Pollination by birds can be advantageous

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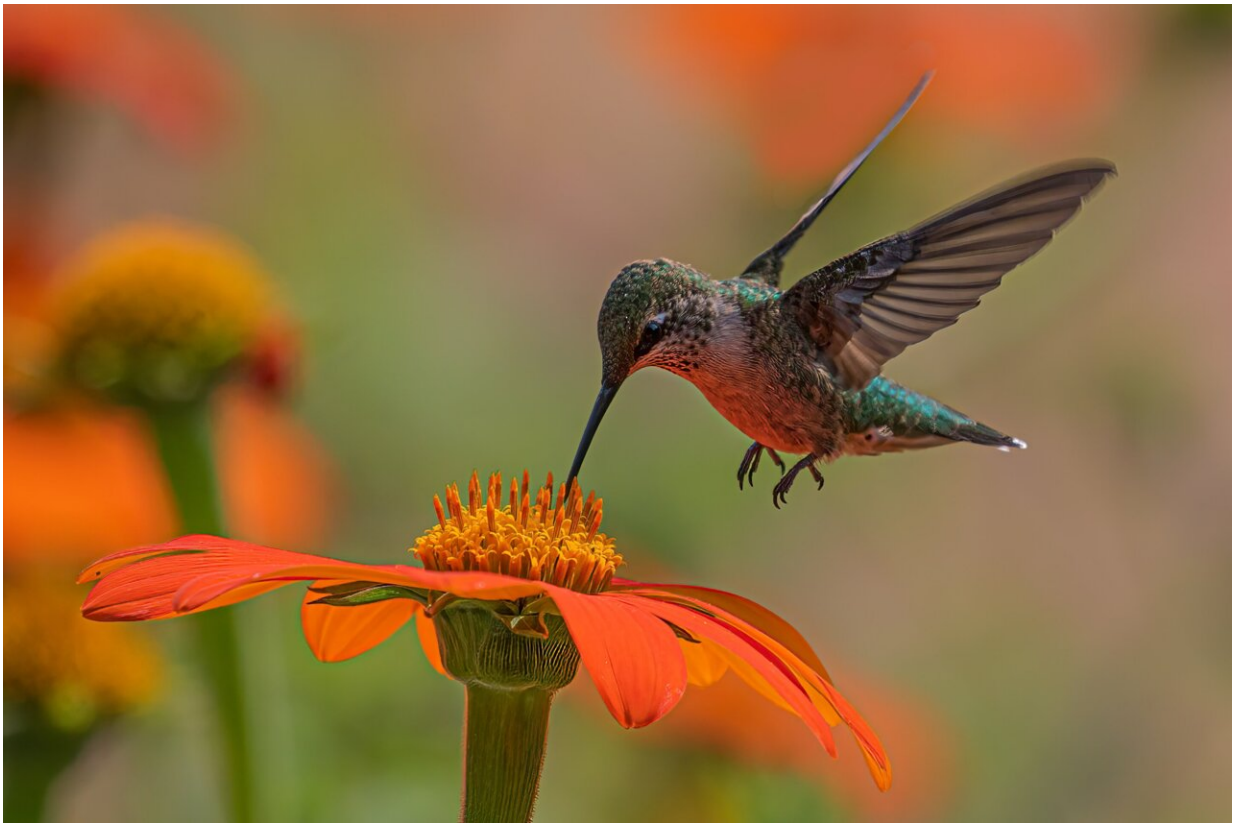

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Why have some plant species changed pollinators in their evolution? An international team of researchers from the Universities of Bonn and Xi'an Jiaotong-Liverpool University Suzhou (China) studied the reproductive systems of three sister species pairs, where one species is pollinated by insects and the other by hummingbirds. Mechanisms were

discovered that explain the switch from insect to bird pollination. The study has now appeared in the journal *Ecology and Evolution*.

Different strategies have evolved in the pollination of flowering plants. The frequency and efficiency of the flower visitor plays a role. Here, there are major differences between the various animal groups. Worldwide, insects, especially bees, are the most common pollinators. Bees usually have quite small activity ranges while other pollinator groups such as hummingbirds fly much longer distances. "It was previously assumed that plants switch their pollinator group from bees to hummingbirds when the activity and thus the pollination efficiency of bees is too low or too unpredictable, for example in the high mountains," says Dr. Stefan Abrahamczyk of the Nees Institute for Plant Biodiversity at the University of Bonn. For example, in cloud forests of tropical high mountains, it is often too humid or too cold for many bees.

But why are there plants in regions with high bee diversity and abundance that have nevertheless switched to hummingbirds, bats, or even small, ground-dwelling mammals such as mice, lemurs, or honey possums? In the current study, Dr. Abrahamczyk and his colleagues have shown that the reasons for evolutionary switching of pollinator groups are much more complex than previously expected. When two new species arise from one original species during evolution, for example because their distribution range is divided by mountain folding or an ice age, the two newly formed species are called a sister species pair.

The researchers analyzed three sister species pairs from different plant families in terms of their reproductive strategies. In each case, one sister species is hummingbird-pollinated and the other is bee-pollinated. All species emerged from bee-pollinated ancestors and occur in areas of North America characterized by high diversity and abundance of bees. Using a series of pollination experiments, it was found that all of the hummingbird-pollinated species had significantly higher seed set and the

seeds had significantly higher germination rates when they resulted from pollination with pollen from another plant individual of the same species.

"From these results, we can conclude that hummingbird pollination evolved in populations of bee-pollinated species that are particularly dependent on cross-pollination, i.e., cannot self-pollinate," Dr. Abrahmamczyk says. Because of their larger radius of activity compared to bees and their frequent movements between different plant individuals of the same species, hummingbirds can pollinate especially plants that do not self-pollinate much more effectively than bees.

Bees often visit all open flowers on one plant before flying to the next. Therefore, bees mainly encourage self-pollination. Compared to hummingbirds, bees have another disadvantage: they groom intensively during flight and deposit the combed-out pollen in their pollen baskets to feed it to their larvae. As a result, only a small portion of the pollen reaches the stigma and can fertilize the ovules. Hummingbirds, on the other hand, are not interested in pollen.

"These newly gained insights can also be applied to the evolution of other pollination systems, such as bat or moth pollination, in terms of their frequency and efficiency," Dr. Abrahamczyk says. These results provide a deeper insight into the evolution of plant-pollinator interactions. They show that plant and pollinator characteristics must be considered in understanding the evolution of pollination systems.

More information: Stefan Abrahamczyk et al, Influence of plant reproductive systems on the evolution of hummingbird pollination, *Ecology and Evolution* (2022). DOI: 10.1002/ece3.8621

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