Damage to Tropical Forests, or Why Were There So Many Kinds of Animals?

Just as biologists are discovering that there are more species of animals and plants on Earth than was previously estimated, the ravages of habitat destruction are beginning to devastate biological diversity, in most cases before individual species have become known to science

THAT renowned ecologist of Yale University, G. Evelyn Hutchinson, once wrote a paper entitled "Homage to Santa Rosalia, or, Why are there so many kinds of animals?" Hutchinson, like the great naturalists and ecologists before him, was dazzled and puzzled by life's tremendous diversity, and not just in animals but in plants and insects too. And for good reason: the exuberance of many ecosystems is awe inspiring, as is the complexity with which such natural communities are assembled.

Biologists are, however, now faced with yet another awe-inspiring feature of biological diversity: namely its imminent collapse in the face of apparently inexorable population growth and economic expansion. The National Academy of Sciences (NAS) and the Smithsonian Institution jointly organized at the end of September a national forum to air some of the issues. The issues included estimates of the number of extant species and the rate of their extirpation; biotechnologies in zoos and botanical gardens for last ditch rescue efforts for individual species; and ecological, economic, and political strategies for halting or diverting habitat destruction. Inevitably, most participants focused on the tropics, because that is where species diversity is richest and is under greatest threat.

The tropics may be the jewel in the crown of biological diversity, but they are also largely unknown and unrecorded by science. "Perhaps one in ten to one in 20 species in the tropics are known to science," observed Thomas E. Lovejoy of the World Wildlife Fund. "How can conservation work in the face of this degree of ignorance? How can economic development be guided in a more benign direction?" Edward O. Wilson of Harvard University concurred. "We are locked into a race. We must hurry to acquire the knowledge on which a wise policy of conservation and development can be based for centuries to come, before opportunities of unimaginable magnitude are closed forever."

The scale of the challenge is huge, especially for a science that traditionally has been one of the smallest of the small sciences. From simply identifying and recording previously unknown species to understanding the structure and dynamics of ecological communities, the gap between what is known and what remains to be known is daunting.

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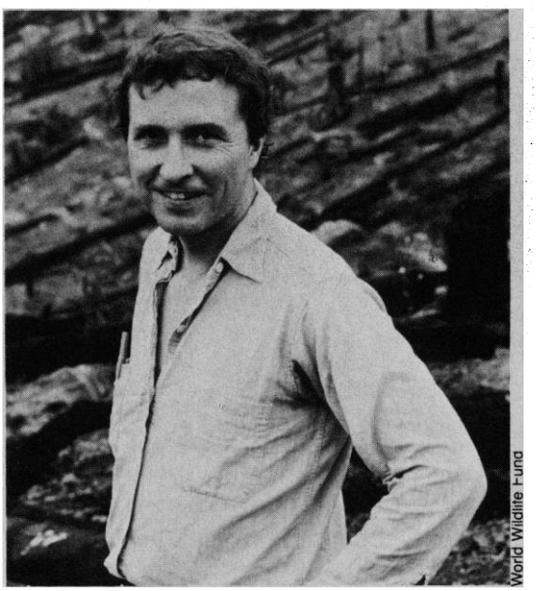


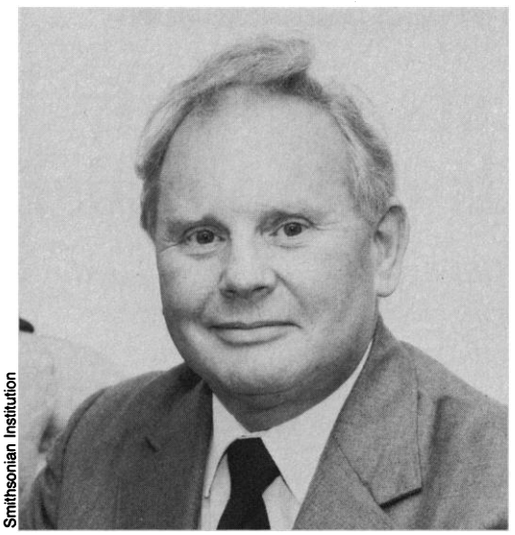
World Wildlife Fund

For instance, researchers at the Missouri Botanical Garden are logging 100 new species of higher plants from Madagascar and the High Andes each year. They estimate that perhaps 50,000 more remain to be discovered. New bird species are still being identified in an already intensively studied tropical forest reserve in Costa Rica. And of course the natural inventory of insects in the tropical forests is legendary. Terry Erwin, of the Smithsonian's National Museum of Natural History, Washington, D.C., recently conducted a survey of insects in the canopy of the Peruvian Amazon rain forest, and counted 41,000 species, including 12,000 kinds of beetles, in a plot no bigger than a hectare. In addition to offering a dramatic confirmation of J. B. S. Haldane's quip that the Creator "was inordinately fond of beetles," Erwin's data imply that there may be as many as 30 million extant species, which is six times higher than previous estimates.

Wilson illustrated the comparative scales of biological diversity between the tropics and temperate regions by referring to some of the collections that Erwin sent him for study. From a single tree in the Tambopata reserve, where Erwin worked, Wilson identified 43 species of ant belonging to 26 genera. "That's about equal to the entire ant fauna of the British Isles," noted Wilson. By the same token Peter Ashton, of Harvard University, identified some 700 species of trees in 10 separate 1-hectare plots in Borneo, which matches the count for all of North America.

The continued erosion of tropical rain forests—through small-scale slash and burn agriculture at one extreme to massive timber operations at the other—is therefore closing in on perhaps half the world's natural inventory of species. Most biologists now agree that the world's rain forests will be all but obliterated at some point in the next century, perhaps as early as A.D. 2100, depending on the figures used to measure the rate of erosion, about which there remains some dispute (*Science*, 3 October, p. 14).

Because tropical species are typically highly parochial, the islands of forest that would



Smithsonian Institution

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—Michael Robinson

remain will not harbor numbers of species proportional to their size. Moreover, small plots offer disproportionately poor protection to the species in them, as a number of large-scale ecological experiments and observations have demonstrated. "When the islands are in the range of 1 to 25 square kilometers—in other words the size of many small parks and reserves—the rate of extinction of bird species during the first 100 years is 10 to 50%," noted Wilson. And the smaller the island, the higher the figure. "Extinction rates rise steeply when the area drops below 1 square kilometer." The implication is inescapable. "The tropical world is clearly headed towards an extreme reduction and fragmentation of tropical forest, which will be accompanied by a massive extinction of species."

Although tropical forests justifiably rank highest in biodiversity stakes, other habitats are richly endowed—and threatened—too. Coral reefs are something of a marine equivalent of the forests, while coastal wetlands are often extremely diverse. Some of the large, ancient lakes of Africa carry huge species flocks of fish, most impressive of which are the many varied cichlids. Unfortunately, recent introductions of exotic species into these lakes are threatening to devastate these species flocks. For instance, Nile perch, a large, predatory fish that was introduced into Lake Victoria some 50 years ago, is known to have eaten into extinction at least 35 species of cichlids, and many more seem destined to follow.

More easily visible, and more popularly known, are such endangered species as the rhinoceros; the African elephant; our cousins the chimpanzee and gorilla; and of course the giant panda. These are the "cute and cuddlies" of the conservation movement, as Grenville Lucas of the Royal Botanical Gardens, Kew, England, put it. "We need them because it is for these large species that national parks are built, and a whole host of smaller animal, plant and insect species come under the same protective umbrella." Inevitably, the inconspicuous, the ugly, the creepy crawlies, and the downright unremarkable species fail to provoke the same compassion in the public breast as do the cute and cuddlies, however endangered they might be. Nevertheless, they are part of the richly patterned fabric of biological diversity that biologists wish to preserve.

Besides being endangered, most of the cute and cuddly species have two things in common: they are known to science and they are more or less successfully bred and reared in zoos. The species still unknown to science would, according to Wilson, require the devotion of 25,000 professional lives of systematists to complete their documentation, which task would occupy some 60 meters of library shelving for each million species. Currently there are perhaps 1500 professional systematists versed in tropical biology. And as an academic discipline tropical biology enjoys about $50 million worth of annual funding worldwide.

If the discrepancy between requirements and reality is large in systematics, so too is it in zoos (and herbaria). Noting that all the zoos of the world could fit within the confines of the District of Columbia, William Conway of the New York Zoological Society said that the number of animals they contain "is roughly 1% of the quantity of domestic cats in American households." This figure amounts to 540,000 individuals representing some 4000 species.

If the zoos of today were to be required to keep viable populations of the sort of species they now house, "the individual numbers of each species necessary . . . would make it impractical for zoos to long sustain more than 900 species and probably far fewer," said Conway. Such an ark would indeed be a poor thing.

Zoos and herbaria in recent years have been developing sophisticated techniques for propagating species in their charge. Even so, less than two dozen species of wild animals have been successfully impregnated using artificial insemination, and of these only seven have utilized frozen sperm. As techniques of freezing and storing sperm and embryos improve, however, zoos will be in a better position to contribute to preserving biological diversity under threat from destruction. "It would be an operation of last resort," said Conway.

Scientific intervention can also be taken out to the field, as Christopher Uhl of Pennsylvania State University described. He and his colleagues have been monitoring the slow process of reestablishment of Amazon rain forest in abandoned pasture sites, which represent highly degraded habitat. They have also been studying the physical and biological factors involved in this process, and are discovering just how complex and recalcitrant it is.

Similar problems are being encountered in superficially more tractable sites in southern California. "Attempts to restore wetlands in southern California, where several salt marsh plants, birds, and insects are threatened with extinction, have not succeeded in attracting target species," reported Joy Zedler of San Diego State University. The plants in question sometimes do not take, and if they do there is no guarantee that the "correct" bird and insect species will take up residence.

The precise composition of natural ecological communities does not represent an absolute prescription for what must be achieved if restoration is to be attempted, because there is some element of randomness in all communities. But what the results of these and other similar projects emphasize is that unless ecosystems are understood vastly better than they are now, restoration attempts, however incomplete, are likely to be disappointing.

Biologists are appalled at the prospect of a collapse in biodiversity, and wonder what they can do. "We are facing the 'enlightenment fallacy'," said Michael Robinson of the National Zoological Park, Washington, D.C. "The fallacy is that if you educate the people in the Third World, the problem will disappear. It won't. The problems are not due to ignorance and stupidity. The problems of the Third World derive from the poverty of the poor and the greed of the rich." The problems are those of economics and politics. Inescapably, therefore, the solutions are to be found in those same arenas. ■

ROGER LEWIN