Abstractions

LAST AUTHOR

Taxonomy is often seen as a dusty, old-fashioned science, but the molecular insights gained from examining species' DNA have invigorated the newer field of phylogenetics — and helped scientists classify organisms by reconstructing their evolutionary relationships. On page 312, Sean Graham, a plant molecular systematist at the University of British Columbia in Canada, and his colleagues show how the Hydatellaceae, a group of aquatic plants that has defied traditional classification, can provide clues to the evolution of flowering plants.

How are classical taxonomic relationships being changed by molecular findings?

We are overturning taxonomic concepts that go back centuries. In 1999, we found that *Amborella trichopoda*, a shrub found in New Caledonia, defines the phylogenetic 'root' of the flowering plants. *Amborella* may be the sister group of all other flowering plants. This discovery rocked the botanical world. Molecular data have also confirmed that dividing flowering plants into dicots and monocots, based on having two versus one seed leaves, is obsolete. The dicots have been broken up, and textbooks rewritten.

Why did you pick the Hydatellaceae?

These small plants were lumped with grasses as monocots, based on superficial structural similarities. Some preliminary molecular evidence also seemed to place them near the grasses. But other features didn't add up. When we finally got our first samples from Australia, genetic evidence showed that the family fits near the very base of the flowering-plant phylogenetic tree, with the water-lilies. Every gene my graduate students investigated gave us the same oddball result, as did examination of structural features.

What does this mean for plant phylogeny?

It causes us to question what we thought we knew. There is some debate about whether the first angiosperms were aquatic or terrestrial. Our work doesn't answer that question. We just show that the water-lily lineage is more diverse than we had thought, and in unexpected ways. It could also help us understand where certain fossil angiosperms belong.

Is linnaean classification still useful?

This is quite a controversial subject. The traditional rank-based classification schemes have had a big overhaul in the past decade. The bigger question, under active debate and fuelling hot tempers, is whether we need to have a rank-based taxonomy at all. But the linnaean system has worked for hundreds of years, so to break with that is a real struggle for many biologists. ■

MAKING THE PAPER

Tobias Brixner

How to exercise control over light pulses at very fine resolution.

Tobias Brixner, a physicist at the University of Würzburg in Germany, has long been fascinated by the idea of exercising control over the way light interacts with matter. Over the years he has developed ways to control pulses of laser light in order to steer chemical reactions. On page 301, Brixner and his colleagues take this technique into the realm of nano-optics.

The move into nano-optics was suggested by Walter Pfeiffer of the University of Bielefeld, who had heard with interest about Brixner's work with lasers. Together, the two set about assembling a team — including Martin Aeschlimann, Michael Bauer and Javier García de Abajo — to realize their ideas. "It was a truly wonderful cooperation between colleagues who all have their expertise in different fields," says Brixner. "We have found an ideal combination, and we will continue to cooperate in the extension and development of this project."

The results that the team hopes to extend have seen the researchers control the interaction of ultrashort laser pulses with matter on a length scale of nanometres. "Roughly speaking, we could 'encode' into the shape of the laser pulse the position at which to deliver an electromagnetic energy 'packet', so that it would automatically arrive in the right place once it reaches the sample, without requiring any processing time," says Brixner.

To do this, the group had to overcome the 'diffraction limit'. Diffraction — the way in which light waves bend and spread as they pass an object — limits the spatial resolution of a light beam, just as a drill cannot make holes smaller than the size of the drill head.

The collaborators knew that electromagnetic waves behave differently when they are close to an antenna. In the 'near field', electromagnetic properties can change on a scale much shorter than the radiation wavelength so, in principle, it should be possible to exert control at resolutions below the light's wavelength. By irradiating a sufficiently small antenna with pulses of light femtoseconds (10^{-15} seconds) long, the team hoped to use interference effects to control the light fields with ultrafine spatial precision.

But getting the appropriate kind of antenna was not going to be easy. Radio waves, for example, would require an antenna tens of centimetres long — and the researchers needed antennas for optical fields with wavelengths that were hundreds of nanometres long. They achieved this by creating a suitable arrangement of silver disks, each with a diameter of 180 nanometres.

Having built the antennas, the team then had to find a way to map changes in the electromagnetic properties of the light pulse within these nanostructures. "We wanted to show that optical fields can be manipulated below the diffraction limit, but how could we possibly measure and prove this?" says Brixner. "If we were to use any optical method to detect the changes, we would again be limited by diffraction." So the researchers used photoemission electron microscopy, which allowed them to detect optical fields with a resolution of 50 nanometres.

By measuring electromagnetic changes in the nanostructures, the team could adjust the shape of the femtosecond laser pulses to beat the diffraction limit and achieve subwavelength nano-optical field control. "It was hard work with a very specific goal. As we had already done the theory and calculations, we were very much hoping to see an experimental success," says Brixner. "When it finally worked, we were happy to see that our previous claims were justified and not some unrealistic fantasy." ■

KEY COMPLEMENTS

When two teams in France and the United States discovered that they were racing to define the same molecular mechanisms in the fruitfly *Drosophila*, they had a decision to make. They could carry on and risk being scooped, they could join forces on a single paper or they could publish back-to-back.

Michèle Crozatier, based at the CNRS in Toulouse, was leading the French group. She became aware that Uptal Banerjee of the University of California, Los Angeles, was working in a similar area to her in 2004, when he published a paper on work close to one of her papers. The two groups met in France last summer and chose to forgo a race. "We decided to fully discuss our results and cooperate by publishing back to back," says Banerjee.

Although both groups studied the same general problem — how signalling from a group of cells called the posterior signalling centre (PSC) creates a 'niche' for the control and production of the precursors to blood cells (see pages 320 and 325) — publishing back-to-back made the papers complementary, says Crozatier.

She and her team focused on elements in the signalling pathway that prevent the blood-cell precursors from differentiating, whereas Banerjee's team looked at, among other things, the gene that specifies the PSC. ■