Many Plants Can Adapt when Climate Goes against the Grain

Seasonal plants, including possibly the world's important grains, can adapt relatively quickly to climate change

By David Biello

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New research shows that seasonal plants can adapt quickly--even genetically--to changing climate conditions and reveals various mechanisms by which they control their growing response when the weather shifts. The studies suggest, however, that longer-lived plants have a tougher time going with the flow.

Plant evolutionary biologist Steven Franks of the University of California, Irvine, and his colleagues tested the weedy field mustard, introduced to California from the deserts of Mesopotamia by way of Mediterranean climes roughly 300 years ago. The plant is a survivor, thriving from marshes to near-deserts. The scientists gathered seeds from the plant in

1997, just before a five-year drought struck in 2000. They gathered seeds again, post-drought, in 2004 to see what changes had been wrought.

By germinating the stored ancestor seeds, descendant seeds and hybrids under controlled conditions, the biologists could determine exactly how the field mustard had adapted to changing conditions. "We held the environment constant and only varied the genes," Franks explains. "We found a rapid evolutionary shift to earlier flowering following a natural climate change."

In effect, the plants had shifted to flowering a few days earlier to take full advantage of the short "wet" season in dry years. This change was even more marked--more than a full week earlier--for plants that originally derived from a population that enjoyed wetter conditions in a California marsh, according to the study's findings published online January 8 in *Proceedings of the National Academy of Sciences.*

This is good news for annual species, like the field mustard, that can adapt relatively quickly to climate changes, but portends poorly for longer-lived plants, such as California's redwoods, that may not be able to change fast enough to keep up. "We are going to see shifts in ranges," Franks says. "Species run into

barriers like deserts or mountains and may just sort of run out of room. They are not going to be able to evolve or migrate fast enough to keep up with climate change."

Other research in Europe has shown that plants can shift another mechanism that controls their response to climate: vernalization, or the length of the cold snap required before a plant will respond to a warm spell as a growth signal. Caroline Dean of the John Innes Centre in Norwich, England, and her colleagues studied this response in the ubiquitous *Arabidopsis thaliana,* or thale cress. Such plants in Sweden require nearly four times as long a winter as their counterparts in England--14 weeks versus four, respectively--before they will interpret warmth as a signal to grow.

"It looks like the variation in this mechanism to adapt the timing of flowering to different winter conditions has evolved extremely quickly," Dean notes. "By understanding how plants have adapted to different climates, it will give us a head start in breeding crops able to cope with global warming."

Most staple crops, of course, are annual plants and therefore might be able to adapt quickly to changing conditions; "I would expect that it would happen in crop plants," Franks observes. But he cautions that genetic variation within the

corn, wheat, rice or other plants may not be enough to enable such rapid transformation.

As a result, biologist Arthur Weis of University of California, Irvine, plans to launch Project Baseline: a collecting effort spanning hundreds of plant species across at least North America and Europe for starters. This bank of seeds will allow scientists in the future to examine how specific plants have adapted--or not--compared with their ancestors. The project will require samples from hundreds of plants within an individual species and represents an effort that will take years to bear fruit.

Ultimately, this would be a smaller effort than that envisaged by Peter Raven of the Missouri Botanical Garden, which aims to protect every endangered species in the plant kingdom. But it would be a time capsule that future scientists could use to map change. If humanity is going to run an uncontrolled experiment on Earth, known as anthropogenic climate change, then we might as well learn from it.

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