

QUICK STUDIES

# How a New Evolutionary Map Could Help Farmers Eliminate Fertilizer

BY JOHN UPTON · June 13, 2014 · 10:36 AM

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## New research offers hope for prodding corn, wheat, and rice into a partnership with nitrogen-fixing bacteria.

“Nitrogen, nitrogen, everywhere, nor any drop to drink.”

If wheat, rice, and corn crops could [rhyme using ancient mariner tongue](#), that might be their unfertilized catchphrase. Despite nitrogen-based molecules being essential for plant growth, and despite nitrogen gas—N<sub>2</sub>—making up nearly four-fifths of the atmosphere, nitrogen in its abundant N<sub>2</sub> form is off-limits for many plants.

The result of evolutionary mapping by European and Australian scientists, [published this week in Nature Communications](#), however, is offering fresh hope for long-running efforts to coax cereal crops into accessing the natural nitrogen around them. That could help wean agriculture off its expensive and environmentally destructive nitrogen-based fertilizer addiction.

The vice-like bonds that hold the two nitrogen atoms together in an N<sub>2</sub> molecule

## Flowering plants evolved a mysterious genetic precursor to enter into a partnership with nitrogen-



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are too strong for plants to break apart, which is why larger nitrogen-based molecules are applied as fertilizer. Many flowering plants have developed a work-around. Some species, including soybeans, alfalfa, and peas, are wedded to nitrogen-fixing bacteria in symbiotic relationships. The microbes are ushered up from the soil through plants' roots to form nodules, where N<sub>2</sub> is absorbed by the bacteria and "fixed" into useful ammonia. In exchange, the plant provides the bacteria with photosynthesized sugars.

Figuring out how to transfer this ability to corn, wheat, and rice crops, all of which are flowering plants, is a [high priority for agricultural researchers](#). "Transferring this symbiosis to non-fixing crops is a huge techno dream," says [Toby Kiers](#), a mutualism researcher at VU University Amsterdam and an author of the new paper. "People have been trying to for decades—and failing."

Kiers was part of a team that compiled a database of nitrogen-fixing plants, then mapped their evolution with the aid of a family tree of 32,223 species of flowering plants.

The team concluded that flowering plants evolved a mysterious genetic precursor to enter into a partnership with nitrogen-fixing bacteria at just one remarkable moment in their evolutionary history—more than 100 million years ago. They speculate that the precursor might have been a tweak to the ancient mycorrhizal

## fixing bacteria at just one remarkable moment in their evolutionary history.



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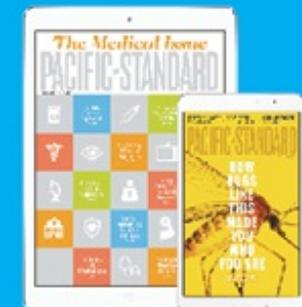


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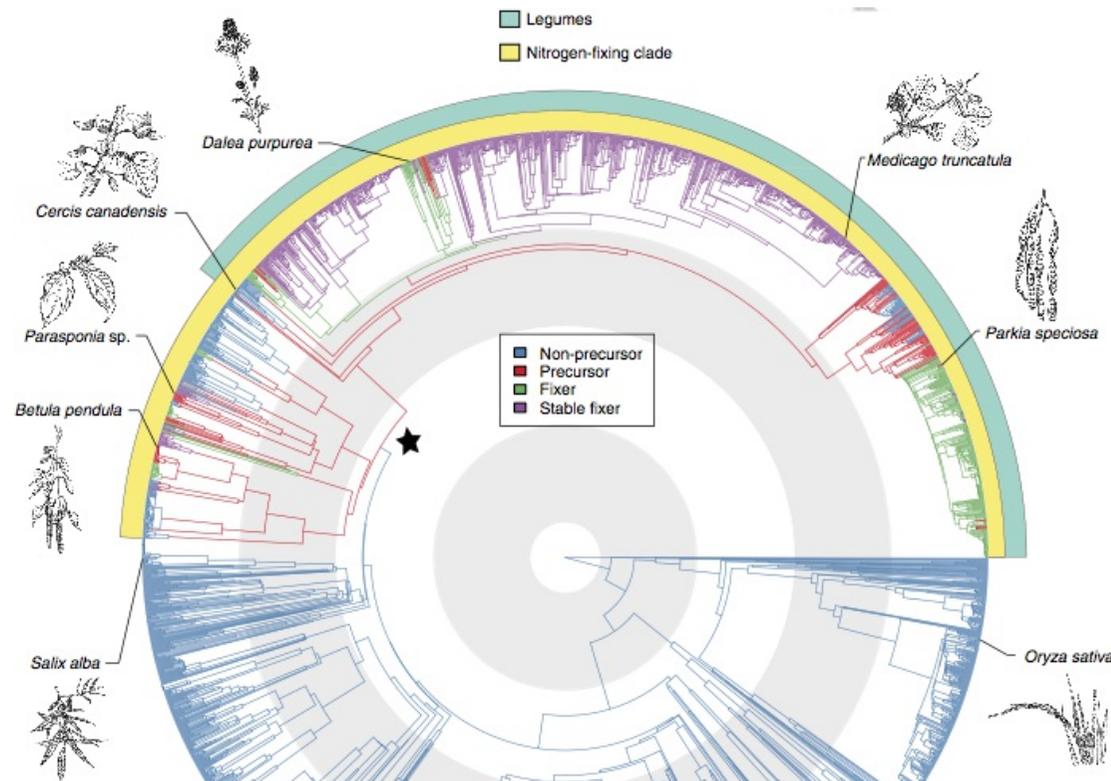
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relationship between plants and fungi. The nitrogen-fixing relationship with bacteria was gained, lost, and regained as flowering species evolved over subsequent eons.

The researchers identified non nitrogen-fixing modern species, which, based on their evolutionary history, may still harbor the precursor.

In the chart below, each white and gray band represents 50 million years of evolutionary history. The star shows the point where the cryptic precursor is thought to have sprung into existence. A “fixer” can fix nitrogen; a “stable fixer” is more likely to sustain the ability down the road.



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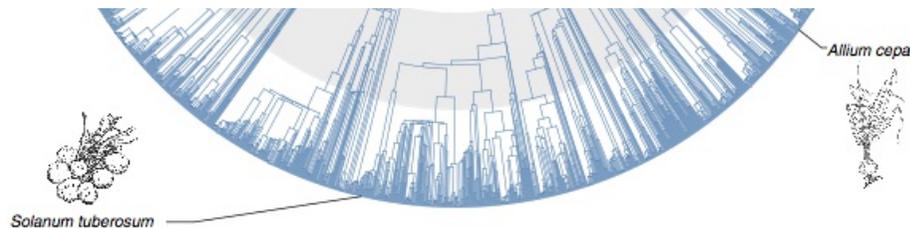
### What Happens When You Put Cameras on Cops?

According to a study released in November, body cameras can help drastically reduce levels of violence by—and against—cops.

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This whole Sony hack should teach us, above all else, a lesson on password security.

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(Chart: Nature Communications)

“Now that we know which plants have a high likelihood of containing the precursor, we can compare their genetic codes,” Kiers says. “By doing this across all flowering plants, we can determine what these plants have in common. Once the cryptic code is known, it will still be difficult, but at least more possible, to introduce it into cereal crops.”



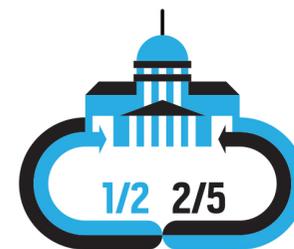
John Upton is a science journalist with an ecology background. He has written recently for VICE, Slate, Nautilus, Modern Farmer, Grist, and Audubon magazine. He blogs at [Wonk on the Wildlife](#). Upton's favorite eukaryotes are fungi, but he won't fault you for being human. Follow him on Twitter [@johnupton](#).

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January 5 • 6:00 AM

### **Save the Honeybee, Sterilize the Earth**

A decade ago, people started panicking about the collapse of the honeybee population and the crash of our food supply. But today there are more honeybees than there were then. We have engineered our way to a frenzied and precarious new normal.



January 5 • 4:00 AM

### **Our Turn to Torture**

A short reminder of America's long history mixing psychology and war.



January 3 • 6:00 AM

### **At Home With the Noonday Demon**

The common misperception of religion as a crutch would have us believe that people are faithful because they want to escape the problems of the world and the realities of everyday life. But my faith tells me the importance of staying put.



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## Why Was This Video Banned?



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January 2 • 2:00 PM

## One Hundred Years Ago, Prohibition Began in Earnest—and We're Still Paying for It

On December 17, 1914, Congress passed the Harrison Act, making non-medical opium and cocaine illegal. It was really about punishment, not public health. And it set the tone for a disastrous century.



January 2 • 1:16 PM

## Don't Buy Your Kid a Clunker

Buying a cheap car for your kid can have dangerous repercussions.



January 2 • 12:00 PM

## From the E.R. to the Courtroom: How Non-Profit Hospitals Are Seizing Patients' Wages

One Missouri hospital has sued thousands of uninsured patients who couldn't pay for their care, then grabbed a hefty portion of their paychecks to cover the bills. "We will be paying them off until we die," one debtor said.



January 2 • 10:12 AM

## The Case for Studying Sports

This introductory column is the first in a new running series, where each week a current event in sports will be examined from a sociocultural perspective.



January 2 • 10:00 AM

## Emotional Investment

Trying to understand my father's get-rich-quick schemes.

January 2 • 7:06 AM

## Reader Feedback: Are We All Confident Idiots?

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January 2 • 6:00 AM

### **How Ambient Intimacy Became So Overwhelming**

Social media allows us to connect with people on a level we wouldn't otherwise have access to—but we may have gone too far.

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January 2 • 4:00 AM

### **The Very Real Dangers of Tasers**

Scientific research reveals the harmful effects of Tasers, on both body and mind.

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December 31 • 2:00 PM

### **The Feds Finally Bar Companies' Long-Distance Lawsuits Against Soldiers**

In the latest move against companies targeting military customers, federal regulators prohibit two Virginia-based lenders from suing out-of-state debtors in Virginia courts.

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December 31 • 12:00 PM

### **If We Don't Kick Racism Out of Criminal Justice Now, Then When?**

With tens of thousands of Americans taking to the streets to demonstrate that "Black Lives Matter," we have a rare chance to confront drug war violence, mass incarceration, and our own deepest misconceptions about black and white.

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December 31 • 10:45 AM

### **Drunk Driving Is Risky in More Than One Way**

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December 31 • 9:05 AM

## **The White Cop Who Embraced #BlackLivesMatter and Saved Richmond**

How a cop whose last job was policing the streets of Fargo, North Dakota, turned around a town that had a reputation as one of the most violent places in America.



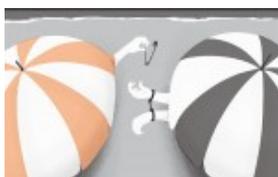
December 31 • 8:00 AM

## **This Is What a Men's Rights Activist Looks Like**

The latest entry in a series of interviews about subculture in America.

December 31 • 7:12 AM

## **Shelf Help: 'Power Lines: Phoenix and the Making of the Modern Southwest'**



December 31 • 6:00 AM

## **Brother, Can You Spare a Shiv?**

How to run for your life and make new friends at the same time.



December 31 • 4:00 AM

## **It's Normal to Be Terrible at Keeping New Year's Resolutions**

Research shows that we're pretty bad at following through.



December 30 • 2:00 PM

## **In Alabama, a Public Hospital Serves the Poor—With Lawsuits**

Public hospitals can be among the most aggressive in collecting debts from poor patients, not only garnishing their wages, but cleaning out their bank accounts. "It makes me sick," said one legal aid attorney.

December 30 • 1:03 PM

## **Coming Soon: Bees, Inc.**

December 30 • 12:45 PM

## The Most Popular Posts on PSmag.com in 2014



December 30 • 12:00 PM

### Medicare vs. National Health Care: How U.S. Seniors Do in Cross-National Perspective

Compared to their pre-Medicare counterparts, seniors today are probably healthier, and they're probably shelling out less for health care. But compared to seniors in other countries, they're not doing so well.



December 30 • 8:00 AM

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Why I just bought a turntable, and what it means to my family and me.

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