The Ecologist

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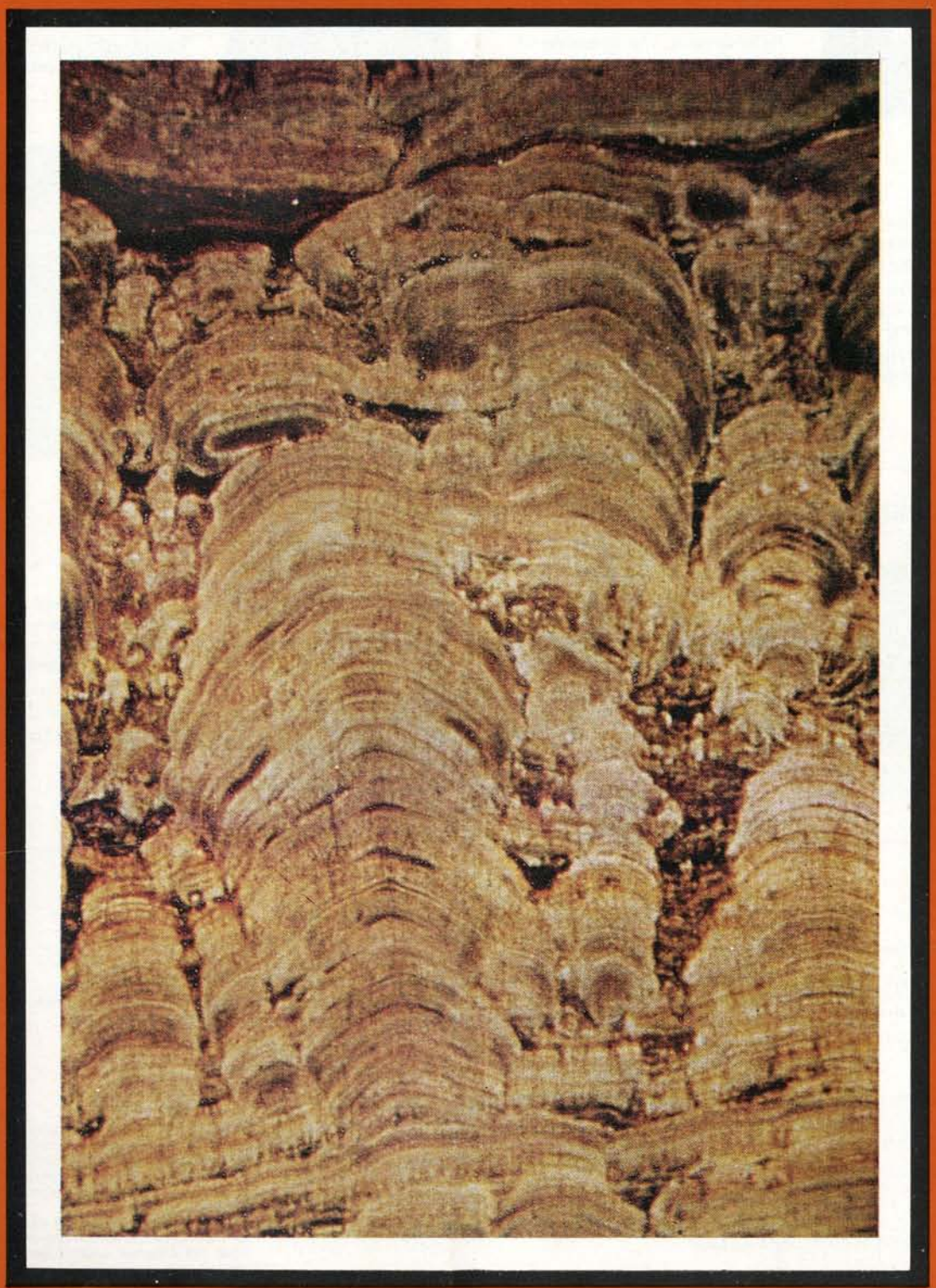

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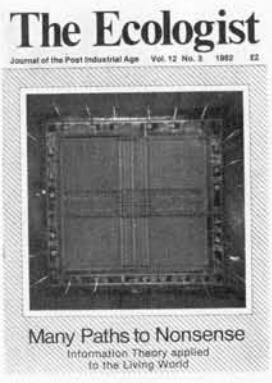

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The Ecologist

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Editorial

Feature Articles

ERRATUM:
See authors details of article A Profounder Ecology in *The Ecologist*, Vol. 13, No. 4. Krishna Chaitanya, is the pen name of K.K. Nair. He was born in Trivandrum Kerala, India in 1918. He obtained an M.A. in English Literature from Madras University in 1939 and has since devoted much time to the study of both science, society and the arts. He has written more than 30 books including a 10-volume History of world literature, a multi-volume History of Indian Painting and a 5-volume Philosophy of Freedom, including the Physics and Chemistry of Freedom (1972), The Biology of Freedom (1975), The Psychology of Freedom (1976), The Sociology of Freedom (1978), and Freedom and Transcendence (1982). He is also arts critic of *The Hindustani Times* and western music and dance critic of *The Times of India*.

Cover Picture: A section through a stromatolite mat. Photograph by Lynn Margulis.

The Gaia Hypothesis and Man's Responsibility to the Earth

In "Gaia: An Ancient View of our Planet" (*The Ecologist* Vol 13, Nos 2 & 3, 1983), Professor J. Donald Hughes gave us the classical view of Gaia—the Earth Goddess—and how man felt that there was an earth deity governing the planet's fertility and productivity. Respect Gaia and her domain and you would be rewarded by bounteous harvests and a benign climate. Maltreat her, for instance by cutting down her forests, and she would unleash floods that would wash away precious topsoil and leave crops withering in ensuing periods of drought. The Greeks were not alone in their view of the world, many different tribes and civilizations having deities that corresponded in some fashion to Gaia. From our present day analytical point of view it would seem that ancient man invented his Gods so as to provide a paradigm of existence, a framework in which he could live in continuing harmony with his environment.

New Gods have emerged—the Gods of Rationality and of Science—and they have banished the animate from the inanimate, with the result that man no longer considers nature a Goddess to be appeased, but rather a subject to be conquered and exploited for his own selfish aims. The logic of man's self-centred rationalism is that the earth is entirely for his use and should he see fit to eradicate what in his judgement are pests or useless creatures, who is to gainsay him? On the contrary, international agencies, including those of the United Nations such as the World Health Organisation and the Food and Agriculture Organisation, pit their considerable resources into none other than trying to achieve man's victory over his supposed natural enemies. And when efforts are made to keep intact a few areas of wilderness, the justification for such 'altruism' is based increasingly on the pragmatic notion that one day we may need the gene pool of wild species for genetic manipulation so that we can create something better than nature managed after a few billion years of effort. But if pragmatism is the excuse—the rationalisation for setting aside wildernesses—I would suggest that the real motivation is based on a deep-rooted sentiment that we are part of nature, not above it, and that our own preservation will be assured not by destroying the last vestige of the wild and replacing it with our own artefacts, but by trying to reintegrate with nature: hence the attraction of the 'biological' approach to agriculture rather than of the bleak, weed- and pest-free horizons of agribusiness.

What therefore can be more exciting than the new version of Gaia which postulates that living organisms cooperate, albeit unconsciously, in creating life-supporting conditions on our planet? Indeed, according to Dorion Sagan and Lynn Margulis, writing in this *Ecologist*, climatic conditions and the surface temperature of the Earth have been kept within tolerable limits by the activities of living organisms, the corollary being that without such activities the earth would soon become as inhospitable to life as either Venus or Mars. Indeed solar luminosity has been increasing steadily since life arose on earth, and one would have expected a corresponding rise in the earth's surface temperature if no counteracting mechanism existed. Equally important, the earth's atmospheric gases are far from their chemical equilibria, there being large quantities of gases in a chemically reduced state in the presence of large concentrations of oxygen. That fact was one which set James Lovelock, the originator of the Gaia hypothesis, into thinking that the atmosphere might be finely controlled with regard to its composition by the activities of the sum of living organisms.

Lynn Margulis's contribution to the theory has come from the extraordinary discovery that stromatolitic rocks, some of them billions of years old, are actually the fossilised remains of aggregates of bacteria which laid down layers of sediment to build up a seeming rock-like structure. Margulis has found comparable structures, some of them hundreds of miles long, still living, and still laying down sediment. The very age of the older stromatolitic structures suggests an origin close to the origin of life. Moreover the biochemical complexity of the bacteria involved, with their cellular mechanisms for respiration, photosynthesis and for reproducing comparable to those found in the cells of today's higher organisms, suggests that the major components of living organisms evolved long ago. As Margulis points out, higher plants and animals, are really

comprised of an interlinking, highly cooperating and organised set of bacterial components. The conclusion therefore is that the conditions for life to flourish and to radiate into its myriad of different forms were created through the biological activities of bacteria existing comparatively soon after the formation of the earth.

By the same token, just as those early organisms coped with conditions on earth that were far from those established today, the suggestion is that they would cope again should man destroy the conditions vital to the survival of higher organisms, including himself. In their article Sagan and Margulis go so far as to suggest that econuts have grossly exaggerated the dangers to the planet brought about by man's polluting activities. They point out ironically that oxygen itself was a waste product of bacterial activity. Yet they themselves would probably agree that oxygen is kept at precise concentrations in the atmosphere because it is part of the homeorrhetic regulatory system. While it may once have been a pollutant, it is certainly one no longer. Perhaps, by some miracle of biochemical ingenuity, dioxin and plutonium will also become in time important components of the Gaia regulatory system, fuelling some organism that makes a contribution to the whole, but whether man will be that organism stretches our credulity: furthermore I am sceptical that by some heroic action on behalf of Gaia man will deflect and destroy asteroids, or will turn lifeless planets into havens of his own making.

The point is we are grappling only crudely with our surroundings, missing out almost completely on the intricate complexity that governs the balances of nature. Modern man is a major perturbation to the system, akin to the impact of an asteroid or a succession of Krakatoas, and none of us can be sure that he will not, one day, push the system too far, and trigger an all embracing catastrophe, at least for himself.

But if Gaia has a consciousness it is through man, and Lovelock with his colleagues, has therefore made an invaluable contribution by re-affirming the nature of our planet as a wonderfully equisite miracle of evolution in which harmonious balances have been achieved, contrary almost to reason. Gaia too has immense consequences for Neo-Darwinism and its reductionist selfish gene approach. No longer is the importance of the individual paramount, as enshrined in neo-Darwinism, but instead the community of living organisms, each balancing out the effects of the other and contributing to a stable ecosystem—from the outer limits of the atmosphere to the bottom of the ocean.

Indeed, the Gaia hypothesis is bound to have mystical consequences, just as much as quantum theory at the other extreme of nature. That new awareness, however dim, must be welcomed, especially if it deflects modern man from his single minded fight against nature.

Peter Bunyard

The Gaian Perspective of Ecology

by Dorion Sagan and Lynn Margulis

The gaia hypothesis is a theory of the atmosphere and surface sediments of the planet Earth taken as a whole. It states that the temperature and composition of the Earth's atmosphere are actively regulated by the sum of life on the planet—the biota. That regulation of the Earth's surface with consequent benefit for the biota has been going on since the earliest appearance of widespread life; thus for at least three billion (10^9) years. Moreover the gaian view of the atmosphere is a radical departure from the former scientific concept that life on Earth is surrounded by and adapts to an essentially static environment. It holds important implications not only for understanding life's past but also for engineering its future.

The gaia hypothesis has become of increasing interest to people of many different disciplines and is likely to provide the foundation for a new ecology. Already it is, in some circles, providing a rich new world-view. What then is the scientific basis for the hypothesis and what are some of its more controversial social implications? First expounded in its modern form by the atmospheric chemist James Lovelock, with supporting biological evidence from microbiologist Lynn Margulis, it was given its name Gaia by the novelist William Golding, author of *Lord of the Flies*, when asked by his friend Lovelock for suggestions. (See *Ecologist* Vol 13, No 2/3, p. 57).

In principle the gaia hypothesis states that both the composition of all the reactive gases as well as the temperature of the lower atmosphere have remained relatively constant over aeons in spite of many external perturbations. What is particularly interesting is that the constancy of chemical composition has been maintained despite the gases being far from their chemical equilibria. Therefore the theory suggests that life to a great extent makes its own environment. Indeed life reacts dynamically to global and cosmic crises such as increasing radiation from the sun or the appearance for the first time of oxygen in the atmosphere, either adapting itself to survive the crisis, which is the classical, Darwinian view of the biota's relationship with its environment, or through its own biological activity actually counteracting the crisis. Both scientifically and philosophically the gaia hypothesis provides a clear and important theoretical window for a 'new look at life on Earth'.[1]

With regard to temperature astronomers generally agree that the total luminosity of the sun has increased during the past four billion years; and therefore they would have expected the mean temperature of the surface of the Earth to have risen correspondingly. Yet evidence from the fossil record indicates that the

Earth's temperature has remained relatively stable. The gaia hypothesis states that such stability is a consequence of life on its surface. With a simple model based on cybernetic concepts relating to the growth, behaviour and diversity of populations, Lovelock has shown how, in principle, the intrinsic properties of life lead to active regulation of the Earth's surface temperature. To make this point, Lovelock considered a mythical world containing nothing living other than daisies and came to the conclusion that it is theoretically possible for the biota to exert control over such potent factors as increased luminosity of the sun. In his model no unknown conscious forces need be invoked; instead temperature regulation is a consequence of well-established properties of life.

Modulation of Atmospheric Chemistry

Atmospheric regulation can be attributed to the combined metabolic and growth activities of organisms, especially microorganisms with their capabilities of transforming the nitrogen, sulphur and carbon-containing gases of the atmosphere.[2] Prior to Lovelock's daisy model it was suggested that whatever controlled atmospheric methane concentration[3] would provide a mechanism by which the stability of atmospheric temperature could be maintained. In addition J. Shukla and his colleague Y. Mintz showed in a quantative model that evapotranspiration from forests determined the concentration of water vapour in the atmosphere and thus certain corelated climatic features.[4] Although those meteorologists did not discuss their work in a gaian context they inadvertently provided another gaian example. Indeed many observations concerning the effects of the biota in maintaining the environment can be reinterpreted in a gaian context.[5]

How indeed can the gas composition and temperature of the atmosphere be actively regulated by organisms? Although willing to believe that atmospheric methane is biogenic and evapotranspiration moves enormous quantities of water from the soil through trees into the atmosphere, several critics have rejected the gaia hypothesis as such because they fail to see how the temperature and gas composition of an entire planetary surface could be regulated for several billion years by an evolving biota that lacks foresight or planning of any kind.[6]

In response to such critics Lovelock has now formulated a general model of temperature modulation by the biota, somewhat light-heartedly referred to as 'Daisy World'. Daisy World uses surface temperature rather than gas composition to demonstrate the possible kinds of regulating mechanisms that are consistent with how populations of organisms behave. The Daisy World example goes straight to the heart of the gaian concept, being based as it is on an analogy between cybernetic systems and the growth properties of organisms. In an admittedly simplified fashion it shows that temperature regulation can emerge as a logical consequence of well-known properties of life: potential for exponential growth, and growth rates varying with temperature such that the highest rate occurs at the optimal temperature for each population, decreasing either side of the optimum until growth is limited by extreme upper and lower temperatures.

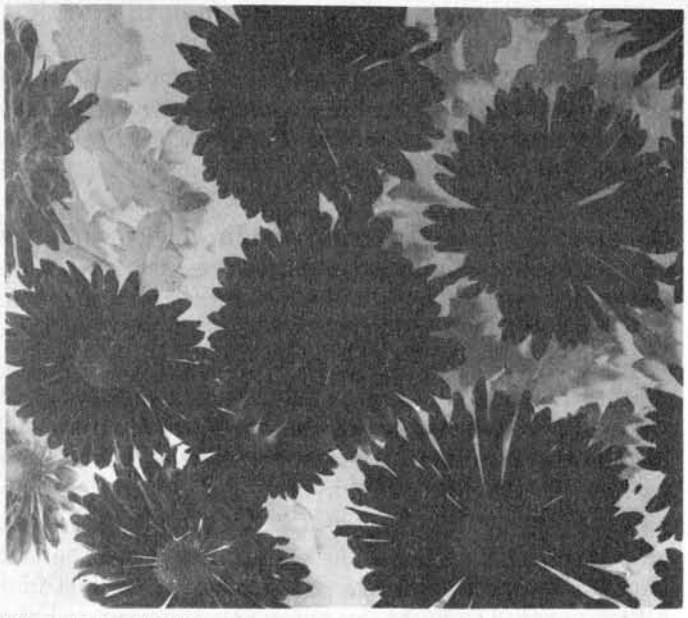
Without question some model is required to explain the regulation of surface temperature while taking into account several observations. For instance the oldest unmetamorphosed rocks both from the Swaziland System of southern Africa[7] and the Warrawoona Formation of Western Australia[8] contain evidence of early life. Both sedimentary sequences are over three billion years old. From three billion years ago until the present we have a continuous record of life on Earth implying that the mean surface temperature has neither reached the boiling nor the freezing point of water. Given that an ice age involves less than a 10°C drop in mean mid-latitude temperature and that even ice ages are relatively rare in the fossil record, the temperature at the surface of the Earth probably has stayed well within 5 and 25°C during at least the last three billion years. Solar luminosity during the last four billion years is thought, by many astronomers, to have increased by at least ten per cent.[9] Thus the Earth (or more accurately life in its gaian context) seems to have acted as a global thermostat. Any current estimate for the increase of solar luminosity, which varies from less than 30 to more than 70 per cent,[9] does not alter the outcome of Daisy World's conclusions. A relative increase of solar luminosity from values of 0.6 to 2.2 (its present value is 1.0) is consistent with Daisy World assumptions since a range of values is plotted.

Cybernetic systems are 'steered'. They actively maintain specified variables constant in spite of perturbing influences. Such systems are said to be homeostatic if their variables (such as temperature, direction travelled, pressure, light intensity and so forth) are regulated around a fixed set point. Examples of such set points might be 22°C for a room thermostat or 40 per cent relative humidity for a room humidifier. If the set point itself is not constant but changes with time it is called an operating point. Systems with operating points rather than set points are said to be homeorrhetic rather than homeostatic. Gaian regulatory systems, like the embryological ones described by C.D. Waddington[10] are more properly referred to as homeorrhetic, as opposed to homeostatic.

Even minimal cybernetic systems have certain defining properties: a sensor, an input, a gain (the amount of amplification in the system) and an output. In order to achieve stability the output is compared with the set or operating points such that errors are corrected. Error correction means that the output must in some way feed back to the sensor such that the new input can compensate for the change in output. Positive or negative feedback, usually both, are involved in error correction. In a first attempt to apply such a cybernetic analysis to the gaia hypothesis Lovelock[11] first by himself and later with Andrew Watson[12] of the Marine Biological Association at Plymouth came up with the Daisy World mathematical model.

Daisy World Model

The Daisy World model is used to demonstrate how planetary surface temperature might be modulated. It



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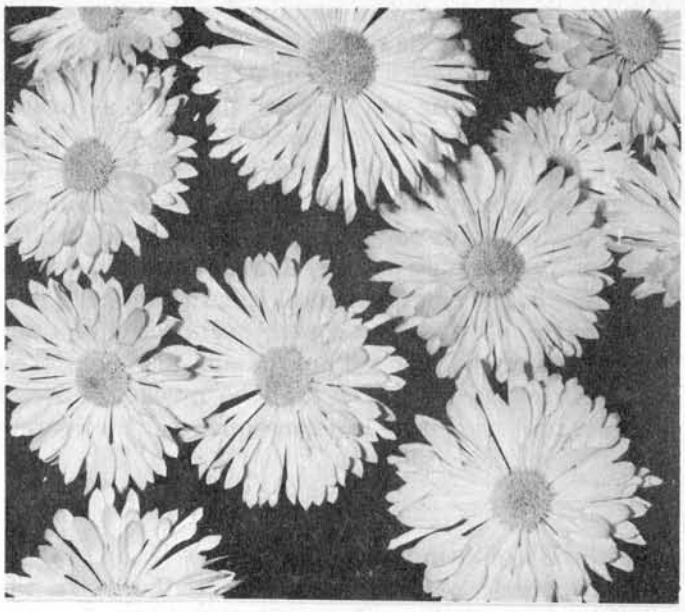


Fig. 1 Daisy World

makes simple assumptions: a polymorphic population only of dark and light 'daisies', and that those organisms always breed true and asexually for whatever albedo value they have. Totally black daisies (albedo 0) absorb all the light and totally white daisies reflect all the light, giving them an albedo of 1.0. An albedo of 0.4 means that 40 per cent of the light is reflected and 60 per cent is absorbed by the organism. It is further assumed that solar luminosity is increasing as a function of time from 0.6 of its current value to about twice that. Temperature optima for both dark and light daisies are considered to be the same: no growth below 5°, increasing growth as a function of temperature to an optimum at 20°C and decreasing growth rate above the optimum to 40°C at which temperature all growth ceases.

At lower temperatures darker daisies are assumed to absorb more heat, and thus grow more rapidly in their local area than lighter daisies. At higher temperatures lighter daisies reflect and thus lose more heat leading to a greater rate of growth in their local area. Now let us look at some graphs. For the mathematically uncomfortable it will be enough to skim the numbers and go directly to the conclusions.

For each of the graphs it is assumed that the total surface area available for growth is constant; and hence that 'fertile ground' can be only up to 70 per cent of the surface area of the planet. The albedo of the ground is arbitrarily taken as constant and equal to 0.5. The extent of barren ground is taken to be the total minus the land colonised by black and white daisies: $G=1-(L+D)$, where L is the area covered by 'light daisies' and D is the area covered by 'dark daisies'. For purposes of discussion it is assumed that since the daisies differ in reflective properties as they grow to cover more ground, the local temperature of a stand of dark daisies is somewhat higher than the mean temperature of the planet. Dark daisies reach their greatest areal extent at lower temperatures (curves labelled D). The lighter daisies generate temperatures locally that are somewhat lower than the mean. Hence they grow most rapidly and reach their greatest areal extent at higher mean temperatures (curves labelled L).

The local temperatures are used in two standard growth equations:

$$dL/dt = L(xB_1 - o)$$
$$dD/dt = D(x12 - o)$$

Where L and D are the areas covered by dark and white daisies respectively, x is the fertile ground not covered by either type and o are the growth and death rates respectively. The temperature dependence of the growth rates is assumed to be parabolic:

$$B = aT^2 + bT + c$$
$$B = 0.003265T_1^2 + 0.1469T_1 - 0.6531$$

which is zero when the local temperature is 0°C and has a maximum value of 1.0 when the temperature is $T_1 = 17.5$°C. The mean temperature of the planet Tm, is found by equating the absorbed and emitted radiation:

$$(Tm + 273)^4 = SL(1 - A)$$

where S is a constant, L is the luminosity of the sun at the time and A is the spherical albedo of the planet. The planet's albedo is determined by

$$A = (XA_g + LA + DA_1 + DA_d)/X + D + L$$

where A_g is the albedo of the bare ground and A_1 and A_d are the albedos of ground covered by light and dark daisies respectively. At steady state it is assumed only a maximum of 70 per cent ground can be covered with daisies.

Only four examples of graphs generated by the model are shown although the results of many more are summarised. The differences between Figs. 2-5 involve changes only in the value of the albedos for light and dark daisies. Fig. 1 shows the daisies. Fig. 2 shows when the 'dark' and 'light' daisies have the same albedo as each other and as ground. In that instance the albedo of the planet remains constant at 0.5 and the mean temperature of the Earth increases steadily as a direct function of solar luminosity. As is known for many eukaryotic organisms (those with nucleated cells) and assumed for the daisies in Daisy World, growth is a simple function of temperature appearing above 5°C and ceasing above 40°C. The maximum growth rate is in the twenties of degrees centigrade. In Fig. 3 the light daisies are assumed to have an albedo of 0.6 and the dark daisies of 0.4. Under those conditions, in which there is a difference between daisies and ground, the tendency to homeostasis is seen: at low temperatures the dark daisies absorb heat and grow faster locally (curve labelled 'Dark'). The light daisies, which lose heat locally and reach greater population densities at higher temperatures, begin their most rapid growth later at higher solar luminosities (curve labelled 'Light'). Both the temperature and albedo of Daisy World are affected: the temperature remains nearly constant between 0.8 and 1.2 solar luminosities. Furthermore a greater population density of organisms, represented by the areas under light and dark curves, is achieved than when the assumptions used to generate Fig. 2 are made.

In Fig. 3 the albedo value of the light daisies is taken as 0.7 and that of dark ones as 0.3. In Fig. 4 the albedo value of the light daisies is taken as 0.8 and of the dark ones as 0.2. The amount of regulation extends over relatively greater ranges of solar luminosities in each case. The temperature of a world without organisms is shown by the dashed line. At low solar luminosities the dark daisies heat up more rapidly and grow more quickly; they all die out when local temperatures reach their maximum. Light daisies show a greater maximum just before succumbing to high temperatures. At this point the temperature returns to the value it would have if there were no organisms. For a value of light daisies taken at 0.9 and dark at 0.1 the regulation of planetary temperature goes beyond 2.2 times solar luminosity. This is consistent with the observation that the greater the difference between the albedos of the two populations of organisms, the greater the tendency toward homeostasis. Models that permit only one type of organisms (light or dark) lead to some temperature regulation as long as the albedo of the organisms differs from ground. In the case of only one type, however, the total population size that is developed is smaller than when two types are represented.

We have been at some length to discuss Daisy World because it is rather remarkable to see that the amplification properties of exponential growth under changing temperatures are enough in themselves to provide the beginning of a mechanism for global thermal homeorrhesis. In general an increase in diversity (the presence of both types of daisies and a greater difference between albedos of the organisms) leads to an in-

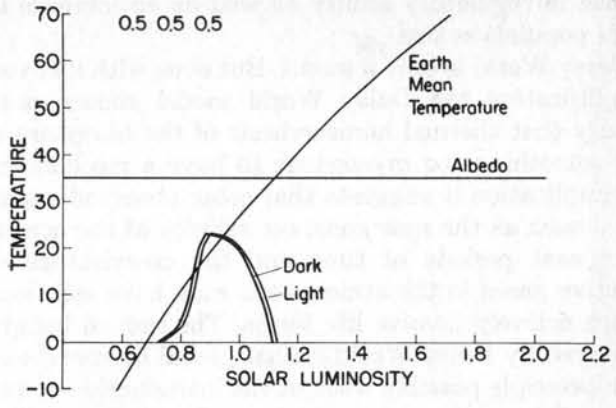


Fig. 2

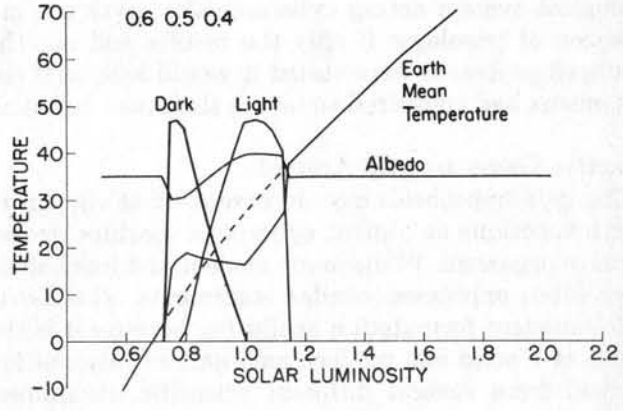


Fig. 3

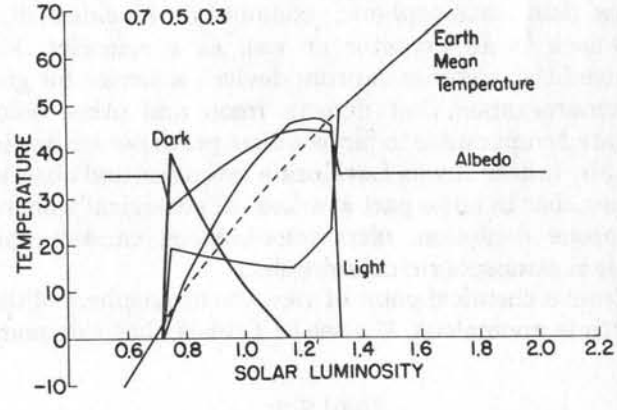


Fig. 4

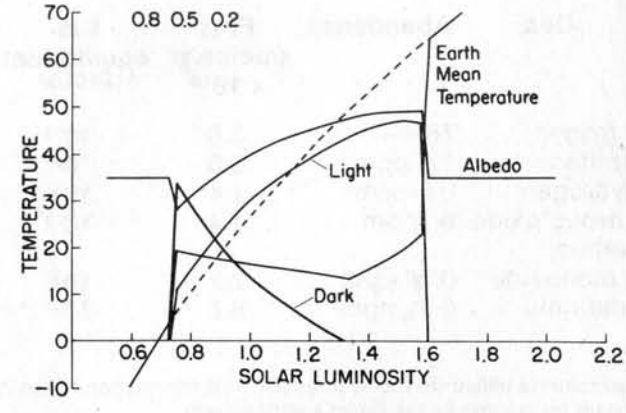


Fig. 5

crease in regulatory ability as well as an increase in total population size.

Daisy World is only a model. But even with its oversimplification the Daisy World model shows quite clearly that thermal homeorrhesis of the biosphere is not something too mysterious to have a mechanism. By implication it suggests that other observed anomalies, such as the near constant salinity of the oceans over vast periods of time and the co-existence of reactive gases in the atmosphere, may have solutions which actively involve life forms. The radical insight delivered by Daisy World is that global homeorrhesis is in principle possible without the introduction of any but well known tenets of biology. The gaian system does not have to plan in advance or be foresighted in any way in order to show homeorrhetic tendencies. A biological system acting cybernetically gives the impression of teleology; if only the results and not the feedback processes were stated it would look as if the organisms had conspired to insure their own survival.

Reactive Gases are still Around

The gaia hypothesis says in essence that the entire Earth functions as a giant cybernetic machine or responsive organism. While many ancient and folk beliefs have often expressed similar sentiments, Jim Lovelock's modern formulation is alluring because it is the result of a solid and modern amalgam of information derived from several different scientific disciplines. Perhaps the strongest single body of evidence for Gaia comes not from the evidence of thermal regulation which is modelled in Daisy World but from Lovelock's own field, atmospheric chemistry. (Incidentally, Lovelock is an inventor as well as a scientist. He devised the 'electron capture device', a sensor for gas chromatographs that detects freon and other halogenated compounds in far less than parts per million in the air. Indeed it was Lovelock's invention and observations that in large part sparked off ecological worries of ozone depletion, ultraviolet-induced cancers and general atmospheric catastrophe.)

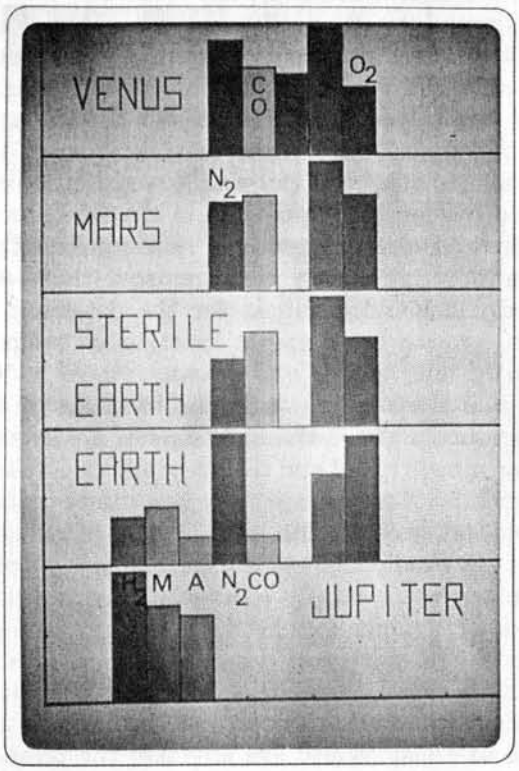
From a chemical point of view the atmosphere of the Earth is anomalous. We see in Table 1 that the quantity not only of major gases such as nitrogen but also of minor gases such as methane, ammonia and carbon dioxide are present at levels many orders of magnitude greater than they should be on a planet with 20 per cent free oxygen in its atmosphere. It was that persistent overabundance of reduced gases in an oxidising atmosphere that initially convinced Lovelock that it was not necessary for the Viking spacecraft to go to Mars to see if life was there. One could tell simply from the Martian atmosphere, an atmosphere consistent with the dicta of equilibrium chemistry, that life did not exist there.[13] The Earth's atmosphere, in fact, is not at all what one would expect from a simple interpolation of the atmospheres of Mars and Venus. Mars and Venus have mostly carbon dioxide in their atmosphere and nearly no free oxygen, while on Earth the major atmospheric component is nitrogen with oxygen comprising a good fifth of the air.

TABLE 1:
Gas Composition and Relative Disequilibrium of the Earth's Atmosphere*

Gas	Abundance	Flux (moles/yr x 10^{13})	Dis-equilibrium factor
Nitrogen	78%	3.6	10^{10}
Methane	1.5 ppm	6.0	10^{30}
Hydrogen	0.5 ppm	4.4	10^{30}
Nitrous oxide	0.3ppm	1.4	10^{13}
Carbon monoxide	0.08 ppm	2.7	10^{30}
Ammonia	0.01 ppm	8.8	10^{30}

*Disequilibria based on the assumption that the oxygen forms 20 per cent by volume of the Earth's atmosphere.

Table 2: Comparative Inner Planet Atmospheres



from an original painting by Jim Lovelock.

Table 2 shows a comparison between the Earth's atmosphere with life and that expected without life. A lifeless Earth would be hot, engulfed in carbon dioxide and lacking in breathable oxygen. In a chemically stable system we would expect nitrogen and oxygen to react and form large quantities of poisonous nitrogen oxides as well as the soluble nitrate ion. That gases, unstable in each other's presence, such as oxygen, nitrogen, hydrogen and methane, are maintained on Earth in huge quantities should persuade all rational thinkers to reexamine the scientific *status quo* taught in textbooks of a largely passive atmosphere that just happens, on chemical grounds, to contain violently reactive gases in an appropriate concentration for most of life.

In the gaian theory of the atmosphere, life continually synthesises and removes the gases necessary for

its own survival. Life controls the composition of the reactive atmospheric gases. Mars and Venus, and the hypothetical dead Earth devoid of life, all have chemically stable atmospheres composed of over 95 per cent carbon dioxide. Earth as we live on it, however, has only 0.03 per cent of this stable gas in its atmosphere. The anomaly is largely due to one facet of Gaia's operations, namely the process of photosynthesis. Photosynthesis by bacteria, algae and plants continuously removes carbon dioxide from the air. Some of this gas is incorporated into solid structures such as limestone reefs and eventually animal shells. The bodies of deceased photosynthetic microbes and plants, as well as all other living forms which consume photosynthetic organisms, are buried in soil in the form of organic or reduced carbon. By using solar energy to turn carbon dioxide into calcium carbonates or organic materials, and then dying, plants, photosynthetic bacteria and algae have trapped and buried the once-atmospheric carbon dioxide which geochemists agree was an abundant gas in the Earth's early atmosphere. If not for life, carbon dioxide would be a major gas in our planet's atmosphere even now.

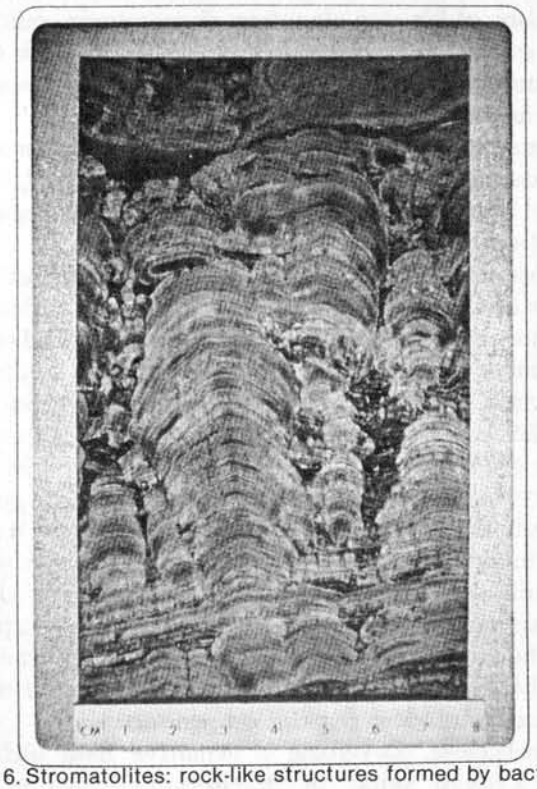


Fig 6. Stromatolites: rock-like structures formed by bacteria.

Microbes and Gaia

Microbes, the first forms of life to evolve, seem in fact to be at the heart of the gaian phenomenon. Photosynthetic bacteria were burying the carbon of carbon dioxide and releasing waste oxygen millions of years before the development of plants and animals. Furthermore methanogens and some sulphur-transforming bacteria, which do not tolerate any free oxygen, have been involved with the gaian regulation of atmospheric gases from the very beginning. From a gaian point of view animals, all of which are covered with and invaded by gas-exchanging microbes, may be simply a convenient way to distribute those microbes more numerously and evenly over the surface of the globe. Animals and even plants come very late on the gaian scene. The earliest communities of organisms that removed atmospheric carbon dioxide on a large scale must have been photosynthetic microbes. In fact we have a direct record of their activities in the form of fossils. These members of the ancient microbial world constructed complex microbial mats, some of which were preserved as stromatolitic structures (Fig. 6). Although such carbon-dioxide removing communities of microorganisms still flourish today, they have been supplemented and camouflaged by larger communities of organisms such as forests and coral reefs.

To maintain temperature and gas composition at livable values, life—and we are still essentially talking about microbial life—reacts to threats in a controlled, seemingly purposeful, manner. We infer that gas composition and temperature must have been stable over long periods of time. For instance if atmospheric oxygen were to decrease only a few percentage points, all animal life dependent on higher concentrations would perish. On the other hand, as Andrew Watson showed, increases in the level of atmospheric oxygen would lead to dangerous forest fires.[3] Small increases of oxygen would lead fires to start even in rain forests hit by lightning. Thus the quantity of oxygen in the atmosphere must have remained relatively constant since the time that air-breathing animals have been living in forests—which has been over 300 million years. Just as bees and termites control the temperature and humidity of the air in their hives and nests, so the biota *somehow* controls the concentration of oxygen and other gases in the Earth's atmosphere.

The Sceptics

It is this *somehow* which worries and infuriates some of the more traditionally Darwinian biologists. The most serious general problem confronting widespread acceptance of the gaia hypothesis is the perceived implications of foreknowledge and planning in Gaia's purported abilities to react to impending crisis and ward off ecological doom. How can the struggling mass of genes inside the cells of organisms at the Earth's surface *know*, ask the sceptical traditionalists, how to regulate macro-conditions like global gas composition and temperature? The molecular biologist W. Ford Doolittle, for example, a man who because of his work is perhaps predisposed toward viewing evolution at smaller rather than larger levels, sees the gaia hypothesis as untenable, a 'motherly' theory of nature without a mechanism.[6] Doolittle, a member of the Department of Biochemistry at Dalhousie University in Nova Scotia, Canada, still does not accept the gaia hypothesis.

Another scientist, the Oxford University evolutionist Richard Dawkins, is even more forceful in his rejection of the theory. Likening it to the 'BBC Theorem' (a perjorative reference to the television documentary notion of nature as wonderful balance and harmony), Dawkins has extreme difficulty in imagining a realistic

situation in which the gaian mechanism for the perpetuation of life as a planetary phenomenon could ever have evolved. Dawkins, author of *The Selfish Gene*, can conceive of the evolution of planetary homeostasis only in relation to 'interplanetary selection': "The Universe would have to be full of dead planets whose homeostatic regulation systems had failed, with, dotted around, a handful of successful, well-regulated planets of which Earth is one."[14]

Those may sound like forceful arguments, yet if the critics of Gaia cannot accept the notion of a planet as an amorphic, but in some sense viable biological entity, they must have equal, if not greater cause to dismiss the origin of life. Surely at one point in the history of the Earth a single homeostatic bacterial cell existed which did not have to struggle with other cells in order to survive, since there were no other cells. The genesis of the first cell can no more be explained from a strict Darwinian standpoint of competition among selfish individuals than can the present regulation of the atmosphere. While the first cell and the present planet may both be correctly seen as individuals, they are equally alone, and as such they both fall outside the province of modern population genetics.

Nonetheless, Lovelock, a sensitive man although with a deep sense of intellectual mischief, has answered his critics with one of their own favourite weapons: mathematical model-making in the form of the aforementioned Daisy World.[15] Not believing that the Earth's temperature and gases can be regulated with machine-like precision for billions of years, because organisms cannot possibly plan ahead, Lovelock's critics reject his personification of the planet into a responsive female entity named Gaia. Originally lacking an explicit mechanism and falling outside the major Darwinian paradigm of selfish individualism, it was and still sometimes is difficult for trained evolutionists to refrain from regarding Gaia as the latest deification of Earth by nature nuts. How can an entangled mass of disjointed struggling microbes, they ask, effect global concert of any kind, let alone to such an extent that we are permitted to think about the Earth as a single organism? The answer, of course, is the kind of analysis explored in Daisy World, and one still waits to see how those who accuse Lovelock of conscious mysticism and pop-ecology will respond to it in all its mathematical intricacy.

In real life, as opposed to Daisy World, microbes play the crucial role in the continual production and control of rare and reactive compounds. They are also responsible, possibly through the production of heat-retaining gases (rather than the albedo of surface organisms), for the ancient thermostasis of the Earth. From an evolutionary point of view microbes are responsible for the establishment of the gaian system. In so far as larger forms of life are essentially a collection of interacting microbes, Gaia may still be thought of as entirely a microbial phenomenon. We, made of microbes, are part of Gaia.

Gaia's Appeal to Environmentalists

There is something fresh, new and yet mythologically appealing about Gaia. A scientific theory of an Earth that in some sense feels and responds is welcome. The gaian blending of organisms and environment into one (e.g. the atmosphere as an extension of the biosphere) is reinvigorating, a modern rationalist formulation of an ancient intuitive sentiment. One implication is that there may be a strong biogeological precedent for the time-honoured political and mystical goal of peaceful coexistence and world unity.

Contrary to possible first impressions, however, the gaia hypothesis, especially in the hands of its innovator, does not protect all the moral sanctions of popular ecology. Lovelock himself is no admirer of most environmentalists. He expresses nothing but disdain for those technological critics he characterises as 'misanthropes' or 'Luddites', people who are "more concerned with destructive action than with constructive thought".[1] He claims: "If by pollution we mean the dumping of waste matter there is indeed ample evidence that pollution is as natural to Gaia as is breathing to ourselves and most other animals."[1] We breathe oxygen, originally and essentially a microbial waste product. Lovelock, who, in fact has been supported in his research for many years by the chemical industry, including Hewlett-Packard, the Manufacturing Chemists' Association (MCA) and other segments of American Industry, believes that biological toxins are in the main more dangerous than technological ones, and he adds in a tone of derision, would probably be sold in health food stores if it were not for their toxicity. Yet there is no clear division between the technological and the biological. In the end all man-made poisons are natural, biological by-products which, though via man, are elements in the gaian system. Similarly, legislation and lobbying attempts, such as the recent furore in the United States over the mismanagement of the Environmental Protection Agency, are nothing more or less than part of gaian feedback cycles.

People as a Part of Gaia

Ecologically speaking, the gaia hypothesis hardly reserves a special place in the pantheon of life for human beings. Recently evolved, and therefore immature in a fundamental gaian sense, human beings have only recently been integrated into the global biological scene. Our relationship with Gaia is still superficial. On the one hand, our ultimate potential as a sort of nervous early warning system for Gaia remains unsurpassed. Deflecting oncoming asteroids into space or spearheading the colonisation by life of other planets represent additions to the gaian repertoire we alone could presently help accomplish. On the other hand, Gaia was a crucial development in history of life's evolutionary past. Only by comprehending the intricacies of Gaia can we hope to discover how the biota has controlled the temperature, the atmospheric composition and other factors around operating points optimal for life for the last two or three billion years. Besides its intrinsic philosophical value, the full scientific exploration of gaian control mechanisms is probably the surest single road leading to the successful implementation of self-supporting living habitats in space. If we are ever to engineer large space stations that replenish their own vital supplies, then we must

study the natural technology of Gaia. Still more ambitiously, the terraformation of another planet, for example of Mars, so that it can actually support human beings living out in the open, is a gigantic task and one that becomes thinkable only from the gaian perspective.

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Lynn Margulis has been a professor of biology at Boston University for over 16 years. She studies the role of bacterial symbioses in the evolution of cells with nuclei (protoctist fungal, plant and animal cells) both in the laboratory and in the field. Her ideas on evolution and symbioses were recently published in book form Symbiosis and Cell Evolution *W.H. Freeman and Co. San Fransisco 1981 and* Early Life *Jones and Bartlett Publishing Co. Boston 1981. She has published a guide to* The Diversity of Life on Earth *with K.V. Schwartz in* Five Kingdoms *W.H. Freeman and Co. 1982. She is a member of the U.S. National Academy of Sciences and is now putting together a comprehensive reference to the nucleated microorganisms,* Handbook of Protoctista *(to be published by Jones and Bartlett in 1984).*

Water and the Flow of Power

by Donald Worster

The oriental despotism of hydraulic societies of the past arose because of the need for a technocracy to create and maintain the mighty irrigation projects on which such societies had come to depend. Today, sociologists still believe that man must have dominion over nature in order to achieve the necessary affluence that is a pre-requisite for democratic freedom. Using the taming of the Colorado River as an example the author argues that, on the contrary, democracy and control over nature are irreconcilable contradictions.

"Water taken in moderation cannot hurt anyone."
—Mark Twain

My subject is water and deserts. It is also power and domination. I want to use the desert environment to throw light on one of the oldest of human experiences: the social and political consequences that follow the process of ecological intensification. By that process I mean the effort to derive a greater economic return, or in some cases it may merely be a steady return in the face of resource depletion, from any natural habitat. Throughout history ecological intensification, after a point, has forced societies into innovation; it has brought into play new tools, new techniques, new sources of capital, and new forms of social organization to extract more of nature's wealth. My concern here is what this process of demanding more from the earth and of devising the means to get it does to the structure of power in a society. Water flowing through deserts can illuminate that universal process, I believe, in ways that no other environment can.

I do not mean, however, to posit a single, dogmatic answer to the question of what causes power to accumulate in a society. The ecological approach to that old puzzle offers only one of many plausible solutions, and it is not even to be demonstrated conclusively by any empirical methods. Glimpses of an important truth—that is all I mean to offer. Glimpses of a truth which has been overlooked in the standard analyses of politics, democracy, and technology.

A common assumption, is that a genuinely democratic society can flourish in a world where every desert has been conquered, where the earth is intensely managed on every hand, and where total dominion is the goal of humans in their dealings with nature. But is it really possible? Can democracy in fact thrive under such circumstances, or does it, along with nature, become a victim? Obviously what one means by democracy is important to such an inquiry. I do not take democracy to be merely a matter of elections and parliaments; I have in mind a deeper condition of widely distributed freedom and autonomy, in which communities, along with the individuals in them, retain considerable power to exercise cultural as well as economic and political self-management. Can it be assumed that democracy in this latter sense automatically follows in the wake of technological progress, or that democracy can exist apart from and in spite of the impact technology has on the natural order?

Take the desert then as a case study in the political, moral, and social issues posed by the human ecological situation. Let a river flow through that desert, bringing life to its apparent emptiness. Introduce a group of people intent on wresting a living from the place and see what the desert, the water, and the people do to each other. Beyond a threshhold of modest resource development, I will argue, concentrated forms of power begin to emerge along the banks of the river and to rule over the people. Intensification of use eventually must give rise to potent anti-democratic forces, whatever their guise may be. The only remedy for that outcome, if people dislike it and demand something different, is to reverse the process of intensification, to 'liberate' the river and the desert wherever possible from domination. If I am right about that process, its outcome and its alternative, the desert example may help us understand the relationship between nature and society in the more dense, tangled environments where most of us live.

For a long time now humans have been going to desert landscapes to free their minds from distractions, to sort out confusions, and to confront ultimate questions. There things can be seen with new clarity and force. The sparseness of the desert concentrates the mind. Its scarcity narrows choices and makes them compelling. Consequences become unambiguous and longlasting, like the bare bones of an animal lying preserved in the sand. The desert too is an environ-

ment that naturally provokes and tests theories, for theories are simplifications that work best in simplified places.

One of the most ambitious and influential ecological theories that has emerged from desert history is Karl Wittfogel's idea of hydraulic society. It is essentially a theory of power. The command of water in arid environments, Wittfogel argues, gives rise to new agglomerations of power, or enhances old ones. He was particularly interested in explaining the stagnation, as he viewed it, of the major Asian civilizations over thousands of years. The problem of explaining why those civilizations failed to maintain their lead in social evolution, why they were eclipsed in modern times by the Europeans, first began to be considered in 18th-century England, which was amazed by its own rapidity of change and newly aware of the past grandeur of the Orient; from there the problem of a stagnant Asia passed down to Karl Marx and on to Wittfogel. The answer given by Wittfogel, beginning in the 1920s, was an ecological one: in their struggle for existence in arid environments the Asians, he pointed out, had developed massive, sophisticated systems of irrigation, which in turn had brought into being highly centralized structures of political power governing large but impoverished peasant populations. He called them the "hydraulic societies." The elaborate apparatus of water control, he maintained, and the managerial organization needed to operate it became, after a long period of intensification, a technological and institutional straitjacket preventing radical change. In countries like China, India, Mesopotamia, and Egypt, preserving the irrigation system intact was the first priority. The system was vulnerable to a thousand mishaps; highly regimented control was the price of survival. Wittfogel went on to describe those societies as "despotic" and "totalitarian," even going so far as to explain the modern totalitarianism of the Soviet Union as an "Oriental legacy."[1]

Technological Conquest of Water

Wittfogel's critics over the past several decades have had a field day with his theory, charging that it is too sweeping, ethnocentric, and simplistic; even that it is dead wrong. In many particulars they have been right. Nonetheless, a number of ecologically oriented anthropologists have continued to follow Wittfogel's lead, although in more restrained fashion. So has Lewis Mumford, whose two-volume work, *The Myth of the Machine,* compares the modern military-industrial complex in the United States with the ancient hydraulic societies.[2] Mumford has, in his inimitable way, extracted the most useful and credible argument in Wittfogel's Asian studies and applied it, as Wittfogel would not, to the 20th century and the Occident. That argument, simply put, is that the domination of nature leads inescapably to the domination of some people by others. Or, to translate the argument into the terms of our case study, the technological conquest of a river flowing through a desert transforms those specific individuals doing the conquering into a power elite.

That insight—call it an hypothesis, if you like—was not Wittfogel's alone. He shared it with his associates in the Institute of Social Research, established at Frankfurt, Germany, in 1923. What Wittfogel did was apply the insight to the archaic Asian irrigation regimes—and thereby restrict its use to a single and remote social type in ancient history. The broader and contemporary implications of the idea were left to be developed by others in the Institute, in particular, by the Institute's two leading lights, Max Horkheimer and Theodor Adorno, and later on by Herbert Marcuse. Most of their ideas are well known today: their shock and revulsion at the sudden emergence of Hitler, fascism, and other forms of totalitarianism in civilized cultures; their interest in the Freudian psychology of repression; their critique of mass society; and their rejection of positivistic science. Less appreciated, at least until rather recently, has been the central place nature occupied in their thinking, especially in Horkheimer's. As Martin Jay puts it, the Institute replaced class conflict with "a new motor of history, . . . the larger conflict between man and nature both without and within."[3] In fact, it is accurate, I think, to describe the Institute's work as, *au fond,* the formulation of an ecological theory of history. The focus of that theory is not so much the impact nature has had on society as the transformation humans have worked on themselves through their working on nature. When the age-old struggle for human existence within nature became the modern struggle for human domination over nature, the Frankfurt theory goes, history began a tragic decline into unfreedom and barbarism.

Modern societies, from the 18th century on, the Frankfurt philosophers argued, were devoted to a project of total domination of nature. Although originating in Western Europe, the project had, by the 20th century, become transcultural in scope, having its roots mainly in capitalism and in marketplace thinking. Nevertheless it spread into and deeply affected the socialism of Marx, Lenin, and Mao. Today, in fact, it is the central project of advanced industrial culture wherever found or pursued. It promises a more democratic future for the human species and an expansion of individual freedom. So far the result has been precisely the opposite.

What then is this project of domination? Horkheimer and Adorno understood it to consist of both an intellectual and a technological element. In the first place domination involves "the disenchantment of the world." Nature is to be emptied of all intrinsic meaning and value, all beauty and mystery, to be "degraded to mere material, mere stuff to be dominated, without any other purpose than that of this very domination."[4] Then the disenchanted world, no longer alive but dead, is to be brought under the absolute control of humans through instrumental or technological rationality. Nothing in nature is to elude mastery; nothing that is potentially useful in it must go unused. Thus the project aims to go far beyond giving people a merely adequate means to survive on the earth, for that would entail a fixed list of specific needs to be filled. Domination aims rather at setting up nothing less than a totalitarian government over nature. It seeks to transform the nonhuman environment into a monolithic unity ruled over by rigid, authoritarian

methods. The exercise of that command becomes in the project an end in itself—an end that has no ending, no point of closure, no sense of limits.

Under this project of total domination, the individual's power over the natural environment (power realized in the form of wealth, comfort, and gratification) increases remarkably. But, the Frankfurt circle repeatedly emphasised, some people gain far more power than others. They may be capitalists, scientists and engineers, or bureaucrats presiding over a state agency—they are whoever is directly involved in and responsible for the conquest of nature, intellectually or technologically. As the project progresses, they become more and more indispensable. They control public policy, they constantly devise new technologies to remedy the imperfections of the old, and they hold the threads of life and death in their hands. They come to manage not only nature but human society as well. "The human being," Horkheimer wrote in *The Eclipse of Reason*, "in the process of his emancipation, shares the fate of the rest of his world. Domination of nature involves domination of man."[5]

For people who have lived long in the midst of megalopolis, seldom if ever escaping from its technological envelope, this ecological theory of the Frankfurt philosophers may seem implausible. To be accepted in a more than academic sense, it requires a capacity to see oneself in the mirror of nature and to say spontaneously, "there I am and I am nature." When, however, people are unaccustomed to discerning in that mirror their own face—their own fate—they turn to other explanations. They may indeed feel a loss of autonomy in their lives, they may complain about the "corporations" and the "bureaucracy", may even rage against their personal and community powerlessness. But the ultimate source of the problem appears to rest within society, in social organization, not in the project of environmental domination.

That is why a desert landscape and its history can be peculiarly instructive. We can find there the project revealed in the clearest light around. We still may not see, of course, or may not accept what we see, but the choices confronting us in the desert are harder to overlook: either we must knowingly accept the project and the human consequences it entails, or we must reject it and search for a different relationship with nature.

Imperial Valley

The Colorado River basin in the southwestern United States affords perhaps the best opportunity we have anywhere on the planet for an inquiry into the project of domination in modern history and its social ramifications. Most of the basin is an intensely arid landscape where a little water is appreciated by living creatures like a transfusion of blood by a dying man. Not far from the river, among its many appendages, is Imperial Valley, which has become in the space of less than a century an intensely irrigated environment and the home of an agribusiness complex that exercises an increasingly global reach. Horkheimer, Adorno, and Marcuse all lived for a number of years within a few hours drive of the basin and the valley, apparently without realizing how well that situation illustrated and extended some of their ideas. Karl Wittfogel also came to live on the west coast of America, on the edge of what has become the most elaborate hydraulic society in history, and even more surprisingly than Horkheimer and the rest, he never paid it much attention.[6] We should undertake to remedy that oversight and learn something useful about the ecology of power in that American desert place.

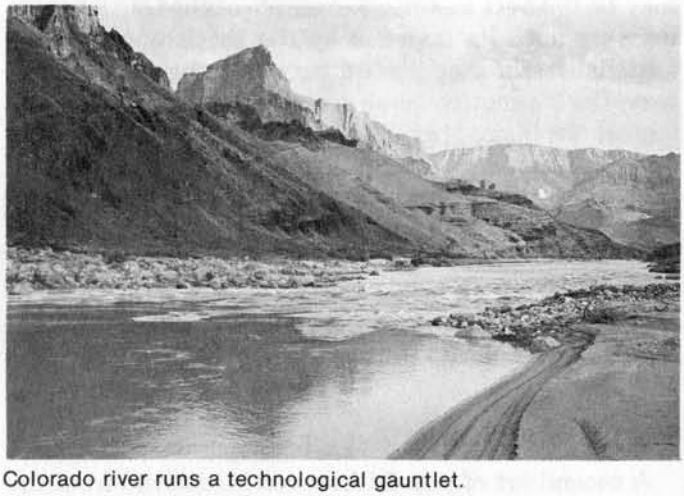
The Colorado was one of the very last major rivers to be discovered and explored by civilization. In 1869, Major John Wesley Powell and nine other men shoved off from Green River, Wyoming, to ride the unknown river through some of the deepest canyons and most dangerous rapids on earth. Three months later two of the original four boats, carrying six of the ten men, pulled in at Grand Wash Cliffs, a hundred miles downstream from the Grand Canyon. Thereafter, Powell went into the federal bureaucracy and gave his best energies to the project of river domination. "All the waters of the arid lands," he predicted, "will eventually be taken from their natural channels."[7] Even the mighty Colorado would be turned out of its course in order to irrigate the desert, redeeming it, transforming it from a condition of waste into a garden of affluence. "The greatest possible development," "total utilization," were phrases he used to describe the project of domination. What he saw in the river were mainly quantities that could be measured and augmented: so many acre-feet of water, waiting to be captured and forced to provide an income, a potential flow of cash and technological power. What he did not acknowledge, or did not care about, was what others have described as the flow of life in that water, the mystery in it that surpasses understanding.

Dams Galore

Today the project of river domination is virtually finished in the Colorado basin. More than thirty dams have been built on the main river and its tributaries. An immense amount of water is steadily pumped out of reservoirs there to support farming on the Great Plains, in central Utah, in Arizona, in southernmost California, and in Mexico; and urban people, swarming into the desert cities of Denver, Las Vegas, Phoenix, Tucson, Mexicali, and Los Angeles, all suck water out of the river too, or expect to do so some day soon. The effect of that intensified use has been devastating for the natural Colorado. For the past twenty years it has not in normal seasons reached the sea. Its lower reaches are now an artificial drainage ditch, dredged and lined, sporadically carrying the heavily saline runoff from lettuce and cotton fields. The Colorado, one recent writer has said, is "a river no more."[8] Nowhere has the disenchantment of nature and the triumph of technological reason been more dramatic and thorough than in this corner of the earth.

All this was more or less in the mind of John Wesley Powell a hundred years ago. What he did not foresee, perhaps could not have foreseen in his time, was the full process of social reorganization required to carry out such domination. Powell naively believed that total domination could be accomplished by small communities of farmers working largely with their own tools and money up and down the river, each community existing largely independent of the others,

each free of outside interference in its affairs: by a series of democratic "commonwealths," as he called them. Instead, the Colorado project has created in the basin, or at least has promoted there, a highly centralized, bureaucratized political order; a technocratic corps of river experts; a set of corporatized agricultural entities with near total dominance over rural affairs; and a class system in which there are sharp disparities of wealth and influence.



Smithsonian

Colorado river runs a technological gauntlet.

Those outcomes are most starkly manifested in Imperial Valley, which lies west of the Colorado River and directly north of the United States-Mexico border. In 1900 this valley was still known as the Colorado Desert. Once an extension of the ocean, it was cut off a few million years ago by the river's delta and then dried up, forming a vast bowl, whose deepest point lay several hundred feet below sea level, a bowl of intense heat and virtually no rain, one of the most formidable environments in North America. The great river ran high up along one edge of the bowl. To bring irrigation water into the valley required simply cutting a notch in that edge and letting the river run downhill. A corporation formed in 1892 to do just that, but it was not until 1901 that the first settlers arrived to begin farming.[9]

According to the most recent tabulations, Imperial now ranks as one of the four richest counties in the United States in total agricultural production. Its average farm is worth well over $1 million. Half the acreage is owned by wealthy non-residents, including several multinational corporations. A few of the long-time resident farmers have begun to throw a large shadow across world food markets; among them is Bud Antle, now incorporated, who has expanded his operation into Africa, growing vegetables there for export to Europe. Yet, along with its rural moguls, Imperial Valley includes many poor inhabitants too. Because a large part of the population (12,000 of them, compared to less than 700 farmers) are seasonal labourers, usually with Hispanic surnames, working on the factory farms, the area has one of the lowest income averages in California.[10]

Command of the Colorado River explains the valley's extraordinary rise from unsettled desert to luxuriant wealth. It also explains in large part the social structure that has evolved in Imperial. Irrigated farming depends on high return-per-acre crops to be profitable. Those crops are typically labour-intensive ones; to get planted and harvested they require a great deal of stooping and picking by an army of hired workers. Crops that are not gathered at exactly the right moment spoil quickly, so the valley's farmers have had a strong incentive (and not a little government sympathy and help) to prevent unionization of those workers. A chain of social consequences, in other words, has followed the project of domination. And it does not stop there.

The total management of a mobile, elusive, dangerous river, carrying millions of tons of silt downstream every year, rising and falling dramatically with melting snow and summer flash floods; the construction and maintenance of a labyrinth of canals and drains; the capitalization of headworks, dams, siphons, and pumping stations—all that obviously could not have been done by ordinary farmers loosely associated in a traditional rural culture. What was needed in Imperial, and what has evolved there, is a complex power centre to do that work. Settlers organized themselves in 1911 into an entity called the Imperial Irrigation District. Ever since then it has performed as a kind of modern business corporation, selling bonds to finance its programme, hiring engineering talent, and welding disparate farmers into a single unified institution. The most recent *Organization Manual* published by the district is a massive document, taking hundreds of pages to trace the lines of authority that run from the Board of Directors (elected by farmers acting as shareholders) through managers, economists, data processors, hydraulic engineers, auditors, and so forth. In his study of the district's political evolution, Ernest Leonard describes it as "a conservative, paternalistic, and self-protective managerial system" that has become immune to the diverse needs in the community. It is effectively run, he writes, by an elite group in the valley, and year after year there is little challenge or alternative to its reign.[11]

The chain of consequences goes on. To intensify their use of the Colorado, farmers in Imperial Valley have been forced to turn to a succession of outside agencies, each one more powerful than the last. In the beginning they relied on several private corporations, including one of the largest railroad empires in the country, the Southern Pacific under E. H. Harriman, for loans, technical assistance, and direction. Without that help, the river, threatening again and again to break through its edge and flood the bowl, would have defeated them.[12] Since the 1920s the valley's farmers have relied on the federal government, specifically the Bureau of Reclamation, the largest irrigation bureaucracy ever assembled in history. BuRec, as it is called, is famous the world over for its ambitious water projects; its slogan, blazoned on report and book covers, is "*total use for greater wealth.*" Today the agency supplies water at very low rates (they are subsidised by taxpayers across the nation) to farmers all over the American West, and in return it asks only for a share of the administrative power. The Imperial grower accepts the federal water, lives better than ever, and becomes a ward of the distant government. If

for some reason, BuRec could no longer effectively control its farflung apparatus, if the ecological problems associated with intensive irrigation became unmanageable, or if the central government began to favour different groups, say, the industrialists in Los Angeles, then the Imperial Irrigation District would be left dry and impoverished. Its own power thus depends on water flowing down from a power higher up.

Who then really dominates society in the American desert environment? There is no simple answer. The power elite in that modern hydraulic society does not rise to a single pyramid point, as Wittfogel found in ancient Egypt. Rather, a number of interlocking hierarchies rule, forming an alliance based on money, class and expertise, one that merges private interests and state authority. Whatever their differences from time to time may be, they are united in the project of environmental domination. Their power, they are aware, stems from their shared role in that domination. Left out of the alliance are those whose contribution is merely to pick a basket of hops or carrots, as are those who merely sit by the river and contemplate its flow from dam to dam. Even those who circle endlessly in their motorboats on the stilled river, enjoying the leisure provided by BuRec recreation planners, are not part of the power structure. They live, as Horkheimer and Adorno have helped us see, "in the world of the administered life."[13]

The Colorado story has many parallels elsewhere, including along the rivers Volga, Zambezi, Nile, and Indus. Though more completely achieved than those other efforts at water control, the Colorado project is not significantly different from them in its purposes. In some places "people's commissars" instead of agribusinessmen may divide the water or direct the farming; or workers rather than a handful of private interests may be said to "own" the land and water with which they work. In some basins the wealth made possible by domination may be better distributed than in others, or the power elite may be more or less benevolent—and those are not trivial differences. But in so far as the democratic qualities of freedom and self-management are concerned, the distinctions from river valley to river valley are increasingly unimportant. Their organization manuals are indistinguishable. In all of them the "administered life" is coming to be the common experience for rivers, deserts, and people alike.

Thousands of tourists gather every year on the crests of Hoover and Glen Canyon Dams, looking down on the governed Colorado River hundreds of feet below, admiring the grandeur of the curving concrete wall on which they stand, talking of the beauty of blue water lapping quietly against brown rock. Down in the bowels of Glen Canyon Dam immense dynamos hum, generating electricity for distant cities, while an electronic toteboard tells the visitor how many dollars are being made from power sales instant by instant. But nowhere in the visitor centres and their rituals of celebration is the question raised: what comes next, now that the project of domination here is complete? There are at least three answers to that question, three possible futures, which have been suggested by scholars and philosophers. I now want to examine each of them.

One set of possibilities for the future of the American hydraulic society emerges from study of its ancient counterparts. Marvin Harris, for instance, following Wittfogel's lead, argues that the old versions went through a long period of social stagnation, during which the power elite remained unchanged in form but was populated by a succession of dynasties. Harris calls this phenomenon the "hydraulic trap." Egypt may be the best historical example of that outcome, at least up until its invasion by the British and French imperialists in the 19th century. In other cases, however, the stagnation came abruptly to an end when ecological problems became unsolveable. Mesopotamia and Mohenjo-Daro are cases in point: silt accumulated in their waterways and salt built up in their fields from intensive irrigation until the effort to maintain their systems became too great a burden, and they let them collapse. There is in both sorts of fate a rather grim lesson to be learned from the archaic desert regimes, one not calculated to amuse or inspire the dam tourists.[14]

The Frankfurt School

A second set of possibilities can be derived from the highly disparate writings of the Frankfurt school. Aside from Wittfogel, they did not address explicitly the subject of water control as a form of domination, nor did they make any specific recommendations about the next stage in the Colorado's history. But they did have much to say about where the human-nature relationship might go, and should go, in the future. They would begin, one and all, with a repudiation of the project of domination, at least for people living in the advanced industrial societies for whom they wrote. What that repudiation would mean in practice, however, is not altogether clear; and it is easier to discern what it would offer for humans than nature. No one in the Frankfurt group was quite willing to give up the economic bounty made possible by domination. What they appear to have wanted was a halt to the project's expansion rather than its deconstruction.

Herbert Marcuse's writings offer the most systematic, coherent vision of a future beyond domination. It is a future in which humans—all humans, not merely those of the privileged classes—are free at last from the burdens of being dominators. Those burdens, Marcuse argues, have been repressive and distorting. Described in the most familiar terms, they are the burdens associated with the traditional work ethic: postponement of gratification, labour without joy, a rigid control of one's libidinal energies in the interest of production and accumulation. At an earlier point in history, Marcuse goes on, when the human condition was one of deprivation, the drive for environmental domination made sense, and its price in psychic distortion simply had to be paid. "Society must first create the material prerequisites of freedom for all its members before it can be a free society," he writes; "it must first *create* the wealth before being able to *distribute* it according to the freely developing needs of the individual." There must be, in other words, a "conquest of scarcity."[15] The crucial issue is knowing when that

conquest has been satisfactorily completed. For Marcuse, the point has long arrived, and it is now time to begin relaxing in the freedom made possible by the conquest. People should henceforth work only at what is truly satisfying to them. They should ease the tight control over their feelings and natural instincts; they should free their minds and bodies from antiquated bourgeois attitudes, remove the dams from their inner rivers and let the pent-up waters flow.

A new human project then should replace domination, the project of rational gratification. It would have, Marcuse maintains, radical political effects, for it would destroy the power elites and lead to a democratization of self-fulfillment. Instead of being driven and manipulated by the discredited elites to keep the assembly lines rolling, men and women would take command of their own lives. But this new project and the democracy it allowed depended, Marcuse insists, on maintaining some technological control over nonhuman nature. It was his belief that automation would be the basis for a fundamental change toward a civilization oriented toward rational gratification. "Complete automation in the realm of necessity would open the dimension of free time as the one in which man's private *and* societal existence would constitute itself. This would be the historical transcendence toward a new civilization."[16] In other words, people would be relieved of all the chores of domination; nature, on the other hand, would be freed only from the pressure to fill an unending list of consumer demands.

What Marcuse failed to realize in his utopian musings was that automation, even for a limited list of "necessities," must require a maintenance crew, along with an organization manual, clockwork regimentation, and a measure of continuing control over those set free to play. How much change then would his utopia require in the existing hydraulic regime along the Colorado River? A precise answer is not easy to come by, for it depends on how much water Marcuse thought we should want to drink—that is to say, how much consumption was assumed in his idea of "vital need." One thing is clear: he was firmly opposed to the practice of "asceticism".

To illustrate the Frankfurt project of democratized gratification (and I think this image applies to Horkheimer and Adorno as much as to Marcuse) we can picture a green oasis, where the date trees are filled with plump fruit, where the senses are filled with the fragrance of spice and wine, where every person is her own master, and where the water drips unceasingly through the automated plumbing. Omar Khayyam joined to Marx and Freud. Marcuse emphatically did not want to live in a desert. He preferred life in an oasis. The Colorado River consequently would still be dammed and siphoned off to provide a basis for his new stage of civilization.[17]

The vision of an oasis appearing out of the desert is an old, old one in history, although in the hands of the Frankfurt philosophers it would assume a radical content. How is it possible, Marcuse asks us, to achieve a reconciliation with nature until after the survival of each of us is assured? And does that mutual survival not require a technological conquest—making the reconciliation ironically the product of domination? It is much easier, he would say, to achieve both social justice and ecological harmony in an oasis than in a desert, in a state of abundance rather than want. There is, however, a persistent uncertainty plaguing that reasoning: can Marcuse deliver what it says he will, a democracy of freedom, self-management, and autonomy? Can a democracy be reliably based, as he would have it, on an appeal to gratification? Always, it seems to me, there must be a flow of power into the hands of those who provide the technological basis for gratification, no matter how strictly it may be limited in material terms. Moreover, it is extremely difficult to locate that point where physical gratification begins to transcend itself, where it becomes the pursuit of spiritual and intellectual pleasure, as Marcuse expected it to become. Who is to say that Las Vegas is not the oasis in which people really want to live?

The mention of America's favourite fun city is a reminder of how far the desert has already been transformed into an oasis of gratification. Las Vegas sits only a few miles from the Colorado River, its brilliant, fantastic neon advertising lit by power from Hoover Dam. Water bubbles out of fountains in an endless stream, though the city is surrounded by an intensely arid region. Its night is abolished by electricity, its heat by air conditioning; food is cheap, work is forgotten. And this city dedicated to the pleasure principle is, as everyone knows, organized and run by powerful crime syndicates, politicians, and the mass entertainment industry. That assuredly is not at all what Marcuse had in mind for his utopia of liberation, for his " 'garden' which can grow while making human beings grow."[18] Yet the distinction between the two oases is not at all easy to draw.

The Utopic Myth

Hedonism has been a notoriously untrustworthy guide in many matters. It has had a way of muddling thought, undermining independence, and betraying its proponents. And that finally is where the Frankfurt philosophers leave us, muddled and too easily betrayed. We must forsake the old bourgeois drive to master and *accumulate*, they tell us; we must now seek to master and *enjoy*. New "projects" take the place of the old ones—"the abolition of toil, the amelioration of the environment, the conquest of disease and decay, the creation of luxury," is the list Marcuse gives—and all of them require considerable manipulation of nature.[19] The earth is supposed to be freed at last from the low coral atolls scattered at sea. In all those deserts life can certainly be found, but it gets along only by learning the virtues of austerity and humility. Despite those constraints, humans have produced some of their finest achievements in the desert: many of its loftiest moral and religious ideals, moving examples of self-sacrifice, noble works of art, strong communal bonds, and extraordinary personal competence. Desert peoples, in contrast to those in oases and irrigated river valleys, have been hard to subdue, as T. E. Lawrence understood some decades back, even by modern forces armed with sophisticated weapons. Can an age that feels itself overly managed neglect then to preserve and cherish its deserts? Are

we well advised to continue taking out the water from our rivers to make more oases and gardens? Is oasis life really so appealing after all?

Several signs of late may indicate that a shift toward "desert thinking" is beginning in the more affluent cultures. Consider, for example, that the Americans, along with several other peoples, have set aside several large desert areas for camping and contemplation. That behaviour required an astonishing turnaround in some old cultural attitudes; it signifies a new thirst for being thirsty, a need to leave behind (if only for a while) the clutter of advanced industrial society and the easy gratifications it affords in order to live a little closer to the bone. It is related, I believe, to a spreading interest in reordering one's life around the principle of material simplicity. According to a recent report by the Stanford Research Institute, some five million Americans, or three per cent of the adult population, now practice an economically simplified lifestyle.[20] That estimate may be too large, but unquestionably there is a group of people, increasing in country after country, who are making a determined effort to free themselves and their communities from consumer gratification as a basis for living. Although they may not in every case be actually seeking out deserts for their inspiration, they are, in a sense, a kind of desert-affirming people. They want neither a made-over, lushly producing Imperial Valley, a high-rolling, high-spending Las Vegas, or Herbert Marcuse's dream oasis of libidinal release.

The recent turning toward deserts and toward simplicity of consumption departs from both the bourgeois emphasis on postponing gratification and the Frankfurt emphasis on escaping repression. The new point of view is that discipline and restraint are not necessarily undesirable, nor are they to be automatically associated with the project of environmental domination. On the contrary, self-discipline may be regarded as the only true antithesis of domination. Liberating nature from the threat of endless conquest, endless instensificaton of use, the argument for simplicity goes, is not likely to be achieved under any social philosophy based on hedonism. Instead, it will require a cultural dedication to the mastery of self. That does not have to be only a private strategy; conceivably, it could have a public, political dimension too, including the decentralization of production into local and regional modes, the development of new forms of technology that interfere less with natural processes, and the setting of personal income ceilings and the redistribution of the surplus.

Despite these evidences that people have begun to rediscover the moral ideal of self-imposed restraint, the obstacles to a wholesale move in that direction remain very imposing. It may well turn out that the human appetite will not be, cannot be, moderated. On a planet teeming with four or eight or twelve billion people, examples of restraint may remain what they are now: a series of minor, isolated gestures, unthinkable to the starving, unacceptable to the aspiring, unappealing to the affluent. If that is to be the case, then the fate of the Colorado River will inevitably become the fate of every river on earth. Their waters will be turned out of their channels onto every remaining scrap of wasteland, changing the last deserts into food, fibre, and energy factories. Whether that future arrives by choice or by necessity is immaterial; in either case, I'm afraid, democracy—in the sense of freedom from centralized authorities and oppressive hierarchies, in the sense of escape from the managed life, in the sense of ordinary people exercising a high degree of autonomy, cultural and political, in their lives—will not remain a realistic social ideal. Where wants and needs are out of self-control, where they cannot be defined or filled by the person and the immediate community, power must gravitate farther and farther away.

Notes:

1. Wittfogel's major work was *Oriental Despotism: A Comparative Study of Total Power* (New Haven, 1957). The phrase "hydraulic society" first appeared in his article, "Die Theorie der orientalischen Gesellschaft" (1938).
2. Mumford argues that the Age of the Pyramids has returned in spirit and ethos, bent as before on establishing "absolute centralized control over both nature and man." See *Technics and Human Development* (New York, 1967), 207.
3. Jay, *The Dialectical Imagination: A History of the Frankfurt School and the Institute of Social Research. 1923-1950* (Boston, 1973), 256.
4. Max Horkheimer, *The Eclipse of Reason* (1947: New York, Continuum edition, 1974), 97.
5. *Ibid.*, 93.
6. Horkheimer and Adorno lived in exile in Pacific Palisades, California, from 1941 to 1949. Wittfogel became an American citizen and taught for many years at the University of Washington in Seattle; while Marcuse spent the last part of his career in San Diego, California.
7. Powell, *Report on the Lands of the Arid Region of the United States* (1879; Cambridge, Mass., Belknap edition, 1962), 54.
8. Philip Fradkin, *A River No More: The Colorado River and the West* (New York, 1981), 16.
9. There is no general history, but see Helen Hosmer, "Triumph and Failure in the Imperial Valley," in *The Grand Colorado*, ed. T. H. Watkins (Palo Alto, 1969), 205-21.
10. Paul Barnett, *Imperial Valley: The Land of Sun and Subsidies* (Davis, Calif., 1978), 3, 60.
11. Leonard, "The Imperial Irrigation District: Agency Behavior in a Political Environment" (Ph.D. thesis, Claremont Graduate School, 1972), 8-9.
12. The story of Harriman's battle with the river is told by George Kennan in *E. H. Harriman: A Biography* (Boston, 1922), II, 136-173.
13. Horkheimer and Adorno, *Dialectic of Enlightenment*, trans. John Cumming (1944; New York, Continuum edition, 1972), ix.
14. Harris, *Cannibals and Kings: The Origins of Cultures* (New York, 1977), ch. 13. Thorkild Jacobsen and Robert Adams, "Salt and Silt in Ancient Mesopotamian Agriculture," *Science* 128 (21 November 1958): 1254-58.
15. Marcuse, *One-Dimensional Man: Studies in the Ideology of Advanced Industrial Society* (Boston, 1964), 40.
16. *Ibid.*, 37.
17. Marcuse differentiated his "mastery" of nature from that of industrial society's as a "liberation" and a "pacification" rather than a "repression." Nature would cease to be "mere Nature" as its violence, misery, and cruelty were reduced. The lion would lie down with the lamb, with Marcuse in the middle. See *ibid.*, 236.
18. Marcuse, *Eros and Civilization: A Philosophical Inquiry into Freud* (New York, Vintage edition, 1955), 197.
19. *Ibid.*, 193.
20. Stanford Research Institute, *Business Intelligence Programme*, no. 1004 (1976). See also Michael Phillips, "SRI Is Wrong About Voluntary Simplicity," *CoEvolution Quarterly* (Summer 1977): 32-34.

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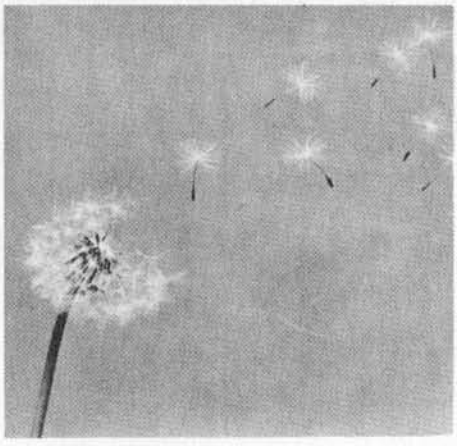


Seeds of Hope*

by Lawrence D. Hills

Gene banks are not enough to save the world's heritage of vegetable and crop varieties. Special vegetable sanctuaries must be established throughout the world, where threatened species and varieties may be grown and the gene pool preserved.

At the 21st F.A.O. Conference held in November 1981, a resolution which had the unanimous support of Third World delegates, was passed calling for an International Convention on the exchange of germ plasm between countries. Meanwhile a final document has been prepared for presentation to the 22nd F.A.O. Conference to be held from the 4th to the 24th November 1983.

At its best, the conference will establish which elements are to be included in the convention, together with the nature of the proposed International Gene Bank, and to instruct the director-general to draft a detailed convention for debate at the 23rd F.A.O. Conference in 1985. The whole field however, is thickly sown with the seeds of disagreement. Even if all goes well, the gene bank cannot be put into operation before 1990. Unfortunately, by that date there may well be few of the world's greatest genetic treasures left to store. Such 'Treasure Chest Varieties' (TCVs) have been bred and selected by generations of farmers and peasants to produce a crop for all seasons, so that, whatever happens some will thrive. Since they are not 'stable, uniform and distinct' they cannot be patented. On the other hand, each is a miniature 'Amazon rainforest' of unexplored possibilities.

With single super-varieties any new plant disease can sweep a country as potato blight *(Phytophthora infestans)* swept Ireland in the 1840s and corn blight the USA in 1970. Although today we can use a mixture of synthetic pesticides and fungicides to combat infestation and disease, such methods select resistant strains and bring higher costs and risks that build up along food chains. In an age of cloning when tissue culture makes possible the almost infinite multiplication of a single specimen of a commercially grown variety, the danger is increased because disease can destroy a clone as completely as fire blight *(Erwinia amylovora)* destroyed the popular pear Laxton's Superb. To counteract such trends the preservation of the widest range of variations of the greatest number of food crops is perhaps the most urgent task for conservationists everywhere today.

Vavilov Centres and the Third World

The original homes of the world's crop plants were determined by Nicolay Ivanovich Vavilov (1887-1943) Russia's greatest plant geneticist. From 1916 to 1933 he made expeditions to many parts of the world including Afghanistan, China, Ethiopia, Iran and South and Central America, bringing back over 50,000 species of wild flowers and 31,000 wheat specimens, which were grown in the 400 research institutes he established in the USSR as head of the Lenin All-Union Academy of Agricultural Sciences.

In 1920 he developed the theory based on his world-wide studies, that the region of the greatest diversity of a species of plant is its centre of origin, and proposed twelve such areas, which are now known as 'Vavilov Centres'. The main areas are in the Near East, including Turkey and Iran, Afghanistan, India and Burma, Malaysia including Java, China, Ethiopia, Central America including Mexico, and the Peruvian Andes.

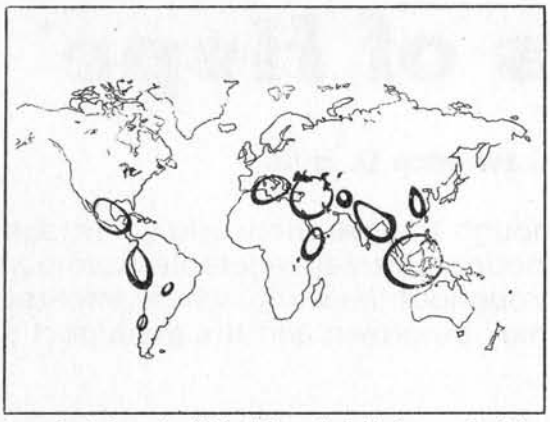
Vavilov was concerned with species rather than with hybrids and his centres were all situated where ancient civilisations developed agriculture using a wide selection of genetic material as a basis of their crops. Meanwhile many areas of advanced cultivation received their crops as hybrids from the originators. Perhaps the first and most far reaching dispersal was that of wheat and barley from the Near East and Ethiopia, to Northern Europe including Britain, with the first Neolithic farmers between 4,000 and 3,000 BC.

TCV mixtures have a far greater chance of success in new countries where conditions select the most suitable variations, than do pure species which have only a single chance. The original gene pools enriched by mutations selected through centuries of observant farmers and gardeners, are the world's greatest remaining unexplored territories.

From some 1,500 wild species eaten by our hunting and food gathering predecessors, man has progressed backwards to consuming less than 500 species, admittedly in a wide range of varieties grown by different ancient civilisations, such as those of Sri Lanka, where 40 root and 28 leaf and salad vegetables were grown to suit the three climatic zones that ranged from steamy tropics at about sea level, to the temperate highlands. Today, only 200 food plant species are grown by those inhabitants of the world that read seed catalogues, and of these only 80 are grown commercially. In the North, the giant seed companies breed a diminishing number of food crops into ever higher yielding varieties, tailored to the needs of the supermarket society. Hence the

*See also *Ecologist* vol. 12, No 6, 1982, L.D. Hills, Seeds of Discontent.

Vavilov Centres



Source: *Genetic Conservation*. FAO Genetic Conservation Training Programme, Crop Ecology and Genetic Resources Unit, FAO, PI/F7460.

Major Gene Banks

Source: *Genetic Conservation*. FAO Genetic Conservation Training Programme, Crop Ecology and Genetic Resources Unit, FAO, PI/F7460.

South or the Third World is under constant pressure to change over to such 'miracle' or 'improved' seeds—the high response and high yielding varieties.

Many such seeds are F.1. hybrids which cannot be raised from home-saved seed, because the second generation inherits the poor yields of the 'in-laws', or has an inbred incapacity to retain germinating power for more than a few months. Seed must therefore be bought every year, instead of at long intervals, thus ensuring that the art of timing, sowing, and organising a holding for self-sufficiency in seeds becomes lost.

Moreover, farmers are encouraged to grow the high yielding varieties not so much to feed hungry people, but to increase their incomes so as to pay higher taxes and to be able t buy Japanese motorcycles and transistor radios and to consume an ever more Westernised diet. It has been estimated that in ten years perhaps only five per cent of the heritage of genes in the TCVs will remain.

Gene Bank and Vegetable Sanctuary

The obvious answer is to send out expeditions and collect every possible vegetable, and all the rice and grain varieties that are not already stored in existing gene banks, so that if their qualities are ever required, they can be extracted from cold storage by the plant breeders concerned. Apart from the long period before any international gene bank can be in operation, and the reluctance of the Third World to put all its most valuable eggs into Northern baskets, there are several important disadvantages.

The first is that whatever arrangement is agreed on the patent rights on varieties stored in gene banks, the TCVs are *not* 'stable, uniform and distinct' and therefore cannot be patented. Although a stable species or a pure bred variety will remain the same in a cold store, a TCV is a mixture and at the first regrowth all the variations that will not stand twenty years of freezing will fail to germinate. They will be grown on or near the gene bank in whatever country that is in, which again will select at each regrowing for the individuals that suit local conditions. Thus a vegetable from India stored in the Philippines will change through the years until it has lost the qualities it had when it was first stored.

In Britain, the Henry Doubleday Research Association has been campaigning to save the vanishing vegetables of the world since the Spring of 1975, and it is often argued that, as Pure Line temperate climate vegetables can survive freezing without change, all the obsolete varieties—as obsolete as the ceolocanth or the Siberian tiger—can stay safely in cold storage for centuries like pictures in the cellars of the National Gallery.

The important difference between pictures and seeds is best illustrated by the case of potato wart disease *(Synchytrium endobioticum)*, the fungus that appeared in Cheshire in the 1890s, and spread slowly on cartwheels, horses hooves, barrow tyres and boots. It looked like black cauliflower curds on rotten potatoes and lasted 30 years in the soil. In 1909 Mr. C.G. Gough, a Ministry of Agriculture inspector observed that the varieties Snowdrop and Golden Wonder were thriving when all the other varieties in his area were wiped out. It is from those two that the modern immune varieties have been bred.

Had the popular but non-immune King Edward been the only potato variety grown, with all the others stored in a gene bank, we should have lost all our potatoes and never have known that breeding for immunity was possible. The Association has now started five vegetable sanctuaries in Britain and one in Sri Lanka, to grow a range of varieties from the past year after year, facing changing climate, rising pollution and new pests and diseases, so that the successors to Mr. Gough and others in search of answers to new problems can see what relevant resistance carrying genes the vegetables of the past can offer to the plant breeders of the future. All the sanctuaries are sited in the kitchen gardens of stately homes open to the public, and it is hoped that eventually funds can be gathered to extend the idea into Europe.

At the gene bank at Wakehurst Place in Sussex a kilogramme of seed of the lady's slipper orchid *(Cypripedium calceolus)*, one of Britain's rarest wild flowers has been stored. Such storage would be useless without storing the also scarce soil bacteria that eats through the seed coat and makes germination possible. The TCV mixtures are parts of systems of cultivation that reside mainly in the memories of illiterate people, a store of oral knowledge that is in as great a danger as the seeds themselves. How much of that knowledge will be of permanent value to the future, we

cannot know, but once it is gone it is lost beyond recall, like rare ferns in tropical rain forests. We need to 'store' the peasants who have grown the crops by traditional methods, just as Wakehurst Place must store the soil bacteria to keep the orchid safe.

Vegetable Sanctuaries and Botanic Gardens

A wildlife sanctuary designed to preserve the gene pool of the plants, trees, fungi, birds, animals, reptiles and insects of a tropical forest in a stable ecosystem, must be large; in that respect it takes about 30 square miles of hunting territory to support every pair of tigers.

On the other hand, 'Tamelife' sanctuary would not endeavour to produce a balanced eco-system for chains of eaters and eaten, but to reproduce the man-made environment in which cultivated food crops have lived, and live, needing only space enough to allow traditional crop rotations. Therefore a TCV could be preserved for ever in the limited area of an English back garden or in a small section of a Javanese rice terrace as a rotational crop. It is of immense importance, in order to maintain the productivity of the land, to select for the ability to fit in the three or even four crop a year rotations which feed the most people from the least land, yet still allow the time to grow the seed which makes each holding self-contained and self-perpetuating.

Ideal sites for 'Tamelife' or vegetable sanctuaries in Third World countries would be at the botanic gardens of which there are more than six hundred spread over the tropical and subtropical world, ranging in area from the 1,365 acres of the National Botanic Gardens of South Africa at Kirstenbosch, to the single acre of Bath Gardens at St. Thomas in Jamaica, which houses a collection of the plants introduced by Captain Bligh. Many of them have followed the tradition of the Royal Botanic Gardens at Kew (288 acres) in collecting, investigating and spreading useful crops around the world. Indeed, Kew, having trained many of the curators of the world's botanic gardens, is responsible for the distribution of the rubber tree, the Canary banana *(Musa cavendishii)*, tea, coffee, cacao and quinine.

Moreover libraries contain an enormous mass of detailed knowledge on tropical plantation crops, from timbers to spices and magnificently illustrated volumes of botanical engravings to supplement the herbarium collections which make it possible to identify the majority of the local flora. The basic concern of botanic gardens however has always been with species and export crops, rather than with the varieties of the vegetables which can feed large populations.

New Role for Botanic Gardens

The suggested new role for the botanic gardens which could provide buildings, skilled staff and expertise for a rapid rescue operation for the world's most endangered genetic resources, would cost no more than a single mighty dam. The major cost would be for laboratory apparatus for analysis, relatively simple but used intensively, plus salaries for skilled staff. One advantage would be the provision of local employment. Thus the Henry Doubleday Research Association vegetable sanctuary on Sri Lanka pays £16 a month to skilled farmworkers with cottages and traditional extras.

Cities have spread around many botanic gardens, which tend to become parks full of magnificent specimen trees, and tourist attractions rather than research centres. However, adding a vegetable sanctuary department under the existing curator and staff would not be merely a matter of single rows of as many local varieties as could be found.

Trial grounds, if possible near the laboratory facilities, of beds each about ten square metres area, would be essential so that seedlings of every acquisition could be grown. A decision would then be made as to whether a given vegetable was a true species, varying only within narrow limits, like many of the salad and leaf vegetables gathered in the jungle near a village, or a genuine TCV.

Because the majority of the vegetables would be annuals or biennials, the beds would not be arranged permanently, but would be expanded to take individual variations from the mixtures, or contracted where a crop grown under many popular names in different villages turned out to be the same unvaried species.

Few tropical vegetables have known chromosome numbers, therefore determining these would be of value, not only in sorting out ones which cross-pollinated as freely as the 18 chromosome brassicas or the 30 chromosome dianthus, but in finding likely parents for bi-generic crosses. The most important task would be assessing the vitamin building and mineral gathering capacities of the individual variations of hybrid races and species.

Where any human race has lived successfully for centuries on an apparently restricted diet, ways have been found to achieve a good nutritional balance, sometimes by means of sprouted grains or legumes, fermented sauces or alcoholic drinks, but more often from a vegetable that happens to be rich in a missing factor. Local traditions of such plants should be gathered in and a search among the TCV with the desired quality could pave the way to breeding for higher vitamin value. As vitamins vary through the seasons a number of tests would have to be made on each candidate.

Many deep rooting vegetables are good mineral gatherers. The classic example is spinach *(Spinacia oleracea)* with up to 77mg of calcium and 4mg of iron per 100 grams fresh weight; yet both useful minerals are locked up as oxalates. Consequently vegetable variations high in calcium and iron, but unassociated with oxalic acid, would be worth a long search. Similarly a useful search would be for tannin-free plants, since tannins inhibit the digestion of certain carbohydrates, and prevent the carob *(Ceratonia siliqua)*, with a yield more than twice that of a good British barley field, from becoming the world's most productive food crop, especially when grown on the dry hot hillsides that make up fifteen per cent of its land area.

Satellite Sanctuaries

Trial areas would have to cover larger areas than existing botanic gardens in differing climatic zones, and be sited away from cities, where land is cheaper. Seed production from the selected varieties, and those that might be selected and bred in the future, would be an important task. The enterprise would

require warehouses, packaging, testing for germination percentage, maintenance in tropical climates, and packing and despatch facilities. In some instances, such facilities could be provided at existing establishments.

The second part of the operation would be the preservation of specimen holdings, or of establishing new ones, where the traditional methods of horticulture and agriculture could be studied and maintained. Successful farmers, or ex-farmers of long experience would have to be employed as 'farmer-curators', at a salary relatively higher than the earnings of modern farmers on holdings of the same size.

Students from the botanic garden, controlling what would be called a 'satellite sanctuary', could spend perhaps a year towards the end of their training working under the farmer-curator, learning and observing the techniques of the past. The satellites would be large enough to need a farm foreman and a labourer as well as the farmer-curator, chosen from the best holdings to set the standard for preservation as high as possible. Each would also take about four students, who would be taught to work in a manner comparable to their peasant farmer ancestors.

The object of the satellites would not be to run farms from the past as tourist attractions, with workers in costume like agricultural Williamsburgs, but to continue ancient and well-tried methods of pest and disease control, cultivations, crop rotations and the timing of flowering periods for seed raising on each holding; the use for instance of bees and ducks as pest controllers in rice paddies would be included. The entire exercise would provide a standard with which to compare new methods and machinery, and to lay bare any possible disadvantages. Moreover, the sanctuaries would provide facilities for those concerned with plant breeding to observe the performance of the varieties from the past under the changing conditions of today, especially with regard to new diseases and rising pollution, as in a British vegetable sanctuary.

A botanic garden would control several satellites, to cover separate climatic zones and types of holdings. Another type of satellite would try out separate variations and hybrids to see how they suited the traditional rotations and methods.

It is certain that the world's oil supplies will eventually run out, and likely that the next 37 years will see twice as many people on our planet. Therefore, preserving the techniques and developing the best crop plants for a low energy, low petro-chemical consuming system for maximum food production in the countries where the population increase will be highest, is a highly desirable enterprise for humanity as a whole.

Gene Banks, Botanic Gardens and The Seed Problem

The relationship between gene banks, botanic gardens and vegetable sanctuaries depends on what is decided at the 22nd FAO Conference in November. Even if there is complete agreement both on plant patents and on the International Gene Bank, the last of the world's TCVs would be far safer growing in sanctuaries attached to the botanic gardens of their countries of origin, than in gene banks in any country. The sanctuaries would provide the safest, simplest, cheapest and most politically possible method of saving them from drowning under the threatened flood of F.1 hybrids.

The risk is that the conference will fail to agree, but such failure in no way alters the urgency of the problem of the vanishing vegetables, nor is there anything to prevent Third World countries and the Northern nations who support them agreeing on conservation through the botanic gardens of the world.

Relations between the botanic gardens of all countries have always been excellent. Such gardens are essentially non-political, non-commercial institutions and are therefore ideally suited to be appointed repositories of the world's genetic heritage of food plants from the past.

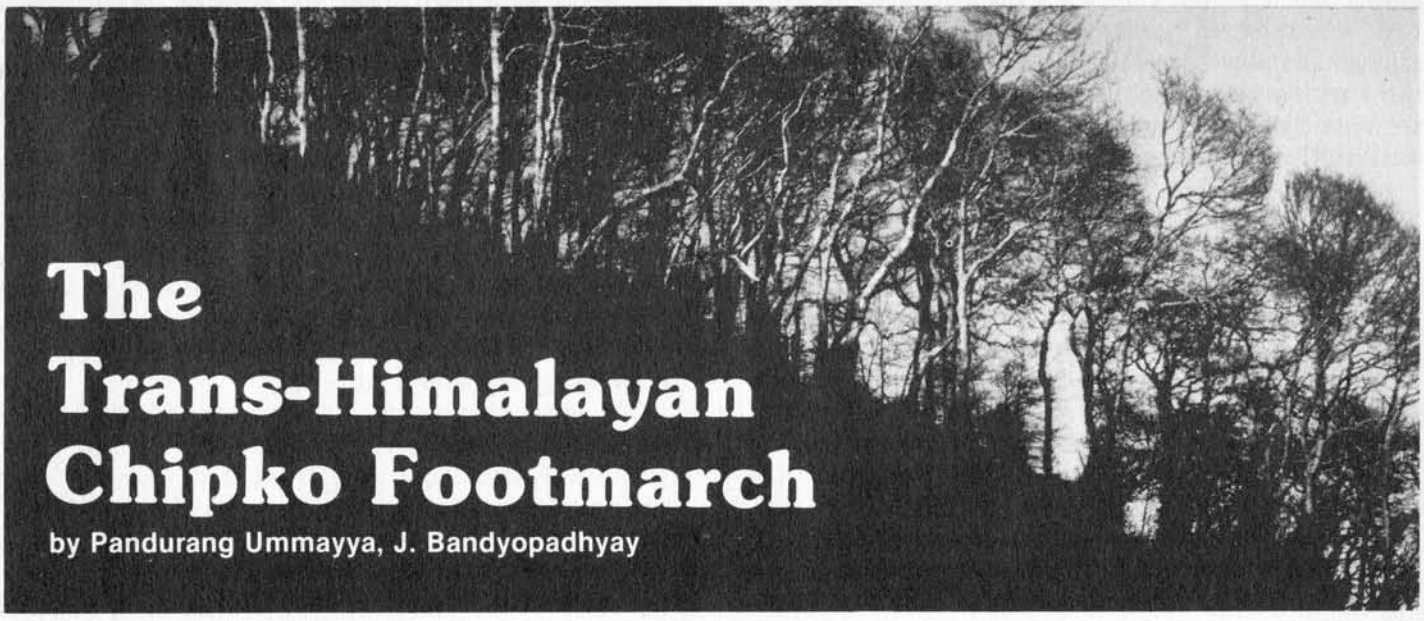
The basic problem to be solved is that of the TCVs, which cannot be patented, yet even though patenting is not possible, every variation selected from HCVs deposited in a botanic garden sanctuary, should carry a prefix and details on computer print-out, which in essence would be equivalent to the copyright sign in a book. No plant with such a prefix in its ancestry could then be legally patented.

Breeding varieties is no part of the work of botanic gardens, but it is their task to guard the raw materials of horticulture and agriculture and keep them true and accurately described, including qualities such as high vitamins and minerals or low tannins or oxalic acid and other attributes unknown to Linnaeus. The implications of this small step forward for mankind are rather important.

It would give the world two classes of seed. The first class would be the patented product of the multinational seed companies, with all its advantages and disadvantages. Because the TCV would be free from patenting, the varieties with the necessary prefix in their ancestry would be classified as second class and akin for example to the varieties raised in India, where there are no large seedsmen, and where plant breeding is carried out by government plant breeding stations, like Britain's National Seed Development Organisation. They breed for the specific requirements of their farmers and peasants and sell at minimum prices without royalties since those would increase the costs to those who cannot afford extra burdens. An alternative seed trade would grow, based on the Third World botanic gardens and as their satellites, trading between countries, and either direct from plant breeders or through local seedsmen. Even today two thirds of the world's seeds are either grown by farmers themselves or by government plant breeding institutes.

It may be argued that this would retard progress in plant breeding. It is not necessarily desirable to breed new varieties as though they were pop records, in order to replace each 'top twenty' with still more expensive kinds in order to earn higher royalties. Peasants and farmers have always preferred the kinds that they know will suit their soil and climate, and this is how seeds have been bred, selected and passed down from father to son through the centuries.

Lawrence Hills is director of the Henry Doubleday Research Association, broadcaster and author on organic farming and gardening.



The Trans-Himalayan Chipko Footmarch

by Pandurang Ummayya, J. Bandyopadhyay

The nine-year-old Chipko movement, begun when villagers flung their arms around trees to prevent felling, reached its climax with the march by Bahuguna and his followers along the Himalayan foothills.

The self-appointed and non-violent sentry of the Himalayan forests, Chipko activist Sunderlal Bahuguna, was addressing a few hundred villagers on a cold December night when the Chipko marchers were located in Tongza. It was a tough job tracking the marchers down in the remote areas of Bhutan and five days of trial and error trekking backed by occasional rides in the vehicles of the Border Road Organisation finally succeeded in leading them to Tongza in Central Bhutan, about 200 kms away from Thimpu, the Bhutanese capital. The people who assembled were simply surprised by the courage and physical stamina of the marchers who had come on foot all the way from Srinagar in Jammu and Kashmir and still planned to go up to Kohima, covering on foot about 500 kms of tough mountain track.

Sunderlal Bahuguna, in his traditional Garhwali woollen coat, with his childlike shining eyes and white flowing beard emphasised the need to save the Himalayas from ecological disaster, the first signs of which are already apparent. "The march is not a pleasure trip," he stated "it is hazardous. Nor is it an adventure in nature like scaling peaks but its purpose is to get in touch with the people in the villages." While his Hindi is translated into Bhutanese, he pauses and then adds that "the footmarch is to share our anguish with our brothers and sisters in the Himalayas from Kashmir to Kohima, anguish caused through the distress of Mother Earth in this region".

The few hundred people gathered listened in wrapt attention as the speaker told them of the ruthless deforestation that was going on in the Himalayas "Man is now going to rip the skin of Mother Earth" he said "and the mother who, over thousands of years has given us food is now pelting stones in anger". The analogy sparked off a wave of concern and the audience made a humming sound as a mark of appreciation. Then he described how village women in the Reni forests of the Chamoli district of Uttar Pradesh started the Chipko Andolan and how it spread to many remote areas of the hills in Uttar Pradesh. He added how the Andolan was spreading from Kashmir to Kohima through the march.

Beginning the March — Kashmir

The idea of padyatra as the most efficient media for spreading any relevant ideas to the people of India is not a new one. For thousands of years those methods have been used. But Gandhiji gave it a new dimension during the independence movement. Sunderlal Bahuguna and other Chipko workers have long been sincerely practising the path shown by Gandhiji. Indeed during the Askot (in Kumaon) to Arakot (Himachel Pradesh) footmarch they came to understand the enormous potential of the method in coming to grips with the societies and the ecology of the remote hill areas as well as how to spread the idea of the movement. However, during the last few years those same Chipko workers were mainly busy at grass roots level organisations in Lasiyalgaon, Badiyargarh and Ranichauri, in Tehri Garhwal. Then having ensured the ban on green-felling in UP Himalayas, Sunderlal Bahuguna realised the idea of the Kashmir to Kohima footmarch. From April 2 to 12, 1981, he took a prayerful fast in Uttar-Kashi to ensure inner strength for the 5000 kms long and hazardous march through the tough terrains of Jammy and Kashmir, Himachel Pradesh, Uttar Pradesh, Nepal, West Bengal, Sikkim, Bhutan, Arunachel Pradesh and Nagaland. He felt that while devastating floods were knocking at the door every year and severe landslides were destroying lives and property on a scale hitherto unknown in the Himalayas, there was no time to spare. Man himself must prevent man-made 'Natural' disasters. Preparations for the march went on immediately after the fast. Soon after Sunderlal Bahuguna left for Srinagar.

The marchers assembled in Srinagar, the capital of Jammu and Kashmit for about two weeks before setting out. The contacts for the way as well as the route to be followed were determined. Meanwhile

money was a big problem, since the little the marchers had, was spent in no time during the initial preparations. The marchers actually started penniless from the starting point in Srinagar. At the same time enthusiastic young companions from Srinagar had to get back to their schools and colleges.

As the marchers walked through the valley of Kashmir they could see the long rows of willow trees on the roadside. As they moved into the Ananthag district they were in the midst of the forest of Kail and Deodar. They met groups of people, on the roadside, in the orchards and held a few meetings. The valley ended at DakSum. Then onwards through the Jhelum catchment areas the march was to lead to the Synthen pass at 12,500 ft. After leaving the valley the way became tougher and on June 8, 1981, the marchers struggled through thick snow to reach the pass. Amidst new snowfall the marchers entered the Chenab valley where they noted large scale damage to the forests caused by heavy snowfall, as well as the construction of motor roads and commercial overexploitation.

During the march the marchers organised a large number of meetings, in the process meeting thousands of people who were invited to talk to them after the religious prayers. When a young man Sunderlal Bahuguna was an underground political activist in Lahore, involved in the freedom movement. During that time he learnt Urdu and read the Quran. Now, some decades later, his knowledge of the Quran and fluency in Urdu united him with the village people in Jhelum and Chenab, and he and his co-marcher Ratan Chand Dehlu, excited everyone with their use of the Quaran, to explain the need to save forests. Thus they continued during dozens of meetings as their march led on through the Kistwar and Bidharwar areas of Jammu into the Himachel Pradesh. The march was suspended after the team reached Chamba on June 27, 1981, during the monsoon.

Marching through Himachel Pradesh

Sunderlal Bahuguna and his team members went back to Chamba to start the march again after the monsoon was over on Sept 12, 1981. In the meantime he made a hasty trip to areas in Jammu and Kashmir where new activist groups were emerging, as well as attending the Nairobi conference on New and Renewable Energy Sources in August 1981. The new members in the team were Dhoom Singh Negi and Kul Bhushan Upamanya. By now talk about the march had spread far and wide. The weather was beautiful in the autumn and the marchers were received with great affection in the villages and towns through which they passed. Meetings were held which went on until the early hours of the morning, while in the day time children were addressed in the schools. Throughout the march in Himachel individuals and small groups joined in for a day, a week or even until the border of the state had been reached. In the Kulu valley and Manali the marchers observed the ruthless clearfelling and large scale damage by landslides. The marchers timed their programme so as to be in Kulu during the famous Dussehra. It was a great opportunity to get in touch with thousands of local people who came to the Dussehra mela from about 300 villages, as well as an additional opportunity to spread the message of Chipko to the hundreds of visitors from all parts of the country. The marchers divided themselves in groups of twos and organised street corner meetings aided by hand-made posters and banners. For the first time something other than Kulu shawls were being sold in the mela—Chipko books were selling like hot cakes to the villagers and towns-folk alike. Whether it was a prayer meeting of Muslims in Kashmir or a Dussehra mela of Hindus in neighbouring Himachel Pradesh, Sunderlal Bahuguna and his co-marchers were welcomed with equal cordiality.

The next major point in the march was the capital city of Simla. The marchers avoided the straight route which was easier and went through an interior route via Banjar to meet the people who could not otherwise be met easily. They organised on average three to four meetings everyday. In some meetings some fifty people came, in others a few thousands, Sunderlal Bahuguna would even stop to discuss the problems of the hill people when just a few eager individuals collected on the roadside.

The conditions of the forests in Himachel Pradesh as seen by the marchers can best be described in the following words of Sunderlal Bahuguna:

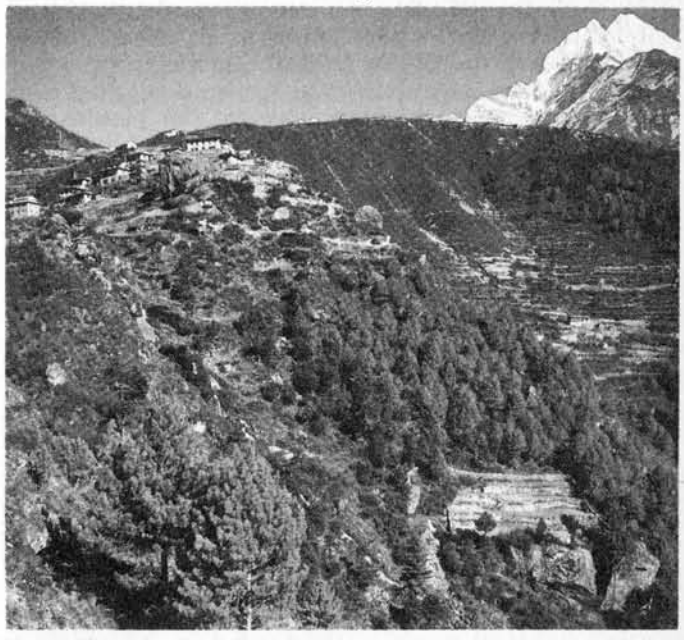
> "Like other Himalayan States, most of the area of Himachel Pradesh was covered with thick forests about 150 years ago. Old people still remember the areas in the vicinity of villages which were dark even during the daytime owing to the dense forests—that was before the introduction of "scientific management" of forests; hence commercial exploitation of forests. The areas first clear-felled were in the river valleys where floating of sleepers was easy. With the expansion of motor roads, the clearing of forests for commercial purposes was extended. Nor was it only the unscrupulous forest contractor, but the state itself which clear-felled the mountain slopes as in Chachpur and Gulaba Camp. Indeed the state derived its main source of income and an ever increasing one, from the forest, despite mass scale devastation of forests. It has gone up from 9.7 crores in 1977-78 to 12.61 crores in 1978-79 and to 16 crores in 1980-81. Out of the total felling of 5,64,076 m^3 timber, 85 per cent is for commercial purposes including some 20 per cent for apple packing cases.
>
> The felling of trees on private lands has also been responsible for the denudation of hills in H.P. When commercial felling was first started in the first quarter of this century, the private landowners wanted to clear tree-covered areas to extend cultivation, even going to the lengths of bribing agents to get the required permits. After independence a new class of clever people came up who despite the legal restrictions, managed to obtain permission for clear-felling from the Government. Having soon made a good fortune out of this trade, this new breed of men entered politics and for a number of years a trio of politicians, revenue and forest officials were busy in clearing the remaining private forests. Instances

have been quoted where permission to fell trees on the same plot of land was given three times within fifteen years. The felling of trees on private lands was stopped in 1977. But the pressure of the private forest enterprises was so strong that the State Government, with some restrictions, again issued permits. A ten year phased programme was declared. But under the pretext of their being private forests, the felling of trees from Government forests continues unabated. Indeed we saw a huge stock of illegal timber in Chaupil Tehsil which was seized in 1978. We have personally verified allegations that the felling of such trees was carried out in Simla and Chamba Districts during April 1981 to September 1981. The most unfortunate aspect is that honest officers find it difficult to follow up such felling owing to political pressure. In one instance, when a truck was detected in the Chopal area, the truck driver ran straight to Simla and by the next day enquired whether the police officer had received instructions from Simla to give up the case. Some saw that mill owners of Dharmapur in Solan District, the biggest centre of illicit timber trade, were involved in a case but the superintendent of police is said to have been forced to withdraw the cases because of political pressure. The State Government has however, promulgated an ordinance to put a check on such felling but its success is doubtful in view of the various strong opposing influences. But the ordinance does not apply on contracts already entered upon. The usual practice in the hills is for timber traders to keep a stock of stamped papers for back-dating."

Uttarakhand: The Height of Enthusiasm

The marchers entered the hills of Uttar Pradesh on October 31, 1981, at Chandridhar. They walked through Chakrata, Barkot, Sunda, Tehri, Pratapnagar, Deoprayag, Pauri, Karnaprayag, Begeshwar, Almora, Nainital, Haldwani, Sitarganj and Khatima Tehsils. The marchers had the opportunity to study the catchment areas of Tons, Yamuna, Dhagirathi, Bhilangana, Nandakini, Alakananda, Pindar, Saryu, Kosi and Sarada rivers. Then the march halted for winter in Ranibagh on December 14, 1981, and resumed on February 25, 1982, crossing into Nepal on March 6, 1982. In the Hills of U.P. there was no need to make the people aware of the Chipko Andolan. Enthusiasm for the march was overwhelming. Meanwhile, in Uttarkashi, hundreds of women formed a procession demanding the preservation of natural mixed forests. In a number of villages of Jakkur Valley the villagers appointed their own forest guards, having framed rules and working plans for the preservation of forests. School children everywhere not only showed great enthusiasm for the marchers, they also took care of tree nurseries for the afforestation plans of the villages.

The marchers observed the massive destruction of chirpine trees in U.P. Hills owing to excessive resin tapping. Such large scale destruction of forests raises a big question as to the "scientificity" of 'scientific management' of forests. Indeed they observed that "some of the areas have become barren, soil erosion and big landslides are common and there was hardly any undergrowth in the pine plantations". With destruction going on on such a large scale on one hand, the marchers observed the sorry state of affairs on the



Nepal: Note the denuded slopes

afforestation programmes on the other. In a plantation in the village of Kemara, in the Tehri-Garhwal District, as a result of the complete failure of two successive chirpine plantings, the services of the guard was done away with because there were no trees to guard.

The destruction of oak forests to be replaced by conifers was no less painful to the marchers. Oak forests were reported clear-felled for the raising of nurseries in Rari of the Yamuna Division and in Banyadhar of the Chakrata Soil Conservation Division. In Gauraghati, the people of Lakhamandal are facing an acute water shortage following the destruction of oak forests. Indeed the year-round availability of spring water, the only drinking and irrigation water resource other than rains, has fallen by 75 per cent.

The marchers not only studied the mountain forest but also the foothill forests in the Terai and Bhabar areas.

"In the beginning of this century those forests were managed to meet the requirements of the tenants; especially in Tharus. Settlements were few and the area was covered with mixed forests of Khairs, Dhauri, Semal and Halder. The density and height of growth were good. The ground layer was generally occupied by very light doob grass, not more than a foot or two in height. Then forests began to be exploited to meet the demands for railway sleepers and for fuel for railway engines. When the area was opened, it encouraged the spread of lantana, a weed. Later after independence, 92,000 hectares of Terai forests were allotted for cultivation. These areas were previously a buffer zone to the protected forests. After the disappearance of the buffer zone, the heavy pressure of grazing shifted to the protected forests. Meanwhile there was basic change in the land use policy. The forests, which were previously managed to meet the local demands of fodder and timber, were changed into commercial forests and stress was laid on growing the species of industrial importance.

"In 1957 the area allotted for the growing of industrial species was 20,000 hectares per year, which after 15 years was increased to 30,000

hectares. There was also a marked change in the exploitation pattern. Thus 3674.67 m^3 of Sal and 2,392.34 m^3 of miscellaneous species per annum were felled from 1928-29 to 1949-50; but from 1950-55 to 1964-65, the reverse took place and 608.32 m^3 of Sal and 9,329.56 m^3 of miscellaneous species were felled per annum. Furthermore mixed forests were clear-felled to grow eucalyptus and other species of industrial value, the plantations being established mainly to feed the paper industry. For the first four years, the land under the new plantations was given for cultivation to big contractors. Later on, some land was given to the landless from the hills, some 2,000 such families having permanently settled there.

"The plantation of eucalyptus has radically changed the ecological conditions of the Terai area. We noticed the changes as early as 1975 during our foot march from Hamnagar to Kaldhungi and requested the FRI to carry out studies. No such studies were made, but Ms. Dhun Kalapesi, an environmentalist from Bombay, disclosed that the once-damp climate of Terai, which absorbed the heat of the plains, has become dry. The rise in temperature of hill-stations like Nainital, has become noticeable and the Pindari glacier further up the mountain is fast receding.

"The water level has gone down near plantations, there being no water in the hand pumps and many streams have dried up. The forest department has admitted that under eucalyptus plantations there is practically no cover for wild life and the burning year after year leaves nothing for herbivorous animals (Working plan to Terai Bhabar 1976-77 to 1984-85). Besides wild life, bee farms have shown a marked decrease. We could see 35 bee hives on a single Siras tree between Chakkarpur and Khatima, and 15 hives on a Semal tree. Bees prefer to live on old trees with wide branches. We were told of two Siras and Gular trees near Jalpania nullah, both some 200 years old, housing 80 to 85 bee hives. Although eucalyptus flowers provide nectar and pollen for bees, the honey is not good, nor can the bees find anywhere to build their hives. The decrease in bee hives during the last ten years has been over 50 per cent."

Nepal—losing ground?

From Banbasa in the Nainital district of U.P. the marchers crossed into Nepal through Mahendranagar. The marchers were talking to an ex-soldier in Bhatadi, near Mahendranagar. The discussion summarises the situation in Nepal exactly.

Question (of Marchers) :How do you meet your fuel requirements?

Answer :There was no problem in the beginning. We had enough twigs and branches. Then we shifted to the dust and refuse of the saw mills. Then we used the stumps. We are now going to dig the roots.

Question :And then?

There was no reply.

The reply was available to the marchers, the writings on the wall were the cowdung cakes.

That is the ecological situation now prevailing in Nepal. Nevertheless the clear-felling of forests for com mercial purposes continues while conifer monoculture is expanded. Another alarming aspect as far as forest ecology is concerned, is the demand of the growing tourism industry, which utilizes scarce fuelwood for space heating and cooking for the tourists. A rough estimate puts the annual loss of topsoil from Nepal at some 250 million tons. The situation will deteriorate more if due attention is not immediately given to forest management. The march through Nepal was tough as well as rewarding. On May 19 the marchers crossed back into India and touched Siliguri, where they halted for the monsoon. In June 1982 Sunderlal Bahuguna attended the UNEP open hearing in London on the state of the World's Environment as one of the team from India.

In Bhutan—the land of eternal happiness

On October 19, 1982, the march started again for the last leg up to Kohima. The marchers were shocked at the sight of devastated forests in the northern parts of the state of West Bengal and called upon the State Governor in Darjeeling to submit suggestions for improving the forests. In Sikkim the forests were, however, much better and commercial felling was far more limited. The marchers left India again and entered Bhutan at Jaldhaka on November 7, 1982. A mass meeting was arranged right at the point of entry and the Royal Government of Bhutan welcomed the marchers. The Director of Forests of Bhutan instructed his officials to help the marchers in all possible ways. There was great interest about the marchers as they reached the capital town of Thimpu. The Indian ambassador to Bhutan walked for about a day with the marchers in sympathy while the first secretary of the Indian Embassy and Everest climber Mr. Rawat, accompanied by his wife walked for two full days up to the district town of Nobding. Since the villages were rather sparsely located, the hospitality of the Border Roads Organisation proved very useful.

One evening at about 5 pm the marchers landed up in a village named Ura situated at an altitude of 10,000 ft., and at a distance of 240 kms from Thimpu. The village women were coming back from the fields and forests after work. They stared curiously at these new faces. The marchers identified themselves. Then they were cordially invited to the house of the local member of the National Assembly, Cheema Wangchuk. The cheema welcomed the marchers and over his megaphone called all the village people for an important meeting. People started pouring in soon and local tea and pop-corn were served. For the marchers it was a daily routine: no rest after a whole day's trek of 30-40 kms. The meeting goes on until late. Slides are shown, tapes are heard, how women in Garhwal have taken care of their forests described and from then on it becomes a real mass-meeting in which the local people participate. The women show special concern and there is commenting on the excellent condition of forests in Bhutan compared to other parts of the Himalayas. Sunderlal Bahuguna told them "The Himalaya is dead in Nepal, dying in India and is only alive in Bhutan, the land of eternal happiness". The good health of the forests naturally contribute greatly to water conservation and to the regulatin of water flow in rivers and streams. The total length of the march in Bhutan was about 700 kms and marchers crossed some high passes at heights of 11000 to 13000 ft.

The marchers entered Arunachal Pradesh at Blating and reached Twang in two days, where forests are fast

disappearing owing to urban expansion. The marchers saw the pathetic scene of people digging up roots of trees for firewood. However, the areas away from the motor roads were still covered by dense natural forest, despite the practice of Jhum (shifting) cultivation. Between Seppa and Segali forest management was observed, indeed the local communities were absolutely hostile to the forest department officials. In areas near the motor roads in Tirap district, where sawmills, plywood and veneer factories have sprung up, young school dropouts act as destroyers of forest wealth by becoming timber suppliers to those industries.

Assam—Where are the Forests?

The marchers entered Assam in Lakhimpur district and crossed Bramhaputra near Jorhat. In this part forests were objects of stories and no longer a living reality. Like the apple orchards of Himachel, the tea industry of Assam consumed the forests for packaging. Walking through the disputed border between Assam and Nagaland the marchers reached Dessa Valley. The march ended at Kohima Raj Bhavan where respect was paid to Rani Gaidinliye, the 68 year-old freedom fighter. Sunderlal's long cherished dream was thus realised after walking 4870 kms in 300 days through tough Himalayan terrain. He carried on without thinking of the next day, without any knowledge of how the next meal would come, without any sign of exhaustion and pain. He supported his march by selling books on chipko and enthused hundreds of hill people to defend the natural ecological capital of the Himalayas from wanton destruction.

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AN INTERVIEW WITH CHIPKO BAHUGUNA
by Sri Pandurang Ummayya

The interview was carried out while Sri Sunderlal (Chipko) Bahuguna was trekking through Bhutan in his historic Kashmir to Kohima Chipko Footmarch

PU: Why did you decide to undertake such a hazardous march and what are the main goals of this march?

SB: Many people see Chipko as a localised movement, restricted to Garhwal, we wanted to give a wider perspective and to widen the base of this movement to other regions in Himalayas. Hence we began this hazardous march. To widen the base of movement it is essential that local activists emerge. These activists are capable of taking up issues relevant to their own area. So our goal is to mobilise local people to form a group which is able to work on long term developmental goals. We also want to understand the hill economy of the Himalayan villages and to share our experiences with brothers and sisters in the great Himalayan parts of the country.

PU: At the end of the march do you think you will have achieved your objectives?

SB: We are sowing seeds in the desert hoping in future to see a fully grown tree. The effect of the march can be judged only in the long run. But to our surprise, already three activist groups have emerged, one each in Bhadarwar of J&K, in Chamba of Himachel Pradesh and in Nepal. This unforeseen success is a great morale booster to the Chipko Andolan. These new groups have taken up local issues such as the rights of villagers on forest produce, and have succeeded in mobilising support. We are regularly following up these groups so that there is a strong well-coordinated movement in the Himalayas on ecological issues. Our success is due to the active participation of youth, especially of women. All along the march we have tried to involve as many young people as possible. It is through our informal meetings, slide shows and discussions on local issues that we were able to communicate the message. The emergence of three groups shows that our ideas are relevant and the methods used are also successful.

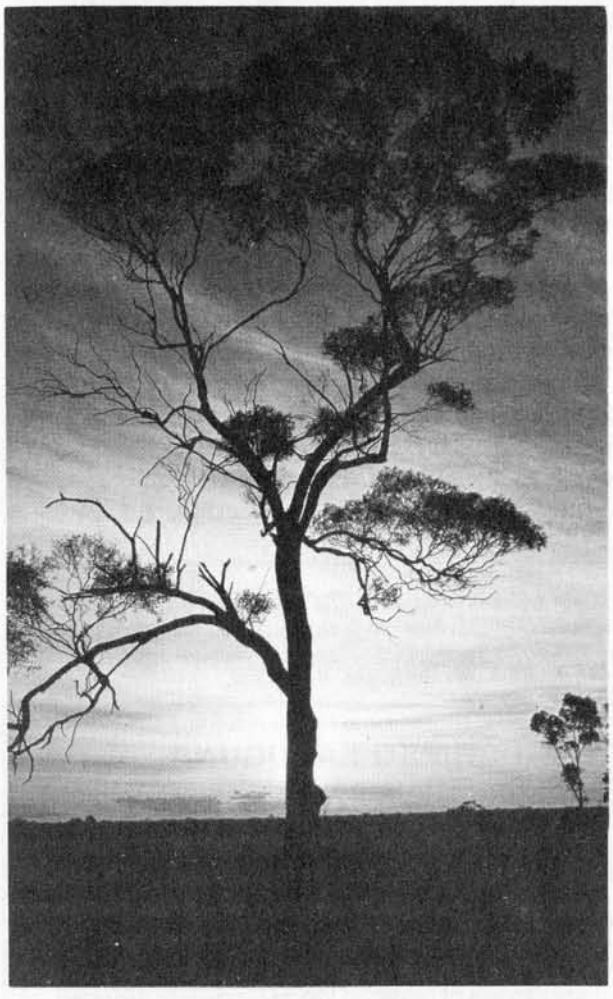
PU: Who is sponsoring your march?

SB: Our sponsors are the people, the common people of hill villages. The villagers support us in all ways, they provide food and shelter and look after us as their own relatives. This generous hospitality reduces all our worries. We sell books on Chipko Andolan. We have also printed them in local languages like Nepalese. At time we get some donations from villagers during the march. Thus we are self reliant depending on local resources and support, we are volunteers working for the cause of the environment and our needs are meagre. We have no funding from large agencies nor have we asked for any.

PU: It is widely understood that ecological demands like those of the Chipko Andolan are obstacles to the economic growth of the country. How do you explain your stand in this respect?

SB: Yes, you have touched the right point—economy versus conservation. There is always a hue and cry about economic development being put ages behind by conservationists. But let me tell you, we through our experience with villagers have brought out a new slogan "Ecology is Permanent Economy". About 10 years back we also believed that it is necessary to have forest-based industries and also that forest wealth should be utilised for commercial purposes. During those years we worked intensively among forest labourers to better their condition. Dhum Singh Negi, our colleague stayed two years with labourers in forests. It is during that period that our belief of economic/commercial necessity of forest was shattered. We were able to observe how even careful felling disturbs eco-systems, how the conifers dominate over broad leaf trees. We saw how such trees allow topsoil to wash away during monsoon. We also saw perenniel springs in the villages and forests drying up and leading to scarcity of drinking water. And during that period Garhwal Hills experienced massive land slides killing and burying hundreds of people and livestock. Villages were wiped out and the debris covered fertile fields. And do you remember the havoc caused by Bhagirathi in Uttar Kashi in 1978? All these experiences led to great loss in our agricultural economy. Man has to live with nature and it is necessary to preserve the delicate areas like the Himalayas from short term manipulation by human beings. That is the reason why we shifted from economic approach to conservation, for stable permanent economy.

Now you may further question—won't this pure approach lead to a decrease in demand for labourers or render labourers without work? We have practical data to show that if the existing land/forest is to be managed in a way beneficial to the long term interest of society then the existing labour force can be conveniently absorbed in taking care of the forests. We need them for afforestation programmes. The management of forests and raising new fruit and fodder trees will definitely call for more labourers. It only depends whether the government has the will, and whether it is interested in changing to a policy which will benefit village people. The slogan for this new policy should be "Ecology is Permanent Economy".



Eucalyptus—a disastrous tree for India

by Vandana Shiva and
J. Bandyopadhyay

There has been considerable and acrimonious debate on issues related to social forestry as a strategy for providing the people with their requirements of fodder, timber, firewood and green manure, while arresting the deepening ecological crisis in the country. The debate is not about the unquestionable need for increasing tree cover. It is primarily a debate on the criteria for the choice of species and land for afforestation and appropriate social organisations to ensure the achievement of the socio-economic goals of the social forestry programmes.

The social forestry programme of Indian states has included a number of components like road-side plantations, canal, tank, and river-bank plantations, common land plantation, a number of local species of trees being used. Moreover, success has been relatively good in the spread of tree cover both in terms of number of seedlings distributed and in new area under plantation in private farmlands. But for various reasons, the species most used has been Eucalyptus, with the result that expansion of Eucalyptus hybrid monoculture onto food growing land has become one of the focal points of debate. The core of the debate is whether such an expansion of Eucalyptus monoculture is desirable from the point of view of satisfaction of the basic needs and of ecological stability of the rural ecosystem, which is needed for the longterm sustenance of not only the rural but also the urban human settlements.

From the content of articles published in the press criticising the extension of Eucalyptus monoculture onto farmland and the official response through the recent press releases by the Chief Conservator of Forests of Karnataka (CCF), it appears that the two debating sides differ in their perceptions of the problem. So that a higher level of understanding can be reached on both sides with the establishment of some communication, it is necessary to identify the nature of the present incompatibility. Analysis of the debate so far suggests that the differences in the perception of the problem beyond the initial arguments on the need for more forests, needs to be understood. The analysis in summary form is given in Table 1. It is evident from Table 1 that the official planning of social forestry has been seriously lacking in an holistic or ecosystemic perspective.

We are not only facing shortage of wood but also food. For the last three consecutive years we have become dependent on food imports. The estimate of the food grain shortfall for the current year is about 13.5 million tons. Under such conditions land use planning should be a balanced combination of silviculture and agriculture. What should be done under such conditions can be ascertained in standard text books of plant sciences, indeed eminent foresters of the past in India had already laid down the methodology for land use for a genuine social forestry. The press release of the CCF and the policies pursued in social forestry by many Forest Departments appear to ignore such well argued observations. Maximisation of the use of our limited land res-

Table 1: Summary of the different perceptions on Social Forestry

Forest experts perception of the problem	Official steps for solution	Counter-expert's perception	Non-official steps for solution
Shortage of wood, especially firewood (Economic)	Maximisation of wood production through extension of forests into new areas, especially farmlands. With the help of quick timber producing species like Eucalyptus	Shortage of land for the satisfaction of all basic needs including food, fodder, firewood, green manure etc.	Maximisation of land use without displacing food crop and introducing deeprooted multi-purpose tree species in farmland for multilayer landuse
Lack of tree cover (Ecological)	Growth of plantations of tree species that survive without any effort. Hence choice of Eucalyptus	Lack of ecological stability and destruction of genetic diversity. Deterioration in the water and soil systems	Growth of tree cover with diverse tree species having soil-improving and water-conserving capacities. Improvement in genetic diversity
Lack of motivation of the people for tree planting (social)	Motivate individual farmers by providing free seedlings of species ensuring quick economic returns and no dependence on social organisation. Hence choice of Eucalyptus	Collapse of traditional community management of common resources like village forests and grazing lands. Lack of social mechanism to motivate plantation on the common	Ensuring social organisation to protect the villages wood lots for long term social interest and provide equal accesss to common resources

ources can be achieved only by mixed cropping of multi-purpose species. Such a strategy is not new to Indian people and has even been recommended by foresters of the highest rank.

The first Indian national to be appointed as the Inspector General of Forests of India, M.D. Chaturvedi as early as 1946 worked out a model of agroforestry that would increase fuel and fodder availability without harming food production. Recommending the planting of Babul as an agroforestry species in the agricultural land of the gangetic plains Chaturvedi (*Land Management*, UP Government Press, 1946 Allahabad) showed that it was possible to create farm forests equivalent to two million acres of pure Babul plantations, twice the area of the reserved forests in the region without any reduction in food production. "Being a deep rooted species it (Babul) does not compete for nutrition in the upper layers of soil which support agricultural crops. It provides excellent fodder, fuel, tannin bark and timber. Above all its attenuated leaf surface and the nature of its crown do not shade crops sufficiently to affect production". The stress on Eucalyptus as a dominant species in social forestry despite the existence of alternative workable models prepared by the highest forest officials of the country amounts to misuse of precious resources, both economically and ecologically.

Well known plant scientists Hall, Barnard and Moss in their famous book *Biomass for Energy in the Developing Countries* (Pergamon, Oxford, 1932, p.49) take the stand that:

> "In cases where land is scarce, *Agroforestry* systems have much to offer. Agroforestry involves the intercropping of trees with field crops, a practice which can allow food and fuel to be produced from the same land. The crops must be chosen carefully so that they complement rather than compete with each other. *Eucalyptus*, for example, is not a good agroforestry species due to its high moisture demand and its tendency to produce toxic substances".

In all types of land use, productivity in a sustained form can be achieved only through the maintenance or improvement of the natural mechanisms which keep the landform stable and the soil in place, maintain its fertility status and its water potential. Eucalyptus hybrid monoculture over large areas undermines those objectives of soil and water conservation. The Central Soil and Water Conservation Research Institute has just completed long term field experiments establishing that loss of groundwater system is greatly increased by Eucalyptus. Further, Eucalyptus does not contribute to the soil fertility. S.K. Seth, retired Inspector General of Forests of India has cautioned about the ecological unsuitability of such trends.

"Today there is a trend induced by much faster recycling in the whole economic field. That trend puts a premium on production and utilization of renewable resources over shorter and shorter periods. Thus, tree species which are fast growing and can be harvested in a few years (eg. Eucalyptus) are preferred to those which take longer to mature. . . . .

In the short term such processes may appear not to injure the inherent capabilities of the resources base, but since most of the processes which are responsible for maintaining the health and regeneration of complex systems, such as soil, are neither adequately understood nor are they amenable to continual or uninterrupted manipulation, it is debatable whether such strategies will not ultimately lead to irreversible degradation."

(Source: DST Seminar on Resources, Development and Environment, New Delhi, 1973).

The fears about the long term ecological impact of the fast growing species, as expressed by Seth have also been shared by a number of ecologists as well as farmers. The policy pursued in Karnataka is in contradiction to those views. In a press release the CCF stated that:

> "Eucalyptus is described by some as an ecological monster. This is because of pooling of the negative qualities of all the 650 species of eucalyptus. In general three species of eucalyptus have been used for draining marshes, but

Planting Trees—Indian Villagers take the decision into their own hands

Everyone agrees on the importance of planting trees, but the species of trees that should be used is a matter of controversy.

For years ecologists have been questioning the emphasis on eucalyptus trees in official tree planting programmes and now the farmers of Karnataka in South India have been moved to action. On August 10th, 1983 in Tumur district, 90 kilometres from Bangalore in the villages of Barka and Holatalli, they marched *en masse* to the nursery at Holatalli and pulled out all the eucalyptus seedlings, inserting tamarind seeds in their place. The farmers made it absolutely clear to the Forest Range Officer that they were opposed only to eucalyptus and not to the other saplings. On the contrary they assured officials that they would co-operate with them in planting other species. At first the police arrested some of the agitators, but when most of the villagers, some 1500 came forward, volunteering themselves for arrest, the police had little choice but to release everyone.

A few days later on the 15th August, 1983, a group of farmers from Neginahalla village in Koratagere Taluk (Tumkur district) gathered to continue their battle against eucalyptus trees. This time the forest nursery at Buddhigavi was the target. While the eucalyptus saplings were being pulled out, the police came and arrested the demonstrators, severely beating them up. However, when the police van carrying the arrested persons approached the village, the entire local population including women, came out in support, with the result that the police had to resort to truncheon charges and tear gas to disperse the crowd.

Farmers' experience:

As Ramaih, a 40 year old farmer from Barka points out, "Thirty years ago we had thick mixed forest, then some ten years ago eucalyptus was introduced to our area. For the first three to four years, the eucalyptus plantation was fenced and guarded, and we were not allowed to graze our cattle. Then after four years the eucalyptus had grown to such an extent that there was no fodder under the eucalyptus tree. Nor would the cattle eat the leaves."

Meanwhile, the problem of getting fuel also increased. "Previously," says one villager, "we used to get enough fuel from the forest, but after the introduction of eucalyptus plantations we were deprived of fuel. The eucalyptus tree grows with a straight stem without side branches and these are of no use as fuel."

Within six to seven years of planting eucalyptus, the village found itself with a scarcity of fodder, fuel and fertilisers.

Water Shortage

Siddaih—a farmer of Bettalagollahalli owns 3 acres of land near the stream known as Bilera Halla. He has used a 3HP pump for the past fifteen years. "I used to irrigate 1 to 1½ acres of land," he states, "and there was enough water all round the year in the adjacent stream. However, for the last three to four years, I have been able to irrigate only ¾ of an acre." Nor is Siddaih's an isolated incident. Three farmers who have pump sets near the same stream are all suffering similar shortages. Furthermore, the drying up of Bilera Halla has caused much hardship to the villagers during the summer months. As one villager said, "Earlier we would take our cattle to this stream in the summer. But now, as the stream is dry, we have to fetch water from the well."

The above experience is not restricted to any one village. It is repeated elsewhere in Karnataka where there are eucalyptus plantations. And to add to the problems, landowners have started cultivating eucalyptus instead of staple crops such as ragi. Consequently the demand for labourers has been reduced drastically and the food of the poor—ragi—which was previously sold at one Rupee or a maximum of Rs 1.50 per kilogram, went up over a span of five years to Rs 2.50 to Rs 3.00 per kilogram.

Pandurang Ummayya and Bharat Dogra

the species most used in India do not have that quality. The fast rate of growth of our eucalyptus is mistakenly ascribed to its requiring a large quantity of water. The rate of growth mainly depends on the ratio of water required to produce dry mass. According to the findings of the Forest Research Institute, the water required for producing dry mass in the eucalyptus hybrid is less than the requirement of rosewood, one of our own slow growing species."

It is however not correct that the Eucalyptus species being used in India do not have a high water requirement. As reported by the leading plant scientist R.K. Gupta *(Plants for Environmental Conservation,* Bishen Singh Publishers, Dehradun 1979) Eucalyptus is being extensively utilised for reclamation of waterlogged areas in Punjab and Haryana. Similarly Eucalyptus has dried up burrow pits common on roadsides. On that point Gupta states that "in low rainfall areas, its (Eucalyptus) roots form a network just below the soil surface to extract every bit of moisture. This results in poor undergrowth". The existence or otherwise of undergrowth in Eucalyptus plantations is, thus, a function of the water availability in the soil and the demand made by Eucalyptus. In arid regions where the use of water must be optimised against diverse requirements the critical factor is the absolute demand made by a species on the water regime and not the specific water consumption for dry matter production. The study made by the Forest Research Institute (FRI) is misleading and insensitive to the realities of drought-prone areas where water is a limiting factor. While the FRI study shows that the consumption of water per unit dry matter is less for Eucalyptus it is however much higher (Table 2) when total consumption is considered.

Eucalyptus does not affect water resources merely by its demand on them. The interception loss in Eucalyptus is strikingly low thus allowing the rain water to erode the soil by direct impingement. In a study by the Soil and Water Conservation Research Institute in

Table 2: Specific and total water demand for Eucalyptus and pine in mm rainfall equivalent

Species	Water Consumption	
	per gm of dry matter	Annual*
Eucalyptus	1.41 mm	1200 mm
Pine	8.87 mm	760 mm

*Source: Stalfelt's Plant Ecology (Longmans, London 1972)

Ooty, the interception loss in native shola forests was found to be 33.8 per cent, for Acacia 21.5 per cent and for Eucalyptus it was only 2.9 per cent (P. Samraj et.al. National Symposium on Soil Conservation and Water Management in the 1980's, Dehradun, March 1980). As a result of that low interception the runoff and soil loss increases with Eucalyptus. This fact has been well established in recent studies at the Ooty Institute. Further, Eucalyptus has a poor leaflitter that does not contribute to humus formation and infiltration of water into underground cavities. In this respect Eucalyptus is inappropriate as a species for ecological rebuilding. The lack of humus also affects its contribution to soil fertility. Moreover, the drastic transformation of soil chemistry in the process of leaching alkaloids prevents the germination of other species, especially in poor rainfall areas. In such arid zones Eucalyptus plantations are thus found to violate all ecological principles of maintaining life support systems and genetic diversity.

In view of such ecological problems afforestation policies predominantly based on Eucalyptus in the pursuit of short-term economic gains must be reviewed. Nor must we forget that such a *purely commercial approach has already succeeded in degrading vast reserved forests throughout the country.* Why did it happen? The sympathisers of Eucalyptus now argue that this 'quick growing' species is the miracle solution to the problems of the rural people, and "farmers want it". The true reality is that farmers want it only because pulp based mills throughout the country have pushed up the price of Eucalyptus and are paying handsome advance payments to the farmers. It is wishful thinking that without a strong social organisation, market forces on their own will benefit the common man, especially the poorer half of the population who have no purchasing power to create a demand on the market. Nor have markets alone ever been able to contribute to an ecological balance anywhere in the world. And to ensure social control over the utilization of natural resources, social forestry programmes need to be recast without linkages of justification with the market economy. That then is the task of forest officials as much as of rural social organisations. Without the realisation of this truth 'social' forestry will never be of any use to the majority of the people. Forest Management in India has to stop providing one-dimensional solutions based on one-dimensional understanding of problems and evolve to a higher level of systems analysis and understanding. The problem of species choice will automatically fall into place when the market forces will be screened out. *Success in the social forestry programme can be achieved not be making Eucalyptus the Kalpavriksh but by organising social controls on the utilization of common natural resources* and by expanding agroforestry with the help of deep-rooted multi-purpose tree-species.

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THE RED DEER OF SCOTLAND

The principal home of the red deer in Britain has long been the Scottish Highlands and Islands. They are believed to have come to this country from the Hartz Mountains of Germany when Britain was part of Continental Europe. Fossil fragments of bones and antlers, exhumed from British quaternary deposits, establish that they must once have been a third as large again as they are today, with antlers sometimes with as many as twenty-two points.

Deprived of the forest which once clothed much of Scotland's land surface, our red deer have been driven from the lower slopes to make way for sheep and have had to adapt themselves to more montane conditions. Their adaptability and enduring resistance have been remarkable characteristics. They have survived in Scotland where many other mammals have become extinct: the elk, reindeer, auroch, brown bear, wild boar and wolf. The late Professor James Ritchie expressed the opinion that the total number of red deer in Scotland in prehistoric times might have been about 700,000. The latest estimate from the Red Deer Commission of the total number now is 255,000, a fall of 15,000 following the severe winters of 1977/78 and 1978/79, when losses of calves occurred.

The Economic Pendulum: deer versus sheep

It was not till the second half of the Eighteenth Century that hill sheep farming revealed its possibilities. In 1760 it was begun in Dunbartonshire, in 1782 in Ross and Cromarty, and eight years later in Perthshire. With the incursion of Lowland farmers to the Grampians the conflict between deer and sheep was truly joined; and it may be said to have continued, in fluctuating degree, thereafter. In 1922 a Departmental Committee on Deer Forests reported that "The events of this period have been the subject of long and bitter controversy which is still a factor in all land questions in the Highlands."

The spread of hill sheep farming had far-reaching effects on the grazing economy. In some areas clansmen were sent packing, cattle were banished, and deer pushed back so that they took refuge on higher ground. For a time it seemed that deer might go the way of the wolf. Yet it was not the case that deer and farm stock could not sensibly be run side by side. The Atholl, Lochiel and Lovat forests were examples of long standing, likewise Invercauld and Glenartney. There was give-and-take; the sheep grazed on the forest in the summer and deer wintered on sheep farms.

The Commission of Enquiry into the Condition of the Crofters and Cottars in the Highlands and Islands of Scotland (1883-84) reported that "If it were not for the deer forests and, if the present condition of sheep farms is prolonged, much of the land in the Highlands might be temporarily unoccupied, or occupied on terms ruinous to the proprietor."

For a time the pendulum swung in favour of increasing sheep farming on high ground, but it was to swing in favour of deer. The first symptoms of reaction to the spread of sheep farming came from landowners who were driven to reclaim their forests in order to save their sport, and numbers of forests were cleared of sheep. Landseer's pencil and Scrope's pen stimulated support for deer-stalking, and it became evident that sheep rents could not compete with deer rents. We read that in 1845 "Lord Fyfe's part of it connected with Mar Lodge is at present let on a lease of some years for the annual rent of £1800." While others might not have done so well, the deer forest owner was then on an acceptable wicket.

Deer Forests: rise and fall

Inevitably the area of deer forests has undergone changes. But between 1883 and 1912 it rose from almost 2,000,000 acres to over 3,500,000 acres; since then, however, it has declined. During both World Wars steps were taken to increase the number of sheep on deer forests. The decline in deer husbandry did not, however, stem chiefly from that. For there was one detrimental effect of leasing stalking which must have told heavily against deer forest owners. Tenants will naturally tend to go for the bigger stags and those with the best heads, leaving the poorer ones as breeding stock. In some forests owners did their best to repair this by periodically giving their royals a 'jubilee year'. In fact the deciding factors were economic, for leasing stalking by the season became too expensive for many visitors.

The Menace of poaching

The owner was thrown back on the direct sale of venison as his source of revenue. It was one thing for him but another for the poacher who had none of the outgoings to meet, and during the first half of this Century there was poaching galore, for until 1959 it was not an offence to shoot deer at night. There was sanction against poaching by day but, as the penalty was only £2, the poacher was in clover. The position contrasted with that in England where, under the Larceny Act 1861 a second offence carried a maximum penalty of two years imprisonment.

A gang could boast that they would slaughter 500 deer in a season; a lorry could go the rounds of butchers in Inverness. The British Field Sports Society drew attention to the number of deer that escaped wounded and lingered on solitarily with their injuries.

Set up in 1949, the Nature Conservancy began forming National Nature Reserves, the first being at Beinn Eighe in Wester Ross. But even on these the maximum fine which could be imposed under bye-law was only £5 and poachers continued their activities. This ludicrous penalty contrasted strangely with comparable fines elsewhere. (Thus in Italy the fine for poaching a steinbock on a Nature Reserve was

based on five times the value of the animal alive; at that time it worked out at the equivalent of about £575.) Moreover the rabbit, an acknowledged pest, had long had protection under our laws against shooting at night. It seemed a curious equation of values that the repeated shooting of rabbits, not necessarily on a Nature Reserve, should carry a penalty of £50.

The Provision of Protection

Following representations by the Nature Conservancy the Government in 1958 introduced the Deer (Scotland) Bill which became law in the following year. It provided for close seasons and fines for poaching; the maximum penalty on summary conviction was £100 and six months imprisonment, and on conviction on indictment of £500 and two years in prison. The same Act set up a Red Deer Commission "with the general functions of furthering the conservation and control of red deer."

Conclusions

We have noted the extraordinary adaptability of red deer and, before closing, it is worth turning our attention to New Zealand where it has been demonstrated to be remarkably swift and illustrates what we might expect if, by some magic, we could recover the forested Highlands that our ancestors once enjoyed. There are no mammals native to New Zealand; all, even rabbits, have been imported. There is an abundance of woodland, some of it dense, and of pasture, both of which have been preserved, for the land has long been the basis of the New Zealand economy. The last consignment of red deer from Scotland were sent out in 1909. When the author was there in 1929, red deer stags weighing forty stone occasioned no surprise; a comparable figure for Scotland today would be about fourteen stone.

We have, however, to look ahead and we can gratefully find satisfaction in the work of the Red Deer Commission which is now twenty-one years old. For today we take pride in the noble red deer of Scotland which have been here since prehistoric times and in our own generation at least enjoy our care and effective protection.

R.A. Haldane

WEST GERMAN REPROCESSING PLANT

Inadequate Safety Report

At the end of September, 1983, the "Safety Reports" for the reprocessing plants to be built near Dragahn (Lower Saxony) and Wackersdorf (Bavaria) were laid open to the public as part of the nuclear licensing procedure. The law requires that a safety report for a nuclear installation describes the plant as well as its possible effects and risks for the environment.

The reprocessing company DWK has now applied for the first partial construction licence which will include the spent fuel entry store and the foundations of the main process building. Meanwhile the first partial construction licence can be granted only if the concept of the whole plant has been examined and found satisfactory.

So much for theory. In practice, DWK's "Safety Report" is grossly inadequate making it impossible for anyone to determine how safe the reprocessing plant will be. In fact the safety report for the Gorleben reprocessing plant, submitted in 1977, consisted of about 3000 pages; even so, at the Gorleben Hearings, 1979, it became clear that there was insufficient detail. The Gorleben plans were subsequently stopped. The new "Safety Reports" consist of merely 600 pages; both being practically identical. In particular, the following crucial data are not contained;

- Exact measures of plant components, including volume of tanks; flow rates at different points in the process; positions of monitors for process control.
- Detailed description of filter systems, which alone would make it possible to check DWK's values for radioactive emissions.
- Description of apparatus for emission monitoring and of sampling programmes for control of environmental contamination in other than the most general terms.
- Adequate discussion of possible accidents—many accident sequences are declared impossible without detailed proof, and no accident which would lead to the destruction of off-gas filters is considered. Severe criticality accidents, for instance, are excluded solely on the basis of laboratory experiments which in no way represent actual plant conditions.
- Estimation of radiation exposure to workers in the plant.
- In some process areas, DWK does not even commit itself as to which technology it will use, for example for high-level-waste vitrification, only two candidate processes, one French and one German, are presented.

The citizens of the concerned areas, as well as environmental organizations, are clearly and understandably outraged. That the licensing authorities have accepted safety reports of such inferior quality shows that they do no take their own controlling function seriously and that the licensing procedure is a sham operation where, in effect, DWK is free to do whatever it may choose.

Concern is particularly high since even DWK's short reports—which appear to be written by its public relations department, not by technical experts—give reason to show that legal limits for radiation exposure will not be complied with. For example, DWK assumes that, in normal operation, only about 1 part in 500,000,000 of Strontium-90 will be emitted with the off-gas. No reason is given for such optimism. Actual operating experiences in real reprocessing plants indicate values higher by several orders of magnitude. Even if the actual emissions were to be only ten times DWK's value, the whole-body as well as bone radiation exposure in the surroundings would be several times the maximum permissible dose.

It is to be hoped that the nuclear industry's strategy to achieve a fast and easy licensing procedure by not giving any detailed information will backfire and that resistance will be strong enough to tear to pieces not only the "Safety Reports", but also the reprocessing ambitions as a whole.

Helmut Hirsch

Books

High Technology Euphoria

THE AWAKENING EARTH, Our Next Evolutionary Leap, by Peter Russell, Routledge & Kegan Paul, 1982, £4.95

This book has had considerable publicity and appears to have been a publishing success. The author recognises the extent of the ecological problems faced by the world today. He recognises too that something drastic has to be done to prevent massive catastrophies. This is as far as I go along with him. In fact I disagree with just about every other point he makes, reflecting as they do a world view that is diametrically opposed to mine.

Russell's world view has much in common with that of Teilhard de Chardin and also with that of Ilya Prigogine and Eric Jantsch and their disciples within the intellectual community, especially on the continent of Europe. It follows that many of my criticisms of the ideas of Ilya Prigogine and Eric Jantsch, that appeared in my article 'Superscience: Its Mythology and Legitimisation' *(The Ecologist,* Vol. 11 No. 5) would also apply to those of Peter Russell. I shall consider them very briefly.

To begin with Peter Russell does not seem to be acquainted with the anthropological literature. If he were, he would realise that man is not just an individual member of a planetary community as he suggests, which to me is not the lesson to be drawn from Lovelock's *Gaia* hypothesis. Natural man—that is man living as he has lived until very recently in a traditional and vernacular society—may well have seen the world as a single living creature. He may also have entertained the idea of an earth goddess of some sort—but she played a small part in his religious life. The basic feature of 'primitive', and hence natural, religion is that a people's pantheon reflects its social structure and its view of the structure of its natural environment. Since the extended family is common to all traditional societies (with the possible exception of the Eskimos) the family gods—the spirits of his dead ancestors—are those which will play the most important part in its religious life. If the extended family is organised into clans and tribes, then the gods of those social units will also play a part in its religious life. It is only when society disintegrates and there is no longer an extended family, a clan and a tribe, that the corresponding gods become redundant and monotheism begins to rear its ugly head. Monotheism (whether the single god that is worshipped is termed 'Gaia' or not) is the religion of an individualistic society, hence a disintegrated society, one in which social controls are no longer operative, and whose behaviour is thereby chaotic and inevitably tends towards disaster. (See E. Goldsmith. *The Stable Society,* WEC, 1975).

In common with Prigogine and Jantsch, Russell has reacted against the reductionism of modern science and has adopted the language of General Systems Theory. Now I am a great admirer of Ludwig von Bertalanffy, the founder of General Systems Theory. I have subscribed to the paper he edited until his death—the *General Systems Yearbook*—for more than twenty years. I have written in it and spoken at the meetings organised by the association that publishes it. But it has always been clear to me that this whole subject suffers from a terrible flaw: the term 'system' has never been adequately defined. A lot of attempts have been made to do so—I could draw up a list of the various definitions provided—but none is satisfactory.

The reason is that the term is used far too loosely. To be useful, it should be used to apply to the natural constituents of the biosphere at every level of organisation. It is clear that humans, whether they be Eskimos, Watutsi tribesmen, Polynesians or Europeans have sufficient in common to justify being included in the category of 'humans'. It is clear too that elephants, sloths and voles, though they look very different, have enough in common to justify their inclusion in the category of mammals. It is less clear to most people however that organisms, families and real communities, (by which I mean tribal groups), and ecosystems also have a sufficient number of things in common to justify their inclusion in a category for which there was until recently no term.

Von Bertalanffy proposed the term 'system'. (I am not sure if he was the first to use the word in this sense. It may have been Paul Weiss.)

The features that all systems have in common are clearly of a general nature—much more general than, for instance, what mammals and humans have in common—but it is the general features which are, after all, the most fundamental. Thus, all natural systems can be shown to be self-regulating: so too, they tend to maximise stability, which means reducing to a minimum the discontinuities to which they are subjected. To that end, they make use of information which, as I showed in a recent article (see *The Ecologist* Vol.12, No.3), tends to be organised in the same way—in order, that is, to constitute a model of their relationship with the environment, and a hierarchical set of instructions for maximising its stability.

By establishing what all systems have in common, it is possible to draw up a set of rules which can be shown to govern the behaviour of systems in general. Only then will one have the basis of a General Systems Theory.

The term 'system' loses its interest when an 'import company' or an 'airline' or an 'oil-pipeline' or a 'smokestack' are seen—as Russell sees them—to constitute a 'system'. Indeed, if everything is a system, then nothing is not a system—and the word ceases to have any meaning.

Of course, Russell's use of the word reflects another aspect of his world-view which again he shares with Teilhard de Chardin, Prigogine and Jantsch. All of them believe in 'progress' which is possibly the most fundamental dogma of what we might refer to as the world-view of industrialism, a world-view with which we have all been imbued since our most tender childhood. Progress is a gratuitous assumption. The word itself has never been defined, but it is assumed to coincide with the development of science, technology and industry and, hence, with the creation of that totally man-made world which is often referred to as the 'technosphere'. That this process can really lead to the long-term improvement of man's lot on this planet is one of the most naive, simplistic and pernicious of all the myths ever entertained by man. We have shown, in *The Ecologist*, during the last thirteen years, that it is this process that is in fact causing all the social and ecological problems which we face today and that, rather than be regarded as progressive, it must on the contrary be viewed as *highly regressive.* This is clear if we consider that the technosphere or surrogate world can only expand at the cost of causing a corresponding contraction and degradation of the biosphere or real world of which we are part—since it is from the latter that it derives the resources it makes use of and it is to the latter that it must consign the increasingly toxic waste products that it must inevitably generate.

Unfortunately those who believe in progress almost invariably see the process they identify it with as an integral part of the 'evolutionary' process. This is clearly a device for rationalising and hence legitimising it by making it appear natural, beneficial and indeed inevitable—the qualities normally ascribed to evolution. This device is clearly made use of by Russell who tells us that "we can sit here and wonder at the whole evolutionary process which has step-by-step resulted in me and in you, in farms, automobiles and computers, in men walking on the moon, in the Taj Mahal, the Emperor Concerto and the Theory of Relativity." So too, he refers to the modern world of man-made artefacts as "a gaia-like complex being" as if in fact it were the natural product of the evolutionary process.

Of course the opposite is the case. The systematic annihilation of the world of living things—the inevitable concomitant of the expansion of the technosphere—can only be viewed as a reversal of the evolutionary process, as *anti-evolution* as opposed to *Evolution* (see E. Goldsmith Thermodynamics or Ecodynamics? *The Ecologist*, Vol. 11 No. 4).

This leads us to Russell's view of how we should solve the terrible problems that confront us today. According to Russell, man must exploit fully the possibilities offered by his 'consciousness' (a term that is particularly dear to Teilhard, Prigogine and Jantsch) in conjunction with the limitless possibilities offered by modern science and technology. In this way man can determine his own evolution and create a veritable paradise on earth. One of the most powerful of the tools that modern science makes available for achieving this end is, Russell tells us (as does Prigogine), genetic engineering.

"Recently", he informs us, "human beings have become more than just passive observers of the living world. Within the last decade biologists have also learnt how to modify the genes in a cell, opening the door to the creation of completely new species. No longer must the evolution of new lifeforms follow the slow process of trial and error, and natural selection. They can be consciously designed and created within a matter of months.

"From an evolutionary perspective, this is a most significant event. The only innovation which previously expanded life's ability to diversify itself on such a widescale was the development of sexual reproduction by simple cells two billion years ago. Yet even this capacity took a billion years to evolve; human science has achieved a comparable step in just a few hundred years."

Atomic physics, we are assured, will also contribute to our further evolution. "With the advent of particle accelerators, scientists once again became more than just passive observers. They were now able to change some elements into others, or even create completely new elements, by bombarding the nucleus with atomic particles and thereby changing its structure."

The invention of the solar cells, he also tells us, "represents an evolutionary development as significant as that of photosynthesis 3.5 billion years ago." Moreover, we shall soon be able to influence our 'evolution' by means of our growing ability to colonise space, "a development as significant as the colonisation of land by the first amphibians 400 million years ago."

The micro-electronics revolution is also transforming communications in a host of different ways and "the combined effect of these developments has been the progressive linking up of humanity, a trend which is crucially important for the further evolution of humanity, and whose evolutionary parallel can be found in the emergence of the first multicellular organisms one billion years ago."

Russell is so impressed by all these developments that he is led to ask whether "the rapid acceleration so characteristic of today is heading us towards an evolutionary leap." Indeed he goes further: "Could we be on the threshold of a leap as significant as the evolution of life from inanimate matter?"

Russell is undoubtedly an optimist. He even sees the world population explosion—as does Prigogine—as highly beneficial. "The human population has been rapidly expanding, and many see this as a negative trend. But from an evolutionary perspective, increasing numbers are vital, as they contribute to the complexity upon which evolution builds." Here, needless to say, he is misusing the term 'complexity' which cannot, by any stretch of the imagination be made to apply to the massive anonymous proletariat that is being built up in the cities of the Third World as a result of the current population boom. (For a discussion of 'complexity', see E. Goldsmith, 'Complexity and Stability in the Real World', *The Ecologist Quarterly*, Autumn 1978).

The question we must now ask is what sort of paradise are all these developments creating for us? The answer is apparently a totally integrated world system in which we all live together in a sort of high technology global village. He even talks of "a global brain" in which everybody's brain cells will be linked together with everybody elses by means of modern communications technology.

Eventually, he tells us, we will reach a time "when the billions of information exchanges shuttling through the networks at any one time create similar patterns of coherence in the global brain as are found in the human brain. Gaia would then awaken and become her equivalent of conscious."

Russell then tells us that the world-view with which we have been imbued since the industrial revolution must be radically transformed. He explores other possible world views; the Chinese one for instance, that of the perennial philosophers and that of the new mystical physicists. It all sounds very ecological but his conclusion seems to be, if I understand him correctly, that all these ideas must merge and that this will permit the development of 'psycho-technology'. This is to be "the application of technology to improve the functioning of the mind and raise the quality of experience and the level of consciousness."

Indeed, no part of Gaia is to be left alone. She is to be devastated by developers of all sorts. Nuclear physics is to be used to transform her very atoms, her basic building blocks: the genes of her living inhabitants are to be systematically reorganised by genetic engineers; photosynthesis, the means she has evolved for harnessing the power of the sun, is to be superceded by solar technology; and the minds of her human inhabitants are to be totally reshaped by psycho-technologists".

It is difficult to see how Russell can advocate such a programme and, at the same time, express his belief in the age-old cult of Gaia, the Earth Goddess. The basic principle of such a cult must be that Gaia is perfect, indeed sacred, which means that she must be left inviolate, preserved in all her perfection, splendour and sanctity.

The programme Russell advocates is, on the contrary, based on the assumption that God (or whoever created the earth) did a bad job, that Gaia is most imperfect and most unsplendid and indeed—far from being holy and inviolate—requires the most radical possible transformation.

The rest of the book consists of euphoric ravings about the New Age that all these activities will bring about. Russell 'thinks big'. The setting up of his global high-technology village, he considers, may well be too paltry an achievement. It may well be that the whole galactic system should be transformed into a global village, and one whose parts are so closely integrated that, like both man and Gaia, it may develop its own consciousness.

Indeed, he writes: "Could the universe as a whole be headed towards becoming a single Universal being?" This would have dramatic implications. "If, over thousands of

millions of years, the ten billion galaxies in the Universe not only evolved into galactic super-organisms, but also began to interact and communicate with each other, there might come the final stage of evolution—a universal super-organism." A seventh level of evolution (I am afraid I have not bothered to describe the other six) might then emerge," a level we could call Brahman, after the Indian word for the wholeness of the Universe in both its manifest and unmanifest forms."

"If this were indeed the final evolutionary development, it would in some respects bring the whole process full circle. Beginning from a unity of pure energy, the Universe would have evolved through matter, life, consciousness, Gaias and galaxies to a final reunion in Brahman. From a unity of total non-differentiation it would have evolved, through the most multifarious diversities, to a unity of total integration. From Brahman to Brahman."

How any serious person can take this naive and euphoric drivel seriously is very difficult to understand, yet a lot of people seem to. But then, of course, so do a lot of people take Teilhard de Chardin, Prigogine and Jantsch very seriously—Prigogine in particular for he is a scientist and has been awarded a Nobel prize.

Perhaps part of the answer is that some of the basic assumptions which underlie their writings also underlie what we might refer to as "the world-view of science". Scientists as a body have accepted the individualist view of man. They need it in order to justify the reductionist or 'analytical' method so dear to them. By disregarding the importance—indeed in many cases the very existence—of societies and ecosystems as essential constituents of the biosphere, they can also ignore the social and ecological constraints to which the behaviour of the individual must be subjected if it is to tend towards the maintenance of stability at these and other levels of biospheric organisation. That, in turn, enables them to see the hierarchy of the biosphere as being essentially malleable, which it must be if the totally destructive nature of the Baconian enterprise—to which they are ever more committed—is to be effectively dissimulated.

The Baconian enterprise, of course, is only justifiable if we accept the principle of 'progress'. Moreover there seems no more effective way of rationalising that myth than by viewing scientific, technological and industrial progress as part and parcel of the evolutionary process itself. It is an assumption that has been made by almost all of our philosophically-minded scientists—from Jacques Monod to Sir Peter Medawer and even the great C.H. Waddington. It is also an assumption that is totally gratuitous.

Edward Goldsmith

Elephantine Mistakes

IVORY CRISIS by Ian Parker and Mohamed Amin. Chatto and Windus The Hogarth Press £14.95.

I wish this absorbing, informative and above all, disturbing book had not been brought out looking like a coffee-table gift volume—as it is I am afraid that some potential readers will pass it by in their bookshops, not guessing that it is important. I hope a paperback edition is planned—never mind that some of the stunning photographs by Mohamed Amin will be less glorious when reduced, because, good as they are, it is Ian Parker's text that matters. Here is a story that should be read by all who support the philosophy of conservation and who give their money, their time and effort to both national and international conservation organisations. If I am unhappy with the glossy presentation of this book I am also uncertain about its title—for the author's thesis from beginning to end is that there is in fact no ivory crisis (there are over a million elephants in Africa at present) but that there is a serious crisis in conservation philosophy. Is *Ivory Crisis* going to grab the right readers? I hope so.

Concern for the survival of the world's elephant population has been around for a long time—Pliny forecast their demise in the first century AD and others have done so, increasingly, for the last two hundred years, for ivory has always been highly prized and the ivory trade has always thrown up its villains and horror stories. You don't need to be an elephantophile to regard the threat of its extinction with horror, indeed it seems to be in everyone's interest, be he naturalist, trader, hunter, poacher or game warden, to preserve the elephant—and yet it is inexorably borne into the reader's astonished and unwilling mind, that it is the conservationists who pose the greatest threat to these mysterious and awesome giants. Ian Parker's book struck me as being a cry of rage—subtly clothed in tones of common sense—against the appalling muddles, secrecy, duplicity and complicity of conservation organisations, and his greatest condemnation is for highly respected international bodies such as IUCN and the World Wildlife Fund. "The evidence", he writes in his introduction, "is both glaring and irrefutable: conservation is a field which has become characterised by lies, half truths and outright distortion". In the chapters which follow he presents his case.

On the subject of culling—now extensively carried out to maintain a manageable population in the game reserves or wherever animals may be dying from the results of famine or drought—Ian Parker is pragmatic. While he accepts that there is widespread public distaste for killing wild animals—especially those in reserves—and a widely held conviction that anyone who embarks on culling on a commercial basis "may be a criminal and certainly cannot be a conservationist", he points out that the profits from the sale of carcasses and ivory brings in much needed revenue for governments who do not find it easy to allocate funds for the conservation of game. "The death of an elephant", he writes "is no more impressive than the death of a mouse compared to the felling of a giant 1000-year-old mahogany".

While the ivory trade remains important and profitable abuse will certainly continue, but nowadays the malpractices are found not so much among the poachers and traders—those traditional villains in the story, as among corrupt officials in government offices, those in positions of trust and in conservation organisations. The differences that show between the low official figures for exports of ivory, and the high figures that are returned by importing countries do not reflect illegal trading but, Ian Parker suggests, deliberate distortion on the part of governments who wish to present an image of conservationist morality.

Ian Parker has spent most of his working life close to African elephants—first for some years with the Kenya Game Department and later as a wildlife consultant. His first-hand knowledge is evident throughout this book which is full of marvellous anecdotes, background history and elephant law. The two chapters on the Wata tribe (sometimes miscalled the Waliangulu) elephant hunters of great skill, for whom he has a high regard, make it clear that he could have written a successful book about his African experience without any 'message', for whether he is writing about friends, Wata 'aces' (supreme hunters) or elephants; whether he is retelling ancient folklore or filling in historical background, he does so with warmth and humour which make him a pleasure to read. His purpose, however, is to throw a searchlight onto the current state of the elephant in Africa and by doing so to improve its chances of survival into the future. Here it is in a

nutshell:

"To me the situation is straightforward. The ivory trade *per se* does not pose the greatest short-term or long-term threat to elephant survival. This role is taken by human increase. It is equally clear that elephant conservation is an extremely complex matter, varying greatly between countries across Africa. The conservationists' own data do not support their conclusions. They contrive their case to make it appear simple; they contrive to make the elephant's case very much worse than it is; they contrive to present the cause as rapacious greed for ivory; and, by turning attention away from the *real* sources of trouble, they themselves become a threat to successful elephant conservation."

This is a hefty accusation. Will the conservation organisations come out and refute it?

Ruth Lumley-Smith

Where has all the food gone?

FOOD AID and POLICY for ECONOMIC DEVELOPMENT, An Annotated Bibliography and Directory by Melissa Lawson Cadet, Trans Tech Management Press, PO Box 23032, Sacramento, California 95823, $19 US.

This is not the first annotated bibliography to appear on this subject in recent times, there appear to have been two others. The first was Elizabeth Henderson's *Selective Annotated Bibliography on Food Utilization for Economic Development* published by the FAO in Rome, which includes 404 entries and covers the period 1954-64. The second is Miloslav Rechcigl's *World Food Problem: A Selective Bibliography of Reviews*, (CRC Press 1975, Cleveland, Ohio). This seems to cover the world food problem in general, though part of it at least is devoted to the question of food aid. So it seems time for a new up-to-date bibliography on this subject.

Food Aid and Policy for Economic Development is very well done. It contains 445 entries—covering the period 1968-79. The entries seem to be chosen with relative objectivity, not just those putting forward a specific view of food aid.

The bibliography contains a considerable number of US Congressional Committee reports and other fairly official documents—reports from OECD for instance. It also contains entries from what one might refer to as alternative sources, such as Susan George and Frances Moore Lappe.

Unfortunately there is little reference to books and articles written in a language other than English. No reference, for instance, is made to the works of René Dumont, Francois de Ravignan and other French critics of food aid.

In addition to the listings, Melissa Lawson Cadet provides an 'Author's Guide', giving a short curriculum vitae of the authors of the books and papers referred to, and also a 'Directory of Food Aid and Development Agencies'—a fairly complete one at that with about 150 entries.

All in all, this is a very useful document which all those interested in the problems associated with economic development should arrange to have access to.

Edward Goldsmith

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The Ecologist, Worthyvale Manor Farm, Camelford, Cornwall, U.K.

Genetic Engineering—a new call for scrutiny

Genetic engineering has moved into its commercial phase, according to its entrepreneurs and 'venture capital' investors. Yet serious questions remain about the economics, and in many instances, even the basic scientific feasibility of many 'gee-qhiz' GE projects. For example, humantype insulin from GE'd bacteria in cultures has been much longer reaching commercial production than was claimed by its would-be producers; and the notion that it could be anywhere near as cheap as the (largely satisfactory) pig insulin, now made as a byproduct, is about as plausible as the claim that nuclear power would be cheap.

Of greater concern to ecologically-aware people are the hazards of GE, ably scanned by Dr. Straton in *The Ecologist* (Vol 7 No. 10). Those wishing to commercialise GE have lately been saying that the hazards envisaged in the mid-70's, when discussion began, have now turned out to be unreal—not merely improbably but actually impossible.

A recent, superb book, Liebe F. Cavalieri's, *The Double—Edged Helix—Science in the Real World* (Columbia Univ. Press 1981) completely exposes the dangerous euphoria of the GE enthusiasts. It claims that the ecological effects can be foreseen of deliberately or accidentally released organisms, which have been assembled with more or less radically new sets of genes from two or more types of cell or virus (for example human genes inserted into the genome of bacteria of yeasts) are shown up as unjustified in the light of what can go wrong in even ordinary 'uncontaminated' cultures.

For instance a recent report in *Nature* (25 August 1983) tells us:

"Flow Laboratories Ltd., of Scotland, one of the major suppliers of liquid cell culture media, have notified 179 British customers that media supplied between March and May of this year may have been contaminated with the mycoplasma bacterium *Acholeplasma laidlawii*, better known as a contaminant of tissue cultures introduced from biological sources. . . . .about 12½ per cent of the company's sales over the period. . . . .the water supply was responsible. . . . .was purified by deionization. . . . .since the contamination problem was detected a stage of reverse osmosis has been added. . . . filter pore sizes have been reduced from 0.2 mm (considered adequate to remove most bacteria) to 0.1 mm and all batches are now being tested specifically for Acholeplasma. This effectively ensures that further contamination cannot occur, although the company admits it could be seen as "shutting the stable door after the horse has gone in a big way....". For customers who received contaminated media, the problems are most likely to be with long-term cultures, from which experimental results will be, to say the least, questionable (or according to one scientist, "totally useless"). . . . .Some individuals are considering seeking compensation. . . . ."

Many questions are raised by this story. For instance, what is the evidence that filter pore sizes of 0.1 mm will suffice, when 0.2 mm was 'considered' (by whom?) adequate to remove only 'most' bacteria? What other undetected contamination has been going on? How much would proper purification of water have cost Flow Laboratories? Why was proper monitoring not routine?

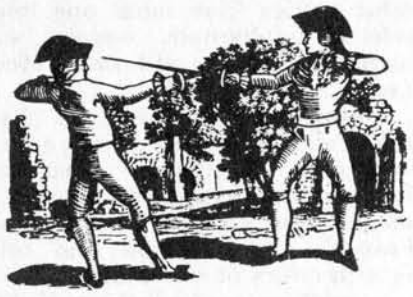
The truth is that, under pressure to get or save money, commercially-minded people decrease safety. In New Zealand two decades ago, a million children were dosed with oral 'Sabin' poliovaccine which the Health Department and its medical school advisors knew to be heavily contaminated with a recently-discovered 'monkey' virus, SV40. The Health Department assured parents in writing that the vaccine had been thoroughly tested and was known to be safe. SV40 has since been found to cause tumours in hamsters, and the assumption that it would have no effect, except in monkeys, was always reckless. The Department and its advisors could have preferred another Sabin vaccine known not to be contaminated with SV40 but costing £100,000 more. No studies have been done on the victims. This atrocity is notorious in New Zealand, despite neglect by the daily media and 'disappearing' of relevant files.

The scope for accidental, or even deliberate, administration of contaminated material from cultures of cells or tissues is known to be nontrivial. It cannot be neglected. This latest story in *Nature* is unlikely to be unique in quality; it is almost certainly only the tip of a sordid iceberg.

Meanwhile, the genetic engineers in the research laboratories strive competitively for 'glory', and are becoming increasingly connected with commercial ventures. They have had an eerily easy run of it; the concerns of Straton and Cavalieri must be brought to the fore as they unfortunately never have been.

Robert Mann

Dr. Mann, a biochemist is in charge of the Environmental Studies course in the University of Aukland, New Zealand, and is a member of the NZ government's Toxic Substances Board.



Letters

FREE PEOPLE ARE RESPONSIBLE FOR THEIR OWN DEFENCE

Dear Sir,

When I read Edward Goldsmith's editorial in the last issue of The Ecologist *I reflected that in the first time in my experience on this planet such views have been published in this country by somebody else. I have tried frequently to make the very points made in this editorial but never with success and I believe this is owing to two reasons. One, such ideas are wholely abhorrent to Establishment publications which are lovers of everything centralist, like huge regular armies, nuclear weapons, nuclear power and all the rest of it. Two, they are equally abhorrent to the Alternative press because the latter will never publish any views that are not uncompromisingly pacifist. Therefore the advocate of Citizen Defence is quite sure that unless he happens to be editor of his own journal his voice will not be publicly heard.*

When I was a free citizen of that reprehensible country South West Africa, now called Namibia, long before the Second World War but not before South Africa had got its independence from the British Empire, I had an official notice to tell me that it was my duty to present myself, if required to do so, to my Veld Cornett, whose name was Menheer 'Vatje' Cronje (vatje was Afrikaans for barrel—the man was shaped somewhat like that), with a horse, a rifle and two hundred rounds of ammunition, because I was a member of the Franzfontein troop of the Outjo Commando of the local Defence Force.

I thought at the time what a most excellent and effective defence system this was for a country. It was this system, of course, which enabled a handful of scattered farmers to keep at bay the greatest empire the world had ever known for two years (in what we have been taught to call 'The Boer War'), and it is the only system ever invented that is capable, at very little expense, of putting into the field an army made up of every single fit adult male in a country (and female too, if the females want to join in the games normally reserved for the boys) and neither Napoleon, nor Hitler, nor Julius Caesar, nor anybody else with the possible exception of Genghis Khan was ever able to do that.

Not that this system has many advantages that Teddy Goldsmith did not have the space to mention in his article. The first and most important one is that an army made up like this has no offensive capability whatsoever. Such an army, if army it can be called, cannot invade another country. All it can do is defend its own. Since the Swiss cantons have organised themselves in this way Switzerland has never invaded even one of its neighbours and, even more significantly, not one of its neighbours has invaded Switzerland. The Germans and Allied trenches ended abruptly at the Swiss frontier during the 1914-18 War just as if they had come to the edge of a flat planet.

Another advantage is that the people who compose such an army can go on doing their ordinary work right up until almost the moment when they are required to go into action. The work of the country can just go on unhindered, and it is not necessary as in conventional military systems to pay and feed a large regular army of people idle for almost the whole of their lives.

Teddy did mention one of the most important advantages and that is the building up of 'real local patriotism' by this method of defence. If I know I have got to stand shoulder to shoulder with my neighbours to repulse the invader, if there ever is one, I am likely to develop strong feelings of unity with them. Old members of the Home Guard still talk of the enduring friendships they made while serving in it and the abiding feeling of loyalty they still feel for their own locality.

An advantage he did not mention is that the development of a centralised despotism is impossible with an armed citizenry. Neither Hitler nor Mussolini, nor Lenin for that matter, could have seized power in a country organised in this way.

And, to counter the jibe of "do you think you could keep the Russians out with something like Dad's Army?" the answer is that, yes you could. The Russian Empire, vast though it is, could never get more than ten million soldiers into little Great Britain and Dad's Army could easily field four times that number, and more if the ladies were inclined to join in. The invaders would be faced with very good modern weapons carried by people well trained to use them, from every ditch, bush, house and hole-in-the-ground in the country, wherever they went they would be shot at. To wipe out the headquarters would not help them for such an armed citizenry needs no headquarters, and the defenders, as Teddy points out, would be defending their own territory—their own back yards in fact. They would never give up. They would be invincible.

I know such ideas as these are unpopular in contemporary Alternative circles. We are all supposed to be pacifists now. So we advance no defence alternative and leave it to the nuclear missile boys. Who can, after all, justifiably say: you won't put forward any proposals—therefore we've got to do something our way.

It's fine being a pacifist—until your own village is under attack.

I put forward these views in a book "BRING ME MY BOW", published by Turnstone Books in 1977. Nobody took any notice of them then and I don't suppose anybody will take any notice of them (and Teddy Goldsmith's) now. No harm in trying though.

Yours faithfully,
John Seymour,
Killowen,
New Ross, Co. Wexford, Eire.

TOO MANY NUTS

Dear Sir,

The article "Permaculture" by Penny Strange (Ecologist Vol.13, No's 2 & 3) contains a most remarkable statement. "Trees are outstanding in that respect, an acre of black walnut trees being as much as 400 times more productive than an acre of wheat". The black walnut, (Juglans nigra) is an American species, so the comparison is with the US average of one

ton (2,000lb) an acre of wheat, not the British figure of over 2 tons of 2,240lb. This gives the fantastic yield of 400 tons, or 25 tons from each of the 16 trees on an acre, which is worth, at the average wholesale price of £50 for a US hundredweight of 100lb, £1,000 a ton, or £400,000 an acre.

The black walnut is a timber tree; its nuts have thick shells that are very hard, but why is not the Third World fed from walnuts growing on every acre of suitable soil producing 180 tons of high protein kernels and 220 of fuel? How is it that the slow growing hardwooded walnut is producing vastly more biomass than the fastest willow, (Bowles Hybrid): gaining weight at 32 tons an acre, beating the bamboo and every tree in the world?

The answer will be found in "Tree Crops - A Permanent Agriculture" by J. Russell Smith (Harper & Row, New York 1950) on page 232, where the average yield from 165 black walnut trees at 16 to the acre from 1940 to 1947 in Ohio is given as 2 bushels a tree, or 320lb of kernels an acre. In Essex there is a big walnut plantation that averages 10 tons off 25 acres, which is 358lb of kernels an acre, but as this is for hybrids of J. regia, —the Common or Persian walnut—the Ohio tonnage would be rather greater, perhaps a ton an acre. The figure given by Penny Strange is entirely inaccurate, as anyone who has ever seen a field of wheat or an orchard of walnuts will know.

Furthermore, she states that Permaculture designers are strangely handicapped. "Some have training in architecture, others in landscape gardening or farming, still others have no relevant prior training at all." They do not, it seems include any foresters, fruit farmers, or commercial growers, who would like to know how many chickens and how much reflecting area of ponds will heat an acre of glass in February. Until Permaculture enthusiasts can quote accurate figures, and show successful commercial holdings, they are merely discrediting what could be a very important development in world agriculture and horticulture.

Yours faithfully,
Lawrence D. Hills, Director,
Henry Doubleday Research Assn.
Bocking, Braintree, Essex.

THREAT TO FORESTS

Dear Sir,

Suggestions to campaign together in a certain field must seem to you rather boring. After all you have joined battle with the forces of evil in numerous theatres of war and on countless occasions already. However the dying woods of Central Europe may open up a new front on which valorous fighting could—for a change—be crowned by success.

A few facts to begin with. The damage done to the woods by poisons (sulphur dioxide, ozone, heavy metals etc.) blown along with the winds and washed down in the rain has so far been considered marginal in our countries. The figures given to the area known to be negatively affected went from 3 to 6 per cent of total forest acreage. Now all of a sudden large tracts of woodlands are breaking down. Worst hit are fir- and pine-trees as well as spruce. But other kinds of trees are showing signs of becoming appallingly desolate as well. According to the association of private forest owners in West Germany every fourth tree has been damaged. (Unofficial statements commenting a recount of devastated areas which is currently being undertaken tend to go beyond such conservative(!) estimates. They are suggesting that between a quarter and a third of the woodland in the Federal Republic of Germany has either had it or will soon be lost beyond recovery.) Obviously we are witnessing a major natural catastrophe brought about by the grossly immoral use to which man has put certain technological means.

The economic dimensions of the forest disaster are no less frightening. The association mentioned above puts the harm done to its members' woods by poisonous pollution at one thousand five hundred million Deutschmarks per annum (press conference of 4th August 1983). Which of course isn't the whole story. For nearly as much has probably to be added if publicly owned woodland (state forests etc.) is included in the reckoning. What is more, the same pollution also impairs and in part literally dilapidates buildings. According to calculations released by the German Federal Ministry of the Interior (7th August 1983) the 2.4 million housing properties in heavily infected urban areas alone each year run up constructional damage to the tune of 1.5 thousand million Deutschmarks. A figure that again, it seems, may easily be doubled if the cost of repairs occasioned by less aggressive air contamination in the adjacent vast suburban sprawls were put into consideration. And what about the buildings serving other purposes than housing? The deterioration and degradation of ancient monuments for instance causes particular concern. Thus three million Deutschmarks are spent annually on repairs to make up for air pollution damage striking Cologne Cathedral.

The general public has been slow to wake up to the dire consequences of a civilisation it has been brainwashed into embracing heart and soul by insidious technocrats for decades. Now they are becoming rapidly more and more alerted. What they mistook for an inexhaustible cornucopia is turning out to be a Pandora's box from which countless ills are let loose upon mankind. Don't we stand to lose all the very real blessings contained in the box by having much too rashly opened it? Yet as in Greek mythology hope alone but hope indeed remains in the chest of Vulcan's earthy creature.

Yours faithfully,
Christian Waldendorff
Salzburg, Austria.

FAO—WISHFUL THINKING

Dear Sir,

I have the misfortune to have read a lot of nonsense in my work and have recently been studying the FAO "Agriculture 2000" Report. Noone with some understanding of the world food situation could possibly take seriously the "methodology" of starting with a hopelessly unrealistic high growth "trend" scenario and then moving, in an obvious process of through-the-looking-glass, wonderland wishful thinking, to play with numbers, in a most irresponsible manner, and to look at two more scenarios with yet higher growth rates.

At a time when a billion people may starve to death in the coming

20-30 years it is hardly appropriate for an expert international body to lead us in a whistling-in-the-dark experience. I happen to believe that it is best to look the facts in the face and not play at ostriches —and many will read that report as if it has some meaning.

Well, I don't think it worth our while wasting our time on this sort of nonsense when we have better things to do, but I would like to ask you if your magazine could find someone who could tell us what is happening in the FAO. What peculiar mix of politics is it that leads so much expertise to be wasted in this way? It is a curious sociological phenomenon. What on earth is going on?

I look forward to an article on the workings of this organisation, telling us perhaps if the staff are happy with their report.

Yours faithfully,
John Robinson,
8 Rue du Mont Rose,
13008 Marseille,
France.

THE CRUMBLING CASE FOR NUCLEAR POWER.

Dear Sir,

The article about the shaky economic case for Sizewell B is excellent but without wishing to devalue Peter Bunyard's hard work I wonder how relevant such arguments are to the real anti-nuclear case, which rests not on economic considerations but on the inherent dangers of nuclear processes.

Even if nuclear power were free or cost only a small fraction of conventional power it should still be rejected because of the terrible risks to which the world and its inhabitants would be subjected. In the nature of things there will always be a non-zero probability of failure in man-made structures and processes, and therefore they must always carry the risk of accident.

The consequences of some familiar accidents which society seems to tolerate are bad enough (e.g. oil tankers and road casualties) but at least they are confined to relatively small areas of the Earth and mostly to those directly involved. In the case of nuclear disasters the consequences are so appalling and so widespread in space and time that it would be insane or criminal or both to allow such possibilities ever to become accepted, whatever the alleged benefits.

It must be remembered that rare events with very small probabilities happen somewhere every day. We are told that the probability of a major disaster at a nuclear installation is so minute as to be negligible (about once in a million years of operation) and that it can therefore be safely disregarded. This reasoning is fallacious because as long as the probability, however small, is greater than zero a disaster is still possible. Moreover, it could happen at any time within, and not after, that million year span—perhaps tomorrow. We have all read of accidents that should never have happened; nuclear accidents will be no exception.

Yours faithfully
R.F. Newby
Wokingham, Berks.

Editor:

I absolutely agree with you that the economic argument against nuclear power is not the most important. Indeed we made it clear in publishing the CSENE report (*Ecologist* Nov/Dec 1981) that the economic case as presented, was but one argument. Nevertheless the economic case against nuclear power is one that must be presented and is likely to have some impact at the Sizewell public inquiry into the PWR.

Classified

MISCELLANEOUS

FOUNDER MEMBERS required for a new political party and conservation society, with the aim of stopping and reversing the destruction of wildlife, as well as improving general standards of life. Especially welcome are people who are willing to stand for parliament, or who will help run the organization. Membership is free, but please send S.A.E. for details. Box No. 148.

NATIONAL TREE WEEK 19th—27th NOVEMBER 1983. PLANT A TREE FOR £1.

In order to celebrate National Tree Week the Woodland Trust is inviting the public to "Plant a Tree for £1" and is aiming to add 30 new planting projects to the scheme. Projects include Chiphouse Wood near Reigate in Surrey, land at Upton Cheyney near Keynsham in Avon, Trigmoor Wood near Kingham in Oxfordshire and areas in Cumbria, Lincolnshire, Devon, Gloucestershire and Sussex, all of which the Trust owns, as well as many areas planted by arrangement with other landowners.

Members of the public throughout Britain will be invited to sponsor tree planting in areas cared for by the Trust, a registered charity.

Details of "Plant a tree for £1" are available from the Woodland Trust, Westgate, Grantham, Lincolnshire NG31 6LL.

CALL FOR PAPERS

Call for Papers: International Conference on ALTERNATIVE ENERGY SYSTEMS: ELECTRICAL INTEGRATION AND UTILISATION will be held at Coventry (Lanchester) Polytechnic, UK from Sept. 10-12, 1984. Abstracts are invited on topics which deal with interesting aspects of electrical integration and utilisation of the alternatives, also encouraged will be papers dealing with practical studies, case histories and future possibilities (hydro, tidal, wind, wave, biomass, geothermal etc.). Abstracts of approximately 500 words in length should be submitted before 1st December 1983 and final manuscripts by 25th May 1984. Further details from Carolyn Hall, Faculty of Engineering, Coventry (Lanchester) Polytechnic, Priory St., Coventry CV1 5FB, UK.

INTERNATIONAL SYMPOSIUM ON ENVIRONMENTAL MANAGEMENT FOR DEVELOPING COUNTRIES will take place in Istanbul, Turkey, from July 25 to 31, 1984. Engineers and scientists of any nationality are welcome to submit papers or participate in the symposium. Authors are invited to submit a copy of a maximum 500 word abstract by January 30, 1984. The theme of the symposium will be: Appropriate Environmental Technology and Management. Further information from: ENVITEK, Environmental Technology Research and Development Centre, Bahariye Cad. 56, Kadiköy-Istanbul, Turkey.

CONFERENCES

An International Conference on MICROSCOPY together with an INTERNATIONAL EXHIBITION of Modern Microscopes and Ancillary Equipment will be held from 9 July to 13 July 1984. All enquiries to: The Royal Microscopical Society, 37/38 St. Clements, Oxford OX4 1AJ.

FAO WORLD CONFERENCE ON FISHERIES MANAGEMENT AND DEVELOPMENT, held in Rome from 27 June to 6 July 1984. Further information can be obtained from: Mr. J.E. Carroz, Secretary General FAO World Conference on Fisheries Management and Development, Food and Agriculture Organisation of the United Nations, 00100 Rome, Italy.

ENVIRONTECH '84—India's largest Exhibition and conference on Pollution Monitoring and Control will be held in Bombay on February 8-12, 1984. Further details from Chemtech Secretariat, 210, Dr. D.N. Road, Bombay 400 001, India.

FOR SALE

1984 WHOLEFOOD CALENDAR from Surrey/Hants Border Group Friends of the Earth, 47 Fellows Road, Farnborough, Hampshire. Farnborough 517567, £1.10 post paid. Bulk Discounts.

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