

## PRESS RELEASE

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# How plants and animals ‘construct’ their interactions: new study reveals consistent patterns of interaction in nature

- A study conducted by the Doñana Biological Station – CSIC and the University of Seville analyses how individual plants in various populations establish their interactions with the animals that consume their fruits.
- On average, a single individual attracts 70% of the diversity of frugivores animals present in its community, yet only a very small fraction of individuals play a central role in the network of interactions.



*Common blackbird (Turdus merula) consuming fruits of dog rose (Rosa canina) in the north of the Iberian Peninsula. Credit: Jesús Lavedán.*

**Sevilla, 3 de marzo de 2025.** In nature, individuals of the same are not identical: they differ in their traits, behaviour, interactions, diet, etc. Researchers from the Estación Biológica de Doñana - CSIC and the University of Seville have just published a study in the journal PNAS analysing how individual plants in various populations structure their interactions with the animals that feed on their fruits. The findings that patterns of interactions at individual level are similar to those observed at the species level, suggesting consistent patterns in the way ecological interactions are organised in nature.

Fleshy-fruited plants interact with a wide variety of animals that feed on their fruits and disperse their seeds, a crucial process for forest regeneration. For this reason, frugivorous animals are often considered the 'gardeners of the forest'. In nature, a multitude of plant and animal species, or more precisely, the individuals that make up their populations, interact with each other and form mutualistic relationships, creating highly complex networks.

The differences among individuals of the same species are known as intraspecific variation. Studies examining this variation are usually approached from the perspective of niche theory, which explores the range of resources a species uses and what proportion of these resources its individuals use. These resources can be trophic, such as prey or other food sources, or ecological services provided by other species, such as flower pollination or seed dispersal.

In this newly published work, the researchers combined niche theory with complex network theory to investigate how individual plants across different populations interact with the fruit-eating animals that consume their fruits. To achieve this, they constructed ecological networks based on individual plants and the community of frugivorous animals from 44 populations spanning South America, Asia and Europe, and encompassing 29 different plant species.

## **On average, one single plant receives 70% of the frugivore diversity**

'Our results reveal that, much like diet studies focused on animals, an individual plant, on average, interacts with 70% of the frugivore diversity in its community, demonstrating a significant degree of generalization,' explains Elena Quintero, researcher and first author of the study

However, the researchers observed considerable variation in interaction patterns among individuals in the same population. Thus, while some plants acted as generalists, engaging with multiple frugivore species, other behave as specialists, restricting their interactions to just one or a few species.

In addition, to identify general patterns across populations, the researchers calculated various network indices to examine how individual plants establish their interactions with the frugivore community. '*We found that in most plant populations, regardless of their species or the ecosystem in which they are found, only a very small percentage of individuals play a crucial role in the interaction network,*' explains Pedro Jordano, research professor at the Doñana Biological Station - CSIC.

These individual plants, referred to as 'keystone' by the researchers, establish multiple interactions with a high diversity of frugivorous animals and play a central role in shaping interaction networks within their population- potentially influencing forest regeneration dynamics. '*It is likely that these plants possess distinctive traits, such as high fruit production or strategic locations, making them reliable resources for many frugivores*' explains Elena Quintero.

This study highlights the importance of examining nature at the individual level to gain a deeper understanding of how ecological interactions are structured. It shows how mutualistic interactions are structured similarly at both the species and individual level and across different ecosystems and biomes worldwide, revealing underlying and consistent patterns of role distribution in nature.

This more detailed approach not only reveals hidden patterns within ecological communities, but also expands niche theory to complex networks such as those representing the highly diverse mutualistic relationships between plants and animals.

The study is part of the research project 'Evolution of biotic dispersal in plants: past, present and future' led by the University of Seville and "The biodiversity of ecological interactions: from individual based interaction motifs to multilayer networks - MOTIFLAYER" led by the Estación Biológica de Doñana -CSIC, both funded by the Spanish Ministry of Science and Innovation.

#### Reference:

Quintero, E., Arroyo-Correa, B., Isla, J., Rodríguez-Sánchez, F., Jordano, P. (2025). **Downscaling mutualistic networks from species to individuals reveals consistent interaction niches and roles within plant populations.** *Proceedings of the National Academy of Sciences*, 122(7), e2402342122. <https://doi.org/10.1073/pnas.2402342122>