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Rare species have a unique ecological role

Many rare species play unique ecological roles that make them irreplaceable, even in the most diverse ecosystems on Earth, an international team has found. Based on data from three very different ecosystems (coral reefs, alpine meadows and tropical forests) scientists from the CNRS, University de Montpellier 2, INRA, EPHE and IRD discovered that unique ecological functions (such as exceptional resistance to fire or drought) are mostly characteristic of rare species and are therefore particularly vulnerable to the erosion of biodiversity. These functions could be crucial in case of major environmental change. The study, published on May 28th in *Plos Biology*, shows that protection of the ensemble of biodiversity is vital for the resilience and survival of ecosystems.

Environments with high biodiversity typically have a great number of "rare" species, in other words species with low local abundance or limited distribution area. The functional importance of these rare species is often underestimated as they are thought to have a minor influence on ecosystem functioning and only to offer ecological "insurance" in case commoner species die out. The present study, published in *Plos Biology*, contradicts this idea.

The researchers examined the functional traits of a large number of plant and animal species. In ecology, such traits enable us to describe a species: Is an animal carnivorous or herbivorous, diurnal or nocturnal, fossorial[1] or capable of flying? Is a plant resistant to drought, does it seek direct light, or prefer acid or alkaline soils? The ensemble of a species' functional traits underpins its ecological function.

In this study, the scientists tested the hypothesis that rare species have specific functions in the ecosystem. They compared biological and biographical information on 846 species of coral reef fish, 2979 alpine plant species and 662 tropical trees from Guiana. Those of the species that had unusual combinations of functional traits, and which consequently played a unique ecological role, were mainly found to be rare, thus confirming the hypothesis.

Three species in particular illustrate these results. The giant moray eel (*Gymnothorax javanicus*) feeds at night on fish and invertebrates in coral reef labyrinths. It therefore eliminates preys that are inaccessible to other predators. The pyramidal saxifrage (*Saxifraga cotyledon*), an alpine plant, represents a unique resource for pollinators on rock faces. Finally, the giant tree, *Pouteria maxima*, a member of the Sapotaceae from the tropical forests of Guiana, is remarkably resistant to fire and drought, which allows the forest to recolonize areas devastated by fire. These rare species only have a few functional equivalents in their ecosystems.

[1] Creatures that can easily burrow through soil (e.g. moles)

However, despite their usefulness for the functioning of ecosystems in case of significant environmental changes and their role in resistance to disturbance, these unique functions could disappear because they are supported by vulnerable species. This latest research therefore underlines the importance of rare species conservation and the need for new experiments to explicitly test the influence of rarity on ecological processes.

Example of a species supporting a vulnerable ecological function: The giant moray eel (*Gymnothorax javanicus*) hunts in the coral reef labyrinths at night. © M.J. Kramer

Coral reefs © J.P. Krajewski

Example of a species with vulnerable ecological functions: The pyramidal saxifrage (*Saxifraga cotyledon)* is a rare and important resource for pollinators on alpine rock faces.
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Alpine meadow © W. Thuiller

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Example of a species supporting a vulnerable ecological function: *Pouteria maxima*, a giant tree from the tropical forests of Guiana, has thick leaves that are resistant to fire and drought.
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Guyanese Tropical Forest © C.E.T. Paine

List of French laboratories involved in the project[2] :

- Laboratoire d'écologie alpine (CNRS / Université Joseph Fourier Grenoble / Université de Savoie)
- Research Unit "Ecologie des systèmes marins côtiers" (CNRS / Universités Montpellier 1 et 2 / IRD)
- Research Unit "Evolution et diversité biologique" (CNRS / Université Toulouse III – Paul Sabatier)
- Research Unit "Ecologie des forêts de Guyane" (CNRS / Inra / Université des Antilles et de Guyane / CIRAD / Agroparistech)
- Institut des sciences de l'évolution de Montpellier (CNRS / Université Montpellier 2 / IRD)
- Centre de recherches insulaires et observatoire de l'environnement (CNRS / EPHE)
- Institut méditerranéen d'océanographie (CNRS / AMU / IRD / Université du Sud)
- Research Unit "Biocomplexité des écosystèmes coralliens de l'Indo-Pacifique" (CoRéUs 2, IRD 227)

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Contacts information

Researcher | Nicolas Mouquet | T +33 (0)6 32 46 89 54 | nmouquet@univ-montp2.fr
From 3 June onwards: David Mouillot | T +33 (0)4 67 14 93 57 | david.mouillot@univ-montp2.fr
CNRS Press Officer | Priscilla Dacher | T +33 (0)1 44 96 46 06 | priscilla.dacher@cnrs-dir.fr

[2] The researchers involved in this study are also memebers of five laboratories of excellence: LabEx Tulip, Ceba, Cemeb, OSUG@2020 and Corail.