Discovery of "jumping gene" in plants provides new tool for genetic engineering

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DISCOVERY OF "JUMPING GENE" IN PLANTS PROVIDES NEW TOOL FOR GENETIC ENGINEERING

A biological tag that offers plant scientists a new tool to identify plant genes of importance to agriculture has been isolated by researchers at the University of California, San Diego.

The tag, known as a mobile transposon, already has been used by the UCSD researchers to confirm the identity of a gene essential for nitrate transport in plants.

Nitrate serves as a common nitrogen fertilizer that is required for plant growth. Identification of the nitrate transport gene could permit researchers to create new plants that need less fertilizer for growth.

Since about $1.5 billion are spent annually in the United States for some 10 million tons of nitrogen fertilizer, the potential windfall from genetically engineered plants that require less fertilizer could be substantial.

"This is a very powerful technology that will allow us to go into a plant cell, clone a gene, study it, manipulate it, and introduce it back into a plant, creating new and improved varieties of crops," said Nigel Crawford, an assistant professor of biology at UCSD and principal investigator of the study reported in today's issue of the journal Science.

Other members of the research team include Yi-Fang Tsay, a postdoctoral candidate at UCSD; Mary J. Frank, a UCSD graduate student; and Caroline Dean and Tania Page, at the John Innes Centre, United Kingdom.

Transposons, or "jumping genes," were first identified in corn about a half century ago by noted plant biologist Barbara McClintock, who discovered that some pieces of genetic material were not fixed in place. Instead, they moved around like molecular tourists, at times hopping from one chromosome to another.

However, it wasn't until much later that biologists recognized that transposons were not just a biological oddity of corn, but instead could be found in virtually every organism they studied.

Subsequently, researchers learned that a certain class of viruses called retroviruses were modified transposons, that once inserted in a new cell, could cause cancer.

Aside from opening up new ways to study and understand cancer, other researchers learned that transposons, by themselves, could disrupt genes and cause mutations that would lead to certain defects in organisms.

This discovery was important, because once the transposons were identified, it gave molecular biologists a means to identify or tag genes disrupted in the mutants.

In the Science paper, researchers led by Crawford described how they isolated a transposon in a mustard plant related to broccoli and cauliflower called Arabidopsis thaliana. Crawford noted that Arabidopsis has been a "tremendous resource" to plant biologists since, with its relatively small amount of genetic material, it is easy to manipulate and engineer. In many respects, plant biologists study Arabisopsis the way animal geneticists study fruit flies.

However, Arabidopsis researchers have been frustrated by their inability to isolate a mobile transposon that would ease the identification of new genes. The closest encounter to transposons has been the discovery of two "fossil" transposons that long since lost their ability to jump.

In their lab at UCSD, Crawford and his team have been working to identify genes of agronomic importance in Arabidopsis. In a significant development, the group reported in the March 12, 1993 issue of the journal Cell that they had isolated an important gene called CHL1 from an Arabidopsis plant that not only was defective in nitrate uptake, but also was resistant to a herbicide called chlorate.

This discovery offered the group a way to improve the technology for gene isolation in plants with the help of Ac, the original transposon isolated in corn by Barbara McClintock. Because of this contribution, the researchers dedicated their Science article to the memory of Barbara McClintock, who died last year.

After Caroline Dean's group inserted the Ac transposon into Arabidopsis plants, Crawford screened offspring from these plants with that hope that Ac would hop onto his newly identified gene, where he would trap it. A plant was found that had an insert on the new gene, but when it was examined, the UCSD researchers were in for a surprise.

"We didn't see Ac, but we found something entirely new, a new transposon that was endogenous to the plant," Crawford said. "That was a surprise to us, and a lucky break."

The discovery also helped Crawford prove that the CHL1 gene was responsible for nitrate transport in plants.

"There's another interesting aspect to this," he added, "since when you inactivate the nitrate transporter by the insertion of this transposable element, the plant resists chlorate herbicides as well."

In California, he said, more than 4 million pounds of chlorate herbicide is used every year to defoliate cotton to destroy their leaves before harvesting.

"One possible application of our results would be to genetically engineer into these plants an ability to be much more sensitive to the herbicide so you wouldn't need as much," Crawford said.

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