

Biogeography of Australian Camphorosmeae and diversification in climatic space and across arid habitat types

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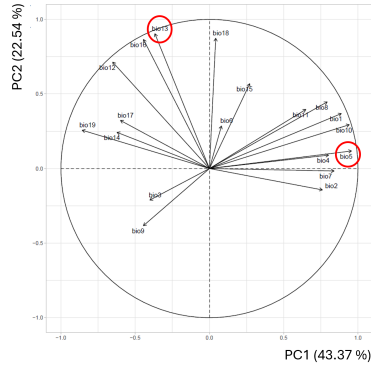
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Abstract

This study investigates the biogeography of the Australian Camphorosmeae (*Amaranthaceae s.l.*) and how it relates to shifts in climatic niche and habitat types of the lineage. Building on previous research and data resources, we integrate molecular phylogenetics, bioclimatic data and biogeographic models to deepen our understanding of the diversification and adaptation of this group across Australia's diverse landscapes in relation to palaeoclimatic changes. For 159 species representing 12 genera, georeferenced distribution points were used to define the most informative bioclimatic variables using principal component analyses. Evolutionary shifts in climatic niches and habitat types were analysed, revealing clade-specific shifts and adaptations to different habitats and climatic conditions. Biogeographic analyses allowed us to infer ancestral areas of Camphorosmeae in Australia and relate their expansion over evolutionary time to habitat shifts. Key periods of aridification in Australia, particularly during the Late Miocene to Pliocene, and the already existing adaptation of this group to warm and dry habitats, were critical in driving its diversification through migration and local adaptation to varied habitats of arid Australia. Our analyses suggest that the "Riverine Desert" habitat that existed already in the Late Miocene and "migrated" eastwards offered suitable conditions for ancestral Australian Camphorosmeae and facilitated their early widespread occurrence in the Western and Eastern Desert. We hypothesise that early diverging lineages such as *Roycea* adapted to the later emerging "Desert Lake" habitat when it spread in Western Australia during the Early Pliocene. Further habitat type shifts occurred from "Riverine Desert" to "Shield Plain", "Karst Plain" and to "Sand Desert" also during the Pliocene and Pleistocene once these habitat types emerged. This research shows the complex interplay between ecological flexibility and niche conservatism in shaping the biodiversity of Australian Camphorosmeae.

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Variable	Loading value (PC1)	Loading value (PC2)
Bio01 - Annual Mean Temperature	0.309	-0.178
Bio02 - Mean Diurnal Range	0.265	-0.069
Bio03 - Isothermality	-0.140	-0.102
Bio04 - Temperature Seasonality	0.279	0.043
Bio05 - Max Temperature of Warmest Month	0.333	0.057
Bio06 - Min Temperature of Coldest Month	0.028	0.138
Bio07 - Temperature Annual Range	0.292	-0.008
Bio08 - Mean Temperature of Wettest Quarter	0.276	0.216
Bio09 - Mean Temperature of Driest Quarter	-0.155	-0.185
Bio10 - Mean Temperature of Warmest Quarter	0.328	0.142
Bio11 - Mean Temperature of Coldest Quarter	0.226	0.191
Bio12 - Annual Precipitation	-0.227	0.345
Bio13 - Precipitation of Wettest Month	-0.128	0.437
Bio14 - Precipitation of Driest Month	-0.217	0.117
Bio15 - Precipitation Seasonality	0.094	0.275
Bio16 - Precipitation of Wettest Quarter	-0.155	-0.418
Bio17 - Precipitation of Driest Quarter	-0.209	0.156
Bio18 - Precipitation of Warmest Quarter	0.015	0.422
Bio19 - Precipitation of Coldest Quarter	-0.299	0.124

