

Co-evolution of plant biodiversity and geochemistry in Australia

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Australia is a natural laboratory for evolutionary ecology and biogeography. It separated from Gondwana and started drifting northward ~43 Ma. It preserves a unique geomorphic record of low-level intraplate tectonic activity. Most of its landmass is arid but temperate, subtropical, and tropical climates also occur. Its vegetation is characterized by two dominant plant taxa, the acacias and the eucalypts, that have evolved on the island continent for 25 and 47 Ma respectively. We used Australia's Virtual Herbarium (AVH) database to extract recorded locations of 1,020 acacia and 841 eucalypt species. At those locations we extracted climate data and estimated geochemical conditions (total elemental concentrations, pH and electrical conductivity (EC)) using the National Geochemical Survey of Australia. We calculated diversity indices, and used numerical ecology methods (ordination, variation partitioning) to investigate the response of both taxa to climatic and geochemical gradients. Many species that tolerate extreme geochemical conditions are range restricted endemics. Strong associations exist between species turnover and climate and geochemistry. Climate, pH, P, Na, Ca, Fe, and EC account for much of the change in acacia and eucalypt species assemblages over the continent, especially across southern Australia. Climate and geochemistry together account for half of the variation in species turnover of both taxa across Australia and for about 60–90% in areas of high species richness. Dated phylogenies for the acacias and eucalypts show that much of the diversification

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is <10 Ma; it probably coincides with cycles of
aridification of Australia since the mid-Miocene.