Discovering the rainforest 'diversity police'

University of Oxford-led research reveals that fungi regulate diversity in rainforests

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In the plant world, close relatives make bad neighbours: witness the way in which seedlings growing near plants of the same species are likely to die. Scientists long suspected that something in the soil was the cause, and now research led by Dr Owen Lewis, of the University of Oxford's Department of Zoology, has demonstrated that fungi play a crucial role. Their effect, though, is ultimately benign: they act as the rainforest 'diversity police'.

"Fungi prevent any one species from dominating rainforests as they spread more easily between plants and seedlings of the same species," explains Dr Lewis, whose ground-breaking study was published in Nature. "If lots of plants from one species grow in the same place, fungi quickly cut their population down to size, levelling the playing field to give rarer species a fighting chance. Plots sprayed with fungicide soon become dominated by a few species at the expense of many others, leading to a marked drop in diversity."

The study was carried out by scientists at Oxford University and Sheffield University (with funding by the Natural Environment Research Council). The researchers tested an explanation for the astonishing diversity of tropical rainforests developed by ecologists Daniel Janzen and Joseph Connell in the 1970s.

The team sprayed plots in the Chiquibul Forest Reserve in Belize with water, insecticide or fungicide every week for 17 months. They found that fungicide dealt a significant blow to diversity, reducing the effective number of species by 16%. While insecticide treatment changed the composition of surviving species, it did not have an overall effect on diversity. Theirs was the first study to unpick the effects of the different categories of pests and diseases.

The study thus demonstrated that fungi regulate diversity in rainforests by making dominant species victims of their own success – a process known as 'negative density dependence'. "Fungi flourish under hot and humid conditions, and this may contribute to the spectacular plant diversity of tropical forests compared to those in temperate countries," says Dr Lewis, a biologist who studies the processes that maintain, structure and threaten tropical biodiversity. "Plants are the basis of the whole forest food web, so ultimately high plant diversity means lots of insect, bird and mammal species too."

Dr Lewis's study – co-led by Professor Rob Freckleton of Sheffield University – provides a startling reminder of the interconnectedness of the web of life, with microscopic fungi having a profound effect on entire rainforests. The work also has important implications for forest restoration. To restore diverse ecosystems like rainforests, simply planting trees may not be enough – conservationists may need to restore soil fungi and other microbes too.

'This is the first study to explicitly link a particular group of natural enemies to negative density dependence and the maintenance of species diversity in tropical forest plants. It clearly implicates fungal pathogens as the most important drivers of these patterns at the seedling-establishment stage.'

Dr Helene Muller-Landau, scientist for the Smithsonian Tropical Research Institute

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