Evolutionary convergence in the flora of New Caledonia: correlated evolution and environmental contingencies of monocauly

David Bruy*[1,2], Laure Barrabé[3,4], Jérôme Munzinger[2], and Sandrine Isnard†[1,2]

[1]Herbier de la Nouvelle-Calédonie (NOU) – 101 promenade Roger Laroque, BP A - 98800 Nouméa, New Caledonia

[2]Botanique et Modélisation de lÁrchitecture des Plantes et des Végétations (UMR AMAP) – Centre de Coopération Internationale en Recherche Agronomique pour le Développement : UMR51-2015, Institut national de la recherche agronomique [Montpellier] : UMR931, Université de Montpellier : UMR5120, Centre National de la Recherche Scientifique : UMR5120, Institut de Recherche pour le Développement : UMR123 – Bd de la Lironde TA A-51/ PS 2 34398 Montpellier cedex 5, France

[3]Institut Agronomique néo-Calédonien (IAC) – Equipe ARBOREAL, BP 711, 98810 Mont-Dore, New Caledonia

[4]Endemia – 3 rue Jules Harbulot, 98800 Nouméa, New Caledonia

Abstract

Evolutionary convergence, i.e. the rise of similar trait attributes among distantly related lineages, is a symptomatic island syndrome. Many tropical islands host remarkable cases of evolutionary convergence in plant forms and functions, among the most famous being secondary woodiness. In New Caledonia, an insular biodiversity hotspot in the Southwest Pacific, secondary woodiness is virtually lacking. Botanists who studied the flora, however mentioned the pervasive presence of monocaulous (unbranched) woody species in many distinct lineages, potentially illustrating a previously uninvestigated case of convergent evolution. Here, we study the evolutionary history of monocaulous species throughout the phylogeny of the New Caledonian woody genera. Using herbarium data, extensive field work and a compilation of the literature, we listed monocaulous species and scored six life-history and two environmental traits for 2114 New Caledonian woody self-supporting species. We constructed a phylogenetic supertree at genus level to investigate minimum number of times monocauly has evolved, phylogenetic signal and evolutionary correlates of monocauly in the island. We found at least 31 independent evolutionary events leading to monocauly, with 182 monocaulous species belonging to 41 genera, 30 families and 15 orders. This repeated evolution of the monocauly is revealed as a remarkable case of convergence in insular environments. Monocaulous species conform to few architectural models. The habit showed a nonrandom distribution over the phylogeny suggesting some prerequisites facilitating its evolution. Monocauly evolved preferentially in rainforest and on ultramafic substrate and triggered the evolution of both cauliflory and marked rhythmic growth, but no preadaptation was identified. Environmental contingencies explaining this notable convergence are suggested to involve rainforest structure and historical climatic stability, ultramafic (nutrient-poor and toxic) substrates and long-term absence of browsers. Finally, we ask whether the

*Corresponding author: david.bruy@ird.fr

†Speaker

convergent evolution of monocauly in New Caledonia results from the loss of branching in the different lineages, as suggested by the few phylogenetic data available. Notably, secondary woodiness is also often associated with the evolution of unbranched rosette trees on islands, conforming to the Holttum or Corner architectural models. Are branches lost on islands? If so, why? Convergent evolution in plant architecture could represent an overlooked insular syndrome.

Keywords: convergent evolution, environmental contingencies, functional disharmony, monocauly, plant architecture