The strategy of plants: It's all about balancing traits

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Just like every other organism on Earth, plants' ultimate goal is to survive and reproduce. In order to achieve this, they must make trade-offs between where and how to allocate their finite set of resources. Whether they put their resources and energy into their growth, reproduction or maintenance, is all part of their so-called plant strategy. With a new framework, Ph.D. candidate Jianhong Zhou and her supervisors found that not all of the currently known strategies represent a plant strategy in real life.

"Plant strategies are important to, for example, predict how plants respond to projected changes in future climates," tells Zhou from the Institute of Environmental Sciences. "However, to date, it remained unknown whether the ways we used to describe plant strategies, reflected these strategies is reality. That has consequences for the models we use to look at the functioning of ecosystems. For example, models to predict how well these ecosystems will function in a changing climate. Our novel framework allows improving these models and the projections they give."

Relationships between different traits

A way to determine a plant's strategy is to look at trait-trait relationships. Traits are attributes of an organism, such as weight or lifespan, and can be measured on individuals. The values of these traits can vary between different individuals within a species, and they can also vary between different species. When you compare how the values of two of these traits relate to each other, you get the trait-trait relationship.

To this date, scientists mostly looked at trait-trait relationships between different species. "When we find a strong trait-trait relationship between species, we commonly regard it as a plant strategy," says Zhou. "For example, there is a positive relationship between the leaf lifespan and the leaf mass per area of plants. This indicates that plant species that produce leaves with a high mass per area, generally also have leaves that last longer."

According to Zhou, this interesting relationship has been interpreted as a plant's strategy in which a species invest many resources in the construction and growth of its leaves to make good use of them. "That way, the leaves will they last long enough to do sufficient photosynthesis."

Not always representing strategy

In reality, however, it remains unclear whether a trait-trait relationship between species always represents a plant strategy. Zhou: "A strong trait-trait relationship between species could also be caused by common environmental drivers. The availability of water and nutrients namely affects many traits. When, for example, the nitrogen content in the soil increases it could affect leaf nitrogen content and specific leaf area independently, making them arise. But that does not necessarily mean that these two traits are physiologically or eco-evolutionary related. That way, the traits would be correlated by coincidence, without representing a strategy."

Zhou and her colleagues, therefore, came up with a new approach to distinguish between trait-trait relationships that represent plant strategies and those relationships due to a "coincidence." "We proposed a new framework," she says. "If a trait-trait relationship really represents a plant strategy, we would expect to see the same trait-trait relationship within a species; so in that case, we look at how the trait values vary between different individuals of the same species. If a trait-trait relationship between species is caused by coincidental drivers, we would not see that same strong trait-trait relationship within species," says Zhou. "This was the case for the former example of specific leaf area and leaf nitrogen."

More accurate predictions in times of climate change

"This knowledge is especially important for making models that predict how ecosystems and the processes in these ecosystems will change in future climates," says Zhou. "Due to climate change, we might experience climate conditions that we have never seen before. This would inevitably affect the environmental drivers we've talked about: two environmental drivers that are only linked through coincidence, that independently affect a plant trait.

Under different circumstances, the way in which they affect the plant trait might change. The coincidental trait-trait relationships caused by these drivers, would then break down. This means our models, involving these relationships, would no longer make accurate predictions. By figuring out which trait-trait relations this might be, our new method can address this problem."

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More information: Jianhong Zhou et al, Global analysis of trait–trait relationships within and between species, *New Phytologist* (2021). DOI: 10.1111/nph.17879

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