Today's white rice is mutation spread by early farmers

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Some 10,000 years ago white rice evolved from wild red rice and began spreading around the globe. But how did this happen?

Researchers at Cornell and elsewhere have determined that 97.9 percent of all white rice is derived from a mutation (a deletion of DNA) in a single gene originating in the Japonica subspecies of rice. Their report, published online in the journal PloS (Public Library of Science) Genetics, suggests that early farmers favored, bred and spread white rice around the world.

The researchers report that this predominant mutation is also found in the Indica subspecies of white rice. They have found a second independent mutation (a single DNA substitution) in the same gene in several Aus varieties of rice in Bangladesh, accounting for the remaining 2.1 percent of white rice varieties. Neither of these two mutations is found in any wild red rice species.

Both mutations produce shortened versions of the same protein in which the missing part is responsible for activating the molecular pathway leading to grain color in rice.

"We think that other domains of this protein are critical for other functions in the plant, because we never see the protein entirely deleted, just the part of the molecule that affects the pathway for grain color," said Susan McCouch, Cornell professor of plant breeding and genetics and the paper's senior author. Megan Sweeney, Cornell Ph.D. '06 and

postdoctoral associate, was the paper's lead author.

The researchers speculate that ancient farmers actively bred and spread white rice varieties first throughout the Himalayan region and then the rest of the world because the varieties cooked faster (requiring less fuel), their hulls were easier to remove compared with red rice, and disease and insects were easier to see amid the white grains. The farmers also may have favored one mutation over the other because it may have produced favorable grains more consistently, the researchers say.

In 2006 the researchers first identified the gene that makes the rice seed's bran layer, or pericarp, white. This gave rice breeders and engineers a genetic marker to help develop new breeds. The Cornell researchers regularly introduce favorable genes from wild red rices into elite white cultivars to improve yields and provide better responses to stress, but they generally select against the gene for red pericarp because it is associated with such unfavorable "weedy" linked traits as seed dormancy and "shattering" (where seeds fall easily from the stalk).

"Breeders can now begin to screen for the red pericarp gene while selecting against closely linked traits like shattering and dormancy," said McCouch. The new tools may lead to more diverse domestic rice varieties.

Also, breeders are interested in using the marker to predict whether new generations will contain white or red grains, using DNA from young seedlings, long before the plants set seed.

McCouch noted that due to the genetics of pericarp color in rice (white grain is recessive and maternally inherited), when white grains appear in the panicle (the grain clusters on the stems), it is an indication that all seeds in the clusters will be white -- and offspring from these seeds will continue to produce white-grain plants. The researchers theorize that

women who shucked rice for cooking thousands of years ago would have recognized the value of the white seeds and may have set aside selected panicles for breeding and planting.

Source: Cornell University