UCSD Biologists Identify Gene In Corn Plants That May Have Paved Way For Development Of Maize

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Biologists at the University of California, San Diego have identified a gene that appears to have been a critical trait in allowing the earliest plant breeders 7,000 years ago to transform teosinte, a wild grass that grows in the Mexican Sierra Madre, into maize, the world's third most planted crop after rice and wheat.

In a paper that appears in the December 2 issue of the journal *Nature*, the scientists report their discovery of a gene that regulates the development of secondary branching in plants, presumably permitting the highly branched, bushy teosinte plant to be transformed into the stalk-like modern maize.

The researchers say the presence of numerous variants of this gene in teosinte, but only one variant of the gene in all inbred varieties of modern maize, provides tantalizing evidence that Mesoamerican crop breeders most likely used this trait in combination with a small number of other traits to selectively transform teosinte to maize, one of the landmark events in the development of modern agriculture.

"What we know is that this gene is critical for branching to take place in maize, including the branches that give rise to the ears of corn," says Robert J. Schmidt, a professor of biology at UCSD who headed the research team. "And we presume that there was something unusual in the morphology that these early farmers selected from the wild teosinte that made it easier for them to plant, grow or harvest their crops. This gene will give us some important new clues to what genetic traits these plant breeders focused on when they transformed teosinte to maize. In a broader context, it is quite possible that the same gene in other plant species is equally essential to the overall architecture that a particular plant assumes by programming the very cells that produce new branches."

The gene cloned by the scientists is called *barren stalk1* because when the gene product is absent a relatively barren stalk results-one with leaves, but without secondary branches. In maize, these secondary branches include the female reproductive parts of the plant-or ears of corn-and the male reproductive organ, or tassel, the multiple branched crown at the top of the plant.

Teosinte has numerous tassels and tiny ears in its highly branched architecture, while maize has only one tassel and much fewer, but much larger, ears. This suggests that the limitations to branching imposed by some combination of the *barren stalk1* and other genes that were selected for by the early plant breeders allowed the early genetic mutants of teosinte to concentrate more of the plant's resources into producing bigger ears that could be harvested.

The recessive mutation leading to barren stalks in corn plants was first identified in 1928 from seeds collected in South America by early maize geneticists. Because the mutation so dramatically affected the reproductive parts of the plants, and because the development of maize involved changes in the architecture of the teosinte plant, Schmidt realized that the mutation was important and set about to study the genetic and developmental basis of the mutation further with Matthew Ritter and Christopher Padilla, two former graduate students in his laboratory.

The isolation of the *barren stalk1* gene and the discovery that it was responsible for this recessive mutation was subsequently made by Andrea Gallavotti, a postdoctoral fellow in Schmidt's laboratory. Other coauthors of the paper include Ritter, now at California Polytechnic State University in San Luis Obispo; M. Enrico Pe' of the University of Milan; Junko Kyozuka of the University of Tokyo; Robert Meeley of DuPont subsidiary, Pioneer Hi-Bred International, Inc.; and Qiong Zhao and John Doebley of the University of Wisconsin at Madison.

Doebley, a professor of genetics at Madison and an expert in the evolution of teosinte to maize, was intrigued by the realization that the *barren stalk1* gene was located in one of five regions of the maize genome known to be important in the breeding of teosinte to maize. With the help of his graduate student, Qiong Zhao, the two scientists found that many variants of the gene exist in teosinte, yet only one was incorporated into modern maize inbreds. This led them to conclude that targeted selection of this particular *barren stalk1* variant by humans was likely an important addition to the traits responsible for the development of modern maize.

"This gene seems to have been the target of human selection," says Doebley. "The fact that humans preferred some allelic form of this gene over others is a smoking gun. But we don't have the direct proof yet. We need to do some follow up studies to see if this gene was really involved."

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