Abstractions

FIRST AUTHOR

Optical imaging is an indispensable tool for studying dynamic processes at high speeds and on micrometre scales. Unfortunately, conventional electronic cameras relying on charge-coupled devices (CCDs) cannot capture fast processes such as the dynamics of cell signalling with high sensitivity. On page 1145, Keisuke Goda at the University of California, Los Angeles, and his colleagues reveal a blueprint for the world's fastest video camera. Goda tells *Nature* that he is eagerly awaiting the scientific breakthroughs that this camera could bring.

Was your work motivated by a potential application or a technical challenge?

My adviser Bahram Jalali's group holds world records in speed for the analogue-to-digital conversion of electrical data and for optical spectroscopy — both using a technique that maps the optical spectrum into a data stream in real time and simultaneously amplifies it optically. We developed a new type of optical-imaging system called serial time-encoded amplified microscopy, or STEAM, which captures two-dimensional images at a frame speed of 163 nanoseconds and a shutter speed of 440 picoseconds — 1,000 times faster than CCDs. As a result, it has a broad range of applications, from imaging shock waves to microfluidics to chemical dynamics in living cells.

How did you get the idea for STEAM?

I went to the 2008 Optical Society of America conference in San Diego, California, where I got a hint that we might be able to achieve optical-image amplification by combining spectrally encoded imaging with our ultrafast spectroscopy approach. With the integrated technique, each pixel is encoded in a different frequency of the optical spectrum, which allows us to amplify the image optically. As a result, we can achieve imaging at high speeds without sacrificing sensitivity — which is what happens when you try to amplify an image electronically.

Are researchers clamouring to get this technology?

No one has to beat down my door to get it. Most components of STEAM are commercially available so anyone interested can build a STEAM camera themselves using our paper as a blueprint.

What is the next record to break?

There is always a new record to be broken, but this paper is not the end of this research. We want to keep increasing the frame rates and shutter speeds to make our camera better. I'm also pushing towards developing three-dimensional imaging at very high frame rates and shutter speeds. ■

MAKING THE PAPER

Luke Harmon

Evolution can put the squeeze back on the ecosystem.

Changes in ecological settings are thought to drive the evolution of one species into many — a process called adaptive radiation. Darwin's finches are a classic example, evolving into species with different beaks adapted to food availability in their island environments. However, few have considered the converse: that evolution might affect ecology. In an experimental demonstration of this idea, Luke Harmon of the University of Idaho in Moscow and his colleagues show that fish speciation can have profound effects on freshwater ecosystems.

Harmon credits his co-author Dolph Schluter of the University of British Columbia in Vancouver, Canada, with the idea of testing the reverse process. For the work, Harmon chose freshwater threespine sticklebacks (*Gasterosteus aculeatus*), which evolved from marine sticklebacks fairly recently — in the 10,000 years since the glaciers retreated from British Columbia. In some lakes, the sticklebacks evolved further into two separate subspecies: a bottom-dwelling fish that feeds on invertebrates in the mud, and an open-water fish that skims near the surface eating zooplankton. For Harmon, this represented the very first step of adaptive radiation — the divergence of one species into two. But what happens to a lake ecosystem as a result of that speciation?

Harmon's group created artificial ponds in 1,136-litre tanks and added fresh pond muck to deliver invertebrates and zooplankton. They then introduced either sticklebacks from single-species lakes, which Harmon calls "generalists", or the more specialized sticklebacks from lakes with two subspecies.

As the 10-week experiment progressed, some tanks bloomed with algae, whereas others showed limited growth. The researchers measured changes in plant and animal populations in the tanks, but the results, Harmon says, were "pretty chaotic. We could tell that there was an effect, but we couldn't explain it."

One part of Harmon wanted to be done with it. "I could've written a paper at that point that said, 'Evolution matters, but in unpredictable ways,'" he says. The other part of him believed that important answers lay in his tanks' muddy waters, so he sought advice from Blake Matthews at the Swiss Federal Institute of Aquatic Science and Technology in Kastanienbaum, an expert in aquatic ecosystems. He pointed out dozens of physical measurements that Harmon's team had overlooked, such as the amount of dissolved organic carbon (DOC) and light transmission.

When the researchers ran the experiment a second time and included these measurements, they found that DOC was a key factor. DOC is essentially organic detritus and gives ponds their tea-like colour. In tanks with the one generalist fish species, most DOC molecules were small enough that light could penetrate to the bottom of the tank, and algae bloomed. In tanks with the two specialist subspecies, DOC molecules were larger, blocking out light. The authors suggest that differences in feeding between the generalists and the the two specialists is what alters DOC size (see page 1167).

Harmon says he didn't appreciate how much "organisms can alter the physical structure of their environment through behaviours such as feeding". And he's not the only one. Lake water chemistry, he adds, "is one of those huge areas of ecology that most evolutionary biologists don't think about". ■

FROM THE BLOGOSPHERE

When did your career turn a corner? Was it a mentor's nudge, a flash of brilliance or an experimental second thought that became a lifelong pursuit? In the first instalment of the 'Turning Points' series in *Nature Cell Biology*, we learn how Gottfried Schatz was drawn into a career studying mitochondria by an unusual response to a postcard.

The Nautilus blog introduces these "short autobiographical essays by leading scientists", which "feature a first-hand recounting of a pivotal event that shaped his or her scientific future" (http://tinyurl.com/cjfmzt). The journal's editors hope that some cell-biology folklore, normally shared only at the bar among a privileged few conference-goers, will be appreciated by larger numbers of early-career scientists each month.

Schatz, emeritus biochemist at the University of Basel in Switzerland, tells how his career was kindled by a senior scientist's generosity (http://tinyurl.com/coqlvy).

If you would like to see a particular cell, molecular or developmental biologist featured in this series, please send your suggestion to cellbio@nature.com. ■

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