No Dinosaurs This Time

Calculations from ecological theory indicate that the loss of species through felling of tropical forests will reach mass extinction proportions by next century

"Earth's biota now appears to be entering an era of extinctions that may rival or surpass in scale that which occurred at the end of the Cretaceous, some 65 million years ago." This gloomy and more than a little startling opinion was expressed by Paul Ehrlich, of Stanford University, at a recent meeting on the dynamics of extinction.* Rampant development, including urban, agricultural, and forest-felling, is the cause of the impending collapse, he says.

Within perhaps 100 years—200 at most—the total of recently extinct species in temperate and tropical regions will likely equal the casualty toll of the event 65 million years ago, which claimed as many as 52 percent of marine species and a lesser but still substantial proportion of terrestrial species, including, of course, all the fabled dinosaurs, large and small.

The gathering, held at Northern Arizona University, Flagstaff, focused principally on major extinction episodes that dramatically punctuate the history of life as reflected in the fossil record. The suggestion that, day by day, year by year, we are witnesses to an event of similar magnitude to some of the past punctuations seemed difficult to grasp, especially by paleontologists and geologists, who are used to compressing shifts in biotic patterns through vast tracts of time into thin sedimentary layers of petrified evidence.

Major marine regressions, global climatic fluctuations, other environmental perturbations, and, of course, asteroid impact—all have variously been adduced as causative agents in historic mass extinctions. The current extinction is, however, different, says Ehrlich: "For the first time in geologic history, a major extinction episode will be entrained by a global overshoot of carrying capacity by a single species—*Homo sapiens*." Human populations, in other words, are growing so explosively and are modifying the environment so extensively that other species are perishing in the wake of it all: no other single species has inflicted such an inimical global impact. The assessment was shared by Daniel Simberloff, an ecologist at Florida State University.

Development is identified as the modern equivalent of the Late Cretaceous asteroid impact: in the richer countries it is mainly urban growth, but includes chemical pollution; in the poorer countries, the race for agricultural development is the principal threat to many species, but this includes the extensive felling of tropical moist forests, which has the single most extensive potential impact on future species diversity.

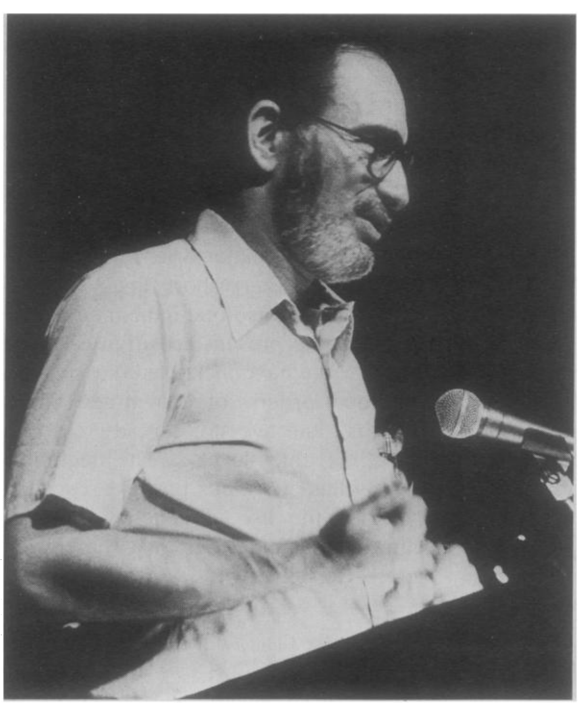
An emotional topic, the issue of species survival and extinction is also hampered by an embarrassing paucity of data. No one knows, for instance, how many species there are. Some estimates put the figure as low as 2 million; many converge on a figure of 5 million to 10 million; while, if recent suggestions for tropical insect species are correct, the number could be closer to 30 million and more. In any case, only a small proportion of even the lowest estimate of total species have been scientifically named and described.

There are very few firm data too, both Ehrlich and Simberloff agree, on the rate at which species are now being pushed into extinction: monitoring of ecosystems is simply too patchy and too limited to provide them. It is possible to say on general grounds, however, that the tropics are the most vulnerable, because of the high diversity and typically restricted ranges of species in the region.

"It is safe to assume," says Ehrlich, "that the destruction of a hectare of tropical rain forest is much more likely to finish off an entire species than the destruction of a hectare of temperate-zone habitat." Although tropical moist forests cover only about 6 percent of the earth's land surface, they contain two-thirds or more of extant species. With the felling of tropical moist forest currently proceeding at approximately 110,000 square kilometers per year, the magnitude of the problem is clear.

There is a strong consensus among conservationists that, although firm data are few and detailed analysis of future prospects virtually impossible, the looming catastrophe is so evident that scientific study is rendered irrelevant and all efforts should be directed to emergency preservation programs. Statistical confidence limits are, according to one prominent ecologist, "luxuries that conservation biologists cannot now afford."

Simberloff, a committed conservationist, nevertheless says that "the urgency of the problem does not mean that statistical analysis will not prove fruitful." He described at Flagstaff his attempt to apply to the problem recent approaches to the theory of biogeography and to use whatever data are available. The idea was also to compare as far as is possible the current extinction with earlier major



Lisa Nelson, Northern Arizona University

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*Dynamics of Extinction, Northern Arizona University, 10 to 12 August.

events. "This is no easy task," he notes, "as available data on both the present tropical crisis and the mass extinctions of the geological past are much less complete than those that ecologists are accustomed to using, and render credible quantitative predictions extraordinarily difficult."

Two ecological factors relating to species diversity may be used in scrutinizing the events of past and current extinctions: these are changes in area and in provinciality. One of ecology's oldest generalizations, says Simberloff, is the species-area relationship: simply, large areas usually accommodate more species than small areas. Provinciality, which is also known as insularization or endemism, refers to the way in which total area is divided into spatially separate units: and, the greater provinciality there is, the more overall species diversity there is likely to be.

The biggest mass extinction of all time occurred at the Late Permian, 225 million years ago, when the world's continents coalesced into the supercontinent, Pangea. The resulting geographical and sea level changes shrank the area of shallow sea habitats by 68 percent and reduced the number of distinct marine provinces from 14 to 8. With these two ecological insults, marine fauna lost 52 percent of its families, which translates to upward of 96 percent of living species.

Most, but not all, mass extinctions are associated with detrimental changes in area and provinciality, notes Simberloff, which typically is the result of major marine regressions. Ecological theory offers no useful guidance on the speed with which species diversity might change following shifts in area or provinciality, and, as might be expected, neither is the fossil record much help in this connection.

The greater overall diversity associated with high provinciality relates to increased opportunity for speciation in isolated ecological units. Again, the notion as yet receives no quantitative support from ecological theory, but is merely an empirical matter. The species-area relationship is quantified through theory, however, and is expressed in the simple equation:

$$S = cA^z$$

where S is number of species, A is area, and c and z are constants. It was this mathematical tool derived from theory that Simberloff applied to prospects of future species diversity in tropical forests.

The situation Simberloff is modeling is the steady erosion of large forest areas that leaves an increasing number of small islands. In other words, there is a reduction in area accompanied by an increase in provinciality. "What we wish to predict is the magnitude and speed of these two processes."

The model, notes Simberloff, is reminiscent of the Pleistocene refuge theory, which sees a fluctuation between large continuous forest (in Amazonia, for instance) during warm climates and scattered remnants during cooler, drier times. This process might have occurred four times during the past 50,000 years. The migration between extremes was slow, and therefore the biota had time to reach some kind of equilibrium positions in, say, the fall in species diversity during area reduction and rise in species number through increase in provinciality. According to refuge theorists, the four provinces of Amazon forest at its climax was reduced to ten provinces totaling a mere 16 percent of the original area. The difference between the events of the Pleistocene and those now is that the current erosion and fragmentation is exceedingly rapid and the return to climactic coverage unlikely.

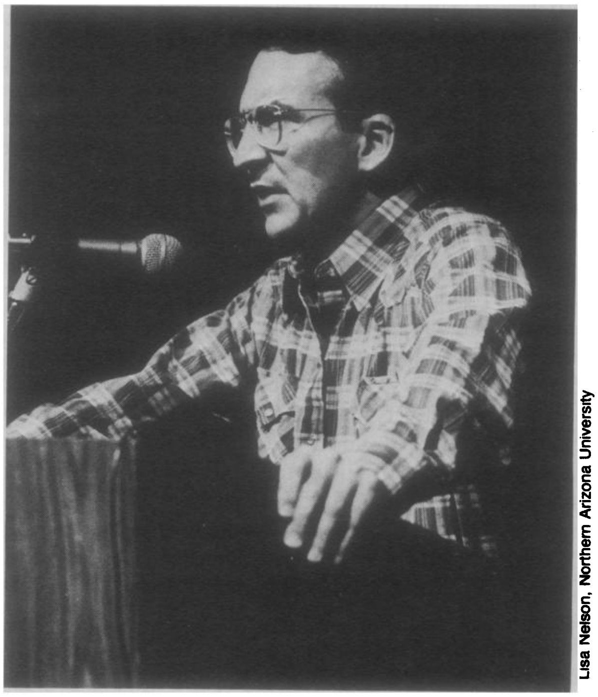
In order to assess extinction prospects Simberloff used data on flowering plants (about 90,000 species) and land birds (704 species) in the American neotropics, the former collected by Alwin Gentry and the latter by J. V. Remsen. At its maximum extent the New World tropical forest covered some 6.93 million square kilometers, a figure that has been reduced today by 27 percent. Simberloff assumed in his calculations that even with this reduction in area no species loss has occurred so far. Instead, he has calculated the extinction that would be predicted consequent upon the expected further reduction by around 1 million square kilometers toward the end of the century and the obliteration of all but about 96,700 square kilometers, which represent current national parks and equivalents, some time next century.

For neither species group has Simberloff considered the potential species enrichment through enhanced provinciality, partly because of the rate at which area reduction and fragmentation is proceeding and partly because the remnant islands might well be too small to be effective refuges. Speciation, he suggests, might take at least a millennium: "I am not cheered by the thought of a thousand years of impoverishment."

Impoverishment there surely would be, according to Simberloff's figures. For, although the species and family loss of birds by the end of this century would be 12 percent and 1 percent, and for flowering plants 15 percent and 2 percent, which do not match figures for major extinctions of the past, some time during next century numbers to rival the great demise of the Late Cretaceous would be reached. These are, for plants, a loss of 66 percent of species and 14 percent of families, and for birds, 69 percent and 26 percent.

"All told, it is clear that the catastrophe we are facing is *not* the worst biological debacle since life began—the Late Permian extinction must be that—but it certainly vies for second place."

—ROGER LEWIN



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