Letters

Species Loss

M. A. Mares (Articles, 15 Aug., p. 734) argues credibly that a stronger database is needed to develop rational conservation strategies for the world's richest biota. Present knowledge of much of the South American biota is simply too rudimentary to substantiate various forecasts of catastrophic species loss in the wake of tropical deforestation. In questioning these predictions, Mares discusses the imprecision of existing quantitative models of species loss. He also advances the analogy that there have been very limited extinctions in the wake of nearly complete deforestation in North America and Europe; virginal forests are practically lacking on both continents today.

Because significant biological differences exist between these regions, this analogy seems biologically improper and imprecise, marring an otherwise insightful article. The analogy is based on comparison of species-rich tropical habitats with those in comparatively impoverished temperate ones; although complex and poorly understood, the overall stability of ecosystems may be related to diversity (*1*). The analogy also compares the insular Neotropical biota, protected from biotic interchange for most of the Tertiary, with the expansive and confluent Holarctic biota of the northern continents. Insularity may promote biotic instability to perturbation via the absence of stringent selection pressures (for example, Australian ecosystems and introductions of European species). Physiologically and behaviorally, each species in temperate regions must have an ecological amplitude sufficient to cope with radical seasonal changes in weather. While seasonal, most tropical climates fail to reach temperate extremes, and organisms adapted to them are correspondingly stenotopic. Such traits make tropical species more vulnerable to perturbation.

Temperate and tropical areas differ importantly not only in the amount of diversity, including its ecological and physiological aspects, but also in its geographic scale. Alpha diversity, the number of species occurring in a restricted area within a given habitat type, tends to be remarkably constant from region to region. In contrast, beta diversity, measuring species turnover between habitats within a region, shows strong geographical patterns (*2*). Thus, tropical habitats owe much of their heightened diversity to high species turnover between habitats. This pattern is based on north temperate species having larger ranges than tropical species, and more continuous (less patchy) distributions (*3*). Environmental changes that have an impact on a given area will therefore affect a smaller proportion of the range of a temperate species. Higher unit densities and wider distributions make temperate species less susceptible to extinctions from spatial perturbations such as deforestation. Scientists can afford to ignore neither the confidence limits on their quantitative models nor the variables and trends in their qualitative ones.

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REFERENCES

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Response: Patterson makes a number of interesting points. Several, however, merely illustrate the general misunderstanding of South American ecosystems that was pointed out in my article. I will largely limit my remarks to mammals, for the sake of brevity. While South America was an island for much of the last 80 million years, several notable colonizations occurred during that period, each resulting in a pronounced adaptive radiation (*1*). More important, the Great American Interchange of about 3 million years ago ended the continent's isolation and resulted in numerous colonizations with subsequent radiations of such groups as rodents, deer, and carnivores. The faunal mixing of the Pleistocene did not result directly in massive waves of extinction (hence, one must question whether insularity on this scale in fact leads to instability); rather, extinctions probably resulted from climatic effects and habitat disruptions (*2*). There is no reason to believe that the South American ecosystems of the pre-Interchange period were unstable; they were both complex and diverse (*3*). Their species, we must assume, were well-adapted to their particular roles in the ecosystem. That massive extinctions were associated with great climatic fluctuations and geological upheavals [for example, the Andes arose primarily in the Miocene and Pliocene, (*4*)] is neither surprising nor reflective of their degree of adaptedness to the environments in which they had evolved.

Patterson's comments on the behavior and physiology of South American species are, again, illustrative of points raised in my article. First, we do not know whether the effects of a dry season on a tropical organism are as pronounced as the effects of winter on a North Temperate species. We do know, however, that periodic droughts can be devastating to small mammals, as was demonstrated by our work in the Brazilian Caatinga, a huge tropical scrubland subjected to pronounced droughts (*5*). Further, much of South America is temperate, with climatic extremes as pronounced as those of North America. Each macrohabitat on the continent has its particular flora and fauna, mostly unstudied. To generalize on stenotopy is presumptuous. One of the first species of mammals we captured while doing research in central Brazil in 1983 was a marsupial, *Monodelphis kunsi*, known from only two specimens in Bolivia, 2000 kilometers distant! Might it have been considered stenotopic before we extended its range?

Finally, a few comments are in order concerning the differences between temperate and tropical patterns of distribution. Temperate areas in North and South America do have lower alpha diversity than do tropical habitats, although I question whether the patterns are "remarkably constant" (*6*). Species turnover within tropical habitats probably differs from taxon to taxon. Many insect species may well be associated with a plant having a very limited distribution, for example, while tropical mammals frequently have extensive geographic distributions. In many cases, we just do not have enough information to know with certainty what the actual ranges of most organisms are. We frequently do not know if two organisms found in two different parts of South America that appear to be the same species are, in fact, separate species. When the ecological, physiological, or behavioral amplitudes of a species are not known, it is hazardous to predict exactly how it will respond to habitat conversion. Clearly, species having a great population density and a broad geographic range (like the passenger pigeon or the bison, for example) would seem to be insulated from extinction, but "it ain't necessarily so." We must understand how obligately specialized an organism is to particular ecological parameters before we can glibly predict its demise. It is relatively simple to proffer sweeping biogeographic or ecological theories when dealing with a fauna that is very poorly known. We may find, however, that theories generated from studies conducted in one region, and that have a particular philosophical orientation to them, may not be tenable when data on the biology of species in the unstudied area become available. The an-