

# Genetic limits threaten chickpeas, a globally critical food

February 13 2018, by Joshua E. Brown

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Domestic chickpea in one hand, wild chickpea in the other, University of Vermont plant biologist Eric Bishop von Wettberg led a team of scientists into remote regions of Turkey--hunting for ways to harness the diversity of agricultural plants' wild cousins. His goal: make crops better prepared for a climate-changed future. Credit: Joshua Brown

Perhaps you missed the news that the price of hummus has spiked in Great Britain. The cause, as the *New York Times* reported on February 8: drought in India, resulting in a poor harvest of chickpeas. Far beyond making dips for pita bread, chickpeas are a legume of life-and-death importance—especially in India, Pakistan, and Ethiopia where 1 in 5 of the world's people depend on them as their primary source of protein.

As [global climate change](#) continues, scientists expect more droughts, heat stress and insect pests—creating need for new varieties of agricultural plants with diverse qualities that will let them cope and adapt to quickly changing conditions. Where could those novel traits come from?

"The wild relatives of crop plants are the most promising reserves of genetic diversity," say Eric Bishop von Wettberg, a plant biologist at the University of Vermont. He led a new research effort that took a deep look at the ecology and genetics of chickpea plants. The scientists discovered an extreme lack of genetic diversity and other threats to the future adaptability of domestic chickpeas. But they also collected wild relatives of chickpeas in southeastern Turkey that hold "great promise," von Wettberg says, as a source of new genes for traits like drought-resistance, resistance to pod-boring beetles, and heat tolerance.

The team's results were published February 13 in the journal *Nature Communications*.

## **Hunting the wild chickpea**

Along with wheat, barley, peas, and other important crops, chickpea—*Cicer arietinum*—was probably domesticated in Mesopotamia, within the "Fertile Crescent," about 10,000 years ago. Its closest wild relative, *Cicer reticulatum*, is now only found in a few provinces of southeastern Anatolia in modern-day Turkey. In 2013, von

Wettberg, and colleagues from Turkey and other countries, spent two months surveying parts of Turkey and Kurdistan, near the border of Syria, searching for the two wild plant species most closely related to domestic chickpeas. "The way we found a lot of these populations was by driving around and asking shepherds on the side of the road, 'yabani nohut?' which means 'wild chickpea,'" von Wettberg says, "then they would take us out in the fields and show us the plants."

At 21 sites, they collected seeds from 371 plants and collected DNA from 839. With this material and other research, they were able to decipher the history of the wild populations of chickpea relatives, estimate how the environment has impacted the genetics of chickpeas, and make links between the wild plants and the domestic ones. They discovered an extreme genetic bottleneck during the plant's domestication history and report that more than 93% of the genetic variation in the wild plants is missing from modern chickpea breeding programs. This lack of diversity threatens the potential of commercial chickpea stock as the conditions in which farmers attempt to grow it—hotter, with a changing palette of pests, diseases, and weather patterns—become less and less like the conditions in which it was originally domesticated.

## **Controlling genes**

"Despite their potential value in meeting the challenges of modern agriculture, few systematic, range-wide collections of wild relatives exist for any crop species," the team of scientists write, "and even the available wild genetic resources are widely under-utilized for crop improvement." As part of the new study, the scientists explored a large part of the geographic range of the two chickpea relatives, "from the bottom of the mountains to the top," von Wettberg say—seeking to capture the diversity that differing micro-habitats, soil types, and elevations had created in various strains of the species. Then they did

extensive crossbreeding of these wild plants with domestic ones. The resulting backcrossed plants and information about their genomes, "shows a way forward for improving chickpeas and many other crops too," says von Wettberg, a professor in UVM's Department of Plant and Soil Science.

Only in recent years have advances in genomics—and understanding how genetics play out in whole organisms—made it realistic for crop breeders to be able to identify traits in [wild plants](#) and selectively breed them into domestic stock. In wild chickpea relatives, von Wettberg and the team—with support from USAID and the National Science Foundation—discovered many useful traits, including "striking resistance to insect pests," he says. But these will only be useful, he notes, if they can be bred into plants without causing them to lose key qualities that farmers need, like growing upright instead of along the ground and seed hulls that don't shatter during harvest. "We're now in an age where we can pretty easily figure out what genes control those differences," von Wettberg says, keeping the qualities that mechanized farming requires, "while adding in resistance to drought, disease, and pests."

The genetic material the scientists extracted, and the seeds they collected, greatly expand the global stock of [chickpea](#) relatives available to science—and will now be part of international seed and germplasm banks that researchers and breeders can use indefinitely. But, the scientists note, there is an urgent need to collect and conserve the wild relatives of many crops. "They are threatened by habitat fragmentation and loss of native landscapes," von Wettberg says. "Where we were collecting [plants](#) in 2013 is now a war zone."

**More information:** Eric J.B. von Wettberg et al, Ecology and genomics of an important crop wild relative as a prelude to agricultural innovation, *Nature Communications* (2018). [DOI:](#)

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