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There's a Really Weird Effect When Honeybees Fly Over a Mirror

In 1963, an Austrian entomologist named Herbert Heran and the German behavioral scientist, Martin Lindauer, noticed something peculiar in the way honeybees zoom through the air.

Carly Cassella

When a selection of bees was [trained to fly over a lake](#), they could only make it to the other side if there were waves and ripples on the surface of the water. If the lake was mirror-smooth, on the other hand, the insects would suddenly lose altitude until they crashed headlong into the liquid looking-glass.

At the time, the findings supported the idea that honeybees use visual cues to navigate during flight, and a follow-up study has now added a fascinating insight into the flying strategies of these talented little aeronauts.

Replicating the 1963 experiment, albeit in a more ethical way, researchers have shown that honeybees watch the ground speeding below them to regulate their altitude in flight.

The experiments took place inside a 220-centimeter-long (87 inches) rectangular tunnel placed outdoors, with mirrors on the ceiling and the floor that could be covered to look like plain old walls.

When all the mirrors were covered, the honeybees usually flew from one side of the tunnel to a sweet treat on the other side while maintaining a near-constant altitude.

When the ceiling was pulled back to reveal a mirror, seemingly doubling the height of the tunnel, the bees easily made it across.

But when the floor became a mirror, making the ground look doubly far away, the crashes began. The bees would start out flying normally, but after about 40 centimeters (15 inches) of flight, their altitude would begin to drop until the insects collided with the glass

bottom.

When both the ceiling and the floor were mirrors, creating a parallel pair of infinite walls, the bees would start losing altitude after flying for only about eight centimeters (three inches), hitting the ground soon after.

The findings are very similar to the [spatial disorientation](#) that sometimes strikes human aviators. When pilots are unable to see their ground speed, they struggle to maintain their altitude.

Even during a '[graveyard spiral](#)', human senses can deceive us into thinking we are still in level flight. That's why airplane instruments are so important; they help us overcome spatial illusions and keep our aircraft aloft even when there is no texture or shadow on the ground or water below.

Unfortunately, honeybees don't have that backup system to help them out. Even when a mirror floor only existed in the second half of the tunnel, their steady flight from the first half was suddenly interrupted by a dramatic plunge.

"Interestingly our double mirror condition allowed us to get closer to the flight conditions of an open sky flight above a calm water surface as used by [Heran & Lindauer]", the authors of the new research [write](#). "Our results agree with theirs insofar as the honeybees lose altitude in the absence of ventral optic flow."

In short, it seems as though bees use visual cues on the ground to maintain their altitude, as opposed to visual cues from above them in the sky.

When the ground is no longer giving the insects a proper baseline, researchers think they drop lower in altitude to see if they can regain that 'ventral optic flow'. Thinking it is farther away than it is, they ultimately crash into the ground.

If the bees in the experiment had been given a wider visual field, they could probably have used other cues around them to help maintain altitude. But when flying across a large, still lake or a

closed-in tunnel, there are few alternatives the insects can use to gauge their altitude.

Interestingly enough, a similar [experiment](#) found fruit flies do not use ventral optic flow to control their altitude. Different species may, therefore, use different techniques to maintain their flight.

At high altitudes, humans are often told to not look down, for fear we will fall. But if a honeybee were to follow those same instructions, its crash would be inevitable.

The study was published in [Biology Letters](#).

<https://bit.ly/36AZXHd>

Substance Derived From Licorice May Have Anti-Inflammatory and Anti-Cancer Effects

A licorice-derived substance may have anti-inflammatory and anti-cancer effects. Researchers look to licorice for promising cancer treatments.

Licorice is more than a candy people either love or hate — it may play a role in preventing or treating certain types of cancer, according to researchers at the University of Illinois Chicago.

Gnanasekar Munirathinam and his research team are studying substances derived from the licorice plant *Glycyrrhiza glabra* to determine if they could be used to prevent or stop the growth of prostate cancer. Munirathinam is an associate professor in the department of biomedical sciences at the College of Medicine Rockford.

A research review into molecular insights of a licorice-derived substance called glycyrrhizin for preventing or treating cancer conducted by Dr. Munirathinam and student researchers suggests further research could lead to specific agents for clinical use.

The journal *Pharmacological Research* recently published the study titled “*Oncopreventive and oncotherapeutic potential of licorice triterpenoid compound glycyrrhizin and its derivatives: Molecular insights.*”

“When we look at the research out there and our own data, it appears that glycyrrhizin and its derivative glycyrrhetic acid have great potential as anti-inflammatory and anti-cancer agents,” Munirathinam said. “More research is needed into exactly how these could best be used to develop therapies, but this appears to be a promising area of cancer research.”

Should everyone go out and eat a bunch of licorice? Probably not, because it may affect blood pressure, interact with certain medications, and cause serious adverse effects, including death, when used excessively. An occasional sweet treat of licorice candy or tea may be better options until more studies can show how to best harness the plant’s benefits.

“Very few clinical trials in humans have been conducted,” Munirathinam said. “We hope our research on prostate cancer cells advances the science to the point where therapies can be translated to help prevent or even cure prostate and other types of cancer.”

Reference: “Oncopreventive and oncotherapeutic potential of licorice triterpenoid compound glycyrrhizin and its derivatives: Molecular insights” by Rifika Jain, Mohamed Ali Hussein, Shannon Pierce, Chad Martens, Preksha Shahagadkar and Gnanasekar Munirathinam, 19 February 2022, Pharmacological Research.

[DOI: 10.1016/j.phrs.2022.106138](https://doi.org/10.1016/j.phrs.2022.106138)

College of Medicine Rockford students Rifika Jain, Mohamed Ali Hussein, Preksha Shahagadkar, Shannon Pierce and Chad Martens are co-authors of the review, which was partly supported by the National Institutes of Health (R0CA227218) and Brovember Inc.

<https://bit.ly/3OwyV4U>

A new nuclear imaging prototype detects tumors’ faint glow

Doctors could someday use Cerenkov light to detect cancer

By [Anna Gibbs](#)

A type of light commonly observed in astrophysics experiments and nuclear reactors can help detect cancer. In a clinical trial, a prototype of an imaging machine that relies on this usually bluish light, called Cerenkov radiation, successfully [captured the presence and location](#) of cancer patients’ tumors, researchers report April 11

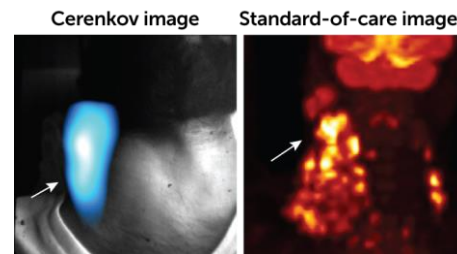
in *Nature Biomedical Engineering*.

When compared with standard scans of the tumors, the Cerenkov light images were classified as “acceptable” or higher for 90 percent of patients, says Magdalena Skubal, a cancer researcher at Memorial Sloan Kettering Cancer Center in New York City.

Cerenkov radiation is generated by high-speed particles [traveling faster than light](#) through a material, such as bodily tissue (SN: 8/5/21). In Cerenkov luminescence imaging, or CLI, particles released by radiotracers cause the target tissue to vibrate and relax in a way that emits light, which is then captured by a camera.

Between May 2018 and March 2020, in the largest clinical trial of its kind to date, 96 participants underwent both CLI and standard imaging, such as positron emission tomography/computed tomography, or PET/CT. Participants with a variety of diagnoses, including lymphoma, thyroid cancer and metastatic prostate cancer, received one of five radiotracers and were then imaged by the prototype — a camera in a light-proof enclosure.

Skubal and colleagues found that CLI detected all radiotracers, suggesting that the technology is more versatile than PET/CT scans, which work with only some radiotracers.



The Cerenkov luminescence image (left) of a patient with classic Hodgkin’s lymphoma shows off a blue glow in the right part of the neck that signifies the focal point of the disease. It corresponds with similar indications of disease by the PET/CT scan (right). E.C. Pratt et al/Nature Biomedical Engineering 2022

CLI images aren’t as precise as those from PET/CT scans. But CLI could be used as an initial diagnostic test or to assess the general size of a tumor undergoing treatment, says study coauthor Edwin Pratt, also of Memorial Sloan Kettering Cancer Center.

“It would be a quick and easy way to see if there’s something off ...

[that warrants] further investigation,” Pratt says.

The findings strengthen the case for the technology as a promising low-cost alternative that could expand access to nuclear imaging in hospitals, says Antonello Spinelli, a preclinical imaging scientist at Experimental Imaging Centre in Milan, Italy, who was not involved in the research.

<https://bit.ly/3JYJLgy>

Japan greenlights Novavax vaccine, shots to start as early as May

Marks the fourth vaccine to be greenlit for use in Japan and will be produced domestically by medical giant Takeda Pharmaceutical Co

Japan's health ministry Tuesday approved the use of a COVID-19 vaccine developed by U.S. biotechnology firm Novavax Inc., with deliveries of the drug to local governments expected to start in late May, and shots might also begin that month.

The approval by the Ministry of Health, Labor and Welfare marks the fourth vaccine to be greenlit for use in Japan and will be produced domestically by medical giant Takeda Pharmaceutical Co., which has been given the technology to manufacture the drug.

Novavax's vaccine will be the first protein-based one, intended for patients who could not use existing vaccines due to risks such as allergies.

"We have purchased the shots to increase the stability and diversity of the vaccine supply," health minister Shigeyuki Goto said at a press conference after the government had secured 150 million doses.

The vaccine can be administered to people aged 18 or older in two shots spaced three weeks apart. It can also be used as a booster shot after six months.

Whether the vaccine can be used for mixing and matching booster shots will be decided by an internal subcommittee in the near future,

the health ministry said.

Overseas clinical trials conducted before the Omicron variant became widespread showed that the vaccine was around 90 percent effective in preventing the onset of symptoms after the first and second shots were administered.

After the third dose, it was also shown to improve the value of neutralizing antibodies that prevent the virus from entering cells in the body.

Although weaker against the Omicron variant, the vaccine also has "a certain effect" on the mutant strain, the health ministry said.

In clinical trials conducted in the United States and elsewhere, 44.5 percent of patients who have received two shots reported side effects such as headaches, 38.9 percent said they felt fatigued, and 48.1 percent said they experienced muscle soreness.

<https://bit.ly/3v55hfz>

Scientists Have Eradicated Liver Cancer in Rats Using Non-Invasive Sound Waves

Rats afflicted with liver cancer have demonstrated the efficacy of a fascinating, non-invasive treatment.

[Michelle Starr](#)

Using focused ultrasound, scientists have managed to destroy up to 75 percent of the volume of a liver tumor. The treatment also seems to trigger the rats' immune systems into taking over and clearing the rest.

In 80 percent of the animals, the cancer seemed to be destroyed, with no sign of metastases or recurrence in the three months they were monitored for, the researchers said.

The treatment, called histotripsy, is currently being trialed [in humans with liver cancer](#).

"Histotripsy is a promising option that can overcome the limitations of currently available ablation modalities and provide safe and effective non-invasive liver tumor ablation," [said biomedical](#)

[engineer Tejaswi Worlikar](#) of the University of Michigan.

"We hope that our learnings from this study will motivate future preclinical and clinical histotripsy investigations toward the ultimate goal of clinical adoption of histotripsy treatment for liver cancer patients."

Developed and pioneered at the University of Michigan, histotripsy seems to offer new hope for patients with one of the deadliest forms of cancer: the five-year survival rate for liver cancer is currently lower than 18 percent in the US.

The technique employs an ultrasound transducer, not for bouncing off internal structures for imaging purposes, but to physically disrupt cancerous tumors.

The way it works is by ultrasound cavitation – similar to the method used to non-invasively break down fat cells for weight-loss treatments. Waves of ultrasound are directed at the area to be treated; the vibrations generate tiny bubbles in the targeted tissue. When the bubbles collapse, or burst, the tissue is disrupted, destroying that part of the tumor.

It's not often possible to target the entire tumor. The way the masses are positioned, their size and their stage can all influence whether it's safe to use histotripsy on the entire tumor.

But even partial treatment resulted in complete regression in 81 percent of the rats treated, the researchers found. By contrast, 100 percent of the control rats showed tumor progression.

"Our transducer, designed and built at [University of Michigan], delivers high amplitude microsecond-length ultrasound pulses – acoustic cavitation – to focus on the tumor specifically to break it up," [said biomedical engineer Zhen Xu](#) of the University of Michigan.

"Even if we don't target the entire tumor, we can still cause the tumor to regress and also reduce the risk of future metastasis."

For the purpose of this study, 22 lab rats were implanted with liver

cancer. Half were left as a control group, while the remaining 11 were treated using histotripsy, targeting between 50 and 75 percent of the tumor volume.

An additional three rats were treated to a lesser extent, with the histotripsy targeting just 25 percent of the tumor volume.

Following treatment, the rats were euthanized and dissected to determine how successful the treatment had been. The researchers looked for signs of progression, metastasis, and immune markers.

The prognosis for the control rats was dire. All 11 showed signs of progression and metastasis. Within three weeks, the tumours reached the maximum size allowed by ethical protocols and the animals were euthanized.

But the treated rats fared much, much better. Not only did the treatment proceed without complication or side effects, the majority of the rats – nine of the 11 – showed tumor regression, and experienced tumor-free survival for the remainder of the study, around 10 weeks.

Previous histotripsy studies had demonstrated that the treatment is effective at reducing tumor volume. The new work shows that it seems to significantly increase survival rates post-treatment, too.

"This study demonstrated the potential of histotripsy for successful non-invasive tumor ablation, and prevention of local tumor progression and metastasis. Even with partial ablation, complete local tumor regression was observed in 9 of 11 treatment rats, with no recurrence or metastasis up to the 12-week study endpoint, as evidenced by MRI and histology," [the researchers wrote in their paper](#).

"These results suggest that histotripsy may not increase the risk of developing metastases post-ablation, as compared to controls. Future studies will continue to investigate the safety, efficacy, and biological effects of histotripsy, for potential translation to clinic."

The research has been published in [Cancers](#).

<https://bit.ly/3L5MF12>

NASA Beamed a Doctor to The ISS in a World-First 'Holoportation' Achievement

There's never been a house call quite like this.

[Peter Dockrill](#)

In a first for telepresence communication, a NASA flight surgeon was 'holoported' to the International Space Station (ISS), appearing and conversing as a virtual presence in real time, hundreds of miles above the surface of Earth.

If it sounds like *Star Trek*, you're not too far off. (After all, *Star Trek: Voyager* did feature an [artificial physician who was a holographic projection](#).)

But this isn't science fiction. When NASA flight surgeon Josef Schmid was beamed up to the ISS in October of last year, the illusion was made possible thanks to [Microsoft's 'holoportation' technology](#), which lets users interact with 3D representations of remote participants in real time.

"This is [a] completely new manner of human communication across vast distances," [says Schmid](#). "It is a brand-new way of human exploration, where our human entity is able to travel off the planet."

Unlike traditional holographic projections that [appear to hover in the air for anybody to see](#), holoportation requires the use of an augmented reality headset, such as [Microsoft's HoloLens technology](#), for the wearer to be able to perceive (and interact with) the remotely captured individual(s), who are filmed with a multiple-camera setup in their actual location.

In this case, European Space Agency (ESA) astronaut Thomas Pesquet, who was on board the ISS and wearing such a headset, had a two-way conversation with Schmid and members of his medical team, along with Fernando De La Pena Llaca, the CEO of AEXA Aerospace, which develops custom holoportation software (the kind

that made this ISS session possible).

While Microsoft's holoportation technology has existed – in various stages of development – for several years, it's never been used for something as ambitious as this before: connecting Earth-based medical researchers with astronauts on mission, orbiting the planet hundreds of miles up in the sky.

Yet it's this exact kind of capability – bridging physical gaps to connect people over huge distances in space – that could be important for future space-exploration missions. This way, scientists could virtually interact with real-time 3D representations of remote participants on Earth, space stations, or other spacecraft, enabling collaborations that can be much more involving and immersive than [standard 2D video calls](#).

"Our physical body is not there, but our human entity absolutely is there," [says Schmid](#).

"Imagine you can bring the best instructor or the actual designer of a particularly complex technology right beside you wherever you might be working on it."



NASA flight surgeon Josef Schmid holoported onto the ISS. (ESA/Thomas Pesquet)

The next step in the technology's evolution is to enable fully two-way holoportation interactions.

During this experiment, Pesquet was the only participant wearing an augmented reality headset that enabled him to perceive the other participants as digital 3D holograms, as Schmid and the other participants did not wear such devices themselves.

Once all participants are similarly equipped, however, the possibilities to [jump into someone else's reality](#) could become even more instructive and transformative for off-world astronauts – whether you're consulting Earth-bound doctors about a medical

issue, or exchanging important ideas about mission objectives with NASA researchers.

"What it really plays into is opportunities for more longer duration spaceflight and more deep spaceflight," Christian Maender, a research director at space infrastructure company Axiom Space, [explained to the Verge in 2021](#).

"Where you are really talking about wanting to create a human connection between your crew – no matter where they're traveling – and back to someone on the planet."

<https://bbc.in/3EEbAKb>

Woman tells of 'mind-blowing' cystic fibrosis drug
Four years ago Gillian Docherty's cystic fibrosis symptoms were so bad she thought she was living on borrowed time but a new drug improved her health so much she has now had a baby.

Gillian, from Glasgow, told BBC Radio's [Good Morning Scotland programme](#) she had lived with CF all her life but her health had declined significantly after going into hospital with flu in her early 30s. The 36-year-old dentist says her lung function was so poor she could not climb the stairs or go for a walk.

Gillian says she was severely underweight and constantly exhausted because of coughing 24 hours a day. She says the only plans she made for the future were getting her end-of-life affairs in order to spare her husband Andy the trouble after she was gone.

Cystic fibrosis is a condition which causes sticky mucus to build up in the lungs and digestive system. This leads to lung infections and problems with digesting food. Eventually, without proper management, patients face a significantly shortened life expectancy and many require lung transplants as there is no cure for the illness. In 2018, Gillian was told she met the criteria for a clinical trial of the now-approved drug Kaftrio, which reverses main symptoms of CF. She told the BBC: "I was so unwell, my lung function was hovering around the 40% mark and it would not be much further

before you would be looking at transplant assessment for new lungs, so there was nothing to lose."

The results of the trial were "mind-blowing", Gillian says.

"I didn't expect that within three or four hours of taking the first pills I would start to breathe more easily," she says. According to Gillian, her sinuses started to clear and her cough started to break up the mucus in her chest, allowing her to breathe more easily.

"It was absolutely mental," she says. Within two weeks of taking the medication, she saw her lung function increase from 38% to 74%. Today it is more than 80%, and continues to improve.

This meant she could sleep better and exercise more, benefiting her overall health. "It changed everything," she says. "There are so many improvements you can't measure. The colour of my skin is more alive, my hair is healthier, every part of me is healthier."

And there is one change that she never thought possible.

Even before she became extremely unwell she and her husband had decided against having a family. She says she would never have been well enough to sustain a pregnancy but even if she did she was concerned about living long enough to raise a child.

"I didn't want my child's mother to die and that's certainly what would have happened," she says.

But Gillian says the dramatic effect of the drug led the couple to reconsider and, in December, baby Frederick was born.

Since Kafrio was approved, more than 250 patients have undergone treatment at the Queen Elizabeth University Hospital in Glasgow.

Dr Gordon MacGregor, consultant physician at the QEUH and one of the team looking after Mrs Docherty, said: "We have a large expert team of staff delivering CF care within the QEUH and Kafrio has really been a gamechanger in treating the patients for whom it is clinically appropriate. "It helps keep them out of the hospital and enables them to live pretty normal lives, albeit they

will always need a level of care from staff for their condition. "It's fantastic to see the impact it's had on Gillian, who has gone from rapid deterioration and an uncertain future to having a family and bright days and years ahead."

<https://bit.ly/3v4KEzW>

Why Venus rotates, slowly, despite sun's powerful grip: Planet's atmosphere explains the gravity of the situation

If not for the soupy, fast-moving atmosphere on Venus, Earth's sister planet would likely not rotate.

Instead, Venus would be locked in place, always facing the sun the way the same side of the moon always faces Earth.

The gravity of a large object in space can keep a smaller object from spinning, a phenomenon called tidal locking. Because it prevents this locking, a UC Riverside scientist argues the [atmosphere](#) needs to be a more prominent factor in studies of Venus as well as other planets. These arguments, as well as descriptions of Venus as a partially tidally locked planet, were published today in a *Nature Astronomy* article.

"We think of the atmosphere as a thin, almost separate layer on top of a planet that has minimal interaction with the solid planet," said Stephen Kane, UCR astrophysicist and lead paper author. "Venus' powerful atmosphere teaches us that it's a much more integrated part of the planet that affects absolutely everything, even how fast the planet rotates."

Venus takes 243 Earth days to rotate one time, but its atmosphere circulates the planet every four days. Extremely fast winds cause the atmosphere to drag along the surface of the planet as it circulates, slowing its rotation while also loosening the grip of the sun's gravity.

Slow rotation in turn has dramatic consequences for the sweltering

Venusian climate, with average temperatures of up to 900 degrees Fahrenheit—hot enough to melt lead. "It's incredibly alien, a wildly different experience than being on Earth," Kane said. "Standing on the surface of Venus would be like standing at the bottom of a very hot ocean. You couldn't breathe on it."

One reason for the heat is that nearly all of the sun's energy absorbed by the planet is soaked up by Venus' atmosphere, never reaching the surface. This means that a rover with [solar panels](#) like the one NASA sent to Mars wouldn't work.

The Venusian atmosphere also blocks the sun's energy from leaving the planet, preventing cooling or [liquid water](#) on its surface, a state known as a [runaway greenhouse effect](#).

It is unclear whether being partially tidally locked contributes to this runaway greenhouse state, a condition which ultimately renders a planet uninhabitable by life as we know it.

Not only is it important to gain clarity on this question to understand Venus, it is important for studying the exoplanets likely to be targeted for future NASA missions. Most of the planets likely to be observed with the recently launched James Webb Space Telescope are very close to their stars, even closer than Venus is to the sun. Therefore, they're also likely to be tidally locked.

Since humans may never be able to visit exoplanets in person, making sure computer models account for the effects of tidal locking is critical. "Venus is our opportunity to get these models correct, so we can properly understand the surface environments of [planets](#) around other stars," Kane said.

"We aren't doing a good job of considering this right now. We're mostly using Earth-type models to interpret the properties of exoplanets. Venus is waving both arms around saying, 'look over here!'"

Gaining clarity about the factors that contributed to a runaway greenhouse state on Venus, Earth's closest planetary neighbor, can

also help improve models of what could one day happen to Earth's climate. "Ultimately, my motivation in studying Venus is to better understand the Earth," Kane said.

More information: *Atmospheric Dynamics of a Near Tidally Locked Earth-Size Planet, Nature Astronomy* (2022). DOI:

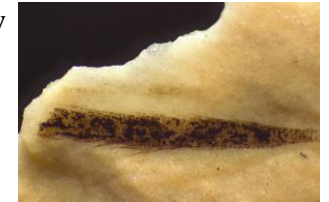
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Pterosaurs may have flaunted colorful plumage long before the reign of dinosaurs

Exquisitely preserved specimen from Brazil suggests ancient origin for feathers

By [Rodrigo Pérez Ortega](#)

The idea that dinosaurs [sported colorful feathers](#), once outlandish, has become conventional wisdom. Now, a new study of a Brazilian fossil suggests that pterosaurs—leathery winged, flying reptiles only distantly related to dinosaurs—were also clad in tiny feathers of varying hues.



This tiny feather, about 1.5 millimeters long, adorned the head crest of a 113-million-year-old pterosaur. Aude Cincotta

The finding suggests feathers may have evolved more than 150 million years before the heyday of the dinosaurs, probably for display, the authors say. "In their very earliest forms, feathers were colored ... presumably for signaling," says paleobiologist Maria McNamara of University College Cork, who led the study.

The paper "reinforces the idea that pterosaurs were 'fluffy,' and indicates at least some of them probably had complex colorful patterns—which is fantastic," says Rodrigo Pêgas, a paleontologist at the Federal University of ABC, São Bernardo do Campo, in Brazil. But Pêgas is not convinced that feathers originated as early as McNamara thinks—and some other researchers doubt the structures are feathers at all.

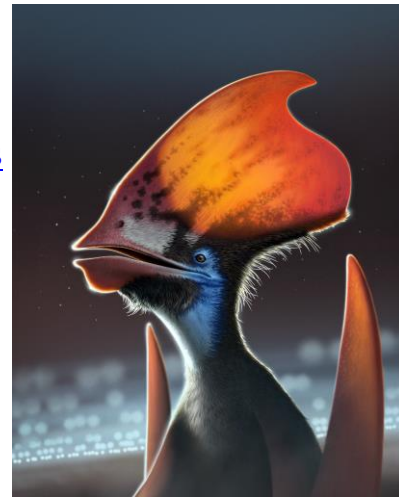
How feathers arose has been a big question in paleontology for

more than 150 years, since the first *Archaeopteryx*—a [feathered dinosaur](#) once thought to be the first bird—was found in Germany. Many researchers think feathers arose for insulation and were co-opted only much later for flight and other uses, such as courtship displays. As for pterosaurs, researchers had previously reported their bodies were covered in pycnofibers, single-stranded structures that formed a “fuzz,” presumably for warmth.

Then in 2018, McNamara and her colleagues reported that two well-preserved Chinese pterosaurs showed what [seemed to be a defining feature of feathers](#): a central shaft with branches. Some paleontologists [were skeptical](#), and McNamara says she understood why. “Their feathers were—to be honest—a bit weird,” she says. “They didn’t branch like modern bird feathers do.”

Now, she and her colleagues have cemented their arguments with a paper this week in *Nature* analyzing the soft tissue of an exquisitely preserved skull of *Tupandactylus imperator*—a pterosaur that had a majestic head crest and a 5-meter wingspan.

It lived 113 million years ago in what is now the Araripe Basin in northeastern Brazil, although McNamara studied the fossil in Belgium. The team thinks it [was poached](#) from Brazil and kept in private collections until recently. Earlier this year, the Royal Belgian Institute of Natural Sciences [repatriated](#) the fossil to Brazil, where it will be displayed at the Earth Sciences Museum in Rio de Janeiro. “It is great that the fossil is back in Brazil,” Pêgas says.



Tupandactylus imperator, a large pterosaur that lived in what is now Brazil, may have sported a colorful head crest, as seen in this artist's illustration. ©

Bob Nicholls 2022

On the pterosaur's head crest, the researchers identified both [single-stranded fibers and featherlike branching ones](#) with a central shaft narrowing at the base. Under the scanning electron microscope, both skin and feathers had melanosomes, intracellular structures containing melanin that give pigment to skin, feathers, and fur in living animals, with differently shaped melanosomes conferring different colors. The pterosaur's melanosomes had diverse shapes—ovoid, spherical, and elongated—something until now only seen in mammalian fur and dinosaur and bird feathers.

The researchers think *Tupandactylus*'s colored, branching structures were indeed feathers, which both kept it warm and enabled it to signal to other pterosaurs, perhaps as male peacocks do by displaying plumage during mating.

The finding means feathers must have evolved far earlier than was thought, McNamara says. “The most parsimonious explanation is that feathers were present in the common ancestor of [pterosaurs and dinosaurs],” about 250 million years ago during the Triassic period.

Some paleontologists say the evidence of feathers is persuasive. “We’re hammering it in with 7-inch nails with these findings,” says Jakob Vinther, a paleobiologist at the University of Bristol. Paleontologist Michael Benton, also at Bristol, agrees, but “I don’t think pterosaur feathers had any function in flight because they’re just fluffy little feathers.”

But paleontologist David Martill from the University of Portsmouth says the small branched structures “look nothing like feathers.” He thinks they are a different kind of keratinous covering, though he agrees they were probably spectacularly colored.

Even if they are feathers, pterosaurs may not have flaunted them like Mesozoic peacocks, Vinther says. He notes that the researchers didn’t infer the melanosomes’ color and says it’s possible the plumage was used for camouflage rather than display.

Nor is it certain that the pterosaur structures share an ancient origin with those of dinosaurs and their descendants, living birds, some researchers say. “We still need fossil evidence for feathers in the Triassic as well as unequivocal molecular evidence for the common origin between pterosaur pycnofibers and dinosaur feathers,” Pêgas says.

McNamara promises more evidence for her scenario. Her team is working to characterize the detailed chemistry of the *Tupandactylus* samples, which could reveal organic compounds in the feathers.

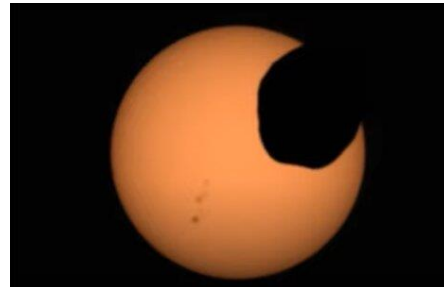
If the current findings hold up, they may shed light on the selection pressures that shaped early feathers, says Jasmina Wiemann, a molecular paleobiologist at the California Institute of Technology. “Thermal regulation has been the old hypothesis out there ... [but] maybe there’s more to it.”

<https://bit.ly/3K6MVy>

NASA's Perseverance rover captures video of solar eclipse on Mars

NASA's Perseverance Mars rover has captured dramatic footage of Phobos, Mars' potato-shaped moon, crossing the face of the Sun.

These observations can help scientists better understand the moon's orbit and how its gravity pulls on the Martian surface, ultimately shaping the Red Planet's crust and mantle.



Phobos solar eclipse taken from the Martian surface. Credit: NASA/JPL-Caltech/ASU/MSSS/SSI

Captured with Perseverance's next-generation Mastcam-Z camera on April 2, the 397th Martian day, or sol, of the mission, the eclipse lasted a little over 40 seconds—much shorter than a typical [solar eclipse](#) involving Earth's Moon. (Phobos is about 157 times smaller

than Earth's Moon. Mars' other [moon](#), Deimos, is even smaller.)

The images are the latest in a long history of NASA spacecraft capturing solar eclipses on Mars. Back in 2004, the twin NASA rovers Spirit and Opportunity took the first time-lapse photos of Phobos during a solar eclipse. Curiosity continued the trend with videos shot by its Mastcam camera system.

But Perseverance, which landed in February 2021, has provided the most zoomed-in video of a Phobos solar eclipse yet—and at the highest-frame rate ever. That's thanks to Perseverance's next-generation Mastcam-Z camera system, a zoomable upgrade from Curiosity's Mastcam.

"I knew it was going to be good, but I didn't expect it to be this amazing," said Rachel Howson of Malin Space Science Systems in San Diego, one of the Mastcam-Z team members who operates the camera.

Howson noted that although Perseverance first sends lower-resolution thumbnails that offer a glimpse of the images to come, she was stunned by the full-resolution versions: "It feels like a birthday or holiday when they arrive. You know what's coming, but there is still an element of surprise when you get to see the final product."

Color also sets this version of a Phobos solar eclipse apart. Mastcam-Z has a solar filter that acts like sunglasses to reduce light intensity. "You can see details in the shape of Phobos' shadow, like ridges and bumps on the moon's landscape," said Mark Lemmon, a planetary astronomer with the Space Science Institute in Boulder, Colorado, who has orchestrated most of the Phobos observations by Mars rovers. "You can also see sunspots. And it's cool that you can see this eclipse exactly as the rover saw it from Mars."

As Phobos circles Mars, its gravity exerts small tidal forces on the Red Planet's interior, slightly deforming rock in the planet's crust and mantle. These forces also slowly change Phobos' orbit. As a

result, geophysicists can use those changes to better understand how pliable the interior of Mars is, revealing more about the materials within the crust and mantle.

Scientists already know that Phobos is doomed: The moon is getting closer to the Martian surface and is destined to crash into the planet in tens of millions of years. But eclipse observations from the surface of Mars over the last two decades have also allowed scientists to refine their understanding of Phobos' slow death spiral.

<https://bit.ly/38iauYd>

Study: Shallow Liquid Water is Ubiquitous across Ice Shell of Jupiter's Moon Europa

Double ridges on Europa may indicate that shallow liquid water is present in the moon's ice shell

Surface landforms called double ridges occur across every sector of [Jupiter's icy moon Europa](#) and can be hundreds of kilometers in length. In new research, planetary scientists from Stanford University and NASA's Jet Propulsion Laboratory identified a similar double ridge in the ice sheet in northwest Greenland with the same geometry as those on Europa. To explore the formation of the ridge in Greenland, they used surface elevation and radar sounding data and indicate it was formed through a succession of refreezing, pressurization and fracture of a shallow water sill within the ice sheet. They suggest that if this process is also responsible for the formation of double ridges on Europa it may indicate that shallow liquid water is present in the moon's ice shell.

Jupiter's icy moon Europa, a [prime candidate](#) for extraterrestrial habitability in our Solar System, [harbors](#) a global subsurface ocean beneath an outer ice shell.

The thickness and thermophysical structure of this ice shell are poorly constrained, but models suggest it may be 20-30 km thick with a layer of warm, convecting ice underlying a cold, rigid crust.

The detailed structure and dynamics of the ice shell and the timescales over which they evolve are critical for understanding both the fundamental geophysical processes and habitability of Europa.

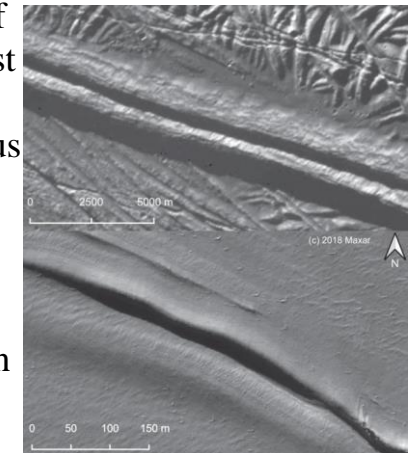
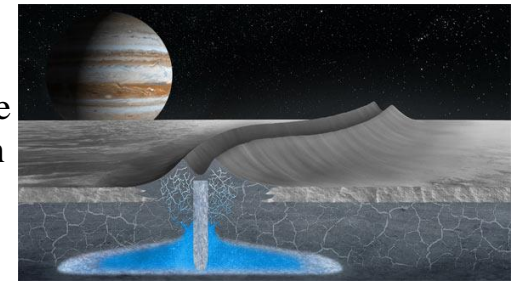
This artist's conception shows how double ridges on the surface of Jupiter's moon Europa may form over shallow, refreezing water pockets within the ice shell. Image credit: Justice Blaine Wainwright.

Europa's surface is young and geologically active, displaying a wide variety of landforms including ridges, troughs, bands, lenticulae, and chaos terrain. Of these, double ridges are the most common, consisting of symmetric ridge pairs flanking a medial trough.

These ridges may extend for hundreds of kilometers and include some of the oldest features visible on the surface, with frequent cross-cutting implying numerous formation cycles over Europa's history. Planetary researchers have known about these features since the moon's surface was photographed by NASA's Galileo spacecraft in the 1990s but have not been able to conceive a definitive explanation of how they were formed.

Surface imagery comparison of a double ridge on Europa (top) and Earth (bottom). Image credit: Culberg et al., doi: 10.1038/s41467-022-29458-3.

Through analyses of surface elevation data and ice-penetrating radar collected from 2015 to 2017 by [NASA's Operation IceBridge](#), Stanford University Ph.D. student Riley Culberg and colleagues revealed how the double ridge on northwest Greenland was produced when the ice fractured around a pocket of pressurized



liquid water that was refreezing inside of the ice sheet, causing two peaks to rise into the distinct shape.

“In Greenland, this double ridge formed in a place where water from surface lakes and streams frequently drains into the near-surface and refreezes,” Culberg said. “One way that similar shallow water pockets could form on Europa might be through water from the subsurface ocean being forced up into the ice shell through fractures — and that would suggest there could be a reasonable amount of exchange happening inside of the ice shell.”

Rather than behaving like a block of inert ice, the shell of Europa seems to undergo a variety of geological and hydrological processes — an idea supported by this study and others, including evidence of water plumes that erupt to the surface.

A dynamic ice shell supports habitability since it facilitates the exchange between the subsurface ocean and nutrients from neighboring celestial bodies accumulated on the surface.

“Our explanation for how the double ridges form is so complex, we couldn’t have conceived it without the analog on Earth,” said Dr. Gregor Steinbrügge, a planetary scientist at NASA’s Jet Propulsion Laboratory. “The mechanism we put forward in our paper would have been almost too audacious and complicated to propose without seeing it happen in Greenland.”

The [paper](#) was published in the journal *Nature Communications*.

R. Culberg et al. 2022. Double ridge formation over shallow water sills on Jupiter’s moon Europa. Nat Commun 13, 2007; doi: 10.1038/s41467-022-29458-3

<https://bit.ly/3Mip5BU>

This Fungus Has More Than 17,000 Sexes
Advances in sequencing technologies have finally allowed researchers to zero in on the genetic diversity underlying the incredible mating system of shelf fungi.

James M. Gaines

Some common mushrooms likely have more than 17,000 sexes,

researchers report March 31 in [PLOS Genetics](#). The work could help us better understand the evolution of sexual reproduction as well as showcases the increasing power of genome sequencing.



Trichaptum abietinum growing on a pine log Dabao Sun Lu

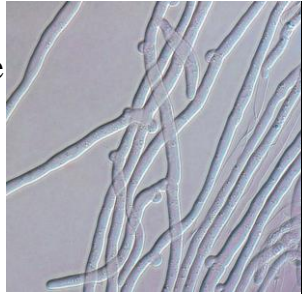
While scientists have long suspected that certain species of fungi have thousands or even tens of thousands of biological sexes, the new research employed cutting edge genetic tools to confirm the extreme diversity of sexes in *Trichaptum* mushrooms.

“The pace of advances in DNA sequencing are just mind boggling,” says Joseph Heitman, a geneticist and infectious disease expert at Duke University who wasn’t involved in the study but has investigated fungal mating strategies before. “This kind of study would have been cost and time prohibitive even five years ago.”

Trichaptum is a group of woody, plate-like mushrooms (shelf fungi) that commonly grow on trees and fallen logs in cooler parts of the Northern Hemisphere. “I think they’re quite pretty, but not very showy,” says Inger Skrede, a fungal biologist at the University of Oslo and a coauthor of the paper. The fungi weren’t chosen for their looks, of course. The international team of researchers decided to examine species in this genus because they had been studied by scientists previously and were easy to grow in the lab.

In total, the scientists obtained 180 specimens from three *Trichaptum* species; some they collected themselves, while others were sent to them from colleagues around the world (“You can just ship it in regular mail,” says Skrede). From each fungal strain, they harvested spores, which were grown individually on agar plates for several weeks so that their DNA could be analyzed and they could be paired with growing spores from other specimens to see if they’d crossbred.

Previous work had suggested that sex in these mushrooms was controlled by two regions of the genome, known as MATA and MATB, and that each of these regions had many different possible alleles. For potential mates to be compatible, both regions must be different from their prospective partner's.



Mating in Trichaptum occurs where the hyphae of two growing spores meet, as seen in this microscopic image of T. abietinum. The small bumps that be seen on the side of some hyphae are known as clamps, which only occur after successful mating. Dabao Sun Lu

This diversity has hampered sequencing efforts. The many divergent alleles make primer design all but impossible, thwarting the use of less expensive, targeted sequencing methods. This hurdle means that researchers wanting to sequence these fungi would need to rely on so-called next generation, short-read genomic sequencing technologies—methods which, given the number of individuals and the depth of sequencing needed to ensure accuracy, have simply been too expensive.

Now, though, lower costs of next generation technologies made sequencing so many individuals feasible. And Skrede and her team were able to use newer, long-read sequencing to generate high-quality genomes that acted as scaffolds for accurate assemblies of the short reads. The combination of methods made it so the researchers could precisely pinpoint which parts of the MATA and MATB genetic regions were important for sex determination as well as count the number of different relevant variations in those two areas. Putting it all together, the team found that, contained within these unassuming shelf fungi, there could be a staggering 17,550 different combinations to choose from.

Why any organism would need so much sexual variation remains an open question, but study author and University of Oslo geneticist

David Peris suspects it has to do with the mushrooms' sessile lifestyle: having to be different at two different gene regions makes it less likely for spores released from the same mushroom to successfully combine, thus lowering the odds of inbreeding.

Also, having so many variants to choose from makes it more likely any given neighbors will be sexually compatible—up to a 98 percent chance, says Peris—which could help the species survive in the long run. “When conditions are changing, you want to generate this genetic variation,” says Peris, as it can act as fodder for adaptation.

Duur Aanen, an evolutionary biologist at Wageningen University in the Netherlands, says the study is such a good example of balancing selection—a phenomenon where the evolutionary favoring of rare alleles leads to higher levels of heterozygosity—that he is considering using it in his population genetics classes.

However, Aanen, who was not involved in the study, also noted that there's one big question none of the scientists who've looked at this system have been able to fully answer: While diversity may help, why push it to this extreme? “If you have 100 alleles, you already have quite a lot of compatibility,” says Aanen. “What is the benefit of number 101?”

<https://bit.ly/3vA2HNA>

Not All Kinds of Alcohol Are Equally Bad For Body Fat, Study Suggests

Drinking beer and spirits is linked to elevated levels of [visceral fat](#) whereas drinking wine shows no such association

Brittany Larsen*, The Conversation

Drinking beer and spirits is linked to elevated levels of [visceral fat](#) – the harmful type of fat that is associated with an increased risk of cardiovascular disease, metabolic syndrome, and other health complications – whereas drinking wine shows no such association with levels of this harmful fat and may even be protective against it,

depending on the type of wine consumed.

In fact, we found that drinking red wine is linked to having lower levels of visceral fat. These are some of the key takeaways of [a new study](#) that my colleagues and I recently published in the *Obesity Science & Practice* journal.

Although white wine consumption did not influence levels of visceral fat, our study did show that drinking white wine in moderation might offer its own unique health benefit for older adults: denser bones. We found higher bone mineral density among older adults who drank white wine in moderation in our study. And we did not find this same link between beer or red wine consumption and bone mineral density.

Our study relied on a large-scale longitudinal database called [the UK Biobank](#). We assessed 1,869 white adults ranging in age from 40 to 79 years who reported demographic, alcohol, dietary and lifestyle factors via a touchscreen questionnaire.

Next, we collected height, weight and blood samples from each participant and obtained body composition information using a direct measure of body composition called [dual-energy X-ray absorptiometry](#).

Then, we used a statistical program to examine the relationships among the types of alcoholic beverages and body composition.

Why it matters

Aging is often accompanied by an increase in the problematic fat that can lead to heightened cardiovascular disease risk as well as by a [reduction in bone mineral density](#). This has important health implications given that nearly 75 percent of adults in the US [are considered overweight or obese](#).

Having higher levels of body fat has been consistently linked to an increased risk for acquiring many different diseases, including [cardiovascular disease](#), [certain types of cancer](#), and [a higher risk of death](#). And it's worth noting that national medical care costs

associated with treating obesity-related diseases total more than [US\\$260.6 billion annually](#).

Considering these trends, it is vital for researchers like us to examine all the potential contributors to weight gain so that we can determine how to combat the problem.

Alcohol has long been considered one possible driving factor [for the obesity epidemic](#). Yet the public often hears conflicting information about the potential [risks](#) and [benefits](#) of alcohol. Therefore, we hoped to help untangle some of these factors through our research.

What still isn't known

There are many biological and environmental factors that contribute to being overweight or obese. [Alcohol consumption](#) may be one factor, although there are [other studies](#) that have not found clear links between weight gain and alcohol consumption.

One reason for the inconsistencies in the literature could stem from the fact that much of the previous research has traditionally treated alcohol as a single entity rather than separately measuring the effects of beer, cider, red wine, white wine, Champagne, and spirits. Yet, even when broken down in this way, the research yields mixed messages.

For example, [one study has suggested](#) that drinking more beer contributes to a higher waist-to-hip ratio, while [another study](#) concluded that, after one month of drinking moderate levels of beer, healthy adults did not experience any significant weight gain.

As a result, we've aimed to further tease out the unique risks and benefits that are associated with each alcohol type. Our next steps will be to examine how diet – including alcohol consumption – could influence diseases of the brain and cognition in older adults with [mild cognitive impairment](#).

* [Brittany Larsen](#), Ph.D. Candidate in Neuroscience & Graduate Assistant, [Iowa State University](#).

<https://bit.ly/37KDCYe>

From 'biologically dead' to chart-toppingly clean: How the Thames made an extraordinary recovery over 60 years

It might surprise you to know that the River Thames is considered one of the [world's cleanest rivers running through a city](#).

by Veronica Edmonds-Brown, [The Conversation](#)

What's even more surprising is that it reached that status just 60 years after being declared "[biologically dead](#)" by scientists at London's Natural History Museum. Yet despite this remarkable recovery, there's no room for complacency—the Thames still faces new and increasing threats from pollution, plastic and a rising population.

The Thames runs 229 miles from Kemble in Gloucestershire to Southend-on-Sea in Essex, where it flows into the North Sea. Where it bisects London, it has experienced pressures from expanding numbers of city dwellers since medieval times.

The river became a repository for [waste](#), with leaking cesspits and dumped rubbish reducing many of its tributaries to running sewers. Many of these small rivers now lie underneath the streets of London, long covered up to hide their foul smells: the Fleet, which runs from Hampstead and enters the Thames at Blackfriars, is probably the best known.

The final straw was the hot [summer of 1858](#)—referred to as the Great Stink—when the high levels of human and industrial waste in the river actually drove people out of London. The civil engineer [Sir Joseph Bazalgette](#) was commissioned to build a sewage network to alleviate the problem, which is still in use today. What followed was over a century of improvements to the network, including upgrading sewage treatment works and installing household toilets linked to the system.

Bombings across the city during the second world war destroyed

parts of the network, allowing [raw sewage](#) to again enter the river. What's more, as the Thames widens and slows through central London, fine particles of sediment from its tributaries settle on the riverbed. These were, and remain, heavily contaminated with a range of [heavy metals](#) from roads and industry, creating a toxic aquatic environment.

For most fish to thrive, the water they live in must contain at least 4-5 milligrams of dissolved oxygen per liter (mg/l). Measurements taken during the 1950s showed that dissolved oxygen (DO) levels in the Thames were at just 5% saturation: the rough equivalent of 0.5 mg/l. That meant the river could only support a few aquatic invertebrate species like midges and fly larvae.

For the 20 miles of the Thames running through central London, DO levels weren't even measurable. And from Kew to Gravesend, a 69km length of river, no fish were recorded in the 1950s. Surveys in 1957 found the river was unable to sustain life, and the River Thames was eventually declared "biologically dead."

Turning tides

With considerable effort from policymakers, the river's fate began to change. From 1976, all sewage entering the Thames was treated, and legislation between 1961 and 1995 helped to raise [water quality standards](#).

The privatization of water companies under Prime Minister Margaret Thatcher also saw the establishment of the protective [National Rivers Authority](#) in 1989, as well as the introduction of [biotic monitoring](#). This is a clever scoring system that measures pollution by counting the macroinvertebrates—such as mayfly, snails or water beetles—found in a river, then giving each species a score according to its tolerance to low DO levels. Low overall scores mean that the river isn't as capable of sustaining organisms that need oxygen, so is less healthy.

As a result, one of the main turning points in the Thames' health

was the installation of large oxygenators, or "[bubblers](#)", to increase DO levels. The Thames Water Authority developed a [prototype oxygenator](#) based on a river barge in the early 1980s. This was replaced by a self-powered "Thames Bubbler" in 1988, and a third vessel was launched in 1999. Together, they're responsible for maintaining oxygen at a level sufficient to support growing [fish populations](#).

The [flounder](#) was officially the first fish species to return to the Thames in 1967, followed by 19 [freshwater fish](#) and 92 [marine species](#) such as bass and eel into the estuary and lower Thames. The return of salmon during the 1980s was a thrilling marker for conservationists, and today around [125 species](#) of fish are regularly recorded, with exotic species like seahorses even being occasionally sighted.

On the surface, this recovery is remarkable. But there remain deeper, unresolved issues relating to contaminated sediments still entering the river. Although the [recession](#) of the 1990s saw the loss of many industries that had been pumping waste into the Thames, water pollution levels haven't significantly fallen since. Heavy metals, for instance, can remain [attached](#) for many decades to clay particles in riverbeds, harming or killing organisms that consume them.

The majority of invertebrates cannot survive or reproduce in such a toxic environment, leaving leeches and fly larvae to dominate the river's fauna. Other dangerous contaminants come from microplastics and water-soluble medicines like [Metformin](#) that sewage treatment works are unable to filter out. The impact of these drugs on aquatic life is unknown.

Both sewage and surface water drains across greater London are overstretched by a system originally designed for fewer than five million people but now used by over ten million. Currently, a new 25 km "[super sewer](#)" is being constructed under London to handle

this increased load. Although it's expected to be completed by 2025, it won't be enough on its own. More investment is also needed in new drainage infrastructure across the city to avoid damage from increasingly frequent [storm surges](#) and overflows if we want to avoid harming the hard-earned health of London's iconic river.

<https://bit.ly/3v8RynL>

Practically forgotten

Reframing the value of outdated practical techniques

By [Oliver Symes](#) 22 April 2022

As chemistry grows in a vast range of different directions, the toolbox of the bench chemist continues to swell. In this oncoming wave of automation, AI and assisted synthesis, older and lesser-used techniques are getting lost in the shadows. The rapid pace with which technology is augmenting chemistry leaves little time to reflect on, review and remember practices of the past – practices which are often still relevant and highly valuable.

The relentless and competitive nature of academic research demands high productivity. Many researchers don't have the luxury of time to contemplate the benefits and drawbacks of all available methods, old and new – they need results, fast. Consequently, older, manual techniques that require additional time and effort are seen as a deadweight, and are discarded in favour of their newer, faster alternatives.

This system of rejection perpetuates an unfair and inaccurate view that older techniques are obsolete and have little to offer, which, in turn, can discourage chemists from engaging with, or even considering, these older methods.

Reflecting on this rather unjust state of affairs, I'm reminded of my undergraduate industrial placement year. I had the challenge of isolating an incredibly water-soluble organic compound and unearthed a generally overlooked technique of purification: continuous extraction. As the name suggests, it essentially extracts

highly water-soluble compounds into the organic phase by running the liquid extraction continuously over a long period of time.

This forgotten technique, among many others, still has some lessons to teach

With the glassware hidden in a storeroom and covered in dust, it became apparent to me that this was not a frequently performed procedure. My incredibly patient supervisor guided me through the set-up, likely holding her breath as I clamped the ancient glassware in place. I poured the aqueous phase into the extraction arm and fitted a clean flask of organic solvent for collection. Then, I lowered the collection flask onto the hot plate and wrapped the whole set-up in cotton wool and foil.

The extraction worked wondrously, with the organic solvent adopting the burnt orange hue of the aqueous phase. Upon returning the equipment, my supervisor told me that it was unlikely to be used again for a long time. I thought it was a shame that the technique was overlooked, especially considering its success and relative ease of use. Even my experienced colleagues were intrigued by how it worked and found its results impressive, which suggests that this forgotten technique, among many others, still has some lessons to teach.

Older and potentially outdated practical chemistry techniques can also be invaluable learning tools. They often form the basis of their modern alternatives, so understanding the core theory of the original method can pay dividends when using their technologically advanced successors.

Before leaving for my placement, my tutor told me that, despite the readily available automated purification systems, I should make the effort to do at least one manual column chromatography purification. This wasn't because he wanted me to suffer or develop a distaste for product isolation, but because he believed doing a manual column would provide me with a greater appreciation and

understanding of the theory behind the method.

And yet I ignored his advice. During my placement and subsequent final year project, I always had an automated option to hand, enabling me to avoid what I perceived to be a manual waste of my time. In fact, it was two years after his comment, upon starting my PhD, that I packed the silica gel myself for the first time. After just one manual column, I realised why my tutor made his original plea. Although it was a disastrous purification and I lost my product, I also gained fundamental insight into the quirks and complexities of this dark art.

Processes that seem so familiar and irreplaceable today will eventually give way to new technologies

Many synthetic chemists will likely scoff and think 'I do six manual columns a day, it's not outdated or forgotten in my lab!' and right you are – for now.

However, the ever-changing face of chemistry means that processes that seem so familiar and irreplaceable today will eventually give way to new technologies and may well cease to be relevant. If we can recognise, extract and record the educational and methodological value of these techniques now, we can help establish their legacy for the future.

By remembering these practices of the past, we as a chemical community could develop a valuable resource for the education and training of all practical chemists, regardless of experience.

For the sake of historical preservation, it would draw a clearer picture of what typically resided in the fume hoods of previous generations, a picture which continues to evolve at a rapid pace. Not only this, but a timeline of techniques would allow for the appreciation of how far practical chemistry has come, and would enable us to anticipate and influence how developing technologies can better enable our chemistry in the future.

<https://wb.md/3rOcEWE>

Researchers Identify Potential Skin Biomarker for ALS

Researchers identified TDP-43 protein in the cytoplasm of dermis cells of individuals with ALS, which was not present in the samples from the two control groups

Carlos Sierra, PhD

[Amyotrophic lateral sclerosis](#) (ALS) is a neurodegenerative disease affecting motor neurons from the cortex, brain stem, and spinal cord. As a result of this disease, motor neurons gradually decrease functioning until they die, which causes progressive and fatal muscular paralysis of the patient. ALS is therefore the most severe motor neuron disease.

Its diagnosis is based on the presence of clinical symptoms such as difficulty walking or carrying out normal daily activities; stumbling and falling; weakness in the legs, feet, or ankles; weakness or clumsiness of the hands; difficulty talking or swallowing; muscle cramps; and spasms in the arms, shoulders, and tongue. These manifestations appear when motor neuron degeneration is in an advanced stage, therefore it is already too late to start a neuroprotective treatment to slow the progression of this incurable disease.

There is a great need to identify biomarkers that would allow for an early diagnosis of ALS. For this reason, researchers from the Autonomous University of Barcelona (UAB) in Spain, Mar Hospital, and Bellvitge University Hospital, all located in Barcelona, Spain, performed skin biopsies on individuals with this disease to analyze their dermis in search of biomarkers that could potentially become tools for early diagnosis.

The results of this study led by Mireia Herrando-Grabulosa, MD, PhD, a postdoctoral researcher, and Xavier Navarro, MD, PhD, professor of physiology, both at the Neurosciences Institute at UAB, and Miguel Ángel Rubio, MD, ALS Unit Coordinator at Mar

Hospital, [were published](#) in the journal *Cells* in January 2022.

The researchers identified TDP-43 protein in the cytoplasm of dermis cells of individuals with ALS, which was not present in the samples from the two control groups. One control group included individuals without ALS, called the healthy control group. The other included individuals with [multiple sclerosis](#) or [Parkinson's disease](#), both neurodegenerative pathologies with a neuroinflammatory component, which was called the neurological control group.

TDP-43 in Motor Neurons

The TDP-43 protein has multiple functions coded by the TARDBP gene. In healthy motor neurons of the brain and spinal cord, this protein is found within the nucleus. However, when these central nervous system (CNS) cells undergo the degenerative processes caused by ALS, this protein is released into the cytoplasm in 97% of individuals with this disorder. It is therefore a marker for this disease. The problem is that conducting biopsies of the CNS to monitor for the possible appearance and progression of the disease is impractical.

However, this protein is also found within the nucleus of all the cells of the body. Therefore, the researchers studied whether the process that occurs in CNS motor neurons of patients with ALS also occurs in the cells of their dermis. In other words, the presence of TDP-43 in the cytoplasm of the dermis of patients with ALS was analyzed.

TDP-43 in Dermis Cells

To examine the possible presence of this ALS skin biomarker, medical professionals participating in this project conducted a retrospective study with a group of 44 individuals (22 women and 22 men with an average age of 66 years) who had previously been diagnosed with ALS at the ALS Units of Mar Hospital and Bellvitge Hospital. The results of this group were compared with

those obtained in the healthy control group, which was composed of 10 patients (6 women and 4 men with an average age of 59 years) with no signs, symptoms, or history of neurological disease and with those of the 10 individuals (5 with Parkinson's disease and 5 with multiple sclerosis) from the neurological control group. All underwent a biopsy of the dermis of the distal third of the leg.

Researchers found that TDP-43 protein had also left the cell nucleus in a significant number of cells of the dermis, the fibroblasts, of ALS patients, while in the samples of the individuals of the healthy and neurological control groups, this protein was found inside the nucleus in almost all cells. Concretely, this anomaly occurred in almost one of every four cells (24.1%) of the dermis tissue of patients with ALS.

"We have found that one biomarker, TDP-43 protein, which functions as a disease fingerprint in the nervous system of individuals with ALS, is also present in the skin," stated Rubio. "Additionally, we have been able to quantify it and determine the theoretical cutoff point to be able to issue a diagnosis in certain cases."

Implications and Next Steps

These results open a promising pathway to allow for the early diagnosis of ALS, "since it is very reasonable to assume that TDP-43 protein is present in the cytoplasm of fibroblasts of the dermis in presymptomatic stages, before initial motor manifestations appear, which justifies its possibly significant diagnostic relevance in those individuals with a family history of ALS and who have gene mutations that predispose them to develop the disease, or in cases of difficult diagnosis," explained Rubio. However, it will not be a tool that can be used in short-term clinical practice. "New studies are needed, with more patients, to certify that this new marker can be used to advance in the diagnosis of the disease," he concluded.

This work was financed by the RTI2018-096386-B-I00 project of the Ministry of Science,

Innovation, and Universities; the Spanish Research Agency; CIBERNED (Network Center for Biomedical Research in Neurodegenerative Diseases, CB06/05/1105) projects; and TERCEL (Cell Therapy Network, RD16/0011/0014) of the Spanish Carlos III Health Institute. The authors have disclosed no relevant financial relationships.

<https://bit.ly/3xR6h8O>

Dingoes aren't just feral dogs, says study

Dingoes might look like regular mutts, but in fact they're genetically in between wolves and dogs, according to a new study published Friday in Science Advances.

by Issam Ahmed

The species—revered in Aboriginal culture but the bane of modern ranchers—has been Australia's top predator since the extinction of Tasmanian tigers last century.

However, "the evolutionary position of the dingo has been debated for a substantial period of time," co-author Bill Ballard of La Trobe University and the University of Melbourne told AFP.

Some hold that the lean, tan-colored canines, brought to the continent 5,000 to 8,500 years ago, are simply another form of domestic dog, though one which is far harder to tame or keep as a pet. Though not normally aggressive, they aren't especially interested in humans.



Sandy the desert dingo as a mature female.

The new research—a global collaboration involving 26 authors from 10 countries—compared the genome of a desert dingo named Sandy, who was rescued in 2014 along with her siblings—to those of five domestic dog breeds and the Greenland wolf.

They found the dingo's genome was structurally distinct from the boxer, German shepherd, basenji, Great Dane and Labrador retriever. But she still shared more similarity with the domestic dogs than with the Greenland wolf. Among the breeds, Sandy was closer to the German shepherd than the rest.

"Sandy the desert dingo is intermediate between the wolf and the domestic dogs," concluded Ballard. To be even more sure, the team is sequencing the genome belonging to an alpine dingo, found in the Australian Alps in the country's east.



Knowing more about dingo evolution can also illuminate the history of the ancient people who brought them across the sea from Southeast Asia, say scientists.

Ancient human movements

The finding can have several applications. For one, the dingo genome can be used as an ancient reference book to help identify which genes are responsible for genetic disease in modern dogs, rather than trying to compare between inbred dog breeds.

Knowing more about dingo evolution can also illuminate the history of the ancient people who brought them across the sea from Southeast Asia.

"At some stage they had to cross some water with some traveling peoples," said Ballard. "Whether they're First Nation Australians or whether they're people that interacted with First Nation Australians, we don't know."

The team hopes to get a clearer sense of the timeline and start to answer other questions like whether it was a single migration or multiple, once they sequence the alpine dingo.

The study also set out to test the differences in how dingoes metabolize nutrients compared to domestic breeds, by running a controlled diet study on a number of dingoes and German shepherds.

Dingoes, like wolves, have only one copy of a gene that creates pancreatic amylase, a protein that helps dogs live on starchy diets,

which humans have thrived on especially in the past 10,000 years. German shepherds have eight copies of the gene. After receiving the same water and rice-rich food for 10 days, the German shepherds' scat was found to contain three bacteria families that helped them in breaking down starch, confirming the researchers' predictions.

Like the wolf in North America, dingoes are deeply polarizing: they are romanticized by city dwellers and feature prominently in Indigenous songs and stories, but are hated by farmers for allegedly killing livestock.

According to Ballard, however, dingoes evolved to prey on small marsupials and aren't easily able to digest high-fat foods—thus lambs are more likely being hunted by feral dogs or hybrids.

He hopes to test the prediction, and perhaps exonerate the dingo, in future behavior experiments.

More information: Matt A. Field et al, *The Australian dingo is an early offshoot of modern breed dogs*, *Science Advances* (2022). DOI: [10.1126/sciadv.abm5944](https://doi.org/10.1126/sciadv.abm5944).
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Longer Interval Between COVID-19 Vaccines Generates Up to 9x As Many Protective Antibodies
New research has shown that a longer interval between primary COVID-19 vaccine doses can boost antibody production up to nine-fold.

The study will be presented at this year's European Congress of Clinical Microbiology & Infectious Diseases (ECCMID) in Lisbon, Portugal, (April 23-26, 2022).

Understanding the immunological response to vaccination against COVID-19 is critical to controlling the virus and minimizing the number of deaths.

To find out factors affecting antibody responses following Pfizer/BioNTech Covid vaccination, Dr. Ashley Otter and

colleagues at the UK Health Security Agency (UKHSA) measured antibody levels in blood samples taken from almost 6,000 healthcare workers from across the UK enrolled within the UK's SIREN study (SARS-CoV-2 Infection and Reinfection and EvaluationN).

3,989 of the 5,871 participants had their first dose of the vaccine at least 21 days earlier. 1,882 had their second dose at least 14 days earlier. The participants were classified by infection history as either previously having had Covid (confirmed by a PCR test or assumed due to their antibody profile) or naïve, with no history of infection. Almost all (>99%) of those who hadn't had Covid seroconverted after vaccination, meaning they made antibodies against the virus.

Post-dose 1, those with previous infection had up to ten times higher antibody levels than naïve individuals, whilst after dose 2, those with previous infection had antibody levels more than twice as high as those who hadn't had previous infection.

When analysing dosing intervals, it was found that longer dosing interval was associated with up antibody levels that were up to nine times higher in naïve participants (>2 and <4 weeks: 1,268.72 (1,043.25-1,542.91) and >10 weeks 11,479.73 (10,742.78-12,267.24), $p < 0.0001$) with a more pronounced effect observed in younger participants.

Dosing interval didn't affect antibody levels in those with previous infection. However, a longer interval between infection and vaccination was linked to higher antibody levels.

Those who had their first dose of the vaccine eight months after an infection had antibody levels seven times higher than those who were vaccinated three months after infection, with a plateau after eight months, suggesting that eight months after primary infection may be an optimum time to receive the first vaccine in those with prior infection.

However, the analysis shows that regardless of the timing between infection and vaccination, all individuals mount a very high antibody response after dose 2.

In addition, female participants and those from an ethnic minority were associated with significantly higher antibody titres, whilst immunosuppression was associated with significantly lower post-vaccination antibody responses.

Dr. Otter says: "This study shows that a longer time between vaccine dose 1 and dose 2 results in higher antibody responses in naïve participants, which strongly supports the decision by JCVI and the UK government to lengthen the interval between vaccine doses.

"We've also shown that in those with previous infection, timing between exposure and vaccination plays a critical role in post-vaccination antibody responses. However, further research is needed to determine whether these higher antibody levels provide greater protection against COVID-19 disease and how this longer dosing interval may affect booster responses."

The analysis was funded by the UKHSA and the UK Department of Health and Social Care and was part of the SIREN study, the world's biggest real-world study into COVID-19 antibodies.

Meeting: The European Congress of Clinical Microbiology & Infectious Diseases (ECCMID 2022)