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Study explains global plant biodiversity patterns in Cape Floristic Region

What explains global patterns of plant biodiversity – environmental history or ecology? A new study, involving University of Cape Town (UCT) researchers, argues that biome (an area of the planet that can be classified according to the plants and animals that live in it) stability is the strongest predictor of biodiversity. Areas that are brimming with species diversity are so because they have been ecologically stable for long periods of time, allowing evolution to forge ahead undisturbed.

This stability coupled with low seasonality and high topographic heterogeneity, may provide a general explanation for global biodiversity patterns.

Researchers investigated plant diversity in the megadiverse Cape Floristic Region (CFR) and tested predictions of the two main hypotheses for the existence of extraordinarily diverse areas. One hypothesis states that areas are diverse because the environment has been particularly stable, leading to reduced extinction of species. The other hypothesis states that areas are diverse because they offer more ecological opportunity, for example, because of topographic diversity, rainfall seasonality, and productivity – amounts of energy that flow through an ecosystem – leading to particularly fast formation of new species. Most areas with high diversity, for example, the tropics, have been both stable and offer lots of ecological opportunities. In the CFR, however, the two hypotheses make different predictions and can therefore be tested.

The researchers found that the CFR's richness could be largely explained by the fact that the region had not experienced major changes in its climate over the past 140 000 years showing that history is an important driver of biodiversity.

These findings reflect the importance of protecting nature and its extraordinary biodiversity against the threat posed by climate change.

"I was always amazed about the spectacular plant diversity right outside our office windows and this study suggests that climatic stability has been important for this diversity to form. I worry that this diversity might be especially vulnerable as the climate is beginning to change," said Professor Res Altwegg, from UCT's Department of Statistical Sciences and African Climate and Development Initiative and co-author of the study.

"We chose to investigate the CFR partly because this Mediterranean-climate region provides an excellent opportunity to investigate simultaneously the ecological and historical drivers of diversity. The flora is the richest extratropical flora in the world, comprising 9 383 species (68% endemic) in just 90 760 km2," he added.

Areas of high productivity such as the humid tropics have always been considered highly diverse. This study shows analytically why the CFR is an exception to this rule as it played only a minor role in the CFR's abundant biodiversity.

Lead author Dr Jonathan Coville, an honorary research associate with UCT's Department of Statistical Sciences and a research fellow at the South African National Biodiversity Institute (SANBI) said: "In South Africa we are fortunate to not only have incredible biodiversity, but also a uniquely detailed knowledge of where these plants are found, thanks to the collections at SANBI. This rich resource enabled us to pull together an interdisciplinary team from South Africa and the UK to tackle one of the most challenging questions in ecology and highlights how important international collaborations are to the future success of South African research and the conservation of its biodiversity."

The study concludes that given sufficient stability in combination with high ecological opportunity (e.g. topographic diversity and rainfall seasonality), there is no obvious reason why megadiversity should not evolve in low-production bioregions. An illustrative example is the extraordinarily high biodiversity of South Africa's winter-rainfall desert – the Succulent Karoo.

The international team of researchers included scientists from the University of York (UK), Nelson Mandela University, Kew Gardens and UCT.

Read the study

The forked watsonia (*Watsonia fourcadii*) growing in recently burnt fynbos shrublands of the Kouga Mountain foothills of the south-eastern CFR. A few hundred kilometres west of this scene, in a strikingly similar-looking foothill landscape, not only will virtually all of the fynbos species be different, but there will be almost double the number. The reason for this is that western parts of the CFR experienced more environmental stability over the past 140 000 years than the east.

Photo: Richard Cowling.

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