

Global distribution and climatic preferences of C₄ eudicots and how they differ from those of C₄ grasses

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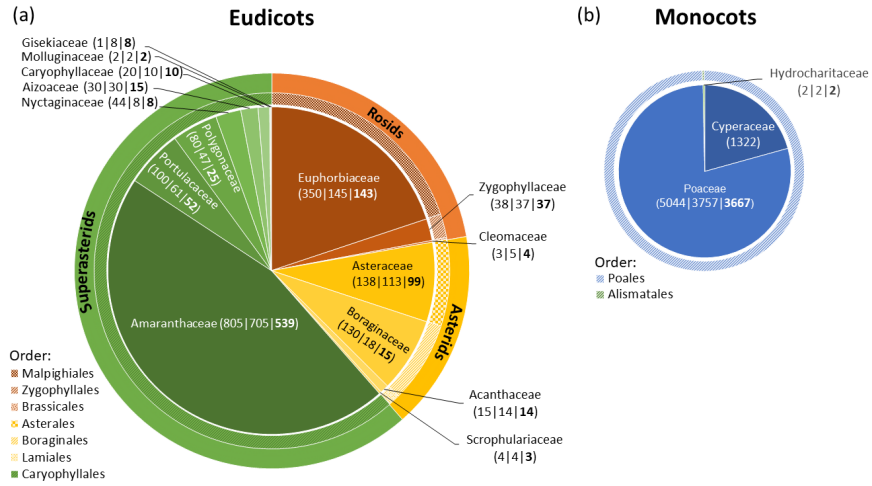
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Abstract

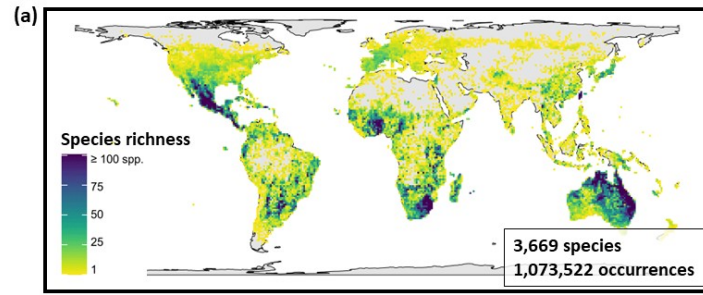
C₄ is one of three known photosynthetic processes of carbon fixation in flowering plants. It evolved independently more than 61 times in multiple angiosperm lineages and consists of a series of anatomical and biochemical modifications to the ancestral C₃ pathway increasing plant productivity under warm and light-rich conditions. The C₄ lineages of eudicots belong to seven orders and 15 families, are phylogenetically less clustered than those of monocots, and entail an enormous structural and ecological diversity. Eudicot C₄ lineages likely evolved the C₄ syndrome along different evolutionary paths. Therefore, a better understanding of this diversity is key to understanding the evolution of this complex trait as a whole. Compiling 1,207 recognized C₄ eudicots species described in the literature and presenting trait data among these species, we identify global centres of species richness and of high phylogenetic diversity. Furthermore, we discuss climatic preferences in the context of plant functional traits. We identify two hotspots of C₄ eudicot diversity: arid regions of Mexico/Southern United States and Australia, where several C₄ eudicot lineages diversified independently. Further eudicot C₄ hotspots with many different families and genera represented are in South Africa, West Africa, Patagonia, Central Asia and the Mediterranean. In general, C₄ eudicots were abundant in deserts and xeric shrublands, tropical and subtropical grasslands, savannas and shrublands. We found C₄ eudicots to occur in areas with less annual precipitation than C₄ grasses which can be explained by frequently associated adaptations to drought stress such as among others succulence and salt tolerance. We conclude that in most eudicot lineages C₄ evolved in ancestrally drought adapted clades and enabled these to further spread in these habitats and colonise even drier areas.

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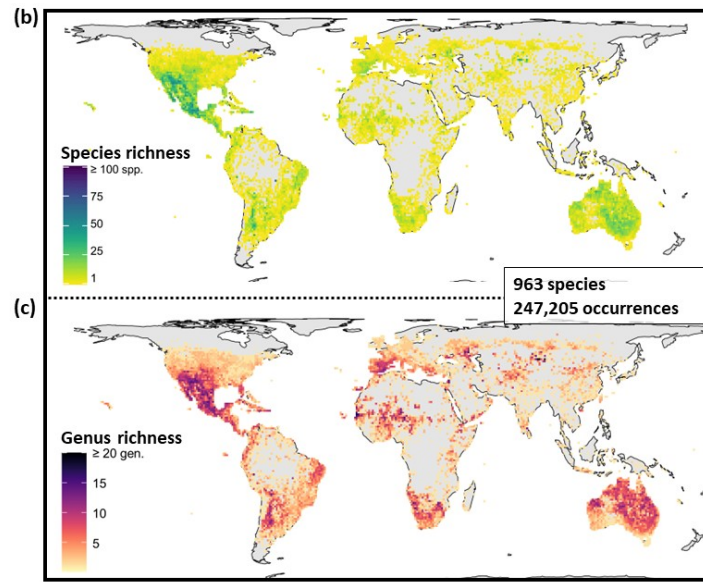
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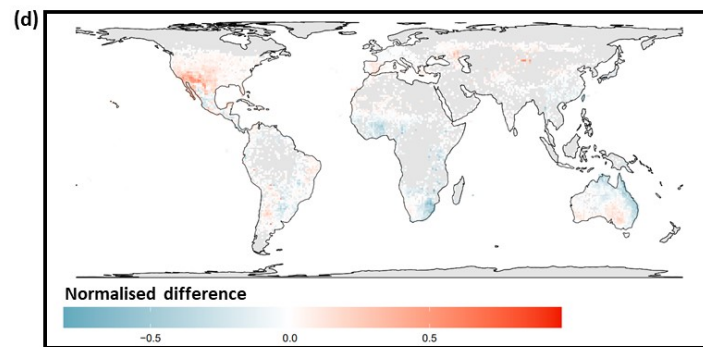
C₄ grasses

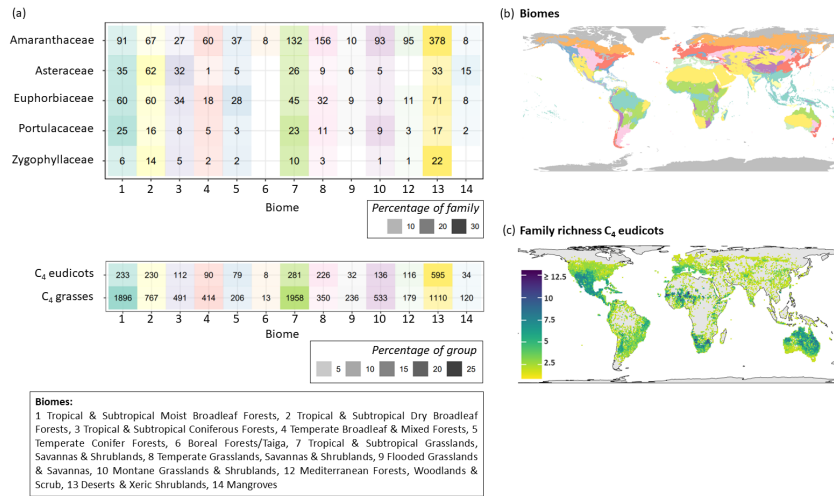
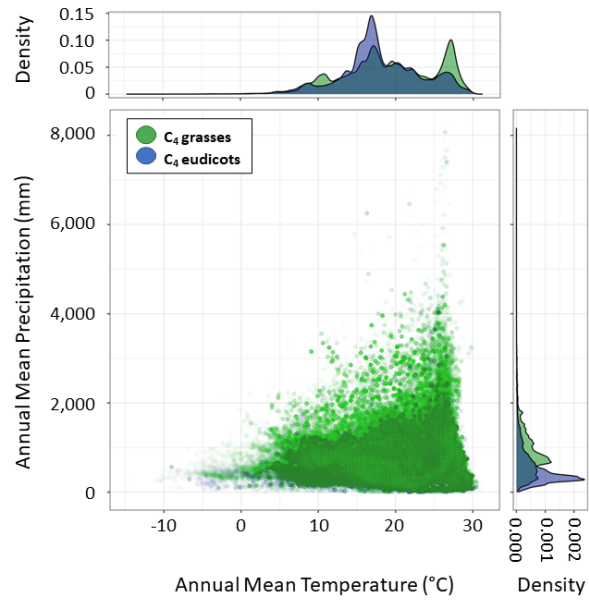


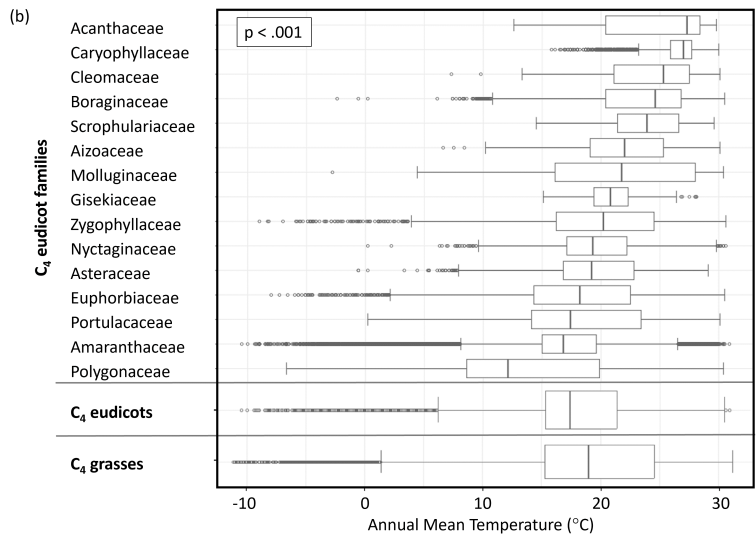
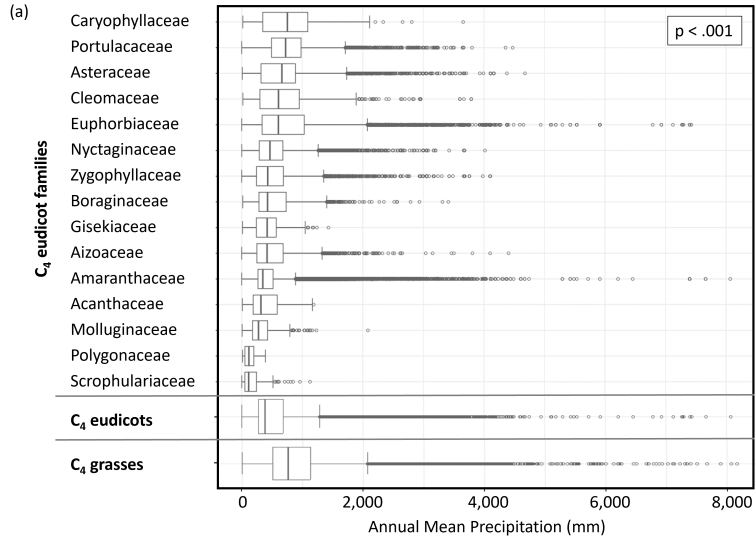
C₄ eudicots

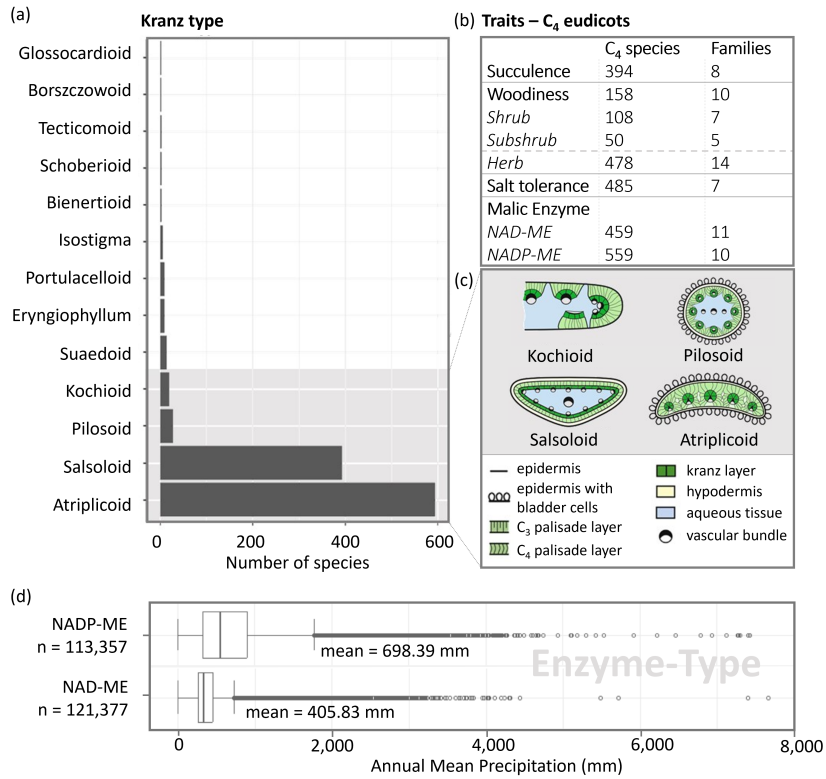


Normalised difference (C₄ eudicots - C₄ grasses)









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