A picture of plant functional diversity on an oceanic island

Extensive fieldwork reveals that island plants have similar functions to plants in other regions of the world, but that the island environment, along with biogeographical and evolutionary processes, filters the life-history characteristics and strategies of the plants, rendering the island flora functionally and ecologically distinct from others.

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The question

For centuries, oceanic islands have served as valuable 'natural laboratories' to test fundamental ideas about biodiversity[1]. Oceanic islands often possess a distinctive geology and are highly isolated. In theory, these characteristics would make their plants functionally distinct from flora in other locations[2]. However, until now, research into the characteristics of island floras has been impeded by a lack of empirical data on fundamental plant traits such as leaf area, plant height and stem density. We addressed this gap by collecting plant-trait data from Tenerife (Canary Islands, Spain), a charismatic oceanic island situated off the coast of North Africa in the Atlantic Ocean, and comparing them against the widely accepted global spectrum of plant form and function data set[3].

The solution

We wanted to obtain trait data for a complete oceanic island flora, to see whether island plants fundamentally differ from mainland plants. To this end, Tenerife was an ideal model system, because it hosts one of the most diverse yet well-researched oceanic island floras. The island is dominated by semi-arid ecosystems and exhibits great environmental variation. We selected traits that reflect life-history characteristics (including growth habits, reproductive behaviours and interactions with other species) of plants in relation to the environment[3]. We collected data on eight functional traits for about 80% of Tenerife's native seed flora. During our sampling, we visited more than 500 locations on the island, from 0 to 2,700 metres above sea level, covering all ecosystems. We used the most up-to-date metrics in functional ecology to capture trait diversity[4].

We found that environmental conditions have selected for adaptations in plant size and shape, as well as for those linked to a plant's persistence on the island. Tenerife's mostly semi-arid conditions favour a dominance of shrubs (Fig. 1). The dominance of woody shrubs might also relate to a frequently observed island phenomenon called insular woodiness, whereby small herbaceous plants develop stems and evolve to become woody over time. We further found that much of the oceanic island's functional diversity came from a species colonizing its habitats through long-distance dispersal. By contrast, we found that the evolution of new species on Tenerife contributed little to the overall functional diversity of the island. This is because many recently evolved plant species on Tenerife had not adapted to different ecological niches, but rather inhabited similar habitats to those of their ancestors. This results in the evolution of species that are functionally similar to their ancestors and thus share similar traits.

Future directions

Understanding the adaptations of plants and their persistence in certain environments, such as those that are arid and isolated, is particularly relevant in the context of anthropogenic climate and biodiversity change. Trait-based approaches are crucial to understanding how a species' functional characteristics interact with its environment and to improving predictions about the impacts of environmental changes on plant diversity and ecosystems.

We studied eight functional traits that describe fundamental plant strategies. However, our study did not consider below-ground traits, traits related to reproduction, such as clonality, or traits related to disturbance adaptations, including the ability to resprout after fire. Future studies on such traits, which are particularly important on islands, would expand our understanding of how plants respond and adapt to the environment and other species. Furthermore, most Tenerife plant species are intermediate in size, consistent with the island rule — a fundamental eco-evolutionary principle that predicts that, on islands, organism sizes tend to converge at intermediate values. However, trait data for continental species with closely related island species, using evolutionary frameworks, would be required to confirm this. Next, studying the proportions of species populations in Tenerife would enhance the picture of plant function dominance on the island. In future, we aim to test the generalizability of our findings by measuring traits that reflect further life-history dimensions, and by studying traits on other Canary Islands and oceanic islands.

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EXPERT OPINION

"As far as I am aware, this is the first comprehensive description of functional trait space for a large insular flora, and it was performed on one of the most floristically diverse oceanic islands in the world, making this an original and notable study. The authors' approach to their methods and data interpretation is comprehensive, sharp and effective, and is likely to become a blueprint for how to execute these types of studies." (CC BY 4.0)

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FIGURE

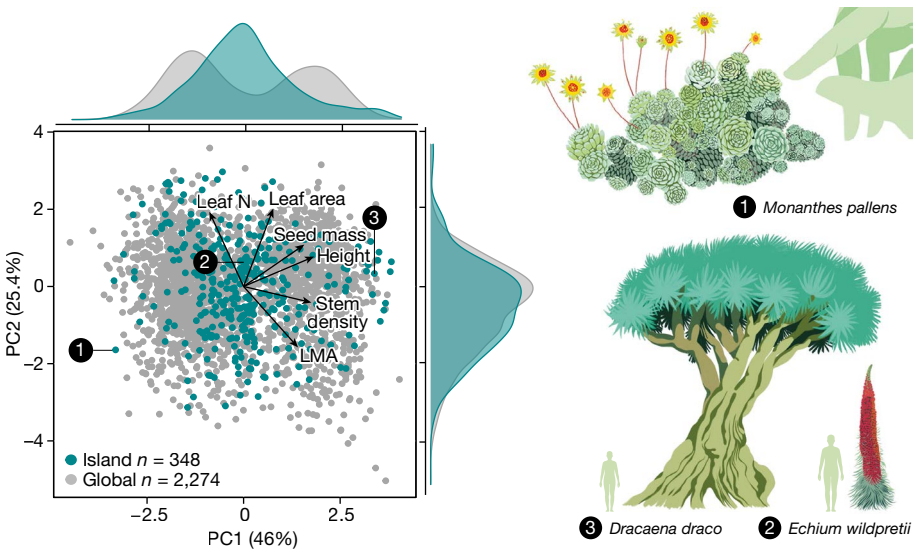

Figure 1 | Exploring the diversity of Tenerife flora within the global spectrum of plant form and function. Plant-trait data for 348 plant species (turquoise) on the oceanic island of Tenerife were collected and summarized as two statistical parameters (PC1 and PC2) that best captured their diversity in a 2D 'trait space'. (The amount of variation captured by each parameter is in brackets for each axis.) These points are plotted with the equivalent points for 2,274 plant species (grey) from the global spectrum of plant form and function data set[3]. Iconic native plant species from Tenerife are illustrated on the right (1–3), and reflect different aspects of the island trait space (numbered in the trait-space graph). Leaf N, leaf nitrogen content; LMA, leaf mass per area. (Illustrations by P. Mocna.)

BEHIND THE PAPER

Our research was motivated by a seminal study[3] about the diversity of plant form and function around the world. We were keen to see how island plants fall into this trait space and whether they show the same trait trade-offs seen in continental species, or whether they are different, as is often assumed. The research was serendipitously funded when a place unexpectedly became available in a research training group at the University of Göttingen, Germany. Many challenges emerged during the trait-data collection in Tenerife. First, to get the data-collection permits, we had to adapt our sampling protocol to minimize damage to the plants. Second, M.P.B.B. spent eight months of her PhD project in Tenerife carrying out the trait sampling, which involved a large amount of work and a steep learning curve to optimize the workflows.

M.P.B.B. and **H.K.**

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FROM THE EDITOR

This study stood out for its extensive sampling of plant traits on Tenerife, which allowed the authors to draw conclusions about the factors shaping the trait space of the island's flora.

Editorial team, *Nature*