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EDITORIAL

EXPLORING BIODIVERSITY IN TIME AND SPACE: PROFITABLE DIRECTIONS FOR MAMMALOGY IN THE 21ST CENTURY

Biological understanding is advancing at an accelerating rate. The infusion of new perspectives provided by multidisciplinary approaches and new tools created by advances in information technology, in mathematics and statistics, and in genomics are making fundamental changes in the tempo and mode of progress in the biological sciences. Within this context, understanding the spatial and temporal dynamics of biodiversity may be the greatest biological challenge of the 21st Century because of the alarming rate at which habitats are being degraded and fragmented as a consequence of intensifying human activities, especially in the developing world. Those studying the natural history, ecology, genetics, and biogeography of mammals in Latin America have a pivotal role and unparalleled opportunity to contribute to this scientific enterprise. In that context, I provide a personal perspective on relevant research directions that may be explored profitably by students of Neotropical mammals.

Where ecological and biogeographic scales meet

Numerous analyses of mammalian ranges have appeared in the past decade that document the spatial organization of species richness at the scale of continents or greater. Less is known about how such results relate to patterns of species richness at the level of local communities or the scales at which policy makers implement conservation decisions. Almost nothing is known about spatial patterns over extensive gradients for other taxonomic aspects of mammalian biodiversity (e.g., species evenness, dominance, or diversity) or for functional, phenotypic, or genetic components of biodiversity. Although controversy exists as to whether the tropics or drylands of South America harbor the greatest mammalian biodiversity, it is clear that full understanding of gradients of biodiversity requires more intensive study of community composition at a number of sites throughout Latin America at all latitudes. In some cases, this requires rededicated efforts at species discovery in poorly known regions.

National Forests, National Parks, and Private Reserves provide some measure of protection for species, including threatened and endangered taxa, thereby delaying the erosion of all aspects of biodiversity. Nonetheless, threats to biodiversity are severe and windows of opportunity for creating nature reserves are narrow and rare, magnifying the need to design networks of reserves based on science-based decision rules. These rules should be represented by a priori criteria which can be achieved via quantitative algorithms that maximize critical aspects of biodiversity (e.g., number of protected species, number of sites in which a species is protected), while minimizing associated costs (e.g., land area, acquisition or maintenance costs). The use of such decision rules to select sites and populate conservation reserve networks should be based on considerations of *data collected at a variety of spatial scales. At local scales, taxonomic results from intensive surveys define the species composition of areas considered for protection. In contrast, data collected at broader scales and embodied in species range maps correspond to the most readily available information about the distribution of biodiversity which can be used to inform decision making regarding conservation at regional, national, or global levels. A comparison of solutions (number and identity of sites) based on these types of data provide critical insights regarding the uncertainties surrounding reserve design efficacy as well as the social and political actions required to provide an adequate degree of protection to biological diversity.*

Where natural and human systems meet

The environmental sciences have been revolutionized by the view that ecosystems are subject to a variety of disturbances that determine their structure and functionality. Although less abundant or diverse than many taxa, mammals often play a keystone role because they act as bioengineers that modify landscapes in a variety of ways. Arguably, humans may be the most intensive, frequent, and broad-ranging agents of disturbance that operate at most scales that are ecologically relevant. Consequently, the characteristics of almost any ecological system are predicated on the degree to which coupling exists between natural and human subsystems.

The control of infectious diseases that are transmitted to humans from species that use mammals as hosts or vectors (e.g., Mayaro virus, rabies, dengue fever, leptospirosis, Hanta virus, Nile virus) is a growing societal concern throughout the world, but especially in developing nations. Determining how anthropogenic activities, such as those associated with urbanization, forestry, and agriculture, alter the biotic relationships of host and vector species likely will provide critical clues for understanding new modes or tempos of disease circulation. In particular, disturbances that alter movement patterns, population density, or levels of physiological stress may alter host-parasite or vector-host associations, thereby affecting the likelihood of disease transmission between humans and mammals or between domesticated animals and mammalian wildlife. From both basic and applied perspectives, increased multidisciplinary collaborations with mammalogists as critical participants should be focused on exploring the dynamics of these interactions and their consequences to human welfare.

Ecological understanding requires a long-term perspective because environmental conditions, including human activities, vary over time in cyclic, directional, and stochastic fashions. Similarly, ecological consequences of disturbances or perturbations (including experimental manipulations) at the level of mammalian populations and communities may only become apparent over long spans of time, depending on the interplay between direct and indirect pathways. Equally important, networks of sites are required to distinguish site-specific responses and historical legacies from more general trends. Indeed, the development of a network of sites with a long-term commitment to ecological research provides an appropriate venue from which to make forecasts, which represent science-based perspectives to inform management, conservation, and policy. In my view, one of the most critical infrastructure needs of science in the Neotropics is the development of national (or better yet, international) **networks** *of sites dedicated to understanding the interactions between organisms and their environment at the level of landscapes.*

These sites should: (1) enhance long-term ecological research using collaborative and multidisciplinary perspectives (including the social sciences), (2) train the next generation of environmental biologists with a firm basis in natural history, but with access to quantitative and molecular tools, and (3) provide "early warning" systems for detecting global change. Because mammals play keystone roles and are important bioengineers in many systems, and are often threatened or endangered because of their habitat requirements or economic value, mammalogists in Latin America must be at the forefront of such scientific endeavors.

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