Environmental filters shape modern biodiversity of woody plants

Yasuhiro Kubota
Buntarou Kusumoto
Takayuki Shiono
Werner Ulrich

Video Abstract

Keywords: Journal of Vegetation Science, University of the Ryukyus, climatic filtering, dispersal limitation, diversification, geographic filtering, latitudinal diversity gradient, phylogenetic clustering, phylogenetic β -diversity, quaternary climate change, tropical niche conservatism, forest census, woody plant, net relatedness index, phylogenetic dissimilarity, extratropical biome, tropical biome, Palearctic, angiosperm, geohistory

Posted Date: October 23rd, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-97480/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
[Read Full License](#)

Abstract

Scientists can't easily peer into the distant past for patterns of evolution. That makes it hard to understand the laws by which species form, transform, and nestle themselves along the tree of life. But studying how species are branched throughout the globe today can provide critical clues. In a recent study, scientists from Japan examined how the diversity of woody plant species varies across continents and across the entire planet. It's the first study of its kind to find patterns on a global-scale data set. And the findings appear to confirm long-standing hypotheses about the roles of climate and geography in the evolution of life on earth. Climate and geography are important constraints that drive patterns of diversity among different species. They act as evolutionary filters. Harsh climates, for example, can create an ecological bottleneck that keeps certain families of organisms from dispersing into colder habitats. Similarly, isolation by distance or elevation can drive the divergence of one species into two or several others. Because species today are the product of these environmental pressures, which unfold over geological time scales, theoretically scientists should be able take modern data on biodiversity and rewind the tape to understand how species evolve. The availability of such data for woody angiosperms around the world provided the team from Japan the opportunity to do just that. By reviewing 90,000 publications, the researchers synthesized a giant dataset of species abundance for more than 21,000 woody plants across over 800 plots worldwide. For each plot, they focused on phylogenetic ecology and calculated a "net relatedness index" of woody plant communities. That index measured the degree to which plants tended to cluster with plants of a similar evolutionary origin rather than with more distant cousins. The team then mapped that index on two scales: a regional one spanning individual continents and a global one. They found that the net relatedness of species was smaller in regions outside of the tropics than in regions within the tropics. Tree species tended to cluster with their own kind in climatically harsh areas, like those around the Arctic. Moreover, they calculated phylogenetic dissimilarity among woody plant communities. Phylogenetic dissimilarity indicates historical diversification of forest biomes. The higher level of dissimilarity across South America, Africa, and Australia reflects a diversification pattern of tropical forests across continents throughout the Cenozoic. In contrast, the lower level of dissimilarity across extratropical regions indicates that relatively recent geohistorical or paleoclimatic events played a critical role in the formation of temperate forests. These results support the predictions made by environmental filtering hypotheses. Filters related to climatic harshness, climatic stability, and geography appear to shape the global diversity patterns of woody angiosperm species, and might drive similar patterns for other life forms on earth.