An Ecologist's Guide to the Problems of the 21st Century

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THE human prospect—whether we should look forward optimistically to continued social progress or pessimistically toward a catastrophic deterioration of the human condition—is something close to the hearts and minds of most thoughtful persons, so why should ecologists believe that they have any special insights as to how humanity must prepare for an uncertain future? The answer is that with the expansion of scientific study after World War II, ecology, which deals with the relationships of organisms to one another and to their environment, took on a new look. Before the war it was largely concerned with the description of plant and animal communities and their distribution in relation to environmental factors of climate, soil, topography, etc. It was, therefore, a mostly outdoor occupation that kept one happy and uninvolved in society's troubles. After the war the emphasis shifted, and ecologists began to deal more with problems of a very different sort, those of ecological processes and mechanisms. Included among them were the following:

- the dynamics of population growth
- the rules governing the flow of energy through ecological systems
- controls on the cycles of matter—of nutrient elements such as carbon, nitrogen, sulfur and phosphorus or of toxic elements such as mercury, lead and cadmium
- the problems of community and ecosystem organization and regulation
- the role of diversity, and its maintenance, in populations and ecosystems
- the understanding of animal behavior

But aren't these the things we read about in newspapers and in weekly news magazines, or see on television? Aren't these the besetting problems of humanity today? Indeed they are, and that is why ecologists often have a better understanding of our problems than do other people. Human beings have been paying a heavy price for treating Nature as an opponent to be subdued, exploited and beaten rather

than a partner to be cherished and protected. The words of Francis Bacon now seem to be unusually prophetic: "Nature, to be commanded, must be obeyed." To begin to treat Nature as a partner people must learn, and learn well, the principles of ecology that regulate population dynamics, energy flow, nutrient cycling and so on, and see their implications not only for natural ecosystems but also for our own artificial and intensely human societies. Let us look briefly in turn at each of the problems mentioned as they concern all people today.

Population Growth

The study of population dynamics poses the difficult question of how to get off the slippery slope of a population explosion, with its upsweeping, compound-interest curve of growth—and to aim for stability rather than the catastrophe that often overtakes exploding, over-extended populations of plants and animals in nature. Some kinds of animals are adapted to survive recurrent catastrophes, but human beings are not. This compound-interest population curve is grimly yoked to similar curves for growth in our use of energy and other resources, in pollution, and in the published material that comprises the sum of human knowledge. Unfortunately, compound-interest curves for wisdom, or for loving kindness and concern for all living things, are conspicuous by their absence from the record of humankind. It has proven much easier for the developed countries to export techniques of death control by sanitation and modern medicine to less developed countries than to export methods of birth control, which often carry with them the connotation of genocide.

A major problem with compound-interest curves is the ever-increasing rate of change. Can the reaction times of human institutions and complex societies be quickened to meet the challenge of ever more rapid change? This may be the pivotal issue for our times, because the pace of change is at the root of a good deal of our social unease. Personal experience and observation suggest that even scientists commonly begin to become obsolescent in their 40s and 50s, and new recruits become ever more specialized because in the rush and bustle of daily life they have not been able to keep up with the information explosion.

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Nothing is more demoralizing than becoming antiquated or facing a future of increasingly narrow competence. Inhabitants of the business and financial worlds may not be entirely clear as to when they are being assisted or dominated by the computer revolution, and behind requisite smiles of optimism their psyches may suffer as a result. Unfortunately, the problem is likely to become progressively worse as the pace of change quickens. Should humanity then—like the Luddites of the early nineteenth century—attempt to slow the pace of technological change, or merely redirect it to more manageable or worthwhile objectives?

Rapid growth, especially population growth, poses a distinct problem: Can freedom as we know it be maintained for individual human beings? There are increasing problems in organizing the huge numbers of people and things imploding into our bursting metropolitan centers. Will the need for ever tighter management of these centers lead in the direction of a hyper-regulated human ant hill? To biologists convinced of evolution, it seems entirely possible that more than superficial freedom of the individual may eventually be seen as but a fleeting phase in the history of human societies. The old adage: "Go to the ant, thou sluggard," now being obeyed by numerous animal ecologists, may have a broader relevance than we think, especially as increased sophistication in the behavioral and social sciences permits more effective manipulation and control of one's fellow human beings. We must remember that science, in this context, is amoral. It can be used for good or ill, and frequently for both.

Energy Flow

Energy is another of the major concerns of humanity, as well as of ecologists today. Today's children learn in school that the major source of energy for humanity, as for plant and animal communities, is that giant nuclear reactor called the sun. Even the gas, oil and coal that we burn are in a sense "fossil sunlight." And although such potential energy took geological epochs to accumulate, we shall dissipate most of it quite wastefully in one or two millennia, causing massive air pollution, acid rain and—if we are not careful—major changes in climate along the way. How can we go farther on less?

It might engender in us a useful sense of humility to realize that, in the words of the chemist Henry Bent, "Life on earth is only a momentary excursion in the natural history of the sun's photons." Another way of acquiring such humility might be to ask ourselves: "Are we really favorites in the evolutionary contest? Is fate on our side? Is it really we who can expect to inherit the earth forever?" In this connection one of the century's great biologists, J.B.S.

Haldane, once asked himself whether, as a student of the Creation, he could deduce anything about the nature of the Creator. After some thought, he deduced that the Lord must have had an inordinate fondness for beetles! If you wonder why, it was because He created so many different kinds—400,000 species as against 8,000 species of mammals—that He must certainly have been fond of them. There is a sting in the tail of this story that Haldane would have appreciated. As it turns out, beetles are extraordinarily resistant to radiation. So, if we incinerate ourselves in a nuclear holocaust, the beetles are waiting in the wings, ready to take over center stage!

Cycles of Matter

Material cycling is a major focus for ecologists today. Likewise, human beings must focus on Nature's model of recycling materials over and over again if civilization is to survive. Up to now emphasis has been almost totally on extraction, manufacture and use of resources. Little attention has been paid to waste disposal. The first rule for it was, "Out of sight, out of mind." The second rule was, "The solution to pollution is dilution." But nowadays there is nowhere that is out of sight or smell or taste. And we are running out of air, water and land to dilute or bury our wastes. The new rule, which is really Nature's old rule, must be "Recycle, recycle and yet again recycle!" Recycling the resources societies need, emulating Nature's way, may well be a major limiting requirement if civilization is to be preserved as we know it.

Community and Ecosystem Regulation

Issues of system regulation are of common interest to ecologists and to those concerned with the human condition. The ecologist wants to know how forests such as those of the Boundary Waters Canoe Area in Minnesota maintain themselves, and what determines the fluctuations in their deer or wolf populations. On a more practical basis, we want to know how our forests should be regulated for multiple use and not simply for timber. These are difficult problems, but if we learn to solve them we shall be better prepared to tackle the far more difficult global problem of how to manage a stable life-support system on Spaceship Earth. Our social relationships are far more complex than those in a deer herd or a wolf pack, and so we are faced with much more taxing questions when we look at social regulation. Are our present forms of government adequate to meet the challenge of change, and to reach the goal of humane, free societies living in a balanced global ecosystem? Can lawyer-legislators be retrained to look forward rather than backward? Legal and governmental precedents

cannot provide the means with which to meet unprecedented problems, so that legislators could benefit from a greater acquaintance with the principles of ecology. The same can be said of the voting public.

The Role of Diversity

Diversity, which provides options for responding to the challenge of change, is another subject of concern shared by ecologists, social scientists and legislators. Ecologists have generally believed that the most stable systems are the most diverse, although this is now being called into question. The human parallel of the tropical rain forest might, therefore, be China, a long-lived, multinational society of diverse ethnic origins. Simple systems, on the other hand, are liable to wild fluctuations and catastrophe, although they may recover regularly from such catastrophes. The Arctic tundra with its waxing and waning populations of lemmings, lynx and snowshoe hares provides a natural example. Ireland in the 1840s—tied to a monoculture based on the potato, which resulted in catastrophic famine when the potato blight struck—is the classic, and tragic, human example. These examples teach the lesson that, although Nature may be almost infinitely resilient in the face of disturbance, her mechanism of recovery is the Darwinian mechanism of natural selection, in which there are always victims—plants or animals, including humans—as well as victors.

In natural ecosystems, ecologists believe that it is of vital importance to preserve genetic diversity, represented by the vast numbers of species that populate the surface of the planet. But are they all important to the functioning of the global ecosystem, let alone vital to its survival? What, for instance, can the snail darter or the Furbish lousewort do for human society? Before these organisms are dismissed out of hand, we should remember that much of our knowledge of human heredity rests on studies of the genetics of even more insignificant organisms—the common fruitfly, *Drosophila melanogaster*, and a kind of bread mold, *Neurospora crassa*. Organisms preserved in their natural environments also yield clues to fundamental scientific problems. Darwin's finches on the Galapagos Islands and Diane Fossey's gorillas in the mist are excellent examples. Aldo Leopold said it best, "To keep every cog and wheel is the first precaution of intelligent tinkering." The botanist Thomas Morley has said likewise, "We may endanger our future by destroying what we think at the time to be unnecessary."

A related question is whether human beings really need wilderness, or is it merely a fetish of elite, affluent societies? Why not open up the wilderness and exploit its resources for the benefit of the many? One answer is that aesthetics, the values of beauty,

are important in and of themselves even, or perhaps especially, in a materialistic society such as ours. The geologist and ecologist Herbert Wright has likened pristine ecosystems to works of art, infinitely more valuable in the original than in the copies that can be made of them. Another answer is that wilderness ecosystems have truly practical values that may even benefit persons who have never set foot in them. They provide us with living museums that show the landscape as it was when our forefathers settled the continent. Thus they allow us to understand, by comparative studies, what human exploitation has done to the land, and they provide a baseline against which to assess local and regional pollution such as acid rain or global climatic warming. Wilderness ecosystems are also storehouses of genetic diversity that may yet serve humanity well; their stores must not be squandered carelessly.

In human societies, genetic diversity should be equally prized—black, white and yellow are all beautiful! Cultural diversity should also be cherished if our options are to be preserved in a rapidly changing world. We know that our culture of planned obsolescence and conspicuous consumption is not a viable pattern for the future. But we do not yet know which of the other cultural patterns observable in the world today—some of them being tried out by our children—is best fitted to improve the human prospect over the generations to come. Here we face a paradox. Is more conformity or less the necessary or desirable pattern for the future? On the one hand, it might be suggested that increasing conformity will be required to allow a workable organization of this increasingly complex world. On the other hand more diversity, both individual and cultural, may be viewed as absolutely necessary to meet the challenge of change. Can the paradox be resolved? Perhaps, if it is acceptable to divide the world into conforming masses and nonconforming managerial elites, as described in both Aldous Huxley's *Brave New World* and George Orwell's *1984*, now six years behind us. But neither Huxley nor Orwell was satisfied with such a resolution. Is there an alternative? We must all hope so and search for it diligently.

Behavior

The last of the topics mentioned at the start of this essay was behavior. Problems of aggression are a particular concern of ours shared by a variety of animal ecologists. To what extent it is inborn and to what extent it can be unlearned are important questions. Unfortunately, we do not yet know the answers in the case of the human animal. Can something useful be learned about the behavior of "Naked Apes," as Desmond Morris has so aptly called us, by studying communities of chimpanzees and gorillas in

their native habitats—now rapidly disappearing? Yes indeed; much has already been learned, and the process must continue.

Conclusion

By now you will have gathered that ecology can provide a bridge from other sciences—physics, chemistry and biology—to the social sciences. What we have to realize is that physics and chemistry are the easy subjects. Biology is more difficult, ecology more difficult still. But the social sciences are the most challenging of all because they are by far the most complex and unpredictable sciences, about which we know the least. Technology, based on physics and chemistry, is upsetting various biological, ecological and social balances far more subtle and significant than the mysteries of the internal combustion engine or the industrial synthesis of organic chemicals. Technologists are in reality a breed of sorcerer's apprentices, whose powers far outrun their—and our—understanding. Forgive them, for they know not what they do! And all too often, we as citizens and consumers know not what we do and are equally in need of forgiveness. The lesson to be learned is that people should practice much greater caution as we begin to manipulate the global environment on Nature's own scale.

What is needed to put in perspective the simplistic and reductionist viewpoints of engineering and chemical technology is a far wider dissemination of ecological knowledge and the ecological point of view: that the web of life is like a spider's web—the whole system trembles whenever it is disturbed. The complicated web of life cannot be understood successfully solely by taking it to bits and by dealing with parts of it in isolation from one another, but only by viewing it as a whole. This holistic attitude toward Nature does not imply that "taking to bits" is not a legitimate part of science, or indeed of ecology, but only that considerable effort should also be devoted to putting the bits back together. In this way their interrelationships may be understood, and if necessary, manipulated in ways that tend to conserve rather than to destroy the global ecosystem. In this connection it is simply heartbreaking that so many of the world's best scientific brains—in particular those in the United States and the Soviet Union—are devoting their exceptional intelligence to building weapons of mass destruction rather than to the development of non-polluting technologies and sustainable agricultural systems.

It is timely to contemplate that somewhere out among the galaxies celestial philosophers may logically be asking, "Is there intelligent life on earth?" At present we are in the humiliating position of having to equivocate across the cosmos: "Yes and No!" "Yes" because of the civilization (at its best) that we have built together here on earth, and "No" because of the prospect that we may annihilate it all in a nuclear holocaust before another century is over. Our most important task in the years immediately ahead is to find the means of avoiding that holocaust. Our next most important task is to maintain the ecological balance of the planet, without which our civilization, and our children's and grandchildren's future, cannot possibly be secure. Indeed, an ecological holocaust of habitat alteration and species extinction already threatens to destroy much of the biotic diversity that characterizes the global ecosystem. Our third major task is to combine appropriate regulation of our complex multinational society with freedom and justice for the individuals that make up that society.

Perhaps we can take heart from the advice of the British poet John Masefield in his poem "The Ending" in *The Wanderer*:

Therefore, go forth, companion: when you find
No highway more, no track, all being blind,
The way to go shall glimmer in the mind.

Though you have conquered Earth and charted Sea
And planned the courses of all Stars that be,
Adventure on, more wonders are in Thee.

Adventure on, for from the littlest clue
Has come whatever worth man ever knew;
The next to lighten all men may be you.

Acknowledgments

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I would also like to acknowledge The Society of Authors, literary representative of the Estate of John Masefield.

Further Reading

The following texts treat in varying detail most of the topics addressed above, and contain a wealth of citations of appropriate literature:

- Cunningham, W.P. & Saigo, B.W. (1990). *Environmental science: A global concern*. Dubuque, Iowa: W.C. Brown.
- Ehrlich, P.R., Ehrlich, A.H. & Holdren, J.P. (1977). *Ecoscience: Population, resources, environment*. San Francisco: W.H. Freeman.
- Miller, G.T., Jr. (1990). *Living in the environment: An introduction to environmental science* (6th ed.). Belmont, CA: Wadsworth.