On the Future of Conservation Biology

Conservation biology has been aptly described as a discipline with a deadline, but for those who work in this intensive-care ward of ecology it is more precisely a never-ending avalanche of deadlines. The conservation biologist knows that each imperiled species is a masterpiece of evolution, potentially immortal except for rare chance or human choice, and its loss a disaster. You and I will be entirely forgotten in a thousand years, but, live or die, the black-footed ferret, barndoor skate, Lefevre's riffle shell, Florida torreya, and the thousands of other species now on the brink of extinction will not be forgotten, not while there is a civilization. Our conservation successes, the only truly enduring part of us, will live in their survival.

Conservation biologists are crisis managers who ply the full array of biological organization from gene to ecosystem. Their scientific work is both basic and practical. It is also one of the most eclectic of intellectual endeavors. Consider the following example from recent media headlines: survival of the red-cockaded woodpecker, a bird (an *American* bird no less) turns upon our knowledge of its distribution and natural history, survival of the mature pine woodland in which it lives, the economic and political forces that erode its nest sites, the legislation that protects it, and, not least, the moral precepts that support the very idea of ecosystem and species conservation.

No real basis exists—as some writers have imagined—for conflict between ecosystem studies and single-species studies in conservation biology. Each is vital and intellectually dependent upon the other. Within the broader framework of ecosystem studies, community ecology in particular is about to emerge as one of the most significant intellectual frontiers of the twenty-first century. Although it still has only a mouse's share of science funding, it stands intellectually in the front rank with astrophysics, genomics, and neuroscience. Community ecologists face the daunting challenge of explaining how biotas are assembled and sustained. Most of their effort today is in description and analysis, with closest attention paid to one species or to several species as modules. As time passes, more resources will be put into the mathematical modeling and experimental manipulation of entire assemblages, from the bottom up, species to communities. Biotas, like cells and brains, are prime targets for the emerging field of general complexity theory. They have already been singled out as paradigms of complex adaptive systems and are certain to attract the attention not just of ecologists but also of physicists, molecular biologists, and others who are running short of virgin fields of inquiry.

Like the rest of science, community ecology advances by repeated cycles of reduction and synthesis, in which bottom-up analysis of the working parts explains the complex whole and, in reciprocity, an evolving theory of the complex whole guides further exploration of the working parts. The relevance of this perpetual process to conservation biology is as follows. The more or less independently evolved key working parts are the species. In the future, solid advances in community ecology will depend increasingly on a detailed knowledge of species and their natural history, which feeds and drives theory.

It follows that community ecology and conservation biology are in desperate need of a renaissance of systematics and natural history. By systematics I mean much more than just the phylogenetic analysis of already known species. Phylogenetic reconstruction, currently the dominating focus of systematics, obviously is worth doing, but more scientifically important and far more urgent for human welfare is the description and mapping of the world biota. They are scientifically important because descriptive systematics is the foundation for community ecology. And they are urgent because the development of a mature, accessible knowledge of global biodiversity is necessary for conservation theory and practice.

Few biologists other than systematists appreciate how little is known of Earth's biodiversity. Estimates of the total number of species still vacillate wildly: 3,600,000 at the low end and 111,700,000 at the high end (*Global Biodiversity Assessment*, 1995). The estimated number of species described and given scientific names ranges between 1.5 and 8 million. Here also the true number is only a matter of speculation. Even figures for the relatively well-studied vertebrates are spongy. Estimates for the extant fish species of the world, including both described and undescribed, range from 15,000 to 40,000. That figure becomes a veritable black hole in the case of the bacteria and archaea, whose species could with

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