Orchids' ability to grow on other plants independently evolved multiple times

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Many orchids grow on trees. A new extensive study of the genetic relationships among orchids clarifies the relationships among orchid groups and reveals that the flower's ability to grow on other plants evolved independently multiple times. Credit: Hong Ma (left and right), Xibing Guo (center)

The most extensive study of the genetic relationships among orchids to date reveals that the flower's ability to grow on other plants evolved independently multiple times. A team of researchers, led by Penn State biologists, compared the sequences of 1,450 genes from 610 orchid species to reconstruct the orchid family tree and clarify the evolutionary relationships among the many subgroups of this large plant family and showed that "epiphytism"—the ability to grow on other plants—evolved at least 14 separate times.

"Orchids are one of the two largest families of plants, with about 28,000 species," said Hong Ma, Huck Chair in Plant Reproductive Development and Evolution and professor of biology at Penn State and lead author of the paper. "Orchids are highly valued in the horticultural community for their beauty, are used in folk remedies in many of the areas that they grow, and are economically important for producing vanilla. Understanding the relationships among the many species can potentially help us to identify new uses for orchids and better understand how their traits, including epiphytism, evolved."

A paper describing the study appears May 12 in the *Journal of Integrative Plant Biology*.

The research team collected samples of orchids from botanical gardens and collaborators across the world. Of the 610 species collected, many had existing genetic data, but the researchers produced new RNA sequences for the transcriptomes—the collection of all genes expressed by an organism—of 431 species. The specimens included representatives from all five orchid subfamilies, 19 of 22 tribes, 44 of 51 subtribes, and 297 genera—the level of classification just above species. They compared the sequence of 1,450 genes among the 610 species to reconstruct the orchid family tree.

"There have been several previous studies with fewer species and not as

much representation of the various subgroups within the orchid family," said Ma. "Our larger study allowed us to fill several gaps in the orchid family tree and clarify relationships among orchids."

Orchids grow primarily in rainforests and most, around 70%, grow on other plants, rather than in the soil on the forest floor. This ability, which is also found in plants like mosses and some ferns, may give them an advantage for growth by exposing them to sunlight, water and pollinators where there is less competition from other plants. Growers of orchids at home will know that they are potted on tree bark rather than soil.

Most of the epiphytic orchids are found in two of the five orchid subfamilies, but it was unclear how many times the trait might have evolved independently in these lineages. Because the orchid family is so large, to get a clear picture of how trait evolved required the large number of species used in this study, including greater representation of species from many of the finer branches of the family tree.

"We invested a great deal of time and energy to produce genetic data for over 400 additional species of orchids, which allowed us to be confident in our representation of the relationships among the species—which are more closely related and which are more distant—and to reconstruct where in the family tree epiphytism evolved," said Ma. "Based on our data, we can see that epiphytism evolved independently at least 14 times. One of these was shared by about 95% of epiphytic orchids and occurred 55 million years ago, supporting the formation of modern rainforests a short time after the extinction of dinosaurs."

The rainforests where orchids grow are incredibly important for their biodiversity and epiphytic orchids can account for up to 50% of the plant diversity in rainforests.

"Understanding the relationships among orchid species can help us with

conservation efforts, with future studies into the evolution of orchid traits, and for identifying new potential uses for orchids," said Ma.

More information: Guojin Zhang et al, Comprehensive phylogenetic analyses of Orchidaceae using nuclear genes and evolutionary insights into epiphytism, *Journal of Integrative Plant Biology* (2023). DOI: 10.1111/jipb.13462

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