

Biodiversity: The Interface Between Systematics and Conservation

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The rapid development of interest in biodiversity has provided unprecedented opportunities for interactions among disciplines. Although systematic biology and conservation biology have developed largely independently of one another, it is clear now from the burgeoning literature that conservation concerns can motivate systematic studies and that better knowledge of the systematics of organisms can provide critical information for the conservation and management of biodiversity. The most obvious need for systematics in conservation biology is that any study depends on the accurate identification and classification of organisms, a point clearly illustrated by the cover of *Nature* entitled, "Bad taxonomy can kill" (related to an article by May, 1990). We have assumed this basic premise and used this symposium to explore further interactions of systematics and conservation biology.

This symposium brought together researchers from a wide variety of fields related to biodiversity and conservation to discuss the relevance of systematics to their research and to evaluate various techniques that make use of systematic data in conservation studies. The topic is timely because of the wealth of new technologies and methods now available to incorporate both historical and recent systematic data into conservation planning tools, as well as the increased recognition of the importance of systematic and phylogenetic considerations in conservation biology. Several new journals (e.g., *Biodiversity and Conservation*, *Diversity and Distribution*) reflect the greater interest in these areas.

The purpose of this group of six papers is to present examples of new ideas on how information from systematic biology can be used in conservation studies and to encourage collaboration among disciplines. In-

cluded in this symposium are papers that apply systematic data to address questions at many levels of organization in conservation biology. These include questions related to population genetics, population biology, speciation of rare and endangered taxa, community-level studies of patterns of endangerment, and use of spatial patterns to identify critical areas for biodiversity. They represent a sampling of the synergism possible with combined approaches of systematic biology and other disciplines in conservation biology. Another important approach presented in the symposium, but not included here, is the role of higher-level phylogenies in conservation (e.g., Humphries et al., 1995).

THE PAPERS

The importance to conservation planning of diversity at the species, community, and ecosystem level has long been recognized. However, it has been more difficult to incorporate the information from genetic diversity that is necessary to maintain the evolutionary processes within a species. Moritz suggests that genetic information on both recent divergence (functional diversity and phenotypic diversity) and vicariance or long-term historical isolation (major historical lineages) needs to be included in the prioritization of areas for conservation. He explores some of the methods used to incorporate information on genetic diversity into conservation planning, including a discussion of various ways to measure genetic diversity. Moritz illustrates these concepts using information on species composition and genetic data for the wet tropics of Australia, and he argues that genetic information on both adaptive divergence and vicariance should be considered in conservation planning to ensure the maintenance of evolutionary processes.

Perry, Lodge, and Feder focus on understanding the consequences of invasions and the loss of resident biodiversity. They

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demonstrate how systematic relationships of species can be confounded by recent divergence and morphological similarity and suggest that a clearer understanding of relationships is critical to directing conservation measures and preventing hybridization and introgression among taxa. As they point out, current studies are done after an invasion has taken place; a predictive approach, based on ecological interactions and phylogenetic relationships, is needed to provide a guide to prevent future hybridizations.

Systematic work, when provided in accessible form, can provide a wealth of ecological data that can be used in conservation planning. *Sakai, Wagner, and Meltrhoff* have collaborated to use ecological and taxonomic data on the Hawaiian flora and combined these with data on risk to evaluate patterns of endangerment in Hawaii. Aware that phylogenetic relationships can change interpretations of patterns of risk, they use knowledge about the lineages of colonists of the Hawaiian Islands to interpret patterns of endangerment affected by endemism, life history traits, habitats, and age and area of the islands in the Hawaiian Islands.

Collections data, data from the specimen labels and field notes that accompany specimens, are a valuable source of biological information for conservation planning. In many cases, systematists provide some of the first biological information on communities and ecosystems of poorly explored areas. The importance of collections data has increasingly been recognized by museums and herbaria as they have tried to maximize accessibility and use of this information. *Funk and Richardson* examine ways that collections data can be used to map species richness and endemism and to select priority biodiversity sites. Better understanding of these possible uses may lead to a reduction in "collecting bias" and an improvement in the techniques used to determine areas for conservation. Using a data set from Guyana, they demonstrate the value of incorporating collection data in conservation planning.

Desmet, Cowlings, Ellis, and Pressey also demonstrate the utility of including data from systematic biology in conservation planning to identify explicitly the optimal spatial patterns of reserves necessary to preserve biodiversity. They stress the importance of systematic conservation planning,

here defined as a series of steps to consider in reserve design reserves to conserve not only current biodiversity but also the ecological and evolutionary processes that generate that diversity. Having explored how systematics, population biology, and community ecology can all be incorporated to identify the spatial components of evolutionary patterns and processes, the authors illustrate this approach in studies of South Africa's Succulent Karoo. They use spatially explicit data on morphological variation within taxa as an indication of the spatial component of lineage diversification, and use this information to guide the development of quantitative targets in conservation planning.

Traditional conservation planning methodologies have rarely capitalized on available biological data or used those data in the most effective way. This occurs largely because relatively few data-rich regions are available around the world to rigorously test new ideas and methodologies that incorporate biological data. *Ferrier* proposes three strategies to use available biological data more effectively: (1) more closely integrating biological and environmental data through predictive modeling, (2) making more rigorous use of remotely mapped surrogates in conservation planning by incorporating knowledge of biological variation within and between mapped classes, and (3) using regions that are relatively rich in biological data as test-beds for evaluating the performance of surrogates. *Ferrier* puts forth the idea that the effective realization of predictive modeling may require a shift in emphasis from modeling individual entities (e.g., species) to modeling collective properties of biodiversity (e.g., patterns of differentiation diversity).

CONCLUSION

The goal of all of these papers is to assist in the conservation of biodiversity, and each paper relies upon some form of information generated by systematic biology—from field collections to molecular phylogenies. These data are applied to conservation studies at all levels, including those to maintain genetic diversity and evolutionary processes, to identify populations and taxa at risk from hybridization and other threats, and to plan preserves at the ecosystem level. These papers demonstrate the importance of

increasing interdisciplinary interactions in conservation biology and the unique and critical contributions that can be provided by systematic biology.

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