

How and why species are rare: Towards an understanding of the ecological causes of rarity

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Abstract

The three-dimensional rarity typology proposed by Rabinowitz in 1981, based on geographic range, habitat specificity, and local abundance, is among the most widely used frameworks for describing rarity in ecological and conservation research. While this framework is descriptive and is not meant to explain the causes of rarity, recent advances in ecology may be leveraged to add explanatory power. We propose a modification of Rabinowitz's typology to better distinguish between the dimensions of rarity and the ecological processes that drive them, and explore the conservation implications of our modified framework. We suggest replacing habitat specificity with occupancy (the proportion of occupied sites within a species' range), yielding a modified classification based on range size, occupancy, and local abundance. Habitat specificity remains embedded in our framework, but as a driver of rarity rather than a rarity axis. Under our framework, habitat specialists are no longer considered rare if they are widespread and abundant; we argue that this modification more accurately identifies truly rare species, as habitat specialists may be common if their habitat is abundant. Finally, we draw on the functional and theoretical literature to identify the key processes and associated traits that drive each rarity axis. In this respect, we identify four processes (environmental filtering, movement, demography, and interactions), and hypothesise that range size and occupancy are primarily driven by environmental filtering and movement, whereas local abundance is more strongly influenced by demography and interactions. We further use ecological theory to hypothesise the conservation concerns associated with each rarity axis, and propose conservation measures that may be suitable for conserving different types of rare species. Our work may provide a basis for developing hypotheses about the causes of rarity of particular focal taxa or groups, and inform the development of targeted conservation strategies.

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