New research suggests natural selection can slow evolution, maintain similarities across generations

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The wild radish has helped Michigan State University researchers posit that natural selection can preserve similarities in addition to driving changes. Credit: Jeff Conner

Natural selection is usually understood in the context of change. When organisms deviate from the norm, they may gain advantages that let their lineages outlast those of their less-adaptable relatives.

But new research from Michigan State University suggests that natural selection also has the power to keep things the same.

"We always talk about the vast diversity of life and we should. It's incredible. Natural selection has given us a lot of that diversity, probably most of it," said Jeff Conner, a professor with the College of Natural Science and the W.K. Kellogg Biological Station, or KBS. "But natural selection can also cause similarities."

Conner is also a faculty member in the Department of Plant Biology and MSU's Ecology, Evolution and Behavior, or EEB, program. Additionally, he serves as president-elect of the American Society of Naturalists.

Conner and his team have published a new report in the journal *New Phytologist* that expands science's understanding of natural selection in the face of another evolutionary mechanism called genetic constraint.

The idea behind constraint is that as species evolve, they can lose genetic flexibility in certain areas. This drives specific traits to stabilize and persist through generations.

Roughly speaking, then, it's tempting to think of natural selection as the accelerator of evolution, driving different or divergent traits and constraint as the brakes, maintaining or conserving similarities.

"Our work flips the script on that a little bit," Conner said. "We're suggesting that selection can also slow things down, that it can cause similarities as well as differences."

During the peer-review process, the work was described as a fascinating project that challenged long-standing assumptions.

Probing selection and constraint

This new paper builds on another report from Conner's group from earlier this year, led by graduate student Robin Waterman. That work was published in the journal Evolution and first hinted that selection could be responsible for conserving traits.

But the researchers still needed to rule out contributions from constraint, which they've done in the *New Phytologist* report.

In both studies, the researchers relied on wild radish as a model organism , but the plant is also a highly damaging weed in agriculture, especially in wheat fields in Australia and the southeastern United States.

In both publications, the researchers studied a defining feature of wild radish, which is the length of its stamens, or pollen-producing parts. Two of its six stamens are short and four are long.

To reveal the conservative potential of natural selection, a research team led by Michigan State University focused on stamen length in wild radishes. In nature, wild radishes have both long and short stamens as seen in the photo on the left. But through artificial selection, the researchers pushed the lengths closer to equal, as seen in the photo on the right. Credit: *New Phytologist* (2023). DOI: 10.1111/nph.19125

This trait or feature is also shared widely across wild radish's nearly 4,000 relatives in the mustard family. That includes Arabidopsis thaliana, another important model organism; garlic mustard, an invasive species in the United States; and many crops such as kale, cauliflower and Brussels sprouts.

So, although the researchers were focused on fundamental biology in these two reports, their work also could inspire future studies to benefit scientists and farmers across the globe.

To evaluate the influence of selection and constraint on this family's distinctive stamen trait, the team turned to what's called artificial selection. That is, they selectively bred wild radishes whose stamens were closer to the same length to try to change that characteristic.

"Perhaps the best method to test for short-term constraints is artificial selection because if a trait responds to artificial selection, it clearly can evolve," the team wrote. "But if the trait does not respond, there is a constraint caused by a lack of genetic variation."

Not only did the trait respond, it did so very quickly. The team reduced the stamen length difference by more than 30% during the experiments.

"This family of plants has maintained this four-long, two-short trait over 50 million years and we can get rid of a third of the difference in five generations, which would be five years," Conner said. "My guess is if we kept going, we would get back to six stamens of equal length."

The ancestors of this family had with stamens of equal length and a few species within the family have reverted to equal lengths over the intervening time. But wild radish and the majority of its relatives have evolved—and kept—the four-long, two-short motif likely thanks to natural selection.

Researchers believe the stamen of different lengths gives the species an advantage when it comes to how pollinators interact with the plant, but they aren't sure exactly what that advantage is. Working with undergraduates and K-12 teachers through their lab at KBS, Waterman and Conner have designed experiments to look into that.

So wild radish still holds some mysteries, but it's provided a potent reminder of the power of natural selection.

"Natural selection is very important," Conner said. "A lot of things people have thought selection couldn't do, we're learning selection can do."

More information: Jeffrey K. Conner et al, Rapid evolution of a family-diagnostic trait: artificial selection and correlated responses in wild radish, Raphanus raphanistrum, *New Phytologist* (2023). DOI: 10.1111/nph.19125

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