Rare species perform unique roles, even in diverse ecosystems

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A new study, published 28 May in the open access journal *PLOS Biology*, has revealed the potential importance of rare species in the functioning of highly diverse ecosystems. Using data from three very different ecosystems—coral reefs, tropical forests and alpine meadows—a team of researchers led by David Mouillot at the University of Montpellier 2, France, has shown that it is primarily the rare species, rather than the more common ones, that have distinct traits involved in unique ecological functions. As biodiversity declines, these unique features are therefore particularly vulnerable to extinction because rare species are likely to disappear first.

"These unique features are irreplaceable, as they could be important for the functioning of ecosystems if there is major environmental change," explained Dr Mouillot.

Biodiverse environments are characterized by a large number of rare species. These rare species contribute to the taxonomic richness of the area, but their functional importance in ecosystems is largely unknown. Represented by few individuals or distributed over narrow geographic areas, rare species are generally considered to have little influence on the functioning of an ecosystem compared with more common species. Indeed, it is often assumed that they fulfill the same ecological roles as those of common species but have less impact because of their low abundance; a phenomenon known as 'functional redundancy'. This redundancy suggests that rare species merely serve as an "insurance" policy for the ecosystem, in the event of an ecological loss.

To test this, the team of researchers analyzed the extent to which rarer species in the three different ecosystems performed the same ecological functions as the most common ones. They examined biological and biogeographical information from 846 reef fish, 2979 alpine plants and 662 tropical trees and found that most of the unique and vulnerable functions, carried out via a combination of traits, were associated with rare species.

Examples of such species supporting vulnerable functions include the giant moray (Gymnothorax javanicus), a predatory fish that hunts at night in the labyrinths of coral reefs; the pyramidal saxifrage (Saxifraga cotyledon), an alpine plant that is an important resource for pollinators; and Pouteria maxima, a huge tree in the rainforest of Guyana, which is particularly resilient to fire and drought. Not only are they rare but they have few functional equivalents among the more common species in their respective ecosystems.

"Our results suggest that the loss of these species could heavily impact upon the functioning of their ecosystems," said Dr Mouillot. "This calls into question many current conservation strategies."

The work emphasizes the importance of the conservation of rare species, even in diverse ecosystems. Rare species are more vulnerable and serve irreplaceable functions, explained Dr Mouillot: the preservation of biodiversity as a whole—not just the most common species, but all those who perform vulnerable functions—appears to be crucial for the resilience of ecosystems.

"Rare species are not just an ecological insurance," he said. "They perform additional ecological functions that could be important during rapid transitions experienced by ecosystems. The vulnerability of these functions, in particular biodiversity loss caused by climate change, highlights the underestimated role of rare species in the functioning and

resilience of ecosystems. Our results call for new experiments to explicitly test the influence of species rarity and the uniqueness of combinations of traits on ecological processes." This line of research will also inform the lively debate about the relationship between biodiversity and ecosystem functioning.

More information: Mouillot D, Bellwood DR, Baraloto C, Chave J, Galzin R, et al. (2013) Rare Species Support Vulnerable Functions in High-Diversity Ecosystems. PLoS Biol 11(5): e1001569. doi:10.1371/journal.pbio.1001569