Biologists Discover Missing Piece of Plant Clock

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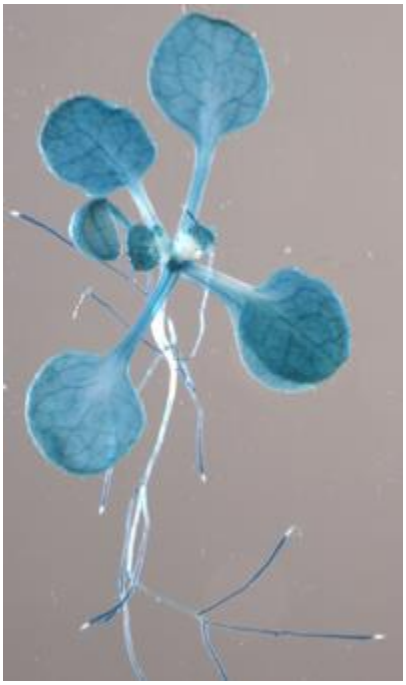

Darker blue areas on this *Arabidopsis* indicate greater expression of CHE

Biologists at the University of California, San Diego have identified a key protein that links the morning and evening components of the daily biological clock of plants.

Their discovery, detailed in the March 13 issue of *Science*, solves a longstanding puzzle about the underlying biochemical mechanisms that control plant clocks and could provide a new way to increase the growth and yield of agricultural crops.

The finding is the first outcome of a larger effort to assemble a complete library of all proteins called transcription factors, which regulate genes, in *Arabidopsis*, a plant often used as a genetic model.

Scientists previously had identified two primary feedback loops in the plant daily clock - one that detects the onset of light in the morning and another that tracks when light fades in the evening.

"The best way to construct a robust clock would be to connect the loops so that they both communicate that information to each other," said Steve Kay, dean of the Division of Biological Sciences at UC San Diego whose research team made the discovery. "Now a protein we call CHE has provided that link."

CHE, first predicted nearly a decade ago, has proved difficult to find. Multiple backup systems for many important functions in plants, including timekeeping, frustrate efforts to identify the function of an individual molecule or gene.

"In plants there are a lot of redundancies - proteins that do similar things," said Jose Pruneda-Paz, a postdoctoral fellow at UC San Diego and the first author of the study. "In the clock, on top of the redundancies, you have feedback loops that are interconnected. So it's difficult to perturb the system."

Disrupting a protein will fail to reveal its function if the system can compensate for its loss, so the team took a different approach. They sorted through proteins with the ability to bind to DNA, and therefore to regulate genes, and selected candidates mostly likely to be part of a clock: the ones that cycle between abundant and scarce.

Of those cyclical proteins, only CHE stuck specifically to the part of plant DNA that controls a critical component of the morning loop. Further experiments demonstrated that CHE also binds to an evening loop protein providing the missing link.

Pruneda-Paz and his co-authors "solve a major puzzle in our understanding of the plant clock," wrote C. Robertson McClung, professor of biology at Dartmouth College, in a commentary on the article that will appear in the same issue of Science.

Evidence increasingly points to the clock as a critical component of functions growth and the timing of flowering. A recent paper published in *Nature* by a group at the University of Texas, Austin reports that an altered clock contributes to hybrid vigor, suggesting that targeting clock genes may be a way to improve the growth of crops. "It's going to be a way to come up with rational design for increasing yield in the field," Kay said.

Kay expects the growing catalog of transcription factors to be completed by the end of the year with more than 2,000 entries, he said. "This is going to be a significant resource for the plant science community developed here at UC San Diego."

Grants from the National Insitutes of Health supported his team's research.