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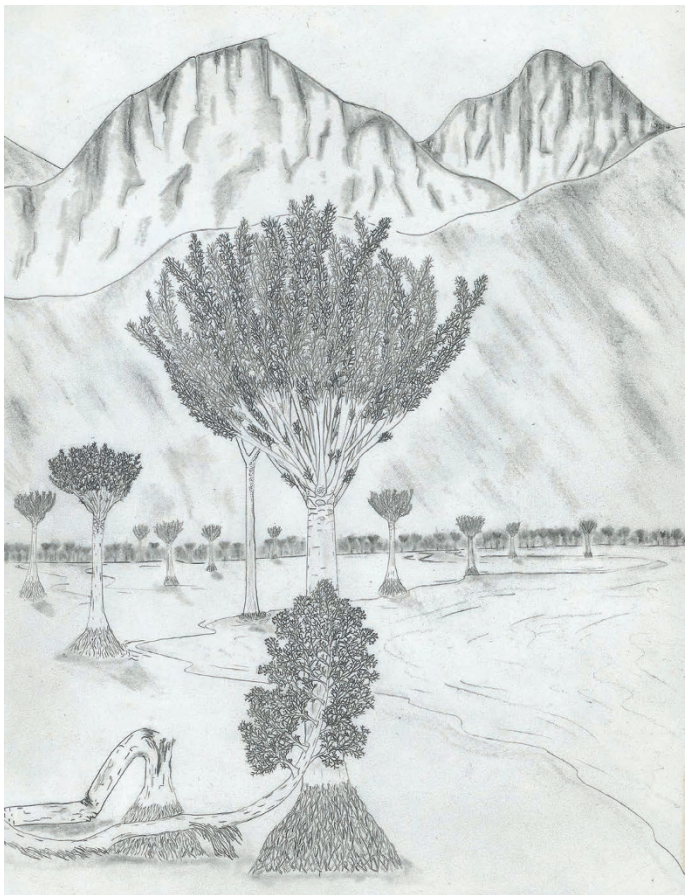


VICTOR LESHYK

Scientific illustrator Victor Leshyk used a sketch from researchers (left) to create a conception of the Gilboa Fossil Forest for a cover of *Nature* (right).

SCIENCE ILLUSTRATION

Picture perfect

Enlisting the help of an illustrator can add impact to research papers and outreach projects.

BY JYOTI MADHUSOODANAN

On canvas, a 390-million-year-old forest springs to life. Massive tree trunks jut into a sunlit clearing from a crowded forest floor. Stubby green branches battle with frilly leaf-like filaments to touch the pink-tinged sky. Palaeobotanist Chris Berry had worked for years with samples from the Gilboa Fossil Forest in New York, but had never before seen what the living forest might have looked like so many millennia ago.

Dubbed 'Lost Worlds', the digital oil painting was created by Victor Leshyk to accompany a 2012 research paper in *Nature* by Berry and his colleagues (W. E. Stein *et al. Nature* **483,** 78–81; 2012). It was commissioned to appear on the cover of the journal and Berry features it in his talks today, especially those for lay audiences.

It was Berry's first experience in teaming up with a scientific illustrator, and Leshyk's work exceeded his expectations. "It was very prestigious for us to have it on the cover, and the image proved very good for engagement and outreach," he says. Berry, who is based at the University of Cardiff, UK, has collaborated with artists twice since then, for press releases and museum exhibitions that involve his research, and he is discussing a second project with Leshyk. "If you've got a story you want to get out there and you've got a really good image," he says, "it will fly a lot farther than just words."

The use of striking images to accompany manuscripts and outreach efforts is growing as more journal publishers are requiring graphical abstracts — depictions of a paper's main thrust or concept — to accompany studies. These commissioned illustrations differ from the everyday photograph, sketch or overview figure that usually accompanies research manuscripts or talks. They get to the core of concepts; they may also depict unobservable phenomena, ▶

ranging from subatomic particles to what extinct life forms might have looked like. Although working on such images with an illustrator might seem like a lot of extra toil, and paying for their services extravagant, the benefits of skilled artistic presentation can be manifold.

Visually stunning representations that result from collaborations between scientists and artists can grab millions of online views, and attract a much wider audience than a non-illustrated paper, both of which are particularly useful for researchers whose grant applications or funding proposals require them to show a public-outreach component. They are also more likely to be written about and shared digitally, helping to raise the visibility of a scientist's work, attract more students to a lab, boost career standing and improve chances of garnering funding. They can even inspire new experiments — or reveal gaps in knowledge.

Even when photographs or images already exist, hand-rendered or digital illustrations and 3D animations can clarify and enhance the technical details of a key data point or finding — exactly how proteins latch onto the surface of DNA, for example, or the shape of butterfly larvae that are usually hidden in leaf litter. Scientists who want to examine their research question or findings more fully, to 'see' their data or to provide a pictorial boost to their manuscript should consider teaming up with an illustrator. Scientific artists can also help to create artwork for a project's website, or explain hard-to-grasp concepts with short videos.

LEARNING POINT

Most such collaborations begin when researchers are writing a paper, but it can be helpful to start even earlier (see 'Turn science into art'). Discussing with an artist how best to depict a mechanism or process — what to include and exclude, how molecules, stars or fossils should be positioned relative to one another — can help researchers to hone their hypothesis, reveal points of disagreement between authors and even identify holes in understanding.

Chemist Lauren Benz of the University of San Diego, California, found that talking with an illustrator helped her to uncover important issues that she had not considered when she started drafting her review article about the applications of membranes made from polymers and other materials. She had commissioned freelance artist Mary O'Reilly, who earned her PhD in biological chemistry from the Massachusetts Institute of Technology in Cambridge, to help illustrate how these membranes work at the molecular level. O'Reilly asked whether she should depict molecules filtering through a particular spot in the membrane, and Benz and her collaborators realized that they didn't know exactly where the filtering happened.

"It made me question some assumptions I had about the filtration mechanism, and going back and forth with Mary helped us come up with some research questions we could ask going forward," she says. She is now planning experiments to tackle them.

Scientific illustration can encapsulate information that is not easily or often conveyed by text, line drawings or simple graphics. But it can also be used when direct imagery such as photographs are impractical or even impossible. Biologist Jessica Linton, who works with the Canadian consulting firm Natural Resource Solutions in Waterloo, was working on a recovery strategy for the endangered mottled duskywing butterfly (*Erynnis martialis*) when she realized that there were no available images of the creature's microscopic eggs and pupae, which tend to be buried in soil under leaf litter, and are extremely difficult to photograph.

"Sometimes, you need an image to tell the story effectively."

Armed with scientific descriptions, she turned to illustrator Emily Damstra, whom she had met through a local butterfly enthusiasts' group. Damstra's illustrations — which are now included in the Ontario government's policy document outlining the recovery strategy — received enthusiastic appreciation from butterfly researchers and ecologists.

For those who work at the molecular level, illustrations and videos often provide the first visualization of materials or concepts that the researchers might have worked on for years — and it can be a revelation. As a graduate student, Janet Iwasa often found herself and her lab mates resorting to stick-figure drawings or waving their hands around to depict the movements of the protein they were studying: kinesin, which scuttles along skeletal filaments inside cells. "Scientific information was often lost," she says. "The first time I really understood how kinesin worked was when my principal investigator hired an animator to illustrate it." (In part because of her frustration over this, she left bench research after completing a postdoc and now works on molecular visualization in her post at the University of Utah in Salt Lake City.)

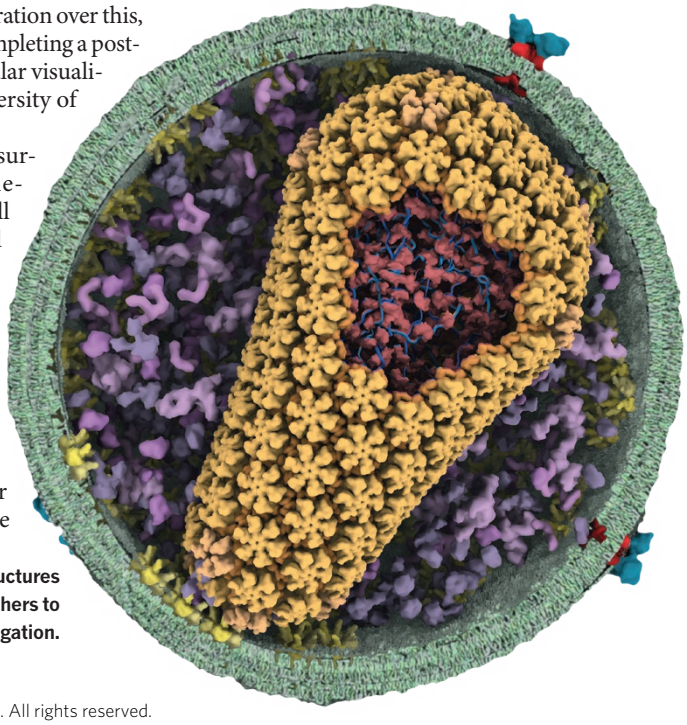
These depictions can offer surprising perspectives. "Sometimes, you need an image to tell the story effectively," says visual science communicator Kate Patterson of the Garvan Institute of Medical Research in Sydney, Australia. "They can also be question-generating, as scientists start to think about what they're seeing in a new way." When Patterson showed some researchers her animation of how DNA can be modified at the chemical level, a lively discussion ensued about how the process. Thanks to the animation, the group began to consider the physical arrangements of molecules inside the nucleus, rather than just the chemistry or enzymes involved.

Working with illustrators can also help scientists to hone their own skills at presenting data in images. Cell biologist Matt Thomson at the University of California, San Francisco, says that collaborating with science illustrator Jessica Huppi for his study on embryonic cells taught him to prune less-relevant details for better impact, and that colour and layout can often convey information more effectively than text labels.

The paper showed that genes in growing embryonic cells can be controlled by light (C. Sokolik *et al. Cell Syst.* **1,** 117–129; 2015), and Huppi's illustrations helped him to realize that there were many ways of conveying information visually. Seeing how Huppi used effects such as colours, shapes and relative sizes has helped him to represent data effectively in subsequent work, he says. "Working with an illustrator gives you a chance to learn how to approach this type of process of thinking visually — how you convey time in a drawing, or how you can convey cause and effect."

CONCEPTUAL APPROACH

Many researchers who have worked with illustrators say that they expect to do so again. But they note that the time needed to produce good artwork can add weeks to preparing a paper, and the expense of hiring a professional ranges from a few hundred dollars to thousands. This kind of time and money is not always defensible. Benz says that illustrations are useful for portraying general ideas or concepts, but that simple data can often be conveyed clearly in charts and graphs. Thomson



JANET IWASA

Molecular visualizations of structures such as HIV can point researchers to new avenues of investigation.

GET STARTED

Turn science into art

Here are some tips for getting the most out of the experience of creating art for science.

- Establish a working relationship with an illustrator long before you will need her or him — when you start writing a review article, for example, or when pursuing outreach projects for schools or museums.
- Seek out illustrators who have expertise in areas related to your research and look through their portfolios for artistic styles that you like. Scientists typically find artists through referrals from colleagues or through online searches for illustrators in their geographic area or field of study. The Guild of Natural Science Illustrators in Washington DC maintains a list of contacts, and many illustrators share their own work on Twitter under #sciart.
- Clearly establish the data points that need to be in the art from the outset, so that the end product is accurate. But allow the artist to maximize the visual impact of their illustration.
- Be bold with ideas. One image isn't the definitive description of a scientific theory, so it's fine if an image includes some ambiguity about unknowns or hypotheses as long as it's done with sufficient context.
- Seek illustrators who ask questions. You should aim to find an artist who engages with your work. **J.M.**

AVI SCHWAB

cautions against enlisting professional help just to make a paper more decorative. Scientists who want to save money and create their own art and figures can use Microsoft Excel, molecular-visualization software and tools such as Adobe Photoshop and Illustrator, but those without artistic training may find they need to invest time in learning how to use the programs.

But they should consider more than just the money when making that choice. Hiring an illustrator saved Benz's two graduate-student co-authors from a huge time sink. "For them to not have to spend hours on learning how to draw a figure was hugely helpful," she says. "There was a direct impact on our work."

And although the right software can help a researcher to produce simple figures and visualize single molecules, that will not always result in a professional-style animation or illustration. Researchers who are not artists tend to lack the sense of design and aesthetics that are a keystones of fabulous artwork. "Where illustrators come in is in their knowledge of colour theory, using composition to guide someone's eye around a page or image in the right order," says O'Reilly. "Or drawing their eye to the centre of interest."

When Berry published a paper about a different fossil forest, his institution's press office asked him for images. With no illustrator accessible at the time, he sketched out trees by hand and sent his line drawings to a colleague who helped to add colour. The image is now widely used on websites, news stories and in research presentations, Berry says. Although his drawing was much simpler than Leshyk's, the process still took him nearly two weeks. "It was a lot of fun," he says. "But I'm not sure I could do it again. That was the first time I tried to draw a whole forest to a standard good enough to let other people look at." The experience underscored to him how much effort — and talent — is required for illustration. Since then, he has chosen to seek professional help when he needs artwork.

Yet the value of professional scientific illustration has been tough to quantify or explain to many. Few, if any, studies have examined its impact on a manuscript, presentation or grant proposal. But many researchers vow that illustrated manuscripts get better results. "Anecdotally, people say you get more citations, or reviewers are happier with a paper, if you have good figures," Patterson says. "Or if you have a cover image, it'll get more attention. But the actual data behind that are lacking."

Still, researchers agree that whether through a simple graphic or a 3D animation, the visual communication of science is growing increasingly important. Some researchers think that professionally made figures can ease a manuscript's path through peer review. Although this is tough to verify, geneticist Deborah Kurrasch of the University of Calgary in Canada says that she has opted to work with illustrators many times before submitting a paper. And when she's acting as a reviewer, she adds, well-made figures make it easier to read and understand the data.

"Making data into art takes skill," Berry says. "If I had the resources, I would always hire an illustrator." ■

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CORRECTION

The Careers Feature 'Doctor's advice' (*Nature* **533,** 429–430; 2016) incorrectly described Jelena Kovačević as a biomedical engineer. She is, in fact, an electrical engineer.

TRADE TALK
College 'mayor'

Elise Covic helps to design academic programmes at the College of the University of Chicago in Illinois. She explains what she does and how she gained the experience that would launch her career there while she was doing her PhD in computational neuroscience.

What do you do as deputy dean at the college?

When I was being recruited for this position, I was told I would be the mayor of a small, crazy town, and that I wouldn't know what problems would hit me when I woke up. I make decisions about awards for students and faculty, curricula development, development money, disciplinary actions. We have initiatives that help faculty members to help students to get the most substantive experience. I feel so lucky.

When did you first consider this kind of career?

By the second year of my PhD programme, I had begun to think that I didn't want a career that was research-based, but I didn't want to tell my principal investigator (PI). I was at a poster session, and my PI was proud of me, telling me I should talk to so-and-so about postdocs. Right then, I said, "We need to talk. I don't want my own lab." He said, "I don't know if I can mentor you, but let me introduce you to some friends." He directed me to the US National Science Foundation's deputy director — she invited me to call and e-mail, to come up with a plan.

What happened next?

I had an honest conversation with myself: what do I like to do? I love science. I love organizing. And I like to boss people around, so it was clear I could do administration. My PI said, "Why don't you run this undergraduate research programme with me?" He taught me how to administer grants and lab budgets, to deal with government agencies, to handle regulatory-compliance issues with the university. I had in-depth training. Other people could gain similar experience, if they ask the right question. ■

INTERVIEW BY MONYA BAKER

This interview has been edited for length and clarity. See go.nature.com/1svOHIM for more.