EARTHCARE: Global Protection of Natural Areas

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bewail, but the political decision-makers do not act, or do not act soon enough. Perhaps, through the urging of the international community at meetings such as EARTHCARE, national pride in a national and international heritage may move governments to action. It was largely by this means that the idea of national parks was spread globally. Perhaps this EARTHCARE Conference can support the program initiated by IUCN-WWF, which have designated this year (1975) as the "Year of the Rainforest."

33. Regeneration Problems of the Tropical Rain Forest

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The Roots of Ecology

The tropics support a great variety of ecosystems, which have attracted the attention of naturalists for a long time. They have been the scene of many important advances in the biological sciences. For example, Charles Darwin, the outstanding biologist of all time, obtained fundamental information in the tropics, and such basic concepts as evolution, species diversity, and speciation have deep roots there. It is astonishing to realize that all of these advances were made at a time when little knowledge was available about the biota of these regions.

I often wonder what our world would be like if development had been based in the tropics. How would human society have evolved if man had discovered and utilized the resources of the tropics to the same degree he has those of the temperate regions? Would we produce food as we now do? Would we manage land differently? Would our concepts of conservation and wildlife management be the same?

The Evergreen Rain Forest and the Process of Regeneration

The term "rain forest" is often generalized to include ecosystems of very diverse natures; I will use the term to mean evergreen rain forests of the tropical lowlands. These are without doubt the most diverse ecosystems on Earth and yet the least known—a paradox that concerns scientists and citizens all over the world. These ecosystems are threatened today in many regions of the world by the increasing demand for new land for the Earth's growing human population.

I would like to discuss one of the most important aspects of the tropical rain-forest ecosystems, one that may help us to see more clearly the problems due to the improper application of knowledge derived in temperate regions to tropical areas. I refer to the process of regeneration of the rain forest.

It should be kept in mind that the most significant characteristic of tropical rain forests is their inability to regenerate after heavy and extensive destruction. Yet many people take it for granted that a forest will regenerate after it has been destroyed. This belief is based on experience gained in heavily populated countries of the temperate regions, where forests have been reestablished successfully even after intensive exploitation and deforestation. But I would like to point out some of the differences between the regeneration of tropical rain forests and that of temperate forests.

Ecological Succession in Tropical Forests

When a tree falls in a forest due to wind, old age, and so on, it is replaced. This is "ecological succession," a process which is, in turn, the result of a long process of evolution; it is homeostatic: it helps maintain the stability of the ecosystem. Ecological succession has been known for a long time and is well accepted, though not all of its characteristics and specific variations are known yet. Because of their natural biological richness and absence of definite limiting factors, the hot, humid tropics in which the rain forests occur have one of the most complex successional processes known.

Let's go into more detail on this process as it occurs in the rain forest. When a tree falls, a "light gap" appears. Some of the seeds in the soil germinate, and some of the established small plants on the site grow faster, while others die. This means that regeneration occurs mainly from pre-established plants under natural conditions.

Regeneration Potential

We studied regeneration potential as the key to understanding the entire process of ecological succession in tropical rain forests. First, to determine the "floristic potential" of its soil, we collected soil samples from the rain forests to find out which species are represented by living seeds. After several years of studies, we discovered that the species present are mainly secondary species; primary tree species were not present in the samples. The obvious question came to mind: What is happening to the seeds of the primary-tree species? We conducted several studies and we found that they either germinate immediately or are soon eaten or decomposed.

That finding was extremely important, because it means that the only way for a primary-tree species to regenerate is for its seedlings to be growing in the understory of the forest when a light gap occurs. Temperate forests may have similar potential in seedlings, but a major difference between them and tropical forests is that the more viable seeds of primary species are stored in the soil of temperate forests. This permits many species to survive for many years, even while the forest is being intensively used. Through a survey of the scientific literature, we found that seeds of primary temperate-forest trees were viable for an average of ten years, while those of primary tropical rain-forest trees were viable for an average of only twenty-five days. Some of the findings we made in tropical Mexico are being confirmed by other studies conducted in Central America and Asia.

A primary tree of a rain forest has to have a large seed, with enough food reserves for fast growth into a large seedling well above the ground. This fast germination is a desirable adaptation because the large seed with its food reserves appeals to frugivorous animals. Fast germination reduces that problem. In addition, the seed is subject to the intense microbial activity in the litter of the tropical soil: a seed without any special protection decomposes rapidly. Immediate germination also helps prevent this problem. This adaptation was favored in evolution and is not a widespread characteristic of tropical trees. Also, primary-tree seedlings are adapted for photosynthesis under filtered light of low intensity.

Secondary species are also fast growing, but they are adapted to intense light. Their problem, then, is different from that of the primary species: because light is the most important trigger factor

for germination, the seeds have to remain dormant and viable until an opportunity to grow arrives—which happens when a light gap occurs. These species have other adaptations that are different from those of primary species, such as their small, well-protected, dormant seeds.

Secondary species are extremely important because they rapidly restore the environment for the primary species. Several studies have been made by my research group on the evolution and adaptation of secondary species. The results of those studies verify the fundamental role that secondary species play in the natural regeneration process.

If we examine them from an evolutionary standpoint, we see that the regeneration system is well adapted to both the present ecological conditions of the tropics and to changes that occurred in the tropics before man appeared on Earth.

The Advent of Agriculture

Up to now I have been talking only of the natural process. With the early agricultural activities of man, the light gaps became larger, although primitive groups have unknowingly imitated the natural process of creating only small openings in the forest. After a few years of being used for agriculture, the fertility of soil in cleared forest patches declines, and various pests become a problem. The only solution has been to abandon the land, allowing time for the old gap to regenerate.

With this primitive, shifting agriculture, natural succession has operated quite well, and examples of a mosaic of land use produced by shifting cultivation can be seen all over the tropical parts of the world. This is a well-established system and, as long as the population density is low, it is an ecologically sound use of hot, humid tropical areas. Many different adaptations of this system exist in the tropics today.

Recently, however, the pressure of increasing populations and their increasing demands for agricultural land have posed new problems, compounded by the scarcity of the remaining primary forests. The fallow period of shifting cultivation has shortened, resulting in infertile soils in some areas.

In areas where no primary forests are left—even if we allow time for succession to occur—forests will never return to their original

state because there are no more primary trees around to produce seeds, and there are no viable seeds in the soil. The larger the clearing and the more intensive and prolonged its use, the less the possibility of regenerating primary trees. In these places, a new and stable, but impoverished, ecosystem composed of secondary species (the only ones available for regeneration) has been established. If to this we add the ever-increasing phenomenon of extensive permanent agriculture, the possibility for future recovery of the forest is even less.

It is my impression that because of these factors, we have lost many hundreds of species of plants in the tropical world in recent times, even before we knew they had existed. This trend will accelerate in the years to come, because the loss of primary trees accompanies the loss of other plants of that ecosystem. This is also true for many of the animals that cannot adapt to the new, arrested-successional habitat.

There is much more to say in this regard, but I would like to leave it there in your minds. If you wish more information, you could read some of our publications and also the literature that has appeared recently on the subject. (See, for example, Gómez-Pompa et al. 1972.)

Solutions

Short-Term Solutions

I want to turn now to possible solutions. There are no simple ones; the problem is complex and of tremendous magnitude. I see two types of solutions, short-term and long-term. The short-term solutions are:

1. To increase the surveys of the biological diversity of tropical rain forests, especially those that are in immediate danger;
2. To increase the number and quality of botanical gardens, biological reserves, and national parks in regions occupied by rain forests;
3. To develop land-use planning methodologies in which ecologically sound considerations could be incorporated;
4. To study the regeneration process further, with the idea of

obtaining sound recommendations for determining the size and shape of biological reserves;

5. To study carefully the land-use systems of "primitive" agriculture, which may offer solutions to our problems in the future; and
6. To investigate the use of rain forests as a productive resource in itself, since the main reason the forest has been destroyed is that is is seen as an enemy of agricultural development.

It is evident that the best way to conserve tropical rain-forest ecosystems is by convincing the people with facts. Rain forests are not incompatible with man. They can provide useful products, and people can secure their livelihood from them. I believe that this approach is the only one that could effectively stop the destruction of these magnificent forests. Their purely aesthetic values should not be overstressed: romantic conservationism can do more harm than good.

The Long-Term Solution

The only long-term solution is to eliminate poverty, ignorance, and hunger among people in the tropics. The world cannot live in peace if there is too much wealth on one side and too little on the other. Selfishness and injustice should yield to cooperation and justice. My thinking may appear naive, but I foresee a dark future for the Earth's wild plants and animals if human beings cannot develop a widespread, well-understood, and scientifically based land ethic.

Man may try to destroy nature. And while there is a good chance that some of the millions of species of living things on Earth will adapt to man's disturbances, the human species might not be one of them. It is in our hands now to provide for the future.

References

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