The World in Miniature

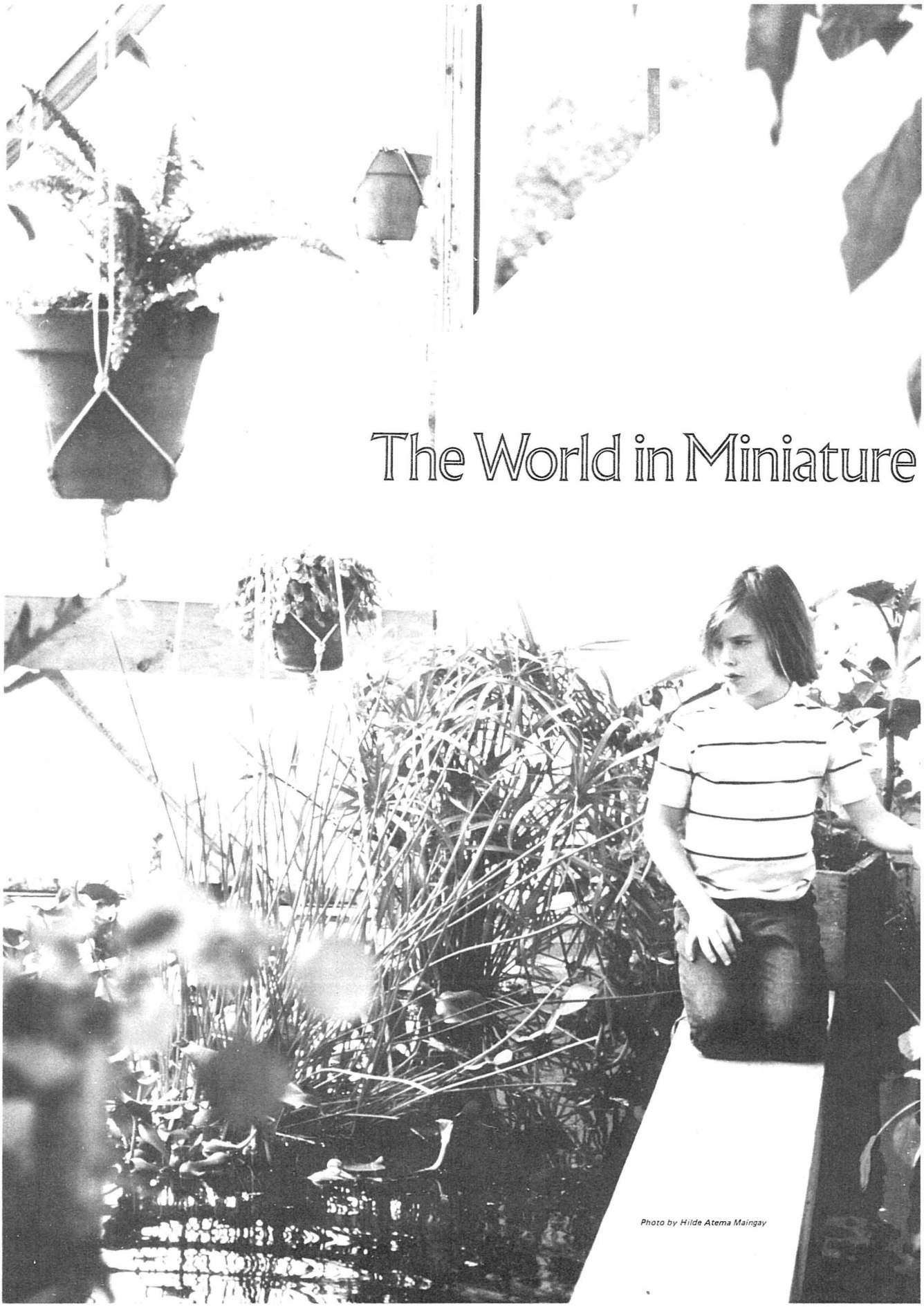
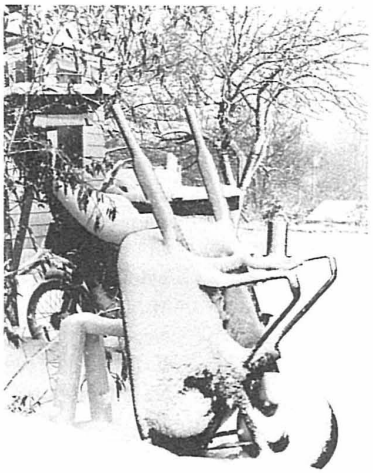


Photo by Hilde Atema Maingay



Winter days and nights have a way of revealing the nature of things. In the valley below my window there is a small pond, frozen to the bottom. The woods are stilled with a blanket of snow. The bark predominates on the bare trees extending upwards in jagged pathways to diffuse without canopy into the sky. The leaves, so recently transformers of life from the sun, now carpet the ground awaiting decomposition and the liberation cycles of spring. Winter holds life suspended in abeyance. Looking outward I feel the structure and composition of this place, how its particular beauty is dependent upon this period of quietude. The essence of the northern woods would be lost without the seasons and the pulses, including the silent ones. The earth's mantle is shaped by and inextricably intertwined with the forces of the weather and the seasons. It is an ancient and sacred relationship. Only within historical times have men tampered with it, tearing at the threads for short-term gain rather than protecting and extending the environments of which they are a part.

A powerful dichotomy threatens people and place alike. Human societies unlike most plants, almost all insects and many mammals do not oscillate in harmony with the seasons. Because our needs are greatest then we come up hard against nature when she is silent and has least to give. When the cold winds blow our needs for shelter and clothing increase, and if we work outdoors our food needs are greater. In the north, humanity makes its heaviest demands in winter. This fact has influenced our use of land and the nature of our societies. It may be no accident that agricultural and industrial capitalism reached its climax in the temperate regions of the world. An expansion of the deep-rooted need to accumulate and store against the demands of winter may have been a factor in its subsequent extension outward eventually encompassing the globe.

Our lives are enmeshed in this process. Below my window, goats are feeding upon alfalfa hay cut and dried last summer in a meadow in upper New York state. To keep them warm and to sustain their milk production, I feed them a daily ration of a mixture of grains and molasses. These grains were grown months, even years ago, in areas across the continent. The corn is from the midwest, and the wheat from the far west. The molasses originated in the cane fields of the Indies or the tropical Americas. Only the oats could be considered a crop suited to the cool coastal regions of the northeast. To carry over the winter, I am dependent on extensive high-energy transportation systems as well.

The goats are, for me, a reminder that my meat, eggs, cheese and milk are plant energies temporarily stored in animals, which unlike the plants can withstand the vicissitudes of winter. If I were to shift to a more vegetarian diet as a resident of a region unfavorable to grain production, it might prove necessary to search even further afield in order to locate food. My rice would have to be transported from the southern U. S. or Central America. Most of the nuts would originate in tropical or Mediterranean climates and the fresh vegetables and fruits of winter from south Florida and Mexico.

I cannot escape a mood of reflection brought on by the coldness of the day. I am drawn to attempt to comprehend sustaining networks as if the woods, bared of leaves, has become a map with its structure etched in tree shapes, in flow patterns on the ground and in the formations of ice upon the banks. Linkages

Photo by Hilde Atema Maingay

now unmasked stand out in relief against the brightness of reflected light. Nature's time moves more slowly and in this simple state, reveals its strengths and frailties.

At this moment millions of people are suffering from want of food. A great many more will yet join their ranks. Modern agriculture, a petroleum-based industry, is at odds with a hungry world, and the grains which fatten the hordes of cattle could be used better to feed hungry humans directly. Feedlots for cattle or miles of batteries for egg-laying hens are the endpoint of an agriculture long estranged from nature by its industrial course. It was brought about by the development of massive amounts of fuels and machinery at a time when it was believed that the flow of oil would continue indefinitely.
But this story is not a simple one. There is a tendency to blame cattle raising for our plight. Yet, in the ecology of things, it is plants and animals together which produce the essential gases, such as oxygen and carbon dioxide. It is the mutual interdependency of plants, bacteria and animals which create soils. Plants feed animals and animals in turn nurture the soils. The plants with their wastes, as well as the bacteria and other micro-organisms govern many of the relationships between the soil and animals. The husbandry of animals for food and clothing need not threaten the health of the planet if carried out wisely. There is a place for cattle in husbandry, but it is not the dominant one they occupy presently in this culture. There are many inhabited parts of the world which produce grains poorly, if at all, yet can sustain cattle. Certain breeds are hardy enough to thrive on fog-shrouded pastures on the edge of the northern seas, while others can withstand great heat foraging upon plants that no human could digest. To husband cattle will involve learning where they belong and in what numbers. Ecosystems rather than economies should determine their numbers and their place. In temperate areas cattle, like humans, overwinter on stored foods. Should feeds be in short supply, the food and energy demands of cattle can be minimized by slaughtering all but the breeding stock.

Even as complexities of plant-animal-human relationships are difficult to grasp, the task of feeding humanity becomes increasingly challenging because ultimately it must be done within a biological and socially restorative context. There will be no panaceas, no single solutions. It will have to be based on a system of knowledge that re-establishes a kinship with all life and on a way of seeing the interdependent nature of all life.
A true alternative to present agriculture will require us to emulate the workings of the biosphere and to seek from it combinations of elements which lend themselves to caring for human societies while neither depleting or destroying the planet's living mantle. Our best guide will not be the past, although there have been cultures that have much to teach us. History frequently shows a record of despoilation, loss of topsoil, destruction of forests and expansion of deserts from overgrazing and exploitation. Powerful civilizations invariably waned when their fundamental ecologies were harmed or irreversibly simplified.

It is true that a few generations ago our ancestors did well enough without the fossil-fueled food networks of today. They were, however, far fewer in number and the majority worked on the land. Initially their agriculture was decentralized and bountiful, but it lasted only as long as there were forests to clear and woodlots to cut for fuel and shelter. Before the soils were exhausted, their fields produced a diversity of grains, fruit and vegetables, many varieties of which were grown because they stored well over long winters. Animals flourished in newly-planted pastures and substance was won from hard work. With few exceptions these farmers were, in no sense, stewards of the earth. Their knowledge rarely included a comprehension of the biological basis of their wealth. In a moment of history, they consumed the legacy of the ages in the stored fertility of forests and soils. The full impact of these destructive practices was never deeply felt in America despite the decimation of cotton land in the south and the dust bowls of the plains in the thirties, for, at the last minute, in the best U. S. Cavalry tradition, agriculture was saved. Fossil fuels in the form of fertilizers, biocides and electric power, as well as fuel for the construction and operation of machinery galloped in rescuing spent soils and debilitated rural landscapes. There was, for a while, a stay of execution. But now we are entering a new phase in which some of the wrongs of the past will return to haunt the present and determine the future.

It might be argued that the virgin forests and soils were the price for creating a powerful, global society. Yet in our time the pillage has expanded to encompass and to affect the whole world in the attempt to replace resources exhausted at home. If this dynamic is viewed as a prerequisite for a powerful society and that the consumption of the planetary resource legacy was necessary to build a great civilization, such an assumption denies the validity of the diversity of native American civilizations. Many of these peoples had a rich culture yet maintained a highly evolved appreciation of ecology and humanity's adaptive relationships with nature. For millennia they trod upon the surface of this continent as gently as any peoples in history. For many of them, their lives and numbers were tuned to the living world which sustained them. We are just beginning to realize the depth and substance of these civilizations. They deified many of the forces that orchestrate the workings of the planet and their religious worldview brought together elements of ecosystems themselves. For them the earth was alive, a sacred entity through which the human passage was unique in the scheme of things.

The immense difference between the cultures of the Indian rooted in nature and our own has been well documented. Our method of food transportation and storage in winter is but one illustration. The basis of our foods is fuels which are rapidly being consumed. A future in which the foundation of our nourishment is a hydrocarbon pedestal is terrifying. Dependence on fossil fuels permeates and dominates our culture. As I write, my physical comfort is derived from the warmth of a gas-fired furnace, and in this I am no different than more than half of the householders in America. Yet the natural gas upon which much of our foods and our heating and manufacture depends is disappearing at a rate close to eight per cent annually. Within a few years, according to petroleum industry forecasts, it will be severely curtailed.

Last night under the light of a newly-rising sliver of moon, I picked my way along the edge of a frozen pond. The little valley was almost completely topographic, each element standing out in stark relief. Some of the boulders, higher than my head, stood out as dramatic wind, rain and ice sculptured shapes, providing the framework for the hillocks along which I walked carefully. Those boulders, pushed down long ago by ice fronts from the north, linked me with latitude and place, and the influence they hold over the affairs of all living things. The pond I had left had its origins, thousands of years ago, in a block of ice buried in an outwash plain. After the retreat of the glacier it melted and the ice block pattern shaped the water's home. Thoreau's Walden Pond has a similar legacy from the southern advance of northern ice and this thought comforts me.

As human settlements extend northward there is a greater need to counter the limits of climate. In earlier times, the forests and their inhabitants provided sustenance and shelter, but with larger populations and declining resources the need to import foods and energy grew as did the need for storage capacity. With increasing latitude there is a concurrent rise in the demands for technology and energy to maintain a given standard of living. A northerner's future is more closely tied to global dis-economies than a southerner, for example, or a resident of a tropical region with sufficient rainfall. Whereas the latter two have at their disposal extended seasons and close to year-round growing seasons, New Englanders require much more energy, transport and storage capabilities to maintain a comparable level of well being. Canadians living in the yet more rigorous maritimes have again greater requirements or must suffer a lower standard of living. I began to appreciate the latitudinal and climatic influences upon societies from working with appropriate technologies in regions as diverse as the tropics and Prince Edward Island in Canada. A windmill that works elegantly and serves a critical function in the welfare of the people

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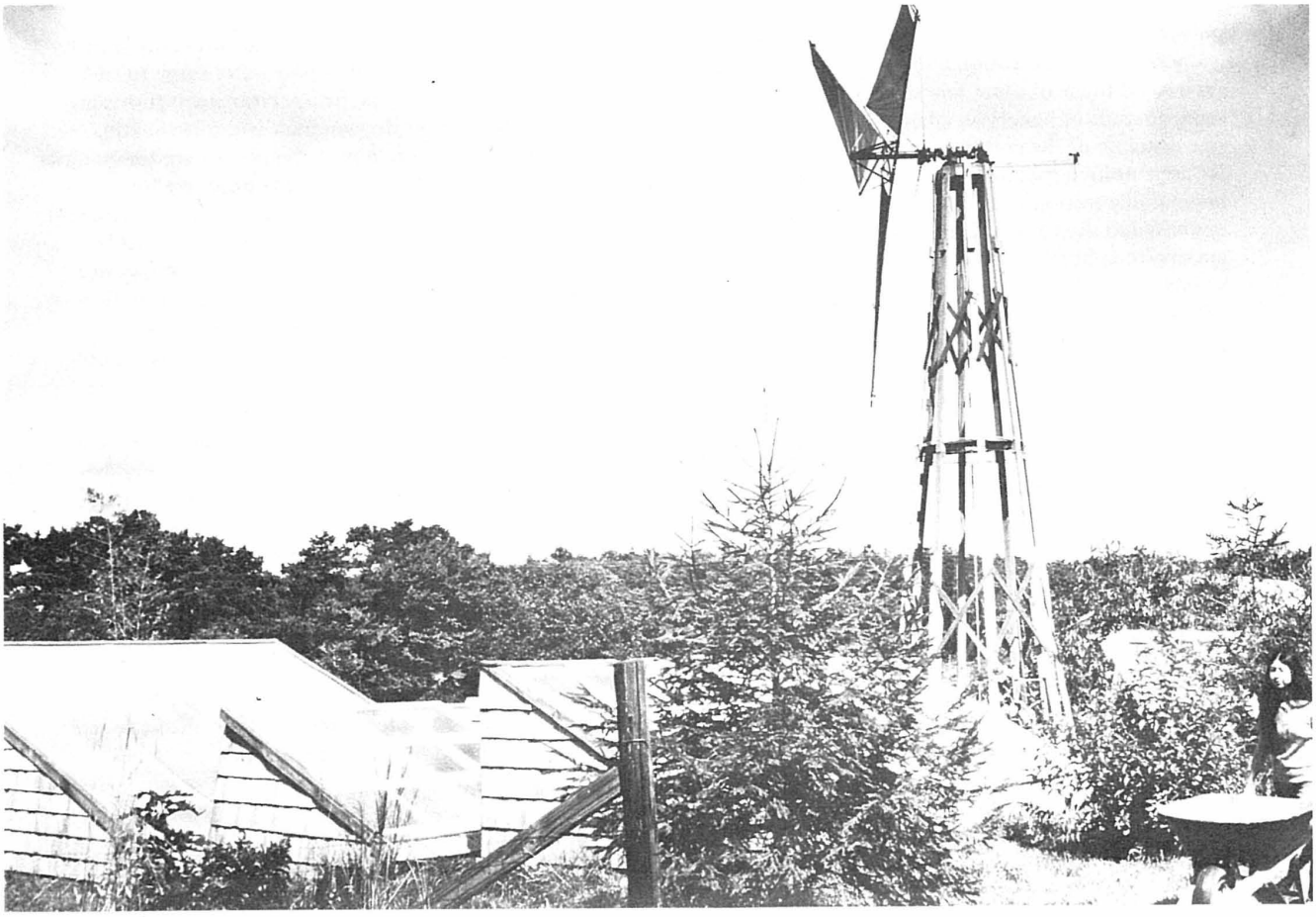

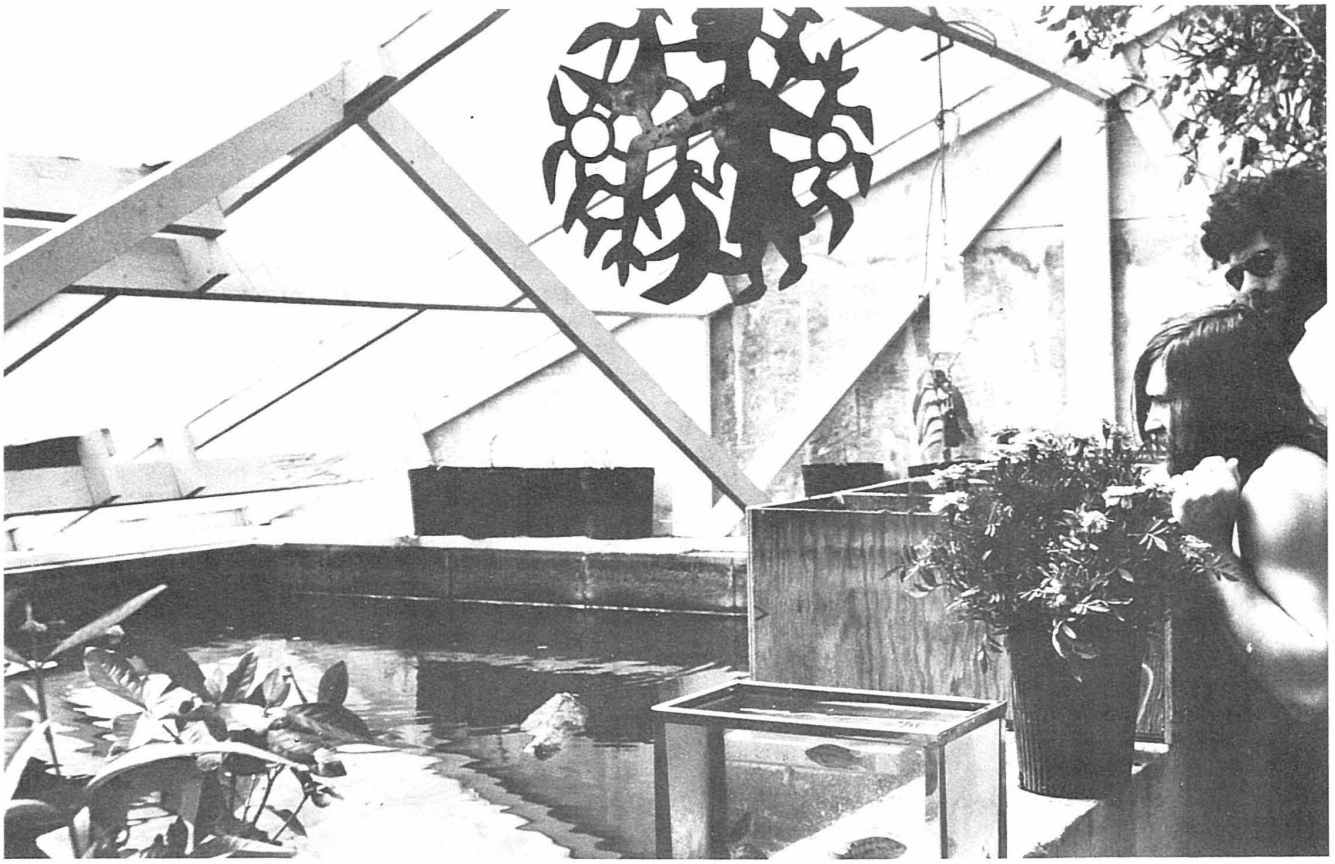

Photo by Fritz Goro

of southern India will not survive the winds and ice of the Atlantic coast, nor will it provide the levels of power critical to northern coastal residents. The ruggedness and sophistication of northern windmills must far exceed those of more temperate areas to affect the same amount of beneficial change. Windmills are just one example of the continuum tied to climate. Though we are employing a common philosophic outlook and comparable stratagems in the design of food culture systems and shelter at different places, we are beginning to appreciate the diversity of societal end points shaped by place, climate and resources. As climate and physical resources have shaped the biosphere, so should they determine future civilizations more strongly than in the past. The rise of industrial and global societies has resulted in a discontinuity and a cleavage from nature. To find our way back is the fundamental task for the remainder of the century. Such basic necessities as foods and fuels are now sustained by waning forces over which few of us have any control. Yet I believe that there are a number of paths leading to a restoration of much that is good available to all who desire to follow them.

Last night temperatures on the Cape dropped to seven degrees, as the bright, clear skies drew up what warmth remained in the ground. At New Alchemy, we have built a structure which, when you enter, seems set apart in place and time. On a winter day, it is warm within, with the sun's heat and filled with the sight and smells of earth, moisture and plants from temperate and tropical lands. The air within is seventy-six degrees Fahrenheit, the pond water some twenty-five degrees cooler. These temperatures are gratifying particularly because the windmill and solar heating panels which heat and power the system are temporarily shut down for repairs. Ringing the pond are food crops and flowers in full bloom. Some of the seeds originated in the deep tropics and one of the tropical fruits is bearing despite the fact that it is our coldest day outside. Several fish break the surface of the water, herbivorous white amur from China and mirror carp from Israel. This structure is our first terrestrial capsule, to be powered solely by the wind and the sun and is a miniature, enclosed ecosystem for the year-round growing of foods. It is the first generation of our arks, named because of their self-sufficient nature and because of the diversity of living things within. It may represent the beginning of a viable alternative which could help pilot us towards a fossil fuel free method of producing food in northern lands, and to do so throughout the winter. Counterparts, utilizing less technology but as many or more organisms could be adapted to arid or warmer areas.

The first ark, for all the flaws and the crudeness of early design, has altered my thinking on the future of agriculture and human communities. What once

seemed difficult or impossible, no longer seems so. Through emulating nature it should be possible to create highly productive food-producing ecosystems, independent of fossil fuels or nuclear power, which will use the wind and the sun on a year round basis to sustain and regulate the climates within. Once established terrestrial capsules such as these could produce foods at little cost apart from the time and labour involved in tending and harvesting.

If it were possible, and I believe that it is, to design and create semi-contained ecosystems, such as our ark, that trap and store the sun's heat and sustain biological food webs with food for humans as end products, and to do so without continuing recourse to waning or dangerous energy sources, and if the skeletons or frameworks of these ecosystems were made of long-lived materials, then they might prove potent enough bio-social tools to initiate fundamental changes in the societies which adopt them. The theoretical ideal of an agriculture that incorporates self-regulating, semi-autonomous ecosystems is appealing in both ecological and social terms. I think not to explore the possibility of an agriculture based to a large degree on terrestrial capsules would be to overlook a major potential biological contribution to the reconstruction of the planet within an ecological framework.

Some efforts in this direction have been made by those working on life-support systems in space. These have neither been powered by renewable energy sources nor primarily concerned with food production, but the principles developed may prove apt for such purposes. Further aspects of an appropriate strategy have been developed by the Chinese with their polyculture ponds. The New Alchemists are combining in many respects "space-ship", ecological and Chinese approaches in their terrestrial capsules.

If modern industrial agriculture were replaced with a diversity of alternatives that included small, biologically-gardened or farmed regions during the normal growing season and terrestrial capsules such as arks for year-round production of foods, then a good deal beyond agriculture would be affected.

Such a transformation would benefit society in many ways. The replacement of fossil fuel agriculture might alleviate some of the impact of the seemingly inevitable economic crash or famine. It would encourage agriculture to be less corporate, and to re-establish it as a local and regional pursuit, involving, as it eventually must, a much larger proportion of society. The massive food transport and storage systems which are dominated by powerful corporations and reflect non-productive energy drains would be minimized. Such a decentralization of agriculture would shift food production back to the basic units of society, permitting it to become an urban as well as a rural pursuit. This decentralization might in turn lead to a repopulation of the countryside and per-

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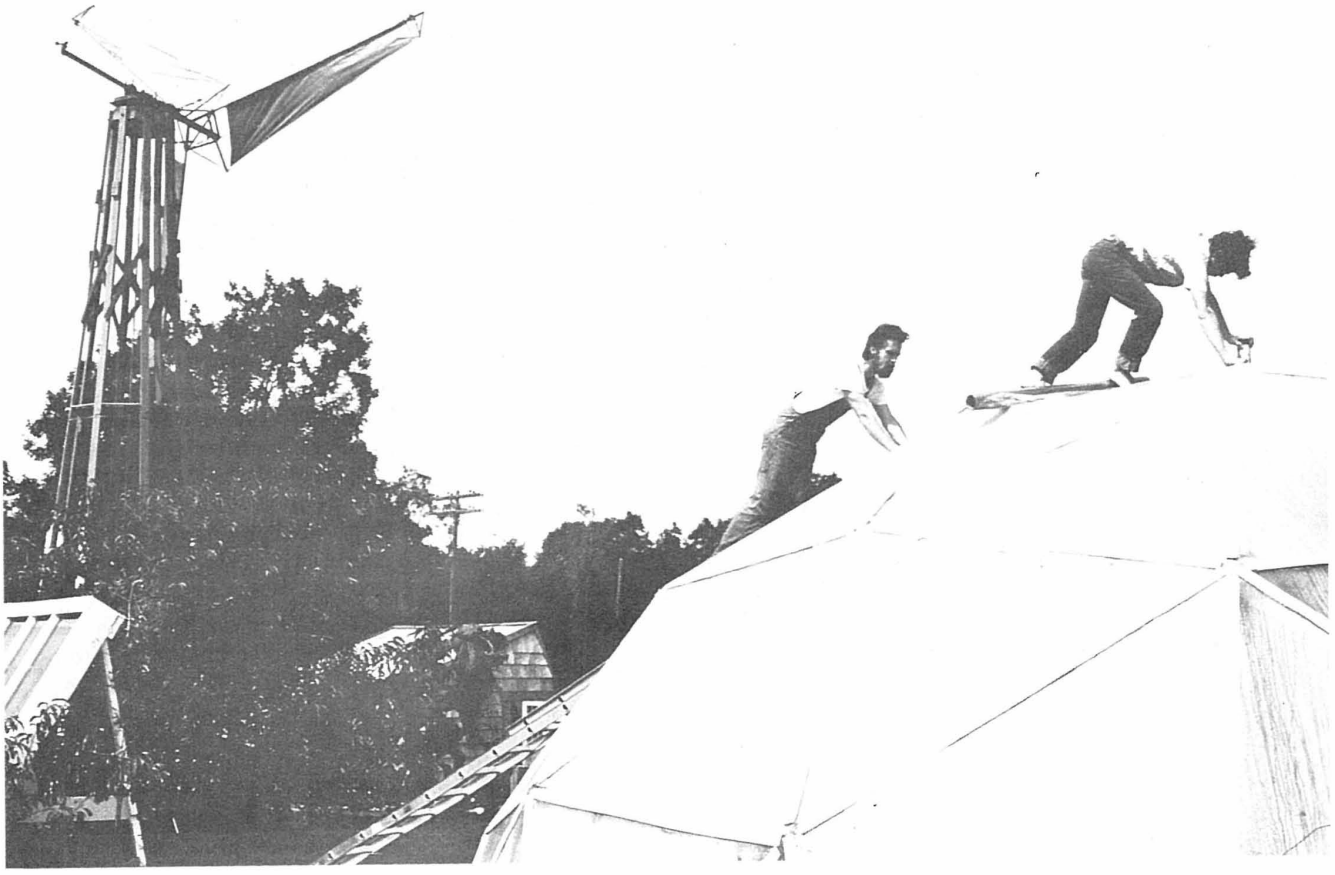


haps even to the re-birth of a diversity of cultures and customs which are bioregional in their content.

With a year-round supply of fruits, vegetables, poultry, fish and crustacea produced in self-renewing food ecosystems, the need for grain acreage would drop. Grains are used predominantly as animal feeds, because they produce rapid growth in cattle and hogs. They also predominate in many human diets, simply because, of all the plants, they are the easiest to store and to use in breads and gruels. Yet grains are shallow-rooted, heavy feeders and are much harder on soils and soil fertility than beans, peas and other legumes, many of which are deep-rooted and capable of bringing up nutrients from sub-soils. Unlike grains, legumes in association with root nodules fix atmospheric nitrogen, thereby improving soil fertility. With increased decentralization grain production could again become a local concern, dependent on varieties indigenous or highly adapted to various regions. Where sensitive land stewardship is practised, grains would be grown in rotation with soil building crops. Rice, my favorite, would be grown on a small scale. It could be started in terrestrial capsules and matured in shallow ponds adjacent to them in association with nitrogen-fixing blue green algae. We grew rice to maturity in the miniature ark last year despite a late start.

A new biological agriculture would bring with it many advantages, not the least being a much reduced need for hardware, such as the big machinery and the giant tractors used today. The massive storage barns of a few generations ago would be replaced by terrestrial capsules with transparent covers enclosing food gardens and aquaculture ponds. Apart from these structures, hardware would be used less. Much of the work should be done by hand and processing such as threshing of grains and legumes could be accomplished with the aid of compact engines powered from wind or solar sources.

Villages and towns as well as the whole countryside would be dramatically altered under a restructured agriculture. If productive encapsulated ecosystems were adopted widely as an adjunct to farming, people working the land might tend to cluster in settlements that would incorporate many facets of community, including micro-manufacture. Villages, buildings and shops for manufacturing would be designed around and would utilize regional materials. They would be powered by its primary resources – generally wind or sun. This ideal, which is not too far-fetched, could be achieved through the reintegration of existing knowledge into an earth-and-people-kindly integrated whole. These communities would be different and more complete than their counterparts in this present industrial period. I want to pursue further the theme of planetary reconstruction but before doing so we should look at the nature of nature itself. Modern civilizations are in conflict with the non-human living world and within this schism originate the crises of our times.

Throughout my life I have known places which were, for me, sacred. More than once I have suffered their destruction for the profit of someone who was bent on improving property for private ends. There is such a place nearby now which Nancy and I visit when we can. It has FOR SALE signs. Since it is beyond my financial means to stop the destruction, I shall witness the tragedy again.

As a small boy I spent long hours beside a watering hole in a diverse, climax forest. Some of the life forms within it had extended their range northward by hundreds of miles to thrive in a sheltered pocket in the lee of an escarpment overlooking Lake Ontario. On summer evenings I used to lie waiting for deer and other animals to come to the hidden pool. On that spot now are the offices of a manufacturing concern. A huge expressway rather than deer tracks leads to my watering hole.

I guess I have pulled through by saying, "It must not always be this way." I longed for a society that had simplified its needs so that much of the land could be taken out of private ownership and returned to nature. Throughout the countryside would be a labyrinth of inter-connected wild places, encompassing a full range of ecosystems. They would wind along the ancient topographies, the ridges and river valleys, and through the mountain passes. Later, I was taught that such visions were unrealistic, the realm of fantasy and poetry, and not the sort of dream for a practical world proud of its ability to control the forces that shaped and created the biosphere.

I have subsequently become a student of the earth, as an organismic entity, of its respiration and cycles, its connections and health. I began to realize that our fate is linked to the natural history of the planet and to wonder if the evolved natural landscapes known by humanity in its hunting and gathering epoch are essential for the long-term survival of humanity. I am not yet certain that this conclusion is true, but I am beginning to read signs that may bear it out.

One of the men wisest with regard to the workings of the world is G. Evelyn Hutchinson, an internationally respected limnologist or student of lakes. He perceives the planet as a functioning organism. In "Biochemistry of the Terrestrial Atmosphere" he explores some of the relationships between the living matter of the earth and the atmosphere above it, including the gases and environmental elements necessary for healthy human life. One of the most interesting substances produced by organisms including plants is the gas, carbon dioxide, a substance essential to plants for the transference of light energy into organic matter. The carbon cycle, of which carbon dioxide is a component in nature, consists of the photosynthetic reduction of carbon dioxide by green plants and a certain number of bacteria. During ordinary

photosynthesis by green plants, the hydrogen donator is water, H_2O, and the by-product is the oxygen produced from the water. Breathable air for animals and man is made available through this process.

In recent years there has been concern that the burning of fossil fuels by industrial societies would lead to an increase in atmospheric CO_2, possibly upsetting global ecologies. Initially it was assumed that the oceans would absorb the changes as carbon dioxide passed across their surfaces, because the oceans were thought to act as regulators of this element of human activities. The oceanic regulatory role is now considered to be relatively insignificant as the oceans seem to generate and use their own carbon dioxide. The bulk of the CO_2 they receive from the terrestrial component of the planet is the result of erosion, via drainages and river waters.

The increase of carbon dioxide in the atmosphere as a result of industrial production has been estimated at close to ten per cent since the turn of the century. Professor Hutchinson suspects that a goodly share of this shift has not been the result of industrial practices as much as the intensified deforestation and the changing ratio on a global basis in favor of agricultural over forest land. A shift from forests to open field culture lowers photosynthetic efficiencies although, in some instances, the amount of photosynthesis is increased for a brief period following deforestation. More important than the reduction of photosynthetic efficiency of the vegetative cover is the fact that under modern agricultural regimes soils lose their respiratory carbon dioxide to the atmosphere at a much greater rate than the forests which are more efficient and complete biologically. He suspects that this increased rate of loss of carbon dioxide from the soil has contributed significantly to the increased carbon dioxide within the atmosphere.

But the process of degrading environments does not stop with an initial loss of respiratory CO_2. The exchange of a forest for a crop, for example, is a complex one and the end result is by no means clear. Forests are capable through photosynthesis of fixing approximately twice as much carbon dioxide as a cultivated system, so initially the widespread destruction of forest vegetation would raise carbon dioxide content because of the diffusion of respiratory carbon dioxide, which is then taken up into the atmosphere. This is what is happening today. However, if the process continues and the landscapes are further degraded, then carbon dioxide levels eventually will fall as exhausted soils decrease their rates of respiration. The forests are much more stable in respiratory terms than bared fields with declining fertility and occasional crops. The health of the atmosphere may rely upon the self-regulating role of forests.

The myriad forces with which we tinker so heedlessly are by no means predictable, but the elimination of forests and the subsequent damage to soils through exposure is leading to changes in the overall photosynthesis and respiration patterns of the earth and is affecting the liberation of oxygen and the fixation of carbon dioxide by plants for their growth and reproduction. Not only are photosynthetic efficiencies of plants being reduced by large scale land degradation for crops, the resulting shifts in levels of carbon dioxide could influence the heat balance of the atmosphere. This, in turn, might cause relatively rapid and deleterious climatic changes. We must begin to see that the earth's biosphere is vulnerable, and much of agriculture represents no less than cancer on its skin. Restructuring agriculture is fundamental to the future.

The ecologists Howard Odum and Ariel Lugo came to a similar conclusion after studying terrestrial microcosms. They worked with the components of the floor of a tropical forest in Puerto Rico before and after exposure to gamma radiation from a radioactive cesium source. The "before" exposure experiments yielded interesting information relevant to the present discussion. Their studies of microcosms or elements of the forest including plants and soils encapsulated in glass chambers suggested to them that large ranges or variation of steady-state carbon dioxide over the earth were possible because of changes in the biota of the planet through evolutionary time. This led them to the idea that ice ages may be the result of changing ecological systems. In their experimental chambers it was found that ratios of litter to consumer organisms and plants varied as did associated carbon dioxide levels. The differing ratios resulted in different gaseous equilibrium points shortly after closure of the systems. In short, they created differing atmospheres within their glass chambers.

They concluded: "This may be an important demonstration of the control of the atmosphere of the planet by the biotic components existing in the system. The physical properties of the atmosphere of the earth are a result of biological evolution as much as vice versa. Since very large changes in the CO_2 level at balance may occur and since carbon dioxide is implicated in the thermal-radiation balance on the earth in relation to ice cap maintenance, it is not unreasonable to suspect that ice ages may be caused by the relative evolution of plants and animals and their excesses or deficits in organic matter production."

It seems the insights of Professor Hutchinson some seventeen years earlier are beginning to receive further experimental verification.

A more recent and intriguing dimension may be added to this story. Three scientists, James Lovelock, Sidney Epton, both English, and the American biologist, Lynn Margulis, are studying the ancient concept of the earth as a single living organism. The Greeks had a name which suits the concept, Gaia, meaning earth goddess. It is at the root of Hopi

mythology. The belief in Gaia has been a deep-felt part of many traditional cultures. It resurfaced in the Renaissance with the translation of the Corpus Hermeticum as well as in other writings. Marsilio Ficino, Giovanni Pico della Mirandola and Giordano Bruno, who was burned at the stake during the Inquisition, spoke of the planet as an entity having an awareness of itself and its place in the cosmos. In more recent times Goethe, the poet-biologist, and Rudolph Steiner and his disciples have made attempts to reveal and study the earth as a living entity. I suspect there are many inheritors of this tradition, but in the main they have yet to recognize each other, for their means of expressing their beliefs are so different.

What makes the work of Lovelock, Epton and Margulis unique and extremely relevant is that they are attempting to verify the idea of Gaia – the earth as a living creature. Out of their work we are beginning to have some inkling of the threat posed to the earth by agriculture. Like Hutchinson and Odum they are looking to gaseous exchanges for clues.

Lovelock and Epton have stated: "As already pointed out, in early times, when the Sun was cooler than it is now, ammonia served to keep the earth warm. At the present time the need for ammonia is different and just as important, because we believe that ammonia keeps the soil near to pH 8 which is an optimal value for living processes. It is needed because a consequence of having nitrogen and sulphur-containing substances in the air in the presence of a vast excess of oxygen is their tendency to produce strongly acid materials – thunderstorms produce tons of nitric acid and if there were no regulator such as ammonia the soil would become sour and hostile to most organisms."

The climate too is elemental and sensitive feedback from the earth may prove critical. Lovelock and Epton have this to say:

"For more than 3,500 million years in the face of a big increase of solar output, the mean temperature of the Earth's surface must have remained within the range of 15-30°C. How did Gaia do this? She must have used several ways to keep temperature so constant. Before there was a significant amount of oxygen in the air, the emission and absorption of ammonia by simple organisms may have been the control process, so making use of its heat absorbing and retaining properties. Variations of the concentration of ammonia in the air would therefore be a means of temperature control."

Thermal control of the earth's surface shifted when photosynthesizing organisms evolved and, in concert with respiring organisms, began to dominate. At this time oxygen became a major constituent of the air and temperatures were stabilized through the control of carbon dioxide which, like ammonia, is a heat absorbing and retaining gas. In order to comprehend the earth's present climate, Lovelock and his associates approach it from the perspective of systems specialists, yet view it as a single entity struggling to optimize and protect itself from deleterious changes.

"If one showed a control engineer the graph of the Earth's mean temperature against time over the past million years, he would no doubt remark that it represented the behavior of a system in which serious instabilities could develop but which had never gone out of control. One of the laws of systems control is that if a system is to maintain stability it must possess adequate variety of responses, that is, have at least as many ways of countering outside disturbances to act on it. What is to be feared is that man-the-farmer and man-the-engineer are reducing the total variety open to Gaia."

This scientific team is presently experimenting with another gas that may, like CO_2, act as a biological climate regulator. This is nitrous oxide which is produced naturally by microorganisms at the rate of hundreds of millions of tons annually. Rates of production are beginning to vary because of changing land use, and, perhaps equally important, through the massive use of nitrogenous fertilizers, themselves petroleum derivatives, which characterize industrial agriculture and the green revolution.

Again Lovelock and Epton:

"We do not know how nitrous oxide could modify the climate, but the evidence suggests that it has been increasing in concentration and it is known to penetrate the stratosphere where its decomposition products could affect the ozone layer."

To the question of Gaia's self-regulation and health, I should like to add one more dimension, one I have pondered for some time. No doubt there are others immersed in the same theory. In my own case, I have had neither the instruments nor the desire to mount a large-scale research project to explore its validity. It is my belief that the planet's climate, to a high degree, is determined biologically and that differing vegetative types may have an influential role in stabilizing the earth's living mantle.

In my front yard I have placed three five-gallon glass jars one of which is filled with a dense brew of a dark-colored green algae which I cultured from household wastes. Next to it is a bottle of algae of different species composition. Its populations are less dense and the overall color effect is somewhat lighter than the first bottle. The last is filled with ordinary tap water and is clear. They react to the sun quite differently. For example, I note from my diary that, on March eighteenth, a clear, cold day with the temperatures hovering just under forty degrees Fahrenheit at noon, the water temperature of the clear bottle was fifty-three degrees Fahrenheit. The one with the less dense algal population was fifty-eight degrees Fahrenheit and the dark algae was sixty-four

degrees Fahrenheit. In the brief span of the morning, each gallon of the dense algal bottle had picked up approximately ninety BTU's more heat than the clear jar. This is by no means the most dramatic example that I recorded.

Might these jars be a micro-model or an analog of how vegetation regulates climate; might the dense jar be equivalent to a forest, the intermediate jar to regularly cropped fields and finally, might the clear jar, like the deserts, act more as a reflector than an absorber? Admittedly the above analogs do not account for changes through evaporation or transpiration. But, I think there is reason to pursue the idea further. Agriculture, as it replaces forests on a global scale, could well be shifting weather patterns in ways that are subtle and as yet not understood.

The surface of the earth varies according to its vegetative types. Associated with this is a varying ability of different bio-regions to absorb or reflect heat and light. If one were able to float or hang-glide over the earth, drifting from place to place, the reaction of one's eyes alone would provide clues of genuine relevance. They would, for example, squint to shut out the intensity of a desert's reflected light. The pupils would widen as one passed from monocrop fields to deep, dark forests with several stories of dense vegetation. No only would reflectivity change from one vegetative type to another, the capacity to absorb and store heat from the sun would vary from place to place, as would the micro-climates and the air currents generated by the vegetation in concert with the regional topography and the sun. Vegetation may also help to draw down rain, whereas highly reflective desert surfaces have an opposite effect, tending to reinforce and extend their drying tendency.

The ecology of the planet has been affected since the beginnings of agriculture over ten thousand years ago. Deserts and arid zones have expanded into areas that were once forested and had readily available water. Much of this change has been brought about by human interference as we felled trees and planted crops. As populations grew soils were exposed under more intense usage. A field with a crop on it is very different from a forest metabolically as well as structurally; just how different it is in the earth's terms we as yet dimly realize. The albedo, or ratio of the biosphere's light reflected to that received, has shifted away from Gaia's sensitive ecologies into the crude hands of humans. We have fallen heir to a powerful obligation, to protect not only ourselves, but every living thing.

The spectre of changing climates and shifting gaseous relationships in the terrestrial atmosphere is cause enough for alarm, and on this basis alone we should re-evaluate the impact of human societies upon the earth's abilities to care for itself. There is yet another dimension to the question of biological stability on a global scale. As a result of the processes of agriculture and urbanization, there is a trend towards a higher degree of environmental homogeneity. The reduction of the earth's living mantle has proceeded further than is generally acknowledged. The overall health of many major ecosystems, not to mention the long-term survival of humanity, may well be threatened by the reduction of wild or relatively undisturbed lands. At the present the diminution of biotic diversity is being intensified by pressure from rising human populations whose priorities are in conflict with those that characterize healthy and stable ecosystems. The trend towards global biological homogeneity must be reversed, with some of the land presently being farmed or intensely forested being allowed to revert back to nature. Contrary as it might seem to current patterns, one of the highest priorities on the agenda for the future is the creation of interconnected wild lands which span continents and encompass all the biomes or distinct ecological regions.

Replacing much of what is currently farm and urban area with zones of undisturbed natural vegetation will serve many ends. Not only will biological diversity be restored, and climates and soils become more stabilized, these wild lands will act as reservoirs for presently threatened plants and animals. This last point may seem insufficient rationale for suggesting the removal of farm lands from agricultural production, but in the long run humanity may be better served, especially since substitute methods of food culture can be developed to compensate for the loss. Returning the task of restoring the planet biologically to nature could well prove vital for reasons which biologists are just beginning to discover. Our greatest natural allies may be organisms for which we have little appreciation or understanding at the present. Little studied organisms may be found to play key roles in the biosphere as biological regulators and as tuners of complex ecosystems. There may be, in nature, orchestrators upon which the regulation of the whole depends. Some of them may be relatively rare though their tasks are critical, comparable to the role of switchmen on the early railways who knew when and how to throw switches in order to prevent collisions and disasters.

In a related vein, the ecologist, Ramon Margaleff, has argued that lost genotypes are irretrievable treasures. He suggests moreover that mature ecosystems, many of which are dwindling rapidly in number and complexity, are factors in bio-environmental stability and that destabilizing effects, if continued, could begin to affect the planet as a whole. It could be possible that destabilization is reaching a critical point. This makes the work of Margulis and Lovelock so timely, for what they are trying to do is devise a planetary early warning system that we

should learn to heed.

The heavy-handedness of human exploitation of environments has been amplified with the introduction of industrial techniques and the amount of damage is increasing. When complex ecosystems, whether forests or coral reefs, are exploited, a total collapse of rich biological organization can result. The addition of potential sources of energy, such as chemical fertilizers, can lead to the breakdown of many natural self righting mechanisms. High energy industrial agriculture has already eliminated many such mechanisms on farm lands. When fossil fuels and their derivatives in the form of pesticides, herbicides and fungicides become scarce sometime in the fairly near future, the havoc will be much greater because of the destruction of these stabilizing elements. The creation of wild corridors would do much to buffer effects of pest, disease and weed outbreaks after initial dislocations have run their course.

Initially, I became interested in chronicling the course of exploited environments through observing plants and animals which I found curious or exciting. It is no accident that the species that suffer most at the hands of humans are often those that are the most beautiful, colorful or unique. We seem most inclined to threaten those organisms which stand out rather like icons in the course of evolution such as immense tropical trees, birds with striking colors and elaborate behavior patterns and delicate flowers highly tuned to weather, season and even the time of day. The butterflies and the mimics which deceive their predators have a special fascination and are collected in large numbers. Yet the meaning of their existence becomes discernible only when they are viewed in complete terms. There is a reason for plants and animals looking and behaving as they do. There are delicate and complex bonds which link creatures to their own kind, to other organisms and to the larger realm which they inhabit. As I have suggested, many of these creatures are performing a function for an ecosystem in much the same way that a heart or lung sustains a human, or that we as individuals perform functions as parts of the larger societies.

The discovery of the beauty of such systems has brought with it an awareness of their fragility. Within this fact may lie a powerful lesson. In my own investigations into the influences of pollutant stresses on the behavior and social organization of fishes, I found that there are fish species which are highly evolved socially, containing over one hundred elements of behavior in addition to communication signals and other characteristics of higher animals. Some, for example, exhibited individual recognition and even cooperative behavior. In a polluted world the very complexity of their social organization condemns them in many respects to life on a razor's edge. The survival of the highly evolved social species depends upon somewhat stable and predicable environments. The ability to respond to normal oscillations and natural stresses is somehow contained within their genetic codes. However, they are not designed to deal with abnormalities and I found that insidious levels of sublethal chemical and thermal stresses could affect their social organization dramatically. In some cases their powers of individual recognition, upon which their social organization was based, was lost. Once this breakdown had occurred, formerly peaceful coinhabitants within a small community were observed to fight to death. While these studies were conducted in laboratories, they did indicate changes almost assuredly taking place in nature.

I also studied fish species which exhibited simple and intermediate levels of social organization. Ironically, at the opposite end of the social spectrum these fish with relatively simple behavior consisting of a small number of social interactions turned out to be much tougher physiologically. They were capable of withstanding artificially induced environmental stresses almost to the death point, whereas the socially complex animals were, in fact, being "killed" in behavioral and psychological terms long before they reached the pollution levels at which they died. They were not able to function normally and it is doubtful that they would be capable of reproduction. The species with the simplest behaviors continued to behave normally until the stress levels which caused death were approached. In evolutionary terms they had adopted a strategy of physiological toughness in lieu of sensitively tuned interdependent behavior.

The conclusions my co-investigators and I were beginning to draw from the research disturbed us deeply. We were starting to decode a possible correlation between the evolution of higher social behavior in aquatic animals and their vulnerability to civilization's pollutants. The most highly evolved creatures socially were, in the instances we studied, the most vulnerable. It struck us that what we were observing indicated the possibility of humanity's insensitivities reversing ecological processes on a global scale, leading away from stability and diversity to a kind of backwards evolution where the most social creatures were being selected against. These fishes and perhaps other animals having what we generally think of as higher behavior may be slowly, but nevertheless surely, snuffed out. I have no doubt that we were uncovering information that has a bearing on the relevance of protecting ecosystems in nature, especially since it may be the animals with intricate social organization that act as the biological regulators and tuners of the ecosystems they inhabit. To continue to ignore the biological lessons in phenomena such as these may prove in the long run a little bit like serving cyanide to the pilot of an aircraft while pouring champagne for the passengers. Fun for a while, but not exactly adaptive.

The messages from the living world are building to a desperate cacophony. For humanity to extend the human experiment and to survive its present travesties against the biosphere there will need to be a complete attitudinal change towards nature. Nature in all its states, and especially its diverse mature ones, will need to be seen as a living entity from which patterns can be drawn to create our future food culture systems.

The whole relationship of agriculture to society and the biosphere is rarely considered in the affairs of our time. Yet it has been instrumental in determining the present and its course will shape the future. Historically, agriculture has been biologically reductive and modern agriculture is unsound energetically. The American ecologist Howard Odum is convinced that our present society is based on cheap, widely available fuels. As these fuels, especially oil and gas, are withdrawn or become less available he fears it will be almost impossible to shift quickly to an alternative form of producing foods. Such a shift requires a long period of transition preceded by much research and testing of solar-based, ecologically sound food culture methods. One possibility he has proposed for the future is the creation of terrestrial capsules similar to New Alchemy's arks and backyard greenhouse-fish farms, and the planned larger bioshelters of designers Day Charoudi and Jean Wellesley Miller from M. I. T.'s solar laboratories. But many of these systems are still either on the drawing boards or in their infancy, and there is much to be learned before their effectiveness can be judged. Since the agricultural establishment has displayed little interest in supporting this type of work or in creating other adaptive agricultures based on solar or wind energies, there is little likelihood that the shift will be easy, graceful or in time to avoid widespread crises in food supply. There is some awareness of the problem. Many homesteaders who have returned to the land within the last decade have tried to reduce their fuel dependencies with little of the necessary resources or knowledge of alternatives. That a few are succeeding is, in most cases, a testimonial to their ingenuity and ability to work extraordinarily hard.

As the changes now taking place could overtake and overwhelm agriculture within a few decades, it might be worthwhile to look back and see how we came to this point of crisis. Agriculture's weakest cornerstones currently are its energetics and its petroleum power base, unlike one hundred years ago when it was scarcely subsidized by fossil fuels. Then farm machines were drawn by draft animals which were sustained by solar products in the form of plants. Transport was local and primarily horse powered. Some coal was used in the manufacture of farm machinery. When long distance transport of food did occur, it was done by sailing vessels and steam locomotives many of which were fired by wood. In short, food production despite marginal fossil fuel inputs was solar based. It was carried out on recently cleared farm lands, the fertility of which had not yet been depleted through ignorance and bad husbandry. Nineteenth century farmers were able to produce about 1.28 kilocalories of harvest per square meter per day. A marked change has taken place in the twentieth century. Fossil fuels, especially oil and gas, have been coupled to the solar base of food production. The result has been the dramatic upswing in the amount of food produced. As a consequence of this infusion farmers and agriculturalists were beginning to believe that nature would place few limits on what they could do, but what was giving the illusion of limitlessness during the middle decades of the twentieth century was cheap fuel. Nature for its part was being stressed by the biocides and additives of an unnaturally productive agriculture. The infusion of external, non-renewable sources of energy into food production and agriculture resulted in its industrialization. Farm activities were mechanized and by the late 1960's, farm land management had become totally dependent upon chemical controls and the chemical manipulation of biological processes.

The basic shift in our food production techniques evolved in three distinct stages and was extraordinarily rapid. The first wave of change followed closely on the heels of the industrial revolution which made it possible. Newly developed harvesting machines began to replace agricultural laborers and small ox drawn implements. Towards the end of the nineteenth century, big threshing machines powered by steam engines were being used in Britain and North America. The shift from men to machine was not always peaceful, particularly in England, where there were occasional agricultural rebellions. Despite the fact that their work was hard, agricultural laborers did not want to be replaced. The shift to large machines and steam engines brought the first major infusion of non solar-based energies into rural communities. This change resulted in the migration of displaced agricultural laborers into mill and manufacturing towns.

The next major stage in the changing agricultural landscape proved more dramatic than the first. Following the 1914-1918 war and the introduction of assembly line production in industry, a new and much larger external energy source was injected into agriculture. Gas powered internal combustion engines were introduced onto the farms to take over most of the tasks which until then had been done by animals or farm workers. Tractors, combines, pumps, self propelled cultivators, harvesters and sprayers became commonplace. Not only did they require large amounts of energy in manufacturing; even larger amounts in the form of fuels were necessary to keep the engines of agriculture running. By the end of the period between the two world wars a mass exodus of people from the countryside was underway and the nature of the countryside and rural societies had been profound-

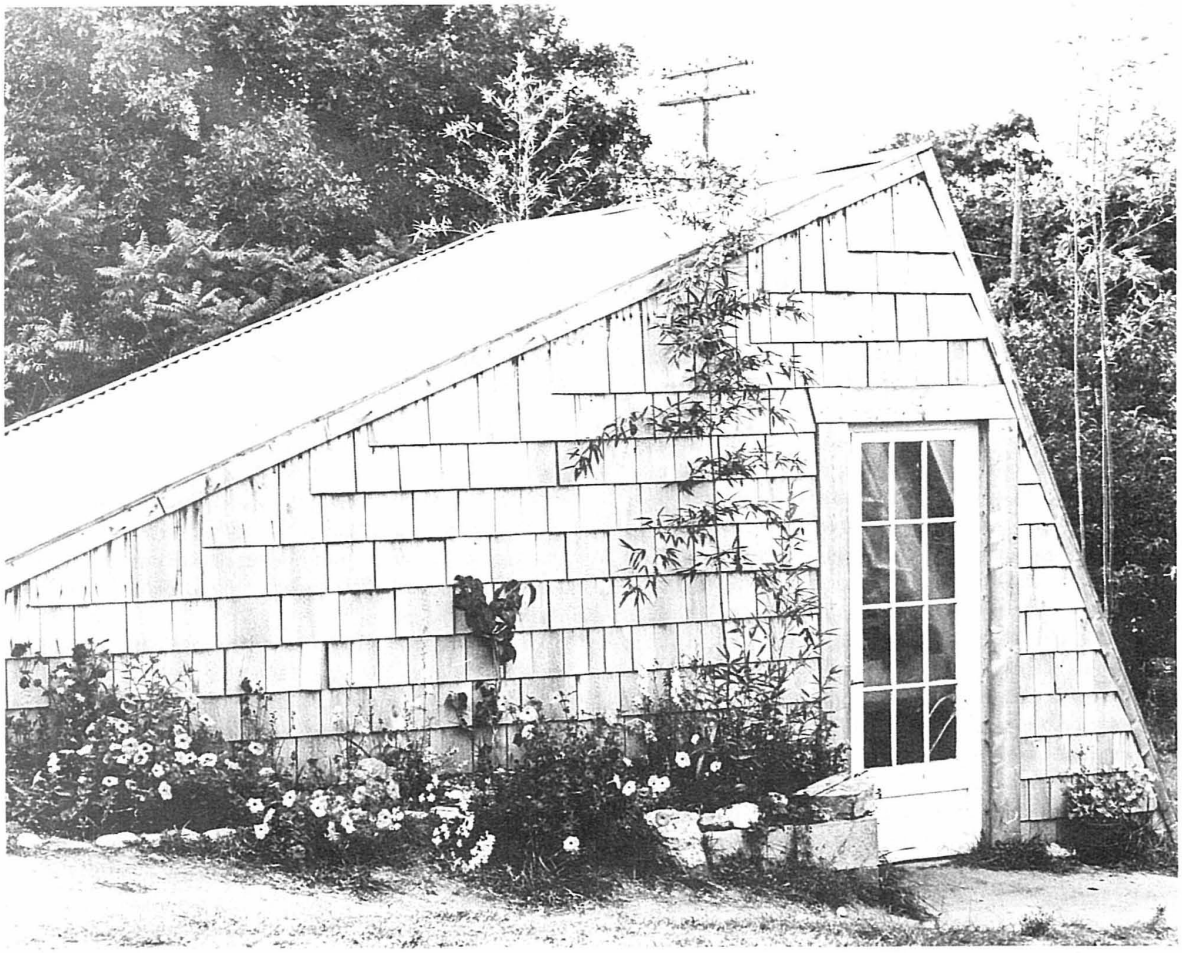


Photo by Hilde Atema Maingay

ly changed. The second war added impetus to the process. I believe that the depopulation of the farmlands of North America has been a major factor in forming the character of the present rootless society. Like a rudderless ship we are at once abstractly global, yet lack a sense of place.

The final stage in the agricultural revolution, the one in which we currently find ourselves, is the most insidious, little understood and potentially dangerous of all. It had its origins in the munitions and chemical warfare industries spawned by the second world war. Many of these are the now giant chemical corporations which have, over the past thirty years, completely chemicalized agriculture. In recent years farm lands have become managed by veritable arsenals of compounds some of which were developed initially through nerve gas research of the 1940's. Almost all of the chemicals are derived from petroleum. The emergence of a petroleum-based chemical agriculture is one of the most significant developments in food production. There are few areas of modern farming that are exempt. Fertilizers, grain drying, weeding, timing of ripening, disease and pest control, fruit thinning, planting, harvesting, storage, storage protection, packaging and transport are now dependent upon products derived from petroleum. The agricultural revolution has, in fact, been a chemical revolution made possible by inexpensive natural gas and oil. The whole process is bizarre energetically and based upon non-renewable substances. For every calorie of food served at an American table, from five to twenty calories of petroleum derived inputs have been involved in the process of growing and getting it there. In short we are eating oil converted to foodstuffs and lots of it.

The shift from a predominantly solar to a predominantly oil and gas basis for food production has been extremely profitable for every link in the food chain except for the farmer. Most of the chemical, manufacturing, packaging and distributing corporations have assiduously avoided this primary level in the food producing process. While they have been accumulating unprecedented profits, farmers and exclusively farm-

ing corporations have not. They have rather shouldered a huge burden of debt to sustain a high energy, industrial agriculture. In 1973 farm debts supervised by the farm credit bureau amounted to $21,842,785,000. There is, however, no discussion of the dilemma in the "trade" publications read by farmers. Chemical and manufacturing concerns control, through advertising and grants, farming publications and many agricultural university departments. This tends to block or disguise the true nature of the crisis facing farmers. The problem is compounded by the fact that farmers, in the main, are caught up in the myth created by the industry-science mill of the modern farmer as scientific business man. He has been brainwashed to see nature as an enemy, and computers and chemicals as his weapons of control. One look at any number of the ads in farm magazines amply illustrates this point. At present it is almost impossible for farmers to see through the sham, but in a few years as gas and oil become scarcer their plight will be felt around the world.

Nature is being sidestepped in almost every way. This point deserves further elaboration. As has been pointed out, with the transformation over the last hundred years from biological to chemical and industrial agriculture, oil, gas and to a lesser degree coal, have been instrumental to the changes. The planting of crops shifted from a task done by hand or simple animal drawn implements to a highly mechanized and complex process involving, for example, "integrated seeders" comprised of split press wheels, anticrustants, liquid starter fertilizer dispatchers, seed injectors and clumpers or seed plates pulled as a unit by hefty tractors. Seeds are no longer a local concern. Seed production often takes place at great distances from the point of use. Regional varieties have all but disappeared, having been replaced by the few "leading" varieties which are most profitable for seed production business. Seeds are treated with a variety of poisons to protect them from spoilage and from disease after planting. The natural mineral recycling systems which return plant and animal products to the land have been replaced by manufactured fertilizers. The nitrogen fertilizers, responsible for many of the increased yields in recent years, are derived from natural gas. To protect crops from competition, weeds were discouraged traditionally by tillage and mulching techniques which also returned organic matter to the soil. Now, herbicides are used. The salting of the soil with chemical fertilizers to a large degree has replaced the best soil building techniques including the use of manures, cover crops, natural recycling in soil humus systems and even the age old techniques of leaving fields fallow to rest and restore themselves. Biocides, which include insecticides, fungicides and herbicides manufactured from crude oils, have replaced biological and chemical regulation systems which prevent disease epidemics and massive destruction of plants by herbivorous insects in healthy and diverse ecosystems. Nature has equivalent processes but they are little acknowledged because they cannot be treated as a commodity by the corporations which dominate agriculture. Food varieties which are such biological freaks they would not produce at all without chemical and other forms of energy-expensive protection have been developed for ease of mechanical harvesting. Further, each time a disease begins to overtake the new varieties, as is inevitable every few years, newer ones have to be developed in order to keep one step ahead of crop vulnerability. Efforts to mold agriculture into an industrial image have succeeded to the extent that chemicals similar to plant hormones have been developed which when applied to some crops cause them to synchronize their maturation to facilitate harvesting by machines. Hand picking has been eliminated from most crops including fruits. Some fruits are now thinned in the spring by chemical spraying which causes just enough of them to fall off to optimize the size and uniformity of those that remain. The trend seems endless and the only limits on the horizon are the availability of fuels and the vulnerability of nature.

One of the most dramatic social effects of the oil revolution in agriculture has been the shift of the bulk of the population from a direct land base to an urban environment. At the present each person actually on the land supports some thirty-two city dwellers. This is without precedent in the ten thousand years of human history. This is generally looked on as progress, but it is a substitution of effort made possible through the manufacturing, transport, chemical and informational industries which sustain food production. Almost all of these profound changes have been made possible by the injection of fuels into farming on a large scale.

What has all of this done to the quantity of production? The modern farming "miracle" has definitely caused it to be increased. Since 1880 there has been a five and ten fold increase in America's food production on a per unit land base measure. The population to be supported, however, has increased six fold. To stay ahead of the population we use somewhere between five and ten or more calories of irreplaceable fuels to produce one calorie of food. We have made quick use of finite resources. Energetics alone suggest that there are troubles ahead.

The substitution of solar based inputs including draft animals, human labor, biological regulators and land restoring processes by highly concentrated forms of energy, oils and gas which can only be biologically replaced extremely slowly has placed humanity well out on a limb. There are indications that the fuel subsidy to agriculture will begin to be withdrawn within

the next five years when natural gas will be in short supply. This trend could grow towards the end of the century when oil products will be increasingly scarce. Should no cheap and effective substitutes be found to sustain chemicalized agriculture, the nation will be confronted with ravaged farm lands. Most farms will be unable to revert quickly to predominantly biological regimes. Their present level of indebtedness alone would impede a transformation to a non-mechanized solar base. Despite an increase in gross farm profits in the last twenty-five years farm indebtedness has jumped eleven fold. Modern farms are operating on borrowed capital. Their modernization has created economic instabilities that would be unlikely to withstand a shortage of any of the fertilizers, fuels or chemical control agents. If their ability to produce was curtailed for a single season, economic disaster could follow.

Should farms be compelled to revert to the methods of 1880, at best they would be able to produce approximately one-tenth what is grown today. My conclusion is based upon production figures from that time. I have assumed that the farmers making the shift would not be as skilled as their grandparents or great-grandparents who were intimately familiar with the appropriate production techniques. I have not included in my estimate the lack of draft animals, should a shift to traditional modes be necessitated by fuel shortages. Professor Odom's projections are even more dour. "If fossil or nuclear fuels were cut off we would have to recruit farmers from India and other underdeveloped countries to show the now affluent citizens how to survive on the land while the population was being reduced one hundredfold to make it possible."

I don't think Prof. Odum is taking into account such unknowable factors as the ingenuity latent in the populace or present excesses in the system or, for that matter, our overstuffed eating habits. Still his point should make it clear that the onus of food production would quickly fall back on the bulk of the population, as has traditionally been the case in human societies, and is still the case in China and throughout much of the third world. There are, unfortunately, fundamental differences between our situation and theirs. Most North Americans are now urban dwellers without agricultural traditions. We have little education in the workings of nature or in the direct culture of foods. It is this tragedy that presents one of the greatest threats to the possibilities for restabilizing populations during periods of food shortage or dramatic change.

At this juncture in the discussion of our agricultural history it seems we must conclude that our present methods of food production are not inherently wiser or better than those of our ancestors. Ways have not nor cannot be found to make nature perform miracles. An important first step in looking at the future is to depose the technocratic-agricultural myth of eternal plenty. Ultimately life-sustaining systems are based upon energy from the sun which strikes the surface of the earth and upon the amount of photosynthetic energy available to a given region. These overall limits cannot be surpassed even by fossil fuel and dollar subsidized agricultures. There is no ever-expanding opportunity for humanity to continue to increase its numbers on the assumption that some newer and better technology will liberate us from nature's constraints.

It is true that in the laboratory it has been possible to devise algae cultures which approach the upper production limits inherent in biological processes. The results are impressive and have generated a false optimism. But it must be emphasized that huge energy subsidies were involved in these experiments, particularly in the form of complex back-up systems including pumps, aerators, injection of gases, mainly carbon dioxide, centrifuging, climate control, auxiliary lighting and so forth in order to optimize algae production. The subsequent transformation of the algae into edible and appetizing human foods was again energy expensive. As the solution to the world's food problems, systems such as these could be taken seriously only in highly affluent, energy rich societies. If one reflects on the nature of the support and the high cost of the scientific, technical and energetic components involved in the algae-as-food experiments, they represent a giant step backwards from a small kitchen garden. In the case of the latter there is a relatively large output compared to the energy that goes into it in the form of seeds and human labor. In fact, a well-designed household garden represents a good standard against which all forms of food culture should be evaluated.

There will, no doubt, be many new schemes proposed in the domain of agriculture in the years ahead. Some may prove sound but the majority, I fear, will smack of a bio-engineering mentality which still dreams of the right machine, perhaps one that might pull nitrogen, carbon, oxygen and other elements from air and water and transform them into minerally balanced amino acid or protein soups. This penultimate machine would represent a triumph for technocratic man, and nature could at last be left behind.

Shifting to a political perspective, the great productivity pouring forth from American farms can be seen in a truer light. Industrialized western agriculture is imperialistic and global. The ability of modern agribusiness to generate immense amounts of food is due less to its clever organization than its power to draw on the resources of other countries. It is quite accurate to visualize many farming operations as "feed lots", or sinks, where most of the in-

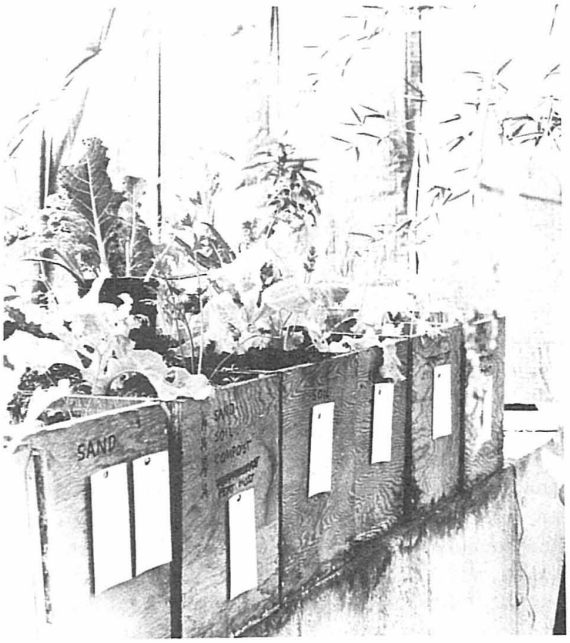
puts that sustain them are brought in from outside. To increase its productivity, the farm has extended its barnyard to encompass much of the globe. The new bounty has come about through the importation of basic materials and feedstuffs over great distances. For example, anchovies harvested off the coast of Peru became a key ingredient in the mechanization and modernization of the chicken industry. Instead of feeding people in Latin America, these fish are processed into poultry feeds in the U. S. and Europe. This is but one example. There are many other commodities including fertilizers and raw materials which are brought half way around the world to sustain American farms. Morocco is the major source of phosphorous and crop yields are dependent upon our keeping the supplies coming. When agricultural productivity is evaluated, it must be seen as involving the exploitation of global resources. We must be prepared for the possibility that donor nations may one day rethink their role in world agriculture in much the same way as oil producing nations have done recently. This will prove serious, for the green revolution could only have been brought about by our prior colonization of the world in an economic sense. Raymond Williams, the English political philosopher, has delineated this process. His analysis suggests that the imperialization of much of the globe by western powers was an essential precursor to the new agriculture which has shifted food production from regional and self sufficient strategies to international ones. In the past farms were organized as fairly complete entities, rather than as links in a lengthy world-encompassing chain, as is the case today. Traditionally the plants and animals that were cultured were nurtured by the farm's overall productivity as were the people who occupied and worked the land. The needs of the farms and farmers were not usually tallied when overall farm productivity was considered despite the fact that the bulk of population was rural. Although this is often overlooked in accounting for farm productivity, it is true that farms were sustained from within, not without. There was a high degree of self sufficiency. The autonomous approach to food culture involved a wholistic perspective. The responsibility for such a perspective and knowledge was on the shoulders of the individual farmers. They grew plant and animal varieties which yielded less than those of today for good reasons. They bred for such characteristics as the ability to produce or grow without the modern arsenal of protective devices and chemicals. This meant that some energy was husbanded for self protection rather than growth. In contemporary food varieties this protection is supplied from outside, particularly derivatives of petro-chemicals, and growth is optimized artificially.

Plants and livestock were not inferior because they yielded less, the cant of agriculturalists to the contrary. The self-protective processes enabled them to withstand climate, pests or predators through such measures as special structures and growth rates tuned to climate and droughts, or, in the case of some animals, through complex behaviors through which they could minimize the impact of weather, disease or external attack. A chicken which can roost in the tops of trees will not grow like one that is housed in a regulated climate cage in Egg City, but it will be better prepared to protect itself from foxes or dogs or from a malfunction in an air conditioned unit. The pre-empted biological approach to farming is far more efficient energetically and takes advantage of "free" subsidies from nature. The green revolution can only work with an abundance of cheap fuels to sustain the food organisms that have been created.

One of the most maddening aspects of the arrogance of modern agriculturalists is that they have permitted many older plant and animal strains and varieties which were uniquely adapted to specific regions throughout the world to become extinct or nearly so. The genetic base of global food production is narrowing rapidly as thousands of local varieties are replaced by a few modern types. This is especially true of the grains. Only the far sighted efforts of a few plant breeders, farmers and the odd horticultural society have resulted in the saving of the relatively few gentotypes upon which our future depends. I share the qualms of a number of experts in plant genetics that not enough has been saved.

The paths that wind historically through the agricultural landscape are those that wind their way

Photo by Hilde Atema Maingay



throughout the whole human experience. As the future looms large and is so difficult to grasp and as the pace of events is so swift, I feel drawn to question the nature of agriculture and its place in the evolution of humanity. I don't believe it is necessary for societies to come up so hard against nature. Are there not lessons to be gained from nature itself? Is it not possible to realize a visionary landscape in which nature and humans live in harmony? Single visions are not sufficient, nor are they up to the task of remaking the world.

Ecologists have the ability to grasp the meaning of the changing of ecosystems through time, a process they call succession. Succession implies an unfolding towards a point where the living and non-living move together in a harmony of complexities. I am drawn to such notions, antithetic as they are to the agricultural history of our species, in designing for the future.

Looking into one of New Alchemy's tropical pond ecosystems which is sustained by other adjunct ecosystem elements in addition to the wind and the sun, I can see the beginnings of a world in miniature with its various elements in tightly knit concert. A marigold falls to the surface and looming out of the depths come the various fishes which are sustained within. The small tilapia begin to nibble at the petals, then the mirror carp rise, gleaming with their scales reflecting the sun's light. Finally the white amur, each about a foot in length, approach in slow moving schools and within moments the flower is consumed. The fish are growing well. We are learning to emulate nature for human ends as well as for Gaia's, but I wonder if we and others like us can learn enough, and in time. Leaving the mini-ark, the cold of the outside chills me as does the thought that what must transpire in our time is no less than a conscious change in our relationship to nature.

It seems necessary, in order to understand this relationship, to probe back further in history to the very roots of agriculture. It has not been my desire in the course of this piece to ridicule contemporary farmers. It is difficult enough for them to keep going and they are not the primary villains. They are cogs in our capitalist, centrally-controlled society and have their counterparts in many other cultures throughout the world. Nor am I nostalgic about pre-capitalist agriculture. Although it did sire the present crisis the origins of the dilemma extend backwards into the very nature of agriculture itself.

I am beginning to fear that much of agriculture always has been destructive to the earth. With this fear comes the realization that traditional farming methods are inadequate to the task of restoring the land, and that practices based on an ethic that is higher and more subtle must evolve in its place. A vision of Gaia mending abandoned lands and rocky hillsides is slowly and imperfectly unfolding. The question is where now do we turn to create futures that are adaptive and kind to the earth and people alike.

Traditional farming methods cannot pave the way to a peaceful transition when the oil and gas age ends. Agriculture had a bad record long before it shifted to a fossil fuel base. Farming has enslaved and oppressed much of humanity for the past ten thousand years. It has brought about the wholesale destruction of one landscape after another and has been critical to the rise and fall of civilizations. A number of visionaries including the agricultural scientist Sir Albert Howard, the novelist-farmer Louis Bromfield, the geographer J. Russell Smith and the Rodales, both father and son, have tried to chronicle the record of agriculture to the English speaking world. Their messages describing the insensitivity of many agricultural practices to nature as well as people has gone largely unheard in the arena of world affairs.

Apart from the economic imperatives of the two world wars, one of the major reasons we in the west rushed so unhesitatingly into fossil fuel farming was because farms were often unpleasant places to live. Farm life frequently involved incessant toil, economic deprivation and a high degree of intellectual insularity. Urban pastoral poets aside, a lot of country living wasn't very exciting. The mass exodus from farms was prompted by hardship, poor farming practices, spent soils and the nature of land ownership, and land reform is still a major issue throughout the world. The problem is close to home even in the United States where over sixty per cent of the private lands are owned by five per cent of the populace. The Jeffersonian dream of landed freeholders is gone. In northeastern Brazil a few landowners have managed to keep the bulk of the population in a state of partial starvation so that they can continue to grow commodity crops for export markets. Comparable if perhaps less dramatic inhuman practices are carried out throughout the world.

The ecologist Paul Shepard inspired by a study carried out for the U. S. Department of Agriculture by Dr. Lowdermilk reported, under the title "Conquest of the Land Through 7000 Years", takes perhaps the harshest view of traditional agriculture. He is convinced that agriculture, especially when organized on a large scale, is little short of a planetary disease and that for Homo sapiens to have shifted from hunting to farming for his food may well turn out to be an evolutionary mistake. It is an extreme position, but it is not the first time I have heard it expressed. Shepard and Lowdermilk have given it a concrete dimension.

Shepard begins with the argument that agriculture was founded on the systematic genocide of hunting peoples over the past ten thousand years. He contends that this slaughter has included peoples with complex cultures, elegant modes of living and profound re-

ligious beliefs. As a result of depriving them of their dwindling hunting resources, they were unable to survive. The clash of white against Indian cultures in North America provides one recent reminder.

Shepard makes the point that, rather than being primitive in a backward sense, non-agricultural civilizations were in fact highly evolved, living in tune with their environments and with the rhythms of nature. Agriculturalists traditionally have justified genocide of such peoples on the basis of cultural superiority, stating that nomadic and hunting-gathering peoples were hostile and aggressive. An opinion of the human paleontologist Richard Leakey may help dispel this image, or perhaps more accurately, this rationalization for inhuman behavior. Leakey is the son of Drs. Mary and Louis Leakey who unravelled so much of early human history from fossils uncovered from the Olduvai Gorge in Tanzania. He made his most famous paleontological finding near Lake Rudolph in Kenya. There he found the skull and leg bones of a women who three million years ago walked with an upright stride, ate a mixed diet of vegetables and meat and may have been capable of speech. Richard Leakey's views on human aggression may bear repeating here as there might be some connection between his speculations and the practice of genocide against hunting-gathering peoples.

Leakey explains: "What we are seeing at Rudolf is a vision of man, bipedal, omnivorous, moving over a rather large area as a hunter-gatherer with a primitive sense of tool making. So far nothing we have developed leads to the "killer-ape" concept. We have no signs of aggression..... When we finish piecing together our history we will find it wasn't until very recently — ten thousand years ago or less — that man had the inclination and leisure to attack his own kith and kin. Between one and four million years ago certain species were unable to compete and eventually became extinct. But apparently they did so without physical aggression."

The meaning of this can only be pondered but it may be relevant to our present story. Perhaps there is a link between concepts of land use and the rise of aggressive behaviors. Paul Shepard's argument of the systematic elimination of hunting people by agriculturalists carries force because the process has continued into the present. Peter Farb in "Man's Rise To Civilization" has outlined its course in North America. It is known that there were more than five hundred different languages spoken by the Indians of North America alone, many as different as English is from Chinese. Almost every category of religious system known to human history had evolved here. Of particular interest to an age that relies upon a few foods to feed humanity, North American Indians used over two thousand different kinds of plants and harvested a wide variety of animal resources. Indians who planted crops used swiddening or long term rotational methods which allowed cultivated areas to be returned to a natural state at frequent intervals. So light was the imprint of their passing on the land that when the white man arrived the continent seemed in a virgin state, filled with game, untrammeled by the plow or axe. Further south, in the Aztec states, the Spaniards found a culture comparable to their own. Hydraulic, primarily monocrop grain agriculture was practised. There were social castes and slaves. The ruling class was obsessed with writing their view of history, a fact which led Farb to speculate whether this might be a mark of dictatorships.

Upon his arrival, the white man destroyed or undermined culture after culture until those that survived did so by becoming poor shadows of his own, giving him justification for his atrocities. Clearing the land for agriculture encroached upon what had once been sacred lands. Present attempts to drive Amazonian tribes to extinction by destroying their habitats to create farm land is one contemporary example of aggression against peoples who neither farm nor understand land ownership. Since the last Ice Age, the persecution of these non-farmers has continued until now, at the beginning of the nuclear age, only some twenty-odd tribes of hunter-gatherers remain. They have been driven to remote areas which are not as yet coveted by agro-industrial societies.

I find it extremely difficult to live with this reality. As a boy I was exposed to some vestiges of Indian culture. Years later on the edge of Hudson Bay in the area where the tundra meets the northern forest I came in contact with it again. Most of the tribe had been interred in the south a generation before. Now there was just one family on the coast led by a young man. Although we never spoke, we acknowledged each other and I learned something about him and his family. Though the caribou are long gone, they still trekked the ancient trails between Hudson Bay and Labrador. Once I came across one of his caches inland, mounted high in a small stand of trees, and later we fished the same river mouth when the arctic char were running. I was there as an observer in the name of science. They were there because it was their life.

Things have been harder for that family since the caribou have been gone from the region. I kept hoping that some relic herd might be lost somewhere in that vast terrain. I can't help but share the burden for their loss, because I know that the same culture that sent me there will not rest until all the resources, from the char to the water power, have been funneled south and until the last Naskapi has been assimilated or is gone. I never saw the young man or his family again but when winter came early and caught us unprepared we opened one of his hunting caches and used his

traps to procur small game in order to survive.

Unlike farmers, hunting peoples do not feel land can be possessed. They believe it is sacred and one must live upon it and within it, as a participant in something that is much larger. If we do not come to grips with these dualities, and with the fundamentally aggressive nature of land use by agriculturalists, the hope for restoration is bleak indeed.

With the gradual displacement of hunting peoples, the long slow transformation of the planet by agriculture began. This period which represents at the most one hundred centuries in an evolutionary sense is but a moment in the history of the species. By focusing his argument on the planetary insensitivity of agriculture, Paul Shepard places it conceptually in the mainstream of social, ecological and political thought. He does not see the development of agriculture as progressing along a tidy linear path of cultural advance, but rather as a powerful and dangerous offshoot in the historical process rationalized and justified by one culture after another. It may have been that ecological and climatic shifts in certain regions originally forced agriculture on people. With its subsequent spread the ecological and human violence which characterize our species may have been perpetuated.

Seven thousand years ago slaves were used to tend the monocrop grain fields in the alluvial valleys of the Tigris and Euphrates. Their subjugation provided the energy, and subsequently the agricultural surpluses, which contributed to the establishment of wealth. During following centuries, towns developed and, with them, the need for a reliable food supply from the hinterland. This placed increasingly heavy demands upon the surrounding countryside. Expanding herds of cattle, sheep and goats began the slow destruction of vegetation across the Sahara, Persia, Morocco and Ethiopia, eventually leaving deserts in their wake.

There is evidence that the rise of states initially may have been based on wealth from the exploitation of previously untapped ecosystems as was the case in the United States and Canada in the nineteenth century. As the agricultural activities of growing populations destroyed the ecosystems, the soil, water, climate and subsequently their wealth began to deteriorate. War was one method used to attempt to replenish dwindling resources and wealth. It was, of course, only a short term remedy, an aggressive attempt to recapture lost resources and basic forms of power.

This entrophic process stretching back into antiquity continues in many parts of the world. I have seen it most recently in Haiti, which has a population of five million people living in an area of ten thousand square miles. The land and the mountain forests have been scalped by browsing goats, by woodcutters in search of fuel and other materials and by farmers who have exposed their soils to tropical sun and drying winds. Trees are not left to grow. They are cut as saplings for charcoal. The charcoal is essential to them to cook grains to make them digestible. Haiti offers a living example of the destructive land use forces that are the theme of Shepard's work.

In the ancient world there was a continuity in the destruction brought about by agriculture, extending from Rome eastward to the heart of China. Lowdermilk, in his lengthy study of agricultural civilizations, was able to trace, through the story of soils, a dynamic in history that makes earth stewardship a central theme. He found, for example, that the low bottomlands along the great rivers of the ancient civilizations are still fertile today though they presently support one-fifth of the populations of three thousand or more years ago. The debacle that overran Babylon, Kish, Ezion, Geber, Timgad, Petra, Carthage and other cities was linked in no small way to two phenomena — hydraulic agriculture and deforestation. The now barren, rocky slopes beyond the city walls from Portugal to Palestine, through much of the near east, North Africa, India, China and Mexico were once covered by soils, grasses and woody plants. On this paleontological, geological, archaeological and historical sources agree. Lowdermilk observed ancient temples on rocky barren, windswept hills. Within their walls, he found in some instances tiny forest groves which by virtue of being in hallowed places had been saved from grazing animals and woodcutters. A church in Cyprus told a strange, revealing tale. It was surrounded by an eight-foot wall of silt. A new floor had been installed recently within the church some thirteen feet above an earlier silt-covered floor. Since the building of the church, clearing, farming, burning and grazing had caused twenty-one feet of silt to wash and blow down from the surrounding hills. Today a desolate and unproductive landscape sustains a small population of impoverished inhabitants.

Like deforestation, hydraulic agriculture played a heavy hand in the fates of civilizations. Through its use many states gained much of their initial power and wealth. It was the ancient equivalent to the infusion of fossil fuels in rich farming countries of today. The nature of farming shifted. With massive irrigation, made possible by the construction of ditches, canals, aqueducts and other ingenious means of moving water, a few high yielding crops could be grown. In any given region these were usually one or two grains. Production on irrigated lands soared. As might be expected, the growth curves for populations rose sharply on a similar, although smaller scale, to those taking place in the world today.

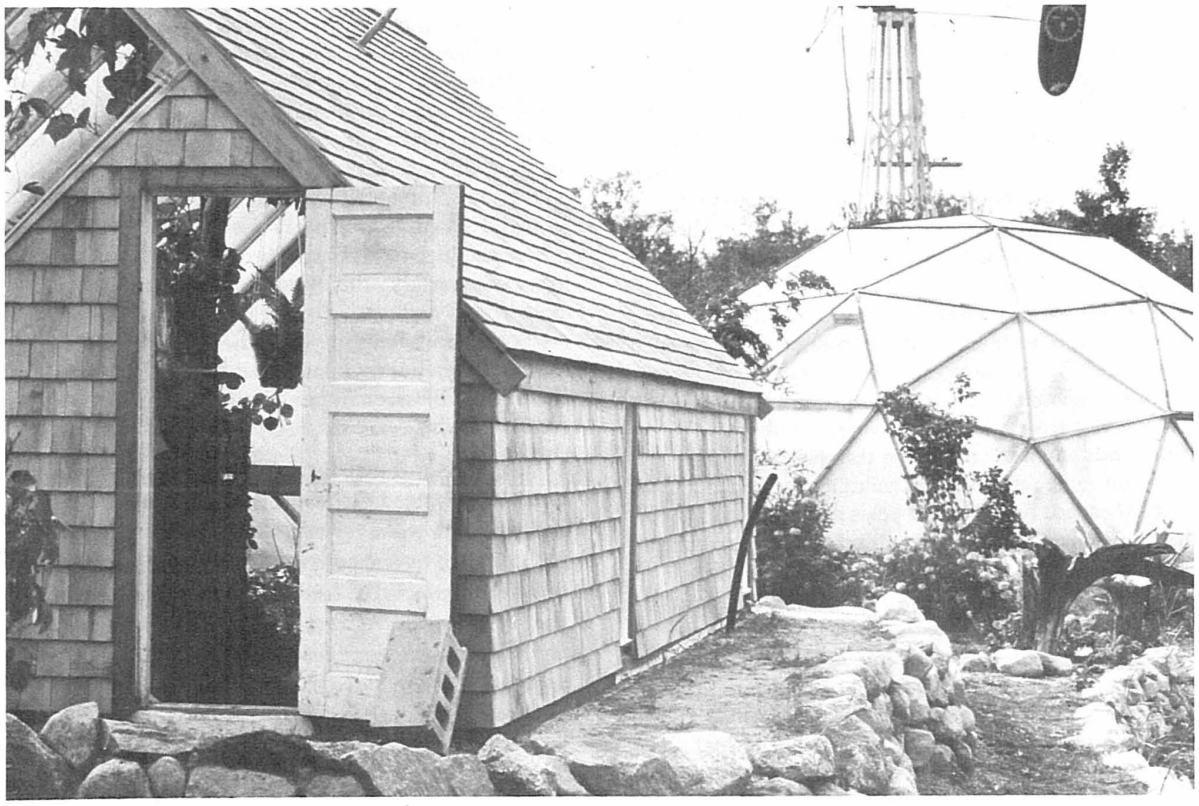
Expanding populations of grain-fed people needed wood for cooking their grains, timber for their shelter and ships, and mutton for meat. Consequently more slopes beyond the population centers were cleared. As cutting and growing extended further outward from the cities, the effort required to deliver these resources to the emerging centers of power was greater. At the same time, and this is a critical element in the process, the erosion of exposed and misused lands caused the silting up of the irrigation channels and the hydraulic works that had initiated the changes in the first place. In some instances this process of silting and clogging took place so quickly that no amount of human effort could win out over the accumulation of the silt. One city, Jerash, which had a population of one quarter million at its zenith now lies under thirteen feet of earth. Today upon the sediments there is a small and poor village of three thousand.

Large scale efforts were inaugurated to slow down siltation but they only succeeded in exaggerating the original causes of decline. Legions of slaves and serfs were brought in to keep the channels free, but slaves had to eat in order to work, and surplus grain was consumed so that in the end the initial basis of wealth, in many instances, was gone. In terms of energetics, these societies were no longer able to yield a net surplus because of the changing dynamic associated with the maintenance of the hydraulic systems. The only direction possible for them as societies was downward towards less stable states.

The story of Rome follows a comparable pattern although the geographic complexity of the empire added a further dimension. It had had its origin as a region of free farmers tending their lands. The success of their crops created conditions for expansion and a need for labor which, in turn, led to enlarged populations. Ultimately pressure from this population caused the holdings to be fragmented into smaller units. Over the years soils were eroded and often exhausted. Social change followed inevitably on the heels of land despoilation and farmers fell back to bare subsistence levels. The weakened countryside was restructured along estate and feudal lines. Some of the serfs and slaves were sons and daughters of free farmers. The countryside, thus reorganized, was vulnerable to the exploitation of labor on behalf of hydraulic agriculture.

During the period of her rise, Rome accomplished some of the most marvelous engineering feats of all times. Most of them were linked to an imperialist agriculture. Farming and urban regions were transformed

Photo by Hilde Atema Maingay



by flumes, ditches, pipelines, conduits, terraces, reservoirs and dikes that spanned the empire. But they could not be maintained indefinitely. As had happened before, misuse of the land caused them to fill with mud and silt. The same land which had been the source of wealth was strained and eventually eroded in the attempt to maintain the network which had originally given Rome its power. Rome became increasingly vulnerable to the wars, famines, invasions and social disruption which finally ended the empire.

Although the factors contributing to the rise and fall of Rome or any other culture are many and complex, it is evident that land use is at the root of wealth and that a decline in agriculture seems interlocked with the process of decay. I do not think it likely that powerful nations can transcend land abuse indefinitely. The quality of land stewardship must ultimately set the stage for any state. We are, as a species, manipulators of lands and the course of this manipulation affects our fate.

This story is not confined to Rome or any particular region or time, for, as Shepard states:

"The destructive combination of hydraulic agriculture and theocratic state has been a major force in the creation of our over dense society and apocalyptic culture. Outside the great valleys other combinations have been chewing at the earth's skin just as effectively although less dramatically. In Morocco pastoral nomadism and other grazing, charcoal making, wood burning and land clearing by fire have combined to deforest a once verdant and shady country."

The highly touted wisdom of the Chinese notwithstanding, the Orient has followed equivalent patterns. In China for some four thousand years lowland people toiled to check the ravages of land abuse by those living higher on the watershed. As their crops and animals destroyed the plant cover and soil, dwellers upstream allowed gullies as deep as six hundred feet to form. Topsoils were swept down to the rivers below. As a result the rivers had to be maintained with man-made dikes. The expenditure of human energy needed to accomplish this over centuries is beyond imagination. Even so, such rivers as the Yellow could not be contained. The flood of 1852 drowned hundreds of thousands when the mouth of the river shifted its position some four hundred miles in one season. About five thousand, five hundred years ago the Tigris River had a comparably disastrous flood due to much the same causes. The story has come down to us in the tale of the biblical flood upon which Noah sailed his ark.

Hydraulic and, in modern times, fossil fuel agricultures have helped create some of the most powerful states the world has known. As civilizations they have proved destructive and imperialistic. It would seem inobdurately short-sighted if by harnessing nuclear energy we should permit the cycle to be repeated once again after the fossil fuel age has waned.

In reviewing history with a wholistic perspective, it would appear that those societies which have loved the earth, treating it as a sacred entity, have been selected against by nation states. Gentler, more earth-bound, conserver societies do not survive amidst exploitative peoples. Steady-state cultures, which usually are organized regionally and in smaller units, are not as destructive of nature as are states. By the conscious extension of their own existence into that of nature they may have, in fact, the opposite effect, acting as sustainers of regions and protectors of lands that in turn sustain them. Many of these people have found means of controlling births without the practice of infanticide and through a variety of methods have attuned their numbers to the carrying capacity of their lands. For reasons not fully comprehended, the history of such people is rarely recorded and their myths are not taken seriously by citizens of a literate world. When people see nature as sacred it is more difficult to understand the value in amassing power, wealth and armies. Without a possessive or ownership attitude towards land it often has been difficult for non-agricultural peoples to defend themselves. To create the mind set and the means for defense they would have had to abandon their traditional ways and beliefs. This becomes increasingly true in the technological era as their weapons are no match for ours.

The practice of an earth ethic accumulates energy in the lands in the form of forests, rich prairies, deep soils and game. This richness attracts exploitative peoples and such corporations as the great fur trading companies of England and France. Invariably there comes a time when the inhabitants become expendable in order to have access to and to make commodities out of those things which have been so carefully sustained by them. I saw this in the lowland jungle where the logging trucks with their cargoes of giant trees were snaking their way out through mile upon mile of rain and mud. For the past seven thousand years the meek have not been the inheritors of the earth. Within our own industrial societies the dichotomy between imperialism and conserver societies remains evident.

The growth of population over the past two centuries has changed the world. Industrial nations have exploited the globe for raw materials and commodities and then have made the third world into markets for the manufactured feeds, fertilizers, medicines and technologies. As a result, the exploited countries are caught in the same rising population curve. They have largely abandoned their traditional farming methods for those of agribusiness. As fuels become scarce the outriders of this technological age will be the first to be victimized. Feeds, fertilizers and medicines will flow less freely from powerful states.

Poorer countries will not receive support in times of rapid transition.

I am painfully aware that in describing agricultural societies I have oversimplified some elements of a much larger whole. However, as an aquarium can be a model of a pond, there is truth within the elements. The methods by which we feed ourselves control much beyond our food. It helps shape the nature of our society. The choice is not a simple one between vegetarianism and non-vegetarianism. Too many people have been enslaved in the rice and wheat fields over time.

At this juncture my greatest hope is that we shall have enough decades ahead in which to learn how to make the transition peaceful and without oppression. If humankind is to restore and reconstruct the earth it will have to begin by rethinking its agricultures and its landscapes. Existing knowledge will have to be re-integrated into healing wholes, and land tenureship first will have to encompass the vision that a sacred ecology can provide.

It is not going to be easy. Although agriculture has shaped the fate of nations, the relationship between land and society is difficult to teach or see. Most intellectuals, business and government leaders, as well as radicals, are urban dwellers many times removed from the forces that sustain them. It is not possible to guide a ship through troubled waters without an intimate knowledge of both the ship and the waters. Most political theory takes little account of the food and energy elements within political systems, and there is yet another related dilemma we must face. At present the scale of contemporary affairs is so great that we can only deal with the world in the form of abstractions which are themselves conceived from imperfect notions. In the future the scale of human endeavors should be reduced and regionalized, so that by so doing we shall become more sensitive to the direct effects of our actions.

These wanderings through the switchbacks of the last seven thousand years have forced me to the conclusion that this is not our world. The theatre belongs to nature and the play is by evolution. It is through this realization alone that adaptive human communities may arise. We need to inquire whether agriculture is merely sick or inherently a planetary cancer. Our species did without it for over a million years. This question is fundamental but rarely asked. I would suggest that farming today is an illness, and that in aggregate only is agriculture a cancer. Yet it need not be. A visionary landscape is possible. On theoretical grounds I would argue that we could generate new agricultures which would be mirror images of nature and that these agricultures would not be cancerous but legacies from the living world. It is in the restoration of nature that we will decode the truly creative forces for the future. One of the major intellectual and actual missions of New Alchemy is the search for ways to replace the engines and the hardware of twentieth century technology with knowledge from nature which when linked to a gentle and appropriate technology can sustain human communities. We are interested in re-integrating existing knowledge to create new wholes which on a smaller scale will begin to mend both lands and peoples. It is just possible that through such activities a transformation of place and consciousness may ensue and that there may be a rebirth of all that is good on the mantle of the earth. I began this writing on a winter's day which imparted a reflection of nature in abeyance. This led to a discussion of the impact of humanity upon the living world and an attempt to trace the history of agriculture from an ecological perspective, or through Gaia's eyes.

Perhaps we can gain strength from an old prophecy.

"This is What the Rebirth
of the World Will Be
A Renewal
of All Good Things
A Holy and Most Solem
Restoration
Of Nature Herself"

—Corpus Hermeticum
attributed to Hermes Trismegistus

The future must touch all of us, for it is within our power as individuals to counter so many things including the continuing loss of biological diversity and the wholesale destruction of soils and forests before the plow.

We can also begin to assist in correcting the imbalances in the gaseous exchanges between the earth and atmosphere. If the subjugation of humans by humans and the rise of warring states has been linked closely with agriculture, the path away may also lie within our reach, through the realization that the future must become a part of us through our every act. That will make the critical difference. Humble things like planting trees in vacant lots become as important as anything. A little garden in a box on an apartment ledge becomes an affirmation of the emerging power, a symbolic and actual measure of change. It may yet come about that the joy and creativity of the human experience, expressed until now through art and music and loving, will yet have their moment in the sun. It is no coincidence that our health and that of the planet are one. We are a part of it in a way we only dimly comprehend. The question is far more subtle than just pollution and destruction. There is a continuum of being in a hillside brook which extends outward to encompass the world while reaching inward into ourselves. We are a mirror image, a tiny reflection of the earth itself and our collective psyche is a superimposition of images of humanity's experience on earth over time. The same forces which have

shaped us have shaped the world. There can be no real separation. The continuities in nature between the design of cells and ecosystems extend from organelles outward to the smallest freshwater pools with their myriad living entities to the oceans and ultimately to the whole planet. These ties are embodied in us too. We look out at the world, and yet are of it. It is no accident that our attempt to affirm these mysterious linkages involves touching upon that which is considered holy or sacred. Such feelings cause me to wonder if there are further threads outward in this continuum. If so, is it possible that there is a relationship between what we do in the world and our religious reconstructions of it? Might there be such a thing as a monocrop of the mind? It seems reasonable to ask whether some of the masculine, monistic religions of the world are a reduction of much that is holy, and a reflection of our mindscape and the imprint of our surroundings upon it. I think perhaps that our mindscape might be an internal ecology with its images in the landscapes of the world.

Our present conception of ourselves and our society may have doomed us. The mushroom cloud is the logical end point of the abuse I have partially chronicled. The epoch of agricultural man seems to be nearing its end. I hope that it is only the end of a journey rather than the end of the road, that new voyages are being planned and that the prophecy of Hermes will one day come true.

I have come to believe that there are many unimagined paths ahead. In our hurry to dominate and control the earth we have become blind to its possibilities. This feeling for the future comes from my experience with many images and ideas contained in miniature at New Alchemy. One evening under the light of the moon I sat down to absorb what we had done. The big sailwing mills turned quietly like dancing ghosts against the sky. One cast its faint shadow against the flickering light emanating from the surfaces of a growing structure. It seemed alive. High overhead was the more distant powerful whirr of the high speed blades of the wind powered electric generating plant. Within the miniature ark it was warm and the earth and plants reeked of fertility and growth. In the distance there was laughter after the day's work.

That moment became the future.

Photo by Hilde Atema Maingay

REFERENCES

Anon., 1975. *The World Almanac and Book of Facts.* Published by Boston Globe. 977 pp.

Charoudi, D. , and S. Wellesley-Miller. 1975. Buildings as Organisms. *Architectural Design.* pp. 157-161.

Farb, Peter. 1971. *Man's Rise to Civilisation.* Paladin, London. 332 pp.

Hutchinson, G. E. 1954. The Biochemistry of the Terrestrial Atmosphere.pp. 371-433. In *The Earth As A Planet.* Edited by Gerard P. Kuiper. The University of Chicago Press. 751 pp.

Jaffe, Andrew. 1975. Paleontology's Daring Young Man: Richard Leakey. *International Wildlife 5 (3)* pp. 4-11.

Lovelock, J. E., and L. Margulis. 1974. Homeostatic Tendencies of the Earth's Atmosphere. *Origins of Life 5.* pp. 93-103.

Lovelock, James, and Sidney Epton. The Quest for Gaia. *New Scientist,* Vol. 65, Number 935. February 6, 1975. pp. 304-306.

Lowdermilk, W. C. 1953. *Conquest of the Land Through 7,000 Years.* U. S. Department of Agriculture Information Bulletin 99.

Margaleff, Ramon. 1968. *Perspectives in Ecological Theory.* The Chicago Series in Biology, Volume 1. The University of Chicago Press. 111 pp.

Margulis, L., and J. E. Lovelock. 1974. Biological Modulation of the Earth's Atmosphere. *Icarus 21.* pp. 471-489.

Margulis, L., and J. E. Lovelock. The Atmosphere as Circulatory System of the Biosphere — The Gaia Hypothesis. *The CoEvolution Quarterly,* Summer 1975. pp. 30-39.

McLarney, W. O., D. G. Engstrom and J. H. Todd. 1974. Effects of Increasing Temperature on Social Behavior in Groups of Yellow Bullheads (*Ictalurus natalis). Environmental Pollution (7).* pp. 111-119.

Odum, H. T., and Ariel Lugo. 1970. Metabolism of Forest-Floor Microcosms, Chapter 1-3, in *A Tropical Rain Forest: A Study of Irradiation and Ecology of El Verde, Puerto Rico.* H. T. Odum, Editor. Division of Technical Information, U. S. Atomic Energy Commission.

Odum, H. T. 1973. Energy, Ecology and Economics. Paper Invited by Royal Swedish Academy of Science. 26 pp. Widely reprinted. See *The CoEvolution Quarterly,* No. 1, Spring 1974, and the *Journal of the New Alchemists (2),* 1974.

Power, M. E., and J. H. Todd. 1975. Effects of Increasing Temperature in Territorial Groups of Pumpkinseed Sunfish, *(Lepomis gibbosus).* In press: *Environmental Pollution.*

Shepard, Paul. 1973. *The Tender Carnivore and the Sacred Game.* Charles Scribner's Sons, New York. 302 pp.

Todd, J. H., J. Atema and J. Bardach. 1967. Chemical Communication in the Social Behavior of a Fish, the Yellow Bullhead, *Ictalurus natalis. Science, Vol. 158.* pp. 672-673.

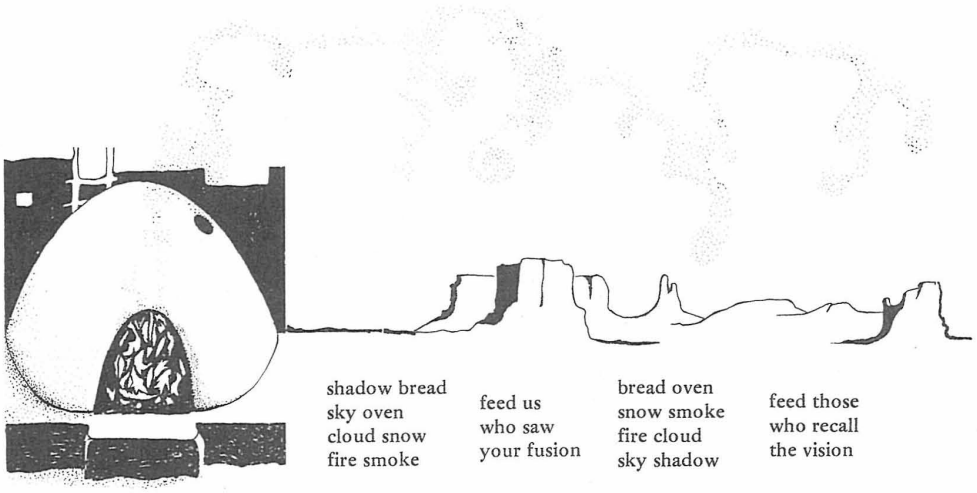
Todd, J. H. The Chemical Languages of Fishes. *Scientific American,* May, 1971. pp. 98-108.

Todd, J. H., D. Engstrom and W. O. McLarney. 1972. An Introduction to Environmental Ethology: A Preliminary Comparison of Sublethal Thermal and Oil Stresses on the Social Behavior of Lobsters & Fishes from a Freshwater and Marine Ecosystem. Woods Hole Oceanographic Institution Technical Report 72-42. 104 pp.

Wellesley-Miller, S., and D. Charoudi. 1974. Bioshelter. *Architecture Plus,* Nov./Dec. 1975.

Williams, Raymond. 1973. *The Country and the City.* Oxford University Press. 335 pp.

Yates, F. A. 1964. *Giordano Bruno and the Hermetic Tradition.* Vintage Book. 466 pp.



shadow bread
sky oven
cloud snow
fire smoke

feed us
who saw
your fusion

bread oven
snow smoke
fire cloud
sky shadow

feed those
who recall
the vision

— Meredith Fuller-Luyton