ISSN 1948-6596

update

# Updated DIVA program

Botanists have long been stuck on the flora agenda, collecting and cataloging plants, and eventually producing narrative explanations of distributions. With increased data access and new analytic tools, the approach is now rapidly changing towards synthesis of more general character.

A recent paper in PNAS, by Alexandre Antonelli and colleagues improves the standard set of tools for biogeographic reconstruction. The core of this paper is a molecular phylogeny of the coffee family (Rubiaceae), with broad taxon sampling but main focus on the Neotropics. The incredible biodiversity of this region is often explained from the extent and geological age of its rainforests, and from niche conservatism, whereby the once-widespread tropical biomes became restricted to low latitudes after the global cooling at the Eocene-Oligocene transition. The Andes is often assumed to have played a big role in South America, although it is poorly understood, first of all because the orogeny was often considered as a single, time-limited event. Little attention has been given to the fact that discrete geological structures were uplifted at different times, and to how the mountains affected the climate of adjacent lowlands and constrained dispersal within the lowlands. Montane biotas are often assumed to be young, recruited from adjacent lowlands, but mountains also seem to play a role as crates of biodiversity and dispersal centers.

The study presents standard parsimony and Bayesian phylogenetic analysis and a likelihood estimation of evolutionary time. Building on Ronquist's DIVA program, Johan Nylander developed a new tool for biogeographic reconstruction, which uses a Bayesian sample of highly probable trees, thereby generating credibility support values for alternative relationships. Thus, even with partially resolved trees and incomplete taxon sampling, the method provides very stable reconstructions of ancestral areas for the different phylogenetic nodes.

The combined chronogram and biogeographic analysis demonstrates: (1) an old world origin of the Rubiaceae with dispersal to North America, before the opening of the North Atlantic in the Eocene, and (2) then to South America (which rejects the former view of Gondwanic origin). (3) During late Oligocene to early Miocene, when the Amazon drained west through a Western Andean Portal, radiation took place in what is now the northern Andes and Amazonia, while the southern Andean region was out of reach. (4) From the mid-Miocene the Andes was connected as a continuous dispersal avenue, but at the same time it was isolated from the eastern Amazonian lowlands by marine incursions from the north and enormous wetlands. (5) Finally, when the present Amazonian drainage pattern to the Atlantic was established in the upper Miocene, there was a strong flora exchange throughout the tropical South American lowlands. Altogether, the study reveals a clear sequence of events of dispersal and diversification in distinct areas.

The analytic approach has been used also in two recent studies of transoceanic dispersal in birds, and we must expect many further examples to follow.

Antonelli, A., Nylander, J.A.A., Persson, C. & Sanmartín, I. (2009) Tracing the impact of the Andean uplift on Neotropical plant evolution. Proceedings of the National Academy of Sciences USA, 106, 9749-9754.

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