

Global database of data for almost 3,000 orchid species show diversity of pollination strategies

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As is the case for many orchids, the Dragon Orchid (*Caladenia barbarossa*) is pollinated by just a single species of insect. Here, pollination occurs via a male thynnine wasp, which is sexually attracted to the flower through mimicry of the

wasp's sex pheromones. In this photo the male wasp removes and deposits pollen in the process of attempting to copulate with the flower. Credit: Dr Ryan Phillips, La Trobe University

Recent research, published in the *Botanical Journal of the Linnean Society*, used the database to reveal that orchids show remarkable diversity of highly specialized pollination strategies that differ across global regions.

The recently published database contains over 2,900 [orchid species](#), detailing information on the identity of their pollinators and how they attract them. Importantly, the database reveals patterns of reproductive biology by habitat, geography and taxonomy.

"From these data, we identify general patterns and knowledge gaps limiting our understanding of orchid biology at the global level," Dr. Phillips said.

Charles Darwin used orchids to study evolution, believing their elaborate flower was an adaptation to enhance the probability of transferring pollen between plants—thereby increasing their offspring's fitness.

"Because of the unusual floral traits and often unconventional pollination attraction strategies, orchids have been at the forefront of understanding floral adaptations to pollinators," Dr. Phillips said.

Indeed, Darwin famously predicted that the Madagascan orchid *Angraecum sesquipedale*—with its 40 cm long nectar spur—would be pollinated by a moth with an equally long and outlandish proboscis.

Using the new database, the research paper, led by Dr. James Ackerman

from the University of Puerto Rico, found that over 75% of orchid [species](#) are dependent on pollinators for reproduction. Interestingly, almost half of the orchids studied did not provide any kind of reward for visiting animals—instead they used deceit to attract pollinators.

Orchids tended to be specialized on just one main pollinator species—be they living in the rainforests of Costa Rica or the montane grasslands of South Africa—but this trend was even stronger for those using deception.

Study co-author, Dr. Noushka Reiter, said that "specializing on one pollinator species leaves many orchids particularly vulnerable to anthropogenic threats including climate change. With the loss of pollinators we would also lose these pollinator dependent orchid species."

The pollination strategies developed by orchids reads like a crime thriller—indeed, Australia is the world epicenter of pollination by sexual mimicry, where a host of different insect groups—from wasps to bees to gnats—are duped by this elaborate ruse.

In South Africa, orchids mimic carrion, on Reunion Island they mimic rainforest fruits and in Brazil they mimic the smell of aphids—all in the aim of deceiving pollinators.

More romantically, in the American tropics, 100s of orchid species provide fragrance to certain bees, which collect them and incorporate them into their courtship bouquet.

Science fiction?

In Australia, there is even a sexually deceptive orchid known as *Caladenia barbarella*—which means little beard in Latin (in reference to

the flower) but also refers to the comic book character of the same name who was infamous for her sexual exploits.

Dr. Phillips said that a surprising finding of the database was that "a hallmark of the orchid family is the high proportion of species that employ deceit to attract pollinators by exploiting the sensory abilities of pollinators via chemical, visual or tactile stimuli, generally in combination," he said.

Orchids exhibit two major forms of deceit. The first involves food deception, whereby the orchid may look or smell like a type of food to attract a pollinator. The second form of deceitful pollination is sexual deception, where male pollinators are enticed to visit flowers that provide visual, tactile and/or olfactory signals that are indicative of a female insect.

"The floral signals can be so persuasive that insects attempt copulation and may even ejaculate," Dr. Phillips said.

"I've even had the wasps fly in through the car window at the traffic lights and start making love to the orchids specimens on the front seat."

Far from being a freak occurrence, this strategy is now known from 20 genera around the world, including 100s of orchid species.

To date a third means of deception, known as brood-site deception, which typically involves mimicry of larval food such as mushrooms, dung, carrion to attract female flies looking for a food source on which to lay eggs—was considered more common in some other families of flowering plants and rarely seen in orchids.

According to the database:

- In terms of scientific study, Australasia and Africa have 15 and 20% coverage of their orchid diversity, respectively, whereas orchid floras of Temperate Asia, Tropical Asia and South America are much under-represented.
- Approximately 76% of orchid species are entirely dependent on pollinators for reproduction.
- Highly specialized pollination systems are frequent, with approximately 55% of orchids studied having just a single known pollinator species.
- 54% of orchid species offer pollinator rewards, and about half of those (51%) produce nectar. Orchids that are pollinated by insect collecting floral fragrances, account for 24% of the rewarding species, whereas those that produce floral oils account for c. 15%. The remaining 10% comprises species that offer trichomes (food hairs, pseudopollen), resins, pollen or sleep sites.
- Deception, including food, brood-site and sexual deception, was recorded in 46% of the species in the database. Food deception was the most frequently recorded means of deception accounting for 60% of deceptive species. Sexual deception accounted for 38% of the records for pollination by deceit and is present in 20 orchid genera.
- Wasps and bees are the group that make up the most common type of pollinator with flies and mosquitoes coming in a close second

The authors caution that there is much data collecting yet to be done.

"Despite containing over 2,900 species, our database covers less than

10% of the family. While they are centers of orchid diversity, the tropical regions of Africa, Southern America and Asia, are significantly under-represented in orchid pollination studies, especially among epiphytic orchids," Dr. Phillips said.

"The study of orchid pollination provides tremendous opportunity to discover new and bizarre pollination strategies, and to understand the adaptations that flowering plants to attract pollinators. While the tropics is the big unknown in orchid biology, many of best-known Australian [orchids](#) have not been studied in detail.

"Aside from scientific interest, this has important practical implications for conservation, given that many [orchid](#) species are reliant on one primary pollinator species for their persistence," Dr. Phillips said.

More information: James D Ackerman et al, Beyond the various contrivances by which orchids are pollinated: global patterns in orchid pollination biology, *Botanical Journal of the Linnean Society* (2023). [DOI: 10.1093/botlinnean/boac082](https://doi.org/10.1093/botlinnean/boac082)

Provided by La Trobe University

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