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From phylogenomics to macroevolution: evolution across the adaptive landscape in a hyperdiverse beetle radiation.

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The extraordinary diversification of beetles on earth is a textbook example of adaptive evolution. Yet the tempo and driver of this super-radiation remain largely untested. Here, we explore this issue by investigating the macroevolutionary dynamics in darkling beetles (Coleoptera: Tenebrionidae), one of the most eco-morphologically diverse beetle family. Using genomic datasets and multiple approaches, we resolve the century-long inconsistency over deep relationships in the family. On a global scale, we show the dynamic evolutionary history of darkling beetles is marked by ancient rapid radiations, frequent ecological transitions, and rapid bursts of morphological diversification. On a regional scale, two major Australasian radiations, Adeliini and the Heleine clade, exhibited contrasting patterns of eco-morphological diversification, representing a prime case of phylogenetic niche conservatism versus adaptive radiation. These findings highlight a significant role of ecological opportunity in driving the immense eco-morphological diversity in a global mega-radiation. More broadly, this study underscores the value of synthesizing large-scale phylogenetic and trait data to enrich our understanding on the accumulation of biodiversity.

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