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PROGRESS IN NORTHERN HEMISPHERE PHYTOGEOGRAPHY: AN INTRODUCTION

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The problem of Northern Hemisphere plant geography was framed long ago by the observation of striking floristic similarities between eastern North America and eastern Asia. Of primary importance was the work of Asa Gray, who produced a series of detailed comparisons of these floras (see Li 1952; Boufford and Spongberg 1983; Wen 1999). During the past several decades, two major symposia, "Floristics and Paleofloristics of Asia and Eastern North America" (Graham 1972) and "Biogeographical Relationships between Temperate Eastern Asia and Temperate Eastern North America" (Davidse 1983), served to highlight both the nature of the problem and the variety of approaches used to examine intercontinental discontinuities in plants. Not long afterward, two landmark papers by Tiffney (1985*a*, 1985*b*) provided a synthesis of paleobotanical and neobotanical data in the context of a dynamic view of Earth history and emphasized floristic exchange via both the North Atlantic and the Bering Land Bridges. In this context, Tiffney (1985*b*, p. 73) noted that "three-area tests of the variety suggested by cladistic biogeographers need to be made and analyzed to determine whether the eastern Asia–eastern North American similarity is a unique pattern or simply a distinctive subset of a larger pattern." Over the last two decades we have witnessed remarkable progress in elucidating phylogenetic relationships at all levels, and the number of phylogenies of Northern Hemisphere plant clades has grown to the point that meaningful comparisons are now feasible. Furthermore, there have been major developments in the theory of biogeography as well as in our knowledge of relevant fossils and Earth-history events.

The symposium from which the articles in this volume emerged was part of the Botany 2000 meetings in Portland, Oregon. It was designed to create a forum for new analyses of the Northern Hemisphere problem, bringing together a set of paleobotanists and phylogeneticists who have concentrated on relevant areas and plant groups. The goal was to provide a focal point for investigators working from various perspectives on reconstructing relationships among the major areas of endemism and to identify key events that might be responsible for observed patterns of diversity and disjunction. The analyses presented here represent the initial steps toward assembling a modern synthesis based on phylogenetic knowledge, fossil distributions, estimates of sequence divergence, fine-scale distributional data for modern species, and phylogeny-based biogeographic methods.

A complete understanding of the historical biogeography of the Northern Hemisphere presents one of the great challenges to elucidating the interaction of Earth history and the biological processes of dispersion, extinction, and diversification. Whereas prior discussion of phytogeographic relationships around the Northern Hemisphere have centered on the development of broad narrative explanations, the focus has shifted to the analysis of phylogenetic patterns using a variety of inferential biogeographic methods. Fortunately, over the last few decades, plant systematics has been revolutionized by our ability to assemble massive new data sets for inferring phylogenetic relationships. Some progress has been made in identifying congruent area relationships across multiple plant phylogenies and in testing for temporal congruence making use of fossil and molecular evidence (e.g., Xiang et al. 1998, 2000). In the spirit of these investigations and others concentrating on Northern Hemisphere animal taxa (e.g., Enghoff 1995), the contributions presented here explore biogeographic patterns across numerous relevant plant groups.

Convincing resolution of complex biogeographic patterns requires increased attention to the incorporation of information on the absolute timing of speciation events as well as the relevant geological and climatological changes that may have had an impact on diversification. Through the continuing work of paleobotanists on Northern Hemisphere deposits, the fossil record for many relevant taxa has been improved substantially in recent years (Manchester 1999). Using these fossil data, paleobotanists have attempted to estimate the first appearance of taxa and to infer the relevant climatic and ecological settings in order to provide working hypotheses of how these factors influence plant movement and diversification. Increasingly, molecular systematists are making use of paleobotanical data to calibrate rates of molecular change and thereby to infer relevant divergence times. To the extent that such approaches yield reliable estimates, they provide a powerful means of discriminating between competing biogeographic hypotheses.

Although we are still far from achieving a thorough understanding of the plant geography of the Northern Hemisphere, the articles assembled here document considerable progress, especially in bringing phylogenetic approaches to bear on the problem. Perhaps most important, these articles set the stage for many additional empirical studies by providing models for integrating increasingly robust phylogenetic hypotheses, paleontological evidence, and estimates of the timing of key

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events. These studies will also fuel the development of the theory and methods of historical biogeography necessary to cope with a complexity of events so strikingly exemplified by the Northern Hemisphere problem. Ultimately, we are confident that a detailed picture will emerge, which will in turn have an impact on our understanding of the assembly, stability, and change of plant communities through time. Such analyses document monumental global changes in the past, and the lessons learned may improve our ability to forecast such changes and their consequences.

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