HUMAN ECOLOGY-WHAT DOES IT MEAN?

By R. O. Slatyer, Professor of Biology, Research School of Biological Sciences, Australian National University, Canberra.

Ecology is the study of organisms in relation to their environment; it deals with the environmental requirements of single species and with whole populations or communities, with the way in which organisms influence, and are influenced by their environment, and with the way in which organisms interact with one another.

Man is an organism, so human ecology is concerned with man in relation to other organisms and to his environment. Because of the complexity of the human environment, which is so strongly influenced by man's own actions, human ecology has many facets, and individual anthropologists, sociologists, and psychologists, as well as economists and biologists, have distinctive views as to what human ecology means.

In this article I wish to discuss first some general ecological principles and phenomena, then to look at man in relation to the ecosystems he occupies and which sustain him, and finally to point out the changes which are needed in his attitude to the environment in the interests of his long-term well-being as a species. To me this is the overview of what human ecology really means.

Ecology and environment

A primary feature of life on earth is that organisms do not exist in isolation; instead, the entire biosphere is composed of a range of ecosystems, each of which contains a number of species and a number of micro-environments, with each species tending to utilise and occupy an environmental niche more effectively than its competitors, and the whole assemblage of species tending to cohabit in a manner that provides a high degree of internal self-regulation. A forest, or a lake, provides examples of typical ecosystems, but the scale can vary widely. The entire biosphere constitutes the earth's ecosystem.

A primary feature of an ecosystem is that it tends towards self-regulation. Solar energy is absorbed by the green plants to provide, through photosynthesis, the basic energy input. Plants also absorb water and mineral nutrients from the soil. The plant components thus produced are then passed through a food chain, in which the initial products are eaten by herbivores, herbivores by carnivores, carnivores by other carnivores, and so on until decomposer organisms return the organic wastes and the remnants of the organisms in the food chain to the soil, in a form that enables their re-absorption by the green plants.

In most natural ecosystems, therefore, there tends to be no net production—in the human sense of a net harvest of materials. The solar energy absorbed and stored by the green plants is gradually consumed by metabolism through the food chain and dissipated as heat. Thus there is a flow of energy through an ecosystem, starting from solar energy, passing through successive forms of chemical energy—at each stage some energy being lost as heat—until it is all dissipated. Associated with this flow of energy is a cycling of nutrients through food chains so that the ecosystem as a whole tends to be balanced and self-contained.

The stability of an ecosystem, its ability to adapt to invasion or catastrophe without major change, is largely a matter of its diversity. In turn, this is largely a matter of the rate of nutrient cycling, or the rate of energy flow. An ecosystem with little diversity is vulnerable to invasion and, especially if energy flow is slow, is often unable to adapt to the change, at least without a period of marked instability. The successful invasion of Australia by rabbits is a good example of limited species diversity in Australian ecosystems. The ability of rabbits to compete favourably with other herbivores for forage, and the absence of effective predators, meant that the rabbit numbers increased dramatically until in many areas competition for food, between rabbits themselves, was the main factor limiting their numbers. The successful invasion of Queensland pastures by prickly pear is another example of ineffective competition and the absence of suitable animals in the food chain to consume it. Fortunately, the absence of predators of the insect *Cactoblastis*, introduced to control prickly pear, meant that this insect could control it effectively and the existing ecosystems, perhaps enlarged by these two species alone forming another loop in the food chain, returned to a degree of stability.

The most impressive examples of potentially unstable communities ripe for invasion by other species, are agricultural crops, where a single species may be grown over thousands of square miles. The opportunities for invasion by "weed", "pest", and "disease" species—all words of modern man's vocabulary—are tremendous.

Management of an ecosystem, "management" is another such word, in such a sense of increasing the numbers of one or a group of species within it, and perhaps in removing them from the ecosystem so that there is a net yield, need not disturb internal self-regulation. The primary need is to ensure that nutrients continue to be recycled, that other important organisms are not adversely affected, and that there is sufficient diversity in species composition to prevent the community from becoming unstable.

Man and environment

Let us now look at man's impact on the environment to see how he had adjusted ecologically to the biosphere in which he evolved. To my mind, it is easiest to do this by looking at man in three stages of his cultural evolution—man the hunter-gatherer, man the herder-cultivator, and man the technologist.

When man first appeared, of the order of a million or so years ago—a very brief time in geological time—the earth contained many of the species of plants and animals which exist today, most of the climates which exist today, and many of today's topographic features. Although the distribution of climates and the location of shorelines have changed, the range of ecological situations available for life has not changed to a pronounced degree. In many regions the first men enjoyed the same weather, breathed the same kind of air, and ate the same kind of animals as did Neanderthal man only a few tens of thousands of years ago, or today's huntsmen-campers in areas remote from industrial centres.

The place of early man in the ecosystems he occupied was a relatively passive one until his first deliberate activities in cultivation and animal herding. The first men preyed on, and were preyed on by, other animals. They gathered plant foods when and where they were available. They were, in all respects part of the natural food chain of the ecosystems they lived in; the changes they were able to make to their immediate ecosystems were probably of minor significance.

Gradually man's hunting and gathering skills increased with the use of crude tools, and with the development of different strategies and procedures. Fire was undoubtedly an important factor in this regard and was his only real instrument of environmental manipulation. The deliberate use of fire enabled man to increase primary productivity by keeping vegetation communities in a relatively productive sub-climax condition. It also encouraged the concentration of food animals on fresh vegetative regrowth, discouraged their concentration on burnt areas, and destroyed the cover offered to predatory animals.

The activities of the Australian Aborigine, prior to European colonization of Australia, in many respects epitomized the life of man the hunter-gatherer. If aborigines could not be seen, evidence of their previous presence at any location was meagre and short-lived. In most respects they were as well adjusted to the natural environment as were the animals and plants they consumed.

Man the hunter-gatherer really lived his natural ecological role. Admirable though this was in the sense of permitting nature's overall fulfilment, it clearly left man vulnerable as a species. So it was that man the farmer gradually emerged.

Those of us who admire the noble savage must conclude that life since the emergence of agriculture has been one long downhill slide—from fun to work. Whether or not one agrees with this view, the fact is that as man's hunting-gathering activities gradually became those of herding and cultivating, and he became a farmer, he began a commitment from which there was no escape.

As we have seen, the numbers of any species in an ecosystem will tend to rise if it is protected from its competitors. Man the herder-cultivator sought to ensure his own survival by protecting his food supplies—the plants and animals he wished to consume—from competition and predation, and by deliberately cultivating them. In ecological terms, he sought to maximize the energy flow passing through himself by maximising the energy flow passing through the species directly ahead of him in the food chain.

Because he was also able to protect himself against predation his numbers increased, and immediately his dependence on the managed ecosystems increased further. There was no going back. Not only did he become dependent on agriculture, but his increasing numbers started a demand-supply spiral which meant that continually he had to attempt to increase both the area under cultivation and the yield of any one area.

Furthermore, the more specialized his agriculture became—that is, the more he attempted to reduce the number of species in his managed ecosystems—the more unstable they tended to become. The tendency for undesirable species to invade his farms increased, the removal of existing vegetation exposed his lands to erosion, and this factor combined with the removal of nutrients from his ecosystems without replacement, began to reduce their productive potential.

Although some specific ecosystems were badly damaged (for example, those on the fringes of the Sahara where herding of goats caused almost completely new, and much less productive ecosystems to be established), man's activities, in most cases, were still of little consequence to

the biosphere as a whole. Not only was his capacity for major change limited by his muscle power and that of his domesticated animals, but his numbers were still so small that there was always more land over the next hill or in the next valley.

Man the herder-cultivator was therefore able, if not to live an ecological role as fully as man the hunter, at least to avoid his large-scale environmental change, although his low numbers were the main factor responsible. Even so, he barely managed to match food production against increasing numbers, as periodic famine in peasant agricultural systems, even today, testifies; thus in ecological terms, he was stretching the capacity of his ecosystems.

The story of man the technologist is, in most respects, simply an extension of man the farmer. However, with the industrial revolution, man's ability to harness power to his needs meant that the impact of his activities on the environment increased tremendously.

To my mind, this impact has two main, closely linked, aspects. The first has been the dramatic and continuing increase in man's numbers as his capacity to manipulate agricultural ecosystems for food production, and his control over human disease, have increased. The second has been the development of a great diversity of human activities, human demands, and human products. Thus not only has population itself increased rapidly, but the demands for each human being for factors other than basic food needs have also been increased. Man the technologist expects, not merely to survive, but to enjoy a socio-economic infrastructure which provides transportation, education, housing, recreational space, and many other cultural facets.

To satisfy these desires and needs, man has affected the environment both directly and indirectly. In a direct sense, his mechanical activity—in constructing cities, highways, and dams, and in soil cultivation and mining—is the most striking and obvious. Indirectly though the other products of modern technology are also of great importance as agents of change.

In these activities, man the technologist has attempted to ignore the capacities and characteristics of his ecosystems. The agricultural ecosystems in which he produces his food have been still further removed from stability. He has loaded them with the products of chemical technology, thinking only of maximizing food yield from a few species. In the process, the nutrient and non-nutrient chemicals (fertilisers, pesticides, weedicides) which he had added have had repercussions far beyond the ecosystems to which they were applied.

In the ecosystems in which man has built his cities he has also added vast quantities of nutrient and non-nutrient compounds—both domestic and industrial wastes. These, too, have affected regions far greater than the areas where they were dumped.

Photo by courtesy W.A. Newspapers

Dead fish line the shore in an area where man is making dramatic changes to the natural environment

The impact of these changes on the environment as a whole is now beginning to be appreciated. Ever since his appearance on earth, man has attempted to exploit his local environment for his own ends. In a sense, all organisms have done this, whether deliberately or not. As long as man used natural methods and the power of his own metabolism for this exploitation, and as long as his numbers were low, there was little likelihood of the changes he induced affecting more than his immediate environment—and his early attempts at exploitation were still essentially conservative, in the sense that they preserved the basic diversity and character of the environment. Now, however, the situation has gone full circle; man is so abundant and so powerful that he is changing the properties of the entire biosphere. The rate of change is far greater than occurred even during the great transitions from one geological epoch to another. Clearly this trend must be reversed.

Ecology and Man

What are the solutions to this collision course between man's numbers and demands on the one hand, and his environment on the other?

It is clear that the goal of "the greatest good for the greatest number" is impossible to achieve. Despite the bliss that this phrase may conjure up in some people's minds, even man cannot

maximise for both of these factors at once. Ecologically, it is probable he cannot maximise for either, unless "the greatest good" is identified with conservation of man as a species. But our present numbers, our present technology, and our present attitudes are not consistent with this goal.

What is really required is nothing less than a change in our basic philosophy of life—from an attitude to our environment which regards it as a resource to be exploited for short-term personal, regional, or national gain, to an attitude of living ecologically in a way that is essentially conservative of the environment.

Man the technologist must therefore become man the ecologist; not the same ecologist as man the hunter-gatherer, but rather one who can use the tremendous intelligence, experience, and power at his command to live in harmony with, rather than oppose, the natural workings of the biosphere. To my mind the human ecology, which spans the whole range of human activities should have at its core the study of man in relation to the biosphere, with a view to developing ecological guidelines for his future well-being.

[Reproduced from Australian Natural History Vol. 16 No. 12 December, 1970 with kind permission of the author and the Australian Museum.]

Western Australia is the fastest growing membership body in Australia. With only 100 members in January 1970 this figure has now climbed to 475. Total members throughout Australia is approaching 6,000.

The A.C.F. is a non-profit, private organisation which was set up in 1965 to promote the understanding of conservation throughout Australia. Its methods are to act as a forum where people can analyse problems, formulate solutions and spread the understanding of these issues by means of publications, press releases, seminars and direct influence.

The Foundation has already been actively involved in many of the major conservation issues in W.A. including; Cockburn Sound, the Fitzgerald River, etc., and has made submissions to the Committee of Inquiry into the Mining Act and to the Select Committee on Wildlife Conservation.

The A.C.F. is controlled by an executive of scientific and business people who are backed up by a council elected by members from all States and the A.C.T. The Governor General, Sir Paul Hasluck, is its Patron and Sir Garfield Barwick, Chief Justice of Australia, its President.

LITTER POLLUTION