

The science of spring: Plants rely on internal alarm clocks to tell them when to wake up from winter

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In many regions, the blooming of daffodils marks the unofficial start of the spring season. Credit: ISNS

Just in time for the birds and the bees to start buzzing, the flowers and the trees somehow know when to open their buds or start flowering. But the exact way that plants get their wake-up call has been something of a mystery.

"Why should plants care?" The general answer to that is that there are a lot of situations where it's important not to do something developmentally until spring has arrived," said Richard Amasino, a professor of biochemistry at the University of Wisconsin Madison.



"Trees want to make sure that their buds are protected until spring."

Sibum Sung, a molecular biologist at the University of Texas Austin has an idea of how this protective action works on a cellular level. He discovered a special molecule in plants that gives them the remarkable ability to recall winter and to bloom on schedule in the spring. Sung published his results last December in the journal *Science Express*.

While digging through the DNA of a small cabbage-like plant called Arabidopsis, Sung and a colleague discovered that the production of a special molecule could be turned on or off by a string of genetic material. When the plant gets cozy for the winter, this molecule is not produced, repressing a plant's ability to create flowers. But after 20 days of consistently frigid weather, production of the molecule gets turned back on, signaling another gene to stop repressing flower production and start preparing for spring. The plant takes another 10-20 days to prime itself for warmer temperatures. Without the 20 days of freezing temperatures, the molecule wouldn't be produced -- even if there is a brief spike in the thermometer reading.

Sung hypothesized that over millions of evolutionary years, this molecule -- called COLDAIR -- has created a sort of cellular memory in generations of plants, letting them know that a month of winter has come and gone, and now they can start preparing for the spring.

Of course, mysteries remain. Sung admits that his team is still working on questions like how the plant knows that temperatures have been low for at least 20 days.

"Well, we know that there are several things done by cold -- but how? That we don't really know yet," Sung said.

The genetic pathways involved are different for each type of plant, said



Amasino, but the kind of alarm clock memory is similar. The reason may have to do with the early evolution of plants.

"Flowering plants had already evolved and changed 150 million years ago, when the Earth was a pretty different place," Amasino said. At that time, the Earth was much warmer, and the Atlantic Ocean didn't even exist yet. "So it's relatively recently that plants had to contend with winter," he said.

The kind of responses that plants developed to cold over the past hundred million years happened independently, said Amasino -- and that is one reason that different plants have unique systems to deal with wintertime. "One aim of plant research for the future is to explore how these systems evolved in different plant species," Amasino said.

When the planet's climate changes more rapidly, it can sometimes be difficult for plants to keep up. Researchers have been studying plants that are opening earlier in the season, according to Ove Nilsson, a professor at the Umea Plant Science Centre in Umea, Sweden. He said that another problem with early spring is that plants get out of sync with their insect pollinators.

"This could potentially be catastrophic for the plants since these flowers can freeze to death," said Nilsson.

But as long as there is winter, nature will keep the pressure on to set an alarm clock for springtime, and the <u>plants</u> will once more open up.

More information: Vernalization-Mediated Epigenetic Silencing by a Long Intronic Noncoding RNA, *Science* 7 January 2011: Vol. 331 no. 6013 pp. 76-79. DOI: 10.1126/science.1197349



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