical substances varies from individual to individual, even more so from one age group to another. As Schubert[27] points out the reason is often genetic and is related to the presence or absence of any enzyme needed to break down a chemical. Children are particularly susceptible to most pollutants, foetuses even more so. Thus whereas adults appear to take up ten per cent of the lead that enters their body, the rest being eliminated, the figure for infants may be as high as fifty per cent.

The susceptibility of foetuses to damage by X-rays is well known. A dose of 500 millirads during the first three months of pregnancy appears sufficient to double the number of cancers likely to develop within the first ten years of life.

The doubling dose however appears to increase to about 2000 millirads if exposure takes place during the last six months of gestation. In general, cells undergoing rapid division as in the foetus and new born are most vulnerable to carcinogens.

No Mr. Average

Individual variability is also related to domicile. People are more or less vulnerable in accordance to their proximity to a source of pollution, and of course it will vary even more in accordance with the work they are involved in which may bring them into contact with pollutants of varying degrees of toxicity. Individual lifestyles are also very relevant, obesity and alcoholism may increase susceptibility to pollutants while eating and drinking habits affect resistance to chemicals that may find their way into different types of food and drink.

Thus in the US, the Federal Drug Administration (FDA) has established an 'interim guideline' of 0.5 ppm of mercury in food. This is based on the assumption that an average serving of fish is 150 to 200 gms. It also assumes that the *average* American does not eat fish more than twice a week, and, as a result, would not consume more than 0.03 milligramms of ethyl mercury per day which is the maximum safe limit.[28]

This may be all right for the average American, but *everyone is not average*. What happens to those people who happen particularly to like fish, or who live in an area near the sea where a lot of fish happens to be eaten, or who are professional fishermen, or married to fishermen. Is it right that they should be condemned to suffer the terrible consequence of mercury poisoning?

In Britain there is the same callous disregard for the non-average consumer. Thus, towards the end of 1970, studies began to show that fish at the top of the food chain such as tuna and sword fish, wherever they seemed to come from, were heavily contaminated with mercury. Nine hundred million cans of tuna were taken off the market in the US because they contained more than 1 ppm of mercury. In Britain, tuna on the market was found to contain similar levels of mercury. For a while, the public was advised not to eat it, but then , as Anthony Tucker points out our Government "contrived to rationalize a course of inaction by resorting to averages. By counting British heads and the number of cans sold a year, and by completely ignoring those who like tuna and eat a lot, the scientific advisory committee was able to arrive at reassuring conclusions." [29]

Mr Prior who was then Minister of Agriculture made his announcement at the end of the year, "The experts consider that it is the total intake of methyl mercury that is important . . . they consider that it is unnecessary at this time to withdraw from sale or to advise consumers not to eat any of the canned tuna now on the market. The tests have shown that all this fish is within the safety limit set in some other countries including Sweden. In short, there is no reason why the housewife should not buy it."

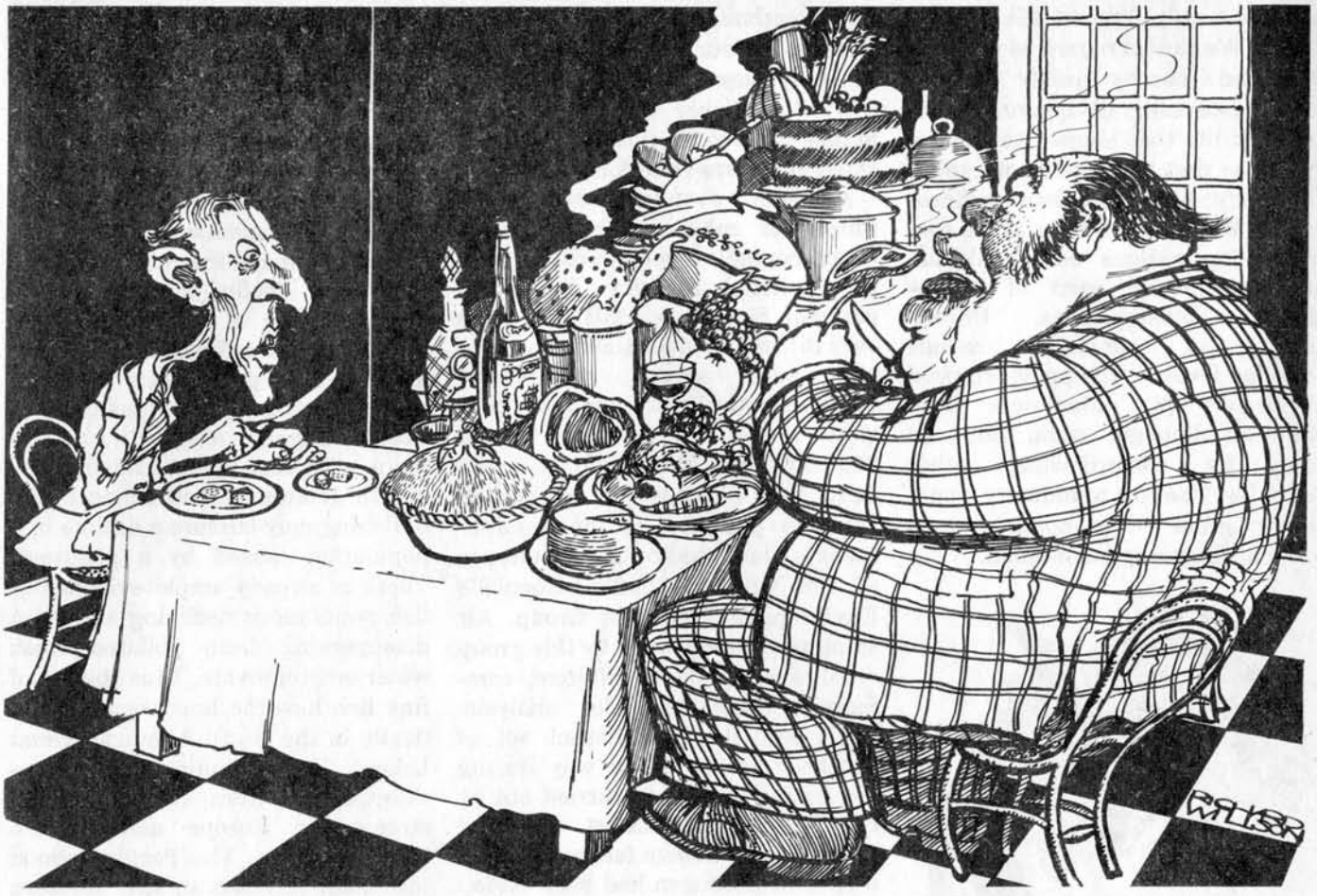
UPI

Dead fish in the Rhine near Koblenz

Critical Groups

How about those people, however, who may wish to fish in this area? The answer, presumably, is that they must be sacrificed in favour of higher economic priorities.

This iniquitous philosophy is clearly reflected in the UK in the current concept of 'critical groups' i.e. of people who are particularly vulnerable to a specific pollutant. It



Mr. Average Mr.Maximum: "What the hell are you complaining about? Statistically we've both eaten the same amount." *Mr. Maximum*

is on the basis of the exposure of such groups for instance that the permissible levels for the discharge of radioactive wastes are calculated.

One such critical group is composed of the eaters of traditional laver bread in South Wales, made from seaweed, which unfortunately, tends to concentrate radio-isotopes of various sorts and in particular Ruthenium.

Concentrations in the seaweed in the vicinity of the Windscale nuclear installations are already above the permissible levels (in a recent test they averaged out at 370 picocuries per gramme of seaweed). This, however, is not regarded as a cause for concern for the unbelievable reason that the Cumbrian seaweed comprised only a small proportion of that used in laver bread manufacture. Too bad of course for anyone who should wish to use more Cumbrian seaweed than the average for making laver bread.

A few years ago, the women who used to collect Cumbrian seaweed stopped work. As a result the laver bread eaters of South Wales are no longer considered to be a 'critical group', and the pollution of seaweed with radioactive waste is no longer of any concern.

If this principle were generally applied to determine permissible levels of all the pollutants released into our environment, we would be safe so long, among other things of course, as *we did not change our habits in any way from year to year.*

At the same time, if ever political, social, economic, ecological or climatic changes of any kind forced us to adopt new living, working, eating, drinking or breathing habits, we would then be exposed to dangerous levels of all sorts of pollutants that we would have previously not encountered in conforming to the authorities' model of the average man.

In other words, this present system involves constantly narrowing down our options for the future and hence reducing our capacity to adapt to changing conditions: a truly suicidal prospect. If our Government were really concerned about the effect of pollutants, it is not the critical groups of today that it would cater for *but all the possible critical groups of an unpredictable tomorrow.* This means that we should not be catering for Mr. Average but for Mr.Maximum.

Catering for Mr. Maximum

There are two other very good reasons why in any case this must be so. Firstly, even if it is possible to be Mr.Average with regard to exposure to a single pollutant, it is obviously unfeasible to be Mr. Average *with regard to the two million or so pollutants that we have introduced into our environment.*

In reality every single person is *likely to be non-average, in some respects at least,* and so *to be subjected to more than average levels of one, and more likely, many pollutants. The fact is that Mr. Average does not exist. He is but a figment of the statistician's imagination.*

The second reason why we must cater for Mr. Maximum is that man

is not the only form of life on this planet. We cannot regard as expendable and thereby justify systematically poisoning all the non-human forms of life that happen to inhabit the areas that man does not exploit to satisfy his immediate requirements. We can only do so at the cost of causing serious ecological disruption with all sorts of unpredictable consequences. Unfortunately, of course, to reduce pollution levels to the point required to protect Mr. Maximum from pollution damage, could only be done by compromising other priorities. The cost to industry would be too great — economic growth could no longer be maintained.

C.B. *Celia Perkins*

Measurements

A further problem is that it is difficult to fix levels below those that can actually be measured by currently available techniques yet they may well be biologically active above this level. Thus, Sturgess of the Essex River Authority points to the damage done by a hormone weed killer in concentrations as low as one in a thousand million. "Present methods", he writes, "do not even enable one to detect the presence of pollutants in this dilution, let alone trace them."[31]

The measurement of ozone concentrations in the stratosphere which are required to confirm or invalidate the thesis that it is being depleted by fluoro carbons and other chemicals emitted by our industrial activities are only possible in a rudimentary way. "Available measuring techniques are too insensitive to detect small long term variations."[32]

Asbestos, even at levels of 0.1 fibres per cubic centimetre of air (the acceptable level proposed by the US National Institute for Occupational Safety — OSHA) — are very difficult to detect and they may still cause cancer — since the average worker doing an eight hour shift would be breathing about 800,000 fibres into his lungs every day. The difficulty in measuring asbestos pollution in the environment is illustrated by the experience of the Greater London Council's Environmental Sciences Group. Air samples recently taken by this group were sent to eight different commercial laboratories for analysis. Each one gave a different set of results.[33] In the same way during the course of a study carried out by the French consumerist magazine *Que Choisir?* human faeces to which a specific pathogen had been added was submitted to thirty-two commercial laboratories for analysis. Only one succeeded in detecting its presence.

Sub-Lethal Effects

For these and similar reasons it is only feasible to measure high levels of specific pollutants in our environment and low levels are simply assumed to have little effect on the health of human and non-human animals. This, of course, as already intimated, is a pure Act of Faith, based on no evidence of any kind. On the contrary the more we learn about the biological effects of different pollutants, the more it becomes clear that exposure to low levels over a long period, can be as damaging, if not more so, than exposure to high levels over a brief period.

This is certainly the conclusion of Dr. Waldichuck of the Pacific Environment Institute, as expressed in a paper he presented at a recent Royal Society Meeting on the effect of sub-lethal levels of pollution on marine organisms.

Waldichuck[34] points out their action to control pollutants in rivers or the sea only tend to be taken after fish kills, i.e. to deal with acutely toxic conditions. It may be just as important to guard against sub-lethal effects which, among other things, can adversely affect fish reproduction and thereby insidiously assure the decline and indeed the disappearance of fish populations. These are very difficult to control, indeed, fish populations or even species can disappear in many cases without anyone noticing it, all the more so in that natural fluctuations in fish abundance and changes due to fishing may obscure a decline in a population caused by a pollutant. There is already ample evidence of fish populations declining and even disappearing from polluted fresh water environments. Thus species of fine fish have declined very dramatically in the North American Great Lakes. The Atlantic salmon has disappeared from many polluted streams in Europe and Eastern North America. The Pacific salmon has been affected in the Western United States, while populations of various fish have declined and, in many cases, disappeared from acidified lakes in Scandinavia.

The sub-lethal effects of low-levels of different pollutants are best understood once we have adopted an ecological view of health.

Today, an individual tends to be regarded as healthy to the extent that he does not display clinical symptoms of disease, but this is totally unrealistic. An organism must be regarded as healthy to the extent that it is viable, more precisely, to the extent that it is capable of dealing adaptively with the various challenges it is likely to encounter in its environment. In this sense, health is synonymous with homeostasis or stability. It can be shown, as I pointed out in "The Future of Tree Diseases"[35] that health can be impaired by all sorts of minor insults, in that they can reduce an organism's ability to deal with environmental challenges, in particular those that can give rise to disease. This appears to be the view of Waldichuck.[36] He shows many of the ways in which a marine organism's behaviour pattern and hence its ability to survive is im-

paired by low doses of different pollutants. Thus, very small quantities of cadmium affects calcium metabolism with adverse effects on the equilibrating mechanism of fish.[37] This probably reduces the ability of fish to avoid predators and also their capacity to seek and capture their own prey.

Very low levels of various pollutants in particular of organophosphorus pesticides inhibit enzyme activity, and can also impair hormone function. Different concentrations of copper and iron[38] have been found to affect plasma cortisone and other hormones in Sockeye salmon.

Oil Pollution

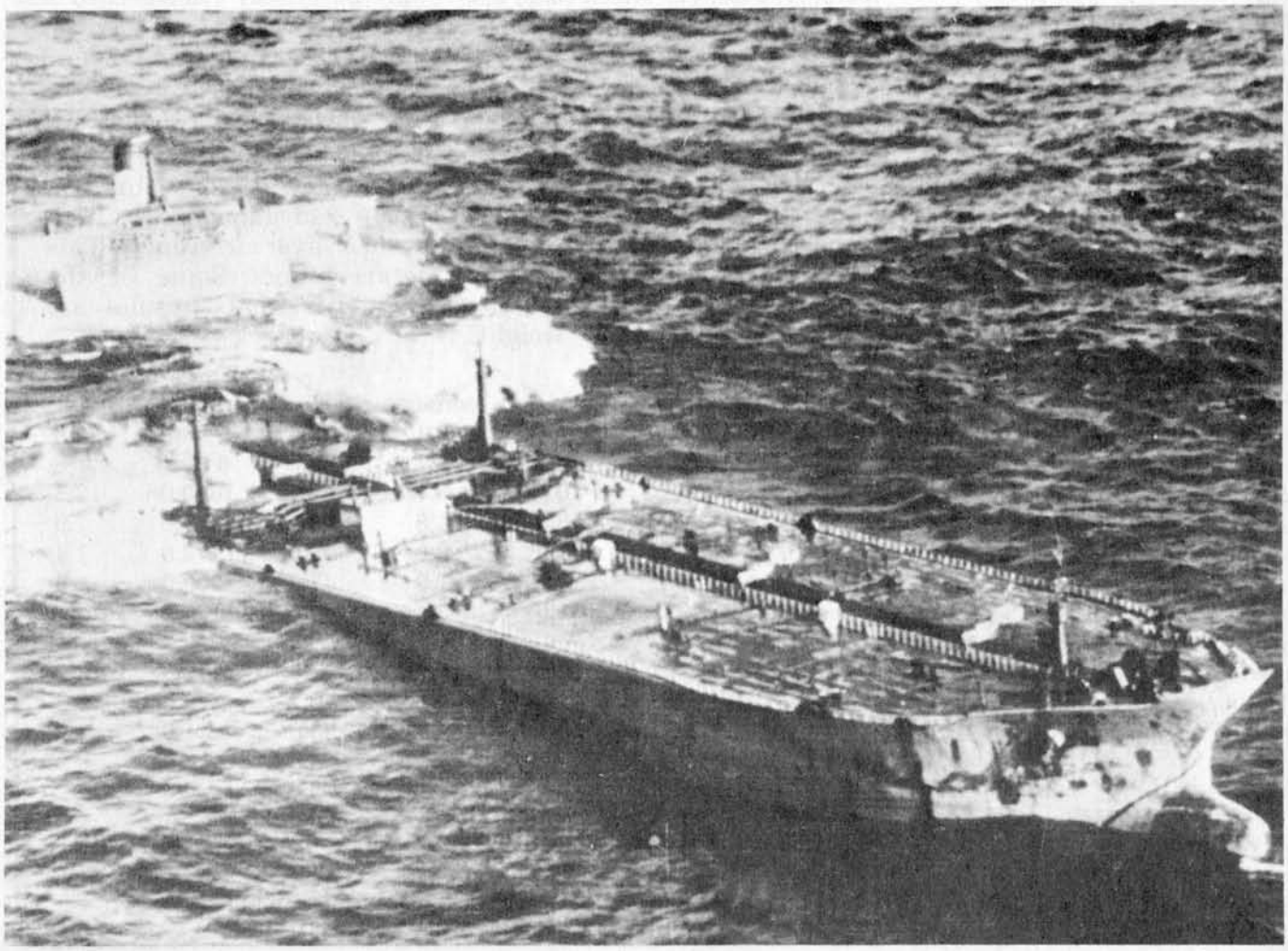
Low levels of oil pollution have been shown to have serious effects on fish eggs, giving rise to chromosomal errors and gene-level mutations, and, when these occur during the gastrula stage they are almost invariably lethal.

Low levels of pollution also give rise to behavioural abnormalities. Normal schooling behaviour, for instance, can be disrupted by a pollutant. The learning ability of fish can be affected by very low concentrations of chlorinated hydrocarbons[39]. This may impair their ability to return to their home stream, especially if they are subjected to these concentrations in the juvenile stage during the imprinting period. It can be shown that the behaviour of fish can be altered by low levels of pollutants.[40] In particular, chemoreceptors can be affected which also impairs the ability of fish to find their home stream, to locate food and avoid predators. A fish's equilibrium can also be affected by low levels of mercury[41] and cadmium[42].

Salmon

Sockeye smolts infected by parasites succumb to lower concentrations of metals than uninfected fish and in general "fish exposed to a pollutant stress either become infected by a disease more readily than unexposed fish, or may break out with a disease that previously existed only in a latent form." What is important is that in general, an organism whose health has been impaired by low levels of different pollutants need not display any clinical symptom until such time as it has been subjected to so much sublethal damage *that it can succumb to some minor challenge, which in normal conditions it could simply take in its stride.* This means that by the time clinical symptoms do appear, the organism is already so badly damaged that it may no longer be viable.

It is easy to see why this must be so once one understands the physiology of basic biological functions. To quote Anthony Tucker[43] "Functions such as seeing or the co-ordination of movements or, indeed, any activity, are not the outcome of the activity of single neural cells. All are the outcome of processes which involve thousands and probably millions of interconnected cells. Such systems have what electronic engineers are prone to call, a high level of redundancy. That means that many pathways are not strictly necessary for the function to be carried out efficiently, but simply duplicate or triplicate other pathways in case



The Press Association

some kind of blockage or breakdown occurs.

Lead

This needs weighing very carefully when considering the effects of organic mercury, lead, or the many organochlorines and other pesticides which, like DDT, can incapacitate neural systems. For it means that by the time clinical symptoms of nervous disorder appear, such as lack or co-ordination or loss of vision, *then enormous damage has already been done to the structure of the brain.* It also means that quite extensive damage can be done without any clinical symptoms ever becoming detectable. This, in relation to heavy metals, is a terrifying situation.''

Dr. S. G. Rainsford[44] of the medical branch of the British Factory Inspectorate, comes to a similar conclusion when reporting on a six year survey of lead workers carried out by his organisation. ''The most disturbing factor'', he writes, ''is that the worker can be severely poisoned by lead without either having symptoms or showing clinical signs of plumbism. Probably the commonest early symptoms are abdominal, discomfort, dyspepsia, loss of appetite and general aches and pains, the latter frequently being described as rheumatism, fibrositis, etc.''. Another very significant study also cited by Anthony Tucker was carried out in Edinburgh in 1965. It revealed that symptoms of lead poisoning tended, in the course of medical practice, to be treated as a normal occurrence without there being any attempt to seek their cause. Needless to say, the health of those affected had been impaired and the chances of their succumbing to a serious disease, which they could otherwise have easily survived, correspondingly increased. Also if they did succumb, it is the disease that actually finished them off, that would have been regarded as the cause of their demise rather than the general weakening of their condition as a result of their exposure to sub-lethal levels of different pollutants — which would have been the real cause. This principle is best illustrated by the well publicised incident in which fifty thousand to a hundred thousand sea birds, mainly guillemots, died from no apparent cause in the Irish Sea in the autumn of 1969. Largely because of the popular outcry, the incident was carefully investigated by a team of scientists, headed by Dr. Martin Holdgate, at that time, head of the Government's Central Unit on Environmental Pollution. What is particularly interesting is that no single factor could be incriminated. During the summer of that year there were heavy storms which may have made it difficult for them to feed themselves. Indeed all the dead birds seem to have suffered, in different degrees, from starvation. Their bodies also were found to contain unusually high levels of PCBs. These tend to accumulate in the body fat, just as does DDT, to which these substances are closely related. It seems probable therefore, that being short of food their surplus fat was mobilized which led to the transfer of these poisons into the blood stream. This could quite conceivably have resulted in their death. But further examination showed that their bodies also contained relatively high levels of all sorts of heavy metals such as cadmium, selenium, mercury, lead, etc. which could also have contributed to their demise. (See table).

Anthony Tucker points to the implications of this disaster:

''The ragged wreckage of dead birds speaks for itself. Like similar wildlife catastrophies in North America and elsewhere, this disaster contains a grave message whose importance cannot be overestimated. It is that the thresholds of environmental calamities are obscure; that levels of contamination are already past the point at which they can amplify many times — perhaps hundreds of times — the fatal effects of purely natural stresses; that it is impossible to predict where disasters will strike and often impossible to define causes after they have happened; and that there is little to be gained from niggling arguments about particular effects of individual components of contamination. The burdens of toxic metals as a whole, and of organochlorines, have already degraded the entire context of the life-system.''

Judging from reports that continue to appear in the Marine Pollution Bulletin, the contamination of sea birds and hence of the marine environment itself, around these islands continues to increase. A 1973 study[45], for instance, on a representative series of marine and estuarine birds revealed that they were all grossly contaminated with mercury. Levels in their liver ranged from 0.7 ppm to 122 ppm in the case of a redbreasted merganser. We can only understand the full horror of

Twelve of 18 guillemots analysed after the wreck of seabirds in the Irish Sea in the autumn of 1969 had anomalously high concentrations of toxic metals in their liver or kidney. This chart shows the scatter of metals found. Some of the concentrations are themselves possibly lethal. Results are expressed as ppm dry weight.

	lead	arsenic	mercury	selenium	zinc	cadmium
1.	40.0+	0.8	0.1	20.0	950.0	6.6
2.	40.0+	0.3	3.1	69.0	640.0	1.6
3.	19.0	0.1	3.7	82.0	1000.0+	12.8
4.	0.8	38.0	1.8	55.0	50.0	1.9
5.	4.9	0.3	8.0	23.0	770.0	1.4
6.	2.1	3.9	1.2	47.0	300.0+	4.3
7.	29.0	1.0	3.4	0.2	130.0	none detected
8.	7.2	0.1	5.5	414.0	170.0	12.2
9.	6.8	37.0	0.1	0.2	23.0	0.2
10.	18.0	0.1	15.0	58.0	11.0	2.5
11.	8.8	8.9	23.0	28.0	190.0	8.9
12.	3.3	9.1	0.1	19.0	30.0	11.7
CONTROL — average of four samples from healthy birds (shot).						
	1.5	1.1	1.1	5.7*	73.3	0.27

*One bird had 16.0 ppm selenium in its kidney.

these revelations if we realise how many other equally toxic pollutants are likely to be lodged in the livers of these birds — pollutants which our scientists have not yet been engaged to look for and measure.

What is happening to our sea birds is also happening to us. A population living in a hideously contaminated environment such as ours, must be a sickly one, which in fact it is. It is not surprising that there are six hundred thousand people waiting for beds in our hospitals and that the bill for our National Health Service should now be nearly £8,000 million and increasing, much faster than GNP, and that if current trends were allowed to continue, the whole of our GNP in a few decades from now, would have to be spent on trying to reduce the toll of human disease. In the meantime the tendency today is still to look unsuccessfully for single cause-and-effect relationships. It is assumed that if a man is ill there is a single reason for it. The possibility that his illness might be due to the combined effect of hundreds and thousands if not millions of different 'causes' all of which have contributed to reducing his resistance to disease, is not even considered.

C.B. *Celia Perkins*

Synergic Effects

It is not just the new effects of so many pollutants that we must take into account but the possibly synergic effects which, as the SCEP Report states between specific pollutants are "more often present than not."[46]

Thus Professor Irving Selikoff has shown that asbestos insulation workers who smoke cigarettes have an eight times greater risk of contracting lung cancer than other smokers simply by virtue of their exposure to asbestos, but a ninety-two times greater risk than non smokers because of the very powerful synergic effect between exposure to asbestos fibres and to tobacco smoke.[47]

The addition of mercury to sea water appears to inhibit the growth of twenty-one different strains of bacteria involved in the degradation of oil in sea water.[48]

The presence of a small amount of DDT, equivalent to that found in humans, greatly increases the liver damage produced by small amounts of carbon tetrachloride.[49] The toxic effects of this solvent are also increased a hundred-fold by the addition of the common drug phenobarbital.

The addition of oil to water substantially increases the damage done by DDT, PCBs and other such poisons that are not very soluble in water, but that are very soluble — perhaps as much as 10,000 times more so — in oil.[50]

The addition of the commonly used dispersant (BP.1100 x Finasol OSR 2) to oil during a spill increases its toxicity to herring larvae by fifty to one hundred times, quite apart from seriously increasing the period during which it is acutely toxic.[51]

The use of chlorine as a disinfectant in our drinking water may have a whole range of synergic effects with chemicals that are often present in it. Thus when associated with Benzene it can, in the presence of ultra-violet light, give rise to MA - *Benzene Hexachlorine,* better known as *Gammexeme* or *Lindane* — a particularly toxic insecticide.[52]

Epstein points out that modern toxicology does not take into account additive or synergic effects.

Nor are they taken into account, as Schubert points out, in setting the acceptable levels for exposure to mutagens. For instance, the International Commission for Radiological Protection defines an acceptable risk as one which would involve the doubling of the spontaneous rate of occurrence of genetic damage. Bryn Bridges [53] demonstrates the absurdity of this standard, in view of the very large numbers of mutagens to which each modern population is exposed.

"What is a suitable recommendation for one mutagen (i.e. radiation) will not suffice when each of a number of mutagens is considered. It has been estimated that about a 1,000 to 1,500 new chemicals are introduced into the environment each year, of which no more than a minute fraction is tested for mutagenic activity. If a thousand mutagens were each allowed at population doses which doubled the spontaneous rate, then the overall rate might go up a thousandfold, quite apart from any synergistic interaction which might occur."

Of course, if minute doses of different pollutants are damaging, then one can only reduce the damage, by limiting the number of pollutants released into our environment. Such a policy, of course, would not be consistent with the achievement of our present economic priorities.

Tumour Promoters

It also appears that cancer can be induced by a single exposure to a very low level of a known carcinogen, one that would not normally cause cancer, when this is combined with prolonged exposure to equally low levels of a substance that is not in itself carcinogenic. Such a substance is referred to as a tumour promoter.[54] This principle may explain the induction of skin cancers. It has also been shown relevant to explaining other cancers including those of the lung, colon, bladder and liver. It tends to confirm the notion that carcinogenesis is a multi-step process. A single insult may not always be sufficient, others of a different sort being required before cancer develops. Croton oil is said to be a promoter. It is a complex mixture of chemicals including esters of the plant alcohol phorbol. The ester referred to as TPA (12-0-tetradecanoylphorbol-13-acetate) is an

especially effective promoter. It appears that the combination of an initiating carcinogen plus TPA is at least ten times as effective in inducing tumours as the carcinogen alone. Other suspected tumour promoters are phenobarbital and the artificial sweeteners saccharin and sodium cyclamate. Bile acid is meant to be a promoter which is supposed to explain, in part at least, the relationship between cancer and a high fat diet.

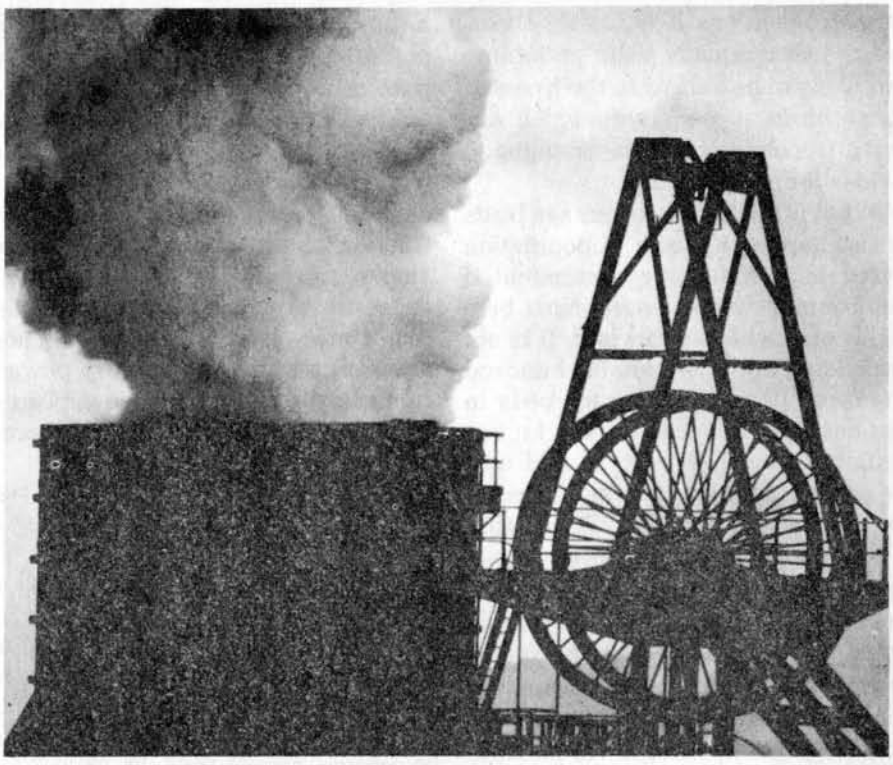
How the promoters act is not entirely clear. One effect may well be to interfere with the normal development of cells. This is shown to be the case with phorbol ester promoters by researchers at the Wistar Institute of Anatomy and Biology at the University of Pennsylvania. These promoters inhibit the differentiation of a variety of cells in culture. Once the cells become mature, they lose their capacity to divide, but, if their differentiation is inhibited, they remain in an immature state and continue to divide, perhaps in an uncontrolled way as do malignant cells.

If this is so, then the implications are dramatic. It means that in trying to determine whether a particular chemical is carcinogenic in the real world, we must not only look for possible effects with other carcinogens, but also with a host of other non-carcinogenic chemicals which could conceivably act as tumour promoters.

Decay Products

To fix an acceptable level for any chemical would also require taking into account the nature and toxicity of the substances that, under different conditions, tend to be associated with it, which would include, as Epstein[55] points out, its "chemical and metabolic derivatives, its pyrolytic and degradation products and its contaminants and reactor products."

Thus the thinning of the shells of birds eggs which has resulted in large scale breeding failures and the near extinction of many species of birds at the top of the food-chain appears to be caused not by DDT as



Nick Holland Susan Griggs

suspected but by its decay product DDD. It is also possible that under certain conditions, it degrades into PCBs which would make nonsense of calculations of acceptable levels of this substance in industrial effluents.

Cyclamates are not dangerous in themselves but because they decay into carcinogenic cyclohexylamine, NTA which detergent manufacturers introduced to replace phosphate-based detergents, also breaks down into products with toxic properties.

Mercury in its inorganic form is largely insoluble in living tissue. Its half life in most mammals as Anthony Tucker[56] points out is only six days which means that it is rapidly removed by the body's natural detoxification mechanisms. However under the action of bacteria in the water and in the soil it breaks down into an organic compound whose half life in the body is about seventy days.

This means that the total body burden of someone ingesting two milligrammes of inorganic mercury would be no more than twenty milligrammes however long the exposure. In the case of organic mercury the figure would be 200 milligrammes within a year, though death would intervene long before.

The same appears to be true of lead, which our scientists have only just discovered to be very readily transformed into an organic form which is very much more toxic than the inorganic variety. It is probably also true of plutonium. Dr. Bowen[57] has reported several times that in the marine organisms examined in his laboratory, he found that concentrations in living tissue were a hundred to several thousand times higher than in the surrounding water.

Bikini Atoll

Particularly significant is the experience of Bikini an atoll in the Pacific from which in the early fifties the local inhabitants were expelled to permit the testing of twenty-three American nuclear devices. When in 1969 the Atomic Energy Commission surveyed Bikini, an AEC official said that "there is virtually no radiation left and we can find no discernable effect on either plant or animnal life"[58]. He even gave the assurance that radioactivity on Bikini was "less than Denver, Colorado." The Bikini islanders who had been forced into exile were allowed to return to their homeland. Measurements today give totally different results. The drinking water is now found to be highly contaminated as are coconuts, fruit, vegetables.

High levels of plutonium have also been found in the urine of the Bikinians themselves. As a result of these findings all agriculture on the Island has been banned and food has been flown in from the outside. How can we explain these developments?

Either the original measurements were totally false or, more likely, plutonium has been transformed into an organic compound that is much more readily taken up by human tissue. This alone makes nonsense of the acceptable levels established by IRCP for the ingestion of plutonium. In Bowen's view, on the basis of the growing knowledge of what happens to plutonium, americium and caesium once they enter the environment, ICRP digestion limits are too high by a hundred or even quite reasonably by a thousand times.[59]

Particularly important for those eating fish from the Irish Sea is that the plutonium isotope Plutonium 241 can decay into Americium 241. The latter is an alpha emitter — the former is not — and releases of it are thereby not included in the permissible levels of alpha emitters released into the sea from the Windscale retreatment plant in Cumbria. The permissible releases have recently been increased from 1800 curies to 6,000 curies per year, and since, according to Bunyard[60] forty times more Plutonium 241 has been discharged from Windscale than all the alpha emitting isotopes of plutonium put together, it may well be that "British Nuclear Fuels who operate the Windscale Plant have succeeded in conning the public into being allowed to discharge more than seven times the quantities authorized which are already scandalously high, as evidenced by the fact that plutonium, one of the most carcinogenic substances known, is now a general contaminant (though at the moment in small quantities) of fish life in the North Irish Sea."

Once again we are faced with a consideration that we cannot afford to take into account without compromising economic goals. The cost of examining the innumerable decay products of all the chemicals we have introduced into our environment would be incalculable, the consequences of banning the chemicals whose decay products proved to be harmful, economically inconceivable.

Toxic impurities also tend to be present in many chemicals causing them to be very much more toxic than they would otherwise be. This is known to be the case with the organo-phosphate, diazinon, used in homes and gardens and for cockroach control. It contains an impurity called sulphotep which is thirty to a hundred times more toxic than diazinon and is much more stable. Its build-up in the environment tends to be favoured by the fact that organophosphate pesticides tend to be applied at more frequent intervals than the more persistent chlorinated hydro carbons that they have in some cases replaced, which must lead to a gradual building up of sulphoteps.[61]

Celia Perkins

Delayed Action

A further complication is that the effect of pollutants on biological organisms may take a very long time to show up.

Thus seven years after atomic bombs had been dropped on Hiroshima and Nagasaki, a high incidence of leukemia began to be observed among the survivors. As after a few years this began to fall off, it was assumed that the worst was over. Fifteen years or so later, however, an unusually high rate of cancer started appearing among the survivors. This tended to confirm the now well-established fact that tumours tend to appear a very long time after exposure to a carcinogen.

It has now been found, of course, that some cancers only appear a generation later. A rare form of vaginal cancer, for instance, has been observed among women whose mothers were administered the hormone stilboestrol (DES) during pregnancy. Carcinogens are also known to cross the placenta and affect the foetus causing cancer in later life.

The fact that such delayed effects are possible, indeed, makes nonsense of current toxicological methods which look only for immediate effects and hence of the measures adopted by health agencies based on data obtained in this way.

The delayed effect on carcinogens also renders useless, epidemiological studies of carcinogenesis induced by substances that have not been in use for at least twenty to twenty-five years. Unfortunately, a large proportion of potential carcinogens, in particular synthetic organic chemicals fall into this category.

This is true of cyclamates. The Committee of the National Cancer Institute looking into the safety of this substance concluded that no epidemiological data were available since bladder cancers had a latent period of twenty years or more and 'cyclamates had not been on the market long enough for cancers to show up.[62] Yet we are still constantly being assured of the safety of chemicals on the basis of such tests.

As Wurster[63] points out, the studies conducted by Hayes et alia and those conducted in the Shell Laboratories which established the innocuousness of DDT could not have done so for a variety of reasons, one of which was that the periods of exposure were too short to detect carcinogenecity.

The National Cancer Institute's report on the effects of fluoridation of American water supplies states that "no significant excess mortality from cancer could be detected up to fifteen years after fluoridation in areas where ninety-five per cent of the population had been abruptly and continuously exposed." This is supposed to justify the ever less tenable thesis that fluoridation does not increase the cancer rate[64].

The delayed effects of pollutants, in increasing the vulnerability of ecosystems to population explosions, in reducing the resistance of populations to disease and also in seriously changing the composition of the atmosphere and the stratosphere, may take a very long time to detect. As the Environmental Directorate[65]

reports, for instance, "because of the long time-lag between release of fluorocarbons to the atmosphere and their migration to, and eventual removal from the stratosphere, their full impact may not be apparent for a decade or more."

This may be an understatement since it may even take as long as a century for halocarbons to reach the stratosphere.[66] The trouble, as the Environmental Directorate points out, (in the case of the effects of fluorocarbons on the stratosphere) is that by that time it may be too late to avoid serious consequences for man and his environment.

The Identification of Chemicals

The problem of establishing levels for different environmental pollutants is further complicated by the fact that we have identified no more than a fraction of them.

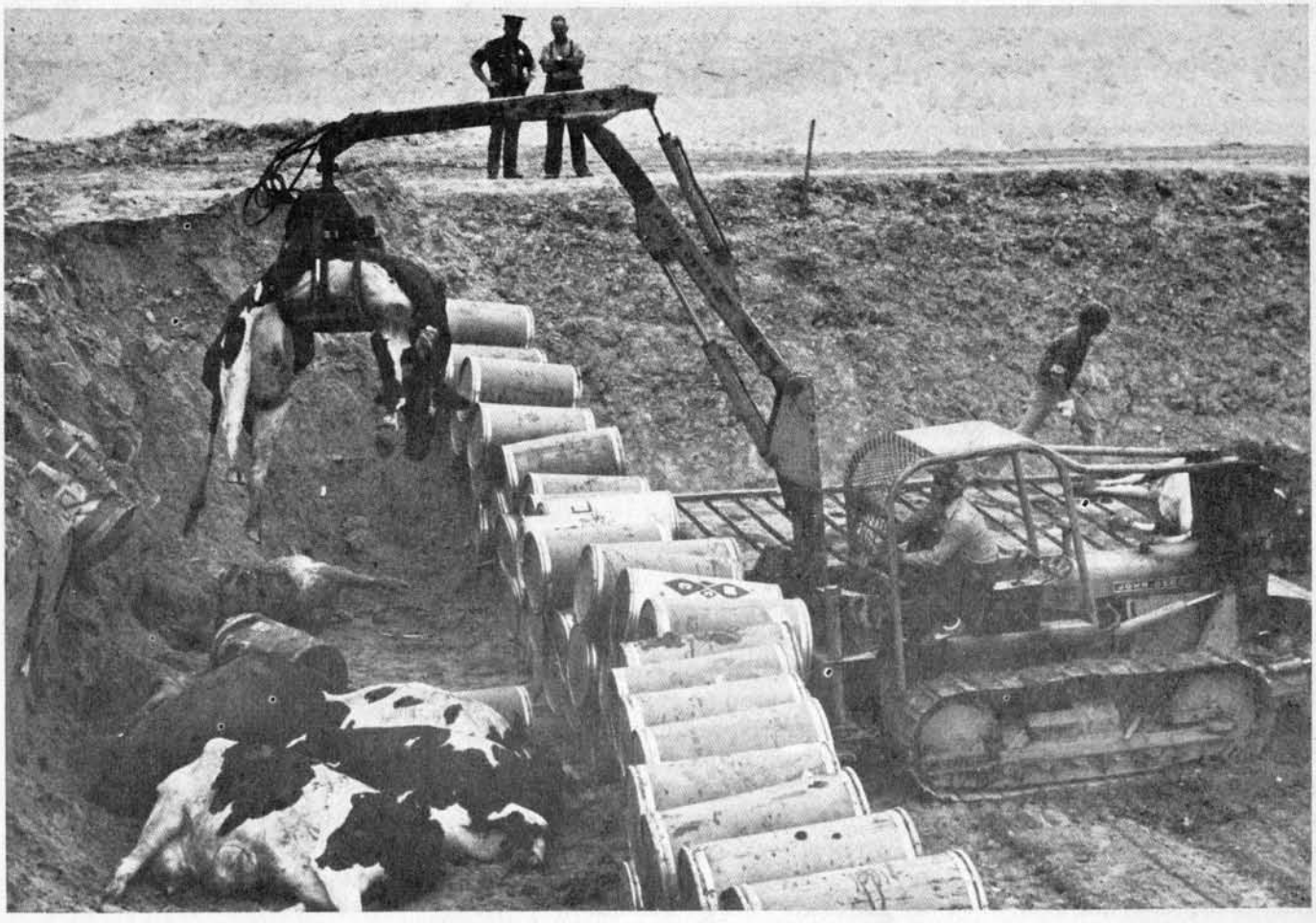
As Rene Dubos[67] points out, there are probably hundreds of unidentified pollutants in car exhaust alone. He estimates that we have identified less than thirty per cent of those contained in the air we breathe in modern cities, but "recent experiments," he writes, "have shown that newborn animals exposed to these undefined contaminants may show disastrous consequences when they become adults."

The plume of vapour from the Sevesco Plant, as Anthony Tucker[68] points out, probably contained "a cocktail of great complexity whose constituents were not only biologically potent as concentrations close to the limits of detection' . . . and 'so subtly interwoven chemically' as, for all practical purposes, to defy identification."

An EPA study of America's drinking water reveals that "there may be a myriad of organic chemicals, not yet isolated and identified, such as the pesticides that could be present in these water supplies, which are carcinogenic, teratogenic or mutagenic."[69]

In the UK, a study by Fielding and Packham comes to the conclusion that it is, to all practical purposes, impossible to identify the organic pollutants in our drinking water. Even though a litre of urban drinking water may not contain more than twenty milligrams of organic constituents, this small amount of material "is a very complex mixture containing hundreds of different compounds some of natural and some of synthetic origin. Its analysis is difficult and even the most advanced and elitic technology cannot yet identify more than ten to twenty per cent of the organic material present."[70]

The inter-agency Task Force on Inadvertant Modification of the Stratosphere (IMOS)[71] has pointed out the difficulty in identifying stratospheric pollutants. "The additive effect from several substances' it warns 'might become significant in the future, even if the effect from any individual substances is relatively small." It also warns that there may well be materials yet to be invented or discovered that are serious candidates for concern.



Dept. of Natural Resources, Michigan — Environment

PBB poisoned cattle being buried in Michigan.

C.B. Celia Perkins

Different Levels at Different Times

The problem of establishing acceptable levels and monitoring them satisfactorily is further complicated by the fact that levels observable in an organism or in an ecosystem are constantly changing. Thus it has been found that American oysters accumulate twice as much cadmium from the surrounding water during the months of July and August as during the winter and the spring. The reason appears to be that the higher water temperature during the summer increases the oyster's metabolic rate. This causes them to pass more of the surrounding water over their gills in a given time and thereby to be exposed to more cadmium.[72]

The DDT content of Barracuda in US waters which tends to be high most of the year, falls by about seventy-five per cent during the spawning season. It coincides with the loss of fat in which the DDT is stored, but is somehow returned to the environment, just how, nobody seems to know.[73]

Unusual climatic conditions can also lead to big variations in pollution levels.

The 1976 drought in Britain, by drastically reducing the flow of water in British rivers, radically reduced their capacity to dilute pollutants. This could not but affect fish life and also reduce the quality of available drinking water.

Because of the 1976 drought too, ozone levels in central London regularly rose above twenty parts per 100 million. Worse still, in early July, for eight consecutive hours on five consecutive days, ozone levels averaged more than ten parts per 100 million (the industrial safety level) with peaks of twenty-five parts per 100 million, which was well above previous peaks of sixteen pphm at Harwell.[74]

The ozone concentration of the stratosphere is also changing very regularly. "There are large natural variations of ozone on a scale of days to many years, and of a complexity which cannot be readily incorporated into current predictive models." The natural variations are in fact so large that it has been "estimated that a five to ten per cent decrease in ozone, persisting and measured for several years, would be needed before a change could be attributed to man's activities with any statistical reliability."[75]

Levels are also constantly changing simply because of people's polluting habits.

If a chemical company cleans out vats containing some noxious chemical on a particular day, levels of the pollutant which may have been very low the day before, will clearly substantially increase, at least temporarily. Dr. J. Sontheimer,[76] a chemist working on the pollution of the Rhine notes how levels of different pollutants vary from day to day. "There is no way of foreseeing what will be floating in the river tomorrow", he writes and as a result "a cleaning process that works one day, works badly the next."

Under these conditions the value of individual measurements is negligible. To be significant, they would have to be carried out over a long period — which, among other things, would present insuperable logistical and financial problems.

Accidents

Establishing acceptable levels for different pollutants is in any case fairly fruitless in view of the increasing vulnerability of our society to large scale technological accidents that are already leading to the exposure of whole populations to very high levels of dangerous pollutants.

Government and industry invariably assure us that the odds against a serious accident occurring to a particular industrial installation are massive, one in a million for instance against this occurring at a nuclear power station. However, as Dr. Wakstein points out, the odds against two jumbo jets colliding on a runway appeared to be equally negligible until it actually occurred at Las Palmas. So were the odds against any of the large-scale pollution disasters of the last few years, the massive leakage of radioactive waste at Hansford, the Dioxin disaster at Seveso, the arsenic trioxide disaster at Manfredonia, and as we shall see the PBB one in Michigan, but they all occurred, and the damage they have done has been on an intolerable scale.

Murphy's Law

We must realise that it is impossible to design, build and operate a technological device that cannot go wrong. This is a principle known to engineers as 'Murphy's Law' which states that "if something can go wrong, it will." One cannot even design a typewriter, a bicycle or even a motor car, that is not subject to breakdowns. This may not matter too much, for any accidents that can occur to them are on a relatively small scale and will affect but a small number of people. This is not so, however, in the case of nuclear power stations and modern chemical plants.

Apart from technological breakdowns one must also consider the human element. People simply cannot be counted upon to deal with routine matters, day in day out, with the care and attention normally displayed in emergency situations only, which means that accidents caused partly at least, by human error, are, in the long run, inevitable.

There is the case of the famous accident at the Browns Ferry Nuclear Power Plant in Alabama on 2nd March 1975. Mr. Gregory Minor, the manager of advanced control and instrumentation stated himself that

the safety systems in operation "went far beyond the normal levels of reliability." What happened was that fire destroyed the safety equipment. This sort of mishap was indeed extremely unlikely but could not be ruled out. "You can't expect these things to run flawlessly for forty years with so many people involved"[77] he said.

With the rapid breakdown of our society and the ever more reduced sense of responsibility, the problem is likely to get worse rather than better. It is interesting that a chief engineer at Windscale should be the one to make this point:

> "I do not think the country can operate with an acceptable standard of safety an extremely dangerous plant like Windscale under current standards of respect for law, national and personal morals and discipline in social and industrial affairs. To maintain safety in such a plant calls for standards of personal dedication, sense of responsibility and discipline which do not generally exist in the permissive society. This has been demonstrated by the fact that the Windscale workforce was prepared to hazard public safety in pursuit of a minor financial objective. Might not a later generation occupy the plant and threaten sabotage if their demands are n ot met?"[78]

The nuclear installation at Windscale has already been the scene of many accidents, one of which in 1957 was very serious, leading to the escape of considerable quantities of radioactive gases into the environment. Dr. Wakstein[79] made a study of the lesser ones from the limited amount of material made available by British Nuclear Fuels Ltd (BNFL). He could only find reference to twenty-eight accidents. However prompted by the then Minister of Energy Wedgwood Benn, BNFL have now produced a list of 177, most of them additional and as Wakstein points out "not hitherto disclosed to the public". If the overlap in the second list is eliminated, it appears that there has been a total of 194 accidents and 'incidents' between 1950 and mid 1977 and I might add that more have occurred since. Eleven involve fires or explosions, seven have reference to criticality and about forty-five involve releases of plutonium, the average rate is seven or eight a year and the number is increasing. BNFL refuse to regard them as accidents. They are referred to instead as 'incidents' and on each occasion the public is assured that no harm can possibly come to any member of the public, a totally dishonest assurance since the pollution released cannot be permanently isolated from the biosphere and must somehow and sometime find its way into biological systems thereby causing biological damage including mutations and cancers. What one must consider is the sheer number of these incidents. Also imagine what it would be like in this country if we went ahead with Mrs Thatcher's programme and sought to become dependent on nuclear power stations for fifty to eighty per cent of our energy requirements, which would mean covering this tiny island with a network of several hundred nuclear power stations together with their allied installations etc. We must also imagine what it would be like, if we then went ahead with our breeder-reactor programme.

Sir John Hill[80] the most fervent advocate of nuclear power in Britain has admitted "that if something went wrong with a fast breeder reactor it could explode. No plant of any description" he said "can be made to deliver over a million horsepower without the chances of an explosion if something goes wrong." Dr. Farmer, Safety Advisor to the U.K. Atomic Energy Authority has admitted that if this occurred there could be as many as a million casualties.

Dr. John Edsall, the Nobel Laureate also describes what the dangers from accidents might be if the US went ahead with its breeder reactor programme:

> "The hazards of the present reactors will be multiplied manyfold in the breeder; an explosion in a fast breeder could make thousands of square miles uninhabitable for many years, and could endanger the lives and health of

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millions of people. Yet the AEC has proposed that as many as 2,000 such breeders may be built and in operation in the United States by the year 2020. As is pointed out in a searching critique by Lovins (1972), the projected breeder system by 2020 would require daily 100 railway cars loaded with casks of spent fuel, on their way to and from reprocessing plants (see also Tinker, 1973). The radioactivity of the spent fuel at the time of shipment from the reactor site, after a cooling-off period of thirty days, would be some 500 million curies for the fuel of a single reactor. The risks of accident during shipment, between the reactor and the processing plant, add another alarming dimension to the problem of nuclear safety.''[81]

The Epidemiological Approach

It may be argued that we can make up for the difficulty in establishing acceptable levels of a particular chemical by laboratory experiments by concentrating more on epidemiological studies. These can obviously help, but too much cannot be expected of them in view of the fact that people living in modern industrial conurbations are exposed to a wide range of different pollutants, at levels, which in a given area at least, may not be too dissimilar, and that, in such conditions, the identification of a dangerous chemical is only likely under exceptional conditions. Thus, as Epstein points out, the carcinogenic effect of asbestos was determined largely because of the very rare form of lung cancer Mesothelioma associated with it.

DES

The carcinogenic effect of Diethylstilboestrol (DES) was also only discovered because of the very rare form of cancer (ademocarcamona) of the vagina it induced in the daughters of women exposed to it during pregnancy — and even then it would probably not have been discovered if a lift had not broken down in Boston enabling the paths of a gynaecologist and a pathologist to cross for a sufficiently long time for them to exchange relevant experiences.[82]

Drugs

The teratogenicity of thalidomide was recognised only by the bizarre deformities it produced. 'In all likelihood', as Epstein writes 'thalidomide would still be in use as a safe drug had it produced relatively common anomalies, such as cleft palate or strial septal defects.[83] Epstein further points out that no known major human teratogens such as X-rays, German measles, mercury or thalidomide 'have been identified by prospective epidemiological approaches, even in industrialised countries with good medical facilities.'

A further problem is that adverse reactions to drugs are rarely reported. Thus, though there were recurring complaints about the side effects of the drug practolol which ICI has recently taken off the market for causing sclerosing peritonitis, these tended to be ignored by prescribers even though they were often serious[84] (damage to sight, hearing, or the gastro-intestinal tract).

From Animal to Man

Even were we to surmount all these problems we would still be faced with a further one. For obvious reasons, it is very difficult to establish permissible levels on the basis of experiments with humans. Animals of some sort must be used. Unfortunately, however, tests carried out with laboratory animals only provide a vague indication of how they will affect humans. Epstein[85] points out, for instance, that ''meclizine, an antihistamine used to treat morning sickness, is teratogenic in the rat, but apparently not so with humans. The opposite is the case with thalidomide, to which humans appear to be sixty times more sensitive than mice, a hundred times more than rats, two hundred times more than dogs and seven hundred times more than hampsters.

On the other hand chemicals which are carcinogenic to one form of life tend to be carcinogenic to others as well. In spite of this the Ames test (famous test by Bruce Ames of Berkeley University) is unlikely to gain general acceptance in official circles. It is based on the assumption that chemicals that prove mutagenic to bacteria tend to be carcinogenic to man which is probably a generally valid assumption.

If the Ames test were accepted the costs of tests would be drastically reduced — but perhaps still not sufficiently to make them practicable on the scale on which they would be required to establish the harmfulness of all the probable carcinogens we have released into our environment.

The Number of Pollutants

The problem is further aggravated by the literally incalculable number of chemical substances we have introduced into our environment.

To begin, there are those that have been introduced on purpose — those that are used in commercial products of different sorts. With regard to the former, the number is increasing very rapidly every year. According to Dr. Blodgett[86] 400 active chemicals were used in this way in 1965, formulated in over 60,000 registered products of which some 35,000 were for agricultural application. By 1973, however, the number of registered products was 33,000 incorporating some 900 different chemicals, although twenty substances amounted to twenty-five per cent of the US production.

As Blodgett points out, very few of these have yet been adequately tested. In the meantime an estimated 500 to 1,000* new chemicals enter large scale commercial use each year. Of these, the NCI subjects only 150 to long-term rodent feeding tests, each of which in 1976 was said to cost 100,000 dollars.[87]**

1,500 is the figure that tends to be most quoted.

***ICI is already complaining that even the limited tests that now have to be carried out to determine the environmental acceptability of a new chemical, can cost a million pounds, while the toxological trials to assure that a chemical is not harmful to humans can cost as much again. According to this company, environmental and toxicological screening already accounts for twenty-five per cent of the money spent on developing a new pesticide.*

Synergy

But we must also take into account, the far more numerous by-products generated during the production of these chemicals. Together, according to UNEP, they amount to several millions and the number of further substances that combinations of these could yield is so great as to defy the imagination.[89]

Dr. Saffiotti of the National Cancer Institute estimates that two million at least are known. Of these, however, terrifying as it may seem, only 3,000 have been adequately tested for carcinogenic properties, while 1,000 have shown some signs of being carcinogenic.[90]

But what do we mean by adequate testing? The NCI tests are carried out on an average of 800 animals. They already cost 100,000 dollars — but can such tests really provide the information we require? Undoubtedly not. If we take into account the immense number of potentially harmful chemicals to which industrial man is exposed, and of their additive and possible synergic effects, we must test for minute biological effects which, needless to say, renders the problem even more intractable. As Epstein writes,[91] "assume that man is as sensitive to a particular carcinogen or teratogen as the rat or mouse. Assume further that this particular agent will produce cancer or a birth defect in one out of 10,000 humans exposed; then the chances of detecting this in a group of fifty rats or mice, tested at ambient human exposure levels, are very low. Indeed, samples of 10,000 rats or mice would be required to yield one cancer or teratogenic event, over and above any spontaneous occurrences; for statistical significance perhaps 30,000 rodents would be needed."

Megamouse Experiments

Saffiotti[92] considers that to test potential carcinogens at the very low levels similar to those at which human populations may be exposed through residues in food, for instance, and in order to detect a low incidence of tumours, about *100,000 mice would be required per experiment.* Each experiment would cost about fifteen million dollars, and to carry out a significant number of them would "block the nation's resources for long term bioassays for years to come and actually prevent the use of such resources for the detection of potent carcinogenic hazards from yet untested environmental chemicals."

Even then, the results, for a number of reasons, would be highly contestable. To begin with such an approach assumes that there is a threshold dose at which a carcinogen is no longer effective, and as we have seen, and also as Saffiotti points out, "there is presently no significant basis for assuming that such a threshold would appear."

Secondly, these studies would, in any case, have to be confirmed by other tests carried out in different conditions such as variations in diet, variation in the vehicles used, in the age of the animals, in their sex etc. Each of these tests would then imply further megamouse experiments. What is more, they would clearly have to be tested in combination with countless other chemicals, with which they may have additive or synergic effects. They would also have to be tested over that period during which delayed symptoms might be expected to occur.

To test for mutations would mean examining the health of the animals for many generations.

The fact is that the *problem cannot be solved in terms of what passes today as scientific method.* This is now admitted by a growing number of scientists who have seriously considered all the factors involved. Alvin Weinberg[93] is among them. He considers that a new 'trans scientific' methodology is required for this purpose. On this subject it is worth quoting him in full.

> "(The question) what is the effect on human health of very low levels of physical insult? Can be stated in scientific terms; it can, so to speak, be asked of science, yet it *cannot be answered by science.* I have . . . proposed the name trans-scientific for such questions . . .
>
> Let me use as an example of a trans-scientific question the problem of low-level radiation dose . . . One may well ask, assuming the dose-response curve to be linear down to zero dose, how large an experiment would be required to *demonstrate* empirically that 170 millirems . . . would increase the mutation rate by the 0.5 predicted by the linear dose-response theory. The answer is that around 8x10 mice would be required to demonstrate a 0.5 per cent level at the ninety-five per cent confidence level. So large an experiment is beyond practical comprehension. The original question as stated is therefore, in my terminology, trans-scientific. . . .Where low level effects are concerned, there will always be a trans-scientific residue."

But even if all these problems did not exist and it were thereby possible to establish safe levels for the major pollutants we introduced into our environment would this enable us to control them? We assume of course that it would. Indeed in the age of technological euphoria in which we live, we take it for granted that pollution could easily be eliminated by installing the appropriate technological controls.

However, it is easy to show that, for a number of closely associated reasons, this is not the case, and that, so ineffective, in fact are our pollution control techniques that the levels released into our environment can be taken, for all practical purposes, to be directly proportionate to the level of economic activity.

The second part of this article, together with the references, will be published in our next issue.

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The Mysterious Case of Karen Silkwood

by
Jim Garrison
Radiation and Health Information Service

Three years ago this month Karen Silkwood was killed in a mysterious car crash. She had documentary evidence that Kerr-McGee Corporation were doctoring safety tests on fuel rods destined for Westinghouse reactors. Did the nuclear industry murder her?

In early 1972, Karen Silkwood, a 26 year-old mother of three children, went to work for the Kerr-McGee (KM) Nuclear Facility in a little Oklahoma town named Cimarron. Trained in physics and a firm believer in the benefits of nuclear power, she was hired as a laboratory technician to test the quality of the plutonium fuel being produced at the plant. KM had been awarded a multi-million dollar contract to produce the plutonium fuel rods for an experimental plutonium-fired Fast-Flux Breeder Reactor being built by the Westinghouse Corp. near Richmond, Washington.

Once working, Karen became quickly involved in the efforts of the Oil, Chemical and Atomic Workers International Union (OCAW) to organize the workers into a local branch of the OCAW. The major reason for organizing was worker complaints about the lack of regard for their health and safety. Many were put on the plutonium production lines without any training at all; the physical plant leaked highly radioactive materials out onto the floor, contaminating dozens of workers at a time; and KM management, in order to meet production quotas, ordered workers to stand in contaminated areas and to continue working while clean up crews attempted to decontaminate the area around them.

By the beginning of 1973, the situation had deteriorated to the point where the OCAW, which had by then won union status, brought the workers out on strike. Non-union workers were brought in, however, and, completely untrained, were put to work on the plutonium production lines. KM was going to prove that no union could 'break' the tough oil-men of the KM Corporation.

KM proved too big to beat, and by the late Spring, 1973, the Union was forced to return to work under a *weaker* contract than the one they had before the strike. Seizing this initiative, KM began during the Summer of 1973 a campaign to "de-certify" the OCAW as the union authorized to represent the workers in the 1974 re-negotiation of their contract. As part of this de-certification campaign, KM issued formal written orders forbidding the workers from discussing working conditions with anyone outside the plant, claiming that such discussions "compromised the security" of the nuclear installation. Workers were also specifically forbidden to talk to anyone from the news media. When some uranium pellets were found scattered around the plant, KM management seized upon the opportunity to force workers to undergo lie-detector tests. They were subjected to questions about their union support; their contacts with union organizers; their sex lives; their use of drugs; and whether or not they had ever made any "anti-Kerr-McGee" remarks to anyone from the news media.

Those who refused to take these tests were either fired or transferred to the wet ceramic division of the plant, an area with an extremely high incidence of radioactive contamination, and were reported to the Federal Bureau of Investigation (FBI) as "suspects" in the uranium pellet scattering incident.

In July, 1974, the Corporation forced the "de-certification" election — and narrowly lost. OCAW thus was assured the right to represent the workers in the new contract negotiations scheduled to begin on

Nov.13, 1974. In August, Karen Silkwood, along with Jack Tice and Gerald Brewer, was elected to be a union negotiator. By December of 1974, Brewer had been fired, Tice had been transferred to the wet ceramic area, and Silkwood was dead.

The following is an account of the events leading up to her death.

The First Skirmishes

When Silkwood was elected to be one of the union representatives, her area of responsibility was the issue of health and safety. The union had been crushed in its first strike over the health and safety issue back in 1972, and she was determined not to have it happen again. She interviewed all the workers who had ever reported KM violations of the health and safety rules; she memorized the Atomic Energy Commission (AEC) regulations promulgated to safeguard the health of the workers; and she conducted her own health and safety inspections of the plant during her free time, compiling a long list of violations she herself noticed.

Knowing what the health and safety regulations were and seeing the violations of these rules by KM, Silkwood flew back to Washington, D.C., in September, 1974 and testified behind closed doors before the AEC, asserting that KM was guilty of violating some 40 different health and safety regulations. The response of the AEC was to tell Silkwood and the OCAW that they would have to further "document" these accusations before it would act in any way.

KM Falsifying Tests

On September 27, 1974, during her stay in Washington, Silkwood first informed the OCAW that KM was not only guilty of gross violations of health and safety regulations but was seriously violating quality control standards as well. She told Tony Mozzochi, Vice President of the Union and Steve Wodka, Mozzochi's assistant, that she could get documented proof that KM officials were knowingly "doctoring", with *magic marker*, the safety inspection X-rays which, by AEC regulation, had to be taken of each plutonium fuel rod to insure that it was not leaking radiation through faulty welding. Tony Mozzochi was later to testify in federal court that these charges by Silkwood "were the most serious charges I have heard in my trade union experience." The AEC demanded perfectly welded fuel rods because, if defective, they could cause a disturbance in the flow of the liquid sodium used to cool the reactor core of the fast breeder. If the sodium is blocked from reaching the portion of the fuel it is meant to cool, the fuel rods can overheat, leading to accidental releases of radioactivity. Under worst-case conditions, faulty fuel rods can lead to a melt down of the reactor itself.

Karen was instructed by Mozzochi and Wodka to return to her job in Oklahoma and secure copies of the "doctored" X-rays along with as much documentation as possible of the 40 other charges she had made of KM health and safety violations.

Karen returned to Oklahoma on Oct. 1, 1974, and spent the entire month working at the plant by day and by night surreptitiously entering KM executive offices and laboratory facilities in order to photo-copy internal KM documents proving her accusations made before the AEC. By the end of October, she had conclusive documentary proof of the validity of 25 of her 40 charges. On Nov. 1, she finally secured copies of two, separate, "magic-marker-doctored" fuel rod safety inspection X-rays, doctored by one Scott Dotter, the special laboratory technician who the KM executives had specifically assigned to conduct the final safety inspection X-raying of the fuel rods. Silkwood discovered that not only was he doctoring up the X-rays indicating faulty welds but that the mere *number* of the fuel rods he "cleared" each week was *itself* a direct violation of AEC regulations requiring that no one inspector be allowed to give the final clearance on over a certain percentage of the fuel rods leaving the plant.

Union Moves into Action

On Nov. 2, Karen telephoned Wodka in Washington and informed him that she had secured the documentary proof for 25 of the 40 charges against KM and that she "had gotten the goods on Kerr-McGee" on the "other matter" which they had discussed. Since the union negotiations were coming up on the 13th, Wodka advised Silkwood to "lay low" until a few days before the negotiations were to start. At this time he would fly out to Oklahoma with Dave Burnham, an investigative reporter of the *New York Times*. Karen would then turn over to Wodka and Burnham all of her documentary evidence sustaining her charges, including her charge of wilful falsification of quality control reports. The plan was that Burnham would write up these charges and print them in the *New York Times* during the first week of the contract negotiations.

KM Spies on Silkwood

Unknown to Silkwood and Wodka, KM executive officials were aware of her every move. Nearly a month before, on Oct. 12, Oklahoma City Police Department Intelligence Unit Photographer Bill Byler and his friend and unofficial assistant, Steven Campbell, made contact with Silkwood while she and a friend, Drew Stephens, were at a restaurant. They "discussed" with Silkwood her status as an employee of the KM Nuclear Facility; her alleged "anti-nuclear" attitudes expressed in the form of her voiced concerns concerning KM violations of worker health and safety regulations; and her activities as one of the elected OCAW negotiators for the upcoming contract negotiations. On Oct. 14, Byler discussed the information he had gained from Silkwood with the Oklahoma City Police Department Intelligence Unit Commander Bob Hicks. Hicks told Byler to gather as much additional information about Silkwood and her associates as he could and to report that information to the Intelligence Unit Commander as he obtained it. Hicks also gave to Byler the private unlisted number of the Director of Security for the KM Corporation, James Reading, instructing Byler to contact Reading and convey to him all the information he had gathered on Silkwood. On Oct.15, Byler telephoned Reading and met with him on the same day. Both Reading and Hicks were kept informed of all subsequent information gathered on Silkwood.

The next move Byler and Campbell made with regards to Silkwood was to photograph pages of a con-

fidential diary Drew Stevens was keeping in which he was cataloging the activities of Karen and her efforts to stop the violations of health and safety standards at the plant where they both worked. Copies of the photographs made were given to both Hicks and Reading. Within this same time frame Karen's phone was tapped and all her telephone conversations monitored. Moreover, Byler, Campbell, Hicks and Reading began to meet privately to discuss the possibility of finding some possible criminal charges against Silkwood and her associates — possibly relating to the paraphernalia Byler saw in Karen's apartment which he suspected was used to smoke marijuana.

Silkwood Contaminated

After the Nov. 2 telephone conversation with Wodka in Washington, Karen took two days off from work. She returned to work on Nov. 5 and performed her usual duties as a lab technician. This included working behind a glass shield, through glove-box openings and rubber gloves, to test various samples of fuel batches.

When she stopped to take her coffee break, she undertook the standard safety check of her person before leaving the glove-box area. She registered radioactive contamination. She immediately called for help and was taken to the decontamination area where she was undressed and scrubbed with wire brushes and treated with chemicals to remove the plutonium from her skin.

The safety inspection team then inspected her glove box but could find no radiation escaping from it; nor was there any radioactive contamination in any part of the room she had been working in. The KM Corp. was later to admit in depositions that the contamination on Silkwood did not come from that room. Nor did she receive the dosage from any other part of the plant.

After the long scrubbing and decontamination process, Karen went home. She returned to work the next day and again when she began her check-out from the glove-box area she registered radioactive contamination. She was again rushed to the decontamination area and put through the process of attempting to remove the plutonium from her skin. This time, however, she registered internal contamination of her nasal passages. She was ordered to go home and to return the first thing in the morning to undergo a "sinus draining" procedure designed to lessen the continuing in-take of plutonium into her lungs — the part of the body most sensitive to the carcinogenic effect of plutonium.

Once again the laboratory area in which she had been working was inspected; again it was entirely free from radiation with the exception of a few places which she had touched with her contaminated hands.

On the morning of Nov.7 Karen reported directly to the decontamination area of the plutonium facility for the "sinus draining" procedure. Upon her first inspection, she was found to be heavily contaminated around her face, neck, shoulders, arms and hands. She had not been to the laboratory, she had not been in any other part of the plant; in fact the only place she had been since she had been decontaminated the day before was her home.

A Convenient Time to Disappear

KM ordered Silkwood to fly immediately to Los Alamos, New Mexico, to undergo a full week of special physical tests to determine the extent of her internal contamination. It was indeed unfortunate, they informed her, that she would have to miss the contract negotiations she had been preparing for but health and safety must come first.

On Nov. 8, Karen was sent to Los Alamos, to a special U. S. government radiation laboratory where she was to be put through a week-long battery of tests and examinations.

Silkwood's Home Searched

Once Silkwood was gone, a Special Inspection Team from the KM Nuclear Facility descended upon her home to begin what one of the team later described in sworn testimony as "a full scale search". Karen's personal mail was read and all tape recordings, personal diaries, notes, memoranda and other documents having anything to do with either her work at KM or her alleged use of marijuana were turned over to James Reading, the Chief of KM security, *not* to the decontamination team.

During the search, the KM Special Investigation Team was joined by federal inspectors from the Region III office of the AEC. On Nov. 8, the AEC inspectors opened up Karen's kitchen refrigerator and found that the bologna and cheese she had been eating was radically contaminated with 400,000 disintegrations per minute of plutonium radiation. The apartment was

immediately sealed off, and *all* of its contents taken, leaving only the bare concrete walls and floors. The contents were sealed up in 55 gallon drums of the type used by KM to dispose of its plutonium waste. These barrels and their contents have never been seen again by anyone other than KM and AEC officials.

"I still have the Documents".

On the night of Nov. 12, although Karen was scheduled for more tests, she gathered her belongings and flew from Los Alamos back to Oklahoma. She telephoned Wodka and told him that despite the loss of everything in her apartment she "still had the documents" and that as far as she was concerned the plan to meet Wodka and Burnham the next evening was "still on".

Karen spent the night of Nov. 12 in Oklahoma City, showing up at the KM facility, some 40 miles away, at 9.00 a.m. on the morning of Nov. 13 for the contract negotiations. She negotiated with Tice and Brewer during the day, not mentioning the documentary evidence she had in her possession proving KM negligence in health and safety and wilful violation of quality control regulations.

After the negotiations broke off in the late afternoon, Karen went with other union members to the Hub cafe in Cresant for a de-briefing session. She took one short break from this meeting to telephone Drew Stephens to make sure he was leaving his work early to go to the Oklahoma City airport to meet the planes on which Burnham and Wodka were arriving, to make sure they got to the 8.00 p.m. meeting on time. After this call, Karen went back to the de-briefing and confirmed to a friend, Jean Jung, that she had documentation concerning health and safety and quality control violations that would "get Kerr-McGee once and for all". She also told Jean Jung about the meeting she was to shortly leave for with Wodka and Burnham.

A fatal Car Crash

At about 7.10 p.m., Karen left the cafe, got into her 1973 Honda Civic with an inch-thick manila folder full of documents, and drove off down Route 74 toward Oklahoma City.

In Oklahoma City, Burnham, Wodka and Stephens sat waiting for Karen in Burnham's hotel room at the Holiday Inn Northwest. Eight o'clock came and went. No Karen.

Eight-thirty came and went. No Karen.

The men then began to become concerned and attempted to call the Hub cafe. They discovered, however, that Burnham's phone was "out of order". Leaving the room, they finally made contact at a pay phone and learned that Karen had left the cafe shortly after 7.00 p.m.

The men jumped in their car and headed out of Oklahoma City along Route 74 towards Cresant.

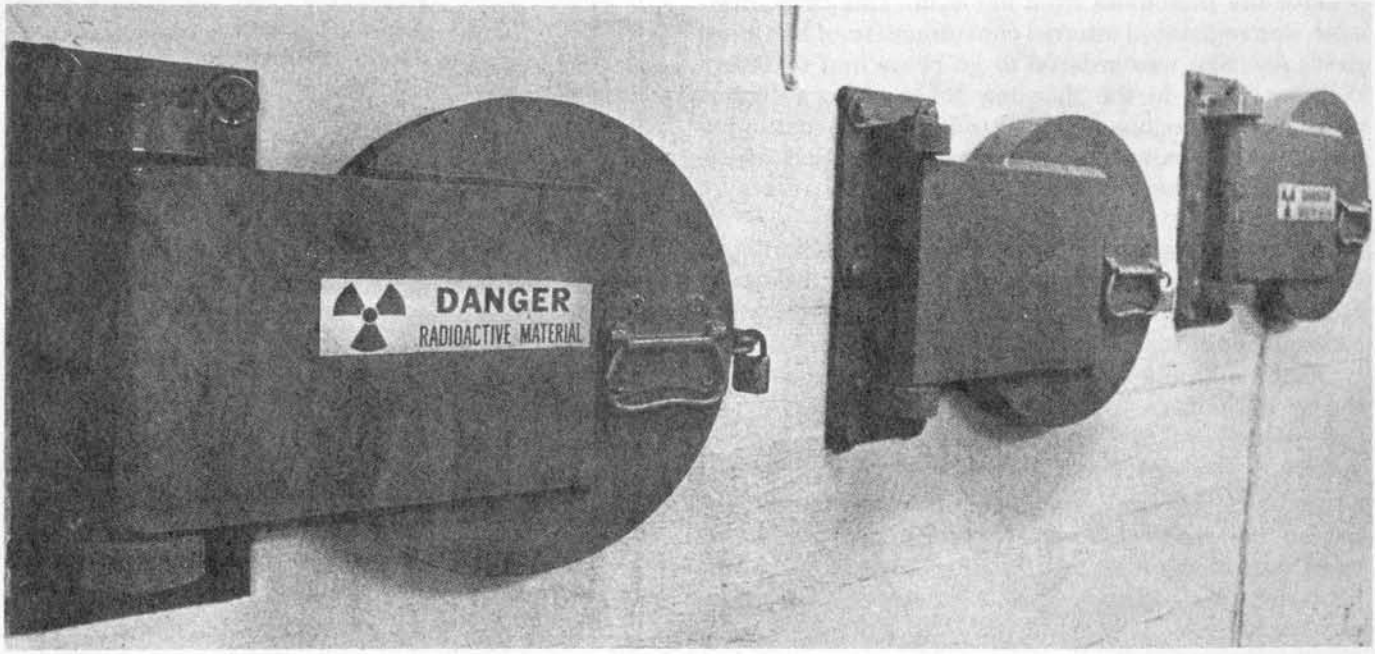
Seven miles from Cresant, they came upon the red lights of police cars and a gathering of spectators. Karen was dead. Her body was gone. Her car had been taken away.

Telephone calls from David Burnham to the Oklahoma State Highway Patrol revealed that Karen's car had been towed away by some private wrecking service, *not* by the State Highway Patrol, as was the usual procedure. An all-night search by Burnham, Wodka and Stephens failed to turn up where Karen's car and her documents had been taken.

Before searching for the car, the men went to the coroner's, viewed Karen's mangled body, and telephoned her parents in Nederland, Texas, telling them of their daughter's death.

Where were the Documents?'

The car had in fact been taken away from the accident by a local wrecker service, Ted Seabring's Ford. At 12.05 midnight, he was called by the Oklahoma State Highway Patrol and directed to open up his garage in order for a group of KM officials to check Silkwood's car, "to inspect it for radiation". Four KM representatives came, dressed in radiation suits, complete with face masks. Both Ted Seabring and his assistant Kenneth Valliquet later asserted that these men took documents from the car and began reading



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them aloud to one another. Neither Seabring nor Valliquet recall whether these men actually took the documents they were reading.

Later that morning, police officials came to the garage and did take items from the car. After this visit, Seabring took all the remaining items and packed them into a cardboard box, which he sealed.

It was not until that afternoon, Nov. 14, that Burnham, Wodka and Stephens finally located Karen's car. After a call to Karen's parents, Seabring released Karen's car and the sealed box of items he had taken from the car to them. Directly in the presence of Seabring, Burnham, Wodka and Stephens opened the sealed box and examined its contents. There was no manilla folder. There were no documents.

Was Silkwood's Death an Accident?

Wodka immediately telephoned Tony Mozzochi, OCAW Vice Pres. The Union decided to immediately hire the best automobile crash reconstruction laboratory in the Oklahoma area to inspect the car and the crash scene in order to reconstruct what had happened. Contracted for the job was the Accident Reconstruction Laboratory in Dallas, Texas. One of their top experts, A. O. Pipkin flew to Oklahoma, inspected and photographed Karen's car; inspected and photographed the accident scene; and reviewed both the police reports and the report of Seabring. On Nov. 19th, the Accident Reconstruction Laboratory issued an official report concluding that the physical evidence Pipkin had been able to evaluate indicated that Silkwood had been struck in the left rear side by another automobile travelling up behind her at approximately 55 to 60 miles per hour. She had been knocked off the road and her car had driven directly into a concrete culvert. Karen had been killed instantly.

Formal Complaint Initiated

On Nov. 20, the OCAW filed a formal complaint with the Justice Department in Washington, D.C., demanding that an investigation be conducted into Karen's mysterious death as well as into her mysterious contamination a week before her death. On Nov. 21, FBI Headquarters in Washington telexed the FBI office in Oklahoma City and ordered a full-scale investigation into the contamination and death of Karen Silkwood and into charges of union harrassment by KM. FBI agent Lawrence J. Olsen was assigned to the case.

Sworn depositions reveal that on the day he was assigned to the case, Olsen met privately with James Reading, informing him that the FBI had ordered him to investigate KM agents for possible criminal wrongdoing against Silkwood and other members of the OCAW at their Cimarron Nuclear Facility. At this meeting, Olsen explained to the chief of KM security what type of information might prove incriminating to KM and asked Reading to set up an emergency meeting between Olsen and executive officials of KM as soon as possible.

This second secret meeting took place on Nov. 25. After explaining to the KM officials what the federal statutes were under which he had been ordered by FBI Washington to conduct a criminal investigation against

Seven miles from Cresant, they came across the red lights of police cars. Karen was dead. Her body was gone. Her car had been taken away. And the vital documents were missing . . .

KM, Olsen agreed to work with Reading in the investigation. During the next several days, Olsen interviewed several OCAW workers at the KM plant in a meeting set up by the Company and personally attended by Reading. At these meetings, the workers were asked whether they had any information they wanted to give concering KM harrassment of the OCAW. When none of the workers were forthcoming with any incriminating evidence, Olsen closed his investigation of charges of KM harrassment of OCAW union workers.

Was the FBI involved in a Cover-up?

Olsen then turned to investigating Silkwood's radioactive contamination. Instead of investigating the possibility of KM contaminating her, however, a confidential memorandum sent by KM Security Chief Reading directly to Dean A. McGee, Chairperson of the Board of Directors of the KM Corporation, indicates that the "thrust" of Olsen's investigation was to discover "what were the means used *by Silkwood* to remove plutonium from the Cimarron Facility, or if in fact, the plutonium she was contaminated with came from some other source."

In March, 1975, Olsen met with an undercover FBI domestic surveillance operative Jacque Srouji who had been asked by the FBI to write a book on nuclear power in order to "establish contacts in this area". Olsen turned over his entire Silkwood investigative file to Srouji for copying. He also set up a secret meeting between Srouji and Reading. Srouji was later to state to a Congressional investigator that at this meeting Reading informed her that he and his associates in the Security Division of KM had wiretapped Silkwood's phone and had electronically "bugged" her home prior to her contamination and death. Srouji states that Reading even showed her typed transcripts of the telephone calls monitored.

In the late Spring, 1975, Olsen closed his investigation, stating that it was not possible to determine how the 400,000 disintegrations per minute of radioactive plutonium got on the food in Silkwood's apartment. In his report on her death, he simply accepted without question a report issued by the Oklahoma State Highway Patrol stating that Karen had simply fallen asleep at the wheel. With regard to the question of documents, Olsen stated in his report that KM officials had said that there could not have been any documents since her charges against the company had not been true. This being the case, he never looked for any.

"The Case is Closed"

Within a few months of her death, therefore, the FBI investigation of Karen Silkwood was closed. In response to official inquiries by her parents, the National Organization for Women, and the OCAW, FBI Inspector Al Connally responded that they "watched too much television" if they expected every case to be completely solved. "In any event", Connally said, "the FBI cannot discuss its investigations into the case, because it is a 'closed' case. And the FBI official policy is not to discuss 'closed' cases.

Unsatisfied with this explanation, the National Organization for Women, the OCAW, the Environmental Policy Center, Critical Mass, and various other interested organizations began to mobilize their constituencies to put pressure on the Senate Committee on Government Operations to hold a public enquiry into what had really happened. In Nov. 1975, Senator Ribicoff, who chaired the Committee, agreed to hold hearings to find out not only what had happened but to determine how effectively the various federal agencies, including the FBI, had performed their duties.

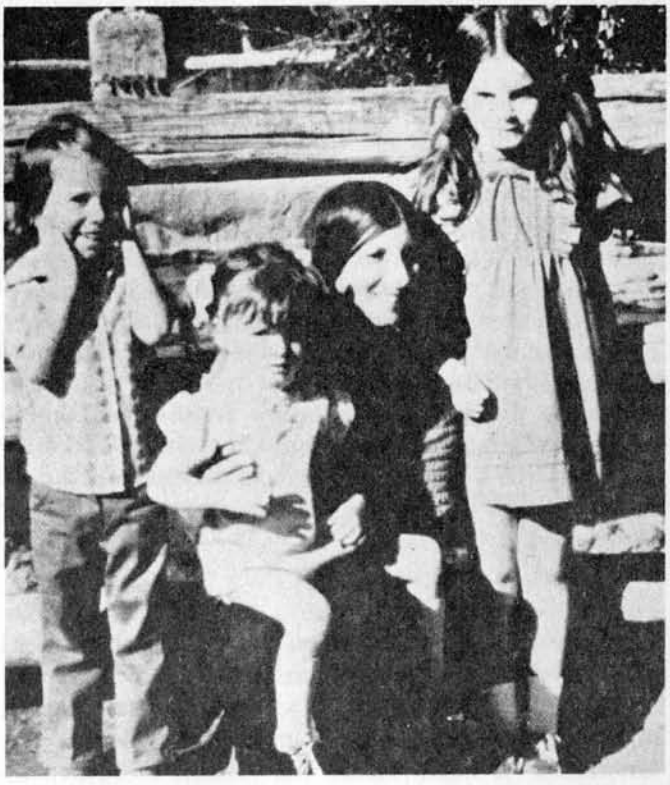
As soon as the Senate hearings were announced, the KM Nuclear Facility was completely closed down and all of its workers summarily fired. The plant was put into "mothballs", to await the pending investigation. Suddenly, two weeks before the investigations were to begin, Dean McGee flew to Washington and met privately with Senator Metcalf, a high ranking member of the Committee on Government Operations who with Ribicoff was heading the inquiry. The only other person present during this meeting was a Mr.Bennet, the Washington representative of KM. No one knows what was discussed at the meeting. The results, however, were dramatic. The very next day, Senator Metcalf issued a press release announcing that the previously scheduled hearings into the Silkwood matter were "permanently closed."

One of the Congressional investigators for the now-closed Senate hearings, Peter Stockton, took the case over to the House of Representatives and got the House Sub-Committee on Energy and the Environment to agree to hold hearings into the Silkwood matter in April, 1976.

The FBI Refuse to Release Files

When the FBI was contacted to provide copies of its Silkwood investigation file, it refused, citing its official policy not to discuss 'closed' cases. The Chairperson in charge of the inquiry, John Dingell, rejoindered by pointing to cases where Congress had been explicitly authorized to obtain copies of 'closed' FBI investigations, when such files were deemed necessary by the Congress for it to perform its responsibilities. Upon receipt of this information, the FBI immediately declared the Silkwood case 'open', refusing to give to Dingell access to its files on the grounds that the FBI had the right to refuse *anyone* the files of an 'on-going' FBI investigation. When questioned by Dingell how the status of the Silkwood case had suddenly switched from 'closed' to 'open' the Deputy Director of the FBI, James Adams, stated that the case had been re-opened "due to all the inquiries being directed to the Bureau about it."

Dingell held hearings anyway. One of the witnesses was Jacque Srouji who, according to FBI documents later obtained through supoena power, was sent to testify in order to blast the OCAW and defame Karen Silkwood. In her testimony, she accused Silkwood of being "mentally unstable", of "deserting her husband and three children", and of "using marijuana". She further stated that in her opinion both the contamination and the death of Silkwood had been done deliberately and hinted darkly that perhaps the group responsible was the OCAW which could have done it to somehow embarrass KM in the contract negotiations. Under Cross-examination, Srouji defended her conclusions by stating that they were based on FBI documents. This brought the proceedings to a halt, for if Srouji, introduced to the investigation as a journalist, had seen FBI files, why had these files been refused to the Congress of the United Stated?



A Little Politicking on Capitol Hill

Before the issue could be resolved, Dingell was ousted as the Chairperson of the Committee in a *coup d'état* engineered by another member of Congress, Tom Steed, from the fifth District of Oklahoma, the home district of the KM Corporation's international headquarters.

With this ouster, hearings ceased, and Karen's parents, until this time waiting patiently for American justice to deal fairly with the contamination and death of their daughter, contacted legal counsel to file a federal lawsuit designed to obtain justice through the federal courts.

Parents File Law Suit

In Nov., 1976, a three count suit was filed charging first, that KM was legally liable for the plutonium contamination of Silkwood which occurred on Nov. 5, 6, and 7, 1974; secondly, that James Reading, Dean McGee, Reading's assistants, and the other members

of the KM Board of Directors participated in a wilful and intentional conspiracy to violate the civil rights of Karen Silkwood in her efforts to organize a lawful trade union at KM; and that they then sought to cover-up these violations. Four FBI agents, including Olsen and Srouji, are named as co-conspirators in the cover-up. The third count charges these same people with an identical conspiracy of attempting to commit and then cover-up a deprivation of the equal protection of the laws and the right to the equal enjoyment of the privileges and immunities of all those persons, of whom Silkwood was one, who reported violations of the federal Atomic Energy Act by the KM Corp.

"KM Showed a Callous Disregard for its Workforce"

The first count finally came to trial in the Oklahoma Federal Court in the Spring of 1979. Dr.John Gofman, known to many as the "Father of Plutonium" due to the fact that he was one of its co-discoverers, set the tone for the plaintiff's case by testifying that current government licences to operate nuclear plants conforming to existing standards are "legalized permits to murder". Evidence from the past ten years, he said, shows that federal standards for plutonium are at least 480 times too lenient and that Silkwood was "married to lung cancer" as a result of her contamination.

Dr. Edward Martell, an environmental radiochemist also testified that existing radiation exposure limits are "misleading and inadequate and have not been reduced because of the government's vested interest" in nuclear power. Dr. Martell called federal standards both in the U.S. and abroad "meaningless" because, contrary to official policy, there is no safe limit for exposure to low-level ionizing radiation.

Dr. Karl Morgan, often referred to as the "father of health physics" for his role in the setting of acceptable standards for radiation releases in nuclear facilities, testified that KM showed a "callous" attitude toward the safety of its workers. He pointed out that the KM training manuals made no mention of the fact that one could contract cancer from radiation exposure, and that because of this refusal to recognize the dangers of radiation both KM management and the workers themselves were lax and in frequent violation of safety regulations.

Former plant workers stated under oath that their training had been so deficient that teenage workers often played at seeing who could get "the hottest the fastest". Workers said that plutonium spills were often painted over instead of cleaned up, workers left the plant contaminated, and plant supervisors were warned ahead of time of upcoming 'surprise' inspections by the AEC. There was also testimony stating that workers used uranium for paper weights, threw it around the rooms at each other, and even took uranium home to show their children.

One of the four plant supervisors, Jim Smith, branded the KM Nuclear Facility a "pigpen", testifying that security was so lax, workers could have thrown plutonium over the fence or taken it past guards simply by telling them it was to be thrown out as waste. Smith also told of numerous incidents where workers were forced to stay in contaminated areas and continue working in order to meet production quotas, their only protection being inadequate face respirators.

Damages Awarded

The jury was convinced by the combined testimony of expert witnesses and former workers, and on May 18, 1979, awarded $10.5 million in actual damages and $500,000 in personal injury damages to Silkwood's three children. In charging the jury, Federal Judge Frank G. Theis directed them to define "physical injury" with regard to plutonium as "nonvisible or nondetectable injury . . . to bone, tissue or cells." The implications of this are profound, for it establishes *legally* that plutonium is in fact a "dangerous material" and causes "physical injury". This means, on the one hand, that nuclear materials are so dangerous that nuclear facilities are under special restraint to prevent the escape of any of the material, whether intentionally or otherwise; on the other hand it means that workers and members of the public are now entitled to claim damages due to the operation of nuclear facilities if they can demonstrate that their sickness is attributable to radioactive releases coming from the plant involved. In charging the jury, therefore, Judge Theis stated that they did not have to find that KM deliberately contaminated Silkwood; the mere fact that plutonium had been allowed to "escape" the plant was sufficient to award damages.

Silkwood's Legacy

The second and third counts have not yet come to trial but a growing body of evidence accumulated by Silkwood investigators is indicating that what was done to Silkwood in terms of covert surveillance and harrassment was not unique to her but is a common practice against those who are perceived by either the nuclear industry or the government as a threat to the continued use and expansion of nuclear power.

Much could be said in comment concerning Karen's contamination; concerning the illegal surveillance and harrassment effected against her; concerning her death while enroute to take documents incriminating KM to a union official and a reporter; concerning the subsequent coverup by the FBI and the failure of other government agencies to bring the facts to the light of day; and concerning the finding of a jury that KM was in fact criminally liable for her plutonium contamination. Much could be also said about the implications of the Silkwood case for the civil liberties of persons in democratic societies which seem intent on constructing a plutonium economy, about the growing conviction of many that democratic freedoms and a nuclearized society are a contradiction in terms. Finally, much could be said about the growing disparity between what the nuclear industry *claims* in terms of a perfectly run technology which, because it is perfectly run, is perfectly safe and the growing body of evidence indicating that in fact the nuclear industry is being run much like any other industry with all this means in terms of sloppiness, inefficiency, and disregard for health and safety. But I do not think that much comment is needed, for the Silkwood case is one case where the facts seem to speak quite adequately for themselves.

Magnesium and Health

Magnesium deficiency in the food we eat could be causing a wide range of nutritional diseases.

Ever since the publication in 1961 of André Voisin's book, "*Sol, Herbe, Cancer*", biologists, especially those interested in nutrition in the modern world of food technology, have paid special attention to the dangers of magnesium deficiency in plants, animals and men. This was clearly demonstrated by the very high quality of the papers presented during the 2nd World Symposium on Magnesium held in Montreal in 1976.

The Symposium covered a wide field, including the biochemical aspects of the use of magnesium salts in the treatment of arthrosis, thrombosis and the prevention of cancer, together with the physiological need for these salts in human metabolism, especially in the ATP synthesis necessary for the production of body sugars, fats and proteins. The Symposium sounded the alarm — there is, at present, grave danger of a magnesium deficiency in foods consumed in the developed countries of the world which could be one of the major causes of the increase in certain diseases, including arthrosis, arteriosclerosis, cancer, thrombosis and bone diseases in general.

Agricultural technology has succeeded in producing three times the quantity of food from the land under cultivation. It has done this mainly by the use of NPK fertilizers; namely, those made up of nitrogen, phosphorus and potassium-producing chemicals. However, little or no thought was given to the effect of these compounds on other minerals in the soil, especially magnesium, in spite of the well known need for a balance between potash and magnesium.

If that delicate balance is not maintained, the plants take up from the soil an excess of potash at the expense of less magnesium. As a consequence, those plants will be deficient in magnesium, and so will the animals and humans who live on them. Next year's harvest will be secured by further applications of the NPK fertilizers and will lead to an even greater deficiency of magnesium in the soil and in the plants.

This is the vicious circle we have caused by our refusal to admit certain basic principles of Nature, because we think that we know better. Compost made from plants deficient in magnesium will also suffer from this lack of a basic mineral and so will green manures. In a word, we are on the point of producing a nutritional disaster.

The tragedy is that few people take any notice of events like the Montreal Symposium. Medical textbooks are reluctant to admit the possibility of a magnesium deficiency, because they insist that the chlorophyll of green plants supplies enough magnesium — and it is easy to tell, by the colour itself, if there is enough chlorophyll in the leaves. In general, it is assumed that most soils are rich in magnesium, and so there is little possibility of a deficiency in plants, animals or humans. This error is repeated time and again but it will not stand the test of thorough investigation.

The assumption that most, if not all, soils are rich in magnesium takes for granted factors which are no longer common today. It presupposes that the loss of those trace elements taken up by crops has been made good by the incorporation into the soil of organic manures and humus rich in magnesium, and that the availability of this element has not been destroyed by the excessive use of chemical NPK fertilizers. It is our contention that this assumption is no longer true in the majority of cases.

Nor is it true to say that plants use magnesium mainly to produce chlorophyll, because only about one per cent of the magnesium contained in any vegetable is used to form this green pigment. Most magnesium is to be found in the rest of the plant in ionic form in union with the high-energy molecules such as ATP. For this reason the greatest source of magnesium intake for animals and humans is found in the seeds and fruit of certain plants, such as soya bean, cacao, almonds, hazel nuts, peanuts, legumes and wholemeal cereals, together with some fruits such as dates and dried figs. The following Table gives the content in mgs/100 gms of assimilable magnesium in some of these foods when grown by organic methods;-

TABLE I.

Food.	Content in Mg.mgs/100 gms
Cacao	420
Almonds	252
Soya bean flour	254
Peanuts	160
Dates	84
Wholemeal flour	82
Spinach (cooked)	53
Parsley	55
White flour	23

Another error, common in medical textbooks and academic works on nutrition, is the assumption that a normal adult needs between 3-5mgs/k of magnesium per day. The truth is that they require between 7-10mgs/k, while pregnant women and those who are breast feeding need 14-15mgs/k, as do children and adolescents in the period of maximum growth. Thus the 3-4mgs/k considered sufficient for adults is far below the true figures, which range between 7-8mgs/k. If this error is perpetuated it is easy to see how a deficiency can exist without being detected.

Processed foods in general suffer a severe loss in their magnesium content. We need only compare the figures given in the above Table for wholemeal flour and white flour. There is a progressive loss of this element according to the rate of extraction of the flour and the quantity of additives used, such as bromate and the chlorine com-

pounds. There is also a corresponding loss of other elements, such as potassium, calcium, iron, copper and zinc, but what is more important is a decided disturbance of the K/Mg balance, which can only give rise to an even greater magnesium deficiency.

Many of these processed foods contain a certain amount of chemically modified starch, either hydrolyzed or treated with phosphorous oxychloride. The new starch molecule thus produced can add substance to such foods as artificial cheese, sausages, tomato paste and jams. It is entirely articifial, tends to coat the intestine and so prevent the assimilation of nutrients, and also damages at least two of the essential amino acids, methionine and lysine. It also produces a decrease in the assimilable magnesium.

If this does not cause concern and even alarm in those official circles responsible for the nourishment of the people and the prevention of disease, then there is little hope of any change for the better in the foreseeable future. In certain countries it is now obligatory to add vitamins and iron to white flour (to replace the natural ones which have been eliminated by extraction), but nothing is done about the magnesium deficiency or about the removal from wheat of the outer husk and germ, both of which are important factors in adequate nutrition and the prevention of disease.

The same type of biological crime has been committed in the case of salt, which every housewife uses from time to time. Sea salt contains a certain percentage of magnesium, which makes it difficult to keep for any length of time, because magnesium is very hydroscopic and the water it stores tends to leak out on to the grocer's shelves. Therefore the magnesium is extracted, as if it were of no importance, but the possibility of a magnesium deficiency is increased.

The effects of magnesium as a preventative agent in tumour formations is now admitted as a distinct possibility. In part this has been due to extensive studies of those countries which show the lowest incidence of cancer. In all those areas the one common element would appear to be a soil rich in magnesium, together with the limited use of chemical fertilizers. The emphasis, in many of those countries, is on 'mixed' farming, in which the animals fed on the farm crops supply the major part of the manure for the land, with little need to spend money on chemicals. In some of them even human wastes are returned to the soil. The plants for processing city refuse into rich manure pay for themselves within ten years and the end product is clean to use and very effective. If it is mixed with sludge, so much the better! The secret is to get the proportions right.

It should not be forgotten that any disturbance of the delicate balance of the trace minerals in the soil means similar disturbances in the human blood stream, with deadly results. In the case of old people, for example, it is very important to maintain the calcium/magnesium balance. It is often assumed that a calcium degenerative deficiency is the main reason why they suffer easily from bone fractures and osteoporosis. This may be only a half-truth, because we now know that, of the total content of magnesium in the body, ninety-nine per cent is found, together with potassium, in the interior of the cells, while the calcium and sodium are to be found mainly in the liquid which bathes the cells. Also it is significant that the highest concentration of magnesium (seventy-seven per cent) is to be found in the periostium, the membrane which covers the exterior of the bones. This should be taken into consideration in geriatric nutrition, especially if we remember that some cases have been reported of cures of degenerative bone diseases by the administration of magnesium content of foods is in in view of the importance of this element in cell reproduction and formation.

We have already mentioned the fact that the daily intake of magnesium necessary for the normal adult ranges between 7-10 mgs/k. However, only about a third of the magnesium content of foods is in fact absorbed by the body through the digestive tract. The rest is eliminated in the urine and faeces. In a word, the body metabolism is slow in absorbing magnesium, even in an assimilable form, and this needs to be taken into consideration also because if the quantity of magnesium available in foods is already deficient, due to methods of cultivation or processing, there is an even greater danger of a deficiency, which can easily pass undetected.

For this reason it is now strongly suspected that the increase in arthrosis, arteriosclerosis, coronary thrombosis and cancer may be due to a general and long-standing magnesium deficiency which disturbs the whole body metabolism.

It is to be hoped that those who have anything to do with nutrition at Government levels will take these facts into consideration in the immediate future and will apply the necessary remedies, without paying too much heed to the specious arguments of the manufacturers of processed foods, whose main interest is to sell their products on the basis of appearance, taste and texture, without much thought given to their nutritional values.

David Greenstock

Books

Pollution in a distorting Mirror

A PERSPECTIVE OF ENVIRONMENTAL POLLUTION, M. W. Holdgate, Cambridge University Press £15.00.

This is a very thorough look at environmental pollution in all its various aspects. Dr. Holdgate was director of the Central Unit on Environmental Pollution in the Department of the Environment and also director of the Institute of Terrestrial Ecology. He has had a chance to consider these problems for a long time and has had access to a lot of information and the book is in fact very highly documented as one would expect. It is also however an establishment study. As a government expert, Dr. Holdgate has had to toe the government line on most pollution issues and the Government line, as we all know, is that pollution is a minor problem, and one which is now completely under control. One is therefore pleasantly surprised to see that he is willing to face a lot of unpleasant aspects of this question which many people in his position would not have the courage to do.

Thus he readily admits that nitrate levels in important British rivers such as the Thames and the Lea are continuing to increase. He also admits that the extensive surveys of rivers conducted by the DOE which have been used to justify the thesis that our rivers are getting cleaner, are very misleading, firstly because they only measure the rivers' oxygen content and take no account of industrial pollutants, and secondly because "the worst-polluted river reaches tend to be those lowest down, and these are the reaches where the volume of flow is greatest and the largest bankside towns and cities are sited . . . Were the statistics arranged in terms of volume, or of human exposure, they would therefore look less encouraging."

He also agrees that estuaries tend to be in a bad way, with limpets from the Bristol Channel occasionally containing 80 ppm of cadmium. He accepts too that pollution control technology is not always very effective. In the cement industry for instance, "Electrostatic precipitators can be designed to give 99.5% efficiency in stopping fine dust, but such devices do not give their full design performance throughout the year, and even when they do, the residual 0.5% can represent a large tonnage of dust, much of which falls in the immediate neighbourhood."

He also admits that DDT could affect photosynthesis in plankton floating on the surface layers of the sea which if it were so "would obviously be a major threat both to oceanic ecosystems and to global oxygen and carbon cycles." But then he states that the solubility of DDT in water, "is so low that the concentrations needed for such an effect are most unlikely to be attained." Clearly he has not read the SCEP report very carefully for it shows that DDT is about ten thousand times more soluble in oil than it is in water — which is very worrying indeed in view of the ever greater levels of oil pollution that our seas are subjected to.

More serious than this is his astonishing statement that there are no substances that in themselves are pollutants and that it depends entirely where they are deposited. This is true in the case of the natural substances, those that can be recycled into living systems but is clearly not true of synthetic organics or 'xenobiotic' substances as Professor Kuenen refers to them, of which living systems on this planet have had no evolutionary experience and into which they cannot be recycled. These are pollutants *wherever they might be deposited.*

He admits that, "there remains a suspicion that such substances might have unforeseen effects on living creatures over longer periods of exposure than we can possibly test for", but that is as far as he goes. He refuses to face the real implications of releasing such substances in ever greater quantities into the natural environment.

Still more serious is his refusal to face the fact that the increased chemicalisation of our environment is leading to an increased rate of cancer. "Trends in cancer provide no evidence of an upsurge that might be related to the increase in the amount and diversity of chemicals emitted to the environment over the past fifty years." It is true there has been a fall in the incidence of cancer of the cervix and of the stomach, as industrialisation has proceeded, but this has been more than compensated for by the increase in breast cancer, cancer of the colon and cancers of the respiratory tract. Indeed, the total incidence of cancers is increasing at more than two per cent per annum. He makes further efforts to under play the contribution of man's industrial activities to the present pollution problems by pointing to the natural poisons that were present in our environment long before industrialisation occurred. Rhubarb is rich in oxalates, cassava contains cyanide. How often have we heard this refrain. This argument of course does not take into account the fact that traditional societies learn how to deal with the poisons with which they have co-evolved, their dietary patterns reflect this learning process.

The pollution problem as a whole he views optimistically and informs us that serious studies on the subject such as the SCEP report are equally optimistic. This again is an error of fact. I quote the conclusion of the celebrated SCEP report. "The risk is very great that we shall overshoot in our environmental demands (as some ecologists claim we have already done), leading to cumulative collapse of our civilisation. It seems obvious that before the end of the century we must accomplish basic changes in our relations with ourselves and with nature. If this is to be done, we must begin now. A change system with a time lag of ten years can be disastrously ineffectual in a growth system that doubles in less than fifteen years." It is difficult to see how this can be regarded as optimistic. Not surprisingly it is only

"popular" studies such as *The Limits to Growth* and Paul Ehrlich's *Population and Resource Environment* that he takes to be pessimistic.

On what considerations, we might ask, does he base his optimism? On precious little. It is in fact largely wishful thinking. He admits that the accumulation of CO_2 in the atmosphere for instance, is likely to cause climatic changes but these he does not consider will be all that serious. Why not? He does not tell us.

In general he considers that pollution levels are falling rather than rising. The two exceptions being nitrates in fresh water and PCB residues in birds. Again this is simply not true. As I have shown in my essay, claims that pollution levels are falling in this country are totally misleading. The myth can only be maintained by applying the wrong criteria, judging air pollution in our cities in terms of the smoke released there; judging river pollution in terms of B.O.D.; judging SO_2 pollution on a purely local basis without taking into account the damage it is doing in the areas to which we are exporting it. In general he grossly over estimates the effectiveness of pollution controls. Thus he states that PCBs are now used in such a way that they do very little harm. We know that Monsento only sells PCBs to people who assure them that they are being used in closed systems but such assurances are quite clearly false as PCB levels continue to increase in the marine environment.

Dr. Holdgate also shows little concern with storage of high level radioactive wastes. His statement that "there is ample safe storage space" is demonstrably false. Nuclear power stations in this country consign their wastes to Windscale. One of the main arguments used by BNFL, at the Windscale Inquiry, for the extension of their retreatment facilities was that this was urgently required for the purpose of getting rid of high level wastes which were accumulating at Windscale in ever more precarious conditions. This is also the argument being used to find a final resting place for these wastes, from which they cannot leach into the surrounding environment. We know and he knows too that such a place does not exist.

In his chapter on standards and objectives, he enters a somewhat different field that of 'social value judgements'. We find here the establishment scientist's bias against any interpretation of data. Science does not judge the fixing of standards, this he regards as a 'social value judgement'. What is needed, he tells us, is to balance "scientifically determined hazard of a contaminant level, the popular desire for the cleanest possible world, and the cost of attaining it, including the possible restrictions on industry, farming or individual freedom: it is clear that the environmental quality standards inherent in this second approach are not statements about the resilience of environmental systems or targets."

This is only true if 'biological' or 'ecological' resilience are things that can be determined clinically. As I have pointed out in my essay, organisms and ecosystems can be seriously damaged by being exposed to sub-lethal levels of different pollutants though no clinical symptoms may appear, nothing in fact that our scientists can measure very easily in a laboratory. However their health and resilience is so much impaired that they can succumb to environmental challenge which in normal conditions they could easily survive. From this consideration it must follow that all environmental pollution is damaging as is any change that causes the environment to diverge from that to which an organism has been adapted by its evolution. This is not a social value judgement. If science is to consist of anything more than the establishment of naive correlations on the basis of blind and unrelated measurements carried out in the totally artificial conditions of a laboratory, if in fact, it is to be, as its adepts maintain it is, the only serious tool for understanding the world in which we live, then *it is very much a scientific* judgement those that our scientists are accustomed to making.

To conclude, at the Second International Conference on the Environmental Future held in Reykjavik in 1977, Professor Reid Bryson stated that the most serious problem we must face today is not the blindness of politicians but the fact that they are *incapable of obtaining a single clear signal from the scientific community.* The signals are all confused and contradictory. As a result they have not yet really been made aware of the seriousness of the environmental problems that confront us. What then, we might ask, is the signal that emerges from this study? With a few minor reservations, it is that, to use the consecrated jargon, "there is no cause for concern" everything is more or less under control and without making any additional efforts or incurring any further expenditure we should, as usual, be able to muddle through.In view of the truly horrific consequences of the inaction thereby condoned, a more criminally irresponsible signal is difficult to imagine.

Edward Goldsmith

Weatherwise

FOOD; CLIMATE AND MAN edited by Margaret R. Biswas and Asit K. Biswas. John Wiley and Sons, £16.75.

There was a time, and not so long ago, when some northern Europeans believed there was a simple causal link between the indolence they remarked in their colonial subjects and the warm climates in which those subjects had lived for many generations. Since the indolence was produced by the climate nothing could be done to remedy it and so there was no reason why the more active, energetic and intelligent masters should not pay low wages, accord inferior social status to their subjects and generally profit in any way that seemed effective.

Dr. A.K.Biswas reminds us of this in his perceptive essay. He is far too polite to mention that the curious psychology of the colonial European remains alive and well and resident in Southern Africa, but he does make a most interesting point. It is that in rejecting the crude racialism inherent in the equation of performance and climate perhaps we went too far. After all, if you draw two lines on the map of the world parallel to the Equator and each of them one thousand miles from it, you will have marked out a belt inside the tropics

that contains not a single developed country. It does look as though some connection exists, and Dr. Biswas sets out to explore it, with much sensitivity and a profound understanding of life in the tropics.

The symposium that includes his paper has been produced by Biswas and Associates, which seems to consist mainly of the Biswas husband and wife team, with some help from the UN Environment Programme, whose Executive Director, Dr. Mostafa K. Tolba, contributes a foreword. Its purpose is to elaborate some of the physical problems that must be overcome if food production is to increase in those regions where increases are needed most urgently.

Apart from the paper by Dr. Biswas himself I found the most valuable contributions were those by Drs. Kovda and Landsberg. Dr. Kovda, of the Institute of Agrochemistry and Soil Science of the Soviet Academy of Sciences, describes the mechanisms by which soil can deteriorate and, more important, the ways in which deterioration can be prevented or reversed. He cites several examples which add force to his argument as well as providing more detailed information. Even he may underestimate what is possible, though. Several contributors repeat what must now be regarded as the heresy that soil takes tens, or even thousands of years to form. Work in reclaiming china clay waste tips has shown that grass and legumes can be grown directly on pure sand, that vegetables can be grown in micaceous waste with the consistency of putty, and that soil appears very soon. The technology is not complex and fertiliser requirements are very low.

Dr. Landsberg writes about the ways in which local climates can be, and are, modified as a result of human activities. His paper is fascinating and informative, although there has been considerable work, especially in studying the fate of atmospheric pollutants, since it was written.

Certain of the other papers seem very old in the light of modern knowledge. Dr.Pimmental's work on energy budgeting in agriculture, for example, is out of date in several respects, not least of which is the correct interpretation placed on studies of this kind. His statement that mechanical weeding represents a more efficient use of energy than the application of herbicides, and his 1972 figure for world petroleum reserves of about 87 billion litres are both incorrect. Herbicides are more economical in energy terms and the current figure for petroleum reserves is about 120 billion litres and conservative estimates place the figure for total recoverable reserves at around three times that. The point is not that energy cannot be provided for agriculture, but that in some areas efficiencies can be improved. Dr. M. R. Biswas places some emphasis on the production of single cell protein from petroleum. The organism most usually employed is a *Torula* spp. of yeast, incidentally, and not "tortula". This technology has failed to meet its early promise and I suspect it is of little real interest today. Apart from its technical and economic drawbacks it supplies no genuine need. Even when allowance is made for the inevitable fall in protein content when cereal yields are increased, the supply of protein constitutes no especial, isolated problem. It is quite misleading to point out that high-yielding grains must be fortified with protein before they can be fed to pigs. Commercially pigs are fed a protein-enriched diet to stimulate their growth, and protein is added even to traditional cereal grains.

The book might have been edited more carefully. The introduction in which several authors in succession outlined the world food situation in similar terms before reaching the substance of their papers might have been curtailed or eliminated. In some papers the use of English might have been improved. The loss of the terminal "al" from the words "technical" and "hydrological" is irritating as well as ungrammatical and I have a suspicion that those who fail to express themselves lucidly may also fail to think clearly.

Its failings apart, though, and remembering the excellent papers it contains, *Food, Climate and Man* will provide valuable background reading for students of geography, agriculture and, perhaps, economics.

Michael Allaby

The History of a Survivor

NEIGHBOURHOOD SURVIVAL: THE STRUGGLE FOR COVENT GARDEN'S FUTURE, Terry Christensen, Prism Press, £5.95.

Bureaucracy, politicians, local and national government, economics, apathy and parochialism are just some of the pressures which Terry Christensen sees as working against the realisation of a dream which Simon Jenkins once summarised as the "city of villages . . . in which the small-scale flourishes — small-scale capitalism, small-scale politics, local needs locally satisfied". Or, in Christensen's shorthand, *neighbourhood survival.*

The basic theme of the book is perhaps best summarised by a section heading on page 144: "Planning with People rather than for People". Planning, Christensen argues, all too often proceeds from strategic considerations, enshrined in structure plans and the like, to the local level — doing considerable violence to the wishes, needs and rights of those living and working in the areas flagged for redevelopment. Instead, he argues, planning should start from the bottom and proceed upward therefrom, with due caution. Neighbourhoods should plan for their own needs, and the job of the planner would then be to put the pieces together in a way which made sense for the city as a whole.

Covent Garden, the subject of this book, certainly epitomises the mismatch between the perspectives of the developer, the planner and those living and working locally. Covent Garden is also, in terms of urban ecology, a prime example of what might be termed a mature urban ecosystem. As Mike Franks, himself once a Covent Garden planner (but since reformed), pointed out in the *New Ecologist* last year (May/June, p 88), "markets everywhere contain the diversity, complexity, symbiosis, low entropy and high number of species that characterise stable ecosystems". This is not, however, a book about the ecology of Covent Garden.

Christensen is a political scientist, currently based at California State

University, and his book is very much a political scientist's view of the history of the Garden — but readable and interesting for all that. The decision to remove the market to Nine Elms removed the Garden's lynchpin and initiated a battle for the area's future which is still being fought out. Early plans for massive redevelopment were successfully fought off, but the opponents of redevelopment found that preservation entrains its own set of problems, including "gentrification" with all that that implies for the erosion of the original sense of community.

But Covent Garden continues to display an unusual resilience in the face of change. As Christensen puts it, "many central city neighbourhoods combat schemes for redevelopment. All of them have some history, some diversity, some sense of community, but most of them lose. This is an atypical history in urban renewal because it is the history of a survivor".

John Elkington

Natural Values

NATURES PRICE: The Economics of Mother Earth, by W. van Dieren & M.G.W.Hummelinck. Marion Boyars £5.95 (Paperback £3.50)

This, the latest in Marion Boyars Open Forum series, is a curious book, difficult to place and disappointing if, after reading the publisher's blurb and Richard Fitter's foreword, the reader expects to find a radically new approach to the ecological conundrums of our maltreated planet. This is not to say that there is nothing of value in the book but rather that it is extraordinarily uneven, inclined to lose sight of its own theme and uncertain whether it is addressing itself to beginners or to those already familiar with the general drift of the conservationist argument. W. van Dieren is a well known Dutch journalist specialising in nature and the environment and Mr Hummelinck is Chairman of the Dutch World Wildlife Fund; it may be because of this joint authorship that the text swings between stern moralising about the degradation of the natural world and a patronising tone that seems to assume that the value of nature can be measured in terms of its usefulness to man. Here is a passage (about dolphins) that set my teeth on edge: 'There has been much research on how they can help in military operations but not a great deal on *what good they can do for man.*'

The authors take as an example to illustrate their thesis — that nature, like every other resource must be paid for — the island of Terschelling (in the Waldersee north-east of Friesland), describe it as it was until early this century — peaceful, self-sufficient, its hard-working citizens quite comfortably off, by the sound of it a veritable ecological paradise, and explain the reasons for its subsequent decline into a tourist playground, living unwittingly off its environmental capital. This part is intensely interesting and relevant to almost every country in the world, for which country does not believe that its tourist trade is money for jam? or have yet woken to the fact that, as they compete for the favours of the holiday makers from foreign parts, they are killing the goose that laid that irreplaceable golden egg? So far so good, but alas at this point the authors foresake their island for a series of rather arbitrary dissertations on a wide variety of subjects not all of them related to their economic theme or to the island. Some of these chapters sound as though they were meant for a pretty young reader, the definition of ecology, for example, but much else that they cover — the need for genetic diversity, the value of tropical forests and so on, are of course valid areas of concern even if they seem a little out of context in this book. Perhaps these things cannot be repeated too often and one should welcome them. At last in the final chapter the anxious reader is led back to Terschelling to be shown it as it might be in twenty years time if the economic accounting proposed by the authors is adopted.

The book has no index but a bibliography which gives one D. Arthur as the author of *The Ecologist's* most prestigious publication; the Dutch authors may be forgiven this error, but Marion Boyars at least should know that 'A Blueprint for Survival' was written by Edward Goldsmith, Robert Allen and their colleagues on this journal.

Ruth Lumley-Smith

Other Books Received

People of the Lake. Man; his Origins, Nature and Future, Richard Leakey & Roger Lewin. Collins £6.50.

For all those intrigued by the continuing story of man's origins and with the discussion that the whole subject engenders about the nature of our remote forefathers (which rages as hotly today as it did when Darwin put us in our place in the trees), Richard Leakey, son of *the* Leakeys and Roger Lewin of the *New Scientist*, have produced a very readable, well designed and lucidly written book. Part detective story, part voyage of discovery and part theory and argument, all of it is relevant to the world situation today and the future role of modern man in a world where he is indisputably less in harmony with his environment than were his ancestors.

Conservation Coal and CHP. SCRAM 2A Ainslie Place, Edinburgh £3.25p.

SCRAM (Scottish Campaign to Resist Atomic Menace) have presumably produced this Guide to Alternatives to Nuclear Power, in the hope of converting those who still don't believe we can live comfortably without nuclear energy. They focus attention particularly on CHP — Combined Heat and Power — which is another way of saying conservation, and they point out that current methods of energy consumption in British homes and factories are wasteful and that the overall total could be enormously reduced by the adoption of sensible insulation and conservation. This, basically, is what the D o E is saying everytime it puts one of its 'Save Energy' ads on the telly. The ads may be banal and simplistic, but they appear for free in millions of cosy living rooms, where they reach a near captive audience. If those viewers haven't got the message yet, will they get it from SCRAM's guide? The question is valid because this publication is very *simple*. It is produced on poster sized paper, folded like a tabloid, uses large type with easy-to-follow illustrations and strip cartoons, and seems therefore to be aimed at much the same public as the telly ads. It patently is not written for the serious people who are wrestling with the ethical or philosophical problems of nuclear power.

Letters

A Vocational Point of View

Dear Sirs,

Ken Penney's article in the September Ecologist *mobilises a coherent and powerful attack upon the economics of greed. However, there is one crucial point which in this, as in many similar statements, is left vague.*

He points out that communities such as the Amish and the Hutterites have remained content with lifestyles unchanged over centuries, and dismisses the objection that such communities are only successful because of their high religious scale of values with the suggestion that "it is only a matter of definition whether some values are religious and some are not. Could it not be possible that profit making itself is the religion of materialism?"

It is scarcely disputable that the race for material goods is a religion-substitute; but that leaves unsolved the problem of what substitute the secular stable economy can find for both religion and money-grubbing. Mere contentedness to live in peace with one's neighbours is a pleasant idea on paper, but it ignores the actual dynamics of human psychology.

The late Dr. Ananda Coomaraswamy pointed out in many of his works that all traditional pre-industrial societies had or have a complex metaphysical doctrine of their various crafts [including agriculture]. Each is seen not only as a means of producing material necessities, but as a paradigm of the cosmogonic act; and consequently also as a meditative path. An individual's craft was a vocation in the true sense; an inseparable part of her own being.

The loss of this traditional approach to the crafts is the root cause of all "industrialism", since it is only when the inner meaning of craft has been forgotten that its whole essence can be sacrificed to methods which merely increase its external productive efficiency.

Having seen for myself the level of real motivation and dedication generated by the "path of works" in traditional Madrian-matriarchal communities in this country, I am convinced that a return to a vocational society in the traditional sense is the only workable long-term solution to the psychological and spiritual problems of a post-industrial economy.

Yours faithfully,
Sister Angelina,
Lux Madriana,
Oxford.

Juggling with the Figures

Dear Sirs,

The patronising tone of Peter Jones's "scarcely justifies a rebuttal" reply to my article, coupled with a blithe disregard for facts and an astounding lack of logic, continues to be one of the endearing features of living with the AEA. At the risk of arousing further disapproval may I have the temerity to point out the following:

1. That the CEGB annual figures for electricity generated at their nuclear power stations, are not and never have been the real costs of generation. These figures have, nevertheless, been repeatedly used by the AEA to justify future investments in nuclear power. It is good that Peter Jones recognises the point that I have been making, that they are past costs and cannot be so used. Could he circulate a memo to Sir John Hill and all the AEA staff advising them to be more careful of what they say on this point in future?

2. In order to understand the way in which the CEGB accounting practices were changed in 1976 (which brought a big leap in fuel costs figures) could we, as well as the AEA, be told, what these changes were quantitatively?Could we have the still unpublished breakdown in the fuel cycle costs in the U.K.? Please note that this is a request for information (as we have no freedom of information act) and not an invitation to another rebuttal.

3. Dr. Jones's figures in the South Bank Poly paper I referred to do not *give figures for a R & D waste disposal or decommissioning. Are they hidden somewhere? If so where, and what are their magnitudes? His capital cost of £740 million came* after *the SSEB had announced that the construction cost for the Torness AGR was to be £750 million. Is this an intention to mislead? Not at all. Such massive understatements of the capital cost have been made with all AGRs, and it seems the AEA have not yet broken with this bad tradition.*

4. Dr.Jones tries to explain away my point that a large scale increase in costs was revealed at the Portskewett seminar in February last, when the CEGB figure of 1.8 pence per kilowatt hour was given for AGR generation. It compares with the current CEGB figure of 7.8 pence (1977/8) and Peter Jones's own figure in November 1978 of 1.28 pence. As both the latter figures are for 1977 and the CEGB figure is for 1978/9 there is a large escalation factor which, it is alleged, I conveniently overlooked. Revaluing 1.28 at 1979 prices does not give 1.8, as Dr. Jones seems to believe, but 1.63 pence. A significant difference. My point that a large rise in the cost of electricity from nuclear power is revealed by the 1.8 pence figure. Why try to conceal it?

5. Energy Commission Paper No.6 Coal and Nuclear costs compared *is a travesty. It actually gives figures for nuclear power generation which are less than those for 1977. If its prognostications are in 1977 figures, as Jones contends, then they are comparable with CEGB figures for that year. So what is he on about? The Department of Energy, on this point of future nuclear costs, finds favour with the nuclear industry, but only at the cost of damaging its own reputation.*

Yours faithfully,
Colin Sweet
Polytechnic of the South Bank
London.

A Plea for Alternative Medicine

Dear Sirs,

Many thanks for the reviews of The Politics of Cancer *and* Cancer; Myths and Realities of Cause and Cure. *That an enormous amount of cancer is caused by environmental pollution and especially by chemical-oriented ways of producing food should be understood and investigated in depth by those responsible for cancer research. It would be far more useful to research real lifestyles than to waste resources on laboratory experiments on animals, which have different reactions from human bodies.*

Sadly, the story about Mrs. D. is quite a common one. In spite of the almost hysterical demands by the medical profession to seek their advice, I have lost friends who have done just that, with regard to something which was no more than a slight inconvenience at the time, but who, after being put onto chemotherapy have collapsed and died within weeks.

Although technologically the original barber-chirurgeons have come a long way, there is a marked distrust for much of the chemotherapy practised today. Indeed I understand that a new word has been coined for medicinally induced diseases. As a result many people are turning to alternative medicine which, if it does not always cure, often alleviates conditions and prolongs life — and is very much less likely to induce death. Unfortunately as is usual with a State monopoly — alternative therapies are going to have a hard struggle to continue unless they receive greater support, and the present state of economics in this country will make this increasingly difficult. But central government should recognise that there is a need and a right for people to have a choice in the area of health, and they should be willing to subsidise practitioners of alternative medicine, so that their services can be made available to all, and not only those who can afford them.

If only some of the money ploughed into cancer research during the last decades had been put towards promotion of health, maybe the present situation would not look so depressing.

Please maintain your 'debunking' of what is socially accepted as compulsory behaviour in accordance with conventional wisdom — you are performing a great public service.

Yours faithfully,
Peggy Lejeune,
Warlingham,
Surrey.

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