Compromises between quantity and quality common in animals: do the same holds for plants, flowers?

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Monkeyflowers (*Mimulus guttatus*) are common wildflowers found in western North America. Credit: Photo courtesy of Michael Mucci of the University of Guelph

Most creatures face compromises when they reproduce — the more energy they devote to having lots of babies, the less they can invest in each one. But do the same tradeoffs hold true for plants? Biologists have long assumed that plants with bigger, showier flowers can make fewer of them per plant. But the data don't always hold up, scientists say. A new study by researchers at the National Evolutionary Synthesis Center may help explain why.

"We expect size-number tradeoffs to be universal, but when we look at

plants we don't always find them, and we wanted to know why that might be," said co-author Christina Caruso of the University of Guelph.

Because plants can't move, many rely on their showy, colorful blossoms to entice birds, bats and insects to deliver pollen from one flower to the next. Plants use a range of strategies to attract their suitors, from a single large flower per plant, to hundreds of tiny blooms.

But even if bigger, more plentiful blossoms are useful for attracting pollinators, no creature can do it all in the face of limited time, energy or resources. For most living things, the necessary tradeoff between quantity and quality means that those with numerous offspring can only invest so much energy in each one.

We see the same thing in people, said co-author Hafiz Maherali of the University of Guelph: "Human babies born as twins or triplets generally have lower birth weights than babies born singly," Maherali said.

From daffodils to dogwoods, models assume that flowering plants are no exception to the tradeoff rule. At least in theory, species with bigger blossoms should make fewer of them per plant. But in many plant studies the data don't always hold up.

To find out why tradeoffs between flower size and flower number are so difficult to detect, researchers conducted an experiment in which they planted more than 1,000 monkeyflowers of the species *Mimulus guttatus* in a greenhouse at the University of Guelph in Ontario, Canada. Credit: Photo courtesy of Michael Mucci of the University of Guelph

"Perhaps tradeoffs aren't as pervasive as we think," Caruso said. "Or maybe plants experience the same [size-number] tradeoffs as other living things, but for various reasons they're harder to detect," she added.

Over the years, several hypotheses have been proposed. One possibility, researchers say, is that differences in resource acquisition ability and overall plant size make tradeoffs harder to detect. "Some plants are better at fixing carbon and getting water and nitrogen than others," Caruso explained. If larger plants are able to make bigger, more plentiful blooms than their smaller counterparts, an inverse connection between flower size and number could be trickier to spot.

To test the idea, the researchers planted more than 1000 monkeyflowers of the species *Mimulus guttatus* in a greenhouse at the University of Guelph in Ontario, Canada. Monkeyflowers are common wildflowers found in western North America, from the Sonoran desert to western Alaska.

Some *Mimulus guttatus* plants produce many flowers, and others produce few. To boost the variation in overall plant size, half the plants in the greenhouse experiment got fertilizer, and the other half went without.

The researchers measured the correlation between flower size and flower number, and at the end of the season they harvested and weighed each plant.

They found that larger plants made bigger, more plentiful blooms, just as they suspected. But when they accounted for differences in overall plant size, the underlying tradeoff between flower size and flower number still held true.

In a second experiment they compiled data for 83 plant genera found in California to test for other possible factors, such as whether a species lives to breed for multiple seasons or just one. But no other factor explained why flower size-number tradeoffs are so hard to spot.

"If you don't account for overall size differences between the species you're comparing, the flower size-number tradeoff is likely to be masked," Maherali said.

The findings appear in the *International Journal of Plant Sciences*.

More information: Caruso, C., H. Maherali, et al. (2012). "Why are trade-offs between flower size and number infrequently detected? A test of three hypotheses." *International Journal of Plant Sciences* 173(1): 26-35. doi:10.1086/662656

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