Elusive flowering signal pruned of mystery at last

J. BURGESS/SPL

Last week, two papers in *Science* reported the discovery of florigen, a long-sought compound with the power to make flowers bloom. But if the celebration of its discovery seems a little muted, it is because many researchers have heard this claim before. And this time, the reports come as an old one is retracted amid charges of data manipulation.

The discovery of florigen was heralded in 2005, when another *Science* paper[1] claimed that it was the RNA produced by a gene called *FLOWERING LOCUS T*, or *FT*. But now the authors of that paper have retracted their findings, and in its stead come two papers that say florigen is not *FT* RNA, but the protein produced by the *FT* gene.

The finding could solve a riddle that has been around since 1865, when German botanist Julius von Sachs observed that illuminating a single leaf on a darkened morning-glory plant was enough to prompt the plant to bloom. That suggested that a signal travelled from the leaf to the site of flower initiation. Some 70 years later, the signal was christened florigen by the Russian plant physiologist Mikhail Chailakhyan.

The hunt was on, and physiologists spent decades testing compounds extracted from flowering plants, only to fail to find the compound responsible. Over time, the florigen concept fell out of fashion, giving way to a hypothesis that the flowering signal was not a dedicated compound but rather a complex mix of nutrient and hormonal signals. "For a long time, florigen was the f-word," says Joe Colasanti, a plant biologist at the University of Guelph in Ontario, Canada. "You didn't want to bring it up."

But the recent work shows that researchers were looking in the wrong places over all those years, says Jan Zeevaart, an emeritus plant biologist at Michigan State University in East Lansing. Most people expected florigen to be a small chemical compound. "They weren't looking for proteins," he says.

Then, in August 2005, two papers reported that although the *FT* gene produces RNA in the leaf, the encoded protein acts in the tip of the shoot, where flowers form. The simplest explanation was that a product of *FT* — either the RNA or the protein — somehow travelled from the leaf to the shoot tip. Within a month, a team led by Ove Nilsson of the Swedish University of Agricultural Sciences in Umeå announced that this product was *FT* RNA. Although that didn't rule out the possibility that the FT protein also travelled from leaf to shoot, it suggested that *FT* RNA was at least a component of florigen. The discovery was significant enough to make *Science*'s list of 'Breakthroughs of the Year'.

But now Nilsson has retracted the paper and has accused Tao Huang, the paper's first author, of manipulating data. Nilsson says Huang selectively excluded some data points and statistically overweighted others. Huang, who left Nilsson's lab for a faculty position at Xiamen University in China after the paper was published, maintains that excluding the data was justifiable. He says he circulated the data — with excluded data points marked — to

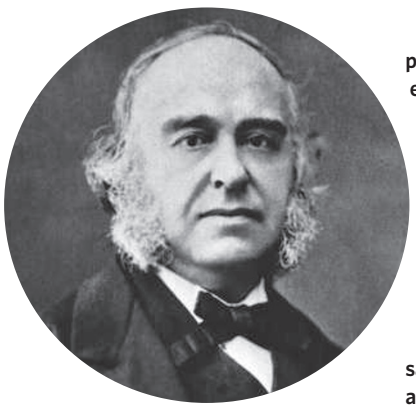
Brain's speech site is revisited and revised

Analysis of two damaged brains, preserved in a museum since the nineteenth century, could force neuroscientists to rethink the area where language resides in the brain.

In 1861, the French surgeon and anatomist Paul Broca described two patients who had lost the ability to speak. One patient, Lelong, could produce only five words, and the second, Leborgne, could utter only one sound — "*tan*". After their deaths, Broca examined their brains and noticed that both had damage to a region in the frontal area on the left side. Broca's area, as it became known, is now thought to be the brain's speech-processing centre.

Broca kept the patients' brains for posterity, preserving them in alcohol and placing them in a Paris museum. And that's where Nina Dronkers, of the VA Northern California Health Care System in Martinez, and her colleagues picked them up, in order to reinspect the damage using magnetic resonance imaging.

Leborgne's brain had been scanned twice before, but not Lelong's. And neither had been compared with modern interpretations of Broca's area. After the team put the two brains through a scanner, they came up with a surprising finding: in both patients, the damaged area was much larger than the region that is now considered to be Broca's area.



CORBIS

Paul Broca: discovered a region of the brain responsible for language.

"We were noticing that what people were calling Broca's area encompassed large areas of the frontal lobe," says Dronkers. The scans show that neither of the old brains had damage that affected the whole region now known as Broca's area. But damage also stretched far into other regions beyond this spot.

Broca realized this at the time, says Dronkers, and noted that the areas of damage were different in the two patients. But his conception of the area involved in speech processing has become simplified by others over time, the authors argue. They published their findings online earlier this

Root cause: the signal for flowering in the thale cress *Arabidopsis* has been found to be a protein.

his lab colleagues before publication, but no one objected to the exclusion. Huang has not agreed to the retraction, calling it premature.

Nilsson's retraction was published at the same time that *Science* released the two new papers[2,3]. Both papers — one on the thale cress *Arabidopsis* and the other on rice — report that although *FT* gene expression is restricted to the leaves, the protein can travel to the tip of the shoot. And both papers fail to find evidence for movement of *FT* RNA.

The timing of the papers, coupled with what several researchers have described as an unusually short, 40-day review, has led some to speculate that the papers were pushed to publication more quickly to coincide with the retraction. But Katrina Kelner, *Science*'s deputy editor for life sciences, says the review period was not abbreviated. "It was sensible to have them come out at the same time for maximum clarity of the literature," she says. "We coordinated them, but the review process of those two papers was in no way abnormal."

The new work comes with its own share of caveats. Both groups rely on commonly used but indirect measures of protein movement, and some researchers have pointed out that key controls are lacking.

Overall, however, many experts say the new papers are convincing. "None of these is really the killer experiment," says Detlef Weigel of the Max Planck Institute for Developmental Biology in Tübingen, Germany. "But I would say the overwhelming evidence is that the protein moves." Zeevaart goes even further. "The problem is solved," he says.

But with a history as chequered as florigen's, not everyone is ready to close the book. "It's always good to be cautious," says Colasanti, "especially in this field." ■

Heidi Ledford

1. Huang, T. *et al. Science* **309,** 1694–1696 (2005).
2. Tamaki, S. *et al. Science* doi:10.1126/science.114753 (2007).
3. Corbesier, L. *et al. Science* doi:10.1126/science.114752 (2007).

month in the journal *Brain* (N. F. Dronkers, O. Plaisant, M. T. Iba-Zizen and E. A. Cabanis *Brain* doi:10.1093/brain/awm042; 2007).

This misplaced focus could lead to problems when diagnosing people with language impairments, says Dronkers. By assuming that only one small area of the brain is responsible for language, clinicians might overlook other regions involved in speech production. In other words, focusing too heavily on Broca's area could be missing the point, Dronkers argues.

N. DRONKERS

The brain of Lelong, one of Broca's patients, about to be scanned.

Others agree. "There's a tendency for researchers to see activation in somewhere like Broca's area and to say 'oh well, we're tapping into a language area'," says Joseph Devlin, a neuroscientist at the University of Oxford, UK, who images language networks in the brain.

Newer imaging techniques may also help researchers to discover what Broca was unable to see. Dronkers and Devlin are both working on the use of alternative imaging techniques to investigate other regions of the brain that may be important in language processing but which are not detected by magnetic resonance imaging, such as the tracts of white matter that connect areas of grey matter. ■

Kerri Smith

ZOO NEWS

Puppy love

Researchers at Seoul National University in South Korea will this year mate Snuppy, the world's first cloned dog (right), with Bona, the world's second (and first female) clone, to check their reproductive abilities.

REUTERS/SEOUL NAT'L UNIV.

NUMBER CRUNCH

US$421,200 was the amount paid at auction last week for the skeleton of a mammoth nicknamed 'The President' — a record for such an artefact.

11 other items in the same sale of palaeontological curiosities, which was held at Christie's in Paris, France, were also sold for world-record prices.

US$1.53 million is the total amount of cash splashed out at the auction, mostly by private collectors.

ON THE RECORD

"This proves it's possible for humans to change the weather on the world's highest plateau."

Yu Zhongshui, an official at China's Tibet meteorological station, on the successful effort to create snowfall over the city of Nagqu by seeding clouds with silver iodide particles.

OVERHYPED

Kryptonite

The name of Superman's nemesis has been given to the newly discovered mineral sodium lithium boron silicate hydroxide, because it happens to have a very similar name to the formulation for kryptonite quoted in the film *Superman Returns*. The real-life version, however, is not green, does not come from outer space and can't kill superheroes.

Sources: AFP, Associated Press, Daily Telegraph, Natural History Museum

SIDELINES