Chapter 4

Golden Garbage

In the peaceful woodlands of southern New York, just west of the Hudson River, a sprightly lady in her eighties, Margrit Selke, presides over an A-framed hut that resembles more the home of the Good Witch in the Grimm fairy tale than an establishment for the pursuit of science. It is Pfeiffer's laboratory at Threefold Farm. All in diminutive storybook form, it contains the equipment for the manufacture of the Pfeiffer starter: alembics, retorts, microscopes, heating and cooling containers, great mixing vats, specially designed, and a line of refrigerators stocked with vials of multiple strains of incubating or dormant microorganisms designed to chew up each and every component of any kind of garbage set before them.

Also an émigré from Hitler's Germany, Margrit Selke continues to produce Pfeiffer's starter, still in demand by those determined enough to request it. On the day we visited, a thousand units lay in plastic bags in a box half the size of a footlocker, ready to be shipped to Saudi Arabia, and another thousand were ready for Dubai, each parcel designed to revivify a thousand acres of barren land. For the more volatile market in this country, Ms. Selke continues to keep the strains alive, along with cherished memories of their developer.

Pfeiffer was barely twenty when he first met Steiner at Dornach just outside Basel, Switzerland, in 1919. The master, then in his fifties, quick to see the young man's talent, turned his interests

Margrit Selke in her lab at Threefold Farm, N.Y.

from electronics and physical chemistry toward what he considered the more vitally important study of biochemistry, biology, and their application to agriculture.

By 1925 Pfeiffer had set up his own Bio-Chemical Research Laboratory in a shed of the Weleda Drug Company, manufacturers of non-chemical medicines, at Arlesheim, near Dornach, intent upon following Steiner's lead not only into anthroposophy, but into his newly expressed theories about the vital state of agriculture. Just before his death, Steiner had made the same request of Pfeiffer he had made of Kolisko, that he search for some chemical agent that would reveal the formative forces in biological substances. Spurred by this need to show, by strictly orthodox scientific methods, the existence of whatever it might be in living matter that differentiates it from the inorganic, Pfeiffer investigated a great number of chemicals, finally settling on copper chloride as the most suitable agent. With it Pfeiffer was able to develop a method similar to Kolisko's to analyze biological substances which came to be known as diagnostic crystallization.

To test the effectiveness of Steiner's preps, Pfeiffer carried out a series of experiments by placing chopped potatoes in thin dilutions of 500 to 507 and studied the development of roots, discovering that 500 had a particularly stimulative effect on root growth, causing numerous fibrous roots, whereas 501 increased the assimilative activity of plants, and 504 had a special influence on flavor; all the others strengthened growth compared with control

samples.

Pfeiffer claimed that in the last half century, since the advent of one-sided fertilization, and of insecticides, humanity all over the world had been receiving increasingly deficient protein in food, and, that there was nothing normal anymore in what was being grown. But by comparable testing of chemically-grown wheat seeds and biodynamic wheat seeds, Pfeiffer showed that, on the seventh day after sprouting, biodynamic seeds contained 42 percent protein compared with 23 percent for chemically-grown seeds. Harvested in the summer, the biodynamic wheat had an almost gloss-like grain, and 12 to 18 percent protein compared to 10-11 percent for chemically-grown wheat, which lead Pfeiffer to remark that with such nutritious wheat one could almost avoid eating meat.

Subjected to 100 degrees of heat for half an hour, the biodynamic kernels still sprouted, whereas artificially fertilized kernels were dead.

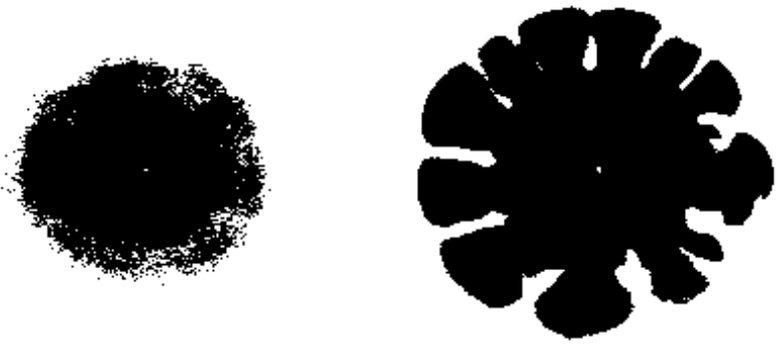
Other experiments were made in fields where parcels of land side by side were repeatedly cultivated in the same way, planted with the same crops, but fertilized differently to demonstrate the difference.

From 1926 to 1938 Pfeiffer also ran several farms in Holland, totaling eight hundred acres, complete with their own flour mill and bakery for making specially wholesome bread, which fed a total of seven hundred families. Biodynamically-produced vegetables, distributed under the Demeter brand—named for the Greek goddess of agriculture—at first avoided by outsiders as too expensive, were soon forced back onto their tables by children who refused to eat any other kind of vegetable put before them.

For fear of startling Americans, Pfeiffer's first book published in the United States, *Bio-Dynamic Farming and Gardening*, so bowdlerized Steiner it avoided offending anyone squeamish about metaphysics, and could thus persist, without causing the slightest reaction, as the guiding light for a few hearty souls. There was no mention of buried cow horns, stag bladders, or the slimy skulls of animals. The preps were politely described as generic concoctions of herbs.

While World War II raged on in Europe, Pfeiffer was establishing his bona fides in America by obtaining an honorary degree in medicine from the Hahneman Medical College in Philadelphia—at one time almost wholly devoted to homeopathy—in recognition of his remarkable biological research with the use of crystallizations. Using a single drop of a sick patient's blood he made it possible to diagnose many forms of disease, including cancer.

By 1944, as an American citizen, after a falling out with his



The left chromatogram shows margarine, lacking in vitamin and enzyme formation. On the right, fresh homemade butter from unpasteurized milk shows what Pfeiffer calls a healthy abundance of vitamin influences.

patron at Kimberton Hills, Pfeiffer moved to a 285-acre farm of his own in Spring Valley, N.Y. which he operated biodynamically. But the land was stony and sterile, the cattle riddled with the dreaded Bang's disease, and only Pfeiffer's cheerful determination, along with his applied scientifically made composts, enabled him within two years to restore the land, feed the grain grown from it to his cattle, and cure them without medication: "They cured themselves," was Pfeiffer's smiling explanation. "We simply provided nutrition and care."

Greatly preoccupied with the general condition of soils in America, Pfeiffer found a third of the United States on the way to becoming useless from erosion and bad agricultural practices. In the Middle West, dust storms were moving eastward at the rate of forty miles a year. Because of unbalanced overgrazing, and a greedy tillage of the soil, with no care given to protect it, the sod was gradually being loosened and the protective soil covering wafted into the atmosphere by drought and wind. A biologically beneficial form of the balanced, diversified farm, with heavy legume plantings, meadows, and green manuring, was being given up in favor of a one-sided monoculture. Between 1935 and 1938 some 90 percent of the settlers of the Great Plains abandoned their farms, tragically described by Steinbeck in *The Grapes of Wrath*.

To make things grow on a piece of soil, Pfeiffer pointed out, was not necessarily farming; it could be destroying the earth's fertility. A cultivated field, he insisted, was a living organism, a living entity in the totality of its processes. "A well-tended field does not have an unlimited capacity for increased productivity, especially not one directly proportional to the amount of fertilizer applied.

An increase in production may be obtained, but the soil, as an organic structure, can go to pieces."

Pfeiffer preached repeatedly that soils intensely treated with chemical fertilizer or orchards sprayed for a long time with chemicals no longer have any biological activity. They begin to die. Also, vineyards treated for years with copper and lime solutions become devoid of earthworms, losing their capacity for creating humus.

Strong doses of chemical fertilizers, said Pfeiffer, especially those containing soluble salts like potassium or ammonium sulfate, or highly corrosive substances such as nitro phosphates, or poisonous sprays, like arsenic and lead preparations, injure and destroy the microorganic world. And he was quick to point out that every measure that disturbs life in the soil and drives away the earthworms and bacteria, renders the soil more lifeless and less capable of supporting plant life; the only healthy alternative, he advocated, was Steiner's biodynamic compost.

But opposition to methods that smacked of witchcraft was still too virulent in North America; and the strain of a constant sixteen-hour day divided between science and farming was too great for Pfeiffer's weak constitution. From congenital diabetes and advanced tuberculosis he collapsed and was confined to a sanitarium for a year. An indefatigable researcher, Pfeiffer took the blow as an omen to change his approach. Out of bed, he headed for the sanitarium's bacteriological laboratory to study under the microscope the very tubercular bacteria that had been gnawing at his lungs, particularly fascinated by the way specimens from digestive tracts break down and digest waste material—all of which gave him food for thought. Already at Dornach, Steiner had suggested he search for a method of transforming vaster quantities of organic matter into fertilizing compost. To Pfeiffer this meant identifying and isolating the individual strains of bacteria that could digest and transform the various ingredients in an entire city dump.

Sufficiently recovered, Pfeiffer founded his Biochemical Research Laboratory at Threefold Farm, in a Steinerian center organized in the 1920s by a disciple of anthroposophy who was happy to offer Pfeiffer the opportunity for developing Steinerian notions.

With the help of Margrit Selke, Pfeiffer patiently sought out and isolated the various strains of bacteria which, rendered dormant and added to Steiner's traditional biodynamic preparations, he predicted would produce a bacterial starter so vital it would be called "bio-dynamite," capable of transforming vast amounts of city garbage and slaughterhouse refuse into valuable organic fertilizer at competitive prices that would lead to the demise of chemicals.

Dr. Pfeiffer at Threefold Farm, Chester, New York in the 1950s.

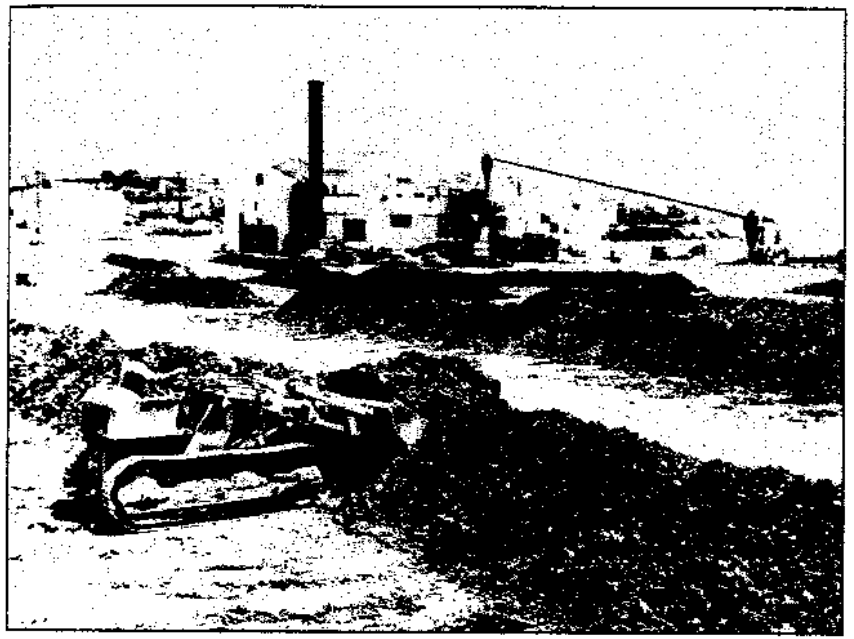
It is said that Pfeiffer was also led to this development of Steiner's original preps because he found it difficult to convince American farmers of the validity of having to potentize the various ingredients by stirring for an hour, let alone bury cow horns, oak bark, or skulls. In his starter he maintained the preps were already correctly potentized by stirring. Only a select group of dedicated biodynamic enthusiasts continued, unostentatiously, to use the original preps, stuffing and stirring as Steiner had recommended, while Pfeiffer launched into the large-scale wholesale reduction of city refuse.

By 1950 he had approached Tony Dalcino, president of an Oakland, California garbage-collecting outfit, and offered to translate into fertilizing humus as much as possible of the four hundred tons a day of garbage collected by Dalcino's trucks from the city of Oakland. To drive home to Dalcino the folly of the present system of handling refuse and the advantages of his offer, Pfeiffer explained how it costs Americans, as taxpayers, billions of dollars a year to cart away as garbage precious minerals and organic material taken out of the soil in the form of food, while it was

costing farmers some $7 billion a year to put chemical fertilizers back into the ground.

For funds to construct a factory to process this material, Pfeiffer convinced the owner of a wastepaper business in Buffalo, New York, Richard Stovroff, by offering him as a carrot the separated wastepaper to recycle. Seven stockholders, mainly paper processors who saw in the garbage the promise of reusable pulp, were persuaded to spend a total of $150,000 to start the Comco Company.

Shortly thereafter a small slate-gray building arose on a peninsula on the edge of San Francisco Bay. In it a hundred tons a day of wilted refuse was fed onto conveyer belts, to come out as compost inoculated with the Pfeiffer starter.



Dr. Pfeiffer's first municipal composting plant in Oakland, California, 1950-52.

As described by a contemporary journalist, lines of heavily laden garbage trucks would rumble down to the Comco factory, jouncing across the refuse-strewn yard to dump their aromatic loads. Tractor plows nosed the muck into piles to be pushed into a long trough leading to the plant. Inside, a pair of giant suction fans hanging over the conveyor belt, like outsized vacuum cleaners, sucked up most of the wastepaper. Huge magnets scanned for metal objects and ten workers rummaged through the refuse with gloved hands to pull out glass or wooden objects. Properly picked over, what was left got dropped through a chute onto waiting

trucks to be carted to a hopper where enormous steel blades, rotating against stationary blades, chewed it like hamburger, while nozzles showered it with water spiked with bacteria, a tablespoon of microbes to every ton of gook.

Action of the bacteria was immediate. Within two to four days they could multiply 300 million times, with metabolic action so intense the mixture heated up to more than 150 degrees as various strains of furiously procreating bacteria decomposed and digested the garbage, producing enzymes to speed up the digestive process and make possible chemical changes—a weird spectacle against the San Francisco landscape as the mountainous piles actually cooked, throwing off dense clouds of steam.

In less than a week, with decomposition completed, the piles would shrink and cool. As Pfeiffer explained the process: "During the digestive period, food-building bacteria have begun to grow. Their function, as in the life process itself, is to use the decomposed matter to build living organic matter, store up nutrients in the mass to be used by growing plants, changing basic elements so they can be absorbed into plant roots."

Such bacterial life, Pfeiffer explained, is present in virgin soil; but in the garbage compost the concentration is several hundred times greater. "After the first week of violent decomposition, the garbage has ceased to be rotting material and has become stabilized plant food. It has no odor. Actually it repels vermin; and carrion birds will hover around the piles but not venture to alight on them."

The result of all this was that some three weeks after an Oakland housewife had scraped from her dinner plates into the garbage can the remains of a meal, this waste, reconditioned, could be shipped as a sweet-smelling black earth to farms and nurseries anywhere in the country. The Ferry-Morse Seed Company, distributor of the product, also used it to cultivate its own prize grass and flower seeds in Salinas, California. It even sprayed Pfeiffer's bacteria directly from a helicopter over several thousand acres of its own farmland.

Vegetables grown with the converted garbage were found to weigh 25 percent more than those grown with conventional fertilizers, and had as much as three times more vitamin A. Grain showed a consistently higher protein content. Laboratory experiments showed that Pfeiffer's mixture could restore even sterile sand to vigorous fertility, eventually transforming desert into rich farmland so long as adequate water was available. Organic matter, mineral balance, and essential structure were restored, permitting the absorption and retention of moisture.

The hope was to provide the nation with a cheap supply of

natural organic matter to anchor the topsoil and reverse the trend towards a continental dust bowl. "If all the U.S. garbage were processed each year," said Pfeiffer, "we would have about thirty million tons of compost, enough to fertilize ten million acres of land. Garbage dumps would just about disappear."

The head of the Oakland Sanitation Department, Walter F. Gibson, called the plant "a boon to any municipality ....Economically sound, it can be operated in any area." *The Oakland Tribune* chided San Francisco for not getting a compost plant, commenting: "California does have its backward cities!" Lady Eve Balfour, organizing secretary of the Soil Association Ltd. of Britain, climbing gingerly around the hillocks of garbage, singled out the Comco plant as the high spot in her U.S. tour.

But Pfeiffer had bitten off more than either he or the phalanxes of his microbes could chew. Concerted opposition by the producers of chemical fertilizers, worried about losing business, was too tough to digest. Within two years the Oakland Comco company had closed its facilities for good.

Fifty years later, no concerted effort has been made to take up where Pfeiffer left off. According to a recent article in the *New York Times*, the next decade's principal agenda for New York City will be the disposal of its garbage, twenty-one billion pounds a year.

"Like time," said the head of the city's Sanitation Commission as he sat in his seventh-floor office surrounded by an "art deco" collection of miniature trash cans, "like time, the flow of garbage never stops."

Back in his lab at Threefold Farm, gravely disappointed but unflinching, Pfeiffer continued to research, battling for his cause from podium to podium, facing odds strongly stacked against biodynamic farming. Along with the efforts of other organic farmers, he was derided by the powerful chemical companies with their vast assets and financial control of agricultural colleges, newspapers, magazines, and publishing houses.

By 1961 Pfeiffer had succumbed, ostensibly to tuberculosis, leaving Margrit Selke to carry on alone.

In her good witch A-frame lab, she reminisced about the highlights of her hero's life. Doc, as his co-workers liked to call him, was always ready, she told us, to help with his knowledge of biodynamics, and would devote as much care to a small backyard garden as to a several-hundred-acre farm, giving instant advice from his cornucopia of experience. Shown a garden with a very high toxic iron content, he would prescribe the Steinerian remedy of planting stinging nettles around the entire perimeter, with the result that the next soil reading would show a 40 percent decline in iron, and stay that way. For an infestation of pea aphids he would suggest, equally successfully, a tincture of green soap, diluted 5 ounces to a gallon of tap water.

Among his more arcane suggestions was the caveat never to take a rock smaller than a man's fist from the soil, as rocks are a valuable source of minerals, and their loss impoverishes the soil. As an excellent means of controlling pests in a garden, Pfeiffer recommended young turkeys "because they clean up insects without disturbing growing plants, and talk to each other all the time in the sweetest voices, a joy to hear!"

Biodynamicist Helen Philbrick, author of a charming book on companion plants, recounts how Pfeiffer cured for her a peach tree that had suffered an injury to its trunk and developed a large decayed area, which, no matter how carefully pruned and excavated, continued to languish. Pfeiffer, she says, looked closely at the tree, up and down, all around, studied the soil, the hillside, the sky, and the adjoining woods. Presently he stepped out onto the road and examined the drainage ditch and fences.

Beginning to suspect he had forgotten all about her tree, Helen Philbrick was about to remind him when he finally returned and said: "The trouble with your peach tree is that row of fence posts over there."

He must, says Helen, have read disbelief in our faces, followed by our immediate question: "What could fence posts up there have to do with a tree down here?"

With his accustomed patience, and with no suggestion that anyone else's knowledge of biology might be disgracefully limited, Pfeiffer quietly explained: "The fence posts are hosts to white shelf fungus which you can plainly see. The function of shelf fungus is to reduce decaying wood to topsoil so that it can be returned to earth to start its cycle again. The shelf fungus from the dead fence posts spreads into the decayed wood in the damaged peach tree and the wood thus continues to decay. If you will either remove the fence posts or treat them with crankcase oil to stop the fungus, there, you will save your peach tree, here." His advice being followed, says Helen Philbrick, many good peaches were gathered from that tree for many years to come.

But Pfeiffer's advice was not always so promptly followed. On the whole he failed to convince his fellow Americans of the tenets of biodynamic farming as taught to him by Rudolf Steiner. So few of his listeners dared follow his prescriptions, he began to water them down and failed to talk openly of what BD preps were actually made. Farmers were too fearful of being caught by their neighbors burying cow horns, and too lazy—or overworked—to spend an hour potentizing the 500 by stirring it into water. Also, they

had no way to assure themselves of a ready supply of stag bladders, bovine mesenteries, or cows' intestines. So BD was barely kept alive by a few devoted farmers who practiced on the sly without publicizing what they were up to.

For many years those who—for whatever reason—could not handle the preparations for themselves relied on the efforts of a devoted spirit that shone among the hills of Pennsylvania just south of the Poconos. Tucked into a petite five-foot-one-inch body with radiant, peach-complexioned features, Josephine Porter became the most industrious and indefatigable supporter of Steinerian biodynamics, keeping the preparations alive for all of a generation, almost single-handedly.

From the middle of the 1940s when she was first apprenticed to Pfeiffer at his Spring Valley, New York, farm until she died in 1985—of emphysema brought on by regular milking of eighty goats to which she was allergic—Josephine took care of producing all the preps. With her tiny gloved hands, she collected cow manure from a herd of her own Angus, scrounged cow horns from local slaughterhouses, wheedled stag bladders from friendly neighboring hunters, raised stands of yarrow, camomile, nettles, equisetum, and valerian, drying, pressing, stuffing, sewing with her finely shaped fingers, day in and day out, year in and year out, for a lifetime, until she put a notice on the BD bulletin board at Kimberton Hills and obtained the devoted discipleship of our naval host, Hugh Courtney. Regularly he came to Pennsylvania to learn from her the secrets of Steinerian magic, convinced as she that in the proper manufacture of the preps lay the healing of America's soil and the future of the country's agriculture. Despite their efforts, for years BD in America remained almost totally unknown.

Chapter 5

MICROCOSMOS

Pfeiffer's preoccupation with microbes may have been less morbid than prophetic; for the little creatures—largely responsible for everything that lives on earth—may yet save the planet from destruction.

Not only is the soil their natural habitat: they invented it: as a base for all that lives. Toothless and mouthless, they ingest through their membranes and chew up with chemical action the seasoned elements from the hard, bare rock of a planet they inherited before it could be advertised as earth, laying down their carcasses to produce a living soil of humus in which the earliest plants, the lichens, progenitors of the giant forests and the majestic redwoods of the West, first established a tenuous toehold.

As Charlie Walters, editor of *Acres U.S.A.*, puts it in his Kansas drawl: there are more kinds and numbers of minute livestock hidden in the shallows and depths of an acre of soil than ever walk the surface of that field. The weight of microorganisms busy under grassland is far greater than that of all the large mammals, cows, horses, rabbits, mice, gophers, toads, snakes, birds, grasshoppers, spiders, and other types of animal life that run above it or take shelter in it. A single microbe reaching maturity and dividing within less than half an hour, can, in the course of a single day, grow into 300 million more, and in another day to more than the number of human beings than have ever lived. As computed by Lynn Margulis and her son Dorion Sagan in their brilliant

Microcosmos, bacteria, in four days of unlimited growth, could outnumber all the protons and even all the quarks estimated by physicists to exist within the entire universe.

That we should be so cavalier about these microorganisms is ironic, if not tragic; for the human body may be a direct descendent of the first single-celled bacterium to inhabit planet earth three and half billion years ago, inventor of life's miniaturized chemical systems, a feat unrivaled in the universe as we know it. Man's body (and woman's), along with every organ in it, is composed of quadrillions of animal cells and a hundred quadrillion of bacterial cells. The intestinal tract is lined with vital microbes that alone enable food to digest. Microbes proliferate throughout the length of the intestine. And every inch of skin teems with friendly but unseen creatures by the billion. Though we kill them religiously with soap, left alone, they clean the skin as well as any cream produced by Arden or Weleda.

As master chemists, bacteria have transformed the planet from a cratered moonlike terrain of volcanic glassy rocks into the fertile globe we know with its entrancing landscapes upon which we walked so well until the advent of the petrochemists.

Life, in its basic form of microbes, has been a companion of the earth from shortly after the planet's inception. And so close is the vital bond between the environment of earth and the microscopic organisms thriving upon it, it is virtually impossible for biologists to give a concise definition of the difference between that which is living and that which is not, or to tell whether microscopic algae, ancient, ubiquitous, perennial source of life—are truly animal or plant.

Within the soil, procreating in high concentrations, bacteria ensure fertility, recycling the elements through the chemical laboratory that constitutes their bodies, making them available to plants. Nitrogen and carbon are not alone in requiring the help of microbes before they can be rendered fit for plants. As nitrogen is converted into nitrate, phosphorus is turned into phosphate, sulfur to sulfate, chlorine to chloride, boron to borate, molybdenum to molybdate, and so on through the elements, thanks to microbes.

While a minority can subsist on mineral inorganic detritus, or rock dust, the majority feed on organic compounds, degrading organic molecules in the soil deposited from plant and animal tissues, recycling dead cells into mineral substances in a solution that can readily be reassimilated, first by plants, and so on, up the ladder of life.

Microbes first attack the substances that decompose most readily, such as sugars and cellulose. When these are used up,

most of the microbes die, making up with their bodies half the total of the soil's organic matter; and a staggering number of dead microbes are decomposed and consumed by other microbes, in never-ending cycles. The oxidation of plant tissues being incomplete, lignin, tannins, fluvic acid, kerogen, and waxes—which resist the action of the microorganisms—are formed into a humus that undergoes a slower degradation, conferring to the soil its hydrophilic, water-loving capacity, its colloidal structure, and its resistance to erosion.

Animal excretory products, such as urea and uric acid, are transformed by brigades of bacteria working in relays into ammonia or ammonium salts, which are then converted by other bacteria into nitrates.

Without the bacteria's ability to capture nitrogen directly from the air, the earth's life forms would long since have died from nitrogen starvation. Beer, wine, bread, and cheese would not exist without the intervention of the microbe, which makes of man as great a scatophage as is the microbe. For alcohol and carbon dioxide—as in a cooling *Spritze*—are but the excrement and exhaled breath of living microbes.

So varied is microbes' alchemy they can convert corn-steep liquor—a waste product—into penicillin, or dead cuttlefish into perfume. And they reveal, as shown in Brian J. Ford's highly readable and informative *Microbe Power*, an astonishing level of over-production: the B-2 which microbes produce is *ten thousand times* as much vitamin as they require for their own metabolism.

Coal, limestone, and iron ore, three basic ingredients of an industrial society, have all been bequeathed to man by microbes. It is possible that all the commercial oil fields are derived from the remains of ancient, extinct microbic diatoms. Fossil beds contain billions of cubic feet of microbes, one tenth of which was originally oil. And sulfur is another element we owe largely to bacteria. Texas deposits, which yield some 90 percent of the world's sulfur, were converted by bacteria from calcium sulfate, the substance known as gypsum or plaster of Paris.

Eventually the total amount of work to be done in the soil by what Walters calls the "farmer's unpaid workers," is divided up among the microbes. Some collect nitrogen from the air. Some serve as scavengers. Some release ammonia from protein substances. Some change the ammonia to nitrite. In the struggle for existence, some find it simpler to feed on the dead bodies of their fellows than continue to synthesize new supplies of food from purely inorganic materials. Others manage to attach themselves as parasites to other living microbes, which serve them as willing

or unwilling hosts.

Margulis and Sagan are certain that all visible organisms have evolved through symbiosis from their invisible predecessors, their coming together leading to mutual benefit through the permanent sharing of cells. They are convinced that all existing photosynthesis—which they call undoubtedly the most important single metabolic innovation in the history of life on the planet—first occurred not in plants but in bacteria. This harnessing of discrete particles of light to reduce carbon to its energy-rich form, a photochemistry that is still not thoroughly understood, evolved, they say, first in bacteria, and only later in plants and algae. Even the minute green chloroplasts within the leaf cells, which actually trap the radiating solar energy, may originally, according to Margulis and Sagan, have been independent microbes of a sort, enslaved and put to work within the plant for its own benefit.

Photosynthetic bacteria appear to be vestiges of ancestors that played an important role before cyano-bacteria appeared and oxidized water to produce the free oxygen they learned, and then taught us, to breathe. "The production of food and oxygen from light were to make microbes the basis of a global food cycle that extends to us today; animals could never have evolved without the food of photosynthesis and the oxygen in the air."

Now plants carry out the greater part of photosynthesis on earth, while most bacteria, and to a lesser degree some fungi, ensure the conversion of wastes from all living organisms into mineral substances available to plants. Thus the biosphere is all of a piece, an immense, integrated, living system, an organism in itself, comprising man, beast, plant, worm, and microorganism, each animated by a different facet of the one.

And, if microorganisms built the soil, the real tiller and fructifier of the soil is not man, but worm. "It may be doubted," wrote Charles Darwin, "whether there are many other animals which have played so important a part in the history of the world as have these lowly organized creatures." All the vegetable mold of England, Darwin concluded, passed through, "and will again pass many times through, the intestinal canals of worms."

Impaling this frantically wriggling body on a fishhook or slicing its spread-eagled body on the dissecting table of some retarded, superannuated high school biology class, may be the closest most people ever get to an earthworm: unjust, unfair, and unwarranted retribution against what may be man's most useful ally in his struggle to survive, considered by Darwin the greatest plowman, an animal of greater value than the horse, relatively more powerful that the African elephant, and more important to man than even the cow.

Despite his classic work on the earthworm, *The Formation of Vegetable Mould Through the Action of Worms with Observations on their Habits*, written shortly before his death in 1881, and despite a comprehensive bibliography of research papers on earthworms prepared for the Darwin Centenary Symposium on Earthworm Ecology, containing some two thousand references covering the period 1930 to 1980, prepared by Satchell and Martin in 1981, the earthworm has been grossly neglected and cruelly mistreated in the course of modern agriculture practice.

Even Darwin missed the prime asset of the worm: that within its digestive tract it incubates enormous quantities of the microorganisms which, in its castings, become the base for fertile humus.

It took a French scientist and ecologist, André Voisin, author of the insightful *Soil, Grass and Cancer*, to point out that the earthworm, and in particular the slippery lubricid, most common in the United States and Europe, is not only essential to good agriculture, but is the very foundation of all civilization. In his *Better Grassland Sward*, Voisin traces man's civilizations in relation to the distribution of active earthworms, of which he lists some three thousand species.

Among the most ancient of terrestrial animal groups, several hundred million years old, they come in various colors and sizes: brown, purple, red, pink, blue, green, and light tan, the smallest barely an inch long, the largest a ten-foot giant in Australia, though South African newspapers reported a boa-constrictor-sized monster twenty feet long, a yard wide through the middle. The most common European and American earthworm, *Lumbricus terrestris*, grows barely longer than six inches.

Ten thousand years ago, immediately after the last ice age, the lumbricid earthworms were to be found only in certain restricted areas of the planet, such as in the valleys of three great civilizations—the Indus, the Euphrates, and the Nile—where crops grew almost without cultivation in a soil of immensely fruitful richness.

As Jerry Minnich points out in *The Earthworm Book*, other areas of the earth offered ideal climates and rich soils, but produced, with the exception of China, no such civilizations. The Egyptian experience alone, says Minnich, is strong indication that a complex civilization cannot develop until the basic agricultural needs of its people are met, and that requires the earthworm.

Not that the point was entirely overlooked by the USDA. An Agricultural report on investigations carried out in the valley of the Nile in 1949, before the folly of the Aswan Dam, indicated that the great fertility of the soil was due in large part to the work

of earthworms. It was estimated that during the six months of active growing season each year the castings of earthworms on these soils amounted to a stunning 120 tons per acre, and in each gram of that soil are more microorganisms than there are humans on the planet.

Thirty years before the birth of Darwin, as the American colonists were breaking away from the mother country, an English naturalist, Gilbert White, was writing:

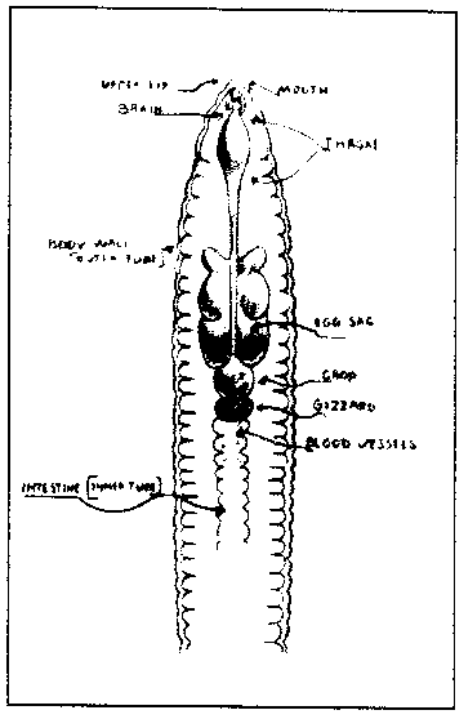
> Worms seem to be the great promoters of vegetation, perforating and loosening the soil, rendering it pervious to rains and the fibers of plants by drawing straws and stalks of leaves and twigs into it; and, most of all, by throwing up such infinite numbers of lumps of earth called worm-casts, which being their excrement, is a fine manure for grain and grass....The earth without worms would soon become cold, hard-bound, and void of fermentation, and consequently sterile.

That the phenomenon was understood before the time of Christ, is clear from Cleopatra's decree that the earthworm be revered and protected by all her subjects as a sacred animal. Egyptians were forbidden to remove it from the land, and farmers were not to trouble the worms for fear of stunting the renowned fertility of the Nilotic valley's soil.

In the northern part of North America the last Ice Age so stripped the country bare of earthworms that in very few areas of what is now the United States were agricultural lands rich enough to support even moderately large populations of native American Indians. As Minnich says: "Before European contact, the only lumbricids native to the United States were some lacy species of Bismatus and Eisenia, essentially worthless as soil builders."

But wedged in the shoes of the colonists' horses were tiny lumbricid egg capsules, and in the rootballs of European plants immigrant earthworms arrived to remedy the situation. In no time a rich but dormant soil was transformed into one of high fertility. The lush meadows of New England, the vast farmlands of the upper Midwest, the great wheat fields of Canada are all attributed to the introduction of the earthworm.

By the early part of the twentieth century, says Minnich, New Zealand soil scientists observed that European lumbricids were making vigorous inroads into the islands' previously wormless soils. Hill pastures that could barely support a stand of grass were gradually becoming lush and green even though no fertilizer was applied. Counts of earthworms ran as high as over four million per acre, more than three times the maximum populations of



Internal organs of the earthworm (*Lumbricus terrestris*). From *The Earthworm Book* by Jerry Minnich.

the same species in their Old World habitats. The source of all this fertility was what the worms excreted in the form of castings, compost of the highest grade, containing mineral and organic matter in a soluble form, excellent as both a fertilizer and as a soil conditioner.

Earthworms can produce more compost, in a shorter time, with less effort, than any other method. As they burrow, they are constantly bathed in mucus which helps them through the roughest ground. Continually rubbed off, this mucus helps cement the walls of their tunnels. And while it helps a worm worm its way out of a predator's grasp, it also helps hold the soil firm, retaining moisture as it hardens.

In classical Greek times, Aristotle called the earthworm "the guts of the soil," because it produces particles that are smaller than when they enter, held together by the intestinal fluid that makes for a finer structured earth. An omnivorous and unfinicky eater, the eyeless earthworm ingests whatever appears before it in morsels fit for its toothless gums.

Muscularly pumping through the soil, it ingests not only organic matter but the raw earth itself, using sand and other mineral particles as grinding stones in its gizzard. Mixed in the crop with digestive chemicals and disintegrator bacteria, the elements

come out in different combinations, more easily taken up by plants.

Worm castings, neutralized by constant additions of carbonate of lime from three pairs of calciferous glands near the worm's gizzard, and finely ground prior to digestion, are five times as rich in available nitrogen, seven times as rich in available phosphates, and eleven times richer in available potash than anything in the upper six inches of the soil, producing a nutrient in just the right condition for the plant to absorb. Real organic NPK! What's more, the castings are always more acidically neutral than the soil from which they were formed, naturally improving the local pH factor as armies of earthworms work to keep the soil in balance, neither too acid nor too alkaline for the growth of plants.

Could it be that these great sinusoid fertilizers actually transmute elements, as the French savant Louis Kervran would have it, or are they merely collecting, distilling, and rearranging them to fertilize the soil? The former would appear to be more likely.

Castings, usually deposited in old burrows, or by night crawlers on the surface when they come up to mate or draw leaves into their burrows, consist of about one third of the contents of the worm's intestines, in pellet-like form, and have a third more bacteria than the surrounding soil. Even when ample organic matter is available, earthworms consume large amounts of soil, and by mixing the two produce a rich humus, perfect in texture, with more plant nutrients than in the material from which it was derived. Castings contain a higher percentage of aggregates than is found in the surrounding soil—aggregates being the formations of individual particles of sand, clay, and silt, grouped into larger units, which help make a crumb like structure of the soil. An earthworm is said to produce its own weight in castings each day it is on the prowl. Henry Hopp of the USDA estimates that one acre of good agricultural land can produce well over five tons of castings in a year, or more than 5 percent of the total soil volume to plow depth. In the process of producing its castings, on an even an ordinary agricultural soil, earthworms are credited with turning more than fifty tons of soil per acre, and in the Nile valley as many as two hundred tons into a fructifying base.

Earthworms are prodigious diggers and earthmovers, capable of burrowing down as deep as fifteen feet. They can squeeze between and push apart the soil crumbs, and one worm alone can move a stone fifty times its own weight. As they burrow, earthworms mix and sift the soils, breaking up clods, and burying stones. Some carry down leaves and other organic matter; others bring nutrients and humus to the top. Tunnels held together by their mucus afford planted roots quicker avenues into the soil. And the mucus, forming humus, prevents erosion. Henry Hopp says these materials, once dried, do not dissolve again in water. Yet, while the soil thus treated holds the required moisture, the burrows drain superfluous water. Experiments have shown that soils with earthworms drain from four to ten times faster than those without. Conversely, in light sandy soils, where water tends to run straight through to the subsoil, the aggregates produced by earthworm castings act to improve the retention of water.

By digging into the subsoil, loosening it, and threading it with tunnels, earthworms gradually deepen the topsoil layer. By ripping up fine mineral particles and depositing them as castings on or near the surface of the soil, they are constantly adding nutrients to the zone in which plant roots feed, delivering mineral substances that would otherwise remain largely unavailable to most plants.

With their mixing, digging, burrowing, fertilizing, and humus-making activities, the worms have an immense impact on the soil, its texture, its fertility, and its ability to support everything that lives in or on it, especially plants that form the basis of our food supply. But the worms must be fed, proliferating in direct proportion to the amount of organic matter incorporated into the soil, a supply which must be kept up so long as one wishes to retain the earthworms. *Eisenia foetida*, a red manure worm that inhabits compost heaps, turning animal manure into sweet smelling humus, grows to five inches, but cannot live without copious amounts of decaying organic matter.

Night crawlers, so named because they creep about at night on the surface of the earth, feed on leaves, which they drag down into their burrows, and even with their pin-head brains they have the wit to pull them by the narrow end—in contradiction to the witless leaf-gathering suburbanite human who spends a fortune to deprive the earthworm of his autumnal fare.

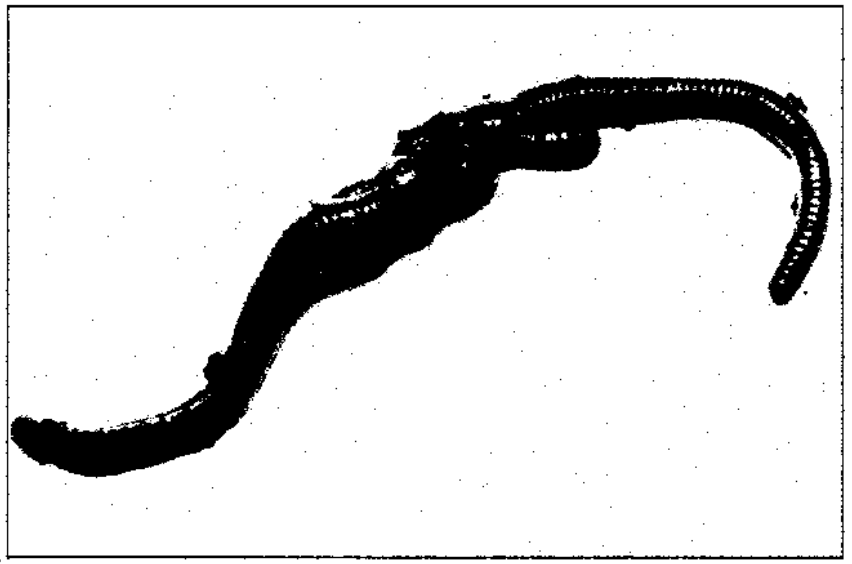
In an orchard, during the three months of autumn, earthworms can dispose of 90 percent of the fallen leaves, dissolving even tough material such as stems and roots. Darwin, who reported seeing burrows plugged with twigs, bits of paper, feathers, tufts of wool, or horsehair, claims that worms, though congenital scatophages, showed a predilection for celery, carrot leaves, wild cherry leaves, and especially raw meat, including fat. Minnich reports that one Wisconsin commercial raiser of earthworms even chose to feed his charges ice cream as a treat on Saturday nights.

More surprising still is his report that a German researcher, C. Merker, writing in the 1940s, astounded fellow scientists by asserting that earthworms have voices, and can actually sing, their faint sound being "rarely in a solo number, but generally in series marked by a definite and changing rhythm." Dr. Merker claimed

to be able to hear the sounds when within twelve feet of the worms, sounds produced not by chance but by the deliberate opening and closing of the earthworms' mouths. How this could be, when earthworms have no lungs—breathing through the whole surface of their skin, moistened to dissolve oxygen, which is pumped through the bloodstream by five sets of double hearts in rings or segments close to the head—is all the more amazing.

A cleric contemporary of Darwin, complained that earthworms are also "much addicted to venery." In suitable weather, night crawlers can spend a goodly portion of their nocturnal activities in the pursuit of sex, even an entire night coupled to a willing hermaphroditic mate, each possessing both male and female organs. With the undersides of their bodies held firmly together by tiny bristles, or setae, they lie with their heads pointing in opposite directions, touching in the region of the spermathecal openings, where the clitter—a white band a third of the way down their bodies—touches the surface of its mate.

They copulate by exchanging sperm cells stored in cuplike hol-



Mating earthworms. As hermaphrodites, they fertilize each other to produce more worms to fertilize the soil. From *The Amazing Earthworm* by Lilo Hess.

lows in the ninth and tenth segments, exuding a special mucus from the sexual region to protect the spermatozoa being mutually exchanged. More mucus secreted by the clitellum forms a jelly-like ring, which picks up the worm eggs from ovaries and sperm cells from testes, slipping the ring off the body, to form a tiny yellow cocoon. Greatly enlarged, it looks like a lemon and

contains scores of fertilized eggs, which can be found in the soil during the warmer months of winter. Under good conditions, an average red worm can produce from 150 to more than 200 young ones annually.

One of the principal functions of the earthworm is to consume available mineral nutrients, and by actions of enzymes in their digestive tract, render them water soluble, easily absorbable by the root hairs of plants, to be made available in turn to the cells of plants, animals, and man.

As Voisin points out, without earthworms there would be no civilization. But Minnich complains that with the single exception of Dr. Henry Hopp, the attitude of USDA scientists, along with many of their associated colleagues in state universities, has traditionally been negative towards the earthworm.

> They have long begun with the assumption that earthworms are just one more facet of the "unscientific" cult of organic gardening and farming, and that this method of growing crops is antithetical to the "modern" methods of agriculture, including its principles of heavy chemical treatment, monocropping, and other facets of maximum-profit agribusiness. The earthworm, thus judged guilty by reason of association (with organic methods), the USDA has long discouraged serious investigation into the possible benefits of earthworms in agriculture, and has even gone so far as to denigrate or ignore the work of other researchers who have revealed such benefits. Since the USDA has either conducted or influenced the great bulk of agricultural research in this country during the present century, its position on any facet of agriculture or horticulture has broad, far-reaching, and determining effects on both scientific direction and public attitudes...The USDA will sponsor no significant earthworm research, and its long tradition of ignorance is the chief reason why we know so little about earthworms, and why we have failed to utilize their power throughout the present century.

The seriousness of the situation was recently emphasized by Marcel B. Bouche, Secretary of the Soil Zoology Committee of the International Society of Soil Science, in his foreword to Dr. K.E. Lee's last word on *Earthworms*, a book published in 1985 by Academic Press, which for the first time places them on a world-wide scale in the economy of nature.

> Humanity [writes Bouche] "knows little about its most important commensals. We are unaware of the nocturnal, hidden, subterranean activity of the most important animal biomass that shares with us the earth's land surface....Using increas-

ingly powerful physical and chemical methods, we decide to remodel the landscape, to disturb the soils, to pulverize chemicals, to release fumes and waste water...ignoring the principal animal that inhabits the environments we alter....If we compare, for example, the significance accorded to ornithology and the multitude of birdwatchers studying about one kilogram of birds per hectare, with the extremely limited number of research workers' interest in the hundreds of kilograms or tons per hectare of earthworms, we must conclude that our knowledge of ecosystems is fundamentally distorted by our above-ground, visual perception of nature and our ignorance of life below-ground."

Normally healthy and long-lived, earthworms are discouraged if not killed outright by many pesticides and most chemical fertilizers. Copper sulfate, in concentrations near the surface of the soil, even in only 260 parts per million, can drastically reduce the worm population, and any nitrogenous fertilizer will quickly wipe them out. Nearly all commercial brands contain high levels of nitrogen in the form of ammonia, which destroys earthworms by creating intolerably high acidic soil.

Yet the more organic material they receive the faster they proliferate. And, as they proliferate, so do their symbiotic progenitors, the microorganisms, manufacturers of humus, the basis for a fertile soil. Steiner's premise was basic: that his bio-dynamic preps create the ambience for the infusion of the essential cosmic and telluric forces to generate this metabolic miracle.

Chapter 6

MICACLE DOWN UNDER

While on the vast continents of the Americas biodynamic agriculture seems hardly to have progressed beyond its introduction fifty years ago, rumor had it that on the world's smallest continent, a hemisphere away, it had successfully spread, in the same half century, to over a million and a quarter acres. To find out if this was so, and how it could have come about, we set off "down under" to investigate.

At the Melbourne airport we were met by a short, almost electrically wiry man with piercing brown eyes of a Slavic cast almost unadorned by eyebrows, Alex Podolinsky, founder of the Biodynamic Farming Association of Australia. Descendent of an ancient Russian-Lithuanian line who took refuge in Germany after the great October Revolution, Podolinsky was raised in Bavaria and educated in England and Europe, where he was exposed to the philosophical tenets of Steiner's peace-loving anthroposophy. Caught in Germany when the war began, as a stateless person, he was dragooned into the German Wehrmacht, a slave-soldier to the Nazis.

Following the Normandy landings, he was so badly injured by a bomb that his spine was permanently damaged. But somehow he survived—as if chosen to fulfill some higher function.

In Australia, in 1949, Alex realized that the essence of the semi-desert island—continent on which he had landed lay not in its crowded cities but in the wide expanses of its endless acreage,

Alex Podolinsky in 1986.

and that his real calling was to work with nature.

His start in agriculture came when a wealthy friend with a small rundown farm near Powelltown, Victoria, a tiny lumbering center east of Melbourne, offered to loan him the farm for a year to see what could be done with its soil.

There Podolinsky began putting to practice the BD knowledge he had picked up in Germany, and to think about how it could be specifically adapted to Southern Hemispheric conditions. These included an intensity and quality of light unknown in northern Europe, short and long periods of severe drought, and soils of such fragility and shallowness that the dominating vegetation on the eastern part of the huge land mass is mainly represented by some eighteen hundred varieties of tall "gums," or eucalyptus, whose roots go not much deeper than those of the rain forest in the Amazonian delta.

On the way from the airport Podolinsky spoke of the older farmers, who had noticed what was happening to their land, who could recognize the indicators. "In the 1920s, they started putting on superphosphate and had a tremendous result in clover which spurted ahead. Over the next decades, one bag of phosphate did less and less until finally five bags couldn't do the same. In irrigation country twelve bags couldn't do the trick. So they went into

potash which after two years no longer had any effect. Next they tried nitrogenous fertilizer which gave a big boost in growth, seriously sickening their soils. Disheartened, and not knowing what to do, a lot of them turned to BD, not because of any anthroposophic or Steinerian philosophy, which in any case they couldn't understand, but as a matter of clear common sense."

With an absolute, almost dictatorial self-assurance, modified by a nurturing instinct, a desire to do right by the world, by plants, animals, humans, and above all by the soil of Mother Earth, Podolinsky made his point. "With the pasture that grew on my first little farm you couldn't have fed two head of cattle." His clipped precise accent could pass for pukka English. "No compost could be made. Instantly I realized that what kept agriculture going in the 'old countries' of Europe was the cow; but in Australia there were no cows, only kangaroos whose droppings gave no such fertility as exists in cow manure. So I sensed that what cow manure had done in Europe over thousands of years would here in Australia have to be replaced with the 'cow-power' of Steiner's 500 to act as an igniting point, to achieve the same result, quickly, giving the land a 'new impulse.'"

Over the past quarter century Podolinsky's Biodynamic practice has expanded across the Australian continent, until now there are hundreds of hard-bitten, practical "Aussies" successfully farming his way, on all types of soil, coast and inland, elevated or at sea level, even though he spent not a single hour in publicly promoting, publicizing, or otherwise devoting to the method any form of salesmanship.

By word of mouth the biodynamic message spread from the first man who saw it working on the Podolinsky farm in the 1950s until today his association, to which only farmers are admitted, covers all of Australia. "It took resolution," says Alex. "In the early days people had very grave doubts." For years Steinerians, or rather Podolinskians, kept to themselves, largely because of the strange methods of biodynamics, and also to avoid confrontation with established chemical practice. Today they speak out. They're successful. And they're growing in number.

What broke their seclusion was a thirty-eight-minute prime-time feature film on Australian television, A *Winter's Tale*, broadcast nation-wide in 1985, as one of a more than decade-long and highly popular series, Big Country. Opening with a haunting scene of Podolinsky on his tractor spraying 500 on a moon-lit pasture with an owl hooting in the background, it went on to show Alex professionally stuffing and burying cow horns, communing with his herd of cattle in a lush and fertile landscape on which not a speck of chemical of any sort had been added in over twenty years.

The film, unsolicited by Podolinsky, but insisted upon by producer-director Paul Williams of the Australian Broadcasting Company, caused a sensation. No other single program in the history of the ABC, either on radio in the early days, or later on television, ever received as much response as the one finally made as a result of Williams's trip to Podolinsky's farm near Powelltown. Soon after the broadcast, the station got over six thousand letters, mostly handwritten, the largest number from farmers bursting to know more about what they'd seen and what many of them characterized as "just plain miraculous!"

Dusk was falling in mid-July, in the depth of Australia's winter, when we pulled into the drive of Alex Podolinsky's modest farmhouse in Powelltown where he has lived twenty-four years and raised seven children. Nestling in a glen on a branch of the Little Yarra River, no more than a stream, the house is surrounded by small wooded mountains, reminiscent of the Welsh-English border or the foothills of the Poconos in eastern Pennsylvania. A damp fog hung over the secluded valley, and a chilly though snowless atmosphere enveloped the house, permeating it except for the kitchen where Alex had prepared a meal of roast beef cut into slabs simmered in vegetable broth.

"BD carcasses," said Alex with gusto, "have much more meat on them and less fat than the average. And a far better taste. It cuts out better, and has none of that fatty 'marbleization' so prized in the States."

Up before dawn, as any dairyman, to milk his cows, year after year, Alex had evidently established with his animals a relationship of a sort not normally granted to less sensitive herdsmen.

"If I'm not in a good mood in the morning," Alex shouted cheerfully, "I very soon am, once I get near my cows. They tell me exactly what I'm like, and they notice cosmic happenings. A cow relates to its total environment. To live in harmony with one's surroundings like that requires a purity, like the purity of a child." As he spoke, a roan Jersey looked over the fence at us, placidly chewing her cud, her limpid eyes full of peace.

Picking up an empty cow horn, Alex waved it like a scepter. "See that cow! Her horns are on her, so to say, to hold in what's taking place in her magnificent cosmos of digestion and metabolism. Deer have antlers reaching out, exactly the opposite from cow horns in expression. Unlike cows, the deer constantly communicate with nature in a state of alertness, with a certain amount of fear in the background, the exact opposite from a cow's placid demeanor. A mature cow has horns, and if they are later cut off, that polled cow will 'go dull,' and never be the same as when she was horned." Alex peered into the horn: "When one looks into such a cavity, washed clean, one gains the impression that if one fell into it, one might never get out again."

Looking up, he pointed to the roan Jersey milk cow. "See that animal? In comparison with other ruminants, such as sheep or goats, which also have several stomachs, she typically just stands there, chewing her cud. Her legs are not meant for galloping about like a gazelle or a horse. She is steady, calm, placid, and harmonious. Her digestive system is a veritable cosmos in nature, the most refined on earth. The manure that comes out of her is up to 25 percent microbes."

Under a watery sun Alex walked to his hectare-sized vegetable garden to demonstrate the difference between the land as he had found it and what it is now. Grabbing a spade, he drove its sharp blade a quarter of the way into a patch of resistant uncultivated ground bordering the garden. With a sharp crunching noise he revealed a sample of black sandy soil so loosely knit it could have been poured from the mouth of a narrow-necked bottle. Moving a few steps into the garden, Alex sent the shovel full length, this time silently, into earth as spongily elastic as a mattress, to turn up a mass of soil the color of chocolate.

"It's the *humus* that gives it that richness," he said with satisfaction. "In Latin the word means 'earth' and gives rise to the adjective humilis, or humble. It's mostly a colloid, a substance like jelly, between a solution and a suspension that can be carried in the hand without running through the fingers. The prime characteristic of humus is that it is at all times solubly available to plants because its elements neither leach out nor evaporate." Alex poked with his spade. "We've had lots of rain here recently, in ten-inch, not one-inch, amounts. Yet you see, it hasn't waterlogged the soil. In the garden, there is over 15 percent of organic matter, maybe up to 18 percent, whereas in the uncultivated strip into which we first dug, there is less than 1 percent. All thanks to the application of 500, key to food production in the future. Its concentrated 'life force' is so powerful a tiny speck will enliven dead soil."

He picked up a clod of earth from which a mass of thick plant roots protruded. "Note the white hair roots healthily growing even in the coldest part of winter. They're only a few days old, but very active. These feeder roots are different from their pipe-like companions, which suck up water for transpiration and are the only ones you'd see in chemically-fertilized ground. These feeder roots are the key to biodynamic success because, symbiotically, it's not only the *soil that makes the plant, but the plant that makes the soil.* Roots and microbes live and die together, and together making humus they breed new life." Strolling over to a shed he picked

up a pint-sized glass jar. "Humus and roots are made for each other. It's a marriage made in heaven. At the height of spring growth a jar full of humus is buried in a biologically active working pasture about four inches below the surface. Six weeks later, the brown spongy substance has completely disappeared and the jar is solidly packed with nothing but white hair roots that can be extracted from it only with great difficulty. Once pried out, they appear as spankingly clean as if they had been thoroughly laundered and dried. The roots have invaded the jar to ingest every smidgin of the humus, not just the soluble elements within it, clearly illustrating that humus is plant food of first priority and choice."

Pitching the jar, Alex walked around the shed, as if lecturing to a chemistry class: "In another jar, I sealed humus air-tight for three days. Cut off from its oxygen supply, the stuff turned into water-holding globs of putrid, evil-smelling green particles. This kind of half-rotted matter, proliferating with harmful anaerobic pathogens—those thriving in an oxygen-deprived milieu—is what makes for dying soil. In living soils, the pathogens are neutralized by *aerobic* microbes. Sensing this, cows will readily drink from pails in which a quantity of humus has been liquefied, even though that humus was derived from their own manure, whereas they will not dare to taste water infested with manure in its still raw form."

Behind the shed, a plot of ground about sixty by seventy feet was covered with galvanized roofing and plastic sheeting: a weather-protected winter resting place for a staggering number of cow horns—130,000—all stuffed and buried by Alex with the help of a single hardworking assistant.

To accent the time and tedium involved in this arduous manual labor, Alex chuckled dryly. "Not only does each horn have to be filled, it also has to be emptied. That's a lot of horns: 130,000 on my farm alone! The biggest lot interred in any one place in Australia, though many other people are now burying their own in other parts of the country. One of them, Max Chandler, with sixteen thousand acres near Monto in New South Wales, just delivered thirty bags of huge horns from an inland cattle breed. They're nearly twice as heavy as any I've ever seen. Beautiful! Way out west across the continent people are gathering them up. One of our members who goes all over the place collecting wild flowering plants has provided a lot of horns. And another, a sugar cane farmer in northern Queensland, has put together a whole ton over recent months. We'll need every one of them and a whole lot more. Since the film was broadcast, many farmers, some of them growing up to twelve thousand acres of wheat, are asking to join

with us, and we'd fail in our responsibility if we let them equip themselves to make the changeover, then be unable to supply them with sufficient sod for their needs."

Was it, we asked, the shape of the cow horn, that was somehow affecting the microbes through a process of mutation, or was it merely the burial process which effected the alteration of manure into the product 500?

Alex hesitated. "It's the 'earth pull' to which the horns are subjected. At the right time of year, when vegetation is dormant, the earth has a strong pull. The process takes place, strangely enough, when the soil temperature is lower than 42 degrees Fahrenheit, so cold it would seem that any microbes could barely be active. This cold area of Victoria is the best I've seen anywhere in Australia." Then he added with finality: "As for the cow horn, it was most strange to those listening to Steiner when he first suggested its use; but all subsequent experiments have proved him out. We have performed tests with the same manure, on the one hand put into a cow horn, on the other into a wooden box, porcelain mug, or other receptacle, side by side in the ground, and only a few inches apart from one another. But the manure in the other containers never converts the way it does in the cow horn. Not that Steiner," he added with a smile, "didn't say to go out and experiment with other methods. He was only leading the way. He wanted the rest of us to look, and see, and try on our own, guided by our own inner vision."

On the way back to the shed, Alex told how he had been brought up at the knee of a German peasant, Ernst Jacobi, who ran one of the first successful biodynamic farms between Freiburg-im-Breisgau, in Southwest Germany, and Basel, in Switzerland.

"Jacobi grew marvelous vegetables," said Alex. "Farouk of Egypt became one of his customers. The king invited Jacobi—a simple, gaunt fellow, and a real philosopher—to Cairo to set up BD gardens for the royal estates. And the king was very pleased."

Inside the shed, Alex displayed the vats in which the 500 is stored when it comes from the horns: cylindrical tanks cut into cubic boxes, surrounded by peat moss and covered with lids some two inches thick that do not close tightly but allowed air to circulate through a space no wider than a stove match.

In the tanks the 500, almost black, was moist to the touch. There were holes in the bottom of the bins to allow aeration from below, and a layer of empty cow horns had been placed at the bottom before the 500 was added, further to allow aeration.

"It's very important," said Alex, echoing the warnings of our Virginia host, Hugh Courtney, that the storage boxes with their tanks not be put close to any foul-smelling source of pollution,

such as a jerry can, or a pump for gas or diesel fuel."

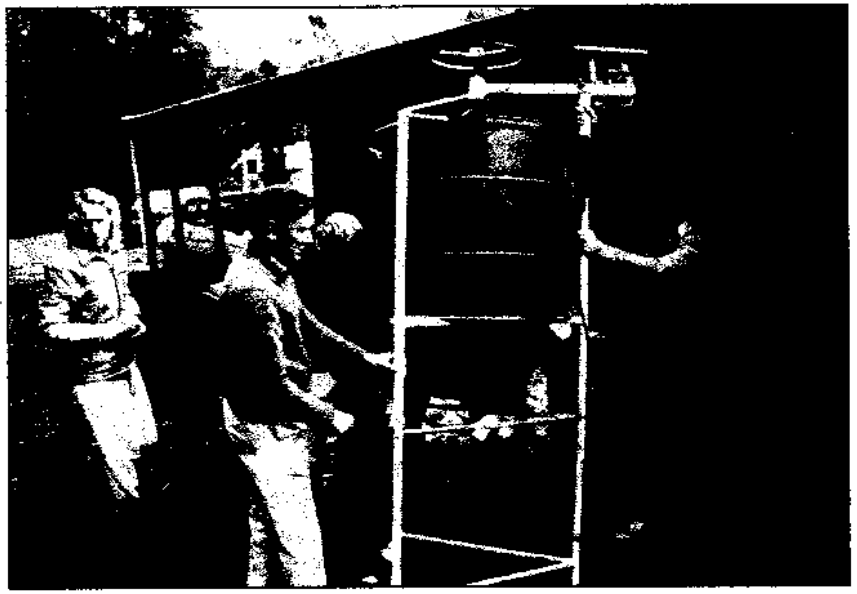
On a 3 1/2-by-10 foot table lay enough 500 to regenerate a thousand acres of dying soil. A tiny lump of the blackish stuff between Alex's fingers, about an ounce and a quarter—enough for one acre—looked not like earth, nor putty, nor the heart of a newly-baked loaf of Russian black bread, but like a combination of all three, pliant to the touch and smelling sweet.

"It's like a speck of matter in atomic fission," said Alex, "which can cause an enormous though much quieter explosion." To activate it, Alex mixes a little over a pound of the 500 into fifty gallons of water, which he stirs automatically with a specially-built machine. He says that stirring, to be more effective, should be done under the open sky rather than under the roof of a barn or shed, that during the stirring, a suctional force is created in the vat by the whirlpool-like vortex which Alex explains as drawing in what he calls "cosmic power."

"It's like planets being drawn in centripetally by the force of the sun, which allows them to remain in their orbits and not drift off into outer space. As soon as a good vortex is created, the machine abruptly reverses itself, completely destroying the vortex, leaving a foamy confusion and chaos in the water, not unlike the "whey water" in river rapids, before setting up another eddy whirling in the opposite direction."

Alex emphasized that the chaos between the alternating vorti-

Alex Podolinsky setting up an automatic stirring machine for BD 500 on a farm in eastern Australia.



ces was a most important factor. To the Greeks, he explained, chaos was the first state of the universe from which cosmic order and harmony evolved. "Though we don't always recognize it, chaos applies to our own creative lives. Every creative artist is in a state of chaos before he brings whatever his creation will be into existence. He is thus, in relation to his environment, in an unbearable state in which something is given birth! It's like the choral passage in Bach's "Passion According to St. John," where one musical theme piles on another with ever-mounting intensity. It's the finest musical example I know of that illustrates 'creative chaos!'"

The next day, in the early-morning sunshine, we set off in Alex's Peugot 504, equipped with special shock absorbers to negotiate the roughest of Australia's pot-holed country roads on a nearly

Hand stirring the BD 500.

six-thousand-mile trek to visit a sampling of Alex's biodynamic farmer adherents.

The trip was to take us from Gippsland in the southeastern quarter of Victoria, to the valley of Australia's largest river, the Murray; over the Blue Mountains west of Sydney; up the coast to Port Macquarie; onto the four-thousand-foot-high New England plateau in South Wales; back over the Great Dividing Range that runs north-south along the eastern edge of the continent at an average distance of fifty miles from the sea, then up into tropical Queensland, more than double the size of Texas, with inhabit-

ants twice as ornery.

On the first leg of the trek the road wound through a forest then out into open farming country towards the Poowong farmstead of Trevor Hatch, one of the very first members to come into the association, whom Alex considered his potential "heir," the one who would eventually lead the association.

In his mid-forties, lean and as strong as a wrestling champion, Hatch is owner of a 450-acre spread, a beef-cattle-raising and potato-growing operation, bought by his father in the early 1950s when the land was considered fourth class. The older man had cleared it almost completely of "bush"—meaning of a heavy forestation of trees—leaving only copses or clumps to dot the landscape. But the soil had been the poorest grade of whitish clay from less than an inch below the surface.

To show an example of this aboriginal dirt, Trevor walked to the base of a large eucalyptus tree where he passed a sharp-bladed shovel into the ground. There was a crunchy sound even louder than at Alex's, and up came an example of totally lifeless soil. Trevor then headed for a large paddock—the Australian term for a fenced field—which sloped towards a creek at the bottom of which some cattle were feeding. There he slid the shovel-blade noiselessly into ten to twelve inches of soft, black, rich loam, teeming with earthworms as well as with white "feeder" roots. Picking up a small pea-shaped object, he held it in the palm of his hand, his lips curled into a satisfactory smile. "Worm egg," he said, "millions of them."

In a glade of eucalyptus, where the bark had been stripped by cattle from the ground up to a point as high as the animals could reach, Trevor explained that before the land had been converted to biodynamic agriculture, the cattle had chewed the bark off trees to supplement something lacking in the pasture. "They needed no dietitian nor nutritionist," said Trevor, "to inform them that the grass was deficient."

Alex smiled: "You only have to look at the sheen on the coats of those animals, or even take notice how they stand and move, to realize that now they've been raised on biodynamic pasture."

As we scanned the landscape we could see where Trevor's pastures were still verdant, though it was the dead of Australia's winter, compared with the brownish-grayish pasture on the neighboring land, farmed in the orthodox Australian manner. Trevor led us down the straight driveway lined with yellow-flowering wattle trees, members of the acacia family, to a shed where he stored his 500 in containers exactly like Alex's. There was also a machine he had specially designed for making the 501. From Queensland, he had brought back several hundred pounds of

pure crystalline quartz for grinding to a flour like powder; abraded for hours between two large, oblong metal plates, it comes out as white as new-fallen snow.

"There is a light-bearing power in the substance of the crystal," said Alex, "but it's congealed, and has to be crushed and ground to be liberated. Buried in a cow horn throughout the summer the powdered quartz absorbs, not sunlight, but Steiner's light ether, which is "activated" by being stirred like the 500."

Trevor showed off the equipment and machinery he had made for himself so he wouldn't need to get off his tractor either to put up hay three levels high in the shed, or feed it out to the cattle in the paddocks, enabling him to manage the whole farm by himself, his father being too old to do much work. Other implements invented and put together by Trevor in his own welding shop were a hay spreader to deliver winter feed to pastured cattle from huge eight-hundred-pound bales in the shape of fat jellyrolls, and a potato picker that, after clawing potatoes out of the ground, sorts and bags them by size, the whole mounted on a single self-propelled vehicle. "Our biodynamic farmers," said Alex, "have learned to design and make their own equipment out of scraps. It has freed them from debt and dependence on the manufacturers of heavy equipment that only destroys the land."

On the way north to the Goulburn Valley near the Murray River, Alex spoke of one of the main concepts he had had to drum into farmers, especially those inland; to make hay while the sun was shining. "In a good season they have a lot of feed going to waste. If anything, instead of conserving it, they'll put more stock on their pastures. Then, when a drought comes, they lose most of the herd—up to 90 percent. Those aren't really farmers," Alex added with a shake of his head. "They're miners!"

Six miles north of the Waranga Reservoir we came to our first night's stop in Merrigum at the home of Farry Greenwood. Until his death in 1986 Greenwood owned and operated the largest pear orchard in Australia, which is now in the capable hands of his son, Linton. As we sat at dinner in the small kitchen of their modest bungalow Linton was explicit: "I take a lot of fruit to the cannery where I have to sit with other farmers while our produce is unloaded and inspected. I've had several growers ask me how on earth we manage without using lots of pesticides. But they never come over to our place to actually have a look or find out how we get by with no 'chemistry' at all."

"Mainly," said his father, "it's because they're scared that their gross profit—that big figure that seems to hypnotize them—will suffer if they abandon chemicals. And it will, to an extent, but what they don't understand is that their net profit will not suffer.

and their soil will improve. The federal government's Agriculture Department has complete lists of all the BD farmers in the country, but they keep them hidden. They know all about BD, but they never let on. They see our method as a threat encroaching on their very reason for being. The only justification for their existence is to tell, or rather to order, farmers to use more and more of their destructive chemicals."

Linton leaned forward to fix us with a steady gaze. "Around here the orchardists have all gone, their land burnt out by chemicals. Did you know that a pear tree should be productive for something short of a century, and peach trees should normally live forty to fifty years! The largest tomato growers in Australia used to be right here. Now they too have departed, having destroyed all the good land in the district."

The only remaining orchard was two hours down river in Walkool, in a mile-wide valley where ten years ago Thory McDougal, a tall, sinewy fifth generation dairy farmer of Scottish descent, had been facing ruin. His land was overworked, his soils dependent on more and more fertilizer. Then he met Alex, and his farm was saved.

In 1984, he purchased another large parcel: rundown, farmed out, little more than a spread of over-salted bare dirt, abandoned by its previous owner. Today, operated as a large and flourishing rice farm, it is unrecognizable as the place McDougal bought—except for one corner.

"Before we applied 500," said McDougal, "the soil was so compacted that the roots of plants just spread out on the surface, and the plants themselves were sickly. Now look! They're deep-rooted and healthy! They considered me mad when I bought this place. One man said to me: 'I thought you'd have more brains.' And it was true. In the sorry condition the property was in, it wouldn't have impressed a cat. But a couple of years ago the same man came over and said: 'I'll take back what I said. You've proved what can be done with your biodynamic method.'"

"On that farm," said Alex the next morning as we drove along the Murray River at first light, a silver moon still hanging in the sky, "McDougal has real BD rice, the only truly unpoisoned rice on earth! And now the Australian Rice Board has approached us because, internationally, it's very difficult to sell any Australian agricultural product. The prices are almost 'give-away.' But we can sell any amount of biodynamic rice at a very good price because there's a big demand for it in such countries as Switzerland where baby food manufacturers and other processors need unpoisoned food, if only to conform to new legislation setting much higher standards on quality than before. We export BD grain overseas in 20-ton containers, and we pay our farmers an extra $50 premium per ton for BD quality grains. Today they're getting $200 a ton, a price at which they can make a living. Thory gets about a ton more rice per acre than the average farmer, and he doesn't have to pay for any of the two dozen different kinds of chemicals the others want to make him use!"

After several months of effort Podolinsky even managed to persuade the Rice Growers Cooperative in Leeton, New South Wales, to hand-store, mill, and market McDougal's first BD crop in complete isolation from rice grown by conventional means according to the stringent guidelines put out by the marketing wing of the BD Association. Impressed with the prices the BD rice could command, both in Australia and abroad, a part of which is tithed back to it, the cooperative published a cover story in the May, 1987 trade journal, *RCL Magazine*: "A Day With Alex Podolinsky."

Because rice growers as a whole were in such bad straits, the editor, Chris Black, announced in an introduction that the cooperative was keen to have more BD paddy, which was tantamount to admitting, for the first time, that rice farming with chemicals, as practiced for decades, was a "sunset" occupation whereas BD rice production was its "sunrise" replacement.

"A decade or so ago," Alex told the farmers, "thousands of babies were deformed by Thalidomide, a drug to stop morning sickness in their pregnant mothers. Had its disastrous effects been known beforehand, it would never have been used! Right now, the same situation holds, not just for pregnant mothers, but for all of us. We are all guinea pigs at this moment. The effect of hundreds of agricultural chemicals on future generations is as little understood scientifically as those of Thalidomide."

As the result of Podolinsky's speech a number of growers in the "Riverina"—as the rice area is known—began to strive for classification as BD farmers. Thirty years of work had broken a barrier set up by the Ministry of Agriculture in Canberra which, though it had files on BD farmers, refused to admit that so salubrious a practice was in existence for rice or any other agricultural crop. The Rice Cooperative's story was followed, six months later, by a full-page feature in the country's only nationally circulated newspaper, *The Australian*, entitled "Bio-Dynamic Man." Depicted with his left hand gripping his ever-present spade, his gaze directed heavenward, Podolinsky laid his central message on the line: "If it's true that you are what you eat, then at this moment, most of us and our livestock are a complicated chemical cocktail of insecticides, pesticides, fungicides, weedicides, and synthetic fertilizers."

Described as leading a lone cavalry charge against "the forces

of chemical might," Alex was quoted as saying: "The worst poisons in use today do not even show a toxic physical symptom when they pass through the body. Almost impossible to detect, they nevertheless cause irreversible changes in the DNA pattern of cell reproduction. Even if an official inquiry were ordered into the harmful effects of pesticides, there is no laboratory equipped to perform it. And so far there have been hardly any funds allocated for that purpose, largely because universities—no longer free institutions—serve commercial interests instead of the public as they should."

Contrasting this situation with the one created by biodynamics, the newspaper article continued: "Podolinsky asks why, on BD farms, plants are never subject to disease, cattle abdomens never bloat from digestive disturbances, and sheep never require drenching to rid them of intestinal parasites, as they are, and do, on all conventionally run farms. And if BD practices were inferior, as officially claimed, then why was his association being inundated with orders for BD barley, oats, wheat, rice, vegetables and other products? Do our customers know something that the national and provincial ministries of agriculture do not yet know?"

As we continued our trip towards New South Wales, Alex turned with a slight smile of contempt and a shake of his head: "The use of toxins in farming is all the more ironic because this continent of ours is otherwise the least polluted in the world and therefore ideally suited to profitably export huge quantities of agricultural products, were they non-toxic."

As he spoke, we crossed over the Murray and drove into New South Wales. Huge black and white birds with curved beaks and long legs were scrambling for their breakfast in an irrigation ditch. "They're ibises," said Alex, "and over there's a flock of swans, black like they all are in these parts. A little further on is where Kevin Twigg lives. But I don't think he's home."

The country flattened, with barely rolling hills. "Pity, because he's one of the most intelligent people you'd ever meet. He made a first-rate stirring machine. Many years ago when I first gave a lecture on stirring, Kevin was there. We had no machines in Australia at that time; we still did all the stirring by hand."

"I rang him right away," said Alex, "to say I'd drive on up to see his machine. When I arrived, there it was: the main pillar of the BD edifice. No man could have done a better job."

A road sign appeared, infrequent in the area, and Alex veered off the main road. "Before Kevin accomplished his feat," he said with satisfaction, "no one in the world had a decent stirring machine. I saw the one on Ehrenfried Pfeiffer's old farm at Loverendale

in Holland. It only went one way round. It couldn't reverse to cause the 'chaos' between alternating whirlpool vortices. That's typical of the Steiner 'theorists,' to produce a stirring machine that only goes one way. Kevin adapted an ordinary electrical motor so it would automatically reverse the direction of the stirring at the proper interval, every nineteen or twenty seconds. No electrical engineer would have thought of adapting an electrical motor the way Kevin did. They can't even explain why it works the way it does. I'll show you how it operates when we get to the grazing lands of the Stephens brothers in New England. They'll be trying out a machine for the first time and want me to check on its proper functioning."

Alex told of how he had learned from *Sensitive Chaos*, a book on water written by a Black Forest hydrological engineer, Theodore Schwenk, inventor of an optical method for testing water quality, that the right shape of a vortex was essential to the stirring procedure. Schwenk had discovered that only if the vortex is sufficiently open does it produce a "reverse" vortical flow to make possible a renewing involution of the liquid in the outward-downward movement. And because Schwenk's tests convincingly demonstrated that water freely moving in a brook or creek, constantly purling to form little whirlpools, is of a "liveness" not seen in city piped water, Podolinsky began to insist that only the highest quality of water available on a farm be used for stirring.

The Stephens brothers, powerful, rugged, Aussie sheep and cattle graziers, had a sheep and cattle range outside the tiny hamlet of Emmaville in high country bought in 1956 near the New South Wales-Queensland border. "But the place wasn't big enough to support us all," said the younger brother, "so I went away for twelve years and when I had put a few dollars together sheep shearing I bought the place next door. In the course of shearing, I ran into a fellow, Max Thompson, another shearer, who told me about biodynamics. Alex here came right away and talked to us as if we were his family."

Outside the house, on legs with rollers, stood a fifty-gallon cylindrical vat, already filled with water, enough to treat sixteen acres. Alex surveyed it with satisfaction, turning the switch to set it in motion. "To begin with, I look to see, as in hand-stirring in a bucket, that the vortex which starts at the rim is even. Then I break it and make a real chaos; that's what we want; but I start with the rim. There! It's finally reversing. But not soon enough. It should switch over earlier."

He paused to fiddle with a float mechanism, and the vortex changed direction more rapidly than before. As we watched the blades create the whirlpool, Alex was inspired: "There are certain

things beyond predictability. An important one is a vortex. All weather works in vortices, and that's why with weather 'fronts' man can tell you *where* the front is but can never know what's developing *inside* the front. Here we have something that is as independently new each time as it develops inside the vat. Mathematicians have tried to get at the problem with equations, but with equations you can't come close to the life of the thing. Each of these stirring machines is exactly identical; but each performs a bit differently. Each has to be adjusted just right."

As the stirrer picked up its rhythmic movement, Alex looked up with satisfaction out across the Stephenses' rolling countryside that could have been the piedmont near the Big Horn mountains west of Sheridan, Wyoming.

"What about the water?" asked one of the Stephens brothers. "Can we take it right from the river?"

"Fine!" said Alex. "Because your river is still *alive*. But make sure you pass it into the vat through hoses or pipes that are uncontaminatedly clean! When I go to farms I look for the most alive water to use for the 500 stirring. Just let samples be given me in a glass and I can tell which is better. It's a function of the light in the water. Dead water doesn't take in light. Living water does. Water gets rejuvenated by going deep down into healthy soil and coming up again through the plant. There is no better purification for water. Water that has gone through our soil cycle and is breathed out by plants is just perfect."

Alex tested the temperature of the water. "Lukewarm water is much easier to stir. I have always been able to adjust the flow of a mono-faucet to the proper temperature, hot or cold, just looking at the water, not feeling it, just looking. See how warm this water is? I know by sight when the temperature is right. When this is lukewarm, it stirs easier and quicker. Can you see the difference? Sense how this is like a great orchestra performing Beethoven's *Eroica* while before it was just limping along. Watch this boiling action inside the center! That is real chaos."

He switched off the machine. "You'd normally keep this stirring going for exactly one hour. That's a German, not an Italian hour. And not a minute longer. Then be sure to have an eighteen-mesh sieve, stainless steel, through which the activated water passes before it ever goes into your spraying unit. Otherwise you'll have fiber, residue, which blocks up your sprayer nozzles. Some say you can use porous cloth, like pantyhose, but don't. If it bursts, you'll get fiber throughout your system."

Riding out onto the Stephenses' pasture through mobs of sheep crossing the dirt track in front of us, Graham Stephens explained that he had constructed a trailer to carry the new machine to any

part of the property to allow tracts to be sprayed immediately following stirring.

"The most important thing of all," said Alex, "is to get the 500 sprayed onto the land within an hour after stirring. The longer you dally, the more of its power you lose. It's the moisture period that keeps the 500 going. If you drag the spraying out, then you'll come toward the end of your rainy season and the 500 will have much less chance to work in the ground than if you'd got it all out the first day. It works down as far as the roots go. So it will go on working even if the next year is dry, because there will still be moisture deeper down with the roots."

Alex waved his hand expansively: "That's the only thing that will get BD going on extended grazing land that makes up so much of Australian farming." Then he added with a friendly smile. "It could even benefit huge areas of your American West where the ranges have been brutally grazed."

On the last leg of our long journey, traveling up the coast from Brisbane to Townsville, to see Barry Ahearn, a third-generation sugarcane grower, the weather became pleasantly hotter. It was like leaving the winter-bound mid-Atlantic seaboard in Delaware and reaching the warmth of the vegetable country south of Miami, Florida.

In Australia, sugar cane is raised, not as in Hawaii and other parts of the world, on huge monopolistic plantations, but by individual farmers on no more than 150 to 200 acres.

Alex said that Ahearn was one of his brightest BD disciples, the first cane grower to come into the association. Two brothers, also cane growers, were just beginning in biodynamics, and Alex was anxious to see what one or two sprayings of the 500 were doing to the sugar cane soil.

"Barry only came into BD a little over a year ago," said Alex, "but in that time he's made leaps and bounds. His understanding of what it's all about is so sure I'm beginning to send him new people who contact me as a result of the ABC film. Some of them come down all the way from Atherton Tablelands in the mountains west of the seaport of Cairns, to talk with him, and now he is going to make trips to visit with them on their own farms way up north."

We were on the long middle stretch of the Pacific Highway set so far back from the coast there was no view of the ocean. Small resorts catering to "summer people" could be reached only on side roads. As we advanced through the flat countryside, Alex told of his first trip across the continent to Western Australia in the fall of 1986. "I drove for two days across the wild Nullarbor Plain in the Great Victoria Desert. It was one of the most exhila-

rating experiences of my life as far as nature is concerned. Never have I seen so large a stretch of country anywhere on earth that is so totally and incredibly natural. Most people who decide to travel that route are told to expect nothing but sand, which, in fact, is all that most of them see. But the whole terrain is overgrown with a great variety of vegetation, and nowhere, for hundreds of miles, did I see a single sick plant. It was a wonder to behold thousands of lush plants growing with almost no rainfall at all, even in the hot April wind. It was a marvelous lesson on how nature can adapt, just as it has done in the Tundra, which, though nearly always frozen, supports copious vegetation of another kind."

Alex paused as we crossed the Burdekin River, then continued: "Yet the population is little over one million, with the bulk of it in the city of Perth. The farms in that dry country are enormous, ten thousand acres each, and more. Two thousand acres in Western Australia is a tiny property. The roads are arrow-straight, and very, very good, easily the best in Australia. You can go for miles on them at a hundred miles an hour before you find a village. There's one man who grows sixty thousand acres of wheat alone! The biggest wheat grower on earth, they say. All that territory, so different from the 'old country' where biodynamics got its start, is largely sand, much of it now with a hardpan so dense you can only get through it with a crowbar."

Alex stepped on the accelerator as if he were out West. "We've developed brand new rippers with huge steel blades." He raised his voice to be heard. "Thick as your arm! They go down four feet to break up the compaction and aerate the soil."

But the road was not up to his driving, obliging him to decelerate again. "The 500 must be put on quickly so the plants can get their roots right down to finish off the job. In Australia BD has become an operation of much larger scale than Steiner would ever have imagined.

We've got a BD farm of nearly ten hundred thousand acres just starting next to that mammoth wheat operation. The farmer uses a hundred-foot boom to put on 500 in swathes one hundred feet wide. He's just come into BD. They're all new in Western Australia. To get their 500 on just right will require a keen sense of timing because they have to catch the rain. 90 percent of the bit of rain they get, about 10 inches a year, is subsequently blown away leaving them with a bare two inches! But once they get their soils in shape, they'll capture it all."

He wrinkled his forehead, as if perplexed. "So far none of them has made his own 500; they haven't enough suitable cattle for manure. They have some horns which they send east to us. It'll

be a few years before they get enough experience. When I was out there for the first time in the fall of last year, I gave the longest lecture I've ever given, eleven hours in a single day to farmers who came from all over, some of them having driven hundreds of miles. Many camped out on the floor of Bob MacIntosh's big house, 87 of them, representing 272,000 acres, over 400 square miles of farmland with all kinds of crops. They'd all seen the film and many of them had written to me via the broadcasting company. It was nearly midnight when I finished."

As we approached Ayr, in the heart of the cane country, Alex complained of the smell of chemical spray on the fields we were passing. "The worst is at Toowoomba, west of Brisbane, 600 miles south of here," he said, his lips curling into a grimace. "They spray there so much they have had to build anti-erosion furrows! They spray all week now with something like "Agent Orange," and worse. You have to make sure your car is tightly shut. It kills everything in sight."

At Barry Ahearn's in front of a tree-shaded farmhouse we were met about noon by a short, muscular, sun-tanned fellow wearing an ancient Australian bush-hat and an engaging grin.

"Barry has three brothers," said Alex with a twisted smile. "Two of them are sugar growers like himself, who are just beginning in biodynamics. The third is a salesman for an agricultural chemical company; so there's something of a rift in the family, as you might suspect."

Over a bowl of soup in an undecorated second-floor kitchen, Barry described the pressure being exerted by the agricultural advisers and chemical salesmen pushing and promoting all the farmers into greater production, whether of sugar cane, wheat, or whatever.

"We're all constantly pressured by the Ag Department to get the maximum out of each hundred acres. It doesn't seem to matter at all to their field advisers what becomes of the soil, so long as we're forcing the largest crop possible. And the big corporations are trying to get rid of all the little farmers and make huge agribusiness sugar plantations with the use of Japanese and other foreign money. It's all for the Australian dollar, which is not as big as it used to be!"

The edge of a field full of tall green sugar cane lay not a hundred yards from the house. When we reached it, Alex walked right into a thicket of plants and opened a hole in the soil to reveal good biodynamic structure. Barry said he had planted his stalks farther apart than other farmers because he had noticed that plants at the edge of a field did much better, obviously needing more room to develop. "The Ag people, of course, insist on more

stalks per acre."

In another field, younger sugar-cane plants, a few inches high, were just getting started. In between the fairly widely spaced rows were zucchini, beans, melons, and other cash crops in rows a hundred yards long.

"Alex explained to me," said Barry, "how vegetables can be intersown with young cane plants as an extra-income crop, so long as enough space is allowed them, and that they'd generate money while I waited for the cane to mature. Add to this the fact that the vegetables are being raised biodynamically, which gives me a higher market price. It's all part of getting away from the insane monoculture of sugar cane, a system which only contributes to the degradation of the soil. Since getting into BD about two years ago, I've been taking an honest look at things, for the first time in my life. Now I know that all the weeds and 'rubbish' coming up in the fields all over the place—stuff you never would have seen years ago—is due to bad farming practices, for over a generation now, such as the continued uninterrupted growing of the same crop, forced by the greed factor. It's a system that actually suits the weeds."

"A lot of people," Barry added with a laugh, "told me I wouldn't be able to grow vegetables in this ground, that they'd rot with mildew, that pretty soon I'd go broke. But look at those flourishing rows! And as for going broke, when I got into BD farming my gross income was about $130,000. True, it has fallen to $90,000. That seems like a terrible drop in revenue until you realize that my net income has remained the same. Why on earth, I asked myself, had I been spending all that money to enrich the chemical companies all those years when I got no more cash out of my whole operation than I do now with no chemicals at all, and with less than I was planting before! And that's just the cash-flow side of it. As I go along now, my soil, which is any farmer's real capital, his money in the bank, so to speak, is going to increase in quality and therefore in value.

"My raising vegetables, which I've never done before, never even thought of before encountering BD, is helping to improve my land while it adds substantially to my net income. BD promises to make my land so much more richly productive, my crops so much healthier, and to relieve me completely of all that terrible pressure." Looking out over the swaying sea of green he sighed with satisfaction: "It's truly economical in every agricultural sense of the word!"

Barry's brother Kevin walked over to join us, so much taller, thinner, and darker than his squat brother, with luminous, fey eyes set in an unmistakably Irish Celtic physiognomy, that one would never have guessed they were related.

Picking up on our exchange, Kevin said he was following Barry's adoption of BD on his own sugar cane acreage: "I think going any other way makes no sense. When I saw the ABC film I was amazed, and though I couldn't really understand what was going on, I saw that the main point was its improvement of the soil. And soil is just like your body. Without good soil, we'd all be dead."

As we took leave of Alex in a Townsville motel, it was clear that Steiner's system is being profitably applied in the great Down Under to over a million acres of land, some of the world's poorest, once dying, now flourishing, completely free of any chemical additive. With the help of 500 and 501, healthy plants, animals and humans are being regenerated throughout Australia. Thanks to Alex Podolinsky and his thirty years of effort in applying Steiner's teachings, Australian biodynamic farmers are producing healthy crops, which can be sold at a profit, and in addition they are increasing their capital: soil.

In the course of forty years, Podolinsky has spread Steiner's method to perhaps twenty times as much acreage as is cultivated biodynamically in all the rest of the world. As startlingly positive proof of its magic we brought back to the United States, two small plastic bags, one containing a hard clayey substance that looked like off-white gravel, taken from an Australian farm on which it extended from one half an inch below the surface down as far as one could easily probe. In the other, was rich brown fertile loam to which the infertile clay-like material had been converted, down to a depth of twelve to fourteen inches, in only three years of BD spraying. Shown to American farmers, the two bags evoked comments of disbelief.

But one thought kept surfacing in our minds: if such a fruitful transformation could take place on the world's smallest continent, why not on the five more extensive ones? Was there any such prospect for the U.S.A.?

Chapter 7

It Can Be Done

So sparsely treed are America's flatlands in North Dakota that the state tree is mockingly featured as the telephone pole.

From the window of a Fairchild Metro-3 thirty-seat aircraft, flying at twenty thousand feet the country east of Jamestown, North Dakota, resembles a vast, borderless checkerboard with mile-by-mile squares subdivided into patches of green, ocher, or chocolate brown. Each quadrant represents a 640-acre section of land—an amount considered by the first settlers to be adequate for the support and survival of two farm families. The whole "dry-land farming" expanse lying west of a former inland sea called the Red River Valley, and east of the Missouri Escarpment, which rises slowly up to the Badlands depends on an annual rainfall of seventeen to nineteen inches. Pumping water from a 420-foot-deep underlying aquifer is too expensive for crop irrigation; the wells are strictly for household use.

Inside the Jamestown Aviation Service building an impressive bulletin board advised visitors they were at the center of one of America's farming heartlands, the Drift Prairie. But stapled and thumb-tacked to the board are not posters or photos of the amber waves of grain coming to head in early July fields that stretch for thirty miles across the prairie's flatness in every direction, but a paper mosaic of flyers and broadsides advertising poisons for bugs and weeds, the brand name of one of which was as intellectually poisonous as its content:"You'll feel safer using MORE!"

In this once beautifully virgin land the chemical industry has clearly gained a raping *droit de seigneur.*

Up to the building drove an ancient Chevrolet Impala out of which sprang Fred Kirschenmann, a blond giant in sturdy leather brogans, dark blue coveralls and a red farmer's cap. What had attracted us to him, apart from his M.A. in history and two Ph.D.'s in political science and theology, was a feature article in Agweek, published by *The Herald* of Grand Forks, North Dakota, whose headline proclaimed: "Switch to Organics Can Be Difficult But Profitable, North Dakota Farmer Says." It reported that his poisonless methods worked: "His production costs are lower than his neighbors....He gets premium prices....His soil is rich and healthy."

One part of Kirschenmann's three-thousand-acre spread lies off U.S. Interstate 84—which runs all the way from Minneapolis-Saint Paul in Minnesota to Seattle-Tacoma in Washington. The farm is near the tiny hamlet of Windsor, which boasts no more than a tiny Roman Catholic church, a grain elevator, and a single public building: a cream-colored cubic blockhouse, self-advertised as "The Best Bar In Town!" An informal meeting place and "watering hole" for farmers from miles around, it serves as a haunt where they can compare notes and troubles over steins of beer, or noggins of harder brews, while sampling pickled hogs' hocks and chicken gizzards from fat stone crocks.

In the late 1970s local residents were amazed to see a strange house going up on, or rather under, a stretch of land a mile or so from Windsor. It was being set, like a bunker, into the side of a hill by Kirschenmann, born and raised on his father's farm at Streeter, thirty miles distant, and by his wife, Janet, brought up in urban Braintree, Massachusetts. They had been inspired by an article in the Boston Globe about the New England architect, John Benard, to build one of his "earth homes," which seemed like an outsized root cellar. Naturally and air-conditionally cool in summer, the house is heated muffin-warm by a single small wood stove in winter, though when a snowstorm piles drifts in front of its doorway, to get out of the house to the roadway, Fred has to cut a tunnel with walls up to eight feet high.

The cozy kitchen is lit by a central thirteen-by-thirteen foot shaft, or "well," driven into the center of the building from the surface of the ground, which provides more interior light than in a many-windowed house.

As we sat near a big table strewn with an accumulation of farm publications, overloaded with the huge encyclopedic volumes on organic gardening and natural insect and disease control pub-

lished by the Rodale Press in Emmaus, Pennsylvania, Fred launched into the story of how he developed the largest biodynamic farm in the United States, growing wheat, buckwheat, rye, millet, oats, and sunflowers. It all happened, he explained, because of two graduate students at the University of Ohio whom he had taken under his wing. One of them, David Vetter, born and raised on a farm in Marquette, Nebraska, and committed to a farming career, had felt, after four years of soil-science studies for a B.S. at the University of Nebraska, that something vitally important had been left out of his farming curriculum, namely any references to loving or wise care for the soil. With Fred as his new and more liberal professor at Ohio, Vetter had been allowed to plan a private study course in the Philosophy of Agriculture, which included a reading program he hoped would broaden his perspectives of soil stewardship enough to tackle the crucial issues in what he saw was an ever-sickening American agriculture, and, he hoped, launch his "Ministry of the Soil."

One morning Vetter rushed into Kirschenmann's office with an excited expression: "You've gotta read this," he said, handing his master a blue-covered compendium of the agricultural lectures delivered by Rudolf Steiner in Germany more than fifty years earlier.

"When I finally read the book," said Fred, "it seemed to me that it contained powerful material. But at the time I really couldn't fathom what Steiner was talking about. It was completely above my head. So I just filed it away in my memory drum, saying to myself that perhaps one day I'd get back to it."

The other important student in Fred's life was a young woman who had come on a scholarship in the 1960s to North Dakota's now defunct church-sponsored Yankton College, where Fred was teaching theology. When she graduated and enrolled in a drama school in New York City, she was so appalled by the cutthroat competition alien to the cooperative "help-one-another" spirit among North Dakotans that she wrote a letter to her former professor seeking advice on where academically to pursue her overriding interests in philosophy and religion.

On a trip back East, Fred looked her up, and for the next several months she used her lunch hours at her telephone-company job to carry on a budding romance with cost-free long-distance calls, a perquisite of her employment. By 1968 she and Fred were married, and in 1972 moved to Massachusetts where Fred served as Dean of Students at Curry College in Milton, while Janet taught drama and theater arts.

Each summer the Kirschenmanns spent their vacations back in North Dakota helping Fred's father, Theodore, by then in his

seventies, with the harvest on his Windsor acreage and on the older "home farm" thirty miles distant at Streeter, including six hundred acres of short-grass prairie still as virgin as in the time they had been roamed by thousands of bison hunted by Sioux Indians.

One evening in 1977, Theodore called to say he'd had a heart attack: "It looks as if I'll have to sell the farm," he told Fred, "which isn't as good as it used to be, unless, of course, you want to take it over."

Across the dining-room table the couple looked at each other and wordlessly recognized their destiny was to return home to wrestle with deteriorating conditions on the family acres. With all their possessions, including their two-thousand-book library, they drove back to the home farm in Stuttsman County where the Kirschenmann parents, first cousins, had continued an agricultural heritage begun a generation earlier by their German forebears, immigrants, like many farmers in that area of North Dakota, from distant Mother Russia.

Partly inspired by the elder Kirschenmann's feeling that something was fearfully wrong with conventional agriculture as practiced under Extension Service advice for more than two decades, Fred and Janet knew that whatever the difficulties, they intended to dispense with chemical additives and "go organic." They had been particularly impressed by the fact that the weight of a bushel of wheat grown chemically on Fred's father's, as on many a neighbor's farm, was mysteriously and inexplicably declining.

Unsure of exactly how to start, Fred called his old graduate student, David Vetter, who drove up from Nebraska. Over several days he helped them work out a plan, based on his analysis of their soil conditions, for converting one-third, or about seven hundred acres, of their cultivated holdings to organic practice.

"David warned us to go slow," said Fred. "To convert seven hundred acres of tillage all at once was to court disaster. Instead, he advised beginning with a few control plots. But I wanted to do more than that right away; so, relenting, he suggested planting side-by-side companion fields, the ones farmed conventionally, the others organically."

Beginning with wheat and oats, the Kirschenmanns heeded Vetter's advice to supply fertility to their newly converted fields over several years to give their soils a chance to adapt to the new environment and get their nitrogen-fixing clover going. For this they imported a fish-and-seaweed liquid slurry from Texas via a Nebraskan distributor.

At the end of their first growing season they were elated to see that there was no difference whatsoever between the grain yields

on their converted acreage and those on the conventionally chemically-farmed ground.

"Right then we decided to rush along, to go whole hog," said Fred. "We were eager to prove that organic agriculture was just as good, if not better than expensive chemical programs."

The following year, the Kirschenmanns cast aside all chemicals and treated the whole of their tillage with natural products, and, as Janet lamented: "We almost lost our shirts."

To their horror, wild oats, mustard, foxtail (locally known as "pigeon grass"), creeping jennie, Canadian thistle, and other perennial and annual weeds that had never appeared after sowing the previous year, burgeoned early and all over their planted ground to rush ahead of the sprouting grain crop. "It was as if a flock of sheep was being bruted away from a feeding trough by a herd of ravenous cattle."

For the cereals, the competition was overwhelming. "We hadn't realized," said Fred, "that the first year we'd been plain lucky. We had an unseasonably warm spring just like 1987. Temperatures rose in late March and early April into the upper eighties and low nineties. This anomalous hot weather was accompanied by a rash of thunderstorms with myriad bolts of lightning that somehow enhanced nitrogen supplies in the soil. The conditions were exactly right for us to get onto the land before planting and rooting out the weeds with disk harrows and rod weeders."

This ideal set of climatic conditions, rare in the Drift Prairie country, was supplanted the following year by a more usual cold wet spring, which made tillage for weeds impossible until late July. Several fields produced only seventeen bushels an acre instead of a hoped-for fifty. Fields of hard durum wheat, excellent for making spaghetti and other pastas, were heavily infested with pigeon grass; others hardly made any crop at all.

"We were really shocked and scared," Janet put in. "There were plenty of 'we told you so' remarks by our neighbors who had warned us that organic agriculture was a thing of the past. But what could we do? We'd made a commitment, and it made absolutely no sense to retreat from it, to go back to chemicals. We were like the master of a ship in a storm forced to sail on until he can break out into clement weather. So we bit the bullet and forged ahead. It got so tight," she laughed sardonically, "we had a freezer full of meat from two of our slaughtered cattle, but hardly any toilet paper or laundry soap or other essential household supplies."

Then endurance paid off. During the third year of their organic operation, the Kirschenmanns were able to establish a system of crop rotation to supplant the monocultures—one crop and one crop only year after year—that had first become popular in corn-raising country in the Middle West and were being increasingly adopted in the wheat country of the Dakotas and neighboring states.

"That mentality of corn, corn, more corn, and corn only," said Fred, "accounted for why the massive use of herbicides first took hold in the Corn Belt. Weeds love and thrive in a monoculture environment, such as is widely accepted in cereal-grain regions, even though it is wholly unnatural. Monoculture crept up here gradually when larger farmers were talked into getting rid of their cattle, plowing up their pasture land, cutting down all the windbreak trees so carefully planted after the 1930s dust bowl, and putting the whole of their acreage into cultivation, concentrating on one, or at the most two, main cash crops. This transition, fostered by Extension Service advisers, began to really take hold in the late 1960s and early 1970s. The advisers were telling producers that this was the only way they could survive. It was the same thing in forestry, with mixed forests being felled and single tree varieties being planted on thousands of acres, as you probably know."

But with a system of rotation, Fred explained that he and other organic farmers are able to keep weeds "off balance." It begins when a cold-weather early-spring crop of winter wheat or oats is planted in a field in mid-April of the first rotational year. The next year this is followed by sunflowers seeded in the ground in mid-May, or millet at the same month's end. It allows the weeds that have established themselves in the "wheat year" to come up before sunflower-sowing and be killed off with tillage.

"This way," said Kirschenmann, "we wait later and later in successive years to catch another batch of weeds before sowing a grain crop and kill them as they are coming up with an implement called a rod weeder, a steel rod on the ground, turned by a chain in the opposite direction to the machine's travel, which yanks weeds out by their roots and spreads them on the surface to die in the hot sun, to nourish, not deplete the soil."

Fourth year fields, allowed to lie fallow, can be kept free of weeds all summer. In the fall, a clover crop sown on the resting ground is disk-harrowed in to prepare for the original rotational cycle of wheat.

"You can't imagine how our soil improved," said Fred, smiling. "The worms just multiplied tremendously in our organic fields. There were so many they hung off the tines of my chisel-plow diggers whenever they lifted out of the ground." His eyes sparkled, then a shadow crossed them. "It's a crying shame what's been going on in these naturally rich Drift Prairie soils. On the home

farm we began, like many others, with an average six to seven inches of black top soil. Chemicals had been ruining it. The pity is that it was all completely unnecessary. A sane organic program would have required no chemicals at all. When Alex Podolinsky visited our North Dakota Natural Farmers group in 1984, after touring the countryside he told us that if an Australian farmer had suddenly woken up on this kind of land he'd think he'd died and gone to heaven!"

North Dakota, like other farm states all over the country, is now on the threshold of having to pay the high price for its "free ride" with chemicals, the binge it's been on, in terms of soil contamination. But there are a few new straws in the wind. Last year, South Dakota passed a law requiring cattle feedlots to prevent nitrates from running off their properties with fines of up to $10,000 a day for each day the runoff remains uncorrected. Important consumer pressure is being put on State House legislators to clean up sources of ground water and food contamination.

"As the chickens of our previous practices come home to roost," said Fred, "farmers will have to foot long-overdue bills, and fundamental changes will be in the offing. The biggest of all is the one to be met on the question of depleted soils. That crunch would come much faster if our oil and gas resources run out. That won't happen soon, but if the price of hydrocarbons goes up again farmers simply will not be able to afford fossil fuels or the petrochemicals derived from them."

Fred paused to let us ponder the implications of his words, then went on, a little more sanguine. "The thing I sense happening is that, finally, conventional farmers are beginning to look sharp-eyedly at the bottom line. They know they've been at the brink of disaster for years and have read all the recent horror stories about increasing numbers of farmers going bankrupt. But the university extension people still keep telling them the last thing they should do is cut back on their chemical inputs, claiming that if they try to do so, they'll see their yields drop and get deeper and deeper in the hole... and into the red."

All this would, in his opinion, lead down the road to a food-production crisis of mammoth proportion, followed eventually, though unforeseeably—because of world-wide overproduction of food—by depressed prices that would put out of business the very farmer in a position to restore the health of the land. In the Drift Prairie area, costs for fertilizers and weed-bug-killers run $60 to $70 an acre, which for a section of land means $40,000 or more. When that cost is compared to Fred Kirschenmann's input of $1.50 for clover seed per acre, plus $3.00 an acre for the biodynamic preps—a saving of more than $36,000 on his 2,100-acre

spread, it is economically puzzling why farmers constantly faced with bankruptcy do not convert to organic or BD agriculture. The main stumbling block appears to be fear of a single year's failure, for which the banks could rapidly foreclose.

"I've talked to nearly a thousand farmers in these prairie states," said Fred, "and not a single one of them told me: 'Chemicals are terrific, just the thing we need for farming in the future.' What they told me almost to a man is that in their guts and hearts they know something is fearfully wrong about the way they've been advised to operate their farms. But they shrug helplessly, or stare at the ground and ask what they can do, which is nothing. Then they say sadly: 'That's how it is. One more bad year and I'm scheduled for service by the sheriff.'"

So trapped by the chemical system are the Drift Prairie farmers, says Fred, they can think only in terms of what chemical to use next. Many have now replaced ordinary NPK, that no longer supplies the "kick" it used to, with anhydrous ammonia, a gas knifed into the ground under pressure from a large tank, that initially, over the first three years, creates what Fred termed a "terrific response" in crops, but later is less and less effective while at the same time it inexorably turns farm—land into the equivalent of a concrete airport runway.

One of the Kirschenmann neighbors managed to acquire eight thousand acres by cheaply buying up land from destitute smaller farmers. "He's a man who farms with huge eight-hundred-horsepower tractors and extra-wide planters," said Janet. "He can afford to leave more crop in the corners of his fields than many little farmers take off the whole of their land. This agricultural mogul was so pleased with first-year results of his anhydrous, as it's called here for short, that he succumbed to the slogan 'More is Better,' and greedily applied a double amount the following year. When the overdose killed every stalk of wheat planted fence-row to fence-row, to the exclusion of any other crop, he filed for a $4 million bankruptcy. But, having cleverly put the title to his acres and expensive farm implements in the name of relatives, he fought off his creditors and has gone right back to his chemically-dependent ways."

Fred nodded, and added: "A second neighbor, in his sixties, with three sons helping him farm another eight thousand acres, contrasted with the bankrupt by at least understanding the need to use as little chemicals as possible. Of all the conventional farmers around here, he's the best. He's been over to our place several times to carefully observe what I'm doing. In his heart I know he'd like to change over to the organic method we're using. Standing next to me in one of my fields, while admiring my soil

structure, he said: 'What you're doing is fine for you, but it won't work for the rest of us unless a lot of us make the decision in common to convert together. Otherwise the banks'll pick us off, one by one.'"

"I gave him a hard stare," said Fred, "and told him: 'If you want to have a look at my accounting ledger, I'll prove to you in a few minutes that, going it all alone on my new program, I'm doing as good as you are acre for acre, or maybe better.' But he just sort of gazed at me slack-jawed without saying a word."

Used to growing only a single crop of wheat or sunflowers, such farmers are loath to adopt new measures of rotational cropping that require a process of "re-thinking." "The Herculean task," said Fred, "is one of undermining the current mindset and status quo kept in place largely by a yearly avalanche of chemical-company propaganda. You simply wouldn't believe the amount of TV advertising for chemicals to which we are exposed. It starts early in the dead of winter on regular networks and cable TV to catch captive audiences sitting idly at home."

With new pest-control toxins appearing each year, in addition to advertising, farmers are beguiled by and rely upon poison salesmen rather than agricultural advisers for advice about which products to put on their fields. In winter, printed ads of the type posted in the Jamestown Aviation Service proliferate wherever farmers congregate to announce what amounts to "customer appreciation" meetings to be held at the local Ramada Inn or other motels where farmers, served free coffee, doughnuts, Danish pastries and crullers, are briefed in detail by chemical company representatives about promising new poisons. The system is similar to the one in which pharamaceutical company "detail men" push new drugs on medical doctors, and the list of herbicides contains no less than seventy-eight separate products, most of them with "macho" names, such as Bronco, Roundup, and Blazer.

Flipping open a copy of the local Jamestown Sun, Fred pointed to a story in its business section by an Associated Press "Farm Writer" in which economist Lester C. Thurow, newly appointed Dean of MIT's Sloan School of Management, was quoted as dourly and direly recommending the government buy up surplus land and help farmers move on to other jobs wherever they might be available.

Fred waved the article: "How naive and totally stupid can the Thurows of this world get? Of course that's been the policy for forty years, ever since it was made in a Washington, D.C. office by the Committee for Economic Development to get two million farmers off the land and into industrial servitude. But, as Wendell Berry in his book *The Unsettling of America: Culture and Agriculture*, asks: Who benefited by so grotesque an agricultural policy? Certainly not the farmers or residents of rural communities. Did city folk benefit? Berry says no. So who did? What the Thurow-type proposals leave out of their narrowly conceived Cartesian mathematical-economic model is any idea of the amount of fossil-fuel energy, and concomitant inputs, spent or misspent for agriculture. That was the policy!"

The tragedy of this bleak philosophy, which recommends that farmers be sent to the cities has already led in North Dakota to rich farmers buying out poorer ones or leasing their land after its takeover by banks or insurance companies. But the worst problem, according to Kirschenmann, is that the larger farmers, practicing the agri-business "Get Big or Get Out" philosophies of city economists, are exactly the ones with no concept of "land stewardship" or concern for soil care. On the other hand many of the smaller farmers now bankrupted, or forced to sell, owned farms that were models of soil conservation, all of which have been or are being destroyed by the deliberately developed big proprietors.

As we set forth in Fred's battered car to tour his BD farm, we passed what seemed to be strange "artillery pieces" in a nearby field of knee-high sunflowers: special "cannons" timed to go off at intervals from twenty seconds to two minutes, to keep ravenous flocks of redwing and yellow-headed blackbirds from gorging on the sunflower seeds before they could be harvested.

On the way to the home farm in Streeter, south of Medina, fields were surrounded on every side with golden-yellow wild mustard that penetrated into corners and patches wherever farmers had not been able to lay down herbicides guaranteed to kill it. Other fields of nearly the same color on the always distant horizon turned out to be not mustard but natural wild native pasture clover dominating all the other grasses with its early-July yellow blossoms.

Dotted over the Kirschenmann acreage, as indeed over all of the surrounding country, were ponds or small lake-sized sloughs, bodies of water that do not drain in the geologically adolescent overburden, the last in North America to be freed from tons upon tons of glacial ice. Related to the "10,000 lakes" advertised on Minnesota license plates, they teem in late March with ducks, geese, and swans on their way north to arctic breeding grounds and again in mid-October on the return trip, when they come under the guns of hunters from as far away as New York and California.

More anomalous were flocks of pelicans, which first arrived in the 1950s after two years of incessant rain had filled the sloughs to the brim. Finding the climate to their liking, the pelicans have

been returning ever since to the northern plains to pass their summer vacations in the company of sea gulls which could be seen here and there in groups of three to six.

"Years ago, there were many more gulls drawn to this part of the country," said Fred, "but a quarter of a century of chemification has so decimated the worms that the seagulls no longer follow the cultivators the way they used to. On my organic acres you can still see plenty of them at soil-tillage time."

We passed over a little levee cutting across the middle of a slough, where a lone mother Canada goose honked a warning to stay away from her nest with its new generation of goslings.

Up a rise on the other side of the slough Fred stopped the car and pointed to a field of wheat. "I don't normally like to put down what my neighbors are doing, but I want you to have a close look at that wheat field of mine. I planted it in hot weather on 10 April this past spring, when all the ground around here was so dry I knew it would be difficult for any of us to get good germination. Nevertheless, as you can see, my wheat seeds all sprouted and the plants are now nearly three feet tall."

A mile around two sides of a quarter section to where a neighbor had sown his own wheat at the same time as had Kirschenmann, some stands of varying height were barely heading out, others had no grain development at all. "It's going to be difficult for him to get a decent crop," said Fred. "When he harvests, he'll either have to lose the late-developing portion or risk waiting till it gets up, which may be too late. Note the empty little canyons running parallel through the stand in that field. That's where the weight of his tractor added additional compaction to already severely compacted soil to prevent good growth. Unable to retain moisture, his land dried out so fast that lots of his kernels didn't get a chance to sprout or, if they did, came up very weak. But the sponge like quality of my soil structure caught and held every drop of rain."

Approaching the home farm, we drove past a fenced expanse of luxuriant mixed grasses nearly three feet tall. "What you're looking at," said Fred, "is natural native short-grass prairie exactly as it was grazed by millions of bison. We have about nine hundred acres of it. It's loaded with thousands of varieties of grasses and wild flowers that bloom in a different set of hues each year. The quality of the forage is unsurpassable. We have learned to use the same practice recommended to Australian graziers by Podolinsky. We turn out our cattle to munch on one portion of it for twenty to thirty days, then transfer them to another portion to allow the first to regain its normal height. Bison, which never read any books on pasture management, followed this same practice, naturally moving from one unfenced range to another, never overgrazing any of their God-given territory."

At the top of a nearby slope was a hundred-head herd of cattle, basically Theodore's Angus-Hereford cross to which Fred has added genes from Tarantais bulls, a French upland breed known for its cold weather resisting stamina and the excellent mothering instincts of its females. Each year they drop some eighty feeder calves, sold when they reach 650 to 700 pounds, a few heifers being retained to replace cows too old to bear young. The steady income from the calf sales is more than outweighed by the manure from their mothers accumulated during winter months, the mainstay of biodynamic farming when injected with the preps.

In the farmyard to one side of Fred's parents' house was a half-acre feedlot, the herd's winter quarters: two sheds with open-sided fronts allow the animals shelter during bitterly cold nights or sudden savage blizzards. Amassed in the lot were seven to eight hundred tons of cow manure and straw, scraped with an old case W-12 front-end loader from where cattle hooves had impacted it, piled into heaps four-and-a-half feet high and twenty feet long. Each year Kirschenmann, using the same loader, turns the organic matter upside down and inside out to allow it to compost before preparing it and spreading it on 250 to 300 acres of his clover-fallow land.

"I don't do it exactly right," he admitted forthrightly. "I don't have time to run it through a manure spreader to break it up properly, as the purists preach. If I had to do that with this amount of manure, I'd be at that single task all year to the exclusion of anything else."

As a spotted-rump Appaloosa mare named Sally, as tame as a lap-dog, nuzzled in our pockets for sugar, Fred related the saga of how he came to adopt the biodynamic agricultural system.

In 1979, well on his way to solving most conversion problems through "learn by one's mistakes" practice, he organized the North Dakota Natural Farmers Association with some twenty members who had like-mindedly begun to pioneer organic methods.

That winter, the newly-formed association came to the attention of Michael Marcolla, an energetic young man in his early thirties who had organized the Mercantile Food Company in Bridgeport, Connecticut, to supply organically-grown cereals and processed foods to enlightened North American and European consumers demanding something nutritionally more wholesome than what they could normally find on grocery shelves.

To assure that the products he was wholesaling were in fact of authentic quality, Marcolla organized Farm Verified Organic (FVO), a program defining and guaranteeing clearly stated organic stan-

dards.

When Marcolla visited the Kirschenmann's farm, he was as impressed with their management practices as Fred was by Marcolla's offering him a 15 percent premium above the price he was receiving for his grains at the local elevator.

"When I started in the organic program," Fred said with a smile, "I had no notion at all of markets anywhere that were willing to pay premiums. I'd begun in organics primarily because of my concern for our nation's soils. When Marcolla told me he was in the market for 15 percent protein organically grown wheat, I told him my wheat contained 15.5 percent. After having my farm checked out, he informed me, to my surprise, that I could get 50 cents more a bushel than the then fairly high $4.50 being paid at the time to farmers growing conventionally grown "chemified" wheat. I was so amazed and excited that I made a trip to Bridgeport to talk with Marcolla, telling him I would grow anything, in addition to bread and flourwheat, and sunflowers, for which he might have a demand. He said I should immediately consider high-protein durum wheat, buckwheat, and millet, grains I had never thought about, let alone considered growing."

Marcolla surprised Fred even more when he told him that most of his customers, more sophisticatedly attuned to the value of organic produce than Americans, were located in Europe where they were particularly eager for biodynamically-grown produce. "Do you know what biodynamics is?" Marcolla asked.

Fred's mind flashed back to his office at Ohio State ten years earlier where he had been handed Steiner's *Agricultural Lectures* by David Vetter. When he mentioned the incident, Marcolla pulled out his own copy of the same volume and Fred Kirschenmann experienced a deja vu.

Fred asked what he should do to take steps to becoming not just an ordinary organic, but a biodynamic, farmer. Placing the book in his hands, the president of Mercantile Food soberly replied: "First read this. Then subscribe to back issues of the *Biodynamic Association* journal put out in Kimberton, Pennsylvania. Then call your midwestern neighbor Bob Steffan for help with specifics."

Bob Steffan, born and raised on a farm in a region of northeast Nebraska settled by Germans, studied with Pfeiffer for a year and a half, during which he was handicapped in his comprehension by the German's inability to speak good English and by his surprising lack of practical farming experience, at least so it seemed to the brash young native of a "cornhusker state."

"I wasn't yet all that sold on BD," Steffan told us. "Pfeiffer had given me what I thought was more theoretical than practical knowledge. The difficulty I had in becoming acquainted with him only began to be corrected when, with his help, we started to make large quantities of compost at Boys' Town, Father Edward Flanagan's home for orphans near Omaha. With a seven-hundred-head herd of cattle we were turning out thousands of tons of composted cow manure each year. It could have been one of the largest, and probably the first operation of its kind in a truly biodynamic United States. But when Pfeiffer and Father Flanagan both died I felt pretty much alone. Then I heard of Podolinsky's life-work in Australia, and I said to myself: Maybe our BD people have been going about it wrong all these years! For one thing none of us has ever dared to mention the cow horns or the stirring. I guess that was the legacy of Pfeiffer, to adamantly avoid any reference to what he thought might be considered too arcane, indeed abandoning the preps in favor of his starters. And I understand his reticence. Even today I know very few of our BD leaders who can stand up and convincingly talk to a crowd of eager yet skeptical farmers about stuffing cow shit into cow horns or oak bark into sheep skulls, and I include myself in their number. Therein may be a clue to the failure of biodynamics to spread throughout America with either speed or acclaim it achieved in Australia."

Despite these misgivings, two days after receiving the call from Fred, Steffan drove up to Windsor to tell the North Dakotan he could improve his compost by inserting the 500 to 507 biodynamic preparations. Steffan also explained that Fred would have to learn how to treat his fields and crops with 500 and 501, recommending that he visit Dennis Montgomery, a young farmer near Carrington, south of the Fort Totten Indian Reservation, who had a stirring machine gifted to him by Marcolla.

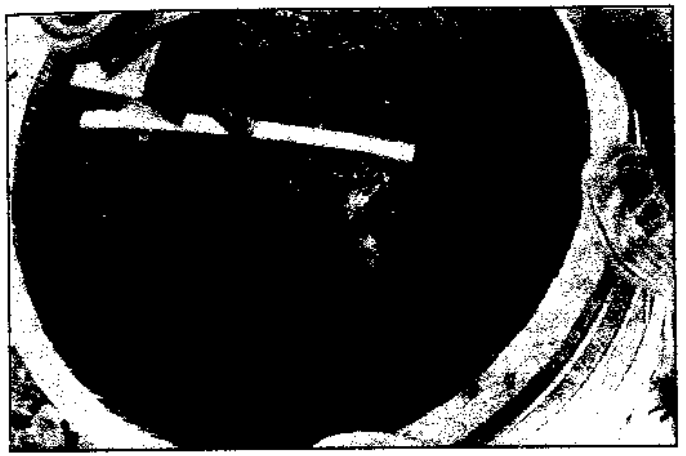
"So I started in," said Kirschenmann. "I called Josephine Porter in Stroudsburg, Pennsylvania, who was making all the Steiner preps and training a retired naval officer to take her place after her retirement, and she began shipping them up to me."

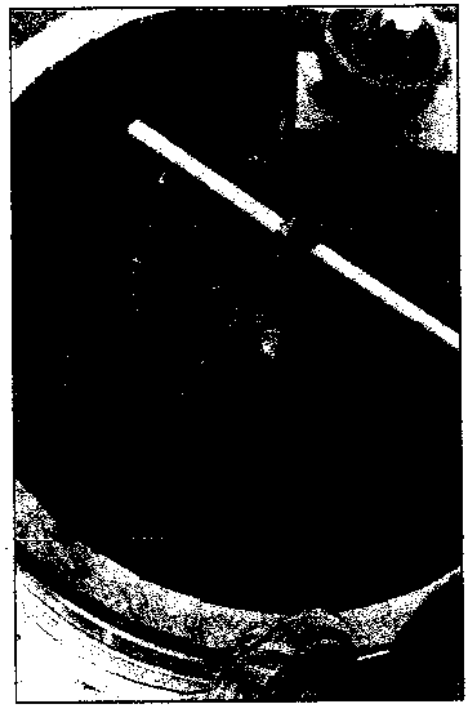
Steffan was at first dubious that the composting method Fred had been using would work properly; but when, a year later, his compost was as good as any Steffan had seen or smelled, with an ideal temperature, he believed that the successful result was due to the large amount of straw, with its high carbon content, incorporated into the piles.

Steffan then built for Kirschenmann a $4,000 stirring machine mounted on the back of a pick-up truck, including two seventy-five-gallon wooden barrels, the water in which is simultaneously stirred by a single electric motor with a float mechanism to reverse its direction each time the vortex in one of the barrels reaches

an optimal depth. For field application, Steffan told Fred he could use his father's old chemical sprayer, a long-chassis vehicle looking like a futuristic racing car called a "Kirschenmann Coupe," made by an unrelated member of the Russian-German clan, installing on it a new tank and two sets of circulatory hoses and nozzles, one for 500, the other for 501.

In 1983, having decided to biodynamically treat one crop at a time in rotation, Fred started with buckwheat. Dennis Montgomery drove from Carrington to show him how to stir the 500 and the 501 and apply it to his fields. As Fred watched the cone-shaped vortices forming and swirling simultaneously in the two big barrels, he wondered to himself how in the world anyone could have possibly dreamed up such a crazy scheme. He simply couldn't believe that the water, strained of all its residue, could provide any benefit at all to his land or anything growing on it. Only later, when he was introduced to the concept of homeopathy and its central tenet that a solution, potentized to the point where anything chemically analyzable was no longer present, could be effectively used in the treatment of disease, did he begin to appreciate what at first seemed to him to be an idiotic and obsoletely "alchemical" process.





Vortex (*above*) and chaos (*right*) obtained by Kirschenmann with the automatic stirring machine designed for him by Bib Steffen of Nebraska. (Photo by Fred Kirschenmann)

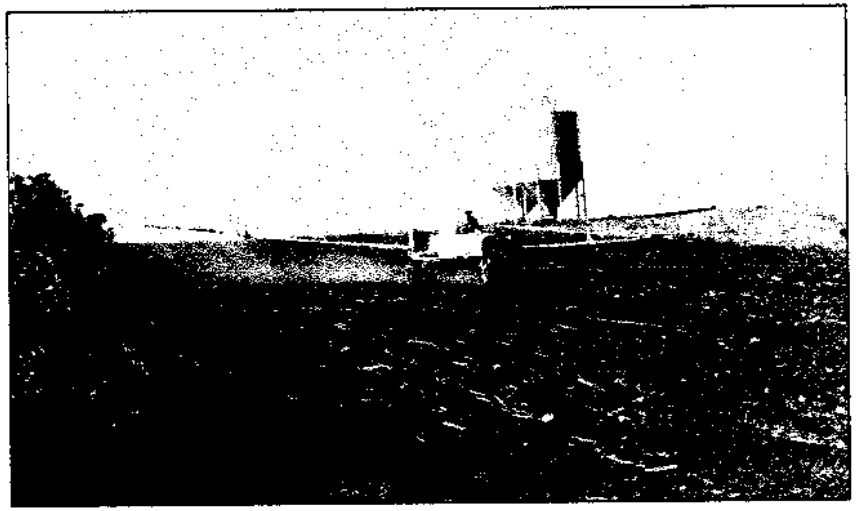
Fred Kirschenmann in North Dakota preparing to transfer 150 gallons of BD 500 from his stirring machine to a special spraying machine.

"There have been some pretty funny rumors going around several counties," Fred said, grinning. "When we truck the stirring machine with those huge barrels from Streeter to the Windsor farm and back, people are sure we have a new still to make our own booze. And right up to this day several neighbors think my BD sprays are no more than witches brews! I let 'em kid me all they want because when, before we began, Marcolla told me I could get $4 a bushel for biodynamic wheat instead of the now depressed going rate of $2.60, I was perfectly willing to humor anyone who considered my stirring and spraying to be so crazy. Now that we see what the method is doing for the land, I have great respect for those who prescribed it, even if it's difficult to

rationally explain."

It was father Theodore who first saw signs that the BD treatment was having an effect. Walking out into one of the fields late one summer afternoon, he noticed that the leaves on buckwheat plants in low-lying wet areas, which had turned almost completely yellow had become green again only three days after being sprayed with 501.

"About a year later my Dad also said to me that he firmly believed the 500 spray was benefiting the structure of the soil, making it 'mellower.' That's the term he used. Of course, it wouldn't produce as dramatic a change on our soils, which had been in an



Fred Kirschenmann in a three-wheeled "Kirschenmann Coupe" (no relation), spraying BD 500 from two twenty-five foot booms. Traveling at eight to ten miles per hour he can spray forty acres in one hour.

organic program for six years as it would in the really seriously compacted soils of average farmers in our area, who have hardpan problems going down as deep as they plow, if they do. A lot of them try to break up the compaction with products sold by the multi-level sales companies, such as Shaklee and Amway, but these are likely to have a detrimental effect on the capillary action of the soil."

Over the next three years Fred Kirschenmann gradually extended the BD program to his wheat, oat, millet, and sunflower rotations while adding still another crop, rye, for which, as Marcolla told him, he had a good market in Europe, though there was none in the United States.

"When we put in that rye," said Fred, "we were overjoyed to see that it had a strangely inexplicable, but most welcome, alleopathic

effect on weeds in the sunflower crop which followed it. That's a natural process in which some plants exude substances from their roots to ward off others."

After considering two schools of thought, one recommending three gallons of Steiner spray to the acre, the other five gallons, Fred began treating forty acres with the 120 gallons produced in two barrels, into which, during the last twenty minutes of each hour-long stirring, he mixes 1 1/2 ounces of Hugh Courtney's barrel-compost for each ounce of 500. The 501 leaf spray is put on in the early morning, the 500 root spray in the late afternoon and evening. In half of a long farming day, Fred can treat two hundred acres, taking fifty-foot swaths with each pass.

Today, with all of his cultivated acreage under BD treatment, he buys 2,400 ounces of 500 in plastic bags, each labeled "1 gallon," and stores it in clay pots in a peat-moss-lined box. And so renowned is his success with his miraculous preps that in March of 1987 Kirschenmann was contacted by Stephen Gage, president of the Midwest Technology Development Institute, to help influence the agriculture committees in Congress. The institute was set up during a governors' conference by seven midwestern states to pool their resources in an attempt to obtain federal funding for new approaches and methods in agriculture. The hope was to be able to span a seemingly uncrossable chasm separating successful organic farmers and university agricultural faculties and get them to exchange views on problems.

Gage asked Fred to testify at a meeting of the House Committee for Agricultural Appropriations, which had done nothing to put teeth in a widely-reported Agricultural Productivity Act, passed in 1985, that was designed to support research in alternative agriculture by allocating funds to get it off paper and into action.

"At first we were allotted half an hour to address the committee," said Fred, "but just before we got to the Capitol, we found that our time had been cut to ten minutes, not for each, but for all of us. It was enough to make me wholly cynical about the political process. Here was this act that had just been lying on a shelf, unfunded for two long years, but the legislators running the hearings apparently thought so little of whatever we had to say about our problems that, with the time allotted, it was hardly worth the Midwest Institute's spending all that money on our travel. If our experience is typical, then the whole situation is ironic, to say the least. Very few people in Congress have any inkling of the larger economic or ecological issues related to agriculture as a whole. One has to wonder how our government gets anything at all done with any real wisdom."

After giving a short history of his farm conversion,

Kirschenmann told the committee: "By now it is crystal clear to almost everyone that agriculture is in serious trouble not only in the United States, but in many other countries of the world. It would be a terrible mistake to think that only a little tinkering can correct its ills. The system is so flawed economically, agronomically, and environmentally that it needs no less than a full-scale overhaul."

Most crucial for farmers locked into the present chemical system, Kirschenmann told the politicians, was practical information on how to get out of it. The current agribusiness structure, with all the weight of forty years of research on capital and energy systems behind it, has given farmers the biased impression that it was the only viable agriculture available. This was patently false in that hundreds of small and large farmers around the world have demonstrated, with no help whatsoever from any national or international agricultural bureaucracy, that low-input systems were not only feasible but highly profitable.

The Agricultural Productivity Act, he went on, called for exactly the kind of research needed to allow farmers, from whom he was receiving desperate letters and telephone calls almost daily, to consider transition to naturally healthy production with minimal risks. Some initiatives in this direction had already been taken by land-grant colleges, notably the University of Nebraska and Iowa State University, but those represented only a tiny step on a trail that could only be blazed with funds appropriated to relieve researchers from having continually to direct their efforts mainly to prove what the chemical companies, which supplied the lions' share of funding in the form of research grants, wanted them to prove.

To bolster his appeal to the senators and representatives, and forcefully bring out to what depths purportedly objective agricultural research had fallen, Kirschenmann needed only to add how one land-grant college professor told Charles Walters Jr., editor of Acres-USA, that if Walters, rather than the chemical companies, wanted to put up $100,000 to fund research, his department would supply data backing up anything he wanted to prove. "What's happened," Walters said wryly, "is that they've changed the Golden Rule from 'Do unto others...' to read: 'He who has the Gold makes the Rule.'"

Back in the kitchen where Janet was preparing a beef stew for supper, we asked Fred what impression his biodynamic practice was making on any of the agricultural schools or their extension agents.

"Good Lord," he replied, "I haven't even raised the question with them. We're still in an uphill struggle to get most of them to

appreciate that ordinary organic farming is not only possible but profitable. I'm trying to get ready for the meeting of our association, now expanded into the Northern Plains Sustainable Agriculture Association," where I'll be giving the keynote speech, which will be attended by some twenty European representatives of Marcolla's FVO group as well as by our own members and new farmers desperate to convert to non-chemical methods. It will focus on the problem of transition from the old way to the new. We'll hold workshops in which our organic farmers who have made a successful go of it can explain to the new men who've already signed up for the conference all the problems they're going to face and get into the nitty-gritty of what to do about them, and tell them about the mistakes that have been made.

"It's a whole new ladder for them to climb, or even a tight-rope to walk," Fred went on, "given their precarious financial conditions. One misstep and they'll plunge downwards into an abyss, with no safety net to break their fall. Most of the new ones will be there out of desperation with what they've been forced to go along with all these years. They'll be both curious and afraid. It's a big responsibility. We have to go as slowly and carefully with them as any teacher instructing a child in swimming, horseback-riding, or mountaineering."

Continuing this theme during dinner, Janet spoke of a "mile-wide" gap separating the day-to-day concerns of farmers from those of city folk represented by the majority of politicians who hold the lives of food producers in their hands. "As one brought up in an urban community who had to learn about a new culture, the culture of the land," she said, "I wonder if that gap, so painfully felt by farmers, will ever be bridged. To give you but one example, a Massachusetts congressman on a delegation to study farm problems here in North Dakota, was invited to take part in a TV-panel discussion including both members of the delegation and local farmers.

"The sharp contrast in thinking between the two groups, as striking as their dress, was unforgettably brought out when the congressman, attired in his natty suit and tie, turned to a dairyman in work clothes to ask in all sincerity: 'Do you have to milk your cows every day?' There must have been an explosion of laughter in kitchens and living rooms all over North Dakota. The dairyman, as he would to a child, quietly replied: 'Yes, sir, every day of the year, in fact twice a day.' You can't really blame that congressman. You should hear the same kind of naive questions I get from my family and friends when I go back East. It's sad that all of them think agriculture can be run like a factory. A lot of them see milk running out of a tap, like water, and their pack-

aged cereal grains as one more analog of a mechanical production line turning out widgets."

The same mentality, said Janet, was illustrated when a New York TV morning show viewed by millions called one cold February morning to say they were doing a story on organic farming and wanted to feature the Kirschenmann farm as a model of that method. The TV crew would arrive in two days, the caller said, to get footage of the farm and especially the land.

"Don't you realize," Janet replied, unable to suppress a giggle, "that if you come now, all you'll get on your film will be thousands of square feet of snow as white as in Antarctica?"

Silence ensued, broken by an embarrassed: "Oh, I see....We never thought of that. Perhaps we'd better delay till summer." Then, with cheery abandon: "We just want you to know we feel you are true pioneers."

Chapter 8

Heaven on Earth

That all this chemical horror is as unnecessary as it is unnatural, that men and women can live into their second century free of all disease, if fed on properly grown organic food, was first proved by an early follower of Sir Albert Howard, a distinguished Scottish physician, Robert McCarrison, who did so with the aid of a crew of city rats. As head of the Nutrition Research Agency for the Imperial Government of India, and director of its Pasteur Institute at Coonoor, McCarrison gained a knighthood and an appointment as personal physician to King George V. But it was his interlude with rats, while still a young man attached to the Gilgit Agency in northern Pakistan, that made his fame. It led to the discovery of the legendary health and longevity of the inhabitants of Hunza, a hardy people living in a remote and inaccessible valley, surrounded by the highest Himalayan peaks.

In the course of a comparative study of the dietary practices of people from various regions of India, young McCarrison was surprised to find that rats that ate the diets of Pathans and Sikhs increased their body weight much faster and were much healthier than those ingesting the daily fares of neighboring peoples such as the Kanarese or the Bengalis.

Even more extraordinary, when his rats were fed the same diet as that of the Hunzas, a diet limited to grain, vegetables, fruits, and unpasteurized goats' milk and butter, the rodents appeared

Major-General Sir Robert McCarrison, C.I.E., M.A., M.D., D Sc., LL.D., F.R.C.P., F.A.O. (From a bust by Lady Kennet)

to McCarrison to be the healthiest ever raised in his laboratory. They grew rapidly, never seemed to be ill, mated with enthusiasm, and had healthy offspring. Autopsies showed nothing whatsoever wrong with their organs. Throughout their lifetimes these rats were gentle, affectionate, and playful.

Other rats contracted precisely the diseases of the people whose diets they were fed, and even seemed to adopt certain of the humans' nastier behavioral characteristics. Illnesses revealed at autopsy filled a whole page. All parts of the rats' bodies, skin, hair, blood, ovaries and womb, and all their systems—respiratory, urinary, digestive, nervous, and cardiovascular—were afflicted. Many of the rats, snarling and vicious, had to be kept apart if they were not to tear each other to bits.

So extraordinary was this data, that several explorers made the difficult and dangerous journey to the remote an inaccessible source to find out just what could be so miraculous about the Hunza diet.

In a narrow sunlit valley, dominated by the snow-capped Himalayan peaks, they found a real-life Shangri-la, inhabited by what they described as the healthiest, happiest mortals, many of them centenarians, subjects of the tiny, semi-independent kingdom of Hunza, legally a constituent of Pakistan.

Until very recently the only way to reach this oasis of life and

health from a degenerate and dying West was via the outpost of Gilgit, a month's hike from the nearest Pakistani railhead at Rawalpindi, along a rough footpath over a 13,700-foot snowbound pass, open only three months of the year. This was the route taken by Marco Polo on his return from Cathay, over swollen rivers and ice-bound passes, past the rotting carcasses of pack animals that could not keep pace with the trains of silk and porcelain hauled from China to be bartered for gold, ivory, and the spices of the great subcontinent.

For centuries entrance to the land of Hunza has been over a treacherously swaying bridge supported by ropes of woven goats' hair. Then, at an elevation of a mere eight thousand feet, there appeared before the traveler's enchanted eye a flowering seven-mile-long valley of green-gold orchards sparkling in springtime with a pastel carpet of apricot blossoms, sharply contrasted against the surrounding, forbidding, snow-capped Karakorum range.

In the valley, small stone farmhouses dot a carefully cultivated landscape, whose endless terraced fields rise up the escarpment in steps towards glacier streams which fertilize them with powder more precious than gold, a glacial dust, teeming with minerals ground from the raw living rock of the mountain.

Five hundred feet above the murky rushing waters of the Hunza river—which threads through the whole valley—stands the town of Baltit, dominated by an old Fort, built while Canute still reigned in England. As the traveler approaches, the women of Hunza rise and place two welcoming fingers to their forehead, pretty children smile enchantingly, mustachioed gallants shout greetings in Burushaski, a native tongue of unknown origin.

Hunzakuts, as the natives choose to call themselves, differ from other races living in that distant corner of the world. With bronzed but Caucasian features, like southern Europeans, they love to boast that they descend from three foot-soldiers of the Macedonian army of Alexander the Great who took refuge with their Persian wives in this remote valley in the third century B.C. There they bred a warrior race of brigands who thrived on raiding the trade route to China, that is, until conquered by the British in 1891, and pacified by a domestic Ismaili ruler, known as the Mir, who had the wit to learn the rules of karma. Visitors have written in great detail about the extraordinary health of the Hunzakuts. There is practically no plant or animal disease, and virtually none in humans: absolutely no cancer, no heart or intestinal trouble; and the people regularly live to be centenarians, singing, dancing, and making love to the edge of the grave.

Visitors tell of seeing no cripples. Wounds are said to heal with remarkable speed, seldom becoming infected if rubbed with the

local soil, rich in minerals, which somehow obviates sepsis. Hunza women are so healthy, they need no assistance in delivering a child, whom they breast feed for two to three years, deliberately spacing their children so as to wean them one at a time. Children are invariably reported as growing up unneurotic and healthy, with none of the normal childhood diseases such as mumps, measles, chicken pox, etc. The girls' complexions are depicted as without acne or blemish, attributable in part to the application of oil of apricot seed. Nor is there any evidence of juvenile delinquency; visitors remark that one never hears a mother scold or bribe a child. Treated as integral members of society, trusted and given responsibility, the children are described as growing up healthy emotionally as well as physically.

Travelers who have been through Northern India agree that the Hunzakuts are superior mentally and physically, excelling in grace, charm, and intelligence. They are frank, and have a fearless look on features that are chiseled and appealing. Strongly built men, with bold eyes and jovial expressions, they have physiques which would delight a Rodin.

There is no moron or cretin among them, which contrasts sharply with the people in neighboring valleys, many of whom suffer from goiter and cretinism due to a lack of iodine in the water. Although surrounded by peoples afflicted with all kinds of degenerative and pestilential disease, the Hunzakuts, who lead a strenuous and spartan existence, do not contract them.

As mountain climbers they are superb and unequaled, with great powers of endurance. Agile as goats, they leap over boulders and icy streams, make holes in the ice in winter to plunge into glacier fed-streams, as swimmers second to none. They are also splendid horsemen, always ready to indulge in their national game of polo, played in every village on its own narrow polo ground with balls and mallets carved from bamboo roots.

Whether at work or at rest, or playing some game, the Hunzakut is always accompanied by a melodious tune which invites him to hum and to dance. The sound of flute and drum is everywhere carried on the air, drifting up to the perennially nourishing glaciers.

Unanimously described as having "rosy complexions, good features, and lovely eyes," the women of Hunza are treated as true partners in life, both at home and in the fields. Slim and erect, dark-haired and svelte, they walk with a light glide, easily climbing the thousand or fifteen hundred feet to the terraced gardens they lovingly tend with their menfolk as the source of their enduring health.

Every bit of Hunza soil has been hand-prepared with delicate

care, often brought from afar, laid in narrow ribbons on terraced fields hacked from the raw face of the surrounding mountain and built up with stones like a jigsaw, as high as thirty feet, using smaller stones as riveting, firm without mortar or mud. Kept fertile with organic compost, the strips are watered by the silt-laden melt of glaciers brought in by man-made conduits of extraordinary engineering, constructed with nothing more than a wooden spade and an onyx-tipped pick. Without benefit of transit or theodolite, the channels go through tunnels, over aqueducts and even hang from the side of cliffs many hundreds of feet high, flowing through timber troughs supported by brackets.

And therein lies the secret of Hunza health: in the finely powdered detritus of rock made by the massive glaciers as they inexorably grind down the raw mountains to produce a silt containing all the mineral elements required by plants. The silt mixed with organic compost provides plant, animal, and human with every element they need for life. Every possible stream from a glacier is harnessed and the water channeled to the fields. In winter the channels are cleaned and the silt is spread on the fields to give a fresh layer of soil for the coming season.

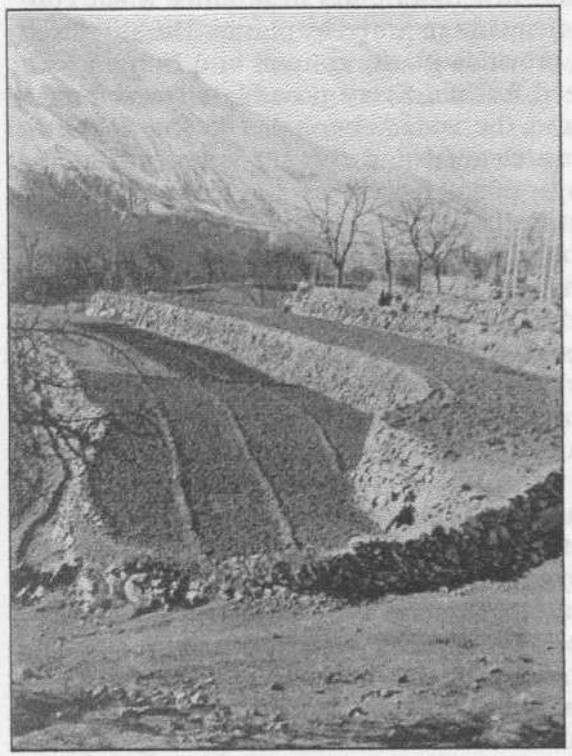
In the Karakorum range lies the most immense accumulation of glaciers anywhere in the world, with the exception of the polar regions: millions of tons of ice and snow, hundreds or thousands of feet thick, are piled high on the mountain flanks. As these glaciers recede, their slippery footing liquefied by pressure, the mass of ice moves slowly downward, and with it comes a scraping of the face of the mountain. No mineral, no rock, no metal, no alchemy is strong enough to resist the weight of these millions of tons of ice.

A finely ground coat containing some or all of the elements moves down to be carried away in the *nullahs*, or glacial torrents. The water, a milky gray, spurts, splashes, and spills out of crevices, canyons, and any aperture in the mountain walls where numerous *nullahs* are formed. These streams carry in colloidal suspension some, if not all, of the mineral constituents of the mountains, the necessary fertilizer for the Hunza fields.

In their manuring, the Hunzakuts return everything they can to the soil: all vegetable parts and pieces that will not serve as food for man or beast, including such fallen leaves as the cattle will not eat, mixed with their own seasoned excrement, plus dung and urine from their byres and barns. Children follow the cows through the fields with shoulder baskets ready to catch the precious substance as it emerges. To be sure that not an ounce is wasted at threshing time—when a mixed team of cows, donkeys, mules, and yaks, yoked abreast, are driven over the cut crop on

the threshing floor—a person driving the team, usually a pretty young maid, keeps a pan in her hand for a catch in mid-air, uncannily anticipating when and which of the animals is about to drop. On mountainsides, children scour the fields to garner every last blade of grass for compost, every last errant speck of goat or sheep manure. Like their Chinese neighbors, the Hunzakuts save their own manure in special underground vats, clear of any contaminatable streams, there to be seasoned for a good six months. Everything that once had life is given new to life through loving hands.

For a thousand years the Hunzakuts have farmed with the same seed, and the result is reflected in the health of their plants. They have no central source of seed supply, yet the species all survive.



Carefully cultivated strips of land in Hunza, every stone of the walls hand-laid. Raka peak, one of the highest in the Himalayas, in the background.

Each farmer saves what's necessary for the next year's crops, or barters with his neighbor. No Hunzakut owns more than five acres, and many families have divided up their ownership into tiny lots, sometimes no bigger than a Persian carpet, every inch of which is cared for with affection and understanding.

Yet in all these plots the produce flourishes, carefully tended by hand, with no other instruments than a pick of ibex horn and

a wooden plow drawn by bullock or yak. Plowing is necessary to aerate the roots of the plants which would otherwise suffer partial asphyxiation. But the Hunzakut does not plow deep, and would not, even if he had the modern moldboard plow. Deep plowing compacts the surface and submerges bacteria and other valuable organisms to levels where their numbers are reduced.

Rich in organic matter, Hunza soil is porous and spongy, encouraging the multiplication of earthworms, which make thousands of burrow holes into which water can easily seep. Each farmer applies his water personally, and when the right amount has seeped into his field the flow is stopped by maneuvering the requisite stones. Were overflows or run-offs allowed to develop they fear a leaching of the nutrients would end in an imbalance of elements, causing crop disease and bringing on insects. The terraces afford perfect drainage and allow for deeper penetration of air into the soil, all of which promotes the growth of microorganisms, enabling both the bacteria and the roots to benefit.

Visitors to Hunza describe the vegetables as rich in flavor, with a delicious taste despite the fact that there is no seasoning, which is not missed when vegetables are grown in mineral-rich soil. Popeye's spinach-generated-muscles may be more than malarkey; Hunzakuts eat large quantities of the green leaf at almost every meal, and the mineral-rich water it is steamed in is always saved and used.

But it is not just their spartan diet that accounts for the extraordinary health, amiability, and lack of neurosis among the Hunzakuts. The real secret appears to lie in the same mineral-rich glacial water that fertilizes their fields, brought to the villages in canals for domestic use. Cool and inviting, it is called "glacial milk" because of its pearly gray color. Every man, woman, and child, drinks an abundance of this water, which is neither boiled nor filtered. And so does the Mir, though he has plenty of clear, "clean" water for unwise, finicky, foreign guests.

Sir Albert Howard once said he hoped some day some enterprising fellow would get himself samples of this Hunza water, have it analyzed, and find out exactly what it contains. "It should give us a clue," said Sir Albert, "to the health of these remarkable people."

John A. Tobe, an American traveler and adventurer, first to scientifically analyze the "glacial milk," says the Hunza minerals go into the soil in a colloidal state, which is described as the state of a solute when its molecules are not present as separate entities, as in a true solution, but are grouped together to form solute "particles." These particles, approximately one hundred-thousandth to one ten-millionth of a centimeter across, only detect-

able by means of an ultramicroscope, carry a resultant electric charge, generally of the same sign for all the particles, usually negative, and it is their colloidal state that enables the human body membranes directly to absorb essential mineral elements without their having first to be processed organically by plant and animal. Every cell of the human body is made of colloids arranged to perform specific functions. Colloidal particles are so small, and therefore have such a large surface area—a teaspoon of particles has a surface area greater than a football field—that, according to Gustave Lebon in his *Evolution of Energy* they generate surface energies that have powerful effects on physical and chemical reactions.

Tobe believes the Hunzakuts' "glacial milk," with which they water their fields and which they drink so copiously, supplies them with all the elements required by their bodies, in nutrient form, and that it is the explanation for how they can be so strong, so energetic, so unneurotic, and have such powers of endurance,

Harsh Hunza country and a few of its aged residents. Good health at over a hundred years of age is common among the Hunzakuts. (Courtesy *Acres U.S.A.*)

both physical and sexual, on such a spartan diet. He believes it is why they always look content, why their gait is springy and full of vitality, why they look forty when they are seventy, why the men can sire children in their nineties, and why they can walk to Gilgit, sixty miles away, over the grimmest terrain, transact their business, and nonchalantly retrace their steps.

In a world of atomic threats, and the instant danger of an epidemic of AIDS that might make the Black Plague pale, knowledge of a group of people living in such complete peace, free of the major fears of mankind—disease and war—should have made an impact. You might think so, says J.I. Rodale, an early enthusiast, who wrote much about the Hunzas. You might think that demonstration of the fact that practically complete elimination of disease in an entire group could be effected by the mere eating of proper foods and drinking vital water would create a tremendous stir in medical circles, would crystallize a demand that the mechanism be immediately created for carrying these findings into actual practice. "It didn't," he complains, "even produce a tiny ripple in the pond of medical inertia. The doctor is too much involved in the morasses of the disease and physic to be able to give much time to the question of mere health."

In the mid-1970s Senator Charles Percy, a member of the Senate Committee on Aging, visited Hunza to note the absence of heart attacks, cancer, and neurosis. Back home he made a laudable effort to awaken his colleagues in Congress to the amazing potential represented by the Hunzakut phenomenon. He might as well have dropped a pebble in the Hunza River.

Now the Pakistani army has built a military road through Hunza to the Sino-Soviet border. Where Polo's mule trains carefully trod, the treads of tanks grind hard, and in their train come sugared drinks, NPK, and the inevitable pesticides to raise the specter of disease and early death. Shangri-La is Shangri-La no more.

Yet the secret of the Hunza health may yet survive to save the soil and health of a sick and ravaged planet. A sample of Hunza water, recently brought back by a young American traveler, Betty Lee Morales, has been thoroughly analyzed with sophisticated laboratory techniques by Patrick Flanagan, author of *Pyramid Power*. The results are as astonishing as they are encouraging. They explain not only the water's life-giving qualities, but vindicate Steiner's clairvoyant vision of the function of the vortex and of the intervening chaos in the life-giving stirring of his biodynamic preps, designed to revitalize a dying soil.

Chapter 9

VORTEX OF LIFE

So strange and mysterious are the properties of water, just ordinary tap water, that anything new about its behavior has become a landmark in the history of science. In the 1920s when the Rumanian scientific genius Henry Coanda made the discovery, apparently banal, that a fluid flowing over any surface tends—as if it were alive—to cling to that surface, it was considered by physicists so important it was called the "Coanda Effect."

Intrigued by tales of the longevity of the Hunzakuts, in the early 1930s Coanda made the arduous journey to Hunzaland. As a water expert he was delighted to be told by the Mir that the secret to the Hunzakuts' longevity and health was hidden in the water they drink so freely.

Convinced that any health-improving properties of the Hunza water would be related to its molecular structure, Coanda set about analyzing a sample of it alongside "ordinary" water, using the facilities of the Huyck Research Laboratories in Connecticut to which he was at that time a consultant. His novel method was to study water in its crystalline form as snowflakes, each of which, as they fall by the zillion, is uniquely designed and molded by unknown forces in its micro-environment, no two being alike, as far as anyone can tell.

With a "fluid amplifier," a device he invented that could make snow from water, Coanda found in the center of each snowflake a

Dr. Henri Coanda (*right*), the father of fluid dynamics, and G. Patrick Flanagan at Huyck Research Laboratories in Stamford, Connecticut, in June, 1963. Dr. Coanda was the scientist who discovered that the secret of long life was in the structure of water. He told Patrick: "We are what we drink." (Photo by G. Harry Stine)

circulatory system composed of tiny tubes in which still unfrozen water circulates like sap in plants, or blood in animals—water which he considered to be what dowsers characterize as "living," to distinguish it from its stagnant, lifeless counterpart.

By carefully timing the life span of snowflakes, which "die" when all the water in them becomes congealed, Coanda was able to establish an extraordinary and direct relationship between the duration of his snowflake water and the life span of people who regularly drink such water. The "living" fluid appeared to add more life to humans.

On far-flung travels Coanda found that the water that produces long-lasting snowflakes is the principal beverage not only of the Hunzas, but of other long-lived peoples in Soviet Georgia, Ecuador, Peru, and on the mountainous Tibet-Mongolian border. Still he did not know why or how the special glacial water extended

human life. Before returning to his native country to become president of the Rumanian Academy of Sciences, Coanda entrusted his water research to a young collaborator at the Huyck laboratories, Patrick Flanagan, a prodigy who, at only seventeen, had been listed by *Life* magazine as one of America's top ten scientists. "I think you are the only one I know," Coanda told him, "who can eventually come up with a system to make Hunza water available anywhere in the world."

Flanagan, a short man of forty, with a closely clipped moustache, his head as razed as Kojak's or Yul Brynner's, met us in a small motel next to the tiny Sedona airport atop a mesa in the mountains of central Arizona. All around us rose a magnificent series of red rock cliffs and spires, dominating the town in the canyon far below.

"I read everything I could on water," said Flanagan, at ease in his khaki clothes from the Banana Republic, "only to discover it was one of the world's most mysteriously anomalous substances."

Once a flamboyant adventurer who would savor the gall bladders of rattlesnakes and cobras to assume their powers and immunity, regularly earning thousands of dollars with far-flung lectures on such arcane subjects as Pyramid Power and Tantric Sex, Flanagan is now a quiet vegetarian, as reclusive and peace-loving as a Tibetan monk, healed and domesticated by his lovely wife Gael, soulmate, so he claims, from an equally adventurous past, an expert on the structure, function, and properties of crystals. Like her husband, Gael received the degree of Doctor of Medicine from the The Open International University for Complementary Medicines in Colombo, Sri Lanka, and now helps, in the seclusion of their Sedona laboratory deep in a pinewood forest, with research on the colloidal properties of water.

Oddly coincidental, or serendipitously propitious, the town of Sedona—lying in the coils of the twisting Oak Creek Canyon, surrounded by gnarled terra cotta peaks against a sky so blue its energy is tangible—is what Lyle Watson in his *The Romeo Error* describes as a unique "power spot," one where great concentrations of energy can be felt coming up from the earth through four separate telluric vortices.

Visitors from all over the world, alerted to the existence of what they believe to be "psychic energy vortices," flock to Sedona to bask and meditate in the extraordinary energy emitted from the soil, and describe experiencing visions, telepathic communication, past-life regressions, precognitions, UFO sightings, enhanced automatic writing, spiritual healing, and other psychic phenomena, especially during the period of the full moon.

Two of the vortices are said to be magnetic, the third electric, and the fourth electromagnetic. The electric vortex, being charged with *yang* or male energy, is reputed to stimulate and elevate consciousness; the magnetic, or *yin* vortices, charged with female energy, are supposed to open one's psychic perception; and the electromagnetic vortex is credited with balancing both body and spirit, stimulating memories of past life experiences.

Author and lecturer Dick Sutphen, an aficionado of Sedona's vortices, has collected an anthology of visitors' experiences, ranging from intense spiritual visions to impressions of what may have taken place in the canyons long centuries ago, especially visions of refugees from what they believe to be the cataclysmic destruction of Churchward's legendary pacific continent of Lemuria, the claim being that the nearby native Hopi Indians are descendants of ancient Lemurians. Many a visitor attests to sensing the presence of great crystals buried beneath the existing town, to which they attribute the emission of intense radiating energy, the source, they say, of the vortices' power in the area.

But whether or not this is just the bright dream of a successful real estate developer, happy to welcome little old ladies with pendulums, Ouija boards, and Tarot decks to dabble in the vortices, it is a fact that magnetic anomalies do exist on the planet, places where cars mysteriously roll backward up a hill as gravity turns to levity. Indeed, at Sedona the trees in the vortex in the canyon by the airport mesa do *not* grow perpendicular, but towards the center of the so-called vortex.

Our purpose—not with these anomalies—was with the secret of the Hunza water and its relation to the stirred BD 500, a field in which Pat Flanagan turned out to be an expert.

For years he has been collecting samples of water from all over the United States. Considered no more than an amalgam of oxygen and hydrogen, water is, in fact, far from banal. Constituting 90 percent of the human brain, it may, says Flanagan, be the most important substance on the planet, perhaps in the universe. With thirty-six distinct isotopes, each possessing different properties, it is the universal solvent of chemistry, capable, with time, of dissolving any and all the elements, even gold. Among its odd attributes, such as growing lighter instead of heavier as it freezes, water, as Flanagan explains the matter, has what is known as surface tension, a force that causes it to stick to itself, to form a sphere, the shape with the least amount of surface for its volume, requiring the least amount of energy to maintain itself. Yet its potential strength is ominous. Were all the extraneous gases to be removed from an inch-thick column of water, that column would become harder than steel.

In a bathtub, Flanagan elaborated, bulk water is composed of

a small number of liquid crystals and a very large number of chaotically random molecules. "In theory, liquid water, even when boiling, has microscopically tiny 'icebergs' of crystalline water within it, liquid crystals that retain their set structure, whereas the rest of the water is all randomly oriented, vibrating vigorously. Cooling water automatically creates more of the crystals until nearly the whole mass becomes crystalline ice."

The point he wished to make was that when a living organism, such as a plant or an animal, takes in water it structures it into a composition with a high percentage of octagonal liquid crystals and very low percentage of unorganized molecules. This, said Flanagan, is done by means of high-energy colloids—particles in suspension or solution too small to accurately be viewed with an ordinary microscope. "Colloidal particles act as tiny 'seeds' of energy, charged to attract freely-roving water molecules, and thus form the nuclei of liquid crystals. But to do this, the colloids, normally of unstable charge, require a high electrical charge. In living systems, they retain this charge by being *protected* by a coating of such materials as gelatin, albumin, or collagen."

To illustrate his meaning with an analogy, Flanagan explained that similar colloids, not found in nature, are artificially manufactured by the detergent industry. These, we learned, have two poles, one lyophilic (liking water), the other lipophilic (liking oil), the latter on the inside facing the colloid, the former on the outside facing the fluid in which the colloid is suspended. This structuring allows the water to penetrate dirty clothing.

Another force causes water molecules to form long complex structures known as hydrogen bonds. These enable water to wet substances such as glass, clothes, powders, or one's hands, a force that can be strengthened or weakened by structuring the water's internal composition.

It was these two properties of water that showed Flanagan the way to duplicate the Hunza water, and thereby resolve part of the riddle of what takes place in the bucket of Steiner's BD 500 being "potentized" as it is stirred into vortex and chaos.

In 1974, Flanagan found that crystals of all kinds, such as quartz and precious gem stones, have a marked effect on water surface tension, a characteristic known to ancient Tibetan physicians who applied it to make crystal-affected water potions for their patients. If poured on wheat, mung-bean, soy, alfalfa, or radish seeds, the "crystal-affected" water produces more vigorous growth, and sprouts much larger and tastier than normal.

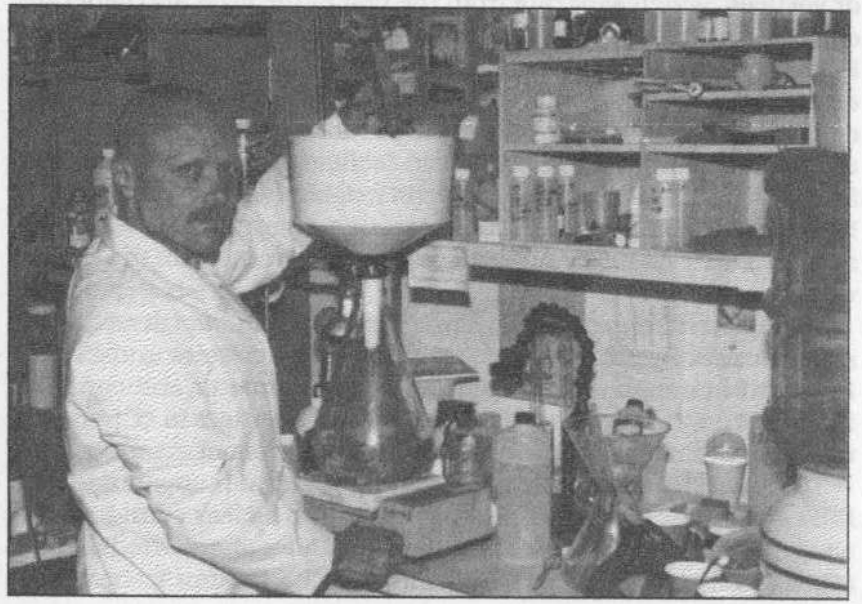
But where, Flanagan asked himself, did the crystals get the energy with which to affect the surface tension of water? It seemed to him they must be "resonators of cosmic energy impulses generated by super-novas, and other deep-space influences." To detect such forces he basically thought to be gravitational in nature he constructed a device to pick up cosmic gravitational waves. These he converted and amplified so as to be recorded on a chart recorder, heard through a loud-speaker, or displayed on an oscilloscope.

Testing showed that whereas ordinary tap water has a surface tension of 75 dynes per centimeter, the cloudy Hunza water that appears "dirty" when held up to a light source has a much lower one of 68, and is negatively charged.

Hunza water was also revealed to contain almost every known mineral element, with an especially high content of silver. To Flanagan the most interesting feature of the minerals was their being not in ionic, but in *colloidal* form—meaning that the minute mineralized particles, though microscopically small, do not dissolve in the water, as salt does, to become ionic sodium and ionic chlorine, but remain in suspension as tiny electrically-negatively-charged and therefore self-repelling stable particles.

Pure water melting from the glaciers in the mountains of Hunzaland, Flanagan realized, would be devoid of minerals. But pressure from the millions of tons of ice—enough to grind to powder four inches of surface every century—would scrape and carry minerals to the valley at great speed to spurt into the *nullahs* or vertiginous torrents. And such is the peculiar nature of water

Patrick Flanagan in his forties in 1988 with his vortex machine in Sedona, Arizona.



that each time its speed is doubled, it can carry sixty-four more times the amount of matter in suspension. In the fast *nullahs*, water thickens up with sediment.

"This colloid matter seemed so important," said Flanagan, "that I pursued the idea that it was these stable colloidal minerals that gave the Hunza water its special structure."

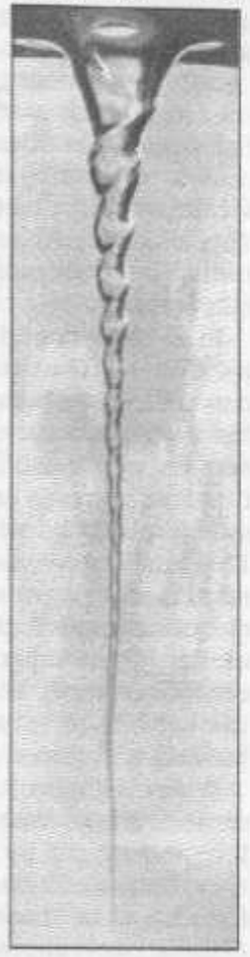
For years Flanagan tried without success to duplicate the colloidal minerals in his laboratory. "I tried all kinds, many of them clays. But none had sufficient electrical charge to lower the surface tension of water down to the sixty-eight figure characteristic of Hunza water."

Flanagan next discovered that the mineral particles in Hunza water had a fatty or oily organic acid around them, derived, he assumed, from old strata through which they had traveled, which, in his eyes, had to be made up of petrified forests or something equally ancient. What was necessary, he saw, was to find a way to make the non-soluble minerals *colloidal* by artificially putting an electric charge on them.

It flashed to him that such a charge could be produced in the Hunza water by a vortex, or whirlpool, such as exist by the hundreds in the fast-flowing glacial torrents, an idea he had extracted, as had Podolinsky, from Theodore Schwenk's *Sensitive Chaos*. Therein he learned that all flowing water, though it appears to be uniform, is actually divided into extensive inner surfaces, or layers, moving against one another. Any obstruction will cause these inner surfaces to flow at different rates of speed and form spirals or vortices, which separate from the rest of the fluid and generate electric current. In flowing rills, brooks, streams, and rivers, millions of vortices form when water rushes over or against stones and other obstructions. It was the vortex, Flanagan realized, that could put an electric charge on the particles of matter suspended in the water and thus render them "colloidal," each tiny element forced to be distinct, repelled from its neighbor by a similar charge. If he could find a way to duplicate this charging of the microscopic matter, he might produce an effective facsimile of the Hunza water.

From careful observation, Flanagan found that vortices have a special cadence of their own. They shrink in diameter and extend in length at one moment, then expand in diameter and contract in length at the next, continuing this oscillation in a periodic manner just like a pendulum or the mainspring of a watch.

To easily view the separate parts of a vortex, Flanagan added a little glycerin to the water and poured it into a clear cylindrically-shaped vessel—similar to, but much smaller than, the BD 500 stirring vat—with a hole bored through the bottom from which



Vortex photographed underwater reveals the spiraling surface between the water and the air which is being sucked in. (Photo by Theodor Schwenk, *Sensitive Chaos*)

the water emerges in vortical form. When the shape of the container is altered, the closer its curvature comes to the ideal for sustaining a vortex, the smaller is the hole required. The perfect container, Flanagan found, was an egg-shaped ellipsoid whose length-to-width ratio was $1:\sqrt{2}$.

If a few drops of food coloring are added, the whole vortex appears to come alive. Not only can its rhythmic pulsation be observed, but layers of internal formative surfaces can be seen spinning much more rapidly than external ones, which themselves form corkscrew patterns reminiscent of the spirals inside conch shells or on the surface of various African antelope horns, all of which are built to scale on the basis of the Fibonacci series: 1,2,3,5,8,11...

In the vortical flows of water, says Flanagan, reside the secrets

of its great sensitivity to cosmic force and its power as a bearer of formative living processes.

"When you read Schwenk's book," said Flanagan, "you realize the organs of every living thing are parts of frozen vortices. Schwenk gives example after example of vortexial formative processes in nature and comes to the conclusion that the vortex formation is tuned to the warp and woof of the Universal matrix. This accords with ancient Vedic texts written millennia ago in the Indian subcontinent that indicate the shape of the Universe as ellipsoidal."

In a monumental ten-volume work, *Wave Theory: Discovery of the Cause of Gravitation*, published in 1943, T.J.J. See, an American professor of mathematics who in the 1930s was in charge of the twenty-six-inch Equatorial Telescope at the U.S. Naval Observatory in Washington, D.C., showed that the entire physical universe revolves around a geometric figure, known as a rectangular hyperbola, which also defines the curve of a water vortex. This basic curve, says Flanagan, was discovered by See to represent many phenomena, including the inverse-square law of electromagnetics; the laws of magnetism, gravity, and planetary motion; the temperature of the sun at any given point from the center outward; and—most important to the subject at hand—the surface to volume relationships and the structuring forces binding all matter.

When Wilhelm Reich, once considered by Sigmund Freud his most brilliant disciple, nevertheless broke with the psychoanalytic movement to make his momentous discovery of a life-energy, "orgone," related by some to Steiner's "chemical ether," he found it to be made of *Kreiselwelle*, or spiral waves. In his book *Cosmic Superimposition* Reich describes the creation of matter from the throat of cosmic vortices, such as nebulae.

In his laboratory, Flanagan demonstrates the cosmic properties of a vortex. Closer examination eerily reveals that the circulating water exactly follows the laws of planetary motion around the sun, such that, in its laws of movement, the vortex is a miniature copy of the solar system, and, on a larger scale, is reflected in the great stellar nebulae, as Reich already showed in *Cosmic Superimposition*.

Schwenk pointed to other properties of the vortex, suggesting cosmic connections. One such connection can be revealed by affixing a pointer, like a compass needle, to a wood chip. As it circles, the pointer always points in the direction in which it was originally aimed when the chip hit the water. Like the compass needle, it is constantly directed to a single point in infinite space. According to Schwenk, this is a clear indication of how a vortex is oriented as if it were held in place by mysterious cosmic threads.

Fascinated by Kolisko's experiments, which showed changes produced in crystallization of mineral salts by planetary transits, Flanagan realized the same cosmic energies could be captured in water undergoing turbulent chaotic movement or vortical flow, and—most important—that these energies would remain in the water after the flow ceased until the water was again agitated violently enough to disrupt them.

When the velocity of a vortex increases, the diameter of its throat gets smaller. In a perfect vortex, as the diameter approaches zero, the velocity approaches infinity. Because infinite velocity in the physical universe is impossible, something has to give. In the case of water, its molecules begin to dissociate into vapor, releasing electric charge. And here comes the first clue to what could be so mysteriously charging the Steinerian BD 500 with electric energy.

What happens, Flanagan explained, is that the hydrogen bonds of water molecules subjected to such stress are stretched like rubber bands; at which point they absorb planetary forces, which, as the molecule snaps back into shape are retained and energize the molecule. This goes a long way towards explaining Steiner's and Kolisko's planetary forces energizing the BD preps.

To find out just how much charge is generated by a vortex four inches in diameter, Flanagan lowered a thin specially shielded wire electrode into the center of its vortical throat, being careful not to allow the wire to touch the water. By means of another electrode touching the water he was able, when the vortex was moving at approximately one thousand revolutions per minute, to record a charge of more than ten thousand volts emitted from its swirling water; quite a boost from the cosmos.

As for the telluric forces that affect the BD preps while they are buried, in the 1930s an intrepid German physicist, Paul E. Dobler, showed that water moving in constricted underground passages radiates energy in what was then called an X-band of the electromagnetic spectrum, X because nobody then had the spectrometric equipment to differentiate any signal in this part of the infrared band of radiation. As set forth in the first of two books—most copies of which were destroyed by the Nazis—Dobler was able to demonstrate mysterious earth rays, such as are said to radiate from the Sedona vortices, by using a highly polished enameled aluminum plate inscribed with the words *Unterirdische Wasserader*, or "Underground Watercourse."

Combined with X-ray film and positioned on the surface of the ground where a vein of water was known to be flowing, the film became exposed to earth rays via the aluminum, and when de-

veloped gave a clear picture of the words "Underground Watercourse." Physicists repeated Dobler's experiment, but were so perplexed by the results they rejected them because "physics recognizes no such radiation."

Continuing to work on the problem of vortices, Flanagan found that the vessel best suited to contain a vortex was one designed as a mathematical complement to See's rectangular hyperbola: a type of ellipsoid. His device, called a *vortex tangential amplifier*, was put to work in 1983 to create what Flanagan describes as a "perfect vortex," allowing newly-formed colloids containing all the ingredients found in both human mother's milk and in fresh fruits and berries, to be fed into the vortex, where they became subjected to forces he says are creatable in no other way. These forces lower the surface tension of water treated with the colloidal mix—all the way down to an all-time low of 26 dynes per centimeter, the same as for ethyl alcohol.

"But very low tensions are not necessarily good," he explained, "in that when they get too low, they are far from equilibrium. Over a period of time they lose energy and revert to water with a normal surface tension. We found that if we produced a water with a tension of 38—lower than the 45 created by washing-machine detergents—it has a stability that could last for years, perhaps as long as a century."

Flanagan based his statement on the fact that colloidal chemistry has discovered that large-sized colloids tend to "bounce around" and lose their electric charge, but tiny ones retain a charge, called a *Zeta*-potential, that is optimally long-lasting.

Thomas Riddick, a pioneer colloid chemist who formed his own *Zeta*-Meter company in New York, says that the *Zeta*-potential is a basic law of nature; it plays a vital role in plant and animal life to maintain a discreteness among billions of circulating cells that nourish the organism. The whole human body is made up of colloids, and all its flows are based on electric attractions. Blood cells have a protective coating of albumen, which keeps them charged, stable, and uncoagulated. Wrong foods, says Flanagan, tend to destroy the electric charges on your blood cells, which then coagulate and get sluggish, eventually dying. But if you are able to take in highly charged colloids from fresh food—or from Hunza water—they help enhance the overall negative electric charge on the blood cells.

By adding one ounce of his newly-made colloidal mixture with its 38 surface tension to a gallon of distilled water, Flanagan has been able to create a product with a surface tension of 55 to 65 that he feels may have the same positive biological effects on living organisms as does the Hunza water.

Professor Kenneth Reed, head of the University of Minnesota's department of mineral engineering, examining the colloidal particles in Flanagan's water with an electron microscope found them to be "a hundred times more active and stronger than the particles in any known surfactant due to much greater dispersal capability in suspension."

To find out, he allowed his thirteen-year-old bitch, "Wishes," a 115-pound cross between a St. Bernard and a Great Dane, to drink nothing but "Hunza" water imbued with what he calls his "Crystal Energy Concentrate." Within just three weeks, the enfeebled dog, which previously had to be lifted over logs on the trail in the forest behind the house, was able to leap them by

herself. In Ohio, one of Flanagan's friends gave the treated water to a valuable thoroughbred stallion so old he could only get a live foal once in three breedings. Soon after being put on the water, the horse, whose coat went from dull to shiny, was impregnating all his mares without a miss. Given the same water, the mares also had such easy births that often the stable men would arrive to find newborn foals on their feet, though no signs of labor had been evident in their dams the previous evening. Race horses known as "bleeders"—because their lungs are so weak they emit blood from their nostrils as they run—showed no more bloodletting symptoms after a regime on Flanagan's water.

More important to humans, and especially to secretaries, authors, and all those obliged to face a computer terminal for hours on end, is the risk, according to specialist John Ott, of having their red blood corpuscles coagulate or clump into aggregated masses the French call rouleaux. Flanagan videotapes, taken through a microscope in his laboratory, show such masses disaggregating in a matter of minutes after ingestion of his water.

While these extraordinary biological results are as yet no more than empirical, strict "double-blind" tests not having yet been attempted, laboratory trials run in Minnesota proved incontrovertibly that Flanagan water has amazing structuring properties.

In this instance the test subject was neither animal nor human, but plain old cement or—mixed with other aggregates such as sand or gravel—concrete. Made with ordinary water, a block of cement, thoroughly dried, has a resistance, prior to cracking or sundering, of 8,400 pounds per square inch. Add only a thimbleful of Flanagan's water to each gallon and a half of ordinary water in the mixer, and the same cement has a resistance of 12,300 psi.

In another trial, called a *slump* test—basically a measure of air content in partially liquid cement—it was found that the normally "entrapped" air, which makes cement weaker, was only 30 percent compared to 70 percent with ordinary water. Remarkably, the treated cement contained less water: with greater plasticity or flow capacity it is also 30 percent *lighter* than the untreated and, because much *less acid*, less corrosive to steel embedded in concrete. It also does not burn the hands and arms of construction workers who use it in such jobs as stuccoing.

Flanagan says the electric charge on his colloids is so well protected they do not become unstable even if frozen, boiled, autoclaved, microwaved, irradiated by gamma rays, or immersed in powerful cationic electrolytes. He found this out after exposing them to such influences, by measuring their electrical charge in a U-shaped glass tube, a type of electrophoresis cell in which colloids, if overcharged positively or negatively, will migrate to

one of two poles.

Using this simple system, Flanagan established a direct relationship between *Zeta*-potential, surface tension, and the structuring effect on water.

When Flanagan viewed the Australian film on Podolinsky that shows the 500 stirring process, he at once saw the connection with his own research, and his explanation of what occurs is at last comprehensible in lay terms. "Steiner's idea that an energy enters the water each time the direction of stirring is reversed is right on the mark," said Patrick with excitement. "I, too, have run tests with reversing vortices but, in my case, I have an instrument that creates instantaneous reversal and I've measured the electromagnetic charges involved."

Flanagan further cleared up the mechanics of how the vortex is actually created. "What is first formed in the Australian BD stirring machine is not a true vortex, but a parabolic curve called a *paraboloid of rotation*. Actually an egg shape, it relates to Steiner's idea that eggs and other ovoid forms such as walnuts or pecans are receptacles for the life-energy suggested by Reich."

It is only when the machine stops and reverses, that, if one looks closely, the parabola is seen to collapse instantaneously, and only just preceding the onset of what Podolinsky calls "chaos" does it then form a perfect vortex.

"The wide deep center of the paraboloid collapses," said Flanagan. "It virtually *implodes* towards the center, at the time of reversal. It then creates for an instant a tiny vortex throat, which disappears into foam and chaos. It looks like chaos, but you must know that any time it's created in water, it's filled with millions and millions, if not billions, of small vortices. Also we have a certain amount of *energy* involved here, the energy of *revolution* rotating this tremendous fluid mass in one direction. When the direction abruptly reverses, where does that energy go? *It has to be absorbed into the hydrogen bonds* of the water and absorbed *onto the particles* of the 500, rendering them *colloidal*, and readily ingestible by both the microorganisms and the hungry single-celled root hairs of plants."

That Steiner was onto a phenomenon somehow familiar to peasants in the old country is clear from the testimony of Viktor Schauberger, a forester who spent a lifetime observing the behavior of water in virgin tracts of forest in his native Austria and also in Bavaria. In a biographical book on *Living Water*, Swedish author Olof Alexanderson includes Schauberger's description of how liquid vortices are associated with strange energy discharges such as halos, ball lightning, and a levitational force capable of bringing heavy egg-shaped stones up from the bottom of a stream to

its surface, where they float on top of the vortices. And *implosion* was the name given by Schauberger to the act of vortical collapse. It is the levitational energy, said Schauberger, that allows fish to leap over high waterfalls from the agitated pools formed by the cascading water below them. Schauberger was the first to refer to the creation in nature of *Edelwasser*, or "live water," the artificial production of which he effected in his laboratory with egg-shaped "vortex reaction chambers," also called "implosion chambers," because the energy developed within them was centripetal (acting toward a center) instead of centrifugal (acting away from a center). "Live water" is the name given by dowsers to the flowing water they detect in underground veins that emits the radiation discovered by Dobler not detectable by dowsers in water coursing through an ordinary pipe. Schauberger maintained that the implosive, centripetal energy was the basis for life, whereas its opposite was the cause of decay and destruction—patently exemplified by atomic explosions. His cosmological outlook insisted that all our technology should be harmonizing "going *with* the flow of Nature" rather than forcing actions contrary to natural motions.

Brought up, like Steiner, in the countryside, Schauberger took as much inspiration from the observations and practices of simple peasants as from the academically-schooled who hardly ever left the city.

In an essay, *Natural Farming*, he recounted a visit made to an old farmer whose harvests were superior to any in the region, but was considered a little touched in the head by everyone in the community.

"It happened one day, as darkness was coming on," wrote Schauberger, "that I came to the farmer's house. In the courtyard I met the somewhat unsympathetic son and inquired after his father. 'The old one is in the back of the house,' the young man answered with an unfriendly gesture. 'Shout loud enough and he will come.'"

Schauberger found the old father standing in front of a wooden barrel as large as three or four buckets, singing in a quaint voice. At the same time, he was stirring the contents of the barrel with a huge wooden spoon. It was not really a song he was singing, but rather a musical scale, rich in tone, ranging from falsetto to double bass. This the old man did as he bent over the barrel, singing loudly down into it. As he went up the scale, he rotated the spoon in an anti-clockwise motion. When his voice deepened, he changed the direction of the rotation of the spoon.

Schauberger says he thought to himself there had to be some reason for all this.

The farmer did not hear me coming, and after I had watched him for a considerable time, I was curious as to what he was stirring. Unnoticed, I came up to the barrel and glanced inside; there was nothing there except clear water. Eventually the old man noticed me, nodded in reply to my greeting, and continued to stir without pause.

My glance alternated between the farmer and the contents of the barrel. With a flick of his hand, he would throw bits of loamy soil into the barrel as he continued to stir the liquid first to the right and then to the left. At the same time he sang quite loudly and not altogether pleasantly into the open container. His stirring the water finished, the farmer loaded his barrel onto an ox-drawn cart and, proceeding into his fields, would dip a palm-frond into it and sprinkle the water accumulated on it onto the ground in very fine distillations, not unlike a priest who sprinkles water on his communicants. Eventually the water evaporated leaving exceedingly fine crystals which carried a negative charge. These crystals attracted rays from all directions and then gave them out again.

Schauberger noted that the farmer had, through trial and error, learned at what pitch his voice would set up a resonance with the shape of barrel that would stimulate the molecular vibration of its contents. The practice, called in German *Tonsingen*–"singing to clay"—was done at specific times, principally immediately after planting and firming of seed in the soil, at just this or that side of Eastertide.

When Flanagan read Schauberger's account he was so struck by the apparent similarity of the old peasant's stirring treatment of his water with a colloidal substance and the one shown in the Australian film that he wondered whether Rudolph Steiner, who was also raised in the Austrian countryside, might not have derived his knowledge from the same kind of Tonsinger—"clay-singer"—as the one described by Viktor Schauberger.

"It is also interesting," said Flanagan, "that the earth travels through space in a vortical manner. Like the other planets, it circles the sun at about thirty kilometers per second. Constantly and rectilinearly, it is also moving in space toward the constellation of Hercules at twenty kilometers per second. The combination of these two movements produces a helicoid trajectory, as beautifully shown by the Italian scientist Giorgio Piccardi, whose animated model revealing it was set up at the Brussels World's Fair in 1958."

A single calculation shows that the speed of the earth's spiral

trajectory reaches a maximum in March and a minimum in September, at approximately the time the cow horns are disinterred, depending on whether they are buried in the earth's Northern or Southern Hemisphere. Could this, Flanagan wondered, somehow be related to the energy-charging effect in the cow horns?

Flanagan further related the 500 stirring process to the work of the Russo-Belgian scientist Ilya Prigogine, author of *Order Out of Chaos*, who won a Nobel Prize for showing that, in a particular type of chemical reaction, chaotic forces in open systems create highly structured order. The kind of environment in which chaos leads to order is called "dissipative structure" which, as Flanagan points out, is characterized by any crystalline structure.

"The energy of chaos," says Flanagan, "transmitted into the water's liquid crystals, and absorbed by them, could only, *a la* Prigogine, destroy the crystalline structures or bring them into a higher state of order."

Steiner, with his vortex, his chaos, and his stirring, may well have been toying, knowingly or not, with the vortical and ellipsoidal sources of life.

Chapter 10

CLAWS OF CHELATION

Had the Great October Revolution never happened to transform "all the Russia" of the Tsars into the Union of Soviet Socialist Republics, Alex Podolinsky might never have made it to Australia, and Dr. Albert Schatz, a second-generation Russian-American, might never have made one of the most important discoveries about soil formation, the basis for which was laid by Russian science. Love for the dark earth of Mother Russia had seduced her scientists, both Sarasotan and Soviet, into a sensitive analysis of her constituent elements and functions, more intuitively delicate than the grossly venal approach of the West to its virginal prairies.

Born in Connecticut, just after World War I, Schatz spent his teenage years on a 140-acre farm acquired in Antic by his Russian grandfather, a former resident of the Jewish "pale" in Russia, who had never been allowed to own a single sod of its precious soil.

In a row house on a tree-canopied street in the Mount Airy section of Philadelphia, Schatz told us: "The land in Connecticut was marginal, even sub-marginal, but for my grandfather it was a real step up, the fulfillment of a dream, to finally own his own land and work in nature." Boyhood work on the Antic farm instilled in Schatz the urge to devote his life to agriculture. New Jersey's Rutgers University gave him a degree in soil chemistry, and a Ph.D. in soil microbiology.

"The Soils Department was unique," said Schatz, self-effacing yet intense. "It was under the direction of Jacob Lipman, a Russian-born professor who had immigrated to the United States and later became the Dean of the Rutgers College of Agriculture. The whole field of *pedology*, from the Greek *peon*: 'earth,' or 'soil science,'—now in disuse thanks to the proliferation of chemical fertilizers, was originated and developed in Sarasota Russia, beginning with Vassily Vassilyevich Dokuchayev, a seminarian turned geologist."

Albert Schatz, Ph.D., discovered the wonder drug streptomycin and developed the concept of chelation as a major chemical mechanism in the formation and fertility of soils.

Dokuchayev developed the singular view that soil was a "living body" as independently distinct in nature as any birch or oak tree, and of work that took him all over European Russia to study soils, laying the foundation for a science that differentiated between living and dead branches of nature. At the age of thirty-seven, Dokuchayev published *Russkii Chernozem*[1] (*The Black Soil of Russia*), the first extensive treatise on the incredibly productive soils of the Ukraine. Three years later, he put out another volume, illustrated with maps, the first to present the concept that soils can be classified by "geographic zones."

"Prior to Dokuchayev's research," said Schatz, "and unfortunately subsequent to it, soil was and is still largely viewed, from the geological angle, simply as the upper, weathered crust of the earth, or, due to its agricultural applications, solely as a medium

[1] The word chernozem, meaning "black earth" in Russian, has been incorporated into English and other world languages to describe humus-laden rich soils, also found in an estimated 560,000 square miles of land stretching from North Dakota to Texas and Minnesota to Oklahoma.

for plant growth, as something in which a plant takes root."

Dokuchayev's follower, Konstantin Dmitrievich Glinka, (related to the opera composer) extended the scope of his master's work with his massive *The Great Soil Groups of the World and Their Development*. Translated into German in 1914, it had a profound influence on the penetration of Dokuchayev's views into Western Europe. Glinka's election to the presidency of the new International Society of Soil Science in 1927 led to the book's translation into English by a Missourian, Curtis F. Marbut, head of the U.S. Department of Agriculture's Division of Soil Survey, who was so impressed with Glinkathat he taught himself Russian at age seventy to become acquainted firsthand with the literature of the expanding "Dokuchayev school," mastering the language well enough to converse with Glinka and his fellow Russians in their native tongue. A year before his death, Marbut wrote an introduction to Joffe's seminal book *Pedology*, published in 1936,[2] which made use of hundreds of Russian articles scattered in dozens of journals, wherein he recommended that all American agriculturists familiarize themselves with at least the broad lines of the Russian development of the science.

"The Russian work," wrote Joffe, "brought the study of soils out of the chaos and confusion of the geologic, agronomic and chemical (Liebig) points of view. For the first time, it plainly showed that soil is not just physical but is intimately related to the biological bodies within it"—the myriads of insects, worms, bacteria and fungi that give the soil its life, and vice versa.

Marbut stressed that, at the time when Western Europe was still engaged in the futile assertion that soil *per se* is dominated by the materials out of which it has been built, the Russian workers had long since shown that soil is the product of a process rather than of material, and is, therefore, not a static, but a developing body. They allied soil to *life* rather than to *death*. In Marbut's view, Dokuchayev occupies the same position in soil studies as Sir Charles Lyell in geology, Lyons in botany, and Mendeleyev in organizing chemical elements into his famous Periodic Chart.

Marbut lamented the fact that soils in the United States were looked upon solely as producers of crops, and no discussion of soil development worthy of the name was attempted in any book dealing with their study. The treatment of soils as such is not considered "practical," but the subject must be made practical at all hazards. It is outrageous that the whole field of the significance of the soil as a body in plant production remains wholly

[2] Revised and greatly expanded in 1949.

uncultivated because of the dominance, even in the third decade of the century, of the ideas of Justice von Liebig that completely overlook the fact that the soil lies in the twilight of life, as a connecting link between the living and the non-living, between material animated by vital forces and material subjected to physical forces.

Schatz, who had learned to speak Russian at his grandfather's knee, and could read the language, said this advantage was the one that led him into pedology. "I call myself a pedologist in tribute to my Russian teachers because people who say they are 'soil scientists' these days are largely taken up, not with pedology as such, but with the unnatural effects of chemical fertilizers as they apply to plant growth. And soil science here is concerned with, and equated to, agronomy, which focuses on the large-scale production of field crops such as grains, and others. My perspective has always been inspired by the original Russian definition."Asked how many true pedologists were still teaching the Russian-birthed science in ag-colleges, Schatz grimly replied: "Hardly a one, largely because it is seen not to 'pay off.' It is considered unpractically academic."

In 1966, Schatz was invited to write an article for *Compost Science*, published by the Rudely Press in Ems, Pennsylvania, to explain why soil research, subsidized almost completely by the U.S. fertilizer industry, was leading to a decreasing interest in humus and soil organic matter in the United States to the point of near extinction.

The central problem, to Schatz, was that the grants to colleges of agriculture provide continual financial support to an army of graduate students while at the same time their professors are raking off thousands of dollars as consultants to the same fertilizer moguls who are supporting the students' research.

The research problems pursued are predominantly those from which the fertilizer companies can make more profit, while the indoctrinated graduate students go on to work along the same lines after receiving their degrees, and those receiving teaching appointments train new students in the same chemically-oriented philosophy.

"Thus," wrote Schatz, "with each passing generation, humus and soil organic matter become more and more abstract textbook topics which gradually lose their identity as real objects of vital interest. This decreasing attention dramatically illustrates how private and selfish economic interest can distortedly influence the direction of scientific research in a major discipline."

The neglect resulted in a corresponding decline in *soil microbiology*. Chairmen of soils departments at many universities complained to Schatz that they could find no young soil microbiologist to teach the subject, and had been unable to offer a course for several years. Graduates originally trained in the discipline were herd-mindedly rushing to accept lucrative appointments in pharmaceutical, fermentation, and fertilizer industries, where financial remuneration was steeply higher than in university faculties. All of which echoed Alex Podolinsky's complaint that any presentation of soil science, of whatever stamp, has been all but dropped from the curricula of Australia's agricultural learning centers.

In eastern Europe, on the other hand, scientists, while pursuing investigations on chemical fertilizers, insecticides, and weedkillers, have not abandoned research into the organic content of the soil. In 1961, a collection of long essays, *Soil Organic Matter: Its Nature, and its Role in Soil Formation and in Soil Fertility*, was edited by M.M. Kononova, a member of the U.S.S.R. Academy of Sciences and a senior researcher at the Dokuchayev Soil Institute. It was made available in English by the Pergamon Press in London. Three years later, an illustrated book, *Humus and its Significance*, authored by S. Prat, was published by the Czechoslovak Academy of Sciences in Prague; it presented a complete history of humus research as it applies both to the natural and artificial fertility of soils. It went into detail on the definition, classification and characteristics of all humus substances, their transformation under natural conditions, and their physiological effects on germination, morphology, anatomy, chemical composition, photosynthesis, assimilation, respiration, nutrition, specific enzyme systems, plant growth, and general development, as all these pertain both to algae and higher plants.

"But even in its Russian heartland," Schatz complained, "this important humus research could not significantly influence the turn-around from Liebig-style artificial agriculture, so deeply entrenched in the Soviet and East European Ministry of Agriculture thinking."

Drafted at age twenty-two into the U.S. Army, Schatz worked in Florida military hospitals where he collected microorganisms in the state's soils and swamps, and the oceans off its coastlines, to test them for antibiotic properties. At Rutgers, as the only researcher who dared to come personally in contact with the tuberculosis bacillus, he went on, alone, in a basement laboratory, to isolate and patent a non-toxic antibiotic which he called *streptomycin*—because its spores appear in chains, *strepto* being the Greek for "twisted," and mykae for "fungi."

Possessed of an unusually broad antibacterial spectrum, and

effective against tuberculosis, it surprisingly came from two independent strains of bacteria, one taken from cultured field soil, the other from the throat of a chicken, thus revealing the power of a family of microbes to exist in the earth itself as well as in creatures walking upon it. The discovery of this life-saving drug, made by a twenty-three-year-old student earning only $40 a week, was awarded the Nobel Prize. The recipient, however, was not Schatz but his professor, who co-authored the patent.

Unabashed by such injustice, Schatz's curiosity was next attracted to the problem of what exactly was happening chemically in the formation of soil as rock is disintegrated into smaller and smaller particles.

The question that puzzled Schatz was: how was it that lower forms of plant life, such as lichens, growing on bare rock, could penetrate into minute fractures in search of foothold and food?

A solution of the problem of how the obvious rock-weathering properties of lichens actually work seemed to Schatz to have important practical implications in agriculture, especially as it related to the total amount of minerals in soil on the one hand, and their availability on the other.

In 1924, E.J. Fry had suggested, in the *Annals of Botany*, a purely mechanical explanation for the action of lichens. And even in the 1950s the potential role of lichens in soil formation was subject to doubt by American soil specialists, two of whom concluded that the evidence for their importance was "exaggerated." They were, however, completely unaware, as Schatz was not, of important work by Soviet scientists on the pedogenic role of lichens. Russian studies indicated that though soils were essentially products of climate—of sun, wind, and ice—microbes and plants also contributed, like heat and frost, to the "weathering" of rocks not only by penetrating deep into cracks and crevices to exert tremendous splitting pressures with their expanding cells, but, more importantly, by disintegrating rock through a mysterious chemical action known as "chelation."

Taken from the Greek word *chela*, meaning "claw" or "pincer," it is the property that allows the formation of a ring-shaped chemical structure, based on six carbon atoms, that enables lichens to literally clamp onto atoms of metals, free floating in the soil. The ensuing more-complex compounds thus created can then be absorbed by the lichen; once within their bodies, the metals are released to serve whatever function is required. The chemical explanation for this canny phenomenon is that in chelation one or more electrons can be shared between two elements, dragging the metals along to be released as the compound is dissolved within the plant.

Chelating substances, present in up to 36 percent of the dry weight of lichens, give them the power to dissolve iron and other metallic minerals, grab them and suck them up in order to feast directly on the hard bare rock.[3]

In 1954, Schatz published in the *Proceedings of the Pennsylvania Academy of Sciences* the first of a series of papers: "Chelation as a Biological Weathering Factor in Pedogenesis." As he continued to work on the problem, it came to him that if the chelating process could explain the predisposition of lichens to dine on no more appetizing a menu than a rock surface, could it not also importantly be involved in the creation of soil fertility? Were the plants not creating soil just as the soil created plants? And was soil formation not an on-going process that *maintained* fertility?

"It was when I found out how lichens were chelating rock to extract minerals," said Schatz, "that I said to myself that something in the soil had to be working in the same way to keep on forming it from solid rock. One couldn't think that just a certain amount of weathering produces soil, after which the rest of the minerals remain intact in it forevermore. It had to be a case of a *continuing* chemical weathering process, which *continually* released minerals for plant growth, as well as the very basis for natural soil fertility. It was then that I concluded that there had to be a chelating agent in humus."

The clue—or claw—with which to unravel the mysterious mechanism of chelation came to Schatz when he ran across an article published 160 years ago in a Boston newspaper, *The New England Farmer*. It was the amazing story of a traveler to the ruins of the celebrated Temple of the Sun, in the high Andean town of Cuzco, Peru, who reported finding stones so finely cut and grooved he could not insert a needle between them. The art behind this feat of masonry had been lost with the demise of the Incas, who were said to have used the juice of a certain herb to soften stones prior to their emplacement. Schatz immediately saw a possible connection between this lost art of masonry and the power of chelation. Delving into the literature on the civilization of the ancient Andean Incan population, he became aware of that people's finely experienced agricultural knowledge, perhaps the world's

[3] Lichens, marvelously resistant to both heat and cold, considered by many as the biblical "manna" of the Israelites, and eaten with relish in both Japan and China, were of unusual interest in that their thalli—or vegetative bodies which, unlike leaves, stems or roots, lack differentiation and do not grow from an apical point—are compositely made up of interdependently growing blue-green algae and filaments of higher fungi. Here is a truly remarkable symbiotic relationship between two members of quite different species. Algae, which contain chlorophyll, range from microscopic unicellular plants to giant sea kelp a hundred feet long. Fungi, which also run from microscopic entities to twenty-pound puffball

most sophisticated, then or since, as dramatically reported in *Lost City of the Incas*, by Hiram Bingham (later a U.S. Senator), who discovered the Inca city of Machu Picchu, one of the sites where Coanda found the natives' water enabled them to live as long and healthy lives as the Hunza.

> To the Incas [wrote Bingham] the art of agriculture was of supreme interest. They carried it to a remarkable extreme, attaching more importance to it than we do today. They not only developed many different plants for food and medicinal purposes, but they understood thoroughly the cultivation of the soil, the art of proper drainage, correct methods of irrigation, land soil conservation by means of terraces constructed at great expense of labor. Most of the agricultural fields in the Peruvian Andes are not natural. The soil has been assembled, put in place artificially, and still remains fertile after centuries of use.

Bingham considered Cuzco, the ancient capital of the Empire of the Incas, one of the most interesting places in the world. In the days of the Spanish conquest of Peru it was the largest city in America. On a hill back of the city stands an old fortress, whose northern wall is perhaps the most extraordinary structure built by ancient man in the Western Hemisphere. Wrote Bingham:

> As an achievement in engineering it stands without parallel in American antiquity. The smaller blocks in the wall weigh 10 or 20 tons. Larger blocks are estimated to weigh 200 tons. A few of the largest weigh 300 tons! And yet they are fitted accurately together. The gigantic polygonal blocks cling so closely together that it is impossible to insert the point of a knife between them. The whole thing staggers the imagination.

Schatz's reading of Bingham convinced him that people who could develop an agriculture revealing an innate knowledge of the importance of organic material for soil health—which has nowhere been resurrected since its destruction at the hands of Spanish conquistadors—could equally well have discovered the use of organic chelating material as it applied to stonework that made them into construction engineers of rare ingenuity, skill,

mushrooms, are now classed as neither plant nor animal, in a category of their own. One member of this "odd couple," the alga, supplies carbohydrates through photosynthesis; the other, the fungus, supplies water storage and chemical salts. Alone on rock neither member could survive. It is also generally accepted that, to break down rock, lichens use acids secreted by filamentous threads making up the bulk of the thalli, which are often submerged in soil or organic matter, the tissues of plants, or rocks. These acids are deposited on the outside of the thread cells as minute yellow, orange, red, or colorless specks.

and competence.

Why couldn't the Incas, he asked himself, have used the principle of chelation to soften stone to the point where, like mortar, it could be leveled to requisite shape or flatness? Another clue to this possibility was presented when he came across the Inca tale of a tiny bird, the pito, living high in the Andes, that used the juice of a plant to dissolve niches in hard rock as nesting places.

A nineteenth-century English explorer, P.M. Fawcett, who disappeared without trace in the Amazon jungle, left an account of how the birds themselves made the holes. A native who spent a quarter of a century in the mountains told him that the birds, arriving at a selected spot with a certain species of leaves in their bills, fastened themselves to the rock, like woodpeckers on a tree, and rubbed the leaves in a circular motion, constantly flying away for more leaves with which to continue the process. After three or four repetitions, the birds discarded the leaves and began to peck at the rock, quickly forming a circular depression. The process took only a few days, at the end of which the holes were sufficiently large to serve as nests.

"I have climbed up to see the nests," said the native, "and, believe me, a man couldn't drill them more perfectly. The birds don't peck away the solid rock with their beaks. Whoever has watched them at their work can see that these birds know about a leaf which has juice that softens the rock and leaves it like wet clay."

At first, Fawcett accepted the native's description only as a "fanciful tale," but when many others all over the country offered similar accounts, he began to wonder whether it could be true. Finally an Englishman, about whose veracity Fawcett had not the slightest doubt, told him a story that clinched his belief in the original tale.

> My cousin was in the region of Chuncho [said the Briton] "near the Pyrene River in Peru. His horse became lame, so he dismounted and took a short cut through part of the jungle where he had never penetrated before. He was wearing riding pants, high boots, and spurs, not the English kind but those large Mexican ones four inches long with center discs as large as a half crown, and these spurs were practically new. When he arrived at his neighbor's farm, after a hot and difficult climb through tangled thickets, he was astonished to discover that his beautiful spurs had been destroyed, eroded in some manner and reduced to black nails one-eighth of an inch long. He couldn't understand what had happened until the owner of the neighboring farm asked him if he had walked over certain plants about one foot high and with dark red leaves. "This," said his neighbor, "is what corroded your spurs; it is the sub-

stance which the Incas used to work their rocks because the juice of that plant softened their rocks and converted them into a paste."

At last it was clear to Schatz that lichens produce and exude a chelating chemical that enables them to soften and seize from raw rock the elements they need to survive. When he included this story in his *Teaching Science with Soil*,[4] a delightful handbook for high-school students, which describes many simple experiments to demonstrate visually what is happening in the earth, Schatz learned from a correspondent in Chile, where he had taught at the University of Santiago, that the Chilean newspaper, *Mercurio*, reported that a Peruvian priest, Jorge Lira, in one of a series of archaeological expeditions carried out over forty years, had finally found a plant which the Incas could have used to soften rocks. Two more years went by before Schatz could locate Father Lira, who sent him a letter from Cuzco to say the plant's name was *harakkeh'ama* in Quechua, the Incan language still so widely spoken by many Andean Indians that Radio Moscow includes it in the several dozen languages broadcasting Soviet propaganda.

The remarkable ability of a plant to disintegrate iron is not surprising, according to Schatz, in light of 1964-68 research proving that chemical constituents of plants can attack even the hardest steel at a surprisingly rapid rate, as seen in the dulling and blunting of steel cutting tools in the lumber industry. These chemical compounds, also present in humus and various forms of composted organic matter, are among the substances that react upon minerals and rock particles in the soil, converting iron, manganese, copper, zinc, and other metals into water-soluble complexes, thereby making the trace elements available to plants.

Consequently, one of the most—perhaps *the* most—important properties of well-composted material, says Schatz, is its ability to react on soil minerals, just as lichens react on rocks. The compounds in the now rare Andean plant reveal clearly how soil organic matter solubilizes soil minerals.

It can be shown in a simple experiment that chelating acids are also excreted by many bacteria, which equally dissolve minerals in soil. It is their ability, with acids like those excreted by lichens, to put minerals into a colloidal solution that makes them especially important to the creation of soil fertility because plants can use such minerals *only* when they are chelated.

Knowing that bacteria are sparsely, if at all, present in dying soils, Schatz wondered which other chemical compounds might

[4] A companion volume, *Teaching Science with Garbage*, appeared a year earlier.

play the metal-grabbing and metal-releasing role comparable to that played in the much simpler lichen-rock association. More specifically, which chelating-effective compounds would be present in the soil, in *quantity*. After several years of detailed study of the analysis of its chemical structure—performed mostly in Russia and Eastern Europe—Schatz found that only *humus* filled the bill.

Schatz also found that his quest was a lonely one in that no fund-granting institution responded favorably to his requests for support. The only interest shown in his work was that of the Kearny Foundation, which offered him a lectureship in soil science that allowed him to present his material orally to various academic audiences.

At the University of California's College of Agriculture, Schatz gave a lecture on "The Importance of Metal-Binding Phenomena in the Chemistry and Microbiology of the Soil," in which he presented all his own experimental results. But when he found, to his amazement, that no U.S. agricultural journal would publish his lecture, he was saved by an Indian publication in New Delhi, *Advancing Frontiers of Plant Sciences*, which accepted it in 1963.

"No one in the United States seemed to care about the subject," said Schatz, "though it is vitally connected with health, not only that of plants, but our own. The difference between soil richly endowed with humus and one deprived of it is the difference between a well-nourished citizen in a developed country and a man suffering from starvation in the Third World. Just as the poorly fed soil will produce weak plants so the poorly nourished Third World native will produce sickly children."

Chelation goes on not only in the soil and in microbes but in the cells of plants and in the bodies of animals and humans. How closely plants and humans are related can be explained by the extraordinary fact that both depend on a chelating chemical compound basic to their physiology. In man it is red-pigmented *heme* that transports in the blood the oxygen liberated by plants, which themselves have a compound, green-colored *chlorophyll*, that is so similar to heme that, to depict its chemical formula, it is necessary only to substitute an iron atom for one of magnesium. "It is one of nature's miracles," says Schatz, "that it could so simply modify a key life-compound, one way for animals, and another way for plants."

Asked why the feeder roots of plants prefer the humus packed in a below-ground open jar to the soil around it, as demonstrated in Podolinsky's experiment, Schatz replied: "First, because the trace minerals prized by plants are more readily available in humus since it has already acted as a chelating agent to solubilize

them. Secondly, the far greater microbial activity in the jar breaks down the humus itself so that the roots can absorb the organic products coming out of it."

With respect to the colloidal nature of humus and compost, Schatz pointed out that the whole of humus is not made of colloid substances but only that part which is chemically constituted to act as a *chelate*. The reason colloids remain in a liquid suspension, he added, is that their surface-to-mass ratio is enormous. To illustrate his point, Schatz put a large wad of ordinary steel wool in a tinned coffee can and applied a match to it. The wool exploded into a white-hot flame. "If you try to ignite an iron nail with a match," he said, "nothing happens. But if you convert the iron in it to very fine steel wool, the surface-to-mass ratio, as in colloids, becomes very large. If you weigh the wool before and after burning you'll find the weight has increased because the final product is no longer just the iron, but iron plus oxygen, or iron oxide. The same thing happens with an iron nail if you allow it to rust in water, the difference being that in the burning of steel wool the oxidation effects are far more rapid.

"To relate this to the *chelating* and *colloidal* properties of humus means that their combination brings about a faster and greater chemical effect than if they were both not acting in conjunction. Nutritionally speaking, whereas a pig, or human being, can't eat a nail, it can easily ingest chelated iron."

Thus Schatz provided for his students a series of seemingly separate links, including studies of chlorophyll, blood, lichens, humus, Incan masonry, the *pito* bird, and a plant called *harakkeh'ama*. Forged into a chain they help disclose the chemical secrets of creation of soil and humus, from which all of life derives. But what the motivating forces might be behind this miraculous process of chelation remained a mystery. What was it that was moving the atoms of elements to put out claws with which to grasp another element? Science, even with its most sophisticated instruments, for the moment, could probe no further. Some finer form of vision was required. Hence Rudolf Steiner's clairvoyant gift, with which he was able to depict extraordinary cosmic formative forces at play and at work in the soil: forces that could motivate elements to search out and bond to each other by putting out claws of chelation.

Details of Steiner's background and of his development of the Anthroposophical Society, to whose members he gave his famous lectures on agriculture in the summer of 1924, can be found in the appendix to this volume, along with some of Steiner's more arcane explanations of what is actually occurring.

Chapter 11

Sonic Bloom

Plants, says Steiner, can only be understood when considered in connection with all that is circling, weaving, and living around them.

In spring and autumn, when swallows produce vibrations as they flock in a body of air, causing currents with their wing beats, these and birdsongs, says Steiner, have a powerful effect on the flowering and fruiting of plants. Remove the winged creatures, he warns, and there would be a stunting of vegetation. His point was well made for us in Florida.

A bird's-eye view across country south and east of La Belle, midway between the great Lake Okeechobee and Sanibel Island, reveals an ocean of citrus orchards cut by a skein of dusty "sea-lanes," extending for miles towards the shores of the Gulf of Mexico, once a paradise for seashell hunters.

Any bird overflying this greensward in the mid 1980s would have been perplexed by the lack of avian fellows among millions of orange trees growing in the confines of Gerber Grove, saturated by a fog of chemicals laid down to ward off swarms of insects—except in Section I. There a multitude of feathered fauna darted among the trees or perched singing in their branches.

To this oasis, the birds had been attracted, not by a natural concert of their colleagues, but by a sonic diapason closely resembling birdsongs, which to human ears—incapable of distinguishing its varied harmonics—recalls the chirping of a chorus of

outsized crickets.

This sonic symphony was being emitted from a series of black loud-speaker boxes set atop twenty-foot poles, each resounding over an oval of about forty acres. Its purpose was not so much to attract birds as to increase the size and total yield of a crop of fruit, "hung," as they say in Florida parlance, on trees as if it were a collection of decorative balls at Yuletide.

"I have hung oranges the size of peas, shooter marbles, golf balls, and tennis balls, some still green, others fully ripe, all on the same tree, all at the same time," said Roy McClurg, a former Union City, Indiana, department-store magnate, part owner of the Gerber Grove.

We had driven down at dawn to his 320-acre holding where two young field hands, brothers-in-law, each with a tractor and a trailer tank of foliar feed had started off between two long rows of trees, dousing them with an aerosol mist from top to bottom while a speaker, similar to the ones on the poles, tuned to maximum volume, shrieked a whistling pulse easily audible above the roar of the tractor motors.

Pointing to one of his many trees, McClurg raised his voice: "This is the typical fruit I'm getting with this brand-new method called Sonic Bloom. It synchronously combines a spraying of the leaves of any plants, from tiny sprouts to mature trees, with a broadcast of that special sound. With that process, simple but scientifically unexplained, I've been able for the first time to get fruit all over the inner branches of my orange trees, greatly adding to the 'umbrella'-type set which is everywhere the norm. And that's not all. I want to show you something far more impressive, even fantastic." On a portion of McClurg's plantation three immature trees with more than half their branches withered or dead were being treated with a solution similar to the one in the trailer tanks, but delivered from plastic bags via tubes and needles punctured into the bark just above the ground.

"What you're looking at," said McClurg, "are three specimens afflicted with a mysterious disease called 'Young Tree Decline' or YTD. It has taken out at least one of every ten citrus trees in groves all over the state of Florida, which has spent more than $50 million, so far in vain, to try to come up with a cure."

Closer inspection of the sickly trees showed them, after only ten days of treatment, to be putting forth a host of brand new sprouts all over their limbs, sure proof that their root systems, known to have been withering and sloughing root hairs, was recovering.

"YTD trees such as these," explained McClurg, "sicken at between eight to ten years of age, before they've begun to bear. It's as if a disease were striking young children. A healthy orange tree, like a human, can live up to eighty or ninety years. Most incredible, as you can see, these little trees are also beginning to put out a heavy bloom, trying to repropagate."

Back in his pleasantly refurbished clapboard house, oldest in the county, McClurg took from his refrigerator a dozen oranges the size of small grapefruit. "These were picked at my grove yesterday," he explained. "Ordinarily oranges as big as these would be pithy and woody inside, with very little juice." Slicing four of them with a razor-sharp butcher's cleaver, McClurg held up several of the hemispheres dripping with juice to show off rinds no thicker than an eighth of an inch. An electric juicer processed three of them to nearly fill a pint-sized glass.

"Oranges like these," said McClurg, "will give me a crop with at least a 30 percent increase in yield and a marked rise in 'pounds solid.' Add to that the fact that the Garvey Center for the Improvement of Human Functioning, a medically-pioneering research group in Wichita, Kansas, has tested the juice to show an increase of 121 percent in natural vitamin C over normal oranges, and you can understand that this new 'Sonic Bloom' discovery we're talking about not only improves quantity, but also quality. I've run blindfolded tests with scores of ordinary people who have compared the taste of my juice with that of oranges from many other groves, and they all selected mine as the most lip-smackingly superior."

While McClurg was happily harvesting his oranges, Harold Aungst, a dairy farmer milking a two-hundred-head herd of Holsteins in McVeytown, Pennsylvania, was equally happily applying the Sonic Bloom method to a hundred-acre field of alfalfa, the deep-rooted leguminous plant grown for hay, brought to Spain in the eighth century by invading Moors and since spread to create agricultural wealth all over the world. Nor did his animals have any difficulty distinguishing the high-quality fodder sprayed with Sonic Bloom.

That year Aungst took off five cuttings, one shoulder-high and so thick he had to gear his tractor down to low-low to pull his cutter through it. With this harvest Aungst won the Pennsylvania State five-acre alfalfa-growing contest over ninety-three other contestants by producing an unheard of 7.6 tons per acre as against a state average of 3.3 tons.

To dairyman Aungst, the size of his harvest was not its most important characteristic. Hay from this alfalfa fed to his herd that winter allowed the cows to step up milk production from 6,800 to 7,300 pounds per hundred-weight of cow, yet eat one quarter less feed. "I could hardly believe it," said the peppery Aungst,

third-generation owner of his property. "My cows were devouring the alfalfa, stems and all. Other years they'd leave the stems just lay. A cow's nose is the very best barometer to tell how good your crop is. Cows are really finicky about what they eat. I threw down hay from another of my fields alongside this record-breaking alfalfa and the cattle first went for the feed exposed to that funny sound every time, changing over to the other only when the good stuff was all gone."

In the cellar of his house, Aungst showed us two dried alfalfa plants, one from his farm, another from his neighbor's. The Sonic Bloom specimen, twice as long as the other, was much greener and had a far thicker root mass.

"Let me show you something," said Aungst, holding the neighbor's plant by its root and flailing it against a bare table until the top was littered with dry leaves. Sweeping them off with his hand, Aungst slapped the Sonic Bloom plant down against the surface. Hardly a leaf fell off.

"There!" he said, speaking emphatically. "That should tell you something about the inherent quality of those two plants. When you have to move or ship the Sonic Bloom hay, it doesn't lose a lot of its bulk the way the other does."

One clue for the cows' preference was a test run on protein analysis by an "infrared scanner" at the Pennsylvania State University "Ag-Days" exhibition and fair. Aungst's sound-exposed hay scored a record 29 percent for protein and an extremely high 80 percent for "Total Digestible Nutrients" (TDNs). At the fair the same test showed similar percentages for Aungst's soybeans.

Across the United States in the Tiwa Indian pueblo of San Juan, New Mexico, twenty minutes drive northwest of Santa Fe, the highly alkaline desert soils composed of playa clay called *adobe*, best suited when mixed with straw to make cheap building blocks for houses, can be as hard-packed and impenetrable as a New York sidewalk. Yet a garden under the ministration of the same aurally-spiced nutrition as used in McVeytown and in Florida was growing as if in Eden.

Alongside more than fifty kinds of herbs, vegetables were flourishing, including tomatoes and carrots never before grown in that arid region at the confluence of the Chama and Rio Grande rivers.

To Gabriel Howearth, a bearded, pony-tailed master gardener employed by the tribe, veteran of several years' work with Maya Indian farmers in Mexico's Yucatan peninsula, Sonic Bloom was as miraculous in its results as was the Mayas' ability to grow crops with no chemical additives by simply mentally communicating with them in some mysteriously hermetic way long part of their ethos.

"As you can see," said Gabriel, parting the purplish-green leaves of a German beet to cup his hands around the top hemisphere of a swollen mauve-maroon root much larger than a softball, "I can't get my hands completely around it. All these beets, which normally scale off at no more than four pounds will weigh at least nine, possibly ten."

With the steely determination of a conquistador overlaid by the gentle traits of Comanche, Howearth uprooted the giant and sliced it open with his Mexican machete. Like McClurg's oranges it had no spongy core. "Pure beet throughout," said Howearth. "Shows every sign of overwintering well. One of these will last a pueblo family a whole week."

He was also growing *quino*, a favorite grain of the Aztecs, and *amaranth*, the prized staple of the Incas, both richer in the amino acids necessary to a body than any temperate-climate cereal. With Sonic Bloom, he had achieved a crop of both grains many times larger than any brought in by the Costa Rican *Centro de Agricultura Tropical y Ensenaza*, which had pioneered their cultivation at lower altitudes for over a decade and a half. "The remarkable thing about these crops," said Gabriel, "is their ability under this special treatment to adapt to altitudes much lower than those of their native climes. Like the beets and the rest of the herbs and vegetables, they're in fine balance. With this Sonic Bloom our sorry soils seem to be 'alchemized' into getting softer through the plants' transferring nutrients into the ground itself. You can test this by smelling, even tasting, the soil, feeling the 'crumb' of its structure, and noting how earthworms proliferate in it."

One of the pueblo administrators scuffed the earth with his boot and said wonderingly: "I can't imagine what would happen if poor people like myself, working with bad soils all over the world, were widely afforded this remarkable method. It could help them grow a great part of everything they need to support their families, and on just a tiny plot of land."

Halfway up the vast arc that connects New Mexico to Pennsylvania, customers at the St. Paul Farmers Market were meanwhile raving about the taste of tomatoes, cucumbers, sweet corn, zucchini, squash, and other vegetables grown with Sonic Bloom displayed there every Friday afternoon and Saturday morning. As one older buyer put it, as if speaking for the rest, "This produce tastes like it used to taste when I was a boy!"

The vegetables had been trucked to a special booth by William Krantz, a former successful Twin Cities stockbroker, sick of the financial rat race, who had bought a plot of ground in River Falls,

Dr. Webster with the tallest sweet corn on record (*sixteen feet high*), grown with Sonic Bloom.

Wisconsin, on the left bank of the St. Croix River, separating the state from Minnesota. On his two-acre vegetable plot, not much larger than those to which the Tiwa Indian had referred, Kranz saw cherry tomatoes, less than four feet tall, each bearing six hundred to eight hundred fruits per plant, *Cucumis sativa* vines sprouting three to six cucumbers at each leaf node instead of the normal one or two, sweet corn growing three stalks, each with two to three ears, all from a single grain. In one corner, a lone viny plant occupied nine square yards of ground, mothering in

the autumn sunshine thirteen huge saffron-colored pumpkins.

All of this produce had been treated with the same method used by McClurg, Aungst, and Howearth, obviating the need for any artificial fertilizer; it cost no more than $50 per acre to spray with Sonic Bloom. The same treatment has been experimentally applied to crops ranging from potatoes, broccoli, cauliflower, carrots, wheat, barley, and soybeans, to such exotic tropical ones as papayas, mangoes, avocados and macadamias, in all fifty states, with results as startlingly impressive as those obtained in La Belle, McVeytown, San Juan Pueblo, and Three Rivers.

The idea was seeded in the mind of its developer one bitter cold winter day in 1960 in the Demilitarized Zone between North and South Korea. Dan Carlson, a young Minnesotan recruit serving with the U.S. Army motor pool, happened to see a young Korean mother deliberately crush the legs of her four-year-old child beneath the back wheel of a reversing two-ton GMC truck. Tearfully the woman explained in distraught and incoherent English that, with two more children starving at home, only by crippling her oldest boy could she beg enough food in the city to feed her entire family.

There and then, Carlson decided he would single-mindedly devote the rest of his life to finding an innovative and cheaper way to grow food, accessible to anyone with even the smallest and poorest plot of land. Back home in Minnesota, he enrolled in the University's Experimental College. Like David Vetter at Ohio, he was allowed to design his own curriculum and reading program in horticulture and agriculture.

Soon he concluded that in poor soils, if plants could be appropriately fed, not through their roots, but through their leaves via the minute mouth like openings called *stomata*—which plants constantly use to exchange gaseous aerosols and mists with the surrounding atmosphere—they might flourish and even grow rapidly in soils that were acidulous, alkalinely salty, arid, desert, or otherwise deprived of balanced nutrients.

But some motive force, he soon realized, was needed to awaken the stomata to action. Puzzling as to what this might be, Carlson stumbled on a record called "Growing Plants Successfully in the Home" devised by George Milstein, a retired dental surgeon who had won prizes for growing colorful bromeliads, members of an extended plant family as diverse as the pineapple and Spanish moss. Milstein's innovative idea had been to get a recording company, Pip Records, to amalgamate into a popular tune the pure sound frequencies broadcast by University of Ottawa researchers to increase wheat yields, which he had read about in *The Secret Life of Plants*.

Picking up where Milstein left off, Carlson focused on finding frequencies that would motivate the stomata to open and imbibe. Though he did not at first suspect a tie with the sound that caused the birds to flock to McClurg's orange grove, he managed through a stroke of spiritual insight to hit upon a combination of frequencies and harmonics exactly accordant with the predawn bird concerts that continue past sun-up into morning.

Carlson enlisted the technical expertise of a Minneapolis music teacher, Michael Holtz to help create a new cassette tape of popular music into which his nonmusical sonics could be imbedded for inclusion in a Sonic Bloom home kit for use in small backyard gardens and greenhouses, and on indoor plants. Within seconds of hearing Carlson's "cricket chirping" oscillating out of a speaker, Holtz realized its pitch was consonant with the early morning treetop concert of birds outside his bedroom window.

The first cassette, using Hindu melodies called *ragas*, suitable to an Indian ear, and apparently delightful to both bird and plant, induced stomata to imbibe more than seven times the amount of foliar-fed nutrients, and even absorb invisible water vapor in the atmosphere that exists, unseen and unfelt, in the driest of climatic conditions. But the sound proved irritating to American horticulturists and farmers, especially women, apart from those few whose tastes for the exotic accepted *ragas* as in vogue.

Looking for western music in the range of Carlson's highest frequencies, the ones which in Hindu experiments had shown the best bumper crops of corn, Holtz culled several baroque selections from the *Dictionary of Musical Themes* settling on the first movement of Antonio Lucio Vivaldi's *The Seasons*, appropriately called "Spring." "Listening to it time and again," said Holtz, "I realized that Vivaldi, in his day, must have known all about birdsong, which he tried to imitate in his long violin passages."

Holtz also realized that the violin music dominant in "Spring" reflected Johann Sebastian Bach's violin sonatas broadcast by the Ottawa University researchers to a wheatfield, which had obtained remarkable crops 66 percent greater than average, with larger and heavier seeds. Accordingly, Holtz selected Bach's E-major concerto for violin for inclusion in the tape. "I chose that particular concerto," explained Holtz, "because it has many repetitious but few varying notes. Bach was such a musical genius he could change his harmonic rhythm at nearly every other beat, with chords going from E to B to G-sharp and so on, whereas Vivaldi would frequently keep to one chord for as long as four measures. That's why Bach is considered the greatest composer that ever lived. I chose Bach's string concerto, rather than his more popular organ music, because the timbre of the violin, its harmonic structure, is far richer than that of the organ."

Holtz next delved into what for him was a whole new world of bird melodies. In the 1930s, Aretas Saunders, author of *Guide to Bird Songs*, had developed a method of visually representing, through a newly devised audio-spectrogram, the arias of singing birds that can neither be described in words nor adequately shown with any accuracy on a musical staff.

Refined at Cornell University's Laboratory of Ornothology into "sonograms," which show electronic frequencies and amplitudes rather than musical notes, they were first popularly used in 1966 in a field guide, *Birds of North America*, where they are printed next to most of the individual descriptions of 645 species of birds representing 75 families that live north of the Mexican border.

A few songs of particularly high pitch—from 6,000 to 12,000 cps (cycles per second)—such as that of the shy Tennessee warbler, whose protectively-colored bright green back blends into the leaves at the tops of trees, are as inaudible to many older people as high-frequency dog whistles. They are distinguishable in the guide because they have to be represented on an extra-large sonogram.

Soon Holtz came to see where the various predominating pitches in birdsongs could be calibrated by reference points on the musical scale and their harmonics. Dan Carlson had instinctively hit upon frequencies that were the ideal electronic analog for a bird choir. "It was thrilling," said Holz, "to make that connection. I began to feel that God had created the birds for more than just freely flying about and warbling. Their very singing must somehow be intimately linked to the mysteries of seed germination and plant growth."

During visits back to the Iowa farm country of his birth, Holtz learned that there had once been literally thousands of songbirds all over the countryside. His aunt Alice particularly missed the lyrically beautiful and extended flute-like trilling of various spotted-bellied thrushes, the high thin whistling of the black-and-white warbler, and the buzzy five-note song of its cousin the blue-winged warbler, recognizable by its bright yellow head, throat, breast and underparts. Most, if not all of these songsters were long since gone from the landscape.

"I guess Rachel Carson was right," Holtz said nostalgically, "the spring season down on the farms is much more silent than ever before. DDT killed off many birds and others never seem to have taken their place. Who knows what magical effect a bird like the Wood Thrush might have on its environment, singing three separate notes all at the same time, warbling two of them and sustaining the others!"

One morning while Holtz was mentally bemoaning all the species of birds that had vanished from Iowa, a yellow warbler, looking for all the world like a canary, flew, as if reading his mind, to perch on the top of a tree outside his bedroom window and, as if cued by his band-maestro's baton, burst into song. Holtz grabbed his tape recorder and managed to register an aria that went on and on for nine to ten minutes. In the field guide he found that the little bird registers a high 8000 cps. Drawn deeper into the subject, Holtz consulted books that detail the structure of birdsong, such as *Vocal Communication in Birds*, *Born to Sing*, and *Bird Sounds and Their Meanings*. He also consulted biological texts to find that tiny villi, minute shaggy hairlike tufts in the cochlea of the human inner ear, vibrate to certain "window" frequencies.

"What I was trying to figure out with Dan Carlson was what exactly we were oscillating in plants," Holtz explained.

Looking at drawings of a cell, Holtz further discovered the representation of a subcellular structure within the cytoplasm known as a *mitochondrion*. Pointing to the enlarged drawing of one of them he asked: "Of what does their shape remind you?"

A glance suggested the form of the wooden-bodied sound box of a violin or viola. "That's right!" Holtz exulted.

"And I found it more than of passing interest that the resonant frequency of mitochondria is 25 cps, which, if interpolated upwards gets to a harmonic of 5,000 cps, the same frequency used by Dr. Pearl Weinberger to grow winter wheat two and a half times larger than normal with four times the average number of shoots, as reported in Dorothy Retallack's *The Sound of Music and Plants*. It could be that the frequency he used vibrated not only the *mitochondria* in the wheat seeds, but the water surrounding them, increasing the surface tension and thus enhancing penetrability through the cell wall."

Holtz connected this to Retallack's having also discovered that the transpiration rate, indicating greater growth activity in her experimental plants, rose when they "listened" to Bach, 1920s jazz, or the Indian strains of Ravi Shankar's sitar; whereas exposed to hard rock, with the same rate nearly tripled, within two weeks the plants were dead.

"I believe such frenetic music," said Holtz, "was too much for their overall systems. The intense grindingly monotonous energy in that rock sound could have virtually blown the cells apart! Young volunteers for the U.S. Navy who have listened to that type of music since childhood have been rejected because of partial deafness, even before reaching the age of twenty."

Asked if one could simply play the recording of a crescendo involving all of a symphony orchestra's instruments with their hundreds of frequencies and harmonics and allow plants to select those best suited for their needs, Holtz replied: "You have to take into account a law of diminishing returns. Too big a dose of anything, is not necessarily of greater benefit than just a little or even a tiny dose."

It seemed significant that Holtz, the musicologist, could say this without any knowledge of homeopathic "potentizing."

Carlson, whom we met in Kansas City at one of Charlie Walter's annual eco-agriculture conferences, explained his approach with lively enthusiasm. "What I've tried all along to do with the *sonic* part of Sonic Bloom," he expostulated, his jet black hair and pirate beard reflecting the hue of the Western-cut suit he wears for public lectures, giving him the air of an Amish Elder, "is to stay within boundaries set by nature. I think there are certain cosmic forces which can account, however 'unscientifically,' for much of our success. Properly adapted they will get plants to grow better, perhaps get cows to give more milk, or even inspire people to relate to one another more harmoniously.

"There's plenty of evidence that various frequencies of both sound and color can be curative. But 'hard rock' is not consonant with nature's own harmonics. I believe birds exposed to it for long periods would fall ill and die, just as Retallack's plants withered away."

He waved his hands like an evangelist. "I get over a hundred calls a year, from people experimenting with my broadcasts. Most of them say that when the sound is turned on, plants actually turn away from the sun to grow toward the speakers! Always! To me that means the sound is as important to plants as whatever we understand about photosynthesis. Perhaps that's what Rachel Carson meant when she intimated that spring might one day be silent."

With a cold Minnesota winter coming on, and limited space in which to carry on his early experiments in a VHA-financed home, Carlson took a big step: he spent eighty-eight cents on a tropical *Gynura aurantiaca* or purple passion vine. Known also as a velvet plant, native to the Indonesian island of Java, its fleshy teardrop leaves are densely covered with violet veins and hairs, and its yellow-orange dishlike flowers exude a nasty smell. But to Carlson, this was his cherished baby. Once a month with a cotton swab he applied doses of nutrient to the tip of his vegetal pet, almost homeopathically weak doses, while simultaneously getting it to "listen" to his sonics. The swabbing turned the tip a withering brown, but quickly resulted in a new sprout burgeoning forth one leaf

below the dead tip to grow at an accelerated rate. Within a few days, the original tip had completely recovered and was spurting rapidly ahead, both shoots exhibiting thick healthy stalks and exceptionally large leaves.

As the vine crawled upwards out of its pot, Carlson screwed teacup hooks into the wall of his kitchen, six inches apart to support it; and so fast did the vine race for the hooks he had to add half-a-dozen every week.

At which point he made another startling discovery. If he snipped the growing tips with a scissors, the Javanese plant, far from daunted, put out a new shoot at the first leaf node below the cut.

As novel as this seemed to Carlson, he was even more puzzled by his pet's growing not only the teardrop leaves characteristic of its species, but also saw-toothed ones typical of its Indian cousin, *Gynura sarmentosa*, along with completely alien split leaves previously never seen on any purple passion plant. The sound-plus-solution treatment appeared to be strangely affecting something to do with his vine's genetic qualities even as it grew.

In a paper on his experiment submitted to his professor, Carlson presciently asked: "Does one cell of a plant genus contain all the characteristics of all the species of that genus? If not, why has my plant, grown from a *Gynura aurantiaca* cutting, developed leaves, over 90 percent of its length, peculiar to the *Gynura sarmentosa* and, at the same time, exhibited an entirely new split-leaf form? Could the combined application of nutrient and audio energy result in such rapid growth rate that the very process of evolution is condensed? Have I enabled my plant to adapt more quickly to its environment? Is this the reason for the different leaf characteristics appearing on one plant? If any of these questions can be answered 'yes,' can this knowledge be applied to other plants? Could food crops be treated to achieve more rapid growth and better adaptability to their own or alien environments?"

As winter wore into spring, and summer into fall, Carlson noticed another oddity: his plant had bloomed not the usual once, but twice. Even more fantastic was its incredibly extending length. In only the first three months, the vine, which normally never exceeds a length of 18 to 24 inches, had grown a total stem of 150 feet. During the rest of the year it pushed on at the same rate, out the kitchen through an inch-and-a-half hole bored in the wall leading to the living room where it boustrophedonly roved back and forth along the ceiling on wires strung eighteen inches apart, to attain a length of over a tenth of a mile.

During the next year Carlson began snipping 4-inch shoots from his vine, which he started in small plastic pots. Four hundred of these, labeled with his address and phone number and a request to call him for a replacement should the shoots die, he took to a flea-market where they rapidly sold for $4 apiece.

"I had many calls," he reminisced, "but none were to complain about sick or dying plants. Instead the callers wanted to know why the offshoots from my mother plant were growing twenty, thirty, forty, fifty feet long, and even more. I at once thought that this unheard of development might give rise to the possibility of whole new strains of hardier super-flora."

Despite this achievement, worthy of Luther Burbank, when Carlson, in happy excitement, asked members of his university committee to come to his house to see for themselves what he had done, their only reaction amounted to a yawn.

Didn't he realize, they asked, that, because his results had been obtained on a non-edible house plant, they were of no commercial value or interest?

"I was dumbfounded," said Carlson. "I could hardly believe this reaction. Here was the first time in their lives they had heard of sound being able to enhance the uptake of nutrients to produce the kind of growth I was getting, and they cast the result aside as worthless."

Desperate to get anything into the public record that would substantiate his achievement, Carlson wrote to Guinness Superlatives Limited in Middlesex, England, publisher of the now famous *Guinness Book of World Records*, which sent to Minnesota to check his claim "specialists in the matter of freaks in the plant kingdom."

Carefully measuring his plant's stem, inch by inch over its entire length, the freak specialists congratulated Carlson. That same autumn the new edition of the record book had an entry on page 113 extolling his find. To counter the caveat that his new method was commercially valueless, Carlson next began to supply portable sonic equipment and nutrient mix to backyard gardeners who had called him after the *Minneapolis Star* ran a huge photo of the Carlson family standing under the passion plant, its leaves intertwined in the supporting chain of a chandelier before proceeding, through additional holes in the wall, into his children's bedrooms.

Not to be outdone, the *St. Paul Dispatch*, describing his African violets, with more than four hundred blooms in a full spectrum of colors, and his morning glories, purple, blue, white, red, and pink, as enveloping his house from its foundation to its roof eaves, quoted Carlson as foreseeing a Jack-and-the-Beanstalk world with gigantic flora capable of feeding multitudes while their stomata increased the earth's supply of life-giving oxygen.

Though he did not inform the reporter that the multi-colored,

old-fashioned trumpet-shaped morning glories had come from an ancient seed packet found by one of his mother's friends when she was cleaning out her attic, it did occur to Carlson that if Luther Burbank could coax a spiny cactus into losing its thorns, not through cross-breeding but by informing the plant that it no longer needed them because he would "protect it," he too might get his climbing plants to adapt to human desires.

"I subscribed to Burbank's idea," Carlson told us, "that at the highest level, plants are capable of creating what is in the mind of man as a means of assuring their survival into future generations. I did not discount the many stories about trees which had borne no flowers or fruits for years, suddenly blossoming and bearing when threatened with an axe or a chain saw."

One spring, as he collected the seeds from his morning glories for successive annual planting, Carlson and his twelve-year-old daughter Justine meditated on how to get the vines to respond to their lovingly felt desires by focusing on their favorite hues, purple for Dan, pink for Justine. "We believed," said Carlson, "that the *plants* might respond to the colors *we* favored and draw closer to us as we were mentally and emotionally drawing closer to them." By late summer when the vines were putting out the usual mixed spectrum of blooms over most of Dan's house, he found massed all around his daughter's bedroom window nothing but pink flowers and around his own bedroom window only purple ones.

"This confirmed to me," he said, "that we can, in some still undefined way, communicate with plant life which is even capable of altering the colors of flowers and the shapes of leaves. It must somehow be based on trust. The plants must feel your intent and realize that if they respond you'll save their seeds to assure their flourishing continuance."

Even more intriguing was Carlson's belief that his method would allow him to determine the very likes and dislikes of plants. By exposing them to a varied menu of nutrients hitherto unavailable to them, he aimed, through their reactions, to find out which selections they might prefer, instead of just forcing them, like human babies plied with distasteful turnips or liver, to accept what their parents believed, usually mistakenly, to be good for them.

This he hoped might ultimately lead to the elimination of deficiencies resulting in bad-tasting fruit or vegetables, the eradication of plant disease, and even, with their exposure to spice-laden aerosols such as mint, cinnamon, or nutmeg, the creation of apples with mint, cinnamon, or other flavors, right on the tree instead of in the pie.

"What I began to realize," said Carlson, "was that my method

was *challenging the seeds' potential*, a potential maximized with the right number of Sonic Bloom sprays—which have turned out to be five—put on two weeks apart." Striking a massive fist on the table for emphasis, he added: "I believe I've come across a new principle that can be called *indeterminate growth*! It shatters the idea that plants are genetically limited to a given particular size or yield."

This lack of limitation led Carlson to another principle: *geometric progression*. "We began regularly to discover that plants treated during one growing season would pass along whatever changes were taking place in them, and create, right through their seeds, a successive generation 50 percent larger and more fruitful, even when the newly generating plants remained untreated with Sonic Bloom. I also call this genetic elasticity, the latent ability of plants to exhibit characteristics hidden in their gene pools, pulling out advantageous ones that may have been hidden for hundreds of years. This is connected to the ever-bearing trait brought out in McClurg's oranges."

Suggesting that the potentials in plants to respond to human wishes should be closely examined, he lamented that botanists, plant breeders, and genetic engineers have failed to understand the problem. "Scientists are rushing headlong into tampering with plants, monstrously slicing and splicing genes with as much surgical fervor as the ghouls who cut and maim animals in laboratories. This has led some of them to proudly announce that in order to produce a leaner grade of meat, they have developed a cross-eyed hog that staggers pathetically on legs that can hardly hold it up." He looked up and away with the firm yet benevolent gaze of a committed soul. "We should *tender* plants and animals, not distort God-given gifts still unrevealed in his creatures, but coax these gifts and learn to live cooperatively with all God's creatures."

He paused to allow the emotion in his words to simmer away. "Some people, with particular philosophies," he added, hardening his tone, "might accuse me of torturing plants, abusing their delicate nature. This is not so. I would challenge anyone to look at the model gardens I've set up, examine the radiant health of the plants, witness the remarkable fructification, and taste of this fruit. It is all done with nothing but affection, natural nutrients, and sound."

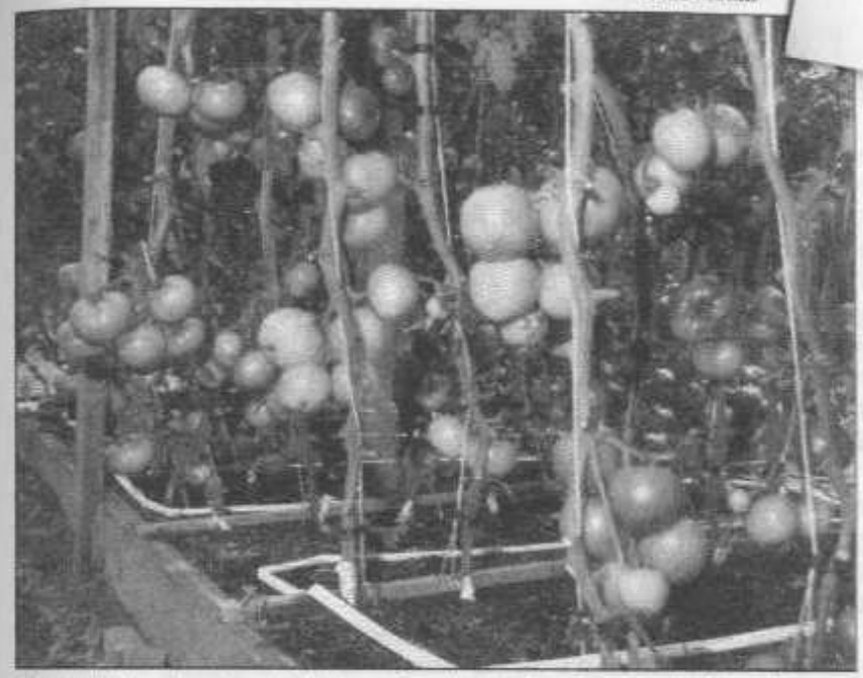
But perhaps the most encouraging prospect for fulfilling Carlson's dream of growing large quantities of food on very small plots of ground in a very simple manner is the marriage of his system with one developed by Ron Johnston of Mississippi, an amateur farmer in his thirties who doubles as a night nurse in a hospital in Memphis, Tennessee.

Ron Johnston spraying Sonic Bloom onto tomato plants grown in boxes of sawdust and sand. Each plant, seven inches apart from its neighbor, can produce upward of sixteen pounds of fruit for a total harvest from a box eight feet by sixteen of over a thousand pounds of tomatoes.

In a mixture of nothing but sawdust and sand in long rectangular boxes ten inches high, Johnston has been growing a staggering amount of delicious healthy produce. With discarded lumber from the sawmill, plus two pickup trucks of free sawdust and one of sand, each box requires no more than a few hours of labor to build; and by Johnston's conservative figures a box eight feet wide by sixteen long can produce as many as 800 cantaloupes or 5,000 pounds of tomatoes—many times more than could ever be grown on an the same sized plot of ground.

"It all came together for me," says Johnston, "three years ago. Before that, I couldn't grow a thing down here on the dead soil of Mississippi. Then I got hold of a tape of Dan Carlson and I ran into a farmer using microbes. I also read about the French Intensive method, and that gave me the idea for the boxes. The system eliminates plowing, cultivating, and weeding. A daily watering can be automated, and extremely economic. My water bill has gone up only a few dollars since I started; and during the drought of 1988, while my neighbors were cropless, my plants were a jungle of healthy green."

With a mere expenditure of $150, Johnston added a frame and



Johnston's tomatoes, growing in boxes of sawdust and sand, matured weeks earlier than his neighbors' and produced individual tomatoes weighing as much as a pound and a half. Such tomatoes, planted in shallow ten-inch deep boxes,can be grown on the terrace of a Manhattan penthouse or even on a sidewalk. (Photo by Ron Johnston)

plastic hothouse to his first box of sawdust-and-sand to produce tomatoes two months before his neighbors. Each tomato plant, planted seven inches apart, and producing twenty-five to thirty blossoms, gave as many as sixteen pounds of fruit per plant, some individual specimens weighing as much as a pound and a half. The chlorophyll content of the leaves was almost double, and they contained so much sugar that insects nibbling on them were killed by an overdose of alcohol. Johnston uses no insecticides.

Two hundred strawberry plants in a narrower box produced two hundred quarts of strawberries with double the normal sugar content. And just one normal box of bean plants is alone enough to feed a family of four for a year. With cantaloupes clipped onto strings and climbing towards the rafters of the greenhouse, Johnston is able to hang twenty full-sized fruits from each plant.

Sawdust and sand form a fluffy consistency which allows plenty of essential air and water to reach the roots. But the real heroes of the system are forty-seven strains of microorganisms that Johnston obtains from a cultivator out of California. "I call them piranhas," said Johnston, only half joking. "They devour whatever nutrients are in the air and turn into healthy plant food

whatever fertilizer I put into the boxes, transmuting potentially toxic salts into a balanced diet for each specific type of plant, providing them with a continuous flow of nutrients."

One teaspoon of microbes is added to a gallon of water and sprinkled around the plant stems; there they proliferate at the rate of 200,000 a minute, dying off individually every thirty minutes, but lasting, as a strain, as long as there is food for them to feed on. "The microbes," says Johnston, "eat any cheap fertilizer I provide them, and switch the elements around. They can turn potassium into sulfur, or whatever is excess into whatever is scarce. And my microbes feed the plants just what they need, just when they need it, providing them with a variety of minerals, the more of which the plants can get the better they taste and the longer is their shelf life."

Like camels, says Johnston, his microbes absorb a great deal more water than they need, which they then relinquish to the plants in moments of drought. Well fed, they proliferate down into the soil below the boxes to a depth of several feet, turning it to humus.

But all of this is only half of Johnston's story. The rest is provided by Dan Carlson's Sonic Bloom. Every morning Johnston plays the enchanter sound to his plants, enabling them to suck in element-laden moisture from the air; and once a week he saturates their leaves with Carlson's liquid nutrient. "It all works in concert," says Johnston. "Sand and sawdust; microbes and fertilizer; Sonic Bloom and sound. Each by itself will not give the same results."

The whole system, as Johnston explains it, started as a hobby, then turned into a driving force. He's now determined to teach people anywhere in the world to grow a garden in their own backyard or terrace that will feed an entire family and leave a marketable surplus. "At first," he says, "people will find it hard to believe; but they'll be amazed when they find they can grow cantaloupe in quantity on the small penthouse terrace of a skyscraper in mid-Manhattan, or when a peasant in the Third World learns that with only a tiny corner of land and a little labor he can flourish as never before."

Ron Johnston paused to survey a whole acre of his boxes laden with produce, worth potentially a couple of hundred thousand dollars. "What I'd really like," he added with a winning smile, "is to help turn this planet back to what it was before the 'original sin' of desecrating the soil of Mother Earth."

Chapter 12

Seeds for Survival

To Michael Holtz, the mystery of Dan Carlson's success with sound may be explainable in terms of the basic philosophy of India. For thousands of years its sacred texts have taught that sound, as the integrating phenomenon of life, holds the key to the mysteries of the universe, to the creation and sustaining of the physical world.

In Indian metaphysics there can be sound without vibration, even without the usual medium of conveyance such as air, water, or so-called solid matter, sound being the cause and not the effect of vibration. The "soundless" sound is said to be the source of cohesion, of electricity, of magnetism, of all that is. And it was a universal ancient belief that God, or a Divine Being, created the universe by means of a vibrating emanation, referred to by early Christians as *Logos*, "The Word." And musicologists point out that the whole-number ratios of musical harmonics—octave, third, fifth, fourth—correspond to an underlying numerical framework which exists from astronomy to atomic physics, through chemistry to crystallography, and even to botany.

In the Indian view of the cosmos, sound precedes light, and the whole universe is viewed as an ocean of sound followed by light of varying degrees of density and luminosity. Strangely, much of this wisdom of ancient India has survived among the native tribes of "Indians" in America.

On an Indian reservation in the arid northeastern corner of

Arizona, at high noon of a scorching July day, with a hundred-degree temperature hanging heavy over land parched by an extended drought, John Kimmey restlessly awoke from his siesta in a cool stone house.

A schoolteacher and founder of New Mexico's innovative Community School in Santa Fe, Kimmey was a guest of David Monongye, a traditional religious leader and elder of the Indian tribe, the Hopi, settled for centuries atop a trio of side-by-side mesas. In their language the appellation *Hopi* means "peaceful" or "good."

As most of the tribe dozed away the midday rest hour imposed by Grandfather Sun, Kimmey let himself out through the screen door into the glare of the *Kisnovi*, the central plaza of the village of Hotevilla, fit at that hour only for mad dogs or Englishmen. Drawn by an urge for which he could not account, Kimmey ambled to the edge of the third mesa and down a dusty trail, guided, as if from the spirit realm, by an iridescent lizard across the countryside to a pile of stony rubble at the base of a cliff. Pausing, Kimmey became aware of an eerie song wafting through the arid surroundings. Beyond the last lithic outcropping, an expanse of planted corn was so vast it didn't seem Hopi. The singing became clearer, coming from a soft, powerful voice, though Kimmey could not see the singer. To his astonishment he noticed that every one of the thousand or more clumps of waist-high Hopi cornstalks, each with a dozen or more ripening ears, were growing as lushly as if it had been planted in rain-blessed Iowa, the whole field contrasting sharply with the brown, wilted crops scattered on parched land all around the village.

Tiptoeing through the cornstalks, Kimmey spotted the grizzled white pate of an old Indian seated on the ground, his closed eyes impervious to the presence of any passing creature, including Kimmey, the atmosphere about him indicative of deep communication with the cosmos.

Gingerly moving away, Kimmey returned to his quarters, where his old Hopi host smiled: "So you came upon old Titus! He still keeps the ancient Hopi way, which unfortunately has all but died out among the present generation. It's not the water, it's the *Navoti* that keeps his plants alive. He knows by heart the right airs to chant to his corn children for whom he offers prayers at planting time. Most important, he knows that he should never worry, like most farmers, about his crop, because anxious thought is as damaging as extended drought. Instead of worrying, he goes to his children in the high heat of noon to impart courage to them with his generations-old songs."

"Surely," Kimmey protested, "all the other corn farmers must see what a difference the songs make to his crop. Why don't they sing to theirs also?" The old Hopi sighed: "It's too late. *Navoti* is no longer alive in other men's seeds."

Returning to his home in Taos, where for fifteen years he had apprenticed in native ceremonialism with the Tewa Indian elders, Kimmey noticed for the first time in several years how so little of the farmland around each of the nineteen Indian pueblos he passed was under cultivation for food or even animal fodder. Listening in his mind to Titus's haunting refrains, he felt he heard the old man's seeds calling to him that their *Navoti* power might still lie trapped in other seeds long stored in half-forgotten caches, in clay pots, old coffee cans, or lard buckets tucked away in the dark corners of tool sheds, in the walls of adobe houses, or in long braids of dried corn woven into *ristras*.

What was calling him, he felt, was the old seed, gathered years, decades, even a century before the commercially-sold seed packets began to appear each spring on general store and supermarket racks, old seed that could still retain its inner vitality, the ancient force imbued into it during an era when men still sang to their plants. The old seed chorused its desperation that it be found and lovingly put in the ground before it disappeared into oblivion.

When he told his eighty-two-year-old adopted Indian father about his experience, the old man's face seemed to reflect a soul swimming back through time to happier days. Arising slowly from his chair he went into a side room to emerge with three small buckets full of what sparkled to Kimmey like bright sapphires. As he stared at the dark blue corn seeds, he heard a choir similar to the one that had come from Titus's throat.

His Indian father explained that only the week before he had found the buckets stashed in an old trunk in his sister-in-law's house among ancient tools, strands of rawhide, assorted turquoises, and other tribal mementos. Planted the following spring to Kimmey's own singing, the seed grew into nine-foot-tall plants, to the amazement of the pueblo's elders, who could not remember having seen anything similar since their childhood.

It made Kimmey feel that he had at last discharged a duty to Kokopelli, the mythological Hopi spirit most closely associated with plant fertility and seed germination. Known to non-Hopi Indian tribes as "the hunchbacked flute-player," his unique image has been painted on countless pots, or etched in stone, throughout the Americas over many centuries, the hump on his back recalling a sack of seeds to be scattered as he moves about, his Pan-pipe flute said to be the source of the spirit breathed into the seed.

Through contact with small seed companies, Kimmey went on

to discover the truth of his Hopi agricultural lesson. And he also discovered a serious problem that has developed in the domination of the seed market by modern hybrids that are not disease resistant or as nutritious as the older, nonhybridized seeds. As Pat Ray Mooney, a leader in the effort to promote a wide diversity of seed for the world of farmers, wrote in his 1979 book, *Seeds of the Earth*: "It should alarm no one that some genetic material, which might ultimately have been of use to major crops, has been, and is, vanishing. What should really cause concern is the massive, wholesale eradication of irreplaceable breeding material over thousands of square miles of arable land."

So fast is the prairie fire of genetic erosion spreading, that biologist Thomas Lovejoy estimates that the world will have lost one-sixth of all living plant species by the year 2000. And Mooney himself concludes that existing wheat cultivars cannot survive twenty years without a constant influx of fresh genes from plants to allow them to stave off new pests and all diseases.

The situation is more than precarious. Based on the rediscovery of Mendel's laws of genetics, a new science of plant breeding has been erected, which, within only a few decades—an "eyeblink" in plant, if not human, history—has been engineered to meet the technological requirements of machine harvesting, grain milling, beer brewing, bread baking, and many other food-processing industries. In the process, genetic strength has been sorely weakened. As the new varieties of hybrid seeds are produced to meet ever new demands, the risk increases of huge crop losses through disease. The only remedy is to have recourse to the ancient centers of plant diversity.

As genetic uniformity of the world's main stable crops increases, breeders are forced to rove deeper and deeper into half-lost valleys and forests in search of new—or rather older—genetic material.

The real heart of the problem, says Mooney, is the so-called "Green Revolution," for which Norman Borlaug won a Nobel Prize in 1970. Its basic impetus derived from the idea that "High-Response" non-self-perpetuating hybrids be exclusively relied upon. While the Green Revolution has been a plague on genetic resources—because it has led to a galloping erosion of native plant varieties in favor of highly inbred imports—it has also been a boon to the world's seed industry. Cost-free, these industries have raked over the genetic riches of poor countries to breed new varieties whose high yields are assured only by massive additions of artificial fertilizers and pesticides, sold, obviously, by the same companies with their built-in bias for industrialized agriculture.

At the beginning of the seventies, according to Mooney, a number of factors propelled chemical firms into seeds. First, they had money to spend on acquisitions, and the economic environment was conducive to mergers. Second, the costs of bringing new drugs and pesticides onto the market were sky-rocketing, due to increased public health and environmental protection concerns. The easy victories of the fifties and sixties were ebbing and the struggle to find new compounds was growing harder. Third, many of the major patents won in the fifties were dying out and some top companies were buying other firms in fear of losing their profitability.

With these concerns and others in mind, chemical firms bought out large areas of farmland, not only in North America, but on every other continent and moved aggressively into produce marketing. In November, 1970, *Business Week* asked, "What has household bleach to do with lettuce patches? What have man-made fibers to do with raising hogs, or chlorinated solvents with catfish farming? Not much. But a growing list of U.S. companies based in chemicals and allied products are venturing back to the good earth."

Yet American business journals failed to note how the seed business was coming under the domination of giant conglomerates. The growing dependency on chemicals of monopolized seed production has led to what Mooney calls a highly unsettling trend: increased buy-up and control of the world seed industry by large chemical and agribusiness corporations.

"The effect in the course of fifteen years," says Mooney, "has been to utterly transform the seed industry. Where once it was small and family-based, it is now large and highly corporate. In 1972, Royal Dutch Shell had no involvement whatsoever in plant breeding. Now, having acquired thirty major seed houses, it is the largest seed company in the world, with sales of more than half a billion dollars, and is seeking still more acquisitions. Every other company with an interest in agricultural chemicals—Atlantic-Richfield, British Petroleum, Ciba-Geigy, Monsanto, Stauffer, Upjohn, ITT, Occidental, Sandoz—is moving into seeds."

Sandoz, the $3-billion-a-year Swiss multinational, has spent more than $300 million acquiring American seed and agri-chemical companies. Along with DeKalb, Pioneer, and Ciba-Geigy, Sandoz accounts for about two-thirds of all seed sales in the United States for corn, America's biggest crop, and about 60 percent of the sorghum seed. As seed prices rise, costing farmers hundreds of millions of dollars, the companies, instead of delivering a self-perpetuating variety, can repeatedly milk the farmer with a non-reproductive hybrid for years and years to come. U.S. farmers and ranchers spend nearly $4 billion each year on seed; world-

wide, the market for agricultural crop seed is $45 billion. And, along with Upjohn, Lubrizol, Limagrain, LaFarge Coppee, and Arco, Sandoz has also garnered more than 230 vegetable-seed patents.

Other corporations hope the seed industry will open the way to expanded agricultural—products divisions currently manufacturing and marketing fertilizers, pesticides, and other agricultural chemicals.

"The intent is to become a full-service operation," says Bob Skaggs of the California Department of Food and Agriculture. "Not only can disease and pest-resistance and earlier and greater yield-potentials be transmitted to crops through new seeds, but these also can deliver agricultural chemicals to the fields through 'controlled delivery systems' such as seed encapsulation processes."

Companies such as the Celanese Corp, which owns the Harris-Moran Seed Company, based in Modesto, and Celprit Industries in Manteca, California, have been experimenting with polymeric seed coatings. This process, which has been applied to seeds in the past, makes the seeds the same size and weight, ensuring uniform planting. Celanese also has been developing chemical "additives" for seeds, such as fungicides, to "protect" plants from soil organisms, pests and bad weather. Mooney foresees the budding chemical-seed partnerships pushing their wares in favor of developing new plant varieties.

Many of the multinationals venturing into the seed business hope to capitalize on the huge, and no longer so distant, promise of genetic engineering. According to Ray Rodriquez, a molecular geneticist at the University of California at Davis, they see an annual market for biotech agricultural products that may be as much as ten times as large as the potential market for biotech-medical products, with a market potential of up to $100 billion by the year 2000.

With gene splicing, the entire plant kingdom becomes one open-ended gene pool, in which genes can be moved about freely from one species or genus to another. In higher plants, upward of ten million genes—more than ten times the number found in man—control the way the plant performs. With the modern ability to screen millions of plant cells in the lab in a matter of hours to move the required genetic characteristics from one cell to another, new varieties and breeds can be created in a matter of days, avoiding the old painstaking process of cross-breeding, selecting, and further breeding that might take up to ten years. The results can now be spread around the world in a matter of weeks through normal trading and shipping.

The Japanese consider this biotechnology the major technological revolution of the century, launching a race comparable to the space race, with impressive possibilities.

In this new biotechnology, almost anything can be envisaged, including, says Jack Doyle in his *Altered Harvest*, a dairy cow as big as an elephant capable of producing up to 45,000 pounds of milk a year. The Carnation Company, known for its dairy products, is already genetically manipulating and selling frozen cattle embryos, which, split and reseated, can produce a herd of a hundred clones. And the futuristically outlandish plans of the new plant monopolists to use the newly born and fast-growing techniques of genetic engineering bid fair not to dispense with chemicals but to foster a vast expansion of their sales.

As seeds remain the primary ingredient of agriculture, Kimmey found corroboration of Mooney's concerns about their plight as he visited the chronically-underfunded seed-storage facilities of the National Plant Genetics Resources Board in Fort Collins, Colorado—healthily located halfway between a nuclear power plant and the Rocky Flats plutonium facility—which operates for some 240,000 seed collections the equivalent of a Fort Knox for gold. So crowded are the facilities that seeds were piled on the floor in brown cardboard cartons and sacks, uncatalogued, some having lost their ability to germinate, or with viruses in their germ plasm, the equivalent of a biological time bomb. Not that Kimmey found the collecting effort any better operated by the United Nations Food and Agriculture Organization in Rome, Italy.

In search of remedies, Kimmey came across a network of individual seed savers, principal among whom was Kent Whealy, a young midwesterner. Having organized in Princeton, Missouri, his Seed Savers Exchange (SSE), Whealy publicly appealed for help in collecting heirloom seeds for propagation, offering instruction for their storage and planting in gardens.

Invited to lecture at the Fort Collins seed bank to a prestigious audience of plant breeders and genetic preservationists in October, 1986, Whealy was dismayed to hear staffers tell him that their way of storing seeds was leading to a decline in the rate of their germination after a period of only a few years. Whealy's invitation had been in tribute not to any scientific prowess, but to what a single citizen had been able to accomplish in twelve years of effort in the area of seed preservation in the United States.

Born into one of the forty million American families who grow part of their own food, and cultivating a vegetable garden of his own almost from the time he could walk, Whealy was entrusted at the deathbed of his wife's grandfather with seed from three garden plants the old man's family had brought over from Bavaria four generations earlier.

Growing them out to ensure their multiplication, and preser-

Kent Whealy examining airtight bottles that hold the Seed Savers Exchange collection of 2,200 varieties of beans. Most are heirlooms passed down from generation to generation since the *Mayflower* landed at what is now known as Plymouth, Massachusetts, in 1620. Though some seeds have to be regrown every four years or they will die.

vation through distribution, Whealy wondered how many other home gardeners might also have cached heirloom seeds in attics or cellars. So he decided, in 1974, to mount a campaign to seek out their locations. As a result of his forays, he discovered to his surprise that while old vegetable and fruit seeds are not common, neither are they all that rare, if one knows where to find them. Whenever he and his associates went into isolated areas, such as the rugged backwoods of the mid-western Ozarks or hidden hollows along the blue ridges of the Appalachians, they were offered seed riches no longer seen in towns or cities or advertised in catalogs.

A whole heritage of plant spawn traded at country general stores or over backyard garden fences could lay the basis for breeding programs to produce a vast wealth of new garden varieties or reanimate old ones.

Particularly solicitous about seed saving were religious sects that have maintained uninterrupted ties to the land, such as the Amish, Mennonites, Hutterites, and Dunkards. As Whealy built trust in his exchange enterprise, he was honored to attract to his effort members of American Indian tribes, long reluctant to share with the perfidious white man seeds which, as the sparks of life, they considered sacred.

In 1986, Whealy published a 250-page eleventh edition of his *Winter Yearbook*, containing lists of 630 members offering to trade seeds or seeking to find varieties half-remembered from childhood. Over a decade the publication had grown to the point where his exchange-membership was collectively offering 4,000 different strains, to allow for over 300,000 plantings of truck-garden and orchard crops, unavailable from any commercial source and mostly on the edge of extinction.

"The material we have been able to locate, is really just the tip of an iceberg," says Whealy. "The unique heritage of seeds in our country has never been systematically collected because most government-sponsored plant exploration has focused on foreign countries. Our next task is to organize the fielding of several hundred local plant explorers, region by region, and state by state. Many professional plant breeders are becoming excited about what we have already uncovered, because it's material they've never seen before, much less been able to work with."

With these rare seeds the breeders produce, not hybrids, but open-pollinated, self-reproducing stock. Typical of breeding programs to which Whealy referred is one at the University of Wisconsin in Madison, directed by Dr. Fred Bliss, who concentrates on beans to create *upright* plants twenty-four inches tall that can be machine-harvested. He has married into their hereditary font the genes of older varieties with tough, rank stems in what Whealy

Kent Whealy, Director of the Seed Savers Exchange, working in its Preservation Gardens where some 1,200 varieties of endangered plants are being regrown from seed.

terms an architectural application.

One of many old bean varieties being brought back from the edge of extinction is the tepary, discovered by Dr. Gary Nabhan, Director of the Native Seed/Search program of the University of Arizona. With the remarkable ability to grow lushly green, even in normally plant-withering conditions—perhaps because it, too, was sung to over several generations—teparies were once widely cultivated in northern Mexico and the south-western United States, but today are found only around the Arizona homes of a few Pima and Papago Indians who still grow them. "I've seen the tepary growing successfully in air temperatures between 115 and 120 degrees Fahrenheit, and ground temperatures over 170 degrees, where pinto and other beans completely failed," said Nabhan. "I've seen it survive on less than two and a half inches of rainfall under extremely arid conditions. It's just plain ornery—it refuses to die."

Other crops highly resistant to heat include teff, a low-yielding but high-protein extraordinarily drought-resistant Ethiopian grain that western scientists, knowing little about have recommended be replaced with corn or wheat. Pat Mooney has seen fields of it growing next to African corn so drought-stricken as to resemble fields of withered onions. "A main reason," chides Mooney, "why people are dying of famine on that continent is because of rotten western agricultural advice. We do it with the best of intentions—not a mean bone in our bodies—but not much humility either. We need to recognize the humanity of the people who are starving. If we don't have the means to end world hunger, they do! And if we don't have the capacity, they do! Together, we might have the combined will to solve the problem."

Concerned with another aspect of the problem of disappearing seeds once known to parents or grandparents, Whealy began systematically to collect every seed mail-order catalog he could locate, no matter how small or obscure. By 1982, he had put out a 448-page *Garden Seed Inventory* compiled from 239 separate catalogs listing over six thousand non-hybrid varieties still offered throughout the United States and Canada. The greatest value of his compendium is its indicating which varieties are in the most danger of extinction, so they can be planted and distributed before they are dropped completely.

"As the *Garden Seed Inventory* grew towards completion," said Whealy, "it became not only more and more fascinating, because the little-known diversity and extraordinary quality of the garden varieties offered is almost beyond belief, but also more frightening, because it became apparent that nearly *half* of all non-hybrid garden seeds were being offered, as randomly as haphazardly, by single companies. And a lot of those have either been dropped in the interim, or will be as soon as remaining supplies are sold. Our efforts aim at reversing this ominous trend."

In Colorado, Whealy was shocked to learn that the computer printouts of the National Seed Storage Laboratory showed that it was stocking only 3 percent of the food plants listed in W.W. Tracy Jr.'s *American Varieties of Vegetables* for the Years 1901 and 1902, published by the United States Department of Agriculture in 1903. "It is depressing," he said, "to see those enormous lists of garden varieties available at the turn of the century and to realize almost all of them have been lost forever. Imagine the tremendous amount of unique material that would still be available to breeders today if that early USDA inventory had only been updated annually, and endangered varieties systematically procured and maintained."

Since 1950 most of the losses have been due to economic pressure, which focused, not on the needs of home gardeners, but on the interests of commercial growers, who demanded such features as ease of harvesting, extended storability, and shelf life. To this kowtowing by plant breeders to the needs of large-scale agribusiness is due not only the loss of irreplaceable heirlooms but the loss of what Whealy calls the *"best garden varieties we will ever see."*

Even with the main tool, the *Garden Seed Inventory*, Whealy is just picking up the pieces. "But we must at least do that," he explained, "and do it quickly, updating the inventory every couple of years. One good example, among many, of material that is available right now, but probably won't be for long, are the Chinese Cabbages. There is a tremendous amount of Oriental material currently flowing into this country. But most of it is coming through just a few small specialty companies, and in many cases these varieties are listed for only a single year."

Because 80 percent of the rare, commercially-unavailable seeds sent him by his members had not been permanently "adopted" by his Growers' Network, in 1985 Whealy rented five acres of rich bottomland to grow out two thousand varieties, including three hundred beans, tomatoes, and squash, and one hundred varieties each of potatoes, corn, muskmelons, watermelons, peppers, with smaller amounts of peas, lettuce, and many other crops.

"All of the corns and all of the cucurbits were hand-pollinated," he said, "and we have been protectively caging all of the peppers after reading some studies from New Mexico which reported that, under some conditions, populations of peppers can cross as much as 80 percent, thus mixing genes and rendering individual varieties unpure. Our garden projects have been funded these last

two summers by Pioneer Hi-Bred International, and I say that thankfully."

To Whealy the most impressive thing about his garden is the effect it has on visitors. When he takes a tour out onto land where there are two thousand different varieties growing, the excitement it generates in those gardeners is little short of amazing. Time and again he has seen people walking along its rows, their mouths falling open. "They just look and look, as if they could never get enough of it," he said excitedly. "We've talked incessantly about the loss of genetic diversity, but the concept is so abstract that most people, failing to even recognize it as a threat, block their ears or turn off their hearing aids. But if we take those same people into our garden, show them hundreds of unique varieties, and tell them that most would be extinct except for our protecting them, then they light up with understanding."

After a two-and-a-half year search, during which he looked at dozens of properties, none of which fulfilled his criteria, Whealy at last located the ideal location, a former fifty-seven-acre Arabian horse stud farm near Decorah, Iowa, with a large barn and a one-acre spring-fed pond with a continuing flow so strong it never freezes over. There his Seed Savers Exchange is in the process of setting up an exemplary seed-preservation center. "In our beautiful new setting, we will expand our huge garden and build, if we can, a system of special greenhouses and large underground root cellars. We also intend to plant large apple orchards of up to two thousand older historic varieties, including those for cider, hoping to focus on some that might fall through the cracks as existing collections are transferred into the new clonal repositories. The work will make possible a massive exchange of scionwood—detached living portions of apple trees for grafting—to spread the apple heritage across the land, just as "Johnny Appleseed" did in the early nineteenth century—now as mythical to orchardists as Paul Bunyan is to lumbermen or Pecos Pete to cowboys.

"Imagine," said Whealy, "a place where the public could come for taste tests at harvest time and our telling them: 'You probably have only known the taste of Red Delicious, Golden Delicious, or McIntosh, picked green months before ripening. Now try these tree-ripened Winesaps, Chenango Strawberries, Winter Sweet Paradises, Yellow Bellflowers, Westfield-Seek-No-Furthers, or one of Thomas Jefferson's favorites, the Esopus Spitzenbergs.'"

Several years from now Whealy envisions adding representations of rare poultry and minor livestock breeds as a way of supporting organizations that focus on preservation in those areas. He wants to attract young apprentices to come during the summer to learn and to work in the garden and, eventually, see a network of such preservation farms, each maintaining plant materials in different climates and sharing data via computers.

Over the past decade or so several pioneers have been working to fulfill Whealy's networking dream. In the 1970s a former Rockefeller University molecular biology and life sciences Ph.D., Alan Kapuler, who taught at his alma mater as well as at Yale and at the universities of Connecticut, Illinois and Wisconsin, sick, at age thirty, of urban life and the academic rat race, founded, with others, Earth Star Botanicals, since become Peace Seeds, a "planetary gene pool service," in Corvallis, Oregon.

In his 1987 *Catalog and Research Journal*, written together with a botanist and alchemist, Olafur Brentmar, Kapuler laid out long seed lists arranged according to a computer-based model for classifying plants devised by Professor Rolf Dahlgren.

Because all the known plants are traced schematically to their near or distant relatives, the system makes clear in evolutionary terms which of them are rarest or unique. Thus, one can at a glance see how lettuces, the highest source of silica in common diets, including such varieties as Imperial Winter, the Italian ruffled minihead Lollo Rosso, the French Barcarole, or the purple-leafed Red Sails, are related to such medicinal herbs as common burdock, or to chrysanthemums, marigolds, zinnias, sunflowers and Jerusalem artichokes.

The seeds of no fewer than thirty-six varieties of tomatoes are offered, including the orange and yellow Marvel, hatched with red stripes. Their relations to peppers, tobacco, huckleberries, purple Peruvian potatoes and the Chinese matrimony shrub are spelled out in the catalog. Out of twenty-four pages of seed listings, four are devoted to radishes, mustard, kale, cabbage, cress, celery, squashes, melons, pumpkins, and cucumbers, all belonging to a single super-order of brassicas, curcubits and their allies, called violiflorae.

Waxing poetic in its enthusiasm, Kapuler's Organic Seeds, the Gene-Pool and Planetary Peace (1987) touches on the fundamentally spiritual role of seeding:

> In our work of growing paradise we have broken from mechanistic rectilinear constraints to begin an exploration of earth sculpture and cosmic relationships to maximize niches for all kinds of vegetal creatures providing love as food, shelter, and happiness. We come to you in the spirit of avatars like Lao-Tse, Krishna, Krystos, Black Elk, Mahatma Ghandi; of musical virtuosi like Mozart, Schubert and Pablo Casals; of poets like Henry David Thoreau; of martyrs like Giordano Bruno;

and of plant innovators like Luther Burbank and George Washington Carver.

It is a far cry from the monotonous cloning of white-coated biotechnologists in agribusiness. And, as a measure of the growing revolt against such autocratic standardization is *Guerrilla Gardening*, a book by Washington State University English professor John Adams, in which he tells would-be heirloom-seed collectors exactly how to begin collecting rare plants and seeds. With the use of step-by-step illustrations, he provides simple growing instructions as well as grafting, budding and propagating techniques.

"Time and a sense of adventure are essential for success," says Adams, "but anyone who gets into planting rare seeds will be more than rewarded, if only because their fruits and vegetables will offer them extraordinary taste experiences they've never had before. The beans I've grown for staples and for chili are head-and-shoulders above red, pinto, and other varieties found in supermarkets that are grown from commercial seed. There are a dozen different varieties of beans, going back long before Columbus was given dubious credit for having discovered the 'New World'! If you grow them you'll find out what the pre-Columbian natives were enjoying. The taste will thrill you."

For beginners, Adams recommends starting small. "When growing heirlooms, mark out your patch of garden, so you know what

Gabriel Howearth and his totally unpolluted farm in southwest New Mexico. With contributions from around the world he has created a unique seed bank to save precious stock from extinction.

is where, and mark the sturdiest plants at full bloom for future seed use. By following this 'First Commandment' of heirloom seed saving you'll wind up with your very own hearty strain."

To provide such strains to people all over the world is a central mission of the Abundant Life Seed Foundation, situated across the state in Port Townsend, a small town on a peninsula which the Seattle ferry passes at the midway point of its shuttle route to Victoria on the island of Vancouver. In addition to a wide spectrum of vegetable seeds, it proffers a range of annual herbs, from heat-loving cumin to lemon and licorice, and fenugreek—also known as "Greek hay"; his biennial and perennial herbs are as diverse as copper fennel, feverfew, and a white insect-repelling daisy, *Euphorbia lathyrus*, said to repel moles and gophers.

Since its publication in 1984, *The Heirloom Gardener* by Carolyn Jabs has spurred an enthusiastic growing group of individuals, motivated by taste preference, curiosity, nostalgia for by-gone days, collectors' mania, or unregenerate vegetal Luddittism, to take up Whealy's call for establishing seed-saver and exchange networks. Like Adams, Jabs gives full credit to Whealy's Seed Savers Exchange for stimulating her research and her writing.

At Fort Collins, Whealy told the U.S. government seed representatives that he hoped he could get at least part of his preserved heirlooms into official government collections to provide a "frozen" backup for his own efforts, and obtain badly needed help in getting material out to plant breeders.

He then gave them the full force of his astonishing accomplishments and aspirations: "During these last twelve years, I have put together a network of over one thousand growers, an incredibly diverse group, which includes university breeders and researchers; elderly backyard gardeners and hobbyists; amateur plant explorers maintaining hundreds of varieties; rooftop gardeners in New York City growing one heirloom tomato; traditional peoples—Anabaptist-descended sects in the Northeast and pueblo-dwellers in the Southwest, still growing their people's seeds; and farm families of every ethnic background. The main strength of this diversity is that the amassed collections are extremely decentralized, so that any catastrophic loss through fire, flood or other act of God met by a couple, or even a handful, of our members will be more than offset by the preserved seed-banks of all the rest."

Chapter 13

WEEDS: GUARDIANS OF THE SOIL

The ideal food to feed the world would be a grass, heavy-headed with seed, which could grow perennially like the wild grasses of the prairie, taking nitrogen straight from the air. Such grasses once grew uninterruptedly across the whole Midwest, from Allegheny to Rocky Mountain crest, some short, some so long they reached the underbellies of the first frontiersmen's horses.

Now, except for isolated islands still being chivalrously preserved by a handful of sensitive farmers like Fred Kirschenmann of North Dakota, the wild prairies have all but disappeared. Pervasive monoculture has led to the wholesale eradication of an extended happy company of prairie plants, which for centuries danced in variegated hues of spring, summer, and autumn flowers, with no more additives than sunshine and a shower of rain, naturally fixing nitrogen into the hungry soil.

In their place, thousands of acres are now plowed, year in and year out, to plant a single crop of wheat or corn. These man-developed grasses have bigger heads of seeds, but in the process have lost the strength to reproduce perennially, obliging farmers to waste weeks of labor, tankfuls of fuel, and tons of fertilizer to reseed them annually.

But what if edible proteins could be grown without the huge energy-wasteful expenditures for gasoline-fueled tractoring for plowing and harvesting, and petroleum-based chemicals for fertilizing and weed-killing? What if food grasses, married to hardy weeds, could be made perennial without having to be replanted annually, yet produce as abundant seed as hybridized corn, barley, wheat, or oats? This was the dream that led one son of America's prairie heartland to give up his comfortable position as a tenured full professor of environmental science at a California university to return to the Smoky Hill River in Kansas to begin a long-term effort at reversing one of the most tediously unvarying

Wes Jackson.

and soil-debilitating practices in agriculture: plowing and sowing.

We found Wes Jackson in Amarillo, Texas, giving a lecture on "Star Wars in Agricultural Choices for a Sustainable Future." When asked how it felt to have his newly coined term—sustainable—universally and unattributively co-opted, he demurred, saying it had long been "in the air," that Lady Balfour, founder of England's Soil Association, might well have been its originator.

A rumpled plant geneticist who appears to have been dropped into his clothes from above, Jackson, in his early forties, founded the Land Institute in Salina, Kansas, but left it, he told us, "because I had concluded that the deterioration of the environment was outwardly mirrored in the present inner human condition and, as such, required not endless discussion but practical action. Most of my students were only passively absorbing my lec-

tures, then going out the door to forget them, taken up with the blandishments of citified preoccupations far from the concerns I was trying to instill in them. Admonished by our children to get off our duffs and practice what we'd been preaching, my wife, Dana, and I left our poshly comfortable life in suburbia to do what Thomas Wolfe said couldn't be done: "Go Home Again."

On his hundred acres of native Kansan prairie, of postage-stamp size compared with the expanses of heavily fertilized wheat growing for miles all around it in every direction, eroding soil into river systems, Jackson was struck with how his virginal setting, perennially teeming with life, contrasted with its surroundings, drearily and artificially inseminated. Why couldn't some of his naturally-growing plants be coaxed to match, or outyield, in terms of nutritious grain harvest, the artificially-planted acreage? Was it possible to get members of such a nonhybrid polyculture to produce seeds in copiously sufficient quantities for human needs? Could plants in an ecosystem that had fed millions of bison and other wild animals not sponsor their own fertility by fixing nitrogen from solar energy alone? Could not the germ plant of so-called "weeds," considered so pathogenic to ordinary cereal crops, be enlisted as allies in the grain-growing art?

The word *weod*, since become *weed*, had a double meaning in English as it was spoken in the Kingdom to about 1100. Its pejorative overtone, when it referred to plants tending to overgrow or choke out more desirable ones cultivated for food, was applied not to their being entirely worthless but to their being without value when growing in certain locations. Weed could also mean herb-derived from the Latin *herba*—or any plant that does not develop persistent woody tissue but like grasses dies back at the end of each growing season. To add to the confusion, the term *herb* also applied more restrictedly to a class of plants having savory, aromatic, or medicinal value.

This old Anglo-Saxon dichotomy suggests that weeds, like people, can be foes or friends, depending on how or in what circumstances they are viewed. What may appear unsightly, troublesome, useless, or injurious in one context can, in another, be comely, effectual, convenient, and benign.

In Romance languages there is no word per se for weed. The French call them *mauvaises herbes*—"bad herbs" or, because *herbe* itself specifically means grass, "bad grasses." In Slavic languages, such as Russian, they are collectively known as *sornaya trava*, or "rubbish grass," or more simply, in the singular, as *sornyak*, an epithet equivalent to *nudnik*, which characterizes a human being as a tiresome bore.

Spanish priests, who spelled herba with a "y," could refer to a fragrant Californian plant of the mint family as *yerba buena* (good herb); whereas Californian tar-brushes, as well as a Mexican oil-yielding plant, were *yerbas santas* (saintly herbs); and various South American vegetal specimens could be *yerbas sacradas* (sacred herbs).

When the conquistadors disembarked, they found native Indians cultivating and caring for all manner of wild plants, using them for both food and medicine, not only for their own bodies, but to nourish and revive the soil, interplanting them with domesticated crops to increase their harvests. The vegetally-unsophisticated priests, seeing beans, corn, squashes, and pumpkins flourishing side by side with what to them appeared to be totally useless companions, dubbed the non-productive offenders malezas—a word vaguely implying a sense of moral depravity. Going by the established standards of Iberian agriculture, they preached that the "bad" weeds should be rooted out and burned, like heretics, to leave the fields as bare as the apses of their grim cathedrals.

Jackson took a different path, surveying the literature to discover wild perennial herbaceous winter-hardy grass species with good seed-production records. Consulting the Plant Introduction Center in Pullman, Washington, as to which relatives of high-yielding plants from all around the world might be worthy of experimentation, he received, to his astonishment, 4,300 accessions, all of which he planted, each in a three-foot row.

In a several-years-long trial, he settled on two of the most promising. The first was giant wild rye, a native of Siberia and northeast Asia, with seed heads twelve to fourteen inches long, which had been prized by Genghis Khan whose Mongol cavalry hordes carried it with them on their campaigns of conquest almost all the way to the Baltic Sea and the straits of the Bosphorus.

The second was Eastern gamma grain, with startlingly high 27 percent protein-content seeds that could be "popped," like corn, made into tamales or bread, or used as an especially rich animal feed.

Looking to convert sorghum, a tropical Old-World grass similar to Indian corn, from a cold-abhorring plant into one that was winter-loving, he crossed one variety with its sorghum cousin, the noxiously weedy Johnson grass, to produce ten progeny, three of which survived the harsh Kansas winter to be recrossed into a succeeding generation of 1,500 grandchildren, 450 of which made it through the winter. Currently he is working to find out if his newly-created vegetal specimens can be safely propagated or whether their seeds may be so weedily aggressive as to represent a threat.

Still another prairie specimen being researched by the Land, as Jackson's institute is called for short, is a 34 percent protein Illinois Bundleflower nitrogen-fixing legume, which manufactures its own fertilizer and is prized for its seed by quail and wild turkeys, thus suggesting its potential excellence as poultry feed. Jackson's young ag-interns who come to work at the Land during one or more forty-three-week growing seasons, had already eaten it in birthday cakes. Preliminary extrapolations suggest that one superior strain may yield as much as 3,000 pounds of seed per acre, whereas 30-bushel-per-acre wheat produces only 1,800 pounds.

Of several alleopathic candidates, which suppress neighboring species by exuding naturally herbicidal toxic substances from their roots, Jackson has selected, as most expectantly successful, Maximilian sunflowers.

"What we're after, in an effort that will take years of dogged work," said Jackson, "are not just perennials per se, but perennials that can thrive among other plants so as to take advantage of the natural integrities within a complete system."

To get at the heart of this problem, John Piper, one of Jackson's young plant-experts, has, on a transect of the Land's chastely unsullied prairie, clipped above-ground portions of all its myriad plants to determine the ratio of "grass-ness" to "legume-ness" to "sunflower-family-ness" to other "nesses" in the whole biomass. This study, it is hoped, will reveal best-bet constellations of plants for meeting what Jackson calls "the expectation of the land," the important main goal being to find the appropriate mixes that can grow harmoniously and productively.

To date, this new research has laid bare various never-before-considered anomalies and curiosities. If Bundleflower, for instance, is planted separately from its natural neighbors, it is found to be prone to a splash-borne fungus bombarded from the earth below onto the underside of its leaves, which are attacked and pruned from the bottom up by the fungal infection. "The usual reaction of plant breeders to such a situation," Jackson ironically explained, "is to launch into a seven-year, highly expensive program to breed resistance to that particular pathogen into the plants, tying up the services of a whole crew of geneticists and plant tenders. But, when my people had a close look at our native prairie to see how Bundleflowers were faring in natural conditions, they were found completely free of the ubiquitous fungus because the entire grassy mat surrounding them absorbed the bombarding raindrop splashes to which its plants were naturally resistant and thus protected the Bundleflowers from attack.

"So what's clear, in the first instance, is that plant specialists

can volunteer to be 'heroes' in a needless battle, while in the second they can, with far less bravado, take advantage of nature's wisdom to manage easily and costlessly, an otherwise ominous threat. This illustrates the elegance of horticultural *simplicity*. It shows up the difference between a natural complexity in native prairies and a *complication* in man's so-called 'scientific' approach."

The saddest side of twentieth-century agriculture is, to Jackson, its having become over-operational and under-observational, with the modern farmer losing the ability to "look" that was common to any nineteenth-century naturalist.

"Agriculture has been subjected in its often nonsensical research to a kind of military attitude that pervades research everywhere, an attitude that sells itself with misplaced concepts of freedom. Our traditional idea of going west to find freedom, abandoning worn-out land to cultivate virginal pasture, is part of the same syndrome. But if we had looked at the land as a nurturing mother, as the Russians did, we might have seen that true agricultural freedom is not freedom to go, but freedom to stay. What Star Wars and chemical eradication of weeds have in common is that they both aim at putting a blowtorch to the planet. Weeds do much more to protect the soil than to harm it."

When Wes Jackson chucklingly says of his Land Institute, "We're out to save the world from sin and death," he is only half-kidding. The fact that his ideas of supplanting conventional annual grain crops with perennial alternatives runs counter to most of what has been taught for decades in state agricultural colleges is to him a sure sign he is onto something real.

Speaking at the Salina County Farmers Union, Jackson ridiculed his audience for wearing their silly visored caps advertising the products of their corporate chemical overlords, comparing them to so many medieval serfs.

Jackson has no illusions that his program can produce rapid results. "What we're trying to do," he says, "is build a symphony orchestra from scratch. Then we have to persuade an agricultural Lincoln Center or a Covent Garden to schedule its premiere performance. That's going to take at least a couple of decades. We've got a tremendous job ahead."

His friend and agricultural philosopher, Wendell Berry, co-author with Jackson of *Meeting the Expectations of the Land*, a collection of essays on sustainable agriculture and stewardship, concedes that finding converts to Jackson's ideas among the highly mechanized farmers in the corn and wheat belts who gamble on the ever-shifting grain tote-bonds is an uphill task.

But Garth Youngberg, executive director of Maryland's Institute for Alternative Agriculture, thinks that some 350,000 farm-

ers reporting annual sales between $50,000 and $100,000—occupying a niche between hobby farms and giant spreads—will be open to new approaches such as Jackson's because of their desperate search to cut costs.

Richard Harwood, deputy director of Winrock International, a development institute with overseas interests, is even more sanguine. He talks of replacing usual annual cereal crops with unusual perennials in a "decade or less," providing Jackson's insights can be institutionalized by rooting them in a nationwide network of private and governmental professional experts.

According to Charles A. Francis, agronomy professor at the University of Nebraska, who is introducing new ideas learned at Robert Rodale's research center in Pennsylvania, this trend is underway. If so, the families of malezas, so genocidally decimated since the first Spanish landings in America, may yet be reborn to play their role in a sane and gentle agri-practice that is truly cultural.

Whereas monks and pilgrims, equally misguided as they arrived in the New World, set about destroying weeds wherever they appeared, beginning the process a debilitation of America's greatest asset, its soil, the richest they had ever seen, the *maleza weeds*, like their Indian tenders, may yet bring back sense to agriculture in the Americas.

An enlightened mind on the healthy role of weeds, Professor Joseph Cocannouer, a widely-traveled Oklahoman soil scientist, who learned much from the Indians and has written extensively on the use and functions of weeds, in particular in *Weeds, Guardians of the Soil*, points out that by foraging far down into the subsoil like prairie grasses, weeds, with deep-diving roots, bring to the surface elements beyond the reach of most cultivated crops.

They also pump up moisture, raising it by capillary action along the miles-long surface of their root systems, breaking up hardpan in mistreated soils that can range from an inch or two to several feet deep between the surface of the ground and its lower strata. It is the weeds' unique ability, developed over millennia-long struggles for existence," says Cocannouer, "to seek food and water under adverse, mostly man-made, conditions, to 'eat' their way through concrete-like compaction by virtue of special dissolving substances exuded from their probing roots.

Expanding on this theme, Cocannouer stresses that most domesticated crops, pampered by man, have lost the ability to probe deep into the earth possessed by their wilder ancestors. But, once room has been made in the root tunnels of the weeds, cultivated crops can follow in search of sustenance; many normally shallow-feeding crops will forage deep into soil if conditions are made

right for them.

Both Cocannouer and Jackson stress that one of nature's valuable laws is that unrelated root systems do better when growing together than when that of a single plant is grown alone. First to go down are the anchorage roots, to support the plant so it can stand high to reach the powerhouse of sunlight with its endless supply of energy for photosynthesizing food in the leaf laboratories. Anchorage roots have to be rigid, yet flexible enough to stand severe strain. Next comes the great mass of roots known as the food hunters, ranging in size as they plow through the soil from many inches in diameter to slender threads.

Yet, when these rover roots have reached their source of food material, they cannot themselves take it up. This must be done for them by the tiny invisible one-celled root hairs, which protrude mostly from the smallest rover roots. These delicate absorbing rootlets, visible only under a microscope, are very short-lived, developing on the spot, living and dying in quick succession as they absorb food and water through a tenuous cell wall and inner membrane. The water streams up through root and stem in what Cocannouer calls "the greatest watercourse in Nature," climbing to the very top of the tallest trees, depositing nutrients in the leaf factory to be turned into the sugar without which there would be no human life. The remaining water, transpired through the leaf's mouth-like stomata is returned, along with gases, to the atmosphere in an endless living cycle.

Organic farmers point out the danger of soil saturation with soluble chemicals such as NPK, because the plant, obliged to suck up water to transpire, and normally selective in what it wishes to chelate and absorb, cannot screen out the excess ionized chemicals and thus becomes engorged with an imbalance which, though it may cause it to grow fast and flush, fails to give it, and those who eat it, the *balanced* nutrients they need.

And the rootlets' ability to function efficiently, drawing up substance from the soil, equally depends on the soil's condition. They cannot do so if the earth lacks suitable fiber, causing it to be too compact, or too loose, affording no support. Nor can the rootlets develop in soil that is too wet, too dry, or too cold.

Hence the usefulness of weeds. Live weeds break up the soil with their own roots. Dying, they bequeath to the soil the fiber of their bodies, rendering the hard clay spongy, the loose sands firm. And all weeds—from sunflowers to carpetweeds—help make the world's best fertilizer, either as compost or when turned back into the land, adding, in biodynamics, cosmic and telluric forces to the soil.

Anna Pederson Kummer, in *The Role of Weeds in Maintaining*

the Plains Grasslands, adds an almost metaphysical dimension, pointing out that, were it not for the constructive work of several important pasture weeds, the last wild-grass pasture areas in the United States—where the deer and the buffalo roamed—would today be as barren as desert. Weed growth, she says, is vital to the return of grass to land where the grass has been seriously thinned through overgrazing, sheet erosion, or a long period of drought.

When adverse factors kill the grass, it cannot come back to refiberize the soil with its own roots. It must wait for the weed roots, like yeomen for the squire, or nature spirits for the devas, to unlock the tight soil, and then fill it with the fiber of their bodies to reestablish porosity. The process may take one or several seasons. But thereafter the weeds do not drive out the grass. They only get the soil ready for the grass to come back. Grass has the power to rout weeds when conditions are right for the return of grass. Once the soil is rich in fiber, grasses dominate the weeds. That this could happen by chance, without the aid of some overlighting intent, is clearly a notion as limited as are the academies that have chosen to subscribe to it.

Wild meadows all contain weeds, many of which are constantly shifting about, imperceptibly improving weak spots so the grass can come back strong and healthy. Some weeds even produce special seeds that can lie dormant over long periods of time, even though sprouting conditions appear to be excellent, waiting for when they may be needed. In this way "nature" miraculously makes sure no situation can arise where varieties of weeds are not available and ready to go to work as necessity calls. Only when the land has been completely peeled by erosion or totally poisoned by chemicals will there be no weeds. And this has happened by the hand of man until half the West is desert.

Professor Cocannouer is convinced that the same laws apply to tall grass regions, and that the dust storms of Jackson's Midwest can be prevented in large measure by the correct use of plains weeds such as milkweeds, thistles, tumbleweeds, and others, without which the grasses could not survive.

For potato gardens, Cocannouer recommends planting pigweeds, spaced far enough apart to permit strong root development without crowding the tubers. A husky pigweed, spaced every two feet in a row of potatoes, can increase production and enhance keeping qualities. The same goes for peppers and eggplants. For a tomato or onion patch he recommends a combination of pigweeds, lamb's quarter, and sow thistle, scattered thinly. In a corn field weeds can become "mothers," making way for the corn roots to produce better stalks and ears. "Mother weeds" will

also loosen the soil for root crops such as beets, carrots, turnips, parsnips, and rutabagas, which need a deep, friable root zone where food material is easily available.

A crop growing in a field with the right amount of weeds, says Cocannouer, will survive droughts much better than crops grown on "clean" land. Moisture comes up along the outside of the weed roots, checking evaporation from the surface soil. The same weeds can provide fine shade for the ground when the sun is particularly scorching, or prevent a torrential rain from pounding the dirt into cement. Many varieties of weeds also protect domestic crops from insect pests, even having a place in the flower beds as companions to their ornamental brethren. If weeds are carpeted around a rose plant, their roots work down into the soil to intermingle advantageously with those of their hosts.

As the American Indians long since discovered, and many North and South Americans are rediscovering, (together with other aspects of a heritage almost completely blotted out by white teachers, priests, and government bureaucrats), a large percentage of the soil-building weeds are themselves succulently edible in one way or another. Most of them, including poke shoots, sow thistle, lamb's quarter, smooth-leaf pigweed, and even stinging nettles, if young and tender enough, are very nourishingly full of elements lacking in domesticated crops. Dandelion and wild lettuce make salads far more nutritious than the water-filled iceberg lettuce dominating the nation's salad bars; it can be cooked in a large kettle and seasoned to taste with anything from salt to bacon. The tender stems of the common milkweed, when boiled in two or three waters to remove the milky sap, are a fair substitute for the best spinach. Milkweed's small pods, when cooked, resemble okra, and are considerably more savory. Milkweed roots, once the original bitter taste is removed, can substitute for potatoes. The roots of primrose are highly nutritious, and sheep sorrel is delicious either in salads or as fillings for pies. And the fruit of the ground cherry makes excellent preserves.

Few would believe that, in pre-agricultural days, man's choice of foods, including what are now called weeds, was truly awesome. In southern Africa's Kalahari Desert, one of the most inhospitable environments on earth, the native Kung bushmen, exiled to that wasteland by tribes invading from the north, make, or made, regular meals on no less than eighty-five wild vegetables, never once setting eye on the less than a dozen kinds of plants that today make up a full three-quarters of the global diet.

Plants maligned as *malezas* by the black-soutaned white-collared advisors of "Stout Cortez," looking out over the Pacific from his "peak in Darien" could, had they tongues, inform us of many

things we need to know about the conditions of our soils, says Ehrenfried Pfeiffer in his book *Weeds and What They Tell Us*. Were we attentive observers we would see that, above all, they are witnesses to our failure to treat soil properly and that their abundant growth takes place only where man has missed the point in regard to them. As nature's corrector of man's errors, they tell a silent story full of subtleties concerning the finer forces through which nature helps soils by balancing and healing.

The powers of plants such as the fungi that produce molds were long unsuspected. For centuries the common mold, penicillium, growing on bread, cheese, other foods and even beverages, gave, at best, a clear warning that comestibles were getting old, rancid, or being stored in temperatures insufficiently cool to preserve freshness and combat decay. But when, just before World War II, its nontoxic acids were discovered to produce powerful antibiotics against microbes such as cocci, it graduated in man's eyes from its humbler role of mold, to that of lifeguard.

Like molds, weeds are both alerters of decay and survival specialists supreme, triumphantly persisting in circumstances where cultivated plants, softened through centuries of human protection and breeding, fail to stand up against nature's odd caprices. Their peculiarities allow them to be classed into three major groups, the first of which indicates increasing *acidity* in the soil. It embraces such species as sour-juiced sorrels; docks, coarse long-taprooted members of the buckwheat family; fingerleaf Lady's Thumb and the horsetails related to ferns. These are the best sentinels of all, for they provide warnings as to when changes for the bad begin in soil, the acidity being due to lack of sufficient air, water standing in the upper surface layer, insufficient drainage, excess of acid fertilizer and, most important of all, *lack of humus*.

Even where soils are underlain with natural limestone, as in Kentucky's famous "Blue-grass" country, acid-loving weeds may thrive because the topmost soil has been delimed through unbalanced cultivation, as when grain is too frequently sown without rotation.

To the second major group that reveal *crust formation* or *hardpan* in soils, belong field mustard, horse nettle, morning glory, quack grass, pineapple weed, as well as cresses and camomiles. The conditions for their redolent growth include wet soil turned up by plowing, or an excess of potash.

The third group, like Good King Wenceslas, treading in man's, not nature's, steps, often spreads out wherever he has disturbed nature, thriving on manure, compost, and other products of his cultivation—extensions, as it were, into man's artificially-created realm. These include plantains, chickweeds, buttercups, dandelions, nettles, mallows, as well as lamb's quarters, prostrate knotweed, carpetweed, prickly lettuce, and common horehound.

Weeds of the rose family are one of the surest signs of lack of horticultural attention to detail and insufficient cultivation. Members of the usually useful legume family, also unfairly termed "weeds," prefer light, sandy, or otherwise poor soil, and those of the pink family choose gravelly earth or strips along hedgerows or the edges of woods where they establish a "borderline" culture between cultivated and uncultivated nature.

Weeds, says Pfeiffer, are dietary gluttons which, if offered a full menu of soils, will go for those carefully hoed and manured rather than their natural habitats as fast as any *bon vivant* will go for a brunch of opulently varied dishes rather than a bowl of oatmeal.

To accurately detect the properties of a given soil it is necessary, he adds, to judge by the prevalence of an entire group of weeds rather than of a single individual. Should many distinct groups of "wild" plants begin an invasion into any area where they have previously been absent—the large, coarse fern called *bracken*, comes to mind—this is as sure a sign of decline in soils.

In the rest of his book Pfeiffer provides an account of what each and every weed among four hundred varieties can tell the gardener and farmer. But before entering into this detailed discussion, he says pointedly: "If you learn to listen to the lessons nature provides in producing weeds under extremely different conditions of soils, climates, and methods of cultivation, then you will have made your first step in the most important combat against them: to put them where they belong and keep them away from where they do not belong."

For centuries if not millennia the *brujos* of the South American jungles have known, just as do the sophisticated sages of the subcontinent of India with their Ayurvedic wisdom, that for every human ailment there exists a naturally growing plant, as often as not, malefically labeled a weed. As fast as we destroy their natural habitat, so, one by one, their remedies will vanish, perhaps forever, from the planet.

In his envoi, Pfeiffer enjoins us always to remember that whenever weeds grow, they speak out to us, and that wherever they flourish particularly abundantly, they indicate not their failure, but man's. "There are many, many dynamic plants called weeds," says Pfeiffer. "Go out in the fields and discover for yourself how benign their properties can be!"

Chapter 14

ICICLES IN THE GREENHOUSE

Two radically conflicting theories about an impending climate shift have polarized the country's "experts" into rival camps. One claims that the planet is gradually warming, with no immediate—though eventually serious—danger to mankind; the other claims that the planet is cooling, placing us in imminent peril of another ice age, with all the consequences of such a disaster, known and unknown. Both schools blame the situation on what they call the *greenhouse effect.*

The notion was first proposed in 1861 by Ireland's renowned natural philosopher John Tyndall, when he suggested that increased concentrations of carbon dioxide (CO2) in our atmosphere might someday raise surface air temperatures enough to cause a problem. When coal, oil, and natural gas are burned, the two principal combustion products are water vapor and carbon dioxide, about half of which remain in the atmosphere; as both are transparent, they allow the sun's rays to pass through to earth, but trap the reflected heat, as in a greenhouse.

Proponents of the warming trend, supported by official government agencies, and widely reported by the media, maintain that rising levels of carbon dioxide in the atmosphere, mostly produced by the burning of fossil fuels, are creating hot air, trapped at the equator that threatens to cause the ice caps to melt.

New York City, they say, will someday risk being not covered again by a mile of ice, as it was twelve thousand years ago, but

being subjected to the climate of Fort Lauderdale, its streets equally canalled by a sea rising gradually in the course of the coming century. It is estimated that the rise of sea level following the last ice age proceeded at the gentle rate of about a meter per century. With the threat far off, no strong countermeasures have been contemplated by a petrochemically controlled establishment, other than—until recently—vague talk of gradually reducing fossil fuel consumption. Now, with the threat to humanity of decades of droughts, coastal flooding, and widespread famine, the problem has begun to be taken more seriously, though many companies argue against bold action for fear of the economic hardships it might cause—to them.

The cooling advocates, mostly tenured professors of climatology and paleo-climatology, maintain, quite to the contrary, that the government's position is based on inadequately programmed computer models that leave out critical data, such as cloud cover, and are politically motivated to protect continued burning of fossil fuels.

To these climatologists, the threat is not warming but cooling: the greenhouse effect, while it does increase warming at the equator, has an opposite and much more dangerous effect of sucking up moisture in the tropics. In heavy clouds, this moisture is propelled by prevailing winds toward the poles where it condenses into snow to cause more cooling.

In the 1930s, Sir George Simpson, then Director of the British Meteorological Office, described what he called the *general circulation pattern* of the winds, whereby air heated in the tropical and subtropical zones rises to a high altitude, where it is moved by the differential in pressure toward the poles, there to be sucked back to the surface of the earth by the expanse of cold snow, causing a cyclic pattern. Increasing carbon dioxide steps up the cycle, contributing more heat to the warm zone, increasing the amount of water vapor taken from the ocean, and increasing the speed with which it is carried north and south. This contributes to more snow cover, which manufactures more cold air, which sinks faster and is carried at high speeds. At the same time, huge masses of heavy cold air fall off the ice and snow banks into the oceans, where currents distribute the cold around the globe. The phenomenon led Simpson to the odd conclusion "that the last Ice Age was not caused by a decrease of solar radiation but by an increase!" as has been recorded in the last few years.

A heavy, colorless, and odorless gas that does not support combustion, CO2 was discovered through the death of dogs in caves where humans could walk unaffected because the weight of the gas kept it below knee level. It is one of the most important ingre-

dients of the planet's biosphere. Exchanged between plants and animals, between air and sea, at a rate of hundreds of billions of tons per year, the gas arises from and helps sustain all life on earth, so long as it is kept within limits—which it currently is not.

By a variety of methods, including analyzing the bubbles trapped in glacial ice, scientists have estimated that in 1850, in a less-industrialized world, CO2 made up between 250 and 290 parts per million of the atmosphere. To monitor the clearly increasing amount of the gas in the present atmosphere, a measuring device was placed atop the Mauna Loa volcano in Hawaii where it has shown a rise from 315 ppm in 1958 to the current extremely dangerous 343 ppm.

Well aware that Tyndall was correct about carbon dioxide causing a greenhouse effect at the equator, "cooling" climatologists in the late 1980s still claimed that the planet as a whole was *not* warming, but cooling, with a loss of 1.5 degrees Celsius in average Northern Hemisphere temperature since 1938; that the arctic was expanding; that growing seasons were becoming shorter; that millions of the earth's inhabitants were threatened by drought; and that drought is due to cooling, not warming, exacerbating a potentially dangerous situation.

In fact, say geologists, ever since its origin, the surface of the planet, and thus its climate, has been cooling, owing to the slow decay of the original inventory of radioactive material in its core. Twelve million years ago, according to their calculations, the cooling reached a point where the "age of ice" began, a period which has seen a series of ice ages of increasing intensity. Furthermore, say the climatologists, the overall temperature has been falling for the last six millennia, and especially during the last forty-four years.

This flatly contradicts the data of the warming temperature experts who, according to the climatologists, fail to take into account the effect of *city* warming, a factor quite distinct from the general trend. They attribute the errors of the warming experts to dubious computer models.

Modern climatology, which only began to flower in the mid-1950s when a number of researchers became interested in what might actually be happening in the world's climate, was largely sparked by the discoveries of Italian-born Professor Cesare Emiliani, head of the Department of Geology at Miami University, published in 1955, now considered the basic modern contribution to deep climate research.

Studying small crustaceans known as *Foraminifera* in cores of sediment dredged up from the Gulf of Mexico, Emiliani was able to trace the climatic history of the planet going back millions of

Cesare Emiliani.

years, and producing the first reliable paleontological framework. What he found was a succession of seven recent ice ages, each lasting about a hundred millennia, with relatively short intervening periods of deglaciation, lasting ten to twelve thousand years.

The greenhouse effect is therefore not the only factor to be reckoned with in the scenario of threatening disaster. Ice ages have been returning, like clockwork, every 100,000 years or so, with short intervening respites—such as the one we have been enjoying since the mythical demise of Plato's Atlantis, about 9,000 B.C. As matters stand, warn the "cooling" climatologists, *only* our intelligent technology can postpone or prevent another cataclysmic freeze, which would wipe out the better part of the human race.

The earliest scientific description of ice ages and their origin was made in the middle of the last century by a Scottish philosopher-scientist, James Croll, who postulated that their cyclical recurrence was controlled by regular changes in the earth's elliptical orbit, the tilt of its axis, and its anomalous so-called "Chandler" wobble. Quickly discredited, the theory was only revived in the 1930s by the convincing mathematical calculations of a Yugoslav geophysicist, Milutin Milankovitch, which supported Croll's original data.

Milankovitch posited a continuous, changing relationship between earth and sun, with the earth's orbit changing shape every ninety thousand to one hundred thousand years. From being almost perfectly circular, the orbit slowly becomes slightly ellipti-

cal, then slowly moves back to circular, varying the sun's intensity by as much as 30 percent over the cycle. Milankovitch also found anomalous cycles in the roll, wobble, and shift of the earth's tilt, one cycle shifting solar energy from the Southern to the Northern Hemisphere and back over a period of twenty-one thousand years.

Even so, skeptics remained, and it took Emiliani's oxygen-isotope data from deep-sea cores to confirm the Croll-Milankovitch mechanism and arouse climatologists to take a better look at what might be in store for man. By Emiliani's scenario the planet is heading straight for the lockers of a deep, deep freeze.

Dr. John Imbrie, of Brown University, then produced a fascinating portrayal of the earth's climatology over the last 50 million years, adding chilling details to show that the end of an interglacial period can be sharp and dramatic, as indicated by the mastodons found in Siberian and North American ice packs, dating from the last onslaught of cold, about twelve thousand years ago—so quickly frozen that wildflowers they were chewing were found still fresh between their teeth.

Further evidence was produced in the 1960s when Professor George J. Kukla and his co-workers at the Lamont-Doherty Geological Observatory found that Czechoslovakian deposits of loess[1] indicated ten distinct ice ages, which fit with Emiliani's ocean-bottom figures to show that the interglacial periods have uniformly been short respites between long glaciations, and that the present interglacial is coming to its end. Kukla, Emiliani, and Milankovitch all corroborated Croll's orbital data.

Roused to action by the threat of imminent disaster, cooling climatologists looked to see what might be done. But they were hardly off their marks when the warming counter-theory was once more brought to the fore, spearheaded, in support of the government and the petro-chemical interests, by Dr. Roger M. Revelle, head of the Scripps Institution of Oceanography, and his German colleague Dr. H. Suess—no relation to the famous Dr. Suess beloved by children, though his notions are considered every bit as zany.

Revelle and Suess simply dusted off Tyndall's greenhouse effect, and by the 1970s managed, with the help of government funds indirectly provided by the petrochemical companies, to create a growing bias in "orthodox" American science toward the warming theory.

But, for those who understood, the climatological writing remained in Emiliani's cores. In the first major conference of climatologists met at Brown University to discuss "The Present Interglacial: When will it End?" the consensus of those attending was that "global climate change constitutes a first order environmental hazard."

[1] A pale calcareous clay or loam, generally of aeolian origin. loess is remarkable for its organic remains, which consist chiefly of land shells and bones of herbivorous and carnivorous mammals.

Letters were issued by the university to the governments of the world in which they were warned of an impending "global climatic disaster."

Two years later the International Federation of Institutes for Advanced Study (IFIAS) held a conference in Bonn, West Germany, which stated in part: "A new climatic pattern is now emerging....We believe that this...poses a threat to the people of the world. The direction of the change indicates major crop failures almost certainly within the decade....We urge the nations, individually and collectively, to plan and act to establish the technical, social, and political means to meet this challenge to peace and well-being. We feel that the need is great and the time is short."

By the fall of 1973 the U.S. Central Intelligence Agency obtained sufficiently foreboding evidence to sponsor a meeting in San Diego of the principal investigators representing the various research approaches. By the second day a consensus was reached that "a global climatic change is taking place, and that we will not soon return to the climate patterns of the recent past."

In 1975, eighty-four climatologists from ten countries attended the First Miami Conference on Isotope Climatology and Paleoclimatology, chaired by pioneer climatologist Cesare Emiliani and by Nobel laureate Willard F. Libby. In a consensus of the conference the latter wrote: "Ice ages have been the normal condition during the last several million years, with temperate climates enduring only 5 percent of the time....Because the global food supply depends primarily on climate, current understanding of climate must be vastly improved in order to meet the challenge of tomorrow's food supply."

Libby then produced the key phrase of the conference: "We possess the methods and techniques to establish climate history and only a concerned effort is needed to do that." By this Libby meant that concerned climatologists, aware that an ice age was coming on fast, had been studying methods to offset its damage with technological expertise.

Of the many suggestions proffered—including some expensive and dubious, such as darkening vast portions of the earth's surface with coal dust or the oceans with strands of black polypropylene—the one preferred by cooling climatologists was the proposal of Space Global of California to launch into orbit in near

space a number of sun-synchronous reflector systems called Solettas to reflect more sunlight onto the planet, enough to offset the natural loss. Similar reflectors, called Lunettas, could be used to increase moonlight by as much as one hundred full moons, allowing for nightwork in agriculture, multicropping, and better street lighting. Though what this might do to vital biological rhythms, not to mention Witches' Sabbaths, remained a perplexing query.

The system would require thousands of rockets to place some 1.5 million square kilometers of reflectors in orbit, costing hundreds of billions of dollars. But its proponents claimed the cost could comfortably be amortized over the sixty to one hundred years the system would last—avoiding the considerably greater discomfort of another glaciation.

That the problem is real and that the world is faced with a developing catastrophe of unprecedented global dimensions became clear from two CIA-solicited reports, which summarized the scientific literature and showed that the United States was facing a world of chaos. The first, "A Study of Climatological Research as It Pertains to Intelligence Problems," prepared by the Office of Research and Development for its internal planning purposes, starkly presented the findings and opinions of the climatological community that the world was cooling and that the next ice age was imminent. The second, "Potential Implications of Trends in World Population, Food Production, and Climate," prepared by the Directorate of Intelligence, Office of Political Research, added tamely that "if the cooling continues for several decades there would almost certainly be an absolute shortage of food."

But the language of the second report also made it clear that its drafters realized that the economic and political impact of a major climatic shift, with its promise of famine and starvation in many areas of the world, was almost beyond normal comprehension. Boldly, the analysts warned "there would be increasingly desperate attempts on the part of powerful but hungry nations to get grain any way they could." The reporters envisaged a dire spectacle, including war: "Massive migrations, sometimes backed by force, would become a live issue, and political and economic stability would be widespread."

Coldbloodedly they concluded that "in the poor and powerless areas, population would have to drop to levels that could be supported." Then came the bottom line, presaging future policy: "The population problem would solve itself in the most unpleasant fashion." By which euphemism they meant genocide, a cynical but handy solution to both starvation and overpopulation.

By 1977 the country was beset by serious drought—a clear

sign of cooling. The government's answer was to put sixty million more acres of land into production, further stimulating sales of chemical fertilizers, pesticides, and herbicides. The result was a very large crop of wheat and corn. But the per-acre yield was one of the smallest in the history of agriculture, and the nutritional content the lowest. For 1978—as predicted by the CIA and just about every cooling-climatologist—the country still faced a shortfall of food.

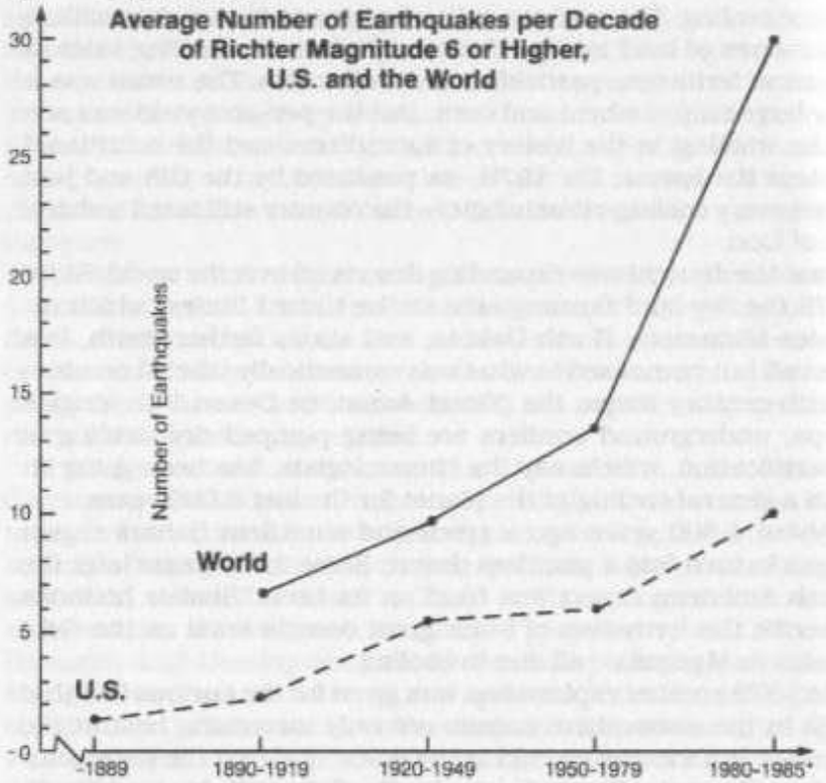
And the drought was expanding deserts all over the world. Since 1976 the dry-land farming area in the United States, which includes Minnesota, North Dakota, and states farther south, has been all but reannexed to what was romantically labeled on nineteenth-century maps: the "Great American Desert." To irrigate crops, underground aquifers are being pumped dry, adding to desertification, which, say the climatologists, has been going on with a general cooling of the planet for the last 6,000 years.

About 4,500 years ago a green and succulent Sahara region began to turn into a plantless desert. Some 2,000 years later the North American desert was hard on its heels. Similar histories describe the formation of other great deserts such as the Gobi wastes in Mongolia—all due to cooling.

In 1979 another explanation was given for the curious fact that CO2 in the atmosphere causes not only increasing heat at the equator, but increasing cold at the poles, and that the latter situation will eventually predominate. Dr. George Kukla and Dr. B. Choudhury published a paper in *Nature* in which they showed that carbon dioxide in the atmosphere *not only* traps the infrared wavelengths rising from the surface of the earth, thus increasing the heat; it also filters out the *near* infrared wavelengths as they come from the sun. These are the wavelengths that melt the ice and snow. Hence: more CO2 at the poles, more ice and snow. And since the snow and ice reflect the rest of the solar energy spectrum back into space, the growing snow and ice are manufacturing increasing amounts of cold.

Already in 1978 the alarming increase in snow cover during the period 1968-72 was discussed in the world's largest scientific journal: *Science*. For several years thereafter the figures for snow remained well above the pre-1972 peak.

Ecologist Irving Kaplan then found a further correlation between increasing cold and the number of earthquakes. The colder it gets, the more earthquakes we get. Ice and snow accumulating on the poles press down on the planet, causing it to bulge at the seams like a balloon. This triggers the pre-stressed earthquake faults into slipping: hence earthquakes. It also causes volcanism—potentially even more dangerous—by squeezing the molten



*Prorated for the decade from earthquakes 1980-85.
Source: James M. Gere and Haresh C. Shah, *Terra Non Firma* (New York: W.H. Freeman, 1984)

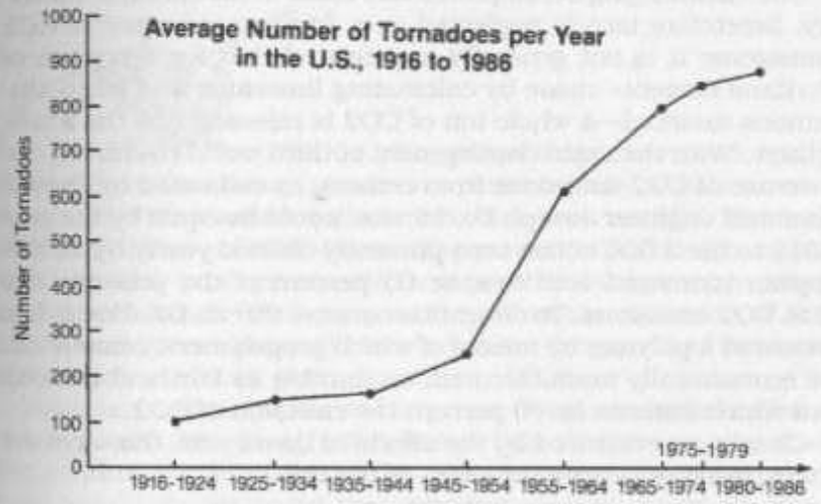
magma and causing eruptions. The colder it gets and the more snow presses down on the poles, the more magma is compressed, and volcanoes act up.[2]

With the eruption of the Pinatubo volcano in the Philippines in mid-1991, sulfates and other aerosols cooled the climate in 1992 and 1993. But thereafter the climate warmed up again. The average global temperature in 1995 was higher than in any years since record keeping began around 1860. Glaciers all around the globe—with the exception of Norway—began to melt. In the Alps since 1980, 10 to 20 percent of the remaining glacier volume has

[2] The 1980 Almanac shows a significant increase in both earthquakes and volcanism; it lists 13 major earthquakes between 1906 and 1942, and 34 for the next 36-year period from 1943-1979, an increase of over 250 percent as many. For volcanic eruptions the same source lists an increase of over 500 percent for the same-length period. Eruptions such as that of Mount St. Helens, occurring closer together, are tied to the process of glaciation. Volcanism, predominately a spring and fall occurrence, is a reflection of the wintertime increase in the weight of the snowfields at the north and south polar regions respectively.

been lost and snowlines are rising. The result is extra runoff in rivers, increasing risk of flooding, erosion and rockslides. In May, 1991, a landslide caused 16 million cubic meters of rock to plunge down a mountainside in Switzerland destroying a small village. In Venezuela, three glaciers have completely disappeared since 1972. In Peru the melting of glaciers in the Cordera Blanca region of the Andes has posed a threat to agriculture.

This conflicting data on cooling and warming had the world puzzled while the experts argued, but both the warming and the cooling proponents now agree that there is danger in the air. In 1996 alone, emissions of carbon dioxide and other heat-trapping gases grew 3.4 percent. In the United States emissions were 7.4 percent above 1990 levels. The United States, with less than a twentieth of the world's population, was giving off almost a fourth of the gases that trap heat in the atmosphere, but only pledged to reduce such emissions to the 1990 level by the year 2000. Japan's



Source: The World Almanac, 1972, 1980. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Technical Report, 1986.

Larry R. Ephron, author of *The End*, forecasting the coming Ice Age, says there is probably some error factor in this graph due to complete reporting, but it is probably significantly less than the 900 percent increase shown from 1920 to 1986, and the 350 percent increase shown between 1950 and 1986.

emissions had risen an alarming 8.3 percent between 1990 and 1995. All together these increases caused the $1.4 trillion insurance industry to grow nervous about their financial vulnerability in the face of imminent worldwide catastrophes. The warming experts, convinced that the average global temperature might increase from 1 to 3.5 Celsius during the next century, now agreed

that without drastic steps to curb greenhouse gas emissions the planet faced disaster, with more frequent and intense heat waves, wide-scale ecological disruptions, a decline of agricultural production in the tropics and subtropics, and continued acceleration of sea-level rise. They estimate that increasing carbon dioxide emissions could lead to doubling the present levels by the year 2050, quadrupling them by 2150. To reverse the trend, reductions would need to be between 60 and 80 percent of today's levels. But the same experts fear that a long time would be needed for the earth system to return to normal levels—not centuries but millennia.

Still, the major petrochemical companies continue to lobby for more research before taking any serious action to cut greenhouse pollution. Though by now it is clear that either the petrochemical companies buckle down to developing alternate systems to reduce the burning of fossil fuels or the planet may be doomed.

One encouraging development has come to the concrete industry, heretofore largely neglected as a dangerous source of CO2 emissions; it is not generally appreciated that for every ton of Portland cement—made by calcinating limestone and silico-aluminous material—a whole ton of CO2 is released into the atmosphere. With the rapid development of third world countries, the increase of CO2 emissions from cement, as estimated by French chemical engineer Joseph Davidovits, would be equal by the year 2015 to the 3,500 billion tons presently emitted yearly by all European industrial activities, or 65 percent of the present total U.S. CO2 emissions. To offset this massive threat, Davidovits has patented a polymer by means of which geopolymeric cement can be economically manufactured, as durable as Portland cement, but which reduces by 80 percent the emission of CO2.

Clearly, as evidenced by the efforts of Davidovits, the ways are there. What is lacking thus far—is the will.

Chapter 15

Dust for Life

If the cooling proponents are correct, tending the planet's soil may now be our prime priority, if only to save the world from imminent glaciation. In a book entitled *The Survival of Civilization* (1982) two cooling proponents, John Hamaker and Don Weaver, came up with a means for doing so, providing we act with haste. Their proposal: rapid remineralization of the planet with ground-up rock dust to hasten the growth of biomass with which to absorb great quantities of CO2.

Hamaker, a seventy-year-old engineer-farmer and climate theoretician, with his young collaborator, Don Weaver, warned that the pending climate catastrophe was imminent, predicting that trees would die the world over, growing seasons would shorten, winters would become more severe and that unless the world mobilized to counter these effects, famine would be our common fate.

All our healthy topsoil, say Hamaker and Weaver, all the microorganisms in it, and all the plants that thrive thereon, from lichens to the great rain forests, received their first nourishment some twelve thousand years ago from billions of tons of mountain rock dust, ground-up and washed away by melting glaciers from the last great ice age, globally spread by whirling windstorms. Now all this life-giving dust has been used up, or wantonly eroded, and unless something is done to replenish the soil with rock dust, and quickly, we may have to wait another millennium for the end

of another great Age of Ice to do it for us.

Hamaker's suggested remedy, quick, easy, and relatively cheap, requires a massive program of worldwide soil remineralization and reforestation. He wants us to grind up glacial gravel (which contains all the required elements, and of which there is an almost inexhaustible supply at an economical price), spread the dust far and wide, and then plant trees as if there were no tomorrow. To facilitate the operation he has patented special grinders to be produced in Australia, Sweden, and Israel, and has hopes of eventually enlisting the world's air forces to distribute the dust, a suggestion that might put these entities to the first productive use of their existence.

Already in the late nineteenth century a German chemist, Julius Hensel, taking issue with Liebig and the proponents of chemicals for agriculture, had proclaimed that all that was needed to produce luscious, healthy crops was ground-up rock dust, the aboriginal food of plants. His method, once put into practice, would not only free the farmer from heavy yearly expenses for artificial fertilizers, but gradually wean back his exhausted fields to their virgin state of fruitfulness.

Something of a mystic, Hensel liked to quote a Hindu saying that "God sleeps in stone, breathes in plants, dreams in animals, and awakens in man!" His appeal to the world was simple: Turn stones into bread! This was all it would take to feed the hungry; prevent disease in animals, or epidemics in man; make agriculture once more profitable; return the unemployed to country life by revealing the inexhaustible nutritive forces—hitherto unrecognized—that are stored in rocks, air, and water.

Two hundred farmers in the Palatinate, delighted with the first few years of experimentation with rock dust on their fields, supported Hensel's claims. They testified before a court of justice that fertilizing with stone meal showed far better effects than those achieved with chemicals.

But the greater Hensel's success, the greater grew his opposition. Though the rock dust was successfully tried out on a large scale on the estates of the grand Duke of Luxemburg, as verified beyond doubt by a company of teachers and editors who made minute comparisons with neighboring fields cultivated with different fertilizers, by that time even royalty could no longer stand up to the chemical interests. Afraid of losing their profitable markets, they launched an expensive and rabid campaign to denigrate Hensel, keep his books out of print, and put a stop to his "heretical" notions that NPK might be bad for the soil.

By the time the German chemical companies had amalgamated into the vast I.G. Farben conglomerate and brought Hitler to

John D. Hamaker, from sketch by Steven Johnson, January 1986.

power, the last of Hensel's books was consigned to the flames.

The loss to Germany from not listening to this prophet was to be a devastating plague of dying trees. By 1987, 50 percent of the forests in West Germany were dying, including large parts of the famed Black Forest, a disaster attributed by Hamaker not so much to their being doused with acid rain as to the fact that the soil in which they struggle to live has been deprived, through constant demineralization, of its essential nutrients. Throughout the past ten thousand years of our interglacial respite we have taken minerals from the soil into the plants we eat, or leached minerals away down river and stream, as Steiner clairvoyantly warned, without replenishing the stock, a disaster greatly increased by the use of chemical fertilizers which exacerbates erosion.

In 1984 the world lost an estimated 22.7 billion tons of topsoil to erosion, and another 25.4 billion in 1985. According to a UNEP estimate at the beginning of the 1990s, 3.6 billion hectares or 70 percent of potentially productive drylands were affected by desertification. Currently 65 percent of agricultural land in Africa, 45 percent in S. America, 38 percent in Asia and 29 percent in North America and Europe is affected by soil degradation. In Mexico 70 percent of agricultural land is affected by soil erosion.

As trees weaken from starvation, they become vulnerable to

pests, industrial pollution, and increasing forest fires. When they start to die—as indicated by decades of narrowing tree rings—they fail to pull excess carbon dioxide from the atmosphere. Whole forests weaken; stray lightning bolts start huge forest fires; more CO2 is spewed into the air.

Trees on hilltops, says Hamaker, go first because they catch more wind than down in the hollows, plus the fact that the soil is thinner on the top of hills, an assertion recently proved all over the Alps. Acid rain puts the finishing touch on destroying the few remaining minerals. And when soil becomes acid, more and more microorganisms are eliminated. The only thing acid rain accomplishes, according to Hamaker, is to accelerate the death for trees already dying of starvation. Efforts to replant seedlings on such demineralized land equally fail because life in the soil is already diminished. There is little for the plants to grow on.

According to a UN-FAO estimate, half the world's tropical forests have disappeared since 1950: 37 percent in Latin America, 66 percent in Central America, 38 percent in Southeast Asia, 52 percent in Africa. And reforestation is slipping far behind. Between 1991 and 1995 the world lost an average of 11.3 million hectares of forest annually—about the size of Honduras. Hamaker warns that man's gross deforestation of the tropical rain forests, added to the rapid increase of CO2, could trigger the next ice age when the amount of carbon dioxide in the atmosphere reaches 345 parts per million—just two pips up from the present 343. Nicholas Shackleton and other scientists in Great Britain writing in *Nature* showed that the last glacial period had begun when the concentration of carbon dioxide in the atmosphere reached a mere 290 ppm.

According to Shackleton, the last interglacial period behaved much like ours, with carbon dioxide rising over the last five thousand years to a peak which ushered in the ice age, after which the cold waters of the oceans quickly absorbed the CO2. Shackleton also implies that the growth of CO2 was caused by the destruction of vegetation through developing drought and cold as an interglacial came to an end.

Like their fellow cooling-climatologists, Hamaker and Weaver predicted worldwide drought, followed by increasing forest fires, earthquakes, volcanic eruptions, high winds and tornadoes, the latter caused by the increasing expanse of arctic snow cover interacting with increased heat from the tropical zones. This scenario for the coming ice age included, as a permanent feature in the middle latitudes, 100-200-mile-an-hour northerlies.

Other Hamaker-Weaver predictions, like so many vultures, were already winging in. 1983 produced more than a 25 percent increase in major earthquakes around the world. Japan had the biggest in a quarter century in May, 1984. The 1983-84 winter broke all records for cold. Storms and earthquakes in the Northern Hemisphere, especially in Canada, Iceland, and Russia, were followed by a similar pattern six months later in the Southern Hemisphere. The November, 1983, winter storm in Soviet Europe was one of the earliest of the century. December, 1983, was the coldest in American history. Oklahoma, Nebraska, Texas had record-breaking winters. Blockbuster snowstorms, quite unseasonal, pounded Colorado and Wyoming. Utah recorded 65 below in January of 1984. Snow blanketed Italy as far south as Florence, while in the Rhône delta of the sunny French Riviera thousands of flamingos died because they could not get at their normal prey in brackish water covered with a layer of ice.

As recently as 1996, floods, hurricanes, wildfires and other weather-related catastrophes caused a record $60 billion in economic damage. Severe flooding in China cost the lives of 2,700 people, driving 2 million from their homes. A series of cyclones in northwestern Pacific Ocean damaged China, Taiwan, Philippines and Viet Nam. A cyclone killed 2,000 in India. And that year produced the most severe storm in the Great Lakes in fifty years.

Meanwhile, south of the Equator drought ravaged Brazil, Australia, Africa, as millions died—over a million in Ethiopia's Sahel region alone. And millions more were threatened by a repetition of the drought in 1988. Vast drought-induced tropical forest fires—a critical factor, according to Hamaker, in speeding the course of glaciation—were set ablaze to release more smoke and CO2, as documented by the semi-secret NASA photos taken from U.S. satellites. In Indonesia a massive forest fire in 1984 burned for five months, devastating an area equivalent to Massachusetts and Connecticut combined. Considered perhaps the most severe environmental disaster the earth has suffered in centuries, it wiped out plant and animal life, including hundreds of thousands of giant mahogany trees, countless birds, bears, deer, pigs, civets, forest cattle, and rodents, leading to the extinction of many species.

Ecological "experts," who had considered the region—formerly Borneo, now East Kalimantan—one of the dampest parts of the world and ecologically stable, began reevaluating existing ecological assumptions. Although the immediate cause of the fire was unknown, forestry inspector-general Hendri Santoso did not rule out the possibility that logging concessionaires, who controlled some 5.2 million acres, ignited the already-dry forest, hoping it would cover up their failure to carry out obligations to plant a seedling for every tree they felled. A West German estimate put

the loss of salable timber at $5.6 billion.

Even worse fires in Indonesia in 1997, deliberately started by land clearers, darkened the skies with a filthy haze across Malaysia, the Philippines, Singapore, Thailand, Brunei, and Papua New Guinea, creating ecological destruction, economic hardship and deaths from starvation, dysentery and influenza, cooling a vast area by impeding the sun's rays.

Yet, despite the general accumulation of evidence in support of the "cooling" school, the warming theory continues to be the basis for "non-official" government policy, though some of its supporters are beginning to express their doubts.

Hamaker boldly accused the administration of lying or of using evasive language for political and economic reasons. He claimed the warming theory to be no more than a conspiracy of the financial complex aimed at preserving massive investments in fossil fuels—oil, coal, and natural gas—along with their related industries. "Such a massive conspiracy of silence," wrote Hamaker, "is understandable only when one realizes that 'official' announcements of our situation would plunge the world into a financial debacle....The bankers have been wringing their hands over this for half a dozen years; meanwhile our chance of survival gets weaker every minute."

In the Ozark highlands of south-eastern Kansas, its limestone sculptured by fast flowing streams, John D. Hamaker and his wife, Anita, had only recently moved into a still unfinished bungalow with a long, gently sloping metal roof.

Already a martyr to the cause of eco-agriculture, John's stooped frame was riddled with Agent Orange, accidentally sprayed onto him by a passing truck while it was still legal in this country. Randomly the poison broke out on his tortured body, causing great discomfort and a much weakened constitution.

Yet his strong Midwestern voice, like gravel rolling in a river bed, resoundingly warns that if we do not hurry, it will all be over before we know it. By his calculations we are already in the crucial stage, with only a few years in which to stop the onslaught of the ice. "We must cut down on fossil fuels, immediately! And we must plant fast-growing trees to absorb as much CO2 as possible. Hopefully they'll mature in time to be harvested for turning into alcohol, a fuel which does not contaminate the air. And we must develop solar heat, and other healthy alternatives for energy, many already invented, but censored by our rulers, yours and mine."

Basic to John's thesis is the urgent need to remineralize the planet's soil not only to save the trees and agriculture, but to provide the vital nourishment man needs to retain his health and

rational wit. Only with remineralization, says John, can the soil's microorganisms obtain the nutrients they need to reproduce, lay down their bodies, and make the stable colloidal humus vital for plants, animals, and humans to thrive on as they once did before we demineralized the earth. Like most great discoveries about nature's secrets, John's was made by a chance observation: rain water running over gravel from a concrete parking lot, a sort of milky fluid, that disappeared into a pile of rocks to produce a dandelion of rare proportions.

"I took home enough of it that night to have a mess of greens for supper," said John, "just from that one plant. And there was enough left over for three more servings. I mean, that was some dandelion, and it had excellent taste. The next day I looked around where that gravel was, and I could see that the feeder roots, way down, had ends that were white. But back on the starter root I saw something which I recognized as humus, attached to the roots, and that gave me something to really think about."

John's wife ushered us to the kitchen table where she had prepared a supper of organic vegetables, and because the Agent Orange has sapped his strength, a meatloaf for her husband. "It's not what kind of food you eat," said John, "vegetarian or meat. The Eskimos lived healthy lives on fish and blubber. What matters is that the foods eaten carry forward the protoplasm of the microorganisms grown with a natural balance of the elements. Man's intestinal tract is a root turned inside-out. The purpose of eating food is to recreate a population of soil organisms in the intestinal tract. Protoplasm from the microorganisms can then be absorbed right into the blood."

It was a novel way to approach one's supper. But on reflection, as it developed, John Hamaker's thesis made more and more sense, though not of the sort provided in Biology 1 at Harvard. Between mouthfuls of his own organic home-grown food, John spelled out the substance of his spiritually and physically nourishing discovery, one with which he hoped to encourage a healthy agriculture in a healthy world—providing we manage to stave off the coming ice age. All plants, animals, and humans, says John, live on protoplasm, and microorganisms are the only living thing that can make organic protoplasm from inorganic elements.

Never yet successfully analyzed, protoplasm is described as a living substance which fills the cells of microorganisms, plants, and animals, containing all the compounds of life in a mixture of such minute components that it has defied analysis with microscope.

Surprisingly, but not unnaturally, Hamaker's idea of protoplasm dovetails with that of the theosophists. According to Annie Besant,

the prana of the Hindus, an energy from the sun that parallels but is different from electromagnetism, builds up minerals. Functioning as the controlling agent in the chemico-physiological changes in protoplasm, prana leads to differentiation, and to the build-up of the various tissues of the bodies of plants, animals, and men.

In the veiled language of *The Secret Doctrine*, Helena Blavatsky speaks of prana as invisible and fiery "lives," which supply the microbes with "vital constructive energy," enabling them to build the physical cells, "the size of the smallest bacterium relative to that of a 'fiery' life being as that of an elephant to the tiniest infusoria."

"The cycle of life" said John "is really the story of the travels of protoplasm as it goes from microorganisms to all the life above the soil, then back into the soil. That dandelion started me into all kinds of new experiments."

"Saucers all over the place: Like petri dishes in a lab." said Anita, smiling benevolently. "All kinds of things in 'em."

John, unperturbed, picked up where he'd left off. "I arrived at the inevitable conclusion, never taught in Aggie colleges, that the plant was sucking protoplasm directly out of the microorganisms, leaving just the skins behind. Fresh organisms, not consumed by the plant roots, dehydrate and join the bank of fertility with almost no loss to leaching or erosion. Ultimately, I realized, what's left over is the makings of real good healthy humus."

The facts fit precisely with Podolinsky's description of the genesis of humus: but the notion that the roots were carnivorously devouring the insides of the microbes was arresting. In Podolinsky's case, his roots devoured the entire contents of the humus jar, the living with the dead.

"The ag colleges," said Hamaker, "funded by the chemical companies, have all along insisted that roots cannot absorb anything larger than an ion in solution, meaning their NPK, ruling out the ingestion of whole molecules of humus, and therefore any advantage to placing organic additives in the soil."

He waved his fork for emphasis: "The chemical food faddists' concept that minerals are taken in by the roots only in the form of ions, and in some unproven way are built into proteins by photosynthesis, is false. The protoplasm of the organisms is simply transferred from the microorganism into the plant cell to perform the functions required by its nucleic acids. Each higher form of life uses the protoplasm transmitted up the ladder of life to make compounds specific to its needs.

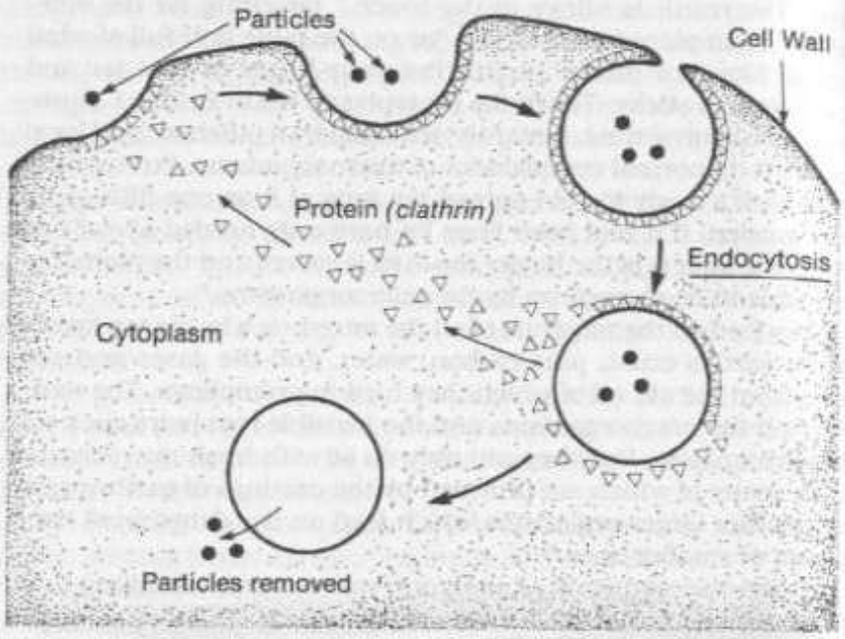
Protoplasm in water is slightly milky and slightly yellow. Both effects are probably from lipids (fats) in a state of colloidal emulsion. The result is sticky to the touch." Reaching for the sideboard, John placed a small jam-jar on the table half-full of what looked like nice brown earth. "Put your finger in that jar and you'll feel it's sticky. That's the protoplasm. It's in British Columbia glacial gravel dust, instantly activated by a pinch of good local soil with its normal complement of microorganisms. Put into the ground, it's ready to go! I spread ten tons of it on one-fifth-of-an acre garden. If it had been finer I'd have only needed about two tons. The finer it is the bigger the area it covers and the more it is available to be chewed up by the microorganisms."

They feed on the minerals of all the mixed rock in the top layers of the earth's crust, plus carbon, water, and the gases and sea salts from the air, all of which they turn to protoplasm. The rootlets find the microorganisms and the invisible root hairs suck up this protoplasm. But they can only do so with fresh microorganisms, many of which are provided by the castings of earthworms or by other larger organisms which feed on the dehydrated carcasses of smaller ones."

At last the sequence of underground events was falling into order: Hensel's fine rock dust, in Flanagan's colloidal suspension, via Schatz's chelation, is the elemental food of microorganisms, which in turn becomes the food of other microorganisms: they, and they alone, according to Hamaker, are capable of transmuting the inorganic rock dust into the mysterious living protoplasm; plant roots, sucking in this basic ingredient, pass it up the ladder of life. An original conceit, it waits for confirmation in the halls of science, but leaves no doubt that plants must ingest more succulent and nourishing sustenance than the synthetic chemicals dished up in NPK.

Since no microscopic analysis of the underground process is as yet possible, anyone's description is as plausible as the next. Dr. Hans Jenny, Professor Emeritus of Soil Science at Berkeley, the world's authority on the subject, whom we consulted on the phone, admits that, although the orthodox term "contact exchange" is restricted to the exchange of ions between soil and root, he does not exclude using the term "diffusion" to cover the intake of whole molecules, providing they are small enough; small, in this context, being a matter of opinion.

Dr. Patricia Jackson, of the USDA in Beltsville, Maryland, maintains that the size of ingestible molecules is limited by the size of the pores of the cell membrane to ten angstroms, a process witnessed in cell cultures in the laboratory, but never in living plants. Yet ever since the 1940s careful researchers have maintained that plant roots can absorb much larger molecules. Recent research shows that thanks to chelating components in humus, plants



How cells form pits in their cytoplasm to ingest particles. From an article by Mark S. Bretscher in *Scientific American*, December 1987.

can capture and ingest enzymes, hormones, and colloidal particles by means of the gelatinous mucigel which they exude.

Dr. Bargyla Rateaver, a petite but fiery supporter of the organic method—who single-handedly and successfully fought for the introduction into California's university system of regular courses on organic agriculture for degree credit and for transfer credit, against the most obdurate opposition from university deans supported by the chemical companies—is categorical in her assertion that root hairs ingest large molecules, and even whole microorganisms. Quite recently, Dr. Rateaver was given an award by the International Alliance for Sustainable Agriculture, not, as the speaker put it, for her brilliant work in support of organic agriculture, but "for the amount of hell she raised in trying to set the record straight." In various publications she has shown how the tiny single-celled root hairs of such nitrogen-fixing legumes as clovers, alfalfa, and vetches, "invaginate" their tips to allow the entry of chains of Rhizobium microbes. Inside the root, the Rhizobium congregate and multiply by the million to fill nodules where they fix nitrogen from the air for their own benefit, for that of their leguminous hosts, and for the soil to which it is eventually bequeathed.

An explanation of this remarkable process of cell ingestion was provided in the December, 1987, issue of *Scientific American* by Mark S. Bretscher. In an article on how animal cells locomote, he describes what is known as the "endocytic cycle" in which a cell's plasma membrane indents into a pit coated on the inside with protein. This pit balloons inward, taking with it the material to be ingested, is pinched off to form a vesicle, moves into the cell and, in plants, releases its load of nutrients in sizes thousands of times larger than the ions of the NPK solution. Comparatively speaking, the difference is between ingesting a mouse and an elephant.

A typical bacterium is about ten times the size of a colloidal particle; the particle, in turn, may be two or three hundred times larger than a small protein, which, in turn, is made of amino acids whose molecules are larger by far than ions. The scale is not peas to watermelons, but peas to dinosaurs.

And yet, as Dr. Rateaver points out, somewhat scathingly, the chemical companies, while insisting that plants can only take in ions in solution, maintain, speaking out of the other side of their mouths, that large molecules of their systemic pesticides can somehow be ingested by the plant so that anywhere a bug bites the plant it is bound to die. No mention is made of what such a bite may do to humans.

John paused to butter some bread. "In nature, this is the only way that plant roots feed. After a while, the older parts of the root become coated with the proteinaceous substance of the humus, which gradually turns to a natural brown. These cells become sealed, so all the intake comes from the tips, which in the soil grow toward new supplies of microorganisms. J.J. Dittmar, of Iowa State University, found that the total length of roots and root hairs of a single rye plant was seven thousand miles, and its total surface area, seven thousand square feet. The roots alone grew more than three miles per day in search of microorganisms. And only the finest particles of mixed rock-dust can cover the phenomenal surface area required to grow significant quantities of something so small as a microorganism. And such particles are only a tiny fraction of the topsoil; if they aren't replaced, the soil wears out, and then it's dead."

John took a mouthful, chewed it deliberately, then, pointed to his mouth. "A lot of the solution's in the grinding. The smart farmer will include very fine sand-sized particles in the silt he spreads, so the earthworm will have grit for his gizzard with which to grind up silt along with any organic matter. Professor Emanual Epstein at the University of California, Davis, has estimated that plants suck up five times the billion metric tons of minerals mined each year by man. And the earthworm grinds up even more than that. He's a big operator, and he works cheap. While the worm cleans

the roots, he is grinding silt and old roots to make fresh organisms which come out of his tail to feed the dandelion root ends. If we fail to keep free carbon throughout the topsoil, which gives it that black color, the earthworms disappear." He wiped his mouth: "It is a reasonable conclusion that without the carbon for his energy requirements he just can't do the work of grinding. Without grinding, new fine silt is not there to replace what's been removed in the crops. When the stock of protoplasm in the soil is gone, growth of crops comes to an end. With pitch, which is mostly carbon, and with rock dust, I did countless experiments."

Anita rearranged the dishes, asking if we cared for custard. "It's made with honey. There's never any sugar in this house."

John smiled, then took a more positive tone. "We can build enormous per-acre tonnages of protoplasm in the soil in a very short period of time, enough so that the sun energy reaching the plant becomes the only limit to its growth. Photosynthesis way up in the leaves is still just as essential as is protoplasm down in the roots, and that's the limiting factor. Whereas record crops have usually been produced by the use of large amounts of composted manure to produce the organisms, such record crops can now be grown on every acre of land by using rock dust with some carbon."

John estimated that the national average yields in fifteen years could run about three times what they are at present. Protein content of grains, the indicator of health-giving potential, could run two to three times the present protein figures.

Despite his warnings of impending doom, the creative farmer in him was still sanguine about the wonders we could perform with his solution. "When we have rebuilt our soil fertility to eighteen inches in depth," he mused, looking eastward at the bare wintry landscape, "the Mississippi River will have an even flow of silt-free water all year round. Annual flooding in the lower Mississippi valley will cease. Underground aquifers will again load up with water."

The bottleneck to enacting Hamaker's vision remained a lack of grinders. His solution awaits a wider manufacture and distribution of these patented devices, easier access to the bottomless pit of glacial gravel, and the eventual cooperation of the world's air forces to help spread the dust in a do-it-or-die program to save mankind. If enough trees are planted and fed with glacial rock dust, and a stop is put to the decimation of the great rain forests, there may still be a chance, says Hamaker, for man's best friends, the trees, to suck up excess CO_2 from the atmosphere and postpone the advent of an ice age long enough for scientific minds and enlightened legislators to come up with a means for more permanently avoiding such disaster.

"I don't know of any commercial grinders that are suitable for direct installation on the farm," said John. "The motors are too big for farm wiring. They are too costly; and the power and maintenance costs are too high. I would say that a ten-horsepower motor, or even less, would take care of most requirements. But all this is going to take government-sponsored programs on a crash basis.

In World War II we learned to build Liberty ships as fast as we built cars. Now, if we don't act soon, we're going to have hunger all over the world, on the broadest scale, together with a crisis in medical care, catastrophic flooding, food riots, and revolt at the polls, or in the streets, against a system which, for profit, substitutes lies for truth and generates national leadership you can't distinguish from the Mafia."

He sighed, his last mouthful of meatloaf as chilled as his prognosis for the future. "Congress could take action," he said wearily. "But they will only do so when they realize they're threatened with impending death. By then it may be just too late. To get them off their duffs we must, each of us, prevail upon our congressman to act, and act immediately. It is still in our hands; and the job can still be done."

Chapter 16

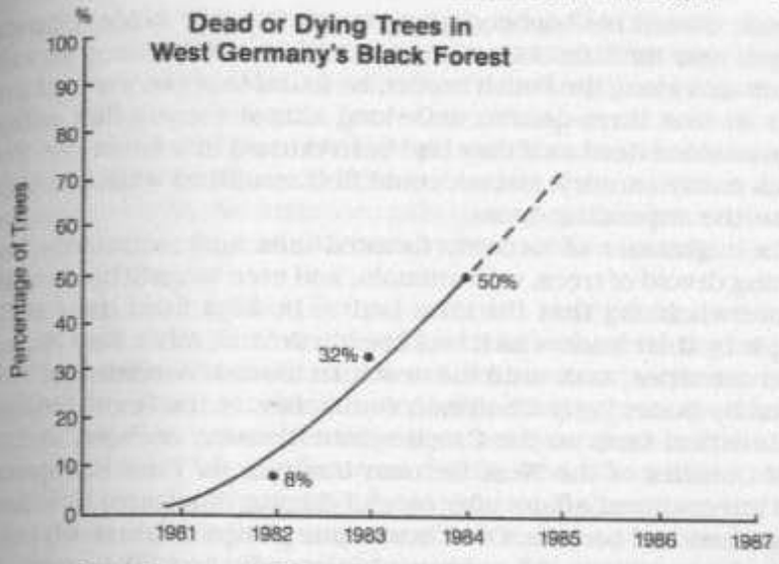
LIFE AND DEATH IN THE FOREST

At the beginning of the 1980s, the leading German weekly news magazine, *Der Spiegel*, rang the first public alarm bell warning that all over Europe forest trees were dying, shedding their deciduous leaves or drooping their sharp needle clusters like soggy rope ends.

Only a few ecologically-aware specialists, such as Hubert Weinzierl, soon to become president of the Bund Fuer Umwelt und Naturschutz (League for the Protection of the Environment and Nature), had been trying, for over a decade, to arouse public consciousness to an issue which, by 1984, Munich's forestry professor Dr. Peter Schuett could characterize as possibly the "greatest ecological catastrophe." A few alert owners of large expanses of forest, whose own survival depends on the health of their trees, called for action. Among the first was Hermann Graf Hatzfeldt-Wildenburg, a dashing and handsome owner of extensive forest lands on the banks of the Sieg River in Germany's Rheinpfalz province.

An economist trained in the universities of Princeton in the United States, Ibadan in Nigeria, and Basel in Switzerland, Hatzfeldt spent time in the late 1960s working as a Ford Foundation staffer in Thailand. But as most of his revenue comes from his forests in Germany, he returned there in 1970 to take care of his estate.

To Hatzfeldt's amazement, there seemed to be no one in Ger-



Source: Embassy of the Federal Republic of Germany, Washington, D.C., 1985.

Dead or dying trees in Germany's Black Forest.

many responsible for the administration of forests at the federal level of the Republic, nor academically for their study in universities and research institutes, nor commercially for their management as a prime source of income. No one seemed to have mustered sufficient concern to analyze the many dimensions of the mysterious new affliction that was taking on the aspect of a sylvan holocaust.

In 1981, as the young owner of Schloss Schoenstein and its surrounding woodlands, Hatzfeldt took it upon himself to call a meeting in the city of Kaiserslautern, to which he invited a score of experts concerned with forestry to discuss what was being called the *Waldsterben* crisis, or "death of the forest."

Hatzfeldt and his colleagues were trying to establish a clear connection between the now baldly evident *Waldsterben* and its supposed underlying causes, the pollution of the atmosphere with carbon dioxide and acid rain, the direct result of the ever-increasing industrial use of fossil fuels for power that appeared to be creating the same kind of havoc in European forests as it was in the troposphere over the Sahara Desert.

In 1982, in the German Federal Republic alone, well over a million acres, or a Rhode Island-size tract of fifteen hundred square miles of forested lands were in various stages of illness. European-born Americans returning to visit their birthplaces were most easily shocked by the disease-caused depredation. When Lehigh University physiologist and historian of psychology, Dr. Josef

Brozek, visited his boyhood playground, Zaichny Rokle, (Hare's Gorge), near the little Bohemian town of Police in the Steny (stone) Mountains along the Polish border, he found that every one of the trees in that three-quarter-mile-long almost canyon-like valley were as stone dead as if they had been burned in a forest fire. Yet in his native country, Brozek could find no official willing to talk about the impending doom.

The nightmare of formerly forested hills and mountains becoming devoid of trees, wild animals, and even singing birds, was so overwhelming that the data had to be kept from the Czech people by their leaders as it had been in Poland, other East European countries, and, until the new turn toward "candidness" initiated by Soviet Party Chairman Gorbachev, in the Soviet Union.

Statistical facts on the Czech sylvan disaster, revealed by Dr. Wolf Ochslies of the West German Institute for East European and International Affairs after careful digging, illustrated how dire conditions had become. Of all taxonomic groups of fauna, 60 percent of amphibians, 35 percent of mammals, and 30 percent of reptiles, birds, and fish were feared threatened with extinction. Almost all the partridges in the country were vanishing, along with 80 percent of the once-abundant hares and nearly half the pheasants.

Ochslies quoted an article from the German newspaper *Die Welt* (July 20, 1984) dealing with a fact-finding visit to Czechoslovakia by Austrian government functionaries, one of whom remarked in

One of thousands of posters in Germany: "Here dies the forest." (Photo by Reinhard Janke)

astonishment: "This forest is no longer dying, it is already dead!" Of other woodlands, the functionary continued: "The impression on all of us was devastating, with forests looking like sylvan cemeteries, not green, but gray, brown, or reddish in color, and completely lifeless, all deer and wild boar non-existent and not a single bird singing! No one would believe it unless they could see it for themselves: how, for instance, mile upon mile of stands of seventy-to a hundred-year-old trees now resemble forests of telephone poles!"

Seeking to maintain the momentum started by the first Kaiserslautern conference, Hatzfeldt called a second one in the spring of 1983. Hatzfeldt introduced the seminar by questioning whether the woods could be saved with forestry practices alone, concluding that foresters could only treat symptoms but not the prime causes. "We are between Scylla and Charybdis," said Hatzfeldt, "and we have little hope, but we cannot give up the struggle, even with little scope in which to find a solution."

And indeed he could see little scope in what amounted to a web of conflicting explanations for the disaster, or even allegations that it did not exist.

Because of his personal preoccupation with public activities on behalf of his forests' looming demise, and his constant peripatetic travels, Hermann Graf Hatzfeldt was a hard man to meet. When finally caught up with in the lobby of Frankfurt's Hessischer Hof, he walked up dressed as if he had just come from a day-long tramp on some wild moor, in farmer's brogans, rough whitish-green cord pants and tattered woolly sweater over a white shirt from whose collar billowed a colorful silk foulard.

Thick glasses gave him a scholarly mien. A slight limp, due to a back injury, gave the impression of a cross between an ancient German *Ritter* returned from a campaign and an anti-business-suit environmental activist.

At an Italian restaurant around the corner Hatzfeldt outlined the campaign he had mounted over six years to arouse German public opinion to the devastation it faced with the demise of its woods. A constant traveler, he had just returned from a trip to Poland to discuss with foresters what was happening in their land.

"I went to Poland," said Hatzfeldt, "to have a personal look at a country which, due to its avid urge for more and more industry, has ignored the effects caused by the factories it spawned onto surrounding nature. Even our almost hopeless situation does not yet match what is taking place in parts of Poland and neighboring Czechoslovakia. Poland's ever-optimistic national anthem, *'Jeszcze Polska Nie Zginela'* ('Poland Has Not Yet Perished'), may still prove false, not in the sense of human politics, but because

of its callous attitude toward the effects of the so-called benefits of industry on its forests. The trees in Polska no longer take a decade to die, they die in a couple of years!"

On the way to visit Hatzfeldt's estates in the Sieg River Valley, as our train pulled into the station at Wissen in the valley of the Siegland right-bank region of the Rhine, filled with smoking industry that had piled up over the centuries enormous mountains of slag, the problem of pollution was evident enough. But Hatzfeldt's Schloss Schoenstein (Beautiful Rock) towered sublimely over the banks of the Sieg River, surrounded by still beautiful woods with centenarian oaks. There we were met by Hatzfeldt's associate, Dieter Deumling, who explained in perfect English that he had been living in Oregon for almost a decade until he had received an urgent call from his friend Hatzfeldt, to come back to Germany to help save the woods, a request with which he had immediately complied.

In a four-wheel-drive Land Rover he chauffeured us up into a vast tract of forest several miles above Schloss Schoenstein. Snaking through a deep wood of dying beeches, he indicated the ones on the left were mere adolescents of 30 to 40 years, the ones on the right just maturing at 150 to 180. "At this relatively low altitude," said Deumling, dejectedly shaking his head, "deciduous trees, like these beeches, are already as badly affected by *Waldsterben* as the evergreens. It is the same all over Germany. In the northern and middle reaches of the Federal Republic, a third of our beeches, maples, oak, and ash have the disease. It's not quite as bad for our 60 to 80 year-old spruces, all of which are affected, but it is a ghastly enough outlook, nonetheless. And it disposes of a crowd of optimists who are vociferously claiming that a perfect solution would be to replace the dying conifers with hardwoods."

Jumping out of the Land-Rover, Deumling walked over to the edge of the road to cut a spruce bough from a sick tree and another from a tree as yet unaffected with *Waldsterben*, or at least not appearing to be.

"See, here," he said, pointing his gloved finger. "On this healthy bough the growth is symmetrical and there are needles growing out all along the central branch; you can clearly make out the annual growth by counting the segments. But on this sick one, there are no needles on the central branch. You will note little abnormally emerging shoots, called *adventitious budding*, where they shouldn't be emerging. In biology *adventitious* means 'appearing in an unusual place or in an irregular or sporadic manner.' In German it's more heartrendingly called *Angstriebe*, or 'anxiety growth,' a term that concisely illustrates that a tree is doing

something abnormal in an attempt to save its own life. Firs even put out such growth from their trunks, which doesn't help because most of the firs in Austria and Germany are already dead. The white fir is extinct."

He threw away the healthy branch and concentrated on the sick one: "For a tree this old, the needles should be much longer. Look how measly they are! They should be at least twice as long. And there are many other symptoms you could look for. You could find some on every branch of this tree, even on apparently healthy branches if you look close enough. It's as frightening as if you were to find pimples or rashes breaking out all over your body."

As we drove back down to Schloss Schoenstein Deumling said wryly: "The whole problem is as thorny as any spruce needle; it's enmeshed not only in seemingly endless scientific debate, but in a political maze worthy of Machiavelli. To offer an eventual solution, whether lime, or rock dust, or something else, will be to attract salesmen in droves. The chemical companies won't be left at the starting gate, and when *they* stage their sales act they'll surely recommend that forest owners cover their bets by mixing a variety of products together; and in terms of profit, the more the merrier. I'm surprised they haven't already got to it in your country, where the trees are dying, not quite as fast as they are here, but almost. In the Smokies your balsam are going, and in New England your precious sugar maples will soon be gone."

He sighed and brought the car to a stop in the courtyard of the castle. "It's just like the situation with American farmers. They're constantly being frightened by chemical salesmen with the threat that if they abandon the use of what amounts to a whole medicine cabinet of chemical products, and turn to a more wholesome way of treating their land, they risk going broke, which they are doing anyhow! It's a cruel system designed to keep them permanently on tenterhooks. There seems to be no solution."

But a solution there was, and not far away, near the little Austrian village of Grimsing on the Danube's *rive gauche*, just down from the riverine city of Melk, dominated by its huge Benedictine monastery, now a boarding school for boys. It was a solution to vindicate both Hamaker and Hensel. There, in the summer of 1980, Rudolf Schindele, a manufacturer of fine veneers, realized, like hundreds of other European foresters, that something sinister was happening in the nearly one square mile of hilly forest he owns outside Grimsing.

As perplexed and worried as Deumling, and little realizing he would make a discovery that could go a long way toward the solution that was evading the academic fraternity, Schindele decided

to build three kilometers of logging roads through some woods he had bought that were severely afflicted with *Waldsterben*. As he began to excavate material for the road-beds right out of the side of a small forested mountain, the derived substance turned out to be a crumbly multicolored, metamorphic rock, geologically known as *paragneiss*, in deposits which Schindele figured might total three million tons.

In existence for more than two hundred years, the area had once been covered by an ocean so old that no living organisms, large or microscopically small, inhabited it to leave fossil remains in the sediment, which ultimately turned into rock. During the road construction, a certain portion of this paragneiss was reduced to powder by the heavy equipment and blown by high summer winds to parts of the forest adjacent to the roads. Just four weeks later, the spruces in these areas, whose needles had been growing increasingly yellow, a sure sign of *Waldsterben*, were turning back to a radiant dark green. The total area of recovering trees extended over some thirteen acres. During the next four years, new growth on the treated trees looked better and better.

Because of the particular susceptibility to the *Waldsterben* syndrome of firs and spruces—now decimated by the millions—attention in Germany, like Schindele's in Austria, has focused on these evergreens.

To see for ourselves what Schindele had accomplished—and could demonstrate—we took a train to Melk in mid-November 1985. There we were met at the station by Maria Felsenreich, Ph.D., a dynamic Austrian environmental activist, who owns a large organic herb garden twenty miles from Vienna and has organized a campaign to save forests throughout Europe's German-speaking region. She introduced us to our host, dressed appropriately in the forest green of a Styrian woodsman. Over lunch at the *Gasthof* in the town's central square Schindele told us the saga of his success in bringing trees back to life with rock dust, adding, with conviction, that he believes that by ingesting such *Gesteinsmehl* even animals and humans can regain their health. Stroking his salt-and-pepper hair, he claimed that by imbibing two teaspoons of the dust every day he had managed to turn his snow-white locks back to gray, a claim confirmed by various newspaper clippings, which showed him before and after.

To see what the dust had done for his trees, we set forth in Schindele's 380 SE Mercedes to climb high up into his forest property, over ground covered with a foot of fresh snow, stopping to put on chains when the narrow road grew so steep the wheels spun ominously close to a vertical abyss.

Progressing through trees hung with dazzling whiteness, as if

Robert Schindele, described by the German magazine *Horzu* sitting on millions of marks' worth of rock dust.

in a huge, endless Christmas card, Schindele pointed towards some handsome beeches with slate-gray trunks and yellowing copper-colored leaves still clinging to their branches. "Deciduous trees, like beeches, are also being affected all over by *Waldsterben*. But it's intriguing that in my forest many of them are beginning to keep their leaves much longer into the season than before, now that they have had the benefit of rock dust." At a curve in the road we stopped to look down a slope to where baby spruces were growing healthily, eight to ten feet high, two to three times taller, Schindele explained, than had they not profited from the rock dust that had fallen on them "as from the hand of God!" Further down the slope, their shorter, sicklier counterparts had received no dust.

"How long," we asked, "can the European forests survive, with no real help, either from rock dust or some other agent?"

The answer he shot back was ominous. "About five years. Ten at the most."

Proceeding "downhill," Schindele provided more gruesome details: "Evergreens normally hold their needles seven years before dropping them to make way for new growth. Trees that have benefited from *Gesteinsmehl* now hold their leaves for almost five years; but those affected by *Waldsterben* are dropping them within two to four years."

To see more evidence of the efficiency of *Gesteinsmehl* in other

parts of Austria we visited a Tyrolean agronomist-engineer, George Abermann. Independently of Schindele, he had made some experiments with *Gesteinsmehl*, this time ground from rock taken from a quarry in the Tyrolean ski-resort village of Kitzbüehl. In Innsbruck's Grauer Baer hotel, Abermann, a lean, graying, fit-looking man of forty-two, with pale-blue piercing eyes, and the self-assurance that comes with high intelligence, motivation, and the joy of cause-oriented work, offered to show us unequivocal proof of the dust's effectiveness.

Trudging through deep snow into the *Matzen Naturschutz*, or Nature Reserve, halfway between Innsbruck and Kitzbüehl, Abermann explained that one of the reasons ground-up rock from quarries had proved disappointing in the past was that the dust had not been ground fine enough to be easily available to the plants—or, in Hamaker's terms, to the microorganisms. "This," said Abermann, "permitted the chemical industries to proclaim that rock-derived materials are useless in agriculture."

But in 1980 Abermann met the owner of a Kitzbüehl stone quarry and gravel works who had been turning out gravel from a basaltic stone known as *diabase* since World War II.

The crushed rock, extremely resistant to crumbling, and thus to deterioration, was used mainly for railway track beds. In the process of crushing, a great deal of apparently useless dust effloresced as a by-product, useless that is, until the quarry owner noticed that farmers would come to his works to truck it away for free and apply it to their lands in quantities of about one thousand tons a year.

The quarry owner donated to Abermann twenty-five tons of this stone flour, a single kilo of which could cover an estimated 2,600 square meters. "On agricultural crop land," said Abermann, "the trick is to mix the dust with dried cow manure from which the dust appears to remove the odor, providing the soil with organic as well as mineral fertilizer. In the forests it seems to do the trick by itself."

About half a mile up into the snowy woods, Abermann caught his breath, and said with a sly grin: "I thought we'd have no results whatsoever to show off before at least two years had gone by. But when we dutifully broadcast the dust by hand not just around the trees themselves, but over this whole area, to treat every square meter of soil, to my amazement, five months later I could see the little trees burgeoning with new healthy explosive growth!"

Pointing to a stand of spruce over one hundred feet tall, whose branches indicated they were already half dead, Abermann added: "It's a bit difficult to photo-document the changes because the

Agronomist-engineer George Abermann in an Austrian Nature Reserve near Innsbuck pointing to a tree recovering with the use of rock dust.

trunks are bare almost halfway up, and the greenery is way up in the air, inaccessible, except maybe by helicopter. But you can easily spot changes for the good if you look in this clump of young spruces."

Standing next to one of them, about as tall as himself, Abermann went on enthusiastically: "Before I started experimenting with this little tree it had no needles at all. The whole above ground portion seemed stone dead. Then it was treated with *Gesteinsmehl* and it didn't die. Its needles regrew, very copiously, as you can see! What we've demonstrated on a few trees can easily be repeated on millions of them, even hundreds of millions, whereas all the young trees which were planted here in reforestation efforts died before we began our experimentation. You should also know that the pollutants in this area are loaded with copper and cadmium, highly toxic to the soil, and that the trees recovered despite the fact that there was no abatement in the cadmium emission."

Bidding us follow him over to another batch of spruces next to a towering larch, Abermann pointed to one of the trunks: "By looking at the spacing on the trunk between the vertically-spaced series of branches you can easily see where these spruces stopped growing, then, after treatment with rock dust, put out three to four feet of new upward growth each year for three years. It's fantastic," he exclaimed, raising his hands as if in disbelief, "millions upon millions of *Schillings* have been spent by our federal and provincial authorities to reforest areas dying of *Waldsterben*, yet most of the newly planted trees, so carefully put into the ground at such expense, have all died. Now even the local forester is beginning to say that by using my rock dust there is no more need to plant young trees; thanks to the dust's effects plenty of new ones are growing spontaneously from seed."

Asked what the effective difference would be between dust ground from Schindele's paragneiss and the diabase quarried in Kitzbühl, Abermann replied: "Not much! If, and when, the idea of using massive amounts of Gesteinsmehl is adopted in official circles, it will be of no real importance whether it is ground from paragneiss, diabase, basalt, porphyry or certain other rocks, because all of them produce dust that works in similar ways. The only problem is to get the *Gesteinsmehl* adopted in official circles, and for that one needs a great push, most likely from on high."

When we came to parting, this man of heart tightened a steely grip, and said with a smile: "*Jawohl*, my friends, it will take an evangelist's fervor to bring about the required change in thinking."

By the end of 1987, Schindele had built what he calls the world's largest mill for grinding *Gesteinsmehl*, which he exports all over the world, for treatment of both forest and agricultural land, and for addition to human diets. Pointing to his own darkening hair, Schindele recommended a daily intake of two spoonfuls of finely ground rock dust, explaining that its high content of silica, aluminum, potassium, iron, magnesium, and other trace elements are essential to health, that vitamins taken in the form of supplements are without effect unless trace elements are provided with them as co-factors.

News of his remarkable rock dust was soon spread by radio, television, and the press, with the result that so many customers turned up in front of Schindele's plant that there were lines of cars several kilometers long. Schindele even claimed that, as a result of his sales of rock dust to the general public as a health-giving dietary additive, pharmacists reported that in parts of Germany drug sales were off as much as 40 percent. Reaction from the pharmaceutical industry, as might have been expected, was

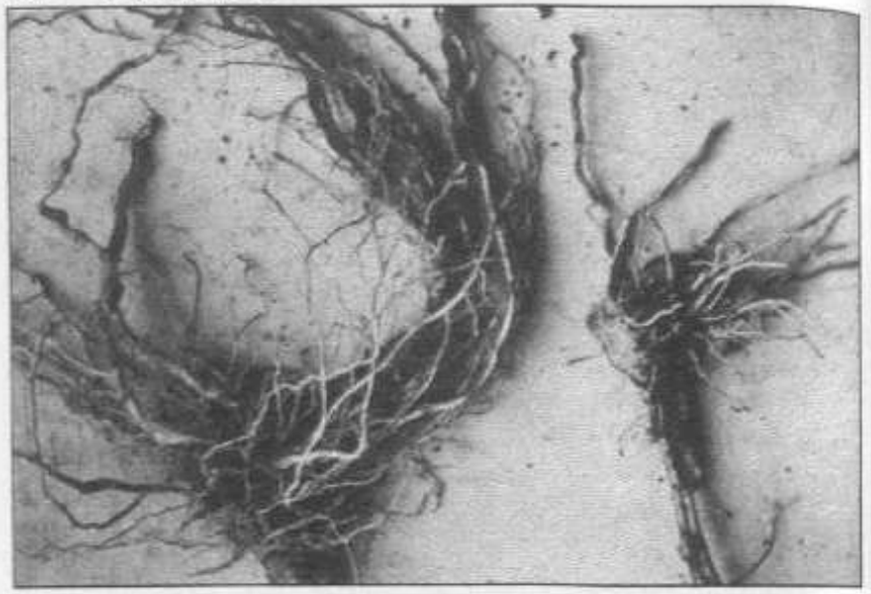
Rock dust being sprayed from a tank to revivify a dying forest in Austria. (Photo by Soil Remineralization)

rapid and deadly.

According to Schindele's unconfirmable estimate, millions of dollars were spent on a media campaign to claim there were deleterious amounts of chrome and cobalt in Schindele's product. The results were a cut back in his sales of rock dust and a prohibition by the Federal Republic against distributing it in Germany for human consumption. And so artificially incited were the good people of Grimsing against the rock dust they petitioned the authorities to prevent Schindele from parading his dusty, noisy trucks through their clean and quiet town. This cost Schindele the trouble and expense of a new road to bypass the town. But he was lucky enough to obtain registration for his dust as a "mineral dietary supplement" in another European Common Market country, and this enabled him to sell it in all participating countries.

When the University of Vienna found that Schindele's product worked against radioactivity—a claim confirmed by a Soviet institute for atomic physics in the Ukraine—the Soviets sent a truck to pick up two thousand kilograms of his *Gesteinsmehl*. Analysis under a micropolariscope revealed an alteration in the molecular and atomic lattice which had an effect on ionized radioactive particles taken into the body.

This led plant scientist Dr. Gernot Graefe, in Austria's Burgenland province near the Hungarian border, to add Schindele's rock dust to an organically processed product he has



Root grown in soil treated with rock dust and organic Biovin (extracted from the residue of grape pressing) compared with the untreated smaller root on the left. (Photo from Larry Ephron's documentary on *Stopping the Coming Ice Age*)

developed over the past ten years from tons of residue that follow grape harvests. With it he was able to bring large sterile acreages back to fertility. He therefore developed a homeopathically dosed spray—a kind of etheric humus as he calls it—which, distributed onto the surface of polluted ponds and lakes, has been found to bring water back to its formerly pristine condition. Even more remarkably, he claims it can be injected into rolling morning fogs to be carried for kilometers—even hundreds of kilometers—through forests where, coming into contact with tree leaves and needles and, via the soil, with roots, it holds promise of resuscitating vast tracts of afflicted woods.

The still invisible and intangible positive effects of the spray have thus far been objectified only through measurements made by dowsing with a pendulum to supersensibly reveal data unattainable by normal human senses. Still considered by orthodox science as mumbo-jumbo, if not outright charlatanry, the art of dowsing has nevertheless been very successfully employed as a diagnostic tool. Aubrey Westlake, M.D., an English physician who used it extensively, stated a year before his death at ninety-two: "I believe that the rediscovery of the dowsing faculty is not fortuitous but has been vouchsafed to us by providence to enable us to cope with the difficult and dangerous stage of human development that lies immediately ahead. For it gives indirect access to a

supersensible world, thus extending our awareness and knowledge. The faculty should be regarded as a special and peculiar sense, halfway between our ordinary physical senses, which apprehend the material world, and our to-be-developed future occult senses, which in due course will apprehend the supersensible world directly."

"Why not admit," suggests Pierre Lehmann, a Swiss nuclear engineer turned environmentalist, "that a comprehensive scientific understanding of all the phenomena involved is completely, perhaps forever, beyond our reach, and then go on to spread finely ground rock dust."

The original rock substance—Lehmann proposes—may have completely different properties when ground fine, just as glass, which seems entirely inert in the form of bottles or window panes, when ground to fine colloidal dust can cause originally neutral water to become alkaline.

Although describing the action of rock dust as catalytic for life processes would be rejected as non-scientific by purists, Lehmann maintains that it is certainly sufficient to justify spreading stone dust without further scientific legitimization. To do this would be to act on the Hamaker-Weaver hunch that important elements are missing in the soil and to try to make them available again. "Once the dust has been spread, it will be nature that takes over and tells us by her reaction whether or not she accepts our offering."

Research during the decade from 1985 to 1995 in Germany, Austria, and Switzerland began to contradict the doomsday fears of the experts of the 1980s as well as their claim that air pollution was the leading cause of forest decline in central Europe. A series of annual reports in the former Federal Republic of Germany between 1984 and 1992 failed to show the predicted steep rise in the degree of damage that had occurred in the 1980s, figures that refuted the theory that acid rain is the primary cause of *Waldsterben*. Silver fir in the Black Forest, which had been predicted to die within ten years, failed to do so. There was, however, an inversion of the proportion of damage between hardwoods and conifers showing a distinct increase in damage to two hardwood species in the early 1990s, whereas conifers showed a lower level of damage. In the former eastern bloc countries sulfur dioxide emanations from two large lignite-mining areas developed in the 1950s were held responsible for forest damage over several thousand square kilometers on both sides of the Ohre Mountains between eastern Germany and the Czech republic, though the actual death of conifers was restricted to the ridge of the mountains where the damage was enhanced, in support of Hamaker's warn-

ing, by strong winds. Now that the high concentration of CO_2 evident in the 1980s has been greatly reduced, a salutary effect on the forests is noticeable with prompt recovery of conifers and the re-immigration of spruce and lichens into areas where they had been absent for almost one hundred years.

Yet Professor Otto Kandler, reporting in the *International Journal of Forestry*, still concluded that soil conditions rather than acid rain is what most affected the forests. Quoting reports of recent improvement in government-and-corporation-owned forests in Baden-Wuerttemberg, Dr. Kandler remarked that instead of asking "why are the forests dying?" we should now ask "why are the forests in Europe growing faster in the second half of the century than they did in the first?"

Could it be rock dust, and the fact that people are beginning to take notice?

Chapter 17

Savory Soil

What if billions of tons of Schindele's rock dust were readily available in America, as effective on crops, trees, and even humans as his Gesteinsmehl? In a narrow valley south of Salt Lake City, blessed with a profusion of pink hills, cobalt lakes, and azure skies, a geological prospector, Rollin Anderson, has discovered just such a treasure.

In a hundred-year-old adobe farmhouse, surrounded by centenary Lombardy poplars, we found Rollin, though already in his nineties, acting like a "crusty young fellow." Like Schindele, he has been swallowing down a spoonful of his native Utah soil with every meal—not just ordinary soil, but a special montmorillonite clay.

"Some scientists," said Rollin, "think my rock stores up energies of sun, earth, and water, only releasing them as needed for the growth of plants." He spread his hands as if accepting bounty. "And Robert Ripley claimed that Sun, Earth, and Water are represented by the Hindu sound AUM; so I thought of calling my ore Anderson's Utah Mining; but I refrained. I called it Azomite: or A to Z Of Minerals, Including Trace Elements. And they're the secret to its great success."

One sunny day in August, as we breakfasted on scrambled eggs and Azomite, Rollin told us how he had come to discover his precious substance, and how he had come to eat it. Half a century ago, as a contracting engineer in his forties, he had become

fed up with city life in San Francisco, convinced that what was wrong with America was its food, and therefore the soil from which it derived. Sick soil, said Rollin, means sick people. And somewhere there had to be a remedy.

Told that gypsum might help neutralize alkaline soils, and that if mixed with fertilizers it could help grow better crops, Rollin packed up and moved to his native Utah to exploit a gypsum mine owned by his father. But, before he could obtain the necessary equipment, World War II broke out, to scotch his every effort.

Roving the river district of Sanpete County, he came instead upon a range of terraced hills with a pink sheen, twenty-one of them to be exact, rising two hundred and five hundred feet from the arid desert terrain, all with a pinkish ore. Intrigued, he took samples to Salt Lake City to his friend Dr. Charles Head, ranking scientific expert and chief microscopist at the U.S. Bureau of Mines. Head placed a piece of ore beneath the lens of his microscope and let out a long low whistle. "How much of this stuff do you think is out there?" he asked in no way attempting to disguise his excitement.

"Several billion tons," replied Anderson. "That's what I reckon."

Head's excitement, it developed, was not because the sample contained nitrates, considered valuable as fertilizers, which it didn't, but because it was a colloidal clay containing quantities of minerals very similar to the caliche rock of Chile and Peru from which the world's nitrates have long been mined. Between 1919 and 1925 Head had been seconded by the U.S. Government to study Chilean and Peruvian nitrates in South America. There he had developed the conviction that the benefit plants were deriving from South American nitrates was not from the nitrates themselves but from minute quantities of trace elements, which served as catalysts—a word coined by the great Swedish chemist Berzelius to describe substances that speed up chemical reactions, but come through these reactions without themselves changing.

In the "gay twenties" few men in the scientific field, especially in agriculture, knew much about trace minerals; and ever since, because of the obscurantism of official bureaucracy, Head was obliged to be careful what he said, lest he lose his job. The prevailing opinion considered trace elements impurities that would contaminate food. The notion gave birth to so-called refined foods, from which these "contaminants" were deliberately removed for a supposed improvement in nutritive qualities.

Now at last Head had a chance to check his own theory. Would Anderson please grind up some of his montmorillonite ore, put it on his plants, and see what happened. Anderson, like everyone

else in those days, had a war-time Victory Garden, and was happy to oblige by pouring powdered montmorillonite onto the ground around his vegetables, leaving several rows as controls to see what difference might develop.

Jutting his bulldog chin with evident pride, Rollin told of his early successes. "The first tomatoes we planted with the dust came up fine and healthy, whereas the controls were attacked by hideous long green worms. We picked off the worms wherever we found them, but they ate a lot of leaves. On the Azomite plot, not a worm. The plants were stronger, held fruit well, and had great flavor. Once you've tasted a vegetable grown with Azomite you're spoiled for life. The beets in the control plot were juiceless and woody. The ones with Azomite dripped with juice and were tender at all ages of their growth. By fall, one measured seven inches

Rollin Anderson's mine in Utah containing billions of tones of Azomite, a natural colloidal silicate with twenty-five or more mineral and trace elements. Colloids are the pantry in which plant food is kept and gradually released as needed.

across, just as tasty as the young ones. The same with tomatoes, cabbages, and peppers; and everything kept better when canned or frozen. We couldn't help feeling that Dr. Head's theory about minerals, trace elements, and catalysts was definitely proved. Here was a substance that gave results that you could see without the aid of any microscope."

Ushering us into a living room lined with some eighteen hundred volumes covering subjects from Agriculture to Zionism, many of them dealing with the occult and the esoteric, Rollin seemed happy to have someone with whom to share the story of his early discovery, and the remarkable results that had ensued.

"None of the local geologists or mineralogists seemed to know what we'd found in those hills: some called it *brecciated rhyolite*, a glassy volcanic rock similar in composition to granite. Others called it *diatomite*, a material made from the calciferous bodies of tiny marine algae. Others called it diatomaceous earth. But to Head it was good old montmorillonite, an aluminum silicate clay admixed with various minerals, rare in the United States, and even in the world, but greatly prized by medicine men of Indian tribes. On Head's instructions, I obtained samples of rhyolite from most of the known deposits in Utah, as well as from the surrounding states; but none was similar to our ore, though all were similar to each other. Ours was definitely a first-class montmorillonite clay. Now geologists consider it to be an ancient oceanic deposit brought to the surface by volcanic action, a form of heavy sedimentation on the sea floor, a mixture of mineral elements and marine life such as seaweed, shrimp, and algae. The clay contains all the essential mineral trace elements in a balanced ratio, as laid down by nature. In this form the minerals are naturally chelated, as in plant and animal, in an organic, easily assimilable form."

Rollin poured a teaspoon of the pinkish-gray Azomite into the palm of his hand to show that it was as fine as a lady's face powder.

"The problem," he explained, "was how to get the stuff out of the ground and refine it in a wartime emergency, which preempted obtaining machinery of any sort. Only when the colonel in charge of a U.S. Ordnance Depot in Tooele, Utah, had the good sense to order several tons for an experiment were we able to acquire a small hammermill and an ancient Fordson tractor. With this rudimentary equipment we set about mining the ore from the pink hills, grinding it to various sizes.

He looked up with satisfaction. "We now know that Azomite aids the soil in fortifying the natural mineral balance. It helps satisfy the 'hidden hunger' in soil caused by mineral depletion or deficiency from continued use over long periods of time. Soil without humus is half alive, and without bacterial action, humus is dead. The reason the bacteria in the soil fail to function properly is because of the lack of natural trace elements and catalysts."

A gust of wind drove down the valley, turning poplar leaves from green to pewter, bending large red poppy blossoms almost to the ground.

"I learned the power of Azomite," said Rollin, "experimenting with earthworms. I didn't know, until I tried it out, that earthworms can be kept alive in a metal container, filled with just the soil the worms are found in, from early spring until late fall, and all year round where winter is not a problem, by the simple addition of a small amount of Azomite, and, of course, moisture. The worms will be lively and healthy, with firm body tissues thanks to all the elements. They not only grow, but multiply. Any boy who has been fishing knows that after a few hours worms in a container will bunch up, become slimy, thin, and sort of transparent, then die, unless you keep replenishing the container with fresh soil or mulch and moisture. Well, I have kept as many as two hundred earthworms in a twelve-quart pail filled with the soil they were dug in, from early June until the middle of November, with nothing added but a heaping tablespoon of Azomite mixed with the soil at the time the worms were dug up. The worms were as fresh and active at the end as when I first took them from the garden. Just try it!" Rollin looked to his wife, Elsie, as if for confirmation, then hurried on, as if his time were running out.

"We further learned that by applying Azomite directly in contact with the seed or root structure, one could get much quicker action. We tried it on lawns, but people complained they had to cut the grass too often. On pasture and perennial crops the best results were obtained by applying about fifteen hundred pounds to the acre. Results were even more noticeable after the second or third year."

He waved towards the valley where fruit trees grew in an orchard. "Trees seem to respond to Azomite about as readily as any vegetation, especially fruit trees. In one orchard where leaf curl, sluggish growth, poor-quality fruit and many pests were the problem, Azomite corrected the conditions within a year. By the end of the third year, none of the conditions existed." Azomite, Rollin explained, should be applied to trees in the fall, just after harvest, starting about eighteen inches from the trunk and spreading as far as the drip line, then disked in, anything from two hundred to three hundred pounds.

"But the real pay-off," he said, smiling broadly, "came when we fed it to cows through silage. Animals showed a definite preference for pasture grown with Azomite. Cows, horses, sheep, goats, rabbits, turkeys, all preferred Azomite-treated hay. I've had animals walk right through belly-deep lush-looking pasture not treated with Azomite to get to that which was, and then eat off it until you'd swear there was nothing left to chew on. Failing to get an adequate supply of any one trace element, animals have difficulty breeding, calves are small, litters of pigs are weak. Beef cattle fail to make the best use of their feed. Dairy cows produce less milk; sheep have thinner fleece."

His wife, Elsie, tall and slim, got up and headed for the kitchen: "Tell them about the chickens," she said. "It was amazing."

Corn grown on soil in which inorganic nutrients have become "locked up" or have been depleted by the use of commercial fertilizers. Compare with corn grown with Azomite (below), which brought a 100 percent increase in crops.

Corn grown with Azomite.

Rollin drew breath, his satisfaction evident. "We got started with poultry quite by accident. It was difficult to get all the Azomite ground to a fine powder. There were a lot of pea-sized nodules left over. So I had the bright idea of feeding the chunk-sized Azomite to poultry as a grinding agent. When a neighbor placed some Azomite in the pen where culled hens were housed, by morning it was gone. None of the hens died; all started laying again. Baby chicks would take Azomite from the very first day, if ground fine enough; it seemed to stimulate their appetite. They developed more evenly, feathered out sooner, and later gave a greater percentage

Turkey growers suffer heavy losses when their birds become infected with "weak leg condition" (staphylococcus infection) which makes them unable to stand.

of fertilized eggs. Pullets were laying a week before they were supposed to, and their shells, which had been fragile, were now much harder. Did you know that it costs the U.S. poultry industry $60 to 70 million annually for broken egg-shells?"

Rollin paused for us to appreciate the importance of the remark, then hurried on. "With turkeys we had even greater success. Azomite gave them earlier maturity, greater weight, stronger legs, and a greater number of prime-grade quality. Then we found that it was just as good for cattle. A farmer's cow got loose in the barn, where she found a bucket of Azomite and licked it up as if it were lush feed. So we spread the word and cattle ranchers started mixing it in with feed. One rancher wrote that since he'd included Azomite the average gain per head per day was more

Turkeys fed on Anderson's Azomite show strong legs, good feather bloom, and no debeaking.

than four pounds. Prior to feeding Azomite the cost per head in the feed-lot for three months had been $140 a head. Since Azomite it was down to $95, and the quality of the beef was greatly improved. Another farmer wrote that seven Holsteins that had been bred four times artificially failed to settle until 5 percent Azomite was mixed into their daily feed. On the fifth breeding, all the cows settled. So we fed it to hogs, and by market-time the runts had caught up to the others. With goats we managed to breed culled ewes past lambing with a ram that was supposed to be infertile; and we got plenty of kids, plus 50 to 60 percent more wool from the sheep."

To make his point, Rollin waved a small booklet: *The Story of Trace Minerals* by Dr. Melchior Dikkers. Already in 1931, Dr. Dikkers, as Professor of Biochemistry and Organic Chemistry at Loyola University, was so struck by the properties of montmorillonite clay—claiming it to be one of the most amazing and unusual materials he had ever been fortunate enough to come in contact with—he launched an extended research program. Years of intensive study convinced him that trace elements were key to all living organisms, essential to the structure of certain complex chemical compounds that influence the course of metabolism, a vital factor in the health of every living being.

Metabolism—the sum total of all chemical reactions that proceed in every single cell of the body twenty-four hours of each day—is what keeps us all alive. Some thirty trillion cells are at

work, constantly, in each and every human body, twenty million in the human brain alone. In each cell, metabolism—the process by which foodstuffs are synthesized into complex elements—is carried out by enzymes, large proteins which are themselves synthesized by the cells. And it became clear to Dr. Dikkers that trace elements were essential to the creation of these enzymes, to act as catalysts to bring about chemical changes by their mere presence, without undergoing change. It is a phenomenon for which science has no real explanation, but which clearly cannot occur without both the enzymes and the elements taking in and radiating energy to achieve specific effects.

Combinations of trace elements have been found, under certain conditions, to acquire entirely new properties, very different from those of individual elements acting singly. There is a noted interaction among trace elements, such as iron and copper, both of which are concerned with blood formation. In plants, iron and magnesium are associated in chlorophyll formation.

Without chlorophyll there would be no life on earth, the very first green plants being the understood link between the energy of the sun and life on the planet. Only green plants and certain microorganisms are able to absorb the sun's energy, store it, transform it, and then transfer it to man in the form of wheat, corn, vegetables, and fruit. Uncooked and unprocessed food will supply enzymes directly to the blood. Some two-thousand different enzymes, every one a protein, are synthesized by every cell from amino acids furnished by the blood, obtained from ingested food, best eaten raw.

Any heat over 119 degrees Fahrenheit destroys enzymes, as does pasteurizing. Many chemical substances—fluorine, chlorine, lead, barbiturates, Benzedrine, amphetamines, nicotine, carbon monoxide, nitrates, sulfur dioxide, DDT, and most other pesticides, herbicides, and chemical fertilizers—all inhibit enzyme activities, as do water and air pollutants.

The activities of enzymes are extremely susceptible to foods. The mere presence of chemical additives in food may cause some trace elements to become unavailable. The same applies to chemical fertilizers in the soil. They can cause trace elements to become unavailable to plants. Enzyme reactions are influenced by a deficiency of any functional nutrient.

Dr. Rudolph Abderhalden, Director of the Laboratory for Endocrinological and Enzymatic Diagnosis in Basel, Switzerland, and Professor of Biochemistry at Halle University in Germany, believes the majority of all diseases may be enzymatic in origin. He asserts that metabolism is synonymous with enzyme activity, and that disease is a disturbance in the harmonious pattern of en-

zyme activity, an activity dependent on the presence of trace elements. Breakdown of the enzyme system results in disease or death of the cell. Many nutritionists and physicians now agree that there is really only one disease: malnutrition; that all the other ills derive from it.

"We now know," said Rollin, "that the synthesis of all known natural mineral elements is the secret of the harmonious synergetic function that forms the basis of healthy living matter. Azomite is a complex compound of natural colloidal silicate minerals and trace elements. Some thirty-two trace elements—iron, cobalt, magnesium, zinc, copper, etc.—occur in such minute quantities they must be measured in parts per million, yet they appear to be basic in the complex chemical and electrical mechanism that makes up the human body. The form in which the major part of the natural inorganic nutrients are assimilated by animal and vegetable consists of material in the colloidal state.

"In plants, rootlets and root hairs are generally in intimate contact with the colloidal sources of the soil nutrients they feed from. Plant nutrients are thought to pass from the soil solids to the plant without leaving the sphere of colloidal influence."

Rollin laid down Dikkers's book, to make the basic point about his precious Azomite. "Trace elements need to be ingested in a balanced manner, because they interact. A little too much of one can produce a critical deficiency of another that is present in barely sufficient amounts. Trace elements function as activators, as catalysts, within the living cell, be it plant, animal, or human; and they are the root of all living processes, with an influence out of all proportion to their size. While the quantity of any one element may be small and effective, compared to another, no element functions alone, but only in conjunction with others equally important.[1]

We were back to the colloidal glacial sediment in Hunza water, full of the same trace elements, electrically charged, which proved to be the source of its vitality. Could Flanagan, we wondered, put an extra charge into Rollin's Azomite by subjecting it to his vortical method?

Rollin was immediately receptive.

"Colloidal," he emphasized, "is a condition, not a mineral. Fine

[1] "All organic activities and processes of growth in any living organism, or any metabolic function associated with sustaining life of any kind is an electric phenomenon and requires elements of ion exchange. Cations (+) carrying a positive electrical charge, and anions (-) having a negative potential are constituents of acids, bases, and salts, which become active as electrolytes (or conductors of electricity) in aqueous solutions. Life in its broadest sense is electrical-derived from the interplay of chemical elements. And the entire electrolyte system must be kept in constant flux, moving blood, digestive fluids, and body fluids." (The Body Electric, by Robert O. Becker, M.D.)

dust-like mineral particles pass into the colloidal state of fineness upon reaching a critical size when their activity prevents them from settling out as molecules of their particular inorganic element. Particles larger than one micron are generally in an available condition ready for immediate use by plant, animal, or human.

To physicists, a piece of material can be subdivided into smaller pieces only so far before these cannot be seen with the most powerful microscope. At a further stage a limit is postulated beyond which particles cannot undergo subdivision without losing their chemical character: this they call the molecule. The smallest particle visible in the microscope is still about one thousand times larger than the largest molecule. In this twilight zone of matter are found the peculiar forms first called "colloidal" by Thomas Graham in 1862.

"By colloidal," said Rollin, "Graham meant those materials which readily crystallize and have the vital function of diffusing readily through animal membranes, as opposed to amorphous or gelatinous masses, which do not diffuse readily or at all through animal membranes, and cannot therefore be assimilated."

And here, we realized, may lie the explanation for the extraordinary vitality of colloids, as well as for the surprising facts of homeopathy, in which the smaller the dose, the more powerful the effect. Copper is said to be effective in plant life when present in a concentration as low as one part per ten million (dry matter); molybdenum is effective when present in one part per two hundred million, and cobalt is effective when present in one part per billion.

By the laws of physics, the smaller an element is divided, the larger is the area of surface exposed by all the pieces. A one-inch cube has a surface area of six square inches; the same cube divided into eight cubelets will together have exactly twice that surface area. By the time the cubelets or particles become microscopic, their cumulative surface is enormously increased. And the larger the surface exposed, the larger the particle's potential to be charged with energy.

In colloids the ratio of exposed surface area to volume of material becomes extremely large. As electrical charge tends to repel particles from each other, colloidal particles are kept separate, in suspension, retaining their vitality. But if the charge decreases (reduced by light, heat, electric fields, etc.) the particles tend to snap together and coagulate. With coagulation the system loses its colloidal behavior and becomes "dead," in both organic and inorganic systems.

All of life is found in the colloidal form and has many charac-

teristics also in inorganic colloids, which led Wolfgang Pauli to conclude that colloids provide the most important known link between the inorganic and the organic, a clue to the very source of life.

One of the keenest supporters of Rollin's Azomite is a veterinary doctor, C.S. Hansen, who attributes the extraordinary powers of trace elements to the microwaves they radiate. He maintains that insects have an innate intelligence that respects a vigorous growing plant, capable of producing seed for reproduction, and will somehow have the sense to avoid it. He said that when the natural trace-element material, such as Azomite, with the proper microwaves present, is supplied to a growing plant he has failed to find any insects present. Insects avoid such treated plants. But when a plant is not of vigorous growth, and capable of carrying on as a perfect species, the insects are given the job of clearing it up.

"Anything that becomes inferior in quality," says Dr. Hansen, "becomes food for insects, so that only the healthy plants capable of developing seed for reproduction are left to mature. Imperfection in life has a way of being destroyed if left to the devices of nature. Food products from a deficient soil should never be used for human or animal consumption, and they should never be used for reproduction again as feed."

To demonstrate the effectiveness of the microwaves radiated by trace elements, Dr. Hansen took a bag of Azomite and spread it on the ground around an orange tree with mature fruit ready to be plucked. "The tree," he explained, "was full of heavy metals: zinc, lead, mercury, and insecticides. Within four minutes after the Azomite was spread, there was not an orange or leaf on that tree that wasn't free of the harmful effects of the heavy metals, DDT, and other chemicals."

So amazed was he by these results, he repeated the experiment several times. His explanation is as simple as it is amazing: "Microwaves from the trace elements in the Azomite catalyze the heavy metals into harmless compounds, which the plant or tree can then use or automatically return to the soil."

Hansen says the effects of different forms of radiant energy on colloids and protoplasm are being extensively studied, and that it is known that different wavelengths and frequencies may produce structural effects on colloids and organisms: ultraviolet rays can slow down or stop the streaming of protoplasm, causing increased viscosity or coagulation.

Rollin sat back and sighed, partly pleased about getting his points across, and partly in despair about the world. "We have ganged up on nature by taking the attitude that insects are invading our fields and destroying our crops. So we kill the bugs, thinking it correct. Instead we are killing ourselves. But the bugs are naturally destroying our crops because we are not feeding the crops their proper food. We are not giving the plants the natural trace elements which give them access to the benefit of the microwaves of creation."

What he meant by the microwaves of creation did not become clear to us until we met with the next person on our list, a brilliant ornithologist-turned-entomologist.

Chapter 18

Biomass Can Do It

The rock dust is there, by the billions of tons; the organic material is there in billions of tons of garbage and sludge; the U.S. population alone produces twelve thousand pounds of excrement per second, while, in that same second, U.S. livestock are producing another quarter million pounds; and there are 2 billion acres of unused or marginal land in the world, 62.5 million in the United States alone. What would it take to stop using poisonous chemicals, stop burning fossil fuels, reduce the danger of CO2 and feed a world population increasing by the billion?

The answer is not the fantasy of some crackpot dreamer, but hard data spelled out by the U.S. Department of Agriculture's vast Beltsville Research Facility, a multi-million dollar outfit spread across miles of the Maryland landscape just north of Washington, D.C., designed, at taxpayer's expense, to improve the conditions of agriculture for the farmer.

Not that this particular approach hasn't been put forward before, time and again, over the past quarter century, by a series of experts writing in Charles Walters' *Acres U.S.A.* It is only that now the proposal comes from an official government agency, in serious form, through the lucid writing of one of its professionals, a tall, jovial Doctor of Botany and Taxonomy, James A. Duke, expert in the study of hallucinogenic plants, whose office looks out across the greensward at the enormous USDA library—an

institution that fails to carry a single book by either Steiner or Kolisko!

With just the acreage that now lies fallow, says Dr. Duke, we could be self-sufficient in energy and not have to burn another pound of fossil fuel. At the same time we could have a large surplus of proteins from legumes and grains; and we could remedy the nation's appalling balance of payments by some $60 billion. All of this simply by planting our marginal soil, all 62.5 million acres of it, and imitating the American Indian method of intercropping legumes such as alfalfa with cereals such as corn to create "energy farms" on soil not presently exploited. Such farms could not only feed the nation, with a surplus, but produce abundant fuel from crops, eliminating the need to import crude oil from abroad. And all this without taking into account the 125

James a. Duke, Phi Beta Kappa, Ph.D. in Botany, has been for many years with the USDA at Beltsville, Maryland, and is responsible for over a hundred scientific publications and several books. He is holding an Australian chestnut that is being tested by the National Cancer Institute for its chemical—castanospermine—as a therapeutic hope for AIDS. (Photo by USDA)