Abstractions

FIRST AUTHOR

The oceans' plants need nitrogen for their growth. So oceanographers are interested in how the levels of this element in the oceans change over time, how they vary in different environments, and how nitrogen interacts with other elements. Nitrogen fixation incorporates the element into compounds such as nitrate that sustain plant life; in the reverse process of denitrification these compounds are broken down to release nitrogen. University of Washington oceanography postdoc Curtis Deutsch and his colleagues discovered that these two processes may be more closely connected than previously thought (see page 163).

How did you conduct this study?

I don't actually go to sea as I tend to get seasick. I think about new ways of using the resources of the World Ocean Atlas, which includes hundreds of thousands of measurements of things such as temperature, salinity and nutrient concentrations. Using these measurements we studied the relationship between nitrate and phosphate to learn about the rates and distribution of nitrogen fixation.

What did you find?

We found that nitrogen fixation and denitrification seem to be happening in the same ocean basins. Previously it was believed that denitrification happened in the Pacific and Indian Oceans, whereas nitrogen fixation happened halfway around the world in the Atlantic Ocean. In fact, it looks as though nitrogen fixation can happen in the well-lit surface waters more or less overlying areas of denitrification below the surface.

What is the significance of changes in the amount of nitrogen in the ocean?

Nitrogen is a scarce resource over vast expanses of the ocean. If the reservoir of marine nitrogen declined, biological productivity would fall, with a host of consequences for the ocean and climate.

Have these processes changed recently?

Our results suggest that nitrogen fixation and denitrification could be closely linked to each other in magnitude and on short time scales — such as decades. That suggests that the overall fertility of the ocean can be stabilized as opposed to undergoing rapid, dramatic fluctuations.

What is your next step?

We'd like to make measurements year after year in a few ocean regions, to get an in-depth look at how denitrification and nitrogen fixation interact with each other. That would mean I'd finally need to get over my seasickness. ■

MAKING THE PAPER

Jake Bailey

A challenge to the interpretation of microfossil 'embryos' from China.

When graduate student Jake Bailey hypothesized that one of the most significant fossil finds of the past decade might have been misinterpreted, it made him "a little nervous", he says. But Bailey, with the support of his adviser Frank Corsetti, an Earth scientist at the University of Southern California in Los Angeles, pressed ahead.

As a student, Bailey followed several palaeontological controversies, including the 1998 discovery of 600-million-year-old microfossils in south China. At first, researchers thought they were algae, but others suggested, on the basis of their shape, size, structure and evidence of reductive cell division (the cleavage of a cell into a number of smaller cells, as occurs in the fertilized eggs of animals), that the 'Doushantuo microfossils' were tiny animal eggs and embryos — the world's oldest animal fossils. If correct, that assessment would have profound implications in helping scientists understand the evolution of cell division in early multicellular organisms. "But I never really thought seriously about it or about working on it myself," Bailey says.

That changed when he read two articles from marine scientists who study similar-looking modern bacterial cells — giant sulphur bacteria. In one, Samantha Joye and Karen Kalanetra at the University of Georgia presented evidence of reductive cell division in these bacteria from the Gulf of Mexico. Bailey noticed that the shapes and structures of these modern organisms were very similar to the descriptions of the putative Doushantuo eggs. His interest was further piqued by evidence from Heide Schulz at the University of Hannover in Germany of biochemical activities in giant sulphur bacteria that promote the formation of phosphorite in their environment — the same type of mineral deposit that preserves the Doushantuo microfossils. The presence of phosphorites has puzzled scientists who believe that the Doushantuo fossils are animal eggs; the mechanism of the mineral's formation remains poorly understood and there's no evidence that animals contribute to the process.

After reading these two papers, "the possibility had to be considered", says Bailey, that the Doushantuo microfossils might not be of animal eggs but of giant sulphur bacteria similar to those living in the Gulf of Mexico. He consulted Corsetti, who encouraged him to contact Joye and Kalanetra.

They agreed to share their samples and assist with the analysis. It only took a few weeks of imaging to confirm his hunch. "Right from the get-go there was this eureka moment," Bailey says. On page 198, the team lays out its evidence that the Doushantuo microfossil 'embryos' are indeed fossilized giant sulphur bacteria.

Bailey admits to some trepidation about going against the conventional wisdom at this stage in his career. "It's intimidating to provide an alternative interpretation to something that some of the biggest names in the field have published earlier," he says. But he also knows that scientific knowledge is a moving target, not a fixed destination. "There's still a lot to do, and I think the controversy might remain for many years," Bailey says. ■

KEY TEAMWORK

A bid to map gene expression to specific cells in the mouse brain involved some 60 full-time scientists — from technicians to the project's scientific board. The $41-million project, run by the Allen Institute for Brain Science in Seattle, Washington, culminated this week with a three-dimensional atlas of the mouse brain, which shows that 80% of all mouse genes are activated in the building of the brain (see page 168).

Technicians took brain slices and then probed them for specific genes using a high-throughput *in situ* hybridization process. They photographed them with automated microscopes and then uploaded the results to a server.

The group's members came from a wide range of backgrounds. Paul Allen, co-founder of Microsoft as well as sponsor of the Allen Institute, contributed a team of software developers from his venture-capital firm Vulcan. Other members included former Boeing engineers, classically trained neuroanatomists, image-processing specialists, robotics experts and a cadre of young technicians.

The trick to making all the pieces fit together was creating operating procedures, standardized data quality, data-delivery benchmarks and a highly automated system for labelling data, says Allan Jones, the Allen Institute's chief scientific officer. ■