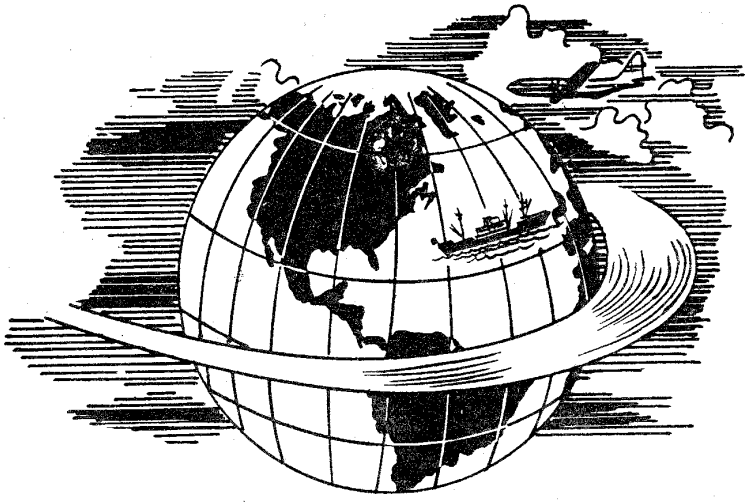
Special Report

WASTEBASKET OF THE EARTH

By WILLIAM A. ALBRECHT, Ph.D.



Man is upsetting much of his natural environment by his contamination of air, water, and particularly soil, reducing Nature's ability to safely dispose of wastes. He seems to be creating his own destruction.

Reprinted Courtesy BULLETIN OF THE ATOMIC SCIENTISTS
Volume XVII, Number 8 October, 1961
FEBRUARY, 1962

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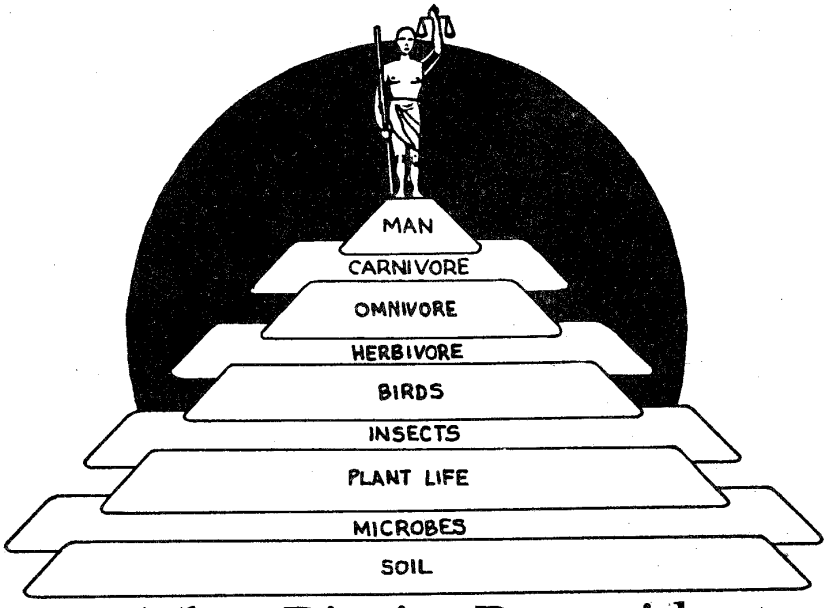

The Biotic Pyramid

CONTAMINATION in the food we eat, the water we drink, and the air we breathe suggests close connection with the soil. Usage such as "your hands are dirty," serves as a reminder that the thin surface layer of the soil is the wastebasket of the earth, the collector for the disposal of all matter that has once lived and moved.

Role of the Soil

The thin layer of the earth's surface is an intensive transformer of all the waste it collects. In that shallow stratum elements are separated out of combinations and reunited into other compounds, effecting vast changes in every kind of water. These activities include transformations of energy by such processes as oxidation, reduction, hydration, hydrolysis, and molecular rearrangement. Oxidation, like combustion, dissipates energy in the form of heat, which escapes from the earth. Reduction concentrates it in compounds of high heat and fuel values. This is illustrated most significantly by the plant's reduction of carbon dioxide by water, storing the sun's energy in the resulting carbohydrates.

These transformations of matter and energy create, nourish, protect, and maintain all living creatures. These creatures vary in physiological complexity from the simplest microbial cell to man, whose high state of evolution has equipped him with a mind to comprehend—and to modify —his environment, even as far as unwittingly contaminating it.

Term With Many Meanings

The term *contamination* has many meanings. The wastes of one population may be either the poison or the life-support of another. We consider populations of different forms of life to see whether their coexistence is cooperative or competitive, and whether their respective wastes may be of benefit or harm to each other.

A high degree of cooperation through evolution and adaptation characterizes nature's management of environment. But when man manages environment, competition stands out—with frequent examples of contamination. As managers, we are biased toward aims and benefits for man alone. We have concerned ourselves little with how, in modifying the environment for ourselves, we may be disrupting it for all the other populations of the biotic pyramid—microbes, plants, animals, and man—all supported by the one creative foundation —the soil.

Man Upsetting Environment

Instead of speaking of the soil as "dirt" to emphasize its contamination of ourselves, the converse might be more appropriate. Man is upsetting much of the natural environment by his contamination of the air, the water, and particularly the soil, reducing its ability to dispose of wastes safely, and to nourish healthy populations of men and all other living things. It is a dangerous boldness to believe that we can manage environments completely by technologies designed for our economic advantage.

Given to a belief in the homocentric purpose of the earth, we have come to take our soil for granted. This view is quite the opposite of that of the pioneer—living mainly by agriculture —who respected and studied his environment and struggled to be naturally fit for his evolutionary survival there. He considered the seasons, the annual amount and distribution of the rainfall, the degrees of heat and cold, the winds and storms. He did not consider land as a commodity. The pioneer appreciated the fact that the soil had been built by nature during the ages pre-dating him, brought about by the climatic forces breaking down the rocks, growing the microbes, the plants, the many other kinds of life. For him, those were the natural forces of soil construction, and he knew he must maintain soil productivity if he were to survive. The pioneers were truly agrarian people. For them the soil was holy ground. Too, it was living soil.

Man Forgets Nature

Because of the scientific organization of our recently increased knowledge about the soil, we forget that the decomposition of rocks, the growth of vegetation, and the complete return of that organic matter in place — all under nature's management — are what brought about productive soils. At first, these soils were not contaminated against the healthy coexistence of a specific, but limited, set of species. The early balance represented an evolutionary set, each form unique in relation to the others, to the soil's particular geologic-climatic setting, and its degree of development in a given area. Examples of this limited balance would include the particular plant and wildlife forms of virgin forests, or the American plains or prairies. All of these conditions were major determinants of the coexistent species; the survival of each was dependent on the survival of the others.

Man's management of agricultural crops and livestock has not been directed by knowledge of the limitations of soil fertility, nor by knowledge of the required climatic-geologic setting for crops and livestock with each in its natural ecological climax. Instead,

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we have been given to transplanting any species from anywhere to everywhere for economic gain, ignoring biological benefits or dangers to the species involved. We have brought in higher (or lower) species while depleting the very soil fertility support required to grow them in health.

Evolution in Reverse

We have thrown natural evolution into reverse. We struggle to nurture species we have made unfit for the environment because creative forces there cannot offer the required quality of food and energy support. We now need to view the pampered species as contamination against all other

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Our fear of microbes, since the work of Pasteur, has led us to wrongly label them our environment's major contaminants.

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lower species which would otherwise arrive at their natural climax. We must accept the fact that the soil, with its dynamics of producing and accumulating organic substances through plants with the support of climatic forces, is still the only energy supply on which all kinds of life depend. Transformation is the major role played by the soil.

Granting that the entire biosphere is dependent on the inflow of that bit of the sun's energy fixed in organic substances by photosynthesis, it is helpful to note that as Nelson G. Harston, Frederick E. Smith, and Lawrence B. Slobodkin said in their article, "Community Structure, Population Control and Composition," in *The American Naturalist* last year, populations divide themselves appropriately into three trophic levels: the decomposers, the producers, and the predators.

The Decomposers

The decomposers are represented by the varied kinds of microbial life which live by degrading organic debris through processes giving the microbes their energy and growth substances. The slow accumulation (at great depths below the earth's surface) of these remnants as fossil fuels of organic origin and a high degree of oxygen removal indicates that this heterotrophic group did not have much in the way of energy-giving "leftovers." Nor can these remains be considered contamination when they are far beneath the soil surface. But when they are brought into the atmosphere, and into the highly aerobic surface soils, after laboratory work has turned them into products such as antiseptics, pesticides, and herbicides, they are the most extensive and powerful biochemical contaminations we have yet known. Their range of disturbances covers the entire biotic pyramid.

Hydrocarbons, which can disrupt the transformations in the soil's surface zone, were buried by nature at great soil depths. These high concentrations of energy are now our industrial fuels. But even such deep burial of the wastes resulting from the use of atomic fuels will not serve as safe removal. Atomic fuels, with their lingering rays for a lingering death of all living cells, are not respecters of the beneficial portions of the soil's microbial flora.

Source of Nutrition

Nutritional requirements of microbial decomposers are met by the contents of the debris and the soil. The essential elements remain very much in the cycle of use and reuse, since sulfur, phosphorus, nitrogen, and carbon occur as major elements in the leftovers. Oxygen is almost absent there, but carbon, linked to hydrogen, occurs in high concentration.

Ever since the work of Pasteur, our fear of microbes has singled them out as our environment's major contamination. We have made them the victims of vengeance and we boil them under steam pressure at every opportunity. Their disrepute has been shared recently by dusts, fungus spores, pollen grains of trees, grasses, weeds, and other particles. Today the

professional allergist devotes his attention to atmospheric contaminants and to other substances disturbing the mucous membranes and similar tissues of the human body. But when microbes are viewed as disposers and transformers they become major benefactors for other populations. Microbes in surface soil serve as wrecking crews and salvage agencies. Simplifying the residue of past populations for energy release and reuse, these decomposers make the upper stratum of soil the real living foundation of the entire biotic pyramid. They keep open the sewage disposal systems of all the population levels.

Uniquely Equipped

Microbes are uniquely equipped to maintain their own populations. They reproduce at the rate of one generation per hour or even faster. They synthesize their own extra- and intra-cellular compounds—some of which we term antibiotics — for protection against competitors for their environment. The antibiotic quality may be merely an evolutionary accident that served to bring death to competitor cells. Nature's conservation practices use wastes from some life forms to make the environment serve its own survival more completely.

Benzene rings characterize the chemical structure of the antibiotic terramycin, for example. Modified ring structures with substitutions of nitrogen and sulfur for some of the carbon are found in penicillin, aureothrycin and other microbial products developed for their bacteriocidal effects on the human body. That ring structure represents highly reduced organic compounds such as those found in crude oil and coal. The chemical structures and biochemical energy potential represent the opposite of that of natural organic wastes dumped on the surface soil. While natural organic wastes offer much as energy through microbial oxidations, crude oil and coal are too stable for biochemical transformation and energy release, even though they rank high as industrial fuels. They are seldom broken down by digestion. They overload the man body. They are leftovers from anaerobic microbial populations, and are well removed as serious contaminants by their natural placement far below the surface soil and by disposal well beyond the entire biotic pyramid.

Acts As Deadly Poison

The benzene ring, in a simpler compound distilled from coal tar—carbolic acid—was an early antiseptic. But now, long-chain compounds and ring structures of carbon, sulfur or nitrogen substitutions, or in chlorinated, nitrated, and sulfonated forms as synthetics from the industrial chemistry laboratory, are being distributed extensively, acting as deadly poisons

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Plants are the source of energy for all biochemical processes.

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against the populations in the biotic pyramid. They come into the atmosphere in "smog" and carbon monoxide, and in herbicides, pesticides, and the like. Those microbial wastes welling upward from the depths of the earth, in their natural forms and in our more poisonous alterations of them, must be considered contamination by man of his own environment and of the environments of all populations that support him. His efforts to so completely destroy microbes are contributing to his gradual destruction by his own hand. Decomposers are not respecters of man when they release their own wastes as contaminants.

The second group among the populations, or trophic levels, of the earth are the plants, which produce organic compounds carrying the chemical and other energy transferred from the sun. They are the only means of storing and distributing that supply. Energy is collected by photosynthesis, the unique process whereby the chlorophyll of the leaves binds it into compounds of carbon, hydrogen, and oxygen in the molecular arrangement of

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carbohydrates. Plants are the source of energy for all biochemical processes, and of their own starter compounds into which they synthesize nitrogen, sulfur, and phosphorus to yield the different amino acids of proteins and living tissues which grow, protect, and reproduce. Plants are the only producers since they are the sources of food energy and growth potential synthesized directly from the chemical elements and flowing through all the other trophic levels.

Significant Stratum

Plants root themselves first into the soil and then extend their tops into the atmosphere. They may be vulnerable to contaminants from both directions. Their unique position and special processes bring both inorganic and organic decompositions from the soil into biochemical union with water, and carbon dioxide, and nitrogen. Plants, representing that limited zone where earth and atmosphere meet, act as a kind of interface for concentrations of different kinds of matter, becoming the significant stratum for the creation of all that lives. All life is possible because the synthetic power of sunlight operates through the plant enzyme, chlorophyll. It is a mobilizer, or chelator, of the chemical elements, unique because the plant itself creates it. Its chemical structure consists of the inorganic element magnesium as the core, combined with nitrogen, linked with carbon, and all three connected with hydrogen. Even this chelator's composition represents a chemical union between the soil, which furnishes the magnesium, and the atmosphere, which yields the nitrogen, carbons, and hydrogen.

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Man aims his technology at complete extinction of many populations.

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Because plants support themselves by their own capacity for combining elements and using solar energy to create compounds, they surpass all other populations in the struggle for survival. Microbes can use the elements in synthesis but must decompose the organic compounds synthesized by plants to provide the necessary energy. Plants, in turn, profit in their extended survival because the microbes simplify the accumulated organic matter to keep the soil's inorganic elements and the atmosphere's organic elements—carbon and nitrogen—in cycles of reuse. Otherwise the accumulated products of plants would contaminate their own environment.

Symbiosis for Survival

Plants and microbes may be considered in a symbiosis for survival independent of more complex populations. But even that symbiosis may be disrupted by one or the other symbiont acting as a competitor, a parasite, or a predator. Either may even produce contamination by its waste products: plant compounds may be poisons for microbes and microbes may be poisons for plants. By competing for essential inorganic elements—calcium, magnesium, phosphorus, potassium, nitrogen, sulfur—and the several "trace" elements, one may limit the other via the soil.

All trophic levels above the plants must live by the compounds of the latter's synthesis—carbohydrates for energy; proteins for growth of tissue, protection, and reproduction; and inorgano-organic combinations associated with the proteins. Proteins in plants result, not from photosynthesis, but from the plant's biochemical processes, which require expenditures of stored energy and assembly of inorganic and organic requirements by the roots. The roots penetrate only a limited volume of soil, living there largely through activities of the decomposers. Plants, like microbes, use carbon dioxide waste—from the roots—to produce active hydrogen in the resulting carbonic acid to mobilize the soil fertility elements for plant survival. These two populations, the producers and the decomposers, as contaminants or as transformers, determine the environmental support of all other populations.

The Predators

All the heterotrophic populations crowd each other to get to the food delivered to them by that mundane team of autotrophs—the symbiotic team of microbes and plants. That crowding, under the deficiencies provoking it, makes the wastes of each a contamination for the other whenever the natural processes of the producers and decomposers are disrupted. All populations above plants and microbes are included in the third category: the predators. They prey upon the plant population, and upon each other to an increasing degree, since the plants are not nourished by the living soil completely enough to be ample prey for man and all the other predators and parasites.

Predators—other than man—do not destroy their prey completely before the numbers of predators drop down so far that the numbers of prey mount to domination again. Increase in prey favors an increase in predators, and then, in turn, a decrease in prey, to yield naturally alternating dominations but not the extinction of either. But man is not merely the predator of one trophic level; he also aims his technology at complete extinction of many populations. Thus he breaks the law of predator-prey relations and of survival. When he causes extinction, he reduces the number of basic segments by which the biotic pyramid supports man.

Interpopulation predations increase as the soil becomes less able to grow the vegetation of nutrition in required quality and quantity. When the soil's inorganic elements have been depleted, then the exploited soils must eventually register their damage on all trophic levels. The most serious effects fall first on man, raising the question of whether the baffling degeneration of our bodily health, now increasing our concern about what was once commonly called "disease," may not suggest patterns of hidden causes connected in some way with the climactic-fertility pattern of the soil. Thus, human ecology may develop into the most important science.

Population-Time Chart

When the numbers in any population are charted as a graph against a base of time, they give a sigmoid curve. Its shape suggests the top of the letter 'S' pulled to the right while the bottom remains attached. The introduction of a single living microbe into a given volume of medium results in a slow increase in numbers with the curve moving along the near-horizontal. But soon the move turns toward the vertical, suggesting a population explosion. Then the increase lessens, ceases, and finally, there is a population decrease followed by even-

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tual extinction. Contamination by its accumulated non-transformed wastes, coupled with exhaustion of nutritional and other environmental supports, eliminates the population from its limited setting.

Populations of older countries, similarly charted, suggest the final third of the biotic curve. France, Scandinavia, Italy, and Spain, starting as far back as 1900, are illustrations. The United States illustrates the lower two thirds, or the beginning of the chart. Predictions from 1920 onward pointed to the falling percentages of increase, if immigrations were limited.

Biological Liability

Since the multiplication of man still conforms to the natural laws of biological phenomena, and since human multiplication is by no means managed to give biological advantages for improved survival, we must characterize man, at this stage, as the main biological liability, not only to himself, but to the other populations supporting him. *He is the contamination in the environment.*

Man's disregard of his ecological limitation to the temperate zone—by the required supply of proteins alone

—should be cited as only one powerful factor. As one moves from the temperate to the torrid and humid tropical zone, the desperate struggle for proteins at any trophic level is evident in the carnivorousness and cannibalism that are common. Here, life forms are mainly predators. The same is true as one moves from the temperate to the frigid zone.

Climatic Extremes

The migrations into the frigid zone, into climatic-soil-fertility settings of little or no soil construction, are badly handicapped by the paucity of producers and decomposers. The predators win support by their carnivorousness or through lifelines reaching back into the temperate zone. In the tropics, high rainfall and temperatures have caused excessive decomposition of the rocks to the point of destruction of soils which then fail to fully nourish plant life. Even proteins are there replaced by poisonous compounds of many producers. Carnivorousness and cannibalism characterize the survival of decidedly limited populations. The dry tropics are in the same category. Populations at climatic extremes are limited because the producers, operating in combination with the decomposers, are not providing the necessary proteins in complete array, nor with their natural accompaniments.

The epoch of man is but a minute segment in the paleontological column of the earth's populations as they have come, gone, or remained. Man has shifted away from the rugged individualism of open country and its diversity of agriculture according to the laws of nature. He has collected himself into congested cities which have been said to require monocultures and chemicalized agricultures; he has controlled the environment of those cities according to the dictates of technology and economics, disregarding nature's laws and even his own biochemistry.

During the latest part of the brief epoch of man's existence, his technologies and their political complications have served to harvest the natural living resources, to exploit soil fertility and to compel the human march from east to west. The march has rolled on until the resources of most recent possession—those of the western hemisphere—are dwindling rapidly under the political demand for coexistence of the Western world with those bringing up the rear in the march—a total world population approaching three billion predators.

Man Ignores Nature

Because they must behave according to the natural laws controlling biological bodies, each population below man has—through evolution—exhibited itself as a climax crop for a limited time in its limited ecological setting. But man, with mental capacity transcending that of the others, has used most of the other levels to his advantage and their disadvantage so that, in general, he does not conform to the pattern of evolution. His technological powers disrupt the pattern and destroy the very conformers that support him. Unwittingly, his development and management of environmental control over materials and energy have increased the contamination of the soil and the atmosphere. He has destroyed the decomposer populations to the extent that the natural basic support of the producers is weakening; the entire biotic pyramid is tumbling because of man's dominance at the top.

In managing her contaminations, nature either transforms them through biotic disposers in the surface soil, or buries them safely at greater depths. Man, managing his contaminations as a helpless novice, seems to be on his way to his own destruction by and amongst them. In all probability, nature, not he, will determine the final outcome. ●