New Scientist

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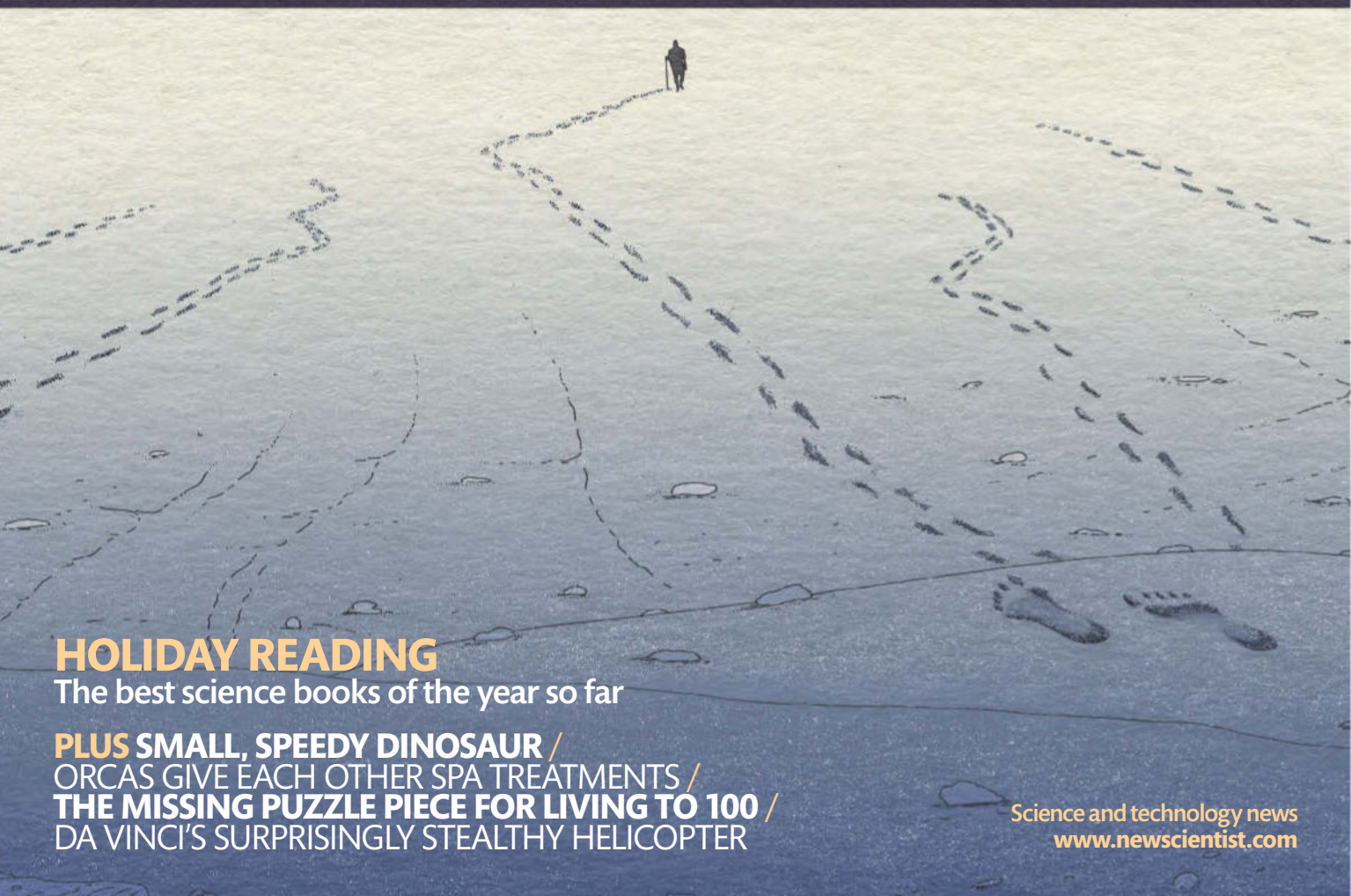
HOW NAPS MAKE YOU SMARTER

WHY ARE WOMEN'S PELVISES GETTING SMALLER?

THE PEOPLE WHO VANISHED

We finally know what happened to our ancient relatives who set out to conquer the world – and didn't make it



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Science and technology news
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THE GREATEST CHALLENGES OF OUR TIME

THROUGH THE EYES OF THE GLOBAL HERO WHO CHANGED THE COURSE OF HISTORY

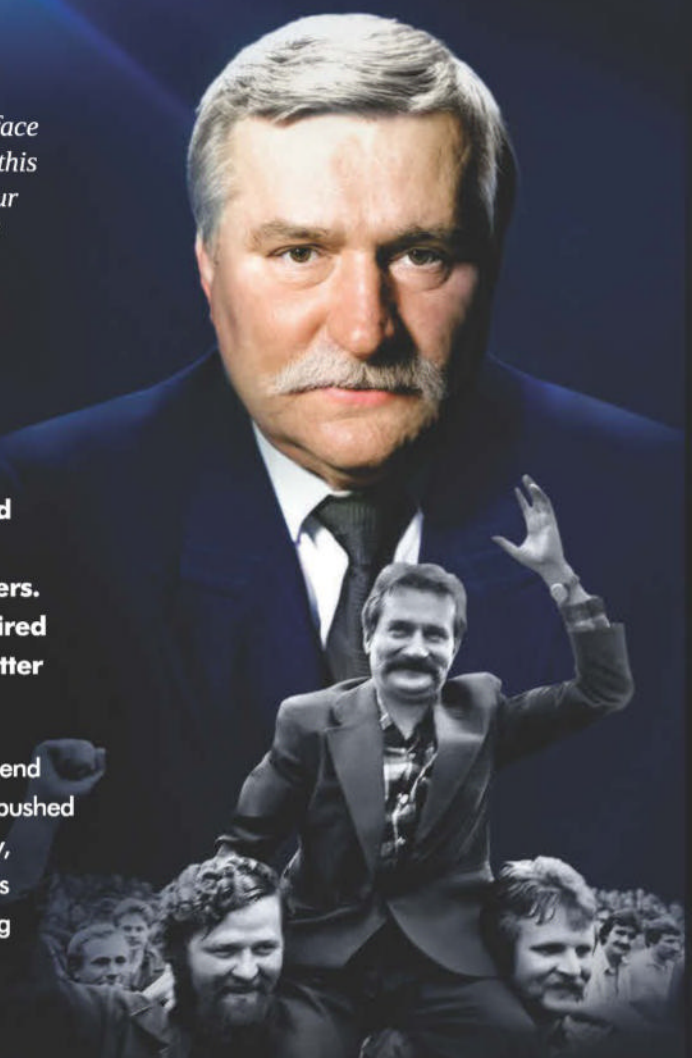
HISTORIC EVENT

AN EVENING WITH PRESIDENT

LECH WALESA

NOBEL PEACE PRIZE WINNER AND FORMER PRESIDENT OF POLAND

USA & CANADA GRAND LECTURE TOUR | AUGUST 31 – OCTOBER 30, 2025



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Sep 6	Oakland, CA
Sep 8	Seattle, WA
Sep 12	Denver, CO
Sep 14	Houston, TX
Sep 18	Austin, TX
Sep 20	Dallas, TX
Sep 22	Atlanta, GA
Sep 24	Columbus, OH
Sep 26	Pittsburgh, PA
Sep 27	Baltimore, MD
Sep 28	Cleveland, OH
Sep 30	Minneapolis, MN
Oct 2	St. Louis, MO
Oct 4	Chicago, IL
Oct 5	Milwaukee, WI
Oct 9	Miami, FL
Oct 11	Orlando, FL
Oct 13	Boston, MA
Oct 15	Charlotte, NC
Oct 17	Philadelphia, PA
Oct 18	New York, NY
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Oct 25	Toronto, ON
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NS Live

Why is health information so confusing?!

Why is it so hard to find useful and understandable medical information on the internet? On 18 October at Excel London, NHS consultant cardiologist and comedian Rohin Francis dives into the wild world of medical media to find out why too much information can be bad for your health.

newscientist.com/nslive

Tour

Alfred Russel Wallace expedition cruise, Indonesia

Hop aboard the beautiful sailing boat Ombak Putih and explore the Maluku Islands (Spice Islands) and Raja Ampat Island, just as Alfred Russel Wallace did. Marvel at the islands' biodiversity and stunning beauty as you visit the regions that shaped Wallace's groundbreaking discoveries. This 13-day tour starts on 23 January 2026, and costs $13,999.

newscientist.com/tours

Podcast

The world, the universe and us

The team discusses the first fertile mice that have been born to two fathers and what it might mean for the future of human births. Find out why taking a nap boosts your brain power, and get some scientific tips for a good night's sleep. Plus, hear about a lizard species that survived the asteroid impact that killed the dinosaurs.

newscientist.com/nspod

ALEXANDER ARNDT/ALAMY

Island adventure Follow in the footsteps of Alfred Russel Wallace

HERNAN STOCKEBRAND/VERA C. RUBIN OBSERVATORY

Stargazing Step inside the Vera C. Rubin Observatory

Video

Look inside the revolutionary Vera Rubin Observatory

After decades of planning and construction, the Vera C. Rubin Observatory is about to begin a 10-year survey of the southern sky and has already produced some stunning images. *New Scientist* got a behind-the-scenes look at the telescope during the first few weeks of its operation.

youtube.com/newscientist

Newsletter

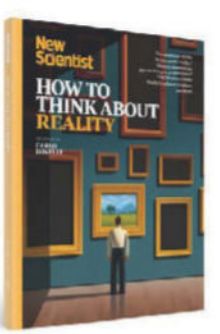
Earth Edition

Earth's climate is changing rapidly, and now it seems the UK may soon face temperature spikes above 45°C. It is looking increasingly foolish to rely on solutions like tree planting to solve our emissions problem. Other areas, from carbon removal to nuclear fusion, are also facing hurdles to progress.

newscientist.com/earth-edition

Video

"We're going to get an entirely new look at the universe"



How to think...

In the second issue of our new *How To Think About* series, we are diving into the mind-bending concept of reality, with the world's best scientists and philosophers as our guides. Together, we'll explore groundbreaking ideas that bring us closer than ever to unravelling the true nature of the universe.

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A drop in the ocean

World's first climate migration treaty is unprecedented, but small in impact

A LIFELINE has been extended to the people of Tuvalu, a low-lying Pacific nation where rising sea levels are creating ever more problems. Each year, Australia will grant residency to 280 Tuvaluans (see page 8). The agreement could see everyone currently living in Tuvalu move within just a few decades.

Effectively the world's first climate migration agreement, the Australia-Tuvalu Falepili Union will also provide adaptation funds to help those who stay behind.

Is this a model for how climate migration can be managed in an orderly way, before disaster strikes? Far from it. To get this deal, Tuvalu must allow Australia a say in future security and defence matters. Few other countries are likely to agree to similar terms.

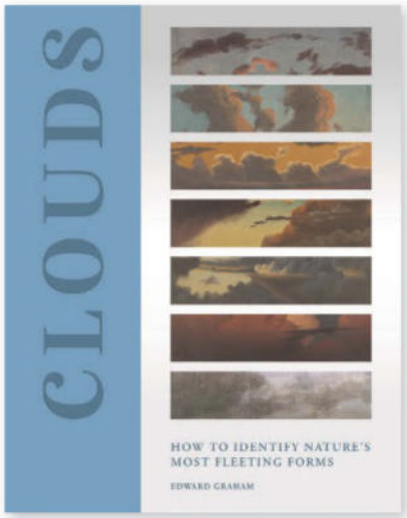
Tuvalu's population is also very small. Taking in around 10,000 climate migrants would be inconsequential for a country of 28 million like Australia. Worldwide, it is estimated that between 25 million and 1 billion people might be forced to move by 2050 because of climate change and other environmental factors. Where will they go?

> "One billion people might be forced to move by 2050 due to environmental factors"

Many argue that the wealthy countries that emitted most of the carbon dioxide that is warming the planet have a moral duty to help people displaced by climate change. But these kinds of discussions have yet to be translated into the necessary legal recognition or acceptance of forced climate migrants. On the contrary, many higher-income nations seem to be becoming more hostile to migrants of any kind.

There has been a little progress in setting up "loss and damage" funds to compensate lower-income countries for the destruction caused by global warming. This could help limit the need for climate migration in the future – but the money promised so far is a fraction of what is required.

The most important thing nations should be doing is limiting future warming by cutting emissions – but globally these are still growing. Sadly, the Falepili Union is a drop in the ocean, not a turning of the tide. ▮

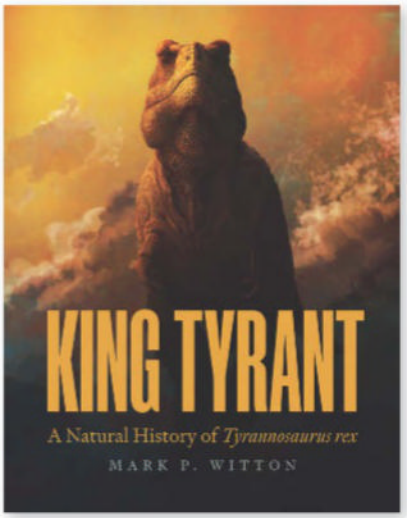


"This truly excellent book will teach you the science of clouds in a manner accessible to anyone."

—David Gascoigne, *Travels with Birds*

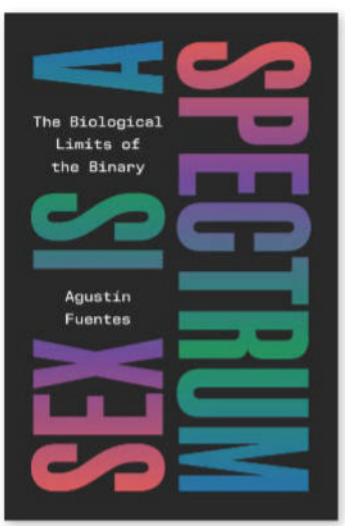
"Taor provides offbeat and intriguing stories showing connections between seemingly unrelated body parts."

—Kevin McDonough, *Booklist*



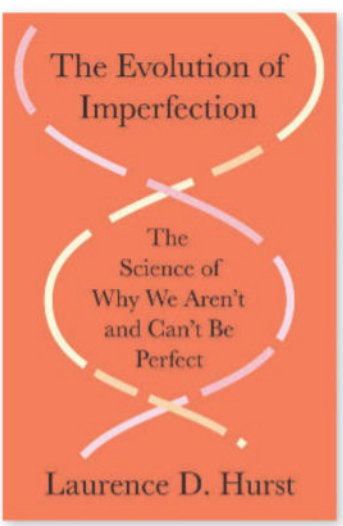
"Witton writes with expertise and enthusiasm in a way that is informative to both newbies and dinosaur aficionados."

—Catherine Lantz, *Library Journal*



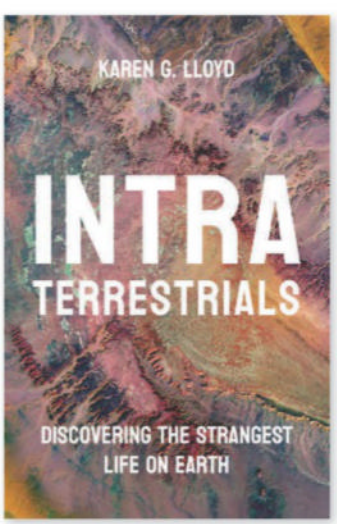
"In clear, accessible language, Agustín Fuentes has written The Book explaining the expansiveness of human biology based on scientific evidence and biocultural reality."

—Karla J. Strand, *Ms. Magazine*



"A profound yet accessible synthesis of evolutionary thinking in the molecular era. I unreservedly recommend this book!"

—Joanna Masel, author of *Bypass Wall Street*



"An astonishing, exhilarating, mind-bending journey into the hidden living world deep beneath our planet's sunlit surface."

—Robert M. Hazen, author of *The Story of Earth*

News

Throwing shapes
Self-righting shape always lands on the same side p11

Fighting back
Ash trees have evolved a defence to deadly disease p13

Ageing artefact
World's oldest boomerang just got even older p14

Generation gap
Generative AI doesn't understand Gen Alpha p16

Cosmic crash
High-speed collision created a weird line of galaxies p19

Ornithology

Follow the flamingos

Reflected on the surface of Lake Tuz in Turkey, these flamingos are following a well-trodden path. Every spring, tens of thousands fly to this salt lake to breed. However, as the lake dries up due to drought and farming irrigation, fewer flamingos than usual arrived this year and around 2000 chicks have died. To adapt, the birds are changing their migration routes to travel to other wetlands in the country.

HARUN OZALP/ANADOLU VIA GETTY IMAGES

Climate change

Tuvaluans seek escape from rising seas

With the island country of Tuvalu in danger of flooding, nearly a third of its citizens have applied for Australia's world-first climate migration visa, finds **James Woodford**

HOW does it feel to lose your home to climate change? The roughly 10,000 residents of Tuvalu will be among the first in the world to have to confront this question.

With an average height above sea level of less than 3 metres, Tuvalu is on course to become completely uninhabitable due to flooding, storm surges and erosion. By 2100, sea levels are projected to rise by 72 centimetres and the coral atoll archipelago, which is roughly midway between Australia and Hawaii, is expected to experience flooding for nearly a third of every year.

But the people of Tuvalu have been offered an escape route. In late 2023, the Australian government announced that it would launch what effectively amounts to the world's first planned migration of an entire nation.

Under the Australia-Tuvalu Falepili Union Treaty, 280 Tuvaluans each year will be granted Australian residency through a ballot. The first lottery opened on 16 June this year, and 3125 citizens – nearly a third of the country's population – have already applied. The closing date to register for this year's lottery is 18 July.

In a statement to *New Scientist*, the Australian government said it recognises the "devastating impact climate change is having on the livelihoods, security and well-being of climate-vulnerable countries and people, particularly in the Pacific region".

"This is the first agreement of its kind anywhere in the world, providing a pathway for mobility with dignity as climate impacts worsen," the government said.

Successful applicants should know the results of the lottery by the end of July, and the first migrants are expected to arrive in Australia by the end of the year.

TORSTEN BLACKWOOD/AFP VIA GETTY IMAGES

The island nation of Tuvalu may soon become uninhabitable

72cm
How much global sea levels are expected to rise by 2100

10,000
The population of Tuvalu

3125
How many Tuvaluans, at the time of writing, have applied for Australia's climate visa

Bateteba Aselu is a Tuvaluan doctoral student at the University of Melbourne who researches the challenges posed by climate change to her compatriots. Aselu is currently on a student visa in Australia while completing her studies, but is considering lodging an application to join this year's ballot along with her husband. Her son, who has just graduated from high school, has already applied.

She says the impacts of climate change are already being felt because the freshwater aquifers that underlie Tuvalu's atolls, which are critical for agriculture and drinking water, are being infiltrated by seawater due to sea level rise. This is forcing people to raise their crops off the ground to keep the salinity at bay.

Stephen Howes at the Australian National University in Canberra says the new visa is "remarkably liberal", giving successful applicants full access to nearly all Australian health and social security benefits, without discrimination based on chronic health conditions, disabilities, age or other exclusions, which is common in other visa streams.

While the agreement is ostensibly about helping Tuvalu deal with its imminent climate crisis, the prize for Australia is to stymie China's push for power in the Pacific, says Howes. The treaty has a provision that Australia and Tuvalu must "mutually agree on" matters of security and defence agreements between the island state and other countries.

"I've described it as a security-migration agreement," says Howes. "Climate change provides the framing, but it is an arrangement whereby Tuvalu gives Australia privileged security treatment, in return for which Australia will give Tuvalu privileged migration treatment."

Jane McAdam at the University of New South Wales in Sydney says there are diverse views in Tuvalu about what the future holds. People have said to her they were told the island would be underwater by now and it isn't.

She also says there are older people who say they will never leave and will die on the islands.

But McAdam sees the new migration scheme as "decent and positive". One important aspect is that once a Tuvaluan has gained the visa, they can return home as often as they like or even live there until the situation on the atolls becomes too dire.

It will be "like an oxygen mask on an airplane", says McAdam. "Hopefully, you will never need it, but you're very grateful it's there."

Wesley Morgan, also at the University of New South Wales, says the agreement could be extended to other nations in similar circumstances, such as Kiribati.

"This is potentially a precedent, a global first where a migration pathway is explicitly tied to climate change and sea level rise," says Morgan. "And because of these unique circumstances, I think Australia might pursue similar arrangements in future with Kiribati."

The question that remains for the Tuvaluan people is how they resolve their identity and sovereignty after moving away from their islands.

"If you have a place where you grew up and something happened and you had to move, how would you feel?" says Aselu. "Would you feel lost? Yes. So, I think that is the kind of feeling that you will have in any place around the world where you lose the place that you love, that you belong to and you feel identified with.

"Because you grew up in that place. It's where your history is. It's where your families are from, and it's a place you identify with regardless of where you are in the world. And if that place is lost, how do you identify yourself? How do we identify ourselves?" ▮

Health

Cancer cells steal mitochondria from neurons to fuel their spread

Carissa Wong

THE discovery that cancer cells are taking the energy-generating parts of nerve cells to help them grow could help improve treatments against the deadliest tumours.

"This is the first time that mitochondrial exchange has been demonstrated from nerves to cancer cells," says Elizabeth Repasky at the Roswell Park Comprehensive Cancer Center in Buffalo, New York, who wasn't involved in the research. "It's a major next step in cancer neuroscience, a field that's exploding."

"This is the first time mitochondrial exchange has been seen from nerve to cancer cells"

We already knew that nerve cells, or neurons, within and surrounding tumours produce proteins and electrical signals that help cancer grow and spread. "Cancers with higher nerve density are associated with poorer prognosis," says Simon Grelet at the University of South Alabama.

Prior studies have also shown that brain cancer cells can acquire mitochondria – energy-generating structures – from non-neuronal brain cells. But it was unknown whether tumour cells could take mitochondria from nerve cells, says Grelet.

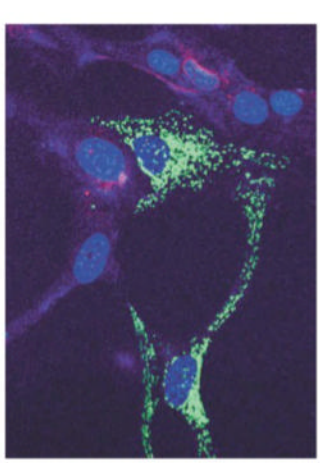
To find out, he and his colleagues genetically engineered breast cancer cells from mice to contain a red fluorescent molecule and mixed them with mouse nerve cells, containing mitochondria labelled with green pigment, in a lab dish. By imaging the cells, they found that cancer cells stole mitochondria from the nerve cells within a few hours (*Nature*, doi.org/g9rd23).

"The cancer cells elongate their membrane so they are stealing, siphoning, the mitochondria from the neurons," says Grelet. "It's like a train of mitochondria that pass through a very tiny structure, entering the cancer cell one at a time," he says.

To see if this occurs in the body, the researchers injected red breast cancer cells into the nipples of female mice to form tumours.

They also genetically engineered the nerves around the tumours to carry green mitochondria. Around a month later, 2 per cent of the cancer cells in these tumours had acquired mitochondria from neurons.

In contrast, 14 per cent of tumour cells that had spread to the brain carried nerve-derived mitochondria – suggesting that cancer cells with nerve-derived mitochondria were much better at spreading than those without. Further experiments suggest this is because cells with stolen mitochondria are better at enduring physical and chemical stresses that they encounter in the bloodstream.



SIMON GRELET AND GUSTAVO AYALA

A neuron's mitochondria (green) start moving towards cancer cells (red)

"There are many, many obstacles for a cancer cell that's trying to spread," says Repasky. "They have to break out of the initial tumour, make it through barriers of the blood vessels, get out of the blood, then get enough oxygen and nutrients at the secondary site – most of them don't make it," she says. "Stealing mitochondria seems to allow cancer cells to better endure that obstacle course," she says.

Blocking the transfer

To explore if this happens in people, the researchers analysed tumour samples from eight women with breast cancer that had spread to distant sites within their bodies. They found that tumour cells from other parts of the body had 17 per cent more mitochondria, on average, compared with those in the breast, suggesting the process does occur in patients, says Grelet.

What's more, the team analysed a human prostate tumour sample and found that cancer cells closer to nerves contained substantially more mitochondria than those further away.

"We think it would be a universal mechanism that all sorts of tumours will be doing," says team member Gustavo Ayala at the University of Texas Health Sciences Center at Houston.

The findings suggest that blocking mitochondrial transfer could reduce the spread of the deadliest tumours. "I do believe this will be possible, at least in certain kinds of tumours," says Repasky. Ayala says the researchers plan to develop drugs that can do this. ▮

Neuroscience

Deep sleep seems to lead to more "eureka" moments

Christa Lesté-Lasserre

YAO QILIN/XINHUA/ALAMY

These people may wake up with some big new ideas

WAKING up from a deep nap appears to make people better at creative problem-solving.

In a new study, people were more likely to have a "eureka" moment if they had recently entered the second stage of sleep than if they had slept lightly or not at all.

The findings suggest that a brief, deep nap can trigger valuable moments of insight, says Anika Löwe at the Max Planck Institute for Human Development in Berlin.

"I think we're at the very beginning of uncovering what's actually happening during sleep that makes it so beneficial," she says. "One possibility is that during deep sleep, our brains sift through what's relevant and what's irrelevant, and so when we wake up, we have these insight moments that get to the gist of the problem."

Previous studies have mostly found that naps can boost creativity and help people solve problems, but there is disagreement over which stage of sleep is the most beneficial. Several suggest that the lightest stage of non-REM sleep, N1, is ideal. But other studies suggest that the deeper N2 stage – which is lighter than slow-wave N3 sleep – triggers more innovation.

To investigate further, Löwe and her colleagues asked 90 people aged 18 to 35 who didn't have a sleep disorder to use a keyboard to classify the direction of motion of hundreds of rapidly flashing dot patterns on a screen. They didn't inform

"We're at the very beginning of uncovering what makes sleep so beneficial"

the participants that the dots' colours gradually began to predict the correct answer partway through the task.

Fifteen participants spontaneously figured out the shortcut during the first 25 minutes of the task. The remaining 75 were invited to lie down for a 20-minute nap in a quiet, dark room, while hooked up to EEG monitors that tracked their brain activity.

After the nap, they tried the tasks again. This time, most of the participants figured out the shortcut from the colours, but the likelihood of a eureka moment appeared to depend on how deeply the people had napped. Among the 68 participants whose EEG data permitted high-quality readings, 85.7 per cent of people who fell into deep N2 sleep figured out the shortcut, compared with only 63.6 per cent of those who reached only the lighter N1 phase and 55.5 per cent of those who didn't slip into sleep at all (*PLOS Biology*, doi.org/g9rhmt).

The study clearly shows that deeper sleep facilitates eureka moments – at least for this particular task, says Itamar Lerner at the University of Texas at San Antonio. "The type of task used is critical for whether it is boosted by sleep or not."

Delphine Oudiette at the Paris Brain Institute notes that different task designs could explain why her team found significantly more problem-solving after N1 sleep. "Maybe both sleep stages matter, but for different types of cognitive processes that we have to isolate to understand better," she says.

Björn Rasch at the University of Fribourg, Switzerland, says the findings support the idea that deeper sleep may support problem-solving. Even so, he cautions that the study's design makes it hard to separate cause from coincidence. Because participants weren't randomly assigned to sleep stages or studied individually across different sleep scenarios, it is possible those who managed to fall asleep in an IKEA armchair at a research lab might just happen to be those who "simply have higher insight capabilities", especially after a nap, he says. ▮

Technology

Flexible fabric could make X-rays more comfortable

Karmela Padavic-Callaghan

GETTING an X-ray can be uncomfortable – you may have to lie still while you are in pain or have part of your body compressed. But a fabric that makes X-rays easier to detect could eliminate that.

"Imagine scanning a child's injury without immobilising them, or enabling pain-free breast exams," says Li Xu at the Hong Kong Polytechnic University. She and her colleagues created a textile called X-Wear that scintillates – meaning it releases light when exposed to X-rays – which could make this a reality.

Because X-rays are more difficult to detect than visible light, medical and industrial X-rays, as well as CT scans, use scintillating components. These can pick up X-rays after, for example, passing through a limb, converting the rays that emerge into visible light that can then be used to create an image of the body part to show details like broken bones. Most scintillators are rigid, which makes the devices that house them bulky and difficult to interact with.

To avoid this, the researchers reshaped scintillating materials, for instance gadolinium oxide studded with bits of europium, into narrow fibres, which is woven into X-Wear (*Science Advances*, DOI: 10.1126/sciadv.adv5537).

In tests, Xu and her team showed that the fabric can be useful for taking dental X-rays, conforming it to the shape of a mouth model made from clay and teeth. They also used it for mammography, creating an X-Wear bra that eliminated the need for a person's breast to be compressed during imaging, which is standard current practice.

The researchers can produce samples of X-Wear up to around a quarter of a square metre, so before it can be widely used, they will have to scale its production to larger sizes and adapt it to industrial-grade equipment, says Xu. ▮

Climate change

Bold plan to save vital ocean current

Giant parachutes could keep warm water circulating in the Atlantic – but some are sceptical

Madeleine Cuff

SHIPPING tankers, drones and fishing boats could be used to drag massive parachutes through the waters of the Atlantic Ocean as part of a drastic plan to avert catastrophic climate change.

The Atlantic Meridional Overturning Circulation (AMOC) transports warm water from the tropics northwards, helping to keep northern Europe temperate.

However, a rapidly melting Arctic and warming ocean temperatures are weakening the current, with some scientists fearing it could shut down altogether at some point in the coming century. This would plunge oceanic ecosystems into chaos and rapidly cool Europe's climate by several degrees.

Greenhouse gas emissions need to be cut rapidly to reduce the risk of AMOC collapse, experts stress. But some are considering other, more radical approaches.

Stuart Haszeldine at the University of Edinburgh, UK, and David Sevier of UK water treatment firm Strengite presented one idea at the Arctic Repair conference in Cambridge, UK. They say that just 35 sea tugboats could be used to pull underwater parachutes, each about the size of half a football pitch, to move enough water to maintain the current.

The parachutes – similar in design to existing sea anchors, which are used to stabilise vessels in inclement weather – would help to propel the water flowing along the surface of the ocean. Each one would feature a hole with a 12-metre diameter in its centre to allow marine life to escape.

Ocean currents have a big effect on Earth's climate

KARSTEN SCHNEIDER/SCIENCE PHOTO LIBRARY

Drones, shipping tankers, tugboats or wind kites could be used to drag the parachutes, operating 365 days a year on a rotating-shift basis.

Sevier described the idea as a "Hail Mary" to prevent the catastrophic consequences of a collapse. "This is about buying time," he argues, for the world to cut emissions enough to stabilise global temperatures at a safe level.

However, the idea has been met with scepticism from leading AMOC researchers. René van Westen at Utrecht University in the Netherlands points out that differences in density between cold, salty water and warm, fresher water are key to the downwelling and upwelling motion that sustains the AMOC.

"If [this idea is] possible, they can only maintain the surface layer using the overhead winds," says van Westen. "The ocean density differences are far more important for the AMOC and hence, I'm not convinced that this can sustain the AMOC."

Stefan Rahmstorf at the Potsdam Institute for Climate Impact Research in Germany agrees. "The issue is not to move surface water along horizontally; it is to make it sink down to a depth of 2000 to 3000 metres and flow back to the south as a cold, deep current," he says.

Meric Srokosz at the UK's National Oceanography Centre says the proposal is "unlikely to work", given the challenges of deploying equipment in the ocean in unpredictable weather conditions.

Haszeldine says he welcomes any feedback from other scientists on the idea and hopes ocean and climate modellers will help to investigate the ecological and environmental impacts of the plan. ▮

Mathematics

Self-righting shape solves long-standing maths mystery

A FOUR-SIDED shape that will always come to rest on the same side no matter what side it starts on has been built, decades after it was first proposed to exist.

Mathematicians have long been fascinated by self-righting "monostable" shapes, which have a preferred resting spot when placed on a flat surface. In 1966, mathematician John Conway proved it was impossible to do this with a four-sided shape, or tetrahedron, that had an even distribution of mass. However, he said an unevenly balanced monostable tetrahedron could work, but never proved it.

Now, Gábor Domokos at the Budapest University of Technology and Economics, Hungary, and his colleagues have built a monostable tetrahedron, using carbon-fibre struts and a plate made of ultra-dense tungsten carbide.

Domokos asked his student, Gergő Almádi, to hunt for Conway's tetrahedron by conducting a brute-force search with powerful computers. As Conway predicted, they didn't find any monostable tetrahedrons with an even weight distribution, but they did find some uneven ones, and proved their existence mathematically.

GERGŐ ALMÁDI ET AL.

This pyramid-like shape will always land on the same side no matter where it starts

But building a real-life example proved to be "an order of magnitude more difficult", says Domokos: their calculations showed that the difference between the density of the weighted and unweighted parts of the object needed to be about 5000-fold, meaning the object would need to be essentially made from air but still rigid.

So, the team partnered with an engineering company to precisely engineer the carbon-fibre struts to within a tenth of a millimetre and make the tungsten plate to within a tenth of a gram (arXiv, doi.org/pttz).

Domokos hopes their work will be used to help make lunar landers less likely to fall over. ▮

Alex Wilkins

Health

Stomach surgery offers cancer clue

Simulating the effects of a weight-loss procedure on bile acids could help treat tumours

Carissa Wong

GASTRIC bypass surgery may cut the risk of colorectal cancer by altering levels of molecules called bile acids in the blood and small intestine. The findings could lead to new treatments.

Gastric bypass surgery involves stapling the stomach to form a small upper pouch and a larger lower pouch. The small intestine is then connected to the upper pouch so food and digestive juices bypass most of the stomach and the start of the small intestine.

Prior studies have linked the procedure to a reduced risk of colorectal cancer, but it was unclear why. To find out, Rebecca Kesselring at the University of Freiburg in Germany and her colleagues fed mice a high-fat diet until they gained around 50 per cent of their initial body weight, on average. They then gave a third of the mice gastric bypass surgery and the rest a sham surgery.

To isolate the effect of having gastric bypass surgery from that of losing weight, the team put the gastric bypass group and half of the remaining mice on a diet

"We could maybe figure out some oral drug that reduces these bile acids to give to people with cancer"

that caused them to lose about a fifth of their weight, on average, over six weeks.

The researchers then implanted colorectal cancer cells into the mice's colons. After another six weeks, they found that colon tumours in the gastric bypass group were two-thirds smaller than those of either the mice that had kept gaining weight or had lost weight through diet alone.

What's more, tumours had spread to the liver in only one mouse out of 20 in the gastric bypass group, but in most animals in the sham groups.

The team wondered if changes in bile acids, a mix of molecules that digest fats, might be why. These are usually made by the liver and pass through the gall bladder, stomach and small intestine before returning to the liver via the blood.

"With bypass surgery, bile acids are introduced later into the small intestine," says Kesselring. This means they may encounter a different mix of gut bacteria, which chemically alter the molecules.

The mice that underwent gastric bypass surgery had reduced levels of some bile acids called primary bile acids in their colons and blood compared with the sham groups.

To test whether these changes alter cancer risk, the team put another group of mice through the same experiment – but instead of gastric bypass surgery, these mice had an operation that simply diverted their bile acids to a later part of their small intestine without altering the stomach.

Crucially, they found this lowered levels of primary bile acids in the blood and reduced the size and spread of colorectal tumours as effectively as gastric bypass surgery. In another experiment they also found that primary bile acids boost the growth of colorectal cancer cells in a lab dish (*Science Translational Medicine*, doi.org/ptgm).

"We could maybe figure out some oral drug that reduces these bile acids, that we could give to people with cancer," says Vance Albaugh at Louisiana State University. ▮

Palaeontology

Small and speedy Jurassic dinosaur reconstructed

LUCIE GODAYLE/THE NATURAL HISTORY MUSEUM, LONDON

The recently discovered dinosaur species was a 64-centimetre-tall herbivore

A NEWLY discovered species of dinosaur, *Enigmacursor mollyborthwickae*, was a speedy, two-legged herbivore that lived about 145 million to 150 million years ago in the Late Jurassic Period.

Susannah Maidment and Paul Barrett, palaeontologists at London's Natural History Museum, analysed the specimen, which was uncovered from the Morrison Formation in the western US in 2021–22.

Back then, it was thought to be a *Nanosaurus* – a poorly known species of small herbivorous dinosaur. The *Enigmacursor* fossil isn't complete, but using the few found teeth – which reveal it ate plants – and portions of the neck, backbone, tail, pelvis, limbs and feet, Maidment and Barrett have defined this fossil as a new species, placed it in an evolutionary tree and reconstructed it for display (*Royal Society Open Science*, doi.org/ptgs). The animal would have been about 64 centimetres tall and 180 cm long.

They have based the structure of missing elements, like the skull, on similar small dinosaurs like *Yandusaurus* and *Hexinlusaurus*.

"This is a two-legged dinosaur and it's got very small forearms that it probably would have used to grasp food to bring it to its mouth," says Maidment. "And it's got incredibly large feet and very long limbs. So, it was probably quite fast by dinosaur standards."

That is where the "cursor" part of its name comes from: it means "runner".

The specimen's vertebrae weren't fused, which implies it wasn't fully mature when it died. "I think this animal was probably a teenager, but it may well have been sexually mature, so it might not have got that much bigger," says Maidment.

The reconstructed skeleton is now on display in the Earth Hall of the Natural History Museum, alongside its contemporary, Sophie the Stegosaurus. ▮

Chris Simms

Health

Deaths from heart attacks have fallen sharply in the US

Grace Wade

HEART attacks are no longer the leading cause of death in the US, while deaths from chronic heart conditions have skyrocketed.

"We've made some really great progress in certain areas of heart disease mortality, but now we're seeing this shift," says Sara King at Stanford University in California.

She and her colleagues collected data on heart disease deaths from 1970 to 2022 using the US Centers for Disease Control and Prevention's WONDER database, which tracks all recorded fatalities in the country.

They found that in 2022, heart disease accounted for 24 per cent of all deaths in the US, down from 41 per cent in 1970. The decline is largely thanks to an almost 90 per cent decrease in heart attack deaths, which were once the deadliest form of heart disease (*Journal of the American Heart Association*, doi.org/ptfr).

"Incredible progress has been made to reduce deaths from heart attacks over the last 50 years," says King, thanks to new therapies and public health measures.

Even so, heart disease remains the country's top killer, mainly because deaths from other types of heart disease – mostly chronic conditions – have increased 81 per cent over the same period. For instance, fatalities from heart failure, arrhythmia and hypertensive heart disease have risen 146 per cent, 106 per cent and 450 per cent, respectively.

"To us, it seems like people that are now surviving these heart attacks are living longer and having more time to sort of develop these chronic heart conditions," says King.

However, the data may exaggerate the shift in heart disease deaths. "There are a lot of different causes that could lead to somebody's death, and that can lead to misclassification or oversimplification," says King.

Biology

Ash trees evolve defences against deadly fungal disease

Michael Le Page

FLPA/ALAMY

The genes of some ash trees help resist ash dieback disease

BRITISH ash trees are rapidly evolving resistance in response to ash dieback disease.

The finding is good news, says Richard Buggs at the Royal Botanic Gardens, Kew, in the UK, but it is unlikely that ash trees will become completely resistant in the near future. "We probably need a breeding programme so that we can help nature along and finish the job," he says.

Ash dieback is caused by a fungus (*Hymenoscyphus fraxineus*) native to Asia that slowly destroys trees' ability to transport water. It began spreading in Europe in the 1990s and reached the UK in 2012.

The death of ash trees leads to the release of carbon dioxide and affects hundreds of species that rely on these trees for their habitat. Falling trees are also a threat to people and property.

Because the fungus takes much longer to kill large, older trees than young ones, Buggs's team was able to compare the genomes of 128 adult European ash trees (*Fraxinus excelsior*) and 458 saplings at a site called Marden Park in Surrey. This revealed that thousands of variants his team had previously shown to be linked to resistance were more common in the young trees – probably because those that lacked them had died off (*Science*, DOI: 10.1126/science.adp299).

It is the most detailed genetic picture of evolution in action ever obtained in the wild.

STEPHEN HYDE/ALAMY

The trunk of an ash tree that had ash dieback disease

"What's original about this study is we've been able to characterise the genetic basis and then demonstrate a shift happening in a single generation," says Buggs.

However, each of the gene variants has only a tiny effect, rather than conferring complete resistance. The rate of evolutionary change will also slow in the future as large ash trees die off and fewer fungal spores are produced, meaning young ash trees will have a better chance of surviving, says Buggs.

"It's a massive problem, but they're not going to disappear," he says. "I think our results encourage us that some of these young ash trees will hopefully make it through to adulthood, and hopefully have another generation of natural selection."

Ash dieback hasn't yet spread to North America, but a non-native insect pest, the emerald ash borer (*Agrilus planipennis*), is spreading and killing ash trees there. It isn't clear what will happen if ash dieback and the emerald ash borer both arrive in the same region, but it could make the situation much worse.

"Globalisation is mixing up the world's insects and microbes, and so we are increasingly seeing these new tree epidemics, and it is very hard for the trees to keep up with it," says Buggs. "Trees are facing threats that they've never faced before, coming at them at speeds that they never have before."

He thinks we need to step in to help trees survive the onslaught, for instance by crossing native trees with exotic species to create resistant hybrids.

"One of the answers is to be moving the genetic diversity of trees around the world as well, to keep up with all of the pests and pathogens that we're moving around," he says.

Archaeology

Ancient boomerang is older than we thought

Christa Lesté-Lasserre

TALAMO ET AL., 2025, PLOS ONE, CC-BY 4.0

This boomerang, shown here from each side, is around 40,000 years old

THE world's oldest known boomerang may be around twice as old as originally estimated.

In 1985, archaeologists unearthed a 72-centimetre-long ivory boomerang buried beneath six layers of sediment in Obłazowa cave in Poland. Later sediment sieving revealed a *Homo sapiens* thumb bone nearby, as well as antler tools, a bone bead and pendants made from fox teeth. In the 1990s, radiocarbon dating suggested the thumb was 31,000 years old – but surprisingly, the boomerang was dated to just 18,000 years ago, several millennia younger than the artefacts in shallower layers.

Sahra Talamo at the University of Bologna in Italy suspected contamination. "Even a trace amount of modern carbon – from glue or conservation products – can throw off the radiocarbon date by tens of thousands of years," she says. Analyses of the thumb's carbon-nitrogen ratios showed signs the collagen might have been contaminated, so the researchers treated the radiocarbon date as a minimum age.

Re-dating the contaminated boomerang would have been futile – and would have damaged the precious artefact needlessly, says Talamo. Instead, she and her colleagues dated 13 nearby animal bones, re-dated the human thumb bone and used statistical modelling to reconstruct the timeline. Their results showed that the entire sediment layer – and hence the boomerang and thumb as well – dates to between 39,000 and 42,000 years ago (*PLoS One*, doi.org/ptc4).

Its new age means the ivory boomerang predates the second-oldest known boomerangs – made from wood by Indigenous Australians – by 30,000 years. Unlike simpler throwing sticks, boomerangs are curved and aerodynamically shaped, even if they don't always return to the thrower, says Talamo.

Although the boomerang could most likely fly, its size and design probably made it unlikely to return to its sender. Instead, it may have served a symbolic or ceremonial purpose, says Talamo, based on its decorative engravings, reddish pigment and smooth polish – combined with its placement beside a human thumb bone in a circle of imported stones. ▮

Environment

Wavy jet stream not behind wilder winter weather

Madeleine Cuff

INCREASINGLY erratic winter storms in the northern hemisphere aren't a result of the polar jet stream getting more wavy – although climate change is making winter weather more intense in other ways.

The northern polar jet stream is a current of winds that sweeps through the northern hemisphere, steered by the boundaries between temperate air and cold air around the Arctic.

For more than a decade, some researchers have suspected that a warming Arctic is causing the jet stream to buckle more dramatically in the winter, causing extreme storms that bring snow and ice further south than usual.

But the theory has been hard to verify, in part due to the relatively short satellite data record, and because of the jet stream's intense natural variability during winter.

Erich Osterberg at Dartmouth College, New Hampshire, and his colleagues set out to identify whether the recent behaviour of the jet stream

"What is happening is not that unusual when you look at the entire 20th century"

is out of the ordinary compared with the long-term average.

Satellites only began collecting jet stream data in 1979, so the researchers used data on temperature and atmospheric pressure going back to 1901 to reconstruct the movement of the polar jet over the US for the rest of the 20th century.

They found that it had experienced several periods of increased waviness during that time (*AGU Advances*, doi.org/ptcw). In some instances, the winter jet stream was even wavier in the past than it is today. "What is happening now with the jet stream does not actually look all that unusual when you zoom out and look at the entire 20th century," says Osterberg.

Winters in the northern hemisphere are becoming warmer and wetter as a result of climate change driving more intense storms and rainfall, even without the jet stream changing, stresses Osterberg. "It is clear climate change is affecting extreme weather events in all sorts of really important ways," he says. "What we're saying is that when it comes to the wintertime jet stream, it does not appear like the jet stream is a critical component of these changes."

Tim Woollings at the University of Oxford says this is a reminder of how important it is to assess long-term data when identifying changes to the polar jet stream. "By using several long data records and a range of methods, it shows how the jet waviness in recent North American winters is no worse than in earlier decades," he says.

It is a different story during the northern hemisphere summer, however, with mounting evidence suggesting that the polar jet is becoming wavier in the warmer months as a result of climate change driving up air temperatures in the tropics. "In the summertime, it does appear that the jet stream is seeing a fundamental change in behaviour, where it is getting slower, with bigger waves, which leads to things like big heatwaves, drought and wildfires," says Osterberg. "That does appear to be associated with climate change." ▮

Geology

Have we found Earth's oldest rocks?

A stony formation in Canada may be the last remains of the planet's early crust

James Dinneen

JUST over 4 billion years ago, magma from Earth's mantle infiltrated a fracture in the young planet's primordial crust. Over the following aeons, nearly all of the planet's early crust melted back into the mantle except for a small area around this fracture, which survives today.

At least, that is the story according to the latest analysis of radioactive isotopes in this rock, which is still accessible on the surface as part of the Nuvvuagittuq Greenstone Belt, a formation on the shore of Hudson Bay in Canada. This potential sample of Earth's early crust is the subject of a long-standing debate: is it the world's oldest rock, or just extremely old?

Jonathan O'Neil at the University of Ottawa and his colleagues kicked off the debate in a 2008 study that estimated the rocks surrounding the intrusion are about 4.3 billion years old, which would make them the world's oldest. With that age, they would have formed during the Hadean Aeon just a few hundred million years after the planet itself.

"When dealing with the oldest rocks and minerals, there's no such thing as settled"

Complete Hadean rocks would offer a new window on this early period of Earth's history, perhaps shedding light on geological mysteries like the start of plate tectonics and the make-up of the first oceans.

However, the method the researchers used to date the rocks made the 4.3-billion-year-old age estimate controversial. Ideally, very old rocks can be dated using a hardy mineral called zircon, which maintains its original chemical make-up over billions of years. But these volcanic rocks didn't contain zircon.

Instead, the researchers measured the atomic weight of neodymium and samarium in the rock. As samarium decays, it produces different isotopes of neodymium at known rates. The ratio of neodymium and samarium isotopes remaining in the rocks can thus serve as a "clock" counting up from the time the rock crystallised from magma. In fact, two isotopes of samarium decay at different rates, allowing them to serve as two parallel clocks. The trouble was, the two clocks didn't agree on the age of the rock, leading researchers to dispute that it actually was Hadean.

Now, O'Neil and his colleagues have counted neodymium and samarium isotopes in rocks that intrude into the layer they think is 4.3 billion years old. By definition, such intrusions are younger than the strata that surround them. Therefore, dating the intrusion would set a minimum age for the surrounding rock.

In the intrusion, unlike the older rock that surrounds it, the two clocks tell the same story: the rock is about 4.16 billion years old (*Science*, doi.org/ptcs).

"The simplest explanation for this data is that these are the oldest rocks in the world," says Jesse Reimink at the Pennsylvania State University. However, this is unlikely to be the last word on the matter, he says. "When dealing with the oldest rocks and minerals, there's no such thing as settled." ▮

Marine biology

Killer whales scrub each other clean with bits of kelp

ORCAS off the west coast of North America are grooming each other with kelp – a rare sighting of marine mammals using tools.

For several years, scientists have been observing 80 endangered killer whales in the stretch of the Pacific Ocean between British Columbia in Canada and Washington state. To get a bird's-eye view, the researchers also tracked them with drones.

While poring over footage from summer 2024, they noticed the orcas were manoeuvring strands of kelp in odd ways. It was "really weird", says Rachel John at the Center for Whale Research in Washington.

In the footage, the orcas can be spotted breaking off kelp stalks near where they meet the rock bed by grabbing them with their teeth and jerking their heads back and forth. The short, snapped-off segments were roughly equivalent in length to the whale's beak-like face. The orcas appear to target that specific segment of the algae, not other random parts of kelp.

SLOWMOTIONGLI/ISTOCKPHOTO/GETTY IMAGES

Orcas may have found a unique way to keep on top of their personal hygiene

After breaking off a strand, a whale would then sandwich the kelp between their head and the bodies of other whales in the pod, rubbing and rolling it onto each other's sides. They took turns cleaning each other with the kelp, sometimes grooming each other for up to 12 minutes (*Current Biology*, doi.org/ptbt).

Orcas are known to rub themselves against kelp on their own, which is known as "kelping". This could be a social variation of that behaviour. "We know that the social bonds in this population are super, super strong, and we know that contact is one way that they reinforce those bonds," says John.

The behaviour was present across all ages and sexes, though the data suggests the whales that were most closely related and those closer in age were more likely to "kelp" together. Crucially, this may be a form of whale hygiene, says John, as they found that orcas are more likely to scrub each other with kelp if they are shedding their skin. ▮

Sofia Quaglia

Technology

GenAI doesn't understand Gen Alpha

A failure to understand slang or memes is raising concerns about youngsters' online safety

Chris Stokel-Walker

GENERATION Alpha's internet lingo is mutating faster than teachers, parents and AI models can keep up – potentially exposing youngsters to bullying and grooming that trusted adults and AI-based safety systems can't see.

Manisha Mehta, a 14-year-old student at Warren E. Hyde Middle School in Cupertino, California, and Fausto Giunchiglia at the University of Trento, Italy, collated 100 expressions and phrases popular with Generation Alpha – those born between 2010 and 2025 – from popular gaming, social media and video platforms.

The pair asked 24 volunteers aged between 11 and 14, who were Mehta's classmates, to analyse the phrases alongside context-specific screenshots. They had to explain whether they understood the phrases, in what context they were being used and if that use carried any potential safety concerns or harmful interpretations. Parents, professional moderators and four AI models – GPT-4, Claude, Gemini and Llama 3 – were also asked.

"I've always been kind of fascinated by Gen Alpha language, because it's just so unique, the way things become relevant and lose relevancy so fast, and it's so rapid," says Mehta.

Among the Generation Alpha volunteers, 98 per cent understood the basic meaning of the terms, 96 per cent understood the context in which they were used and 92 per cent could detect when they were being deployed to cause harm. But the AI models recognised harmful use in only around 4 in 10 cases – ranging from 32.5 per cent for Llama 3 to 42.3 per cent by Claude. Parents and professional moderators were no better, spotting only around a third of harmful uses (*FAccT '25: Proceedings of the 2025 ACM Conference on Fairness, Accountability, and Transparency*, doi.org/ps5f).

"I expected a bit more comprehension than we found," says Mehta. "It was mostly just guesswork on the parents' side."

"Gen Alpha language is so unique, the way things become relevant and lose relevancy so fast"

The phrases commonly used by Generation Alpha included some that have double meanings depending on their context. "Let him cook" can be genuine praise in a gaming stream – or a mocking sneer implying someone is talking nonsense. "Kys", once shorthand for "know yourself", now reads as "kill yourself" to some. Another phrase that might mask abusive intent is "is it acoustic", used to ask mockingly if someone is autistic.

"I think it's really critical that LLMs can at least understand what's being said, because AI is going to be more prevalent in the field of content moderation," says Mehta.

"It's very clear that LLMs are changing the world," says Giunchiglia. "This is really paradigmatic. I think there are fundamental questions that need to be asked."

"Empirically, this work indicates what are likely to be big deficiencies in content moderation systems for analysing and protecting younger people in particular," says Michael Veale at University College London. "Companies and regulators will likely need to pay close attention and react to this to remain above the law in the growing number of jurisdictions with platform laws aimed at protecting younger people." ▮

Zoology

Sneaky lizards survived asteroid that killed dinosaurs

A SMALL, secretive group of lizards may have been the only terrestrial vertebrates that survived in the vicinity of the Chicxulub asteroid collision, which led to the extinction of the non-avian dinosaurs.

It has long been known that xantusiid night lizards – found today in Cuba, Central America and the south-west US – are an ancient lineage. But Chase Brownstein at Yale University and his team suspected the group may have arisen earlier than we thought: in the Cretaceous Period, which ended around 66 million years ago, with a giant asteroid strike in the vicinity of Yucatán peninsula, Mexico.

PHILIP JONES/ALAMY

This Costa Rican night lizard comes from a long-lasting family of survivors

Brownstein and his team used previously published DNA sequence data for xantusiids to create an evolutionary tree for the group. They combined this with skeletal anatomy across living and fossil night lizards, in order to determine how old their lineages are.

They found that the most recent common ancestor of living xantusiids emerged deep within the Cretaceous, over 93 million years ago (*Biology Letters*, doi.org/ps5g).

"I think it is very possible that these ancient populations were as close or closer to the impact site than those today," says Brownstein. "It's almost as if xantusiid distribution sketches a circle around the impact site." Based on fossil evidence, he says it is unlikely they recolonised the region later on. "The fossil record of xantusiids is pretty much fairly continuous on either side of the boundary layer marking the impact," he says.

Many night lizard species live in rock crevices and have slow metabolisms like other survivors of the impact, such as turtles. This may have let them take shelter during the impact, says Brownstein. ▮

James Woodford

Women's pelvises are shrinking – how is that changing childbirth?

Michael Marshall

OVER the past 150 years, women's pelvises have become narrower, according to a study of over 8000 people from three countries. There are many factors at play, but whatever the ultimate cause, it is the latest piece of evidence leading researchers to rethink the "obstetrical dilemma", a description of the competing evolutionary pressures on pelvis size. The need to accommodate babies' large heads drives pelvises to widen, but the need to walk bipedally pushes them to narrow.

We don't know exactly what is driving this change, or all the ways it will affect people's health. But if pelvises continue shrinking at this pace, it could make C-sections more likely out of necessity.

Maciej Henneberg at the University of Adelaide in Australia and his colleagues reanalysed an existing dataset of 1247 Australian women, born between 1900 and 1984, and found that pelvic width decreased by 0.42 millimetres per year. Likewise, among 3486 Polish women, pelvis width decreased by 0.47 mm per year between 1880 and 1970, and among 320 Mexican women, pelvis width shrank by 0.42 mm per year between 1900 and 1970 (Research Square, doi.org/ps77). In the same time periods, average height increased and shoulder width either held steady or increased.

"Given that in these different regions, it evolved in the same direction, even though body height increased, I personally find this convincing," says Philipp Mitteroecker at the University of Vienna in Austria.

"The dataset is fantastic," says Lia Betti at University College London.

For Henneberg, the finding shows that medicine is weakening natural selection's impact on the human pelvis – and especially on the width of the birth canal. In the past, if a baby was too large or the birth canal was too narrow, both mother and baby would probably die in childbirth. However, safe and effective C-sections mean this evolutionary pressure is reduced. As a result, birth canals and pelvises can become narrower.

HALFPOINT IMAGES/GETTY IMAGES

Pregnancy care may have reduced evolutionary pressure on the pelvis

Mitteroecker also thinks C-sections are changing the evolutionary pressures at work on the birth canal. He predicted that this might drive pelvises to narrow in a 2016 analysis, and says this is the latest iteration of a long-standing phenomenon.

> "Finding an explanation for narrowing pelvises could help us understand why childbirth is so difficult"

"Midwifery is old," he says, and "really unique to humans". Women have been getting help with childbirth, often from other women, for hundreds of thousands of years. This cultural practice has relaxed the selection pressure on the pelvis and birth canal – so our behaviours have affected our own biological evolution. "C-section is, in a way, an extreme form of that," says Mitteroecker. C-sections took off starting in the 1970s through the 1990s, and the global rate increased from 7 per cent in 1990 to 21 per cent in 2021.

However, Betti is sceptical that C-sections are the main cause. She points out that humans got a lot taller in the same time frame, but that is probably due to diet and better healthcare – not an evolutionary change in our genes. "We know that diet can affect the pelvis," says Betti. When nutrition is scarce, our bodies allocate more nutrients to organs like the brain, at the expense of others. But now that we have ample nutrition our bodies may have reallocated nutrients. "So we end up with different body proportions," she says. "That's quite possible."

Finding an explanation for our narrowing pelvises could help us understand why human childbirth is so difficult – which brings us back to the obstetrical dilemma. However, the exact nature of the dilemma has been disputed. In a 2024 study, Mitteroecker and his colleagues found that the pelvic floor, not walking, was probably the key driver towards narrowness: wider pelvises increase the already high pressure on the pelvic floor, boosting the risk of prolapses and incontinence.

Many factors at play

Or both influences could be at work. A study of 31,000 people, published in April, linked wider pelvises to easier births, but also slower walking and a greater risk of pelvic floor conditions.

There could be even more influences in this dilemma. Betti argues that our pelvises are sensitive to many factors in the environment, such as temperature. Other researchers have described a "new obstetrical dilemma" linked to rising rates of obesity, which can make babies larger. The real answer is probably some combination of factors, says Betti. She says some researchers have rebranded the dilemma as a "multifactor pelvis".

Narrower pelvises will make vaginal childbirth more difficult, potentially leading to even more C-sections. At the same time, narrower pelvises may reduce the risk of pelvic floor problems, which can be very harmful. Childbirth, says Betti, can have "very unpleasant, long-lasting effects".

However, she says predicting what will happen is difficult as so many factors are in play: people are having fewer children, which might reduce the risk of injury, but they are also having them later. "A lot of things have changed at the same time," she says. ▮

Climate change

Earth is more sensitive to emissions than we thought

Madeleine Cuff

JOCHEN TACK/ALAMY

Greenhouse gases are warming the climate

GREENHOUSE gases may be affecting the climate more than we had hoped, which could mean it will be harder to limit the rise in global temperature to less than 2°C.

This is "bad news" for global efforts to tackle climate change, says Gunnar Myhre at the CICERO Center for International Climate Research in Norway.

We have long known that pumping greenhouse gases into Earth's atmosphere will warm the climate. But what scientists don't know for sure is how much warming we can expect. In other words, how sensitive is Earth's climate to these emissions?

The main uncertainty is around how clouds will respond to a warming atmosphere, as shifts in cloud systems can amplify the warming effect in a vicious feedback loop.

Most estimates of how much warming we can expect by the end of the century are based on running climate models with a range of sensitivity assumptions. The Intergovernmental Panel on Climate Change uses models that suggest that a doubling of atmospheric carbon dioxide concentrations relative to pre-industrial levels would produce between 2°C and 5°C of warming, with the organisation settling on a central estimate of 3°C.

Alongside his colleagues, Myhre set out to compare predictions from these climate models with satellite readings of Earth's energy imbalance. This is a measure of how much surplus heat is in our climate system, and it gives an indication of the sensitivity level of the global climate.

> "The optimistic models that would give us a small amount of warming are more unlikely"

The team found that climate models with low sensitivity – those that suggest Earth's climate is more resistant to greenhouse gases – don't match satellite records gathered since the turn of the millennium (*Science*, doi.org/ps4c). Models with a higher level of sensitivity, suggesting Earth's climate is less resistant to these gases, more closely match observations, says Myhre. "The optimistic models that would give us a small amount of warming are more unlikely," he says.

The findings call into question the accuracy of climate models that predict less than 2.9°C of warming for a doubling of atmospheric CO_2. Instead, they suggest warming above this level is more likely for the same amount of pollution.

This also tallies with recent record-breaking temperatures recorded over land and sea since 2023, which "point towards a stronger climate feedback" in the atmosphere, says Myhre.

A more sensitive climate means emissions must fall faster to maintain the same temperature trajectory. In short, the world has to decarbonise further and faster to fulfil its climate commitments.

Johannes Quaas at the University of Leipzig in Germany says the research presents a "very plausible argument" that Earth is more sensitive to warming than some models suggest, adding that it "narrowed the range" of model estimates scientists should work from. "It underlines the need for political action against climate change."

Richard Allen at the University of Reading in the UK points out that the satellite record only began in 2001, so "natural climate fluctuations" could also form part of the story. Nevertheless, he says the study "adds more evidence that simulations which predict less warming in the long term are less realistic". ▮

Technology

Leonardo da Vinci's 'helicopter' design beats today's drones

Alex Wilkins

A FLYING machine designed by Leonardo da Vinci may have been much quieter than modern drones.

Da Vinci's "aerial screw", which he designed in the 1480s, is similar to an Archimedes' screw, a helix-shaped pump that transports water as it rotates. Da Vinci envisaged the machine as being powered by humans, which would have made it challenging to get off the ground due to weight. But with light electric motors spinning the rotor, it could have actually flown.

Rajat Mittal at Johns Hopkins University in Maryland and his team built a simulation of the screw and put it in a virtual wind tunnel to see how it would perform while hovering in place, testing it at different rotational speeds, and comparing it with a conventional drone rotor with two blades.

They found the aerial screw could generate the same amount of lift while rotating more slowly, meaning it would consume less power.

By measuring the pressure and wind-flow patterns that moved around the virtual screw, they could also calculate how much sound it might produce, and found it was less than the conventional design for the same amount of lift (arXiv, doi.org/ps8b).

Mittal and his team now want to see if they can make the design more efficient while keeping its noise-reducing qualities. ▮

Da Vinci came up with his design for the "aerial screw" in the 1480s

GIANNI DAGLI ORTI/SHUTTERSTOCK

Archaeology

Ancient people canoed with wallabies

The animals were transported across oceans thousands of years ago for their meat and fur

Christa Lesté-Lasserre

AS EARLY as 12,800 years ago, people captured wild wallabies and transported them in canoes to islands dozens or even hundreds of kilometres away.

Native to Sahul – the prehistoric landmass that split into Australia and New Guinea – the marsupials probably accompanied human explorers and traders to islands across South-East Asia as sources of food, decorative pelts and, eventually, bone tools. The imported animals thrived there for thousands of years, in one of the world's oldest known animal translocations, says Dylan Gaffney at the University of Oxford.

"This builds into a global picture where these early people were moving, managing and rearing animals in much more complicated and purposeful ways than we thought," he says.

Scientific work on species translocations has typically focused on European explorers.

But in the 1990s, researchers found bones of two kinds of marsupials – a cuscus (*Phalanger orientalis breviceps* or *Phalanger breviceps*) and the bandicoot (*Echymipera kalubu*) – on islands

"These early people were managing animals in much more complicated ways than we thought"

east of New Guinea, and brown forest wallabies (*Dorcopsis muelleri*) on islands as far west as Halmahera, about 350 kilometres from the ancient coastline of Sahul.

Based on the age of nearby charcoal and the depth of the remains, those teams estimated that the wallabies arrived about 8000 years ago, and the other animals between 13,000 and 24,000 years ago.

How those animals got to the islands hadn't been established. To find out, Gaffney and his colleagues investigated a site in the Raja Ampat Islands in Indonesia, which lay a few kilometres offshore from north-west Sahul when sea levels were low thousands of years ago.

There, skeletons with ages thousands of years apart suggest that colonies of brown forest wallabies lived and reproduced on the islands for generations before vanishing about 4000 years ago, for reasons yet unclear.

Radiocarbon dating in an inland cave showed people were butchering and cooking wallabies as early as 13,000 years ago – 5000 years earlier than on islands further west – and were still doing so around 4400 years ago.

The researchers also found several bone tools, including one confirmed by molecular analysis to have been made from a bone of the wallaby family about 4300 years ago (*Journal of Archaeological Science*, doi.org/ps4h).

The team used computer modelling, accounting for sea levels and environmental conditions at the time, which supports the idea that humans transported the animals by canoe, Gaffney says.

Without human help, the wallabies would have had to swim across the ocean for more than 24 hours in powerful currents or cling to vegetation rafts for up to 10 days. Canoe trips, by contrast, would have lasted just a few hours to two days, depending on the route.

The findings highlight just how far back human-driven species movements go, says Tom Matthews at the University of Birmingham, UK. "We often assume introductions only started in the last 500 years, but this shows humans were reshaping ecosystems thousands of years ago." ▮

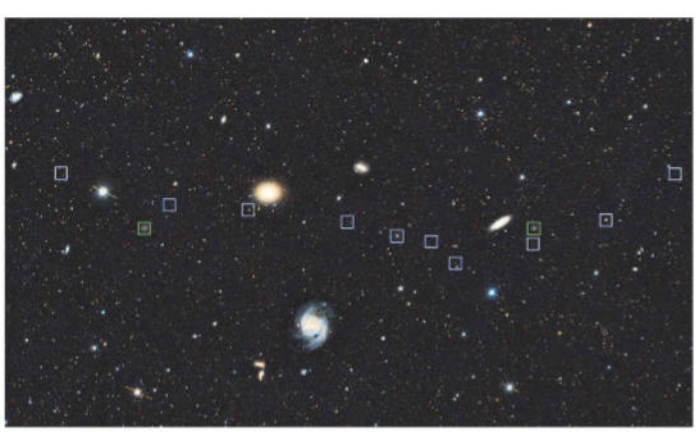
Space

Cosmic crash left behind a weird string of galaxies

A STRANGE line of dwarf galaxies may have been the result of a bullet-like collision billions of years ago.

Michael Keim at Yale University and his colleagues used the Keck Observatory in Hawaii to study a unique trail of 12 small and faint dwarf galaxies about 75 million light years from the Milky Way.

The orientation and speed of the galaxies suggest they originated from a head-on collision between two galaxies in a group called NGC 1052. The collision left gas in its wake, which eventually clumped into groups of stars under gravity (arXiv, doi.org/ps4g).



KEIM ET AL./DECALS

These galaxies (in squares) may have been the result of a high-speed collision

There is a similar collection of larger galaxies called the Bullet Cluster, so Keim and his colleagues have nicknamed this system the "bullet dwarf".

The two galaxies are thought to have collided at 350 kilometres per second relative to each other about 9 billion years ago. As they passed through one another, gas was ripped from each of them.

Curiously, the clumps of stars left behind from the collision are devoid of dark matter. This is very unusual as most galaxies have a large amount of dark matter.

Keim and his team think this might be because, while the gas was torn from the galaxies, dark matter doesn't interact with matter – or even itself – so it was unaffected.

This could refute ideas for dark matter that suggest our evidence for its gravitational influence result from a mismeasurement of how stars and galaxies behave. "This is saying dark matter is a particle, and it can become separated from a galaxy," says Keim. ▮

Jonathan O'Callaghan

TRIP

Calm is just a can away

Magnesium &
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An essential mineral for the body. Recent studies suggest it may help to lower stress levels and improve your mood.

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Views

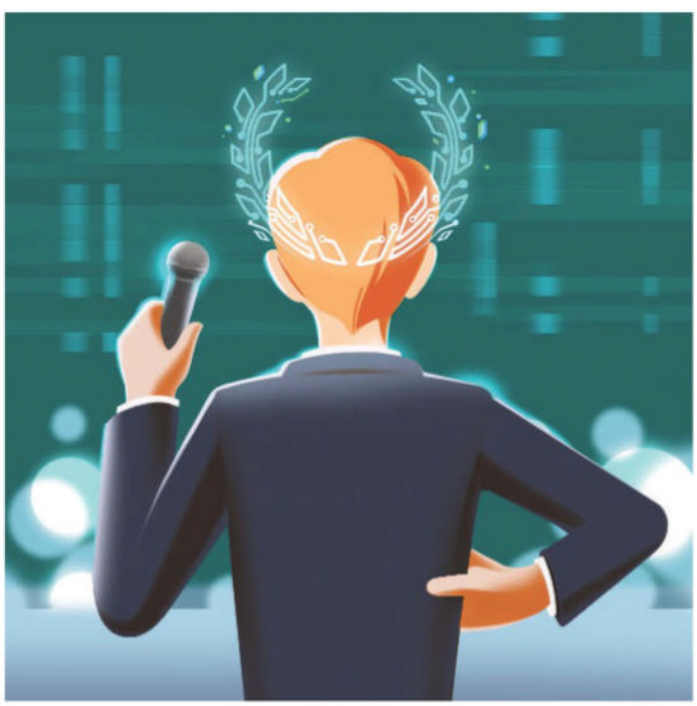
Comment

Don't ask these experts

Beware the tech leaders making grandiose statements about artificial intelligence. They have lost sight of reality, says **Philip Ball**

DEMIS HASSABIS, CEO of Google DeepMind and a Nobel prizewinner for his role in developing the AlphaFold AI algorithm for predicting protein structures, made an astonishing claim on the *60 Minutes* show in April. With the help of AI like AlphaFold, he said, the end of all disease is within reach, "maybe within the next decade or so". With that, the interview moved on.

To those actually working on drug development and curing disease, this claim is laughable. According to medicinal chemist Derek Lowe, who has worked for decades on drug discovery, Hassabis's statements "make me want to spend some time staring silently out the window, mouthing unintelligible words to myself". But you don't need to be an expert to recognise the hyperbole: the idea that all disease will be ended in around a decade is absurd.



ADRIÀ VOLTÀ

Some have suggested that Hassabis's remarks are just another example of tech leaders overpromising, perhaps to attract investors and funding. Isn't this just like Elon Musk making silly forecasts about Martian colonies, or OpenAI's Sam Altman claiming that artificial general intelligence (AGI) is just around the corner? But while that cynical view may have some validity, it lets these experts off the hook and underestimates the problem.

It is one thing when seeming authorities make grand claims outside their area of expertise (see Stephen Hawking on AI, aliens and space travel). But it might appear as if Hassabis is staying in his lane here. His Nobel citation mentions new pharmaceuticals as a potential benefit of AlphaFold's predictions, and the algorithm's release was accompanied by endless media headlines about revolutionising drug discovery.

Likewise, when his fellow 2024 Nobel laureate Geoffrey Hinton, formerly an AI adviser with Google, claimed that the large language models (LLMs) he helped create work in a way that resembles human learning, he seemed to be speaking from deep knowledge. So never mind the cries of protest from those researching human cognition – and, in some cases, on AI too.

What such instances seem to reveal is that, weirdly, some of these AI experts appear to mirror their products: they are able to produce remarkable results while having an understanding of them that is, at best, skin deep and brittle.

Here is another example: Daniel Kokotajlo, a researcher who quit OpenAI over concerns about its work towards AGI and is now executive director of the AI Futures Project in California, has said: "We're catching our AIs lying, and we're pretty sure they knew that the thing they were saying was false." His anthropomorphic language of knowledge, intentions and deceit shows Kokotajlo has lost sight of what LLMs really are.

The dangers of supposing these experts know best are exemplified in Hinton's comment in 2016 that, thanks to AI, "people should stop training radiologists now". Luckily, experts in radiology didn't believe him, although some suspect a link between his remark and growing concerns from medical students about job prospects in radiology. Hinton has since revised that claim – but imagine how much more force it would have had if he had already been given the Nobel. The same applies to Hassabis's comments on disease: the idea that AI will do the heavy lifting could engender complacency, when we need the exact opposite, both scientifically and politically.

These "expert" prophets tend to get very little pushback from the media, and I can personally attest that even some smart scientists believe them. Many government leaders also give the impression they have swallowed the hype of tech CEOs and Silicon Valley gurus. But I recommend we start treating their pronouncements like those of LLMs themselves, meeting their superficial confidence with scepticism until fact-checked. ▮

Philip Ball is a science writer based in London. His latest book is *How Life Works*

Future Chronicles

Patching it up By the 2030s, hormone implants enabled users to boost everything from pain tolerance to libidos, reveals **Rowan Hooper**, our guide to future scientific developments

Rowan Hooper is *New Scientist*'s podcast editor and the author of *How to Spend a Trillion Dollars: The 10 global problems we can actually fix*. Follow him on Bluesky @rowhoop.bsky.social

In Future Chronicles, he explores an imagined history of inventions and developments yet to come.

This column appears monthly. Up next week: Chanda Prescod-Weinstein

FANCY being in direct, hormonal control of your body and mind? By 2035, a range of options had come to the market. A pickup in the morning? A libido boost at bedtime? Or a period of immunity to pain? All became available.

The process started in 2027, when serious surface wounds and internal injuries began to be routinely treated with dressings that were themselves alive. The dressings were of a class known as engineered living materials (ELMs), which produced enzymes and antibiotics to speed up healing.

ELMs were inspired by the biofilm that sometimes forms on vinegar and is also used to make the fermented drink kombucha. Known as the "mother" layer, the biofilm is a living material, a symbiotic culture of bacteria and yeast (SCOBY). In vinegar, the SCOBY turns alcohol into acetic acid, while in kombucha, the SCOBY produces acetic acid and other compounds from sugared tea. But if you make your own synthetic SCOBY – a syn-SCOBY – with gene-edited yeast and bacteria, you can get it to produce whatever enzyme, nutrient or hormone you require. In 2021, a team at Imperial College London made programmable SCOBYs by using Baker's yeast, which could be easily edited to produce a range of different compounds.

The first widely used syn-SCOBY was a medical material, which was kept sealed and dormant in first aid kits and in hospital surgical units. When needed, the material, which became known as a Heal Me patch, is removed and applied to a wound. Exposure to oxygen revives the yeast, which begins converting its cellulose matrix into the required compounds. These include proteolytic enzymes, which rapidly break down dead and damaged tissue, and other enzymes that relieve pain and reduce inflammation, speeding up the healing process.

After successful use in medicine, in the 2030s syn-SCOBYs were created for diverse applications, from sensing pollutants in the environment to providing essential nutrients, enzymes and hormones. Syn-SCOBYs replaced the bionic pancreas that people with type 1 diabetes used to produce insulin and control their blood sugar levels. Other varieties produced glowing proteins when a specified pollutant, metal or pathogen was detected in the environment.

"Customised living implants could be activated to boost focus, aggression, endurance and pain tolerance"

Military scientists developed Fight Me patches that secreted adrenaline and testosterone, which suppressed pain and increased aggression. However, while the Heal Me patches had direct access to the bloodstream through a person's wound, Fight Me patches had to be ingested, which meant the compounds were subjected to digestive enzymes before being absorbed. To get around this, scientists developed patches designed for implantation in the thigh or abdomen. When the soldier required the boost, they got an activation enzyme injected at the implant site. The start enzyme then set the syn-SCOBY in the patch to work secreting the desired compounds into the blood.

Customised living implants could be activated when needed to boost focus, aggression, endurance and pain tolerance. Recreational syn-SCOBYs were designed to produce stimulants, psychedelics and libido enhancers.

A range of implanted patches soon became available. Feed Me secreted leptin to simulate fullness and blocked the release of ghrelin, which promotes hunger; in another variety, Sate Me, the living implant produced semaglutide drugs such as Mounjaro, Wegovy and Ozempic to remove the desire to eat or drink. Focus Me produced drugs such as modafinil and oxiracetam aimed at sharpening the mind and improving memory recall.

For recreational drug use, Trip Me secreted psychoactive compounds such as psilocybin, easily made by gene-edited yeast. Love Me suffused the user in oxytocin and serotonin, prompting feelings of love, euphoria and sexual desire. Dream Me came in two varieties, Lucid and Black Out, promoting controllable dreaming or blank deep-phase sleep, respectively.

The most exclusive and coveted implants were the Juve Me range. These produced a variety of anti-ageing compounds known as senolytics, which cleaned up ageing cells in the body, and senomorphics, such as the drugs rapamycin and metformin, which morph older cells into behaving like younger ones. Unlike most other ELMs, which had a transient lifetime in the body before being consumed, the Juve Me implant was designed to be self-sustaining. It was a symbiotic entity itself living symbiotically within a lucky human, who provided nutrients to maintain the life of the implant in return for enjoying extended life and vigour. ▮

Hat tip to Iain M. Banks's Culture *novels for providing the inspiration for my symbiotic implants, which Banks calls "glanding".*

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ETHAN MOK

ALL IN THIS ROW: WILL SARDINSKY

Meet the storm chasers
Learn more about the researchers battling hail in the name of science at **newscientist.com/video**

Hail hunters

MOST storm chasers live for tornadoes. A few live for hailstorms. That is certainly true of the more than 50 weather scientists involved in the largest-ever field survey focused on extreme hail, now under way across the US Great Plains.

Since mid-May, the researchers involved in the ICECHIP project have raced from the Texas panhandle to South Dakota in search of storms that produce the biggest hail – from golf balls (pictured bottom, near-left) to grapefruits of ice. Hail causes billions of dollars of damage each year, but forecasts of which storms will produce the most hazardous kinds are unreliable. ICECHIP wants to change that by measuring everything possible about these storms and relating it to the ice they generate.

An average day of the campaign involves intensive forecasting to track down a storm like the one in the main picture, captured near Arnett, Oklahoma, on 17 June by Ethan Mok, a member of the ICECHIP team. A tornado, here obscured by rain, has just touched down in the hail core of the storm, where most of the hail is falling.

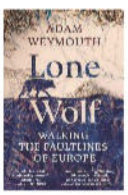
As a fortified truck called the Hail Hunter drives into the core to collect the biggest, freshest stones, dozens of other vehicles (bottom, far-left) surround the storm to measure it using mobile radar, weather balloons and a fixed-wing drone. Other teams place specialised equipment such as a hail-impact disdrometer (second from left) in the path of the storm to record the size distribution of the hail and its impact velocity.

Once the storm has passed, the researchers return to survey the damage across the swathe of hail and collect as much ice as they can before the precious data melts (third from left).

James Dinneen

Great pickings so far

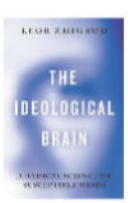
Radicalisation's roots, the downsides of diagnosis and an epic trek following a Slovenian wolf are among **Liz Else's** top popular science books of 2025 to date



***Lone Wolf* by Adam Weymouth**
"He retains a sharp memory of the trap, last summer, his forefoot clamped and the utter terror, and of later waking, woozy, and the awful, human scent all over him, and the thing awkward around his neck... His brother was shot. He saw it happen. One-third of them, at least, die before their first year is out. Already he is a wolf that defies odds."

This young wolf is Slavc, tracked by GPS on an epic walk from Slovenia through the Alps to arrive at the Lessinian plateau, north of Verona, Italy, months later.

Intrigued, Adam Weymouth follows Slavc's route, creating his own epic. His is made of different but resonating strands: humans' tricky relationship with nature and each other, a continent under environmental pressure – and the wolves, of course. Beautifully interwoven and lovingly written.



***The Ideological Brain* by Leor Zmigrod**
Why are some people more likely to become radicalised or support extreme world views? This book shows how political neuroscience is probing our inflexibilities and dogmatisms. A key question posed by neuroscientist Leor Zmigrod is whether a person's susceptibilities could "be rooted in their cognition and biology".

One experiment she cites, published in 2008 in *Science*, suggests that more politically conservative people show a stronger reaction to threatening bursts of noise than those with more liberal views. Then there is the parallel between how easily we adapt to rule changes in a card-sorting game and how tightly we hang on to our political or social ideologies.

Now add these fascinating, if terrifying, findings to those of science historian **Rebecca Lemov** in her book ***The Instability of Truth***.

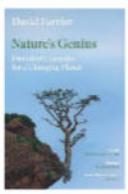
This looks at 20th- and 21st-century mind control and hyper-persuasion, from the "invisible" brainwashing techniques used on US prisoners of war in North Korea in the 1950s to today's "soft" brainwashing and behaviour modification that is brought on through our interactions with social media.

If the lessons of history in Lemov's book coupled with the ongoing insights of the political neuroscientists are even half right, we should all be paying very, very close attention.


LANAGI/ALAMY

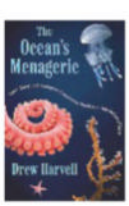
Hang out: time to zone out with some intriguing and inspiring reading

"I love books about proof, and statistician and epidemiologist Adam Kucharski is a great storyteller"



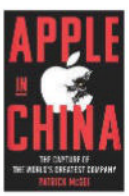
***Nature's Genius* by David Farrier**
Hope and adaptation are joined at the hip, as David Farrier argues that animals are changing fast under human pressure, and that we too must change our ways of life if we are all to thrive. "Climate change is altering the many 'wild clocks' that regulate migration, breeding and blossoming, but learning to coordinate our time with nature's rhythms – to make time with a whole forest – would revolutionise our politics." His pursuit of human plasticity makes for a bold vision.

***Proof* by Adam Kucharski**
Determining whether something is true really is the point of science, wrote Jacob Aron in his review of this book. I love books on proof, and Adam Kucharski (a statistician and epidemiologist) is a great guide and storyteller. Abraham Lincoln, we learn, found Euclid's *Elements*, with its definitions and axioms, irresistible because it created a way to construct seemingly universal truths from fundamental principles. Lincoln was to use one famous proof in his fight against slavery.

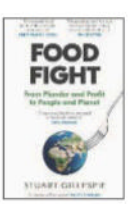


***The Ocean's Menagerie* by Drew Harvell**
Corals, sponges, worms, jellyfish, clams, crabs, octopuses and more – is it really possible that invertebrates make up 99 per cent of the diversity in the ocean? Yes indeed, says marine ecologist Drew Harvell, who wants to introduce them and their superpowers to us, in their habitats ranging from Hawaii to

the Caribbean to Indonesia. There are also exquisite photos. Enjoy!



***Apple in China* by Patrick McGee**
In the early 2000s, the world's largest tech company shifted its manufacturing to the world's second-largest economy. Apple's presence in China could never be a simple story of getting ever richer by taking advantage of low wages and few rights for workers. And it isn't, with this book cleverly exposing paradoxes around its subtitle: "The capture of the world's greatest company". While China did "capture" Apple, the company changed China by creating 5 million jobs, as it also altered the US's future by fuelling Chinese tech development. Given the increasingly authoritarian regime of Chinese leader Xi Jinping, the ripples created by Apple's achievement continue to criss-cross in today's world of economic conflict.

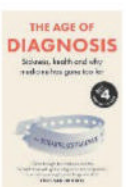


***Food Fight* by Stuart Gillespie**
Most books about the monolithic machine that is our food system argue that, in a very real sense, it is killing us. Designed in a different century to mass-produce cheap calories to avert famine, it is no surprise that it is creating ill health – like obesity and diabetes – and driving the climate crisis.

Where the books differ is in their rescue formula: what would a system look like that nourishes 8 billion people and the planet?

Stuart Gillespie seems more radical than most, writing that transformation without political change, without a shift in power, is "fake", and what is discussed at conferences and in reports is transition, not transformation. Real change would involve major shifts in power across the system.

His manifesto includes fighting for proper nutrition and health to be enshrined in law, and not a "paper " human right. Now that would be a real game-changer.



***The Age of Diagnosis* by Suzanne O'Sullivan**
Everyone wants to know what's wrong with them when they are sick. Not so fast, says neurologist Suzanne O'Sullivan, who thinks diagnosis can have serious downsides. Judging by her book's popularity, she has tapped into something big.

In her work, and generally, O'Sullivan says she has observed the rise of conditions such as hypermobile Ehlers-Danlos syndrome and a range of novel genetic disorders, plus the massive increase in rates of diagnosis of ADHD, autism, depression and more. Other conditions, like cancer, diabetes, hypertension and dementia, also seem to be trending upwards. So what is going on?

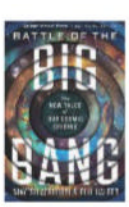
O'Sullivan shows the span of her inquiries as she explores some most illuminating case studies, evidenced by her chapter headings: Huntington's disease; Lyme Disease and Long Covid; Autism; The Cancer Gene; ADHD, Depression and Neurodiversity. There is even one called Syndrome Without a Name, describing vanishingly rare conditions that take years to label.

Labels are a big part of the problem, says O'Sullivan: they are of little value if they recruit people with mild versions of a condition, and sometimes there is nothing to offer anyway. What to do?

Here are a few of O'Sullivan's prescriptions: stop expecting medicine to help us manage our disappointments; resist the medicalisation of normal life experiences; get doctors to rethink their specialisation silos, which can leave them de-skilled in general medicine; and spend money on people, not novel technologies. Stimulating and provocative.

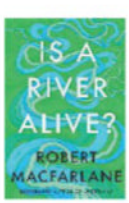
***The Price of Our Values* by Augustin Landier and David Thesmar**
This is an unusual book – to be written by economists, at least. Unlike everyday folk, economists like to separate their economic choices from moral ones. Their moral toolkit is utilitarianism. This holds that the most ethical choice is the one that will produce the greatest good for the greatest number: efficiency at the expense of values.

Here, they set out not to ignore values such as compassion, liberty and fairness, but to argue that to be fully ethical, our moral decisions must confront their cost implications. Their hope is that they can offer "a framework for processing moral values while taking economic constraints into account". Now there's a brave endeavour.



***Battle of the Big Bang* by Niayesh Afshordi and Phil Halper**
Just in case – perish the thought – you haven't quite got to grips with what happened to the universe 13.8 billion years ago, here's a terrific round-up of just about every theory about the big bang: bouncing and cyclic universes, time loops, multiverses, string theory, black hole births and much more, written by a physicist with skin in the game (Afshordi) and a top science populariser (Halper).

Over 12 chapters, the authors explore what they call "science's earliest memory", when the universe "sprang forth from an infinitely dense inferno" and began to expand, never once looking back. For them it is about the "origin of our origins" – but also the need for a new physics. Their plan is to take us through a new landscape of ideas, where we discover the strengths and weaknesses of competing models and learn how science is done, including the rivalries and fights over tiny details of abstruse theories. And, of course (no spoilers), it all starts with what you think you mean by the big bang...



***Is a River Alive?* by Robert Macfarlane**
The metaphors we choose say a lot about us. So when Robert Macfarlane, well-known for his nature books, asks if a river should be considered alive, then it is bound to make, er, a splash.

He travels the world to explore this idea and others like it, such as whether a forest might think, or a mountain remember. Rowan Hooper called it "beautiful, wild and wildly provocative" in his review, but worried Macfarlane might be trying to re-establish a form of animism in an attempt to make us treat non-human life better. Better look to good ecological thinking and science instead, says Hooper. Over to you!

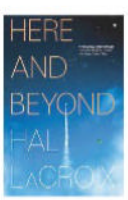
Visions of the future

From generation ships to climate change, there has been some stellar sci-fi out in the past six months. Our columnist **Emily H. Wilson** picks her favourites

SO FAR, it has been an encouraging year for science fiction. My favourite new offering to date is probably Hal LaCroix's *Here and Beyond*, but then, I'm a sucker for a good ark-ship story.

In LaCroix's take on the trope, a vessel called Shipworld is heading for HD-40307g, "a habitable Super Earth hug orbiting a simmering red dwarf star". It is a journey of 42 light years – meaning that none of the 600 souls who begin the journey will actually live to see HD-40307g. Only the Seventh Generation will make planetfall.

There are rules on board. People are given a treatment that allows them to stay healthier longer, but they aren't allowed to have children until their 50s. Everything must be in support of the Mission – reaching the planet – even though no one on board alive will see it.



Ark-ship stories (also known as generation-ship stories) suffer from the structural challenge of having to shift among sets of characters as generations are born and die, which can be distancing for the reader. LaCroix, fortunately, is wonderfully good at quickly building characterisations and drawing you in. Indeed, as generations come and go, our knowledge of the history of Shipworld helps the story develop into a satisfying and meaningful drama. We the readers end up being more expert than each new generation, as living history slips into deep past for those on board.

LaCroix sometimes seems to shy away from the most dramatic moments. His most surprising choice is to render quite mute the most shocking event in the story: a mystery object deliberately turning and choosing to bear down on Shipworld. This isn't to complain; these are artistic decisions LaCroix makes.

GREMLIN/GETTY IMAGES

In *Here and Beyond*, it will take 42 light years to reach a new planet

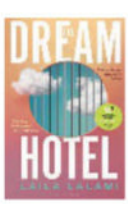
The ending, meanwhile, didn't quite land for me personally, but then, producing a really satisfying ending to a story that has been 360 years in the making is no mean feat, and this mesmerising, finely tuned story is a worthy addition to the great ark-ship canon.

Anyone enjoying Alexander Skarsgård's delightful turn as Murderbot on Apple TV+ may also want to treat themselves to the story in its original form. Luckily, Martha Wells's *The Murderbot Diaries* novellas were reprinted as three omnibus editions earlier this year. (By the way, when I read the first novella, I thought Murderbot was female; apparently it's quite common to assign Murderbot your own gender. Anyway, Skarsgård was a surprise pick to play "her" when I found he had been cast!)

Adrian Tchaikovsky has had another busy six months producing more work in the general arena of non-human intelligence. In February, his novel *Shroud* examined the very unhuman-like alien lifeforms inhabiting a horrifyingly dark and noisy moon. Then, last month, the third novel in his *Dogs of War* sequence, *Bee Speaker*, was published. The books are less well-known than his smash-hit *Children of Time* series, but they also examine what kind of people non-human species of animals – with a bit of tinkering – would turn out to be.

Tchaikovsky is brilliant at thinking his way into the minds of these tinkered-with animals. I found my heart really going out to Rex, the star of the first novel in the series, as he juggles being a good dog with the fact that he is also a deadly, 7-foot-tall, "bioform" fighting machine.

Two notable artificial intelligence-related books this year include Laila Lalami's beautifully written dystopian novel *The Dream Hotel*, and Grace Chan's clever and thoughtful virtual-reality novel *Every Version of You*, in which humans escape catastrophic climate change by uploading their minds to a virtual paradise.



Meanwhile, Kaliane Bradley's bestselling *The Ministry of Time* came out in paperback in March, and I quickly made up for my failure to read it in hardback. It's an easy book to eat up, with lots of delicious energy to it. Another great read, out in April, was Roz Dineen's climate change novel *Briefly Very Beautiful*, which I found hard to put down.

Here's to even more thought-provoking sci-fi in the second half of this year. I look forward to sharing it with you.

Emily H. Wilson is author of the *Sumerians* trilogy

Editor's pick

Two views on the naming of female body parts

14 June, p 21

From Sam Edge, Ringwood, Hampshire, UK

I agree with Adam Taor that some of the terminology used for female anatomy, especially reproductive parts, is extremely paternalistic, if not outright misogynistic, and could do with revision.

I remember a discussion on the subject involving Germaine Greer, who recalled that once she had found out "vagina" comes from the Latin for "scabbard", she began to prefer the earthy, four-letter C-word, as it has a more interesting and less demeaning derivation from Old Norse or possibly Latin. Of course, given the less-than-positive uses to which the C-word is now put, making its anatomical use mainstream might be difficult.

From Andrew Evans, Pembroke Dock, UK

Taor contends that male eponyms for female anatomical structures are somehow wrong. Actually, they are part of the rich history of nomenclature in anatomy. Since the 1960s, many have been supplanted by more descriptive terminology, but a lot of the enduring terms do bring to mind the lives of those long-dead anatomists and surgeons whose names they take.

Labels that are historical in context aren't shameful or offensive, but may certainly be replaced with more nuanced wording, as has happened over the decades since I studied anatomy.

How mucus helped tame my sore throat

7 June, p 40

From Bonita Ely, Sydney, Australia

I totally endorse the healing qualities of mucus. My doctor wasn't able to heal my persistent sore throat, so referred me to a specialist who said my throat was sensitive, not inflamed. So there was no treatment.

I discovered that if I swallowed the mucus in my throat, the irritation ceased. Over time, the mucus has lessened the soreness, so it no longer causes out-of-control coughing or persistent irritation. Excellent work, mucus.

Fear a future of 'radical abundance' under AI

21 June, p 10

From Carl Zetie, Raleigh, North Carolina, US

We should be grateful that AI companies aren't, in fact, on the brink of ushering in an era of "radical abundance". Based on all the evidence of innovations in technology over the past few decades, this wouldn't result in a "golden era" for humankind, but instead create more obscenely wealthy individuals overseeing crushingly powerful corporations while everybody else toils for minimum wage or is unemployed.

We already live in an era of abundance: there is plenty to go around; the problem is that it doesn't. Society is nearing a crisis of systemic inequality. Perhaps we should focus on fixing that before wasting time on implausible talk of large language models as harbingers of superintelligence.

The US's academic loss may well be others' gain

14 June, p 22

From Alisoun Gardner-Medwin, Heddon on the Wall, Northumberland, UK

Chanda Prescod-Weinstein is right to remind us that in 1922, Germany was the global epicentre of science and that this pre-eminence was destroyed by the Nazi government. In the 1930s, British and US universities, to their credit and advantage, welcomed scientists fleeing persecution by the Nazis.

It appears that US universities are now having their research funds reduced and scientists themselves are even being thrown out of their jobs. Universities in Europe and elsewhere can welcome them. We may not have as much money to fund research, nor can we pay high salaries, but we can offer friendship, a home and the chance to pass on knowledge and even extend it, perhaps to the advantage of the whole world.

Was Tutankhamun's bling done on the cheap?

14 June, p 34

From Daniel Hunter, Hales, Norfolk, UK

Economics could also explain why Tutankhamun's tomb contained so many high-value goods. When his father Akhenaten closed the traditional temples, presumably he seized a lot of their gold. Gold has two key functions: decoration and a medium of exchange. If the temple gold was melted down and turned into a medium of exchange – perhaps to pay for Akhenaten's capital, Akhetaten – it could have led to a fall in gold's value. In historic terms, it may have been fairly cheap to fill Tutankhamun's tomb with gold.

If Big Pharma won't act, then perhaps states will

14 June, p 30

From Bryn Glover, Kirkby Malzeard, North Yorkshire, UK

The article on new discoveries about cancer cells and nerve cells was very upbeat until near the end, when the pharmaceutical industry's reluctance to fund work on out-of-patent drugs was raised. I can think of no better argument for the creation of a state-owned drugs manufacturing industry.

You can try an isometric workout in your bed

7 June, p 44

From Clive Bashford, London, UK

You don't need to go to a gym to do isometric exercise, where you tighten and hold certain muscles, for example in a plank. You don't even have to get out of bed, as no movement is needed. I started doing this when I noticed my arms getting weak – at 79, I am amazed at how my strength has improved.

We can take many paths, but all are predestined

7 June, p 8

From Andrew Smyth, Los Angeles, California, US

The many-worlds interpretation of quantum physics may suggest that humans lack true free will, even though they feel as if they have it. Each choice a person makes splits them into parallel, pre-existing block universes, each with its own fixed past and future. While it may seem like we choose between alternatives, in reality we may merely be shifting onto one of many predetermined paths.

Dino could be the labrador of the prehistoric world

14 June, p 9

From Dyane Silvester, Arnside, Cumbria, UK

Could the sauropod described as an "indiscriminate bulk feeder" have been the dinosaur ancestor of the labrador dog?

Best anti-ageing medicine is your fine magazine

7 June, p 17

From John Grant, Caloundra, Queensland, Australia

May I hypothesise that a *New Scientist* subscription invigorates the brain by stimulating curiosity, thus reducing mental ageing?

Want to get in touch?

Send letters to letters@newscientist.com; see terms at newscientist.com/letters

Letters sent to New Scientist, 9 Derry Street, London, W8 5HY will be delayed

The lost humans

Over tens of thousands of years, waves of *Homo sapiens* set out across Europe and Asia, only to mysteriously vanish. At last, ancient DNA is revealing why, finds **Michael Marshall**

IT WAS a lonely and cold life. In the chilly wastes of northern Europe during the last glacial period, when the ice sheets had spread from the poles and the forests had been driven far south, a small group of humans clung to existence.

They roamed widely, between the British Isles in the west and what is now Poland in the east, yet there were only a few hundred of them. They hunted reindeer and woolly rhinoceros, and made distinctive leaf-shaped stone tools.

And then they disappeared. No living person carries DNA from this little population, so the leaf-shaped stones and a few bones are just about all that is left of them. We don't know what they called themselves or what happened to them. All we know is that they didn't make it.

We are now realising that stories like this are surprisingly common in prehistory. While it can be tempting to think of human evolution as a tale of progress and success, ultimately

HARRIET LEE-MERRION

leading to a global population, the reality is that many lineages of our species died out and left no descendants.

Now, thanks to insights from ancient DNA, we are finally able to tell some of their stories. These lost peoples are also shining a light on why our once-insignificant branch of the wider human family tree survived and thrived.

The oldest known *Homo sapiens* – or what we call modern humans – lived in Africa, perhaps 350,000 years ago. Our understanding of the earliest members of our species is fragmentary, because we have hardly any fossils. But we know from genetics that all non-African people alive today seem to be descended from a single wave of migrants, who came out of Africa 50,000 to 60,000 years ago. After entering western Asia, some went east towards what are now India, China and Russia, while others headed north and west, to Europe.

All these lands were already inhabited by other species of human. The Neanderthals had been living in Europe and western Asia for hundreds of thousands of years. To the east were the mysterious Denisovans, and in the islands of South-East Asia there lived the diminutive *Homo luzonensis* and the "hobbits", or *Homo floresiensis*. These would all soon disappear. The Neanderthals may have been the last survivors, clinging on in southern Spain until around 40,000 years ago.

We can see traces of the expansion of modern humans in the archaeological record. On the banks of the Don river in south-west Russia, archaeologists uncovered the remains of a man dubbed Kostenki-14, who lived 37,000 years ago. In 2014, DNA analysis revealed that he was closely related to today's Europeans, and to some of the earliest modern humans in Europe. Further to the east, DNA from the 40,000-year-old remains of a man from Tianyuan cave in China showed that he belonged to a population that contributed to modern Asian peoples.

It is easy to interpret this as a story of modern humans triumphing. Thanks to our unique advantages – whether that is language, better tools, a more cooperative nature or something else – we outcompeted the Neanderthals and others, and today we reign supreme. We are the only remaining species of human, and there are over 8 billion of us.

Of course, it isn't quite as simple as that. For one thing, modern humans interbred with the Neanderthals and Denisovans and many people today carry their DNA, so, in some sense, these extinct hominins are still with us.

And more to the point, modern humans didn't have it all their own way. The first groups to enter Europe don't seem to have endured there. At Bacho Kiro cave in Bulgaria, for instance, there are *H. sapiens* bones from 46,000 to 42,000 years ago. A 2021 genomic ›

analysis found that they are related to present-day East Asian people, but there is no trace of their DNA in modern Europeans. They may have lived in Europe, but they didn't survive there in the long term. The same seems to be true of modern humans who lived around 40,000 years ago in a cave in Romania.

"There is strong evidence that some early *Homo sapiens* groups that initially entered Europe did not contribute genetically to later populations," says Priya Moorjani at the University of California, Berkeley. "Only molecular data revealed the absence of genetic continuity."

One such lost group made those leaf-shaped artefacts. The distinctive tools were first discovered in the 1800s – at distant locations. British examples were called "Lincombian", after Lincombe Hill in Torquay: set into this hill is Kents Cavern, where the artefacts were found. In Germany, the tools were discovered in Ilsenhöhle cave near the town of Ranis, so they were called "Ranisian". In Poland, similar artefacts were found in a cave in the village of Jerzmanowice, so they were dubbed "Jerzmanowician".

By the 1980s, archaeologists realised that these seemingly disparate objects were essentially identical, so they renamed them Lincombian-Ranisian-Jerzmanowician, or LRJ for short.

For a long time, we couldn't be sure who made these tools, because they weren't unambiguously associated with human remains. The mystery was finally solved in 2024, when a team led by Jean-Jacques Hublin at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, re-excavated Ilsenhöhle and recovered fragments of bone. The mitochondrial DNA within these revealed them to be from modern humans, who lived there around 45,000 years ago.

"These groups were living really at the extremes, and were also vulnerable to climate change"

The LRJ tools, it seems, were made by modern humans. Suggestive evidence from elsewhere now made sense: for instance, a 43,000-year-old jawbone from Kents Cavern had been tentatively identified as that of a modern human.

Later in 2024, researchers led by Arev Sümer, also at the Max Planck Institute for Evolutionary Anthropology, managed to obtain six nuclear genomes – the DNA from the heart of cells, as opposed to the more limited genetic material from mitochondria – from the Ilsenhöhle remains. Two seemed to be mother and daughter, and a third female was more distantly related to them. There were also three males who weren't close relatives of the three females, but did belong to the same lineage.

There was a surprise, however. The team also sequenced a genome from a second site: Zlatý kůň in the Czech Republic, over 200 kilometres to the south-east. This individual proved to be a relative of two of the people from Ranis, despite living so far away. In other words, the people of Ranis and Zlatý kůň all belonged to the same extended family.

Furthermore, the team was able to estimate the size of the group by examining how similar the genomes were. They estimated that there were around 200 breeding adults in the Ranis/Zlatý kůň clan, and this had been steady for 15 generations. This figure was "extremely low given the large range from UK to Poland at the time", study co-author Johannes Krause, also at the Max Planck Institute for Evolutionary Anthropology, said in a press conference.

The implication is both eerie and incredible: that a population that barely numbered in the hundreds was scattered over a distance of over 1500 km.

Feeling the chill

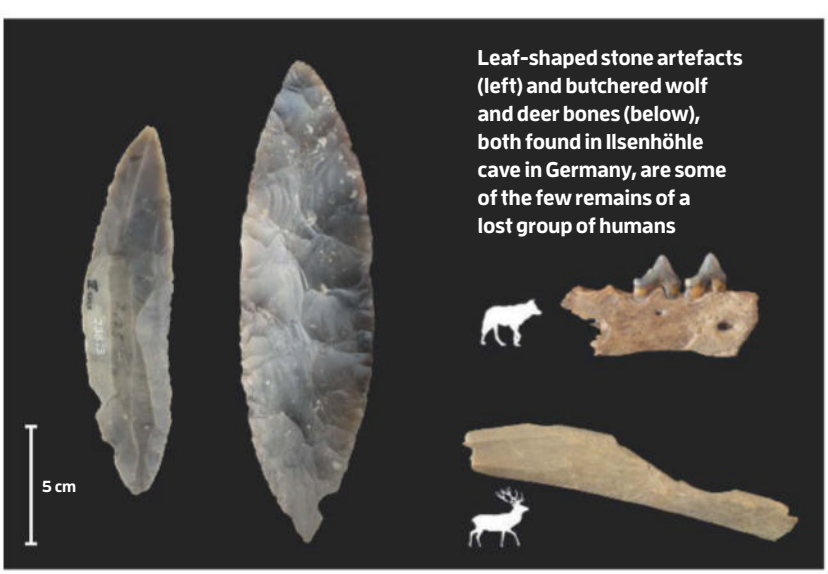
Who were these people? Their DNA points to them having dark skin, eyes and hair – exactly what we would expect for people whose recent ancestors lived in Africa. Based on animal bones found in Ilsenhöhle, the cave was mostly used by hibernating cave bears and denning hyenas, which indicates that the people only stayed there intermittently. Bones with cut marks, suggestive of butchery, point to the LRJ people eating a lot of reindeer, horse and rhinoceros (which still lived in Europe at the time).

What happened to them? We don't know for sure, but can hazard some guesses.

The LRJ people were far from humanity's ancestral home in Africa, in ecosystems that were relatively new to them. The planet was in a glacial period, and while the Mediterranean and Africa were sheltered from the worst of it, northern Europe was feeling the chill. "These groups were living really at the extremes, and were also vulnerable to climate change," says Katerina Harvati at the University of Tübingen in Germany.

Then there is their tiny population. "When you have a small group, if you lose an individual that hunts very well or who socially keeps the group together, everything can easily fall apart," says Sümer. "If there are only a few hundred of you, a few strokes of bad luck can spell doom – and if you don't have any friendly neighbours, no one will come to your aid."

In other words, the odds were stacked against the LRJ people and the other small bands of modern humans who were among



Leaf-shaped stone artefacts (left) and butchered wolf and deer bones (below), both found in Ilsenhöhle cave in Germany, are some of the few remains of a lost group of humans

L: JOSEPHINE SCHUBERT/MUSEUM BURG RANIS/CC-BY-ND 4.0; GEOFF M. SMITH; CC-BY-ND 4.0

Extinction in the Americas

North and South America were the last continents reached by our species, apart from Antarctica. People first entered the north-western part of North America in what is now Alaska, which is only a few tens of kilometres from the north-eastern corner of Eurasia.

However, there is a lot of disagreement and uncertainty about when and how people got there. In a 2022 review, Ben Potter at the University of Alaska Fairbanks and his colleagues argued that the evidence to date suggests that people began entering no earlier than 16,000 years ago and spread rapidly across both continents.

Other researchers have claimed that modern humans were there earlier. At Chiquihuite cave in Mexico, sediments laid down 33,000 years ago contained what appear to be stone tools. Meanwhile, footprints from White Sands National Park in New Mexico seem to be 21,000 to 23,000 years old – and earlier this year, the same site yielded marks that may have been left by crude wooden vehicles.

One interpretation is that there were early migrations into the Americas and those groups died out, just like the first modern humans in Europe. However, Potter is sceptical, arguing for instance that the Chiquihuite tools are so crude, they may be the result of natural processes such as rockfall, rather than human activity.

23,000-year-old footprints found at the White Sands National Park in New Mexico

ASSOCIATED PRESS/ALAMY

the earliest waves to reach Europe. "For a very long time, we thought that [*Homo*] *sapiens* arrived in Europe by 42,000 years ago," says Ludovic Slimak at the University of Toulouse in France. But it is clear that some modern humans got there earlier: "This colonisation is very likely to work as waves of populations coming to the west."

In 2023, Slimak argued that there were three waves of modern humans that entered Europe between 55,000 and 42,000 years ago. The third was the one that established our species throughout Europe. Its members made distinctive "Proto-Aurignacian" artefacts. "We find it everywhere, in all Europe," he says. "It's a very large wave."

The first two waves, in contrast, were smaller and less successful. "They go for some generations, some centuries, some millennia, in a part of Europe and then we lose their traces, and the genetics says we have no descendants of this population," says Slimak. He says the LRJ people look to have been from the second wave.

The three waves all came from the eastern Mediterranean, argues Slimak. After migrating from Africa, modern humans lived continuously in that area, and from time to time some of them wandered further afield. This can be seen at Ksar Akil, a rock shelter near the coast of Lebanon. It contains 22.6 metres of sediments, divided into 36 layers, giving an unprecedented record of changing stone tool technology between about 50,000 and 30,000 years ago. The most recent layers contain Proto-Aurignacian tools; older layers harbour tools resembling the LRJ.

One such early migration has been documented at Grotte Mandrin, a cave overlooking the Rhône valley in southern France. Neanderthals lived there from before 80,000 years ago until 54,000 years ago. But then modern humans pop up in the archaeological record of the cave, in the form of one baby tooth from about 54,000 years ago. There are also distinctive stone points, which may have been arrowheads. Traces of soot from fires suggest that modern humans were there for about 40 years – after which they either died or left, and the Neanderthals returned. Only around 44,100 years ago – during Slimak's third wave – did modern humans return to this area in numbers and permanently.

Larger and more connected populations may also help explain why the third wave succeeded in Europe. "This one is certainly a very large wave of population," says Slimak. The archaeological record suggests Aurignacian populations were bigger, perhaps partly because of warmer conditions at 43,000 and 41,000 years ago. "They have a real success in terms of reproduction," says Slimak. As populations became more dense, some people would have felt pressure to move, rapidly expanding their presence in the region: "You have a generation of people that have to move somewhere else where there are more proteins and less people."

The larger populations may have also enabled Aurignacian people to maintain their cultural practices even as they moved long distances, which Slimak says is reflected in the uniformity of Aurignacian tools from different regions.

What about modern human groups elsewhere in the world? Did some of them also die out? There is tentative evidence from the Americas (see "Extinction in the Americas", left), but for the most part we are stymied by bias in the archaeological record due to the fact that DNA doesn't preserve well in hot and humid environments. "We have really good preservation of DNA in colder climates," says Harvati, hence the many examples of local extinctions in Eurasia. "We don't know what's going on elsewhere."

In particular, we have very little ancient DNA from Africa, the modern human heartland. "If you're in one of the core areas, there's always going to be other people around," says Harvati. This may mean that African populations were safer, because they were always part of a network and could get help if they ran into trouble. But without DNA we can't be sure.

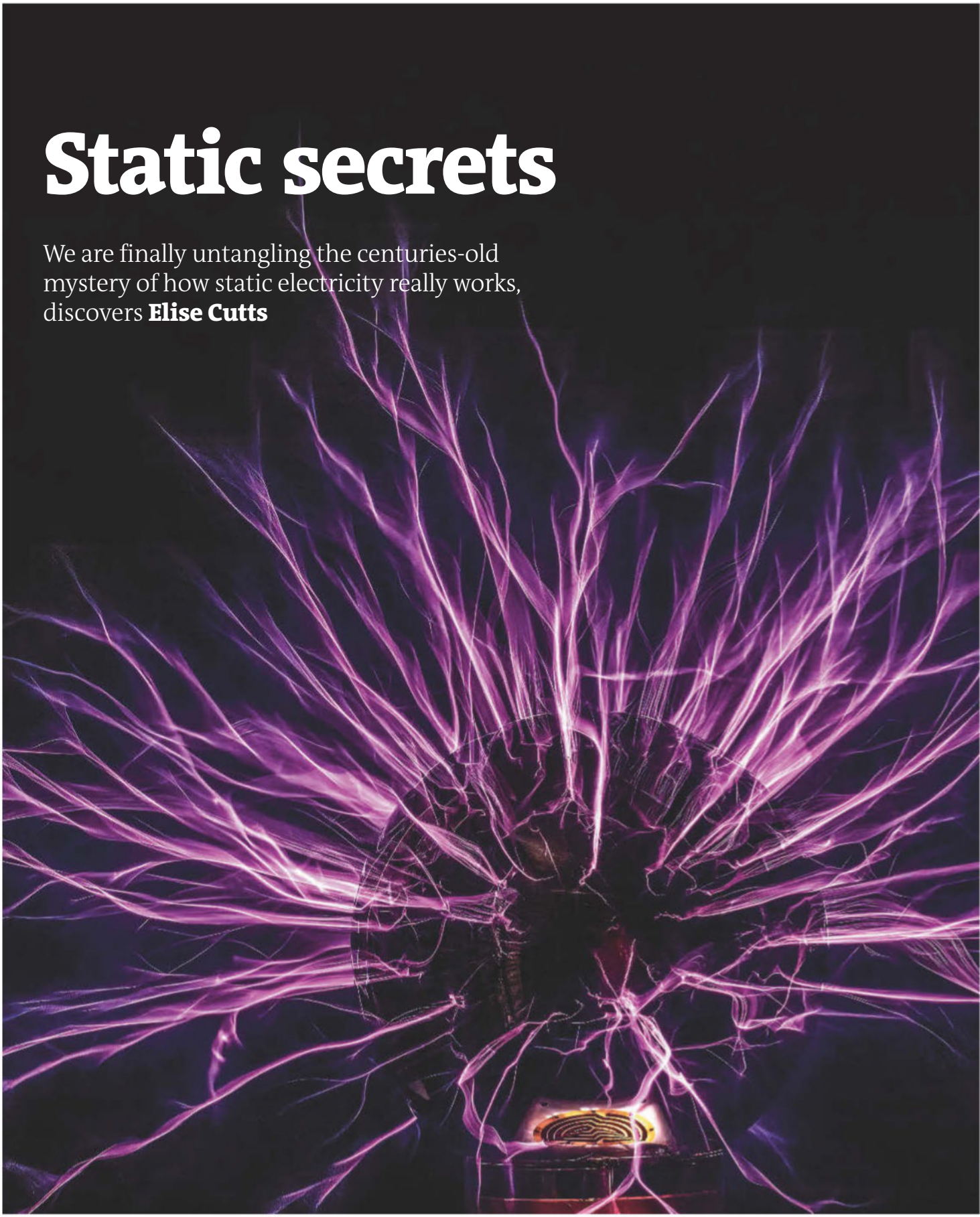
Nevertheless, one lesson is clear: isolation is deadly. Over and over, groups that get "cut off from the bigger network of the societies around them" find themselves in trouble, says Harvati. And once the group size starts shrinking, their culture may die even if some of the people survive. "If you have a certain level of population collapse, then you also have loss of cultural knowledge as well," she says. "If only a handful of individuals survive, then a lot of the traditions and the cultural knowledge of that group don't necessarily make it, even if those people get absorbed in another group."

People, it turns out, need people. And for our lineage – just one branch on a once-diverse family tree – this seems to have been the key to our survival and global ascendency. ▮

Michael Marshall is a science writer based in Devon, UK, and author of *The Genesis Quest*

Static secrets

We are finally untangling the centuries-old mystery of how static electricity really works, discovers **Elise Cutts**



PHIL DEGGINGER/ALAMY

WHEN you rub a balloon on your hair to make it float and cling, you might not think of it as one of the deepest – and strangest – mysteries of science. When you reach out to open a door and your finger sparks against the doorknob, that doesn't seem like an enigma that defies explanation. Nor does it when socks stick to the inside of a shirt on the way out of the dryer.

Static electricity – or, as scientists prefer to call it, contact electrification – was our species' first introduction to the electromagnetic force. The word "electricity" was coined in the 1600s and derives from the Greek *elektron*, or amber. As early as the 6th century BC, the ancients knew that amber rubbed against an animal pelt "animates" and begins to attract dust. Our species has had literal millennia to come to grips with contact electrification, so it is perhaps shocking that we still have little idea how it works.

"Everything is unknown," says physicist Scott Waitukaitis at the Institute of Science and Technology Austria. Different researchers report different findings from the same experiments. Seemingly solid results fail to replicate. Scientists struggle even to figure out which materials become positive or negative on contact with other materials. "We can't even get the experiments to just behave," Waitukaitis adds.

That last part, at least, is starting to change. Waitukaitis and his colleagues have recently discovered a hidden rule that helps explain static electricity's unruliness: the way an object exchanges charge when touched isn't an unchanging, intrinsic property, but rather a product of its history. Samples "remember" previous contacts. That progress is being made in a field notoriously devoid of it means some physicists are labelling the development a "big deal", one that should lead others to rethink their experiments into the phenomenon. Others are noting the wild reality that the systematic workings of this ostensibly simple curiosity – something that most people have encountered, yet few think much about – are only now starting to be illuminated.

Contact electrification is what it says on the tin: electrification via contact. It happens when two objects touch and somehow swap electrical charge. Even when both start out neutral, with their charges balanced, one ends up positive and the other negative. "There's no way to predict based on material properties which is positive and which is negative. The only way you'll know is by trying," says engineer Daniel Lacks at Case Western Reserve University in Ohio.

How the charge transfer occurs isn't known, either. In fact, scientists still don't agree on what actually gets transferred – in metals, it is electrons, but other materials might exchange charged atoms or small molecules, or even entire chunks of material.

"Nobody can find a thorough explanation," says Waitukaitis's colleague Juan-Carlos Sobarzo over the indignant hissing of the humidifier in the chamber where he performs his experiments.

Charge-swapping

When Sobarzo joined Waitukaitis's lab, he didn't think he would discover an explanation for the disorder that plagues experiments on static electricity. Instead, he planned to test one particular hypothesis: we know that humidity can influence static charging, so Waitukaitis had a hunch that water molecules on the surfaces of materials facilitated charge-swapping. But before they could test anything, the duo needed a way to perform experiments that could be replicated. That might sound easy – tapping two objects together isn't exactly rocket science. But in the study of contact electrification, replication is a tall order.

"There are too many things that have been proven to have an effect on how things exchange charge," says Sobarzo. The humidifier's hissing surges in protest as Sobarzo sticks his hands through the ports on the front of the box and picks up a sample, a fingernail-sized square of clear silicon polymer called polydimethylsiloxane (PDMS).

If this were a real experiment, Sobarzo wouldn't touch the sample at all. His hands could transfer charge to the PDMS and ruin the experiment – indeed, almost anything could ruin the experiment. The setup is so sensitive that Sobarzo and Waitukaitis originally wanted to avoid putting their hands in the box altogether. The researchers started off manipulating samples through rubber ›

gloves mounted on the outside, but the gloves were too staticky, so they removed them. Then, even Sobarzo's arm hair started smuggling in static. Installing anti-static flaps on the ports mostly solved that problem. But that was just the beginning.

The air temperature and humidity inside the chamber had to be continuously monitored and adjusted. The air inside was filtered to remove dust, which can carry charge. Before experiments, the samples were fanned with ionised air to neutralise any excess charge on their surfaces. Instead of ordering ready-made PDMS, Sobarzo whipped it up himself to control any properties that could influence the results. During experiments, even touch was standardised: a motorised rig tapped the PDMS samples together inside a closed copper tube, while a pressure sensor ensured that each contact was equally forceful; an electrometer hooked up to the tube measured the samples' charge.

Static charging is sensitive to phenomena across an enormous range of scales in space and time, from individual atoms on surfaces to sparks we can observe with the naked eye, says physicist Yaroslav Sobolev at the Center for Algorithmic and Robotized Synthesis in South Korea. Predicting anything at the human scale feels impossible, he says, since a single molecule out of place can influence a material's large-scale behaviour. The situation recalls the butterfly effect of chaos theory: tiny tweaks to a system compound over time or space to produce dramatically divergent outcomes later. "A tiny effect can make a very big difference," says Lacks.

Loops of charge

So, for Sobarzo and Waitukaitis, getting their "Frankenstein" setup to work took years of trial and error. "It was very frustrating for a long time," says Waitukaitis. And once the system was finally working, the pair immediately discovered something that completely derailed their plans to study water molecules: a few of the PDMS samples inexplicably kept ending up negatively charged.

Scientists have long paid attention to the tendency of certain materials to charge negatively or positively after touching other

RON BULL/TORONTO STAR VIA GETTY IMAGES

Static electricity may make your hair stand on end, but what is it?

materials. For instance, glass usually becomes positively charged on contact with paper, and humans usually charge negatively after touching carpet. Observations like this are often organised into lists called triboelectric series, triboelectricity being another word for static electricity. The first such list was published in 1757. "But not much progress has really been made since the 1700s because it's a really, really difficult problem," says Lacks. Triboelectric series produced by different labs often disagree.

Materials might begin with a tendency to end up positive or negative after a contact, only to switch after a while. Sometimes, they can even produce illogical loops: A would become negative on touching B, B would become negative on touching C, but A would become positive on touching C. Such series loop back on themselves like an impossible staircase in an M.C. Escher print.

Given their handful of stubbornly negative PDMS samples, "we wanted to know if identical materials, when they are touched together, would create a triboelectric series", says Waitukaitis. "And, well, it led us down the rabbit hole."

Sobarzo got to work in the lab. On the first try, "we got a series, a perfect series", he says. The samples charged relative to each other in a neat chain, with no unruly loops. "We were super excited. Like: oh my God, we found this! Nobody has done this before!"

That excitement was short-lived. Waitukaitis was stunned – and cautious. He feared a fluke and asked Sobarzo to repeat the experiment. True to triboelectric form, the samples refused to behave. The series was scrambled. But Sobarzo was convinced that his first result hadn't been mere chance. He went back to the lab, intent on re-creating his first series with a fresh batch of PDMS. At first, it didn't work. Frustrated, he tried again with the same set of samples. It didn't work. He tried again and again and again until, finally, after about a week of stubborn determination, he had his perfect series again. And this time, he knew why.

Somehow, Sobarzo realised, his simple silicon squares had "remembered" their contact history. Sobarzo observed that, at the beginning, the samples charged randomly. When he tried to arrange them into series, he got knotted loops instead of neat chains. But after a few days and several hundred contacts, the initially random behaviour grew more regular. A perfect triboelectric series emerged.

In follow-up experiments, Sobarzo and Waitukaitis confirmed that the mere act of contact changes how PDMS charges – in general, samples are more likely to become negatively charged after more contacts.

"It didn't confirm what I had already thought. It surprised me a great deal that there would be this self-organisation," says Troy Shinbrot at Rutgers University in New Jersey, who studies static.

But what is contact actually changing? How can blocks of polymer remember being touched?

"We probably spent a year on that. We tried every fancy, expensive, surface science tool we could get our hands on. And every one of them said the surfaces before and after contact were identical," says Waitukaitis. But finally, after a thorough analysis using atomic force microscopy, the pair realised that contacted

SEAN MCGRATH

Cat fur is especially prone to static electricity

samples were smoother at small scales than fresh ones – like saws that had blunted their teeth.

Because researchers still don't know how contact electrification happens, it is hard to say why a smoother surface would cause a sample to become more negatively charged. But Waitukaitis is now pretty sure it isn't the presence of water molecules. Instead, he and Sobarzo suspect a phenomenon called flexoelectricity: charging by bending. Bending a surface squeezes charges together in some places and spreads them out in others. Pressing a material over a rougher surface bends it more as it accommodates the peaks and valleys of the textured interface. Since PDMS samples smooth out with contacts, perhaps their tendency to charge negatively is a hint that flexoelectricity could be involved in contact electrification.

Shinbrot and Lacks think the new data could also be consistent with other charging mechanisms, though. It is possible that the phenomenon we call contact electrification is actually several different processes working in tandem, none of them yet understood, and they could be different in other materials than in PDMS. Key questions in contact electrification – which charges are transferred and how – are still open. But now, researchers have a better shot at answering them.

Mystery solved?

Waitukaitis and Sobarzo's results revealed a hidden order underlying the chaos of triboelectric series: contact history matters. So it isn't surprising that so many experiments haven't been replicated. It isn't possible to repeat exactly the same measurement with exactly the same sample, since the mere act of contact changes how a sample charges the next time it is touched. Tracking contacts in future experiments could help resolve some of the confusion that has long plagued the field.

Contact electrification is so entrancing because it shouldn't be – something this mundane shouldn't be so mysterious. But familiarity often conceals complexity. The phenomenon is hard to understand for many of the same reasons that scientists struggle to explain and predict weather, the economy, consciousness and life.

Shinbrot points out that contact electrification is an example of self-organised order in defiance of the usual natural drive to entropy, the thermodynamic measure of disorder. The second law of thermodynamics holds that, overall, entropy can't decrease. And it is usually taken for granted that touching, shaking, heating or otherwise jostling up a system will make it less orderly, jumbling any organisation of particles or, indeed, charges. The exact opposite happens in tribocharging. "You take two identical materials, you rub them together, one becomes more positive. You rub it more and it becomes even more positive. So, what happens to entropy?" asks Shinbrot.

This isn't breaking the second law of thermodynamics – entropy can decrease locally if it increases somewhere else. On the other hand, we generally think of this kind of mysterious, self-organised order as distinctive to life and other complex systems like economies and climate. For scientists hoping to understand everything about our universe, the fact that even dead silicon squares can be so complex is perhaps a sobering thought.

Twenty years before he devised the most important equation of quantum mechanics, Erwin Schrödinger wrote his PhD thesis on contact electrification. He never returned to the subject. Quantum mechanics is famously hard – but perhaps not as hard as static charging.

"People who are serious about figuring stuff out start with contact electrification. And after some time, they just run away," says Sobolev.

But Waitukaitis isn't running. If anything, this project has only drawn him further into the mystery. "It's so juicy. You can have large hadron colliders and you can have quantum computers, but you can't understand why a balloon rubbed on hair makes it stick," he says. "The deeper we get, the more mysterious it becomes, the harder it becomes. And that makes you want it more." ▮

ELISE CUTTS

To investigate static electricity, researchers use this experimental set up to test contact between different samples

Elise Cutts is a science journalist based in Graz, Austria

"The idea that individuals are fully responsible for their health doesn't reflect the realities of people's lives"

Diet and exercise will only get you so far when it comes to living longer, but there is a magic bullet that could help us all, **Devi Sridhar** tells Graham Lawton

BECKI GILL

ACCORDING to Devi Sridhar, we have our health priorities all wrong. In fact, we've been sold a giant myth. We are unhealthily obsessed with what we can do personally – diet, exercise and the rest – and largely ignore the most important determinant of our health. This magic bullet: government.

Public health measures like universal healthcare, drinkable water, clean air and safe roads have a much bigger impact on our chances of making it to 100 than any number of gym sessions or kale smoothies. Sridhar, a professor of global public health at the University of Edinburgh, UK, has a new book out called *How Not to Die (Too Soon)*, which makes a robust case that public health, not just individual striving, is key to living a long and healthy life.

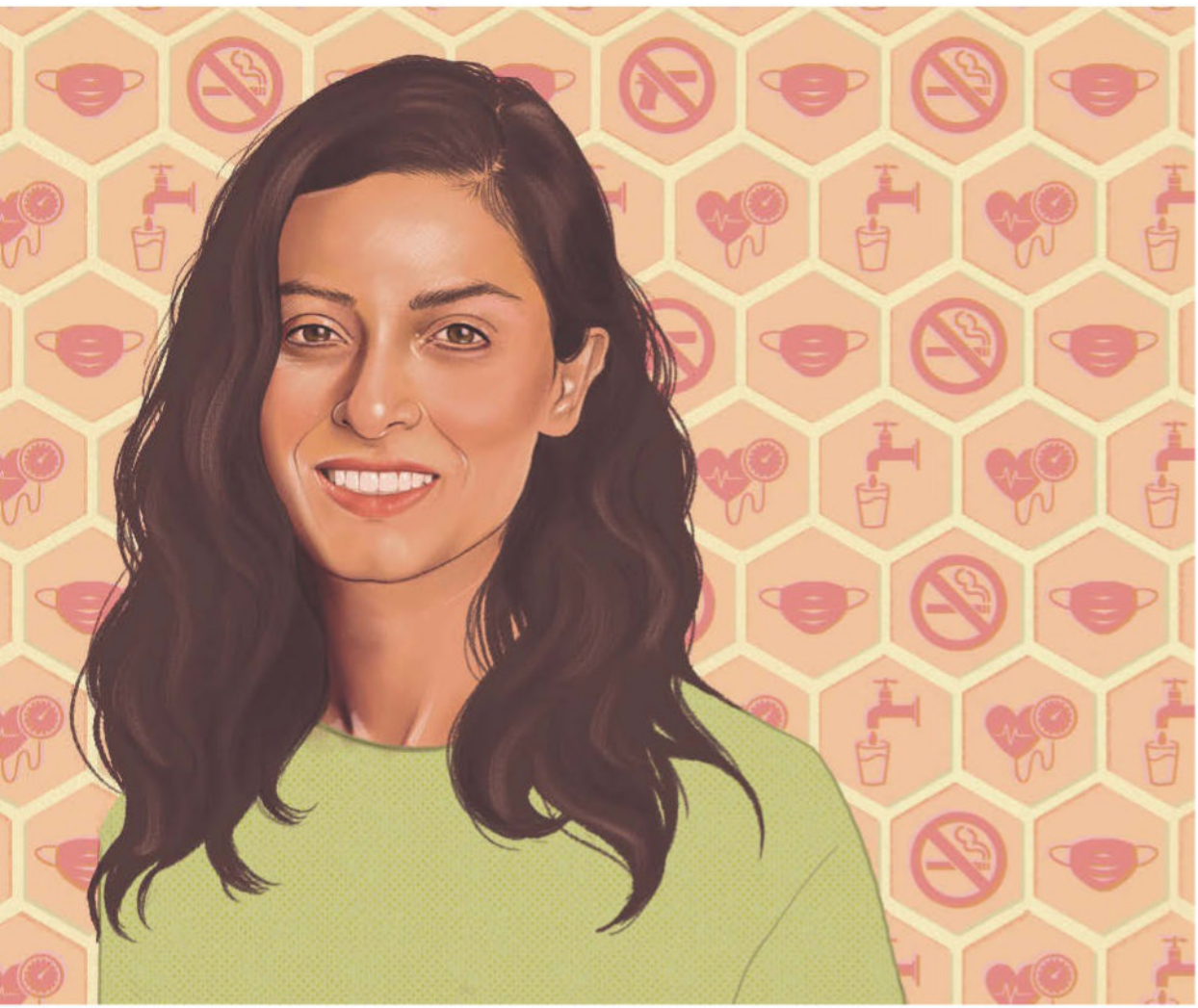
She spoke to *New Scientist* about why we swallowed the myth of purely individual health, how we can make public health more appealing and what she would do if she were in charge.

Graham Lawton: Are you saying that taking responsibility for our own health is a waste of time?

Devi Sridhar: No, no! It's super effective if you can do it. You can make the choice to be healthy if you have resources and time and education. But I think the idea that individuals are fully responsible for their health – which is what is being projected to us – doesn't reflect the realities of people's lives. Where you live and the circumstances you are living in affect how long you live. That's so easily forgotten with health issues, which are seen as your responsibility. You do need people to have agency over their lives and feel like they can make change. But actually, when we see change at a population level, where does it come from? Generally, it comes from governments.

Why did we fall for the myth that it's down to us?

It makes us feel empowered. People are like, "What can I do, today?" and "I can do it if I'm tough enough!" But it's difficult to get people



to think about wider structural issues and how to change them. And we aren't exposed to that as much. We're exposed to self-help books – the wellness literature – which are great if you have time and resources. But there's less about the structural factors because people can't see it as directly applicable to their lives. And there's a lot of cynicism about politicians, thinking that they're all the same and nothing ever changes.

What's the right balance between personal interventions and public health interventions?
I think it depends on the issue. With diet and fitness, you can take a lot of responsibility. But with things like air pollution and clean water, what can you do individually? You're at the mercy of the place you live and your government.

Do things like celebrity diets and TikTok influencers also skew the balance?
Yes. It's the marketing. We seem to think things that are marketed and sold to us in the right way are better. I think there is a real marketing problem in public health. The past years probably haven't helped. Public health is seen as draconian and overbearing, taking away freedoms instead of giving freedoms.

How do we change perceptions of public health?
It's about how we talk about public health. Rather than saying that it's good for the ›

"I think there is a real marketing problem in public health"

MORWAN ALI/EPA/SHUTTERSTOCK

Vaccinating children for measles saves lives, yet doubt can be spread via social media

planet or it's good for society, we could talk about it in terms of how it makes life easier and better. I think people want to know, why is it good for me? It makes me sound cynical, but that's the world we live in.

Even then, it can be difficult to get the message across when there's so much misinformation about things like vaccination. Why do so many people believe nonsense?
I think part of it has to do with social media and the fact it doesn't matter if you are accurate or not: popularity determines truth. For instance, you have Joe Rogan on his podcast talking about measles – saying that everyone had measles when he was a kid and it was all normal. It's astonishing. He isn't a doctor. He isn't a public health expert. He's just giving his opinion. But he will be more influential than any health agency. If I came out and said, "You know what the secret to longer life is? Gin and tonic!", it would get a million clicks. I think that's the challenge.

And there's also the challenge of implementing sensible public health policies, right?
There's always resistance to change. Think of the smoking ban in pubs, there was resistance. When seat belts came in, there was resistance. But generally, resistance comes in the first six months or year, then people get used to it and that becomes the norm. Norms are changeable.

Your book contains many stories of successful government intervention from around the world. Which is your favourite?
Because I'm in Scotland, I have to say Dunblane. The gun legislation [put in place after a school shooting in 1996 using legal firearms] was a hard-fought battle, there was real resistance, but the pay-off is decades of no mass shootings in British schools. Many lives have been saved. And we've seen that template used around the world.

In high-income countries, an estimated 20 per cent of deaths are from preventable causes. What can we learn from countries with lower rates of preventable deaths?
The places to look are what we call the better-performing countries – places like Japan, which has one of the lowest rates of chronic disease and highest rates of cancer survival. So, it's looking at the best performers and saying, if every country looks like that, what would the numbers be able to come down to? Japan's is remarkably low, estimated at about 10 per cent.

Our aim should be increased life expectancy for all – getting to 80, 90, possibly 100. If you can die of old age, you're doing pretty well, right? Because it means there's no identifiable disease or organ failure.

But success would mean that we end up with an older population. How would we deal with that?
I think we have to see ageing as a positive force instead of a negative one. We should talk about healthy ageing, not getting to 100 for the sake of getting there, but with full mental and physical abilities, without chronic diseases like diabetes or hypertension, which are a burden on the healthcare system, and with the ability to live independently, which takes pressure off social care.

How long would it take to achieve this idealised situation where the preventable death rate is comparable to that of Japan?
Being realistic, it's probably a 10-to-20-year timescale. Things like reversing childhood obesity and changing city design aren't possible overnight. But they have large pay-offs over time. One of the problems is that our current model of government is news cycle to news cycle. It isn't even year to year. It's headline to headline, and it's incessant. So, there's no bandwidth for people to think 10 years or 15 years ahead because they are caught up in it.

OK, so if you were in charge of the National Health Service (NHS) in the UK, what changes would you make?
I'm sure they've thought about this, but for me, prevention. We spend far less on prevention and far more on acute care. Right now, the focus in the UK is on hospitals and ambulance wait times, and it's only going to get worse with an ageing population. So, I think I would go straight to prevention. What are the cheap ways we can invest in prevention to detect things earlier? Pick three or four issues that are the main reasons for hospital admissions and ask, how do we address them?

For example, we know hypertension is a silent killer. Could we have a programme where people go in and get their blood pressure checked once a year? It might cost more in the first year, but five or 10 years down the line, you're saving money. We could also take regular measurements of things like waist circumference, abdominal fat levels, sugar and cholesterol in blood, or even grip strength.

We last interviewed you during covid, when you said the pandemic was an opportunity to tackle some long-standing public health issues. Did that happen?
No. I think, if anything, there has been a backlash against public health and a backlash against state intervention because it was so draconian, in the sense of lockdowns and wearing masks. So, I don't think we have seized that moment. It's quite fascinating what has emerged from the pandemic. Now there is even more emphasis on individual responsibility rather than acting collectively.

"Our aim should be increased life expectancy for all – getting to 80, 90, possibly 100"

There was resistance to making seat belts mandatory, but now they are the norm

CRACKERCLIPS STOCK MEDIA/ALAMY

Did we learn the lessons of the pandemic itself, and is the world better prepared for the next one?
It depends what you look at. In public health, I'd say no, we're going backwards. The public health infrastructure, like the testing infrastructure in the UK, has been completely dismantled. But in scientific progress, I'd say yes. We are better at designing vaccines. We have better vaccine platforms, more streamlined research. The scientific community has become faster and more adept. I'm pretty sure that if avian flu starts spreading [among humans], the UK government will have a vaccine, they'll get it into clinics. They'll be ready to go.

One quote near the end of your book jumped out at me: "We don't need more research." Really?
Yes. We know a lot. We can probably get 90 per cent of the way there with existing knowledge about how to improve public health at a population level. Of course, there is always room for further research, but do we need another study showing that exercise reduces your risk of heart attacks? Probably not. It can almost be a distraction to say, "Let's do more research." Because you can just delay a decision. That was what I was trying to get at.

Globally, are we going in the right direction on public health?
I think, in general, yes. Life is getting longer. We live better today than 100 years ago. We maybe aren't making progress as fast as we could, and there are some places where things are being rolled back. But the larger trajectory is that we've made so much progress.

What do you hope people will take away from the book?
That politicians can make a difference. Think of the NHS. There was a deliberate decision made to create it. It didn't just randomly happen. I'm trying to show that, in the world we live in, everything we have is a set of policy choices that were made before, sometimes decades ago, that we're benefiting from today. What we do today, we may not see improvements from, but future generations will. What I've tried to do is give a bit of hope. ▮

Graham Lawton is a staff writer at *New Scientist*

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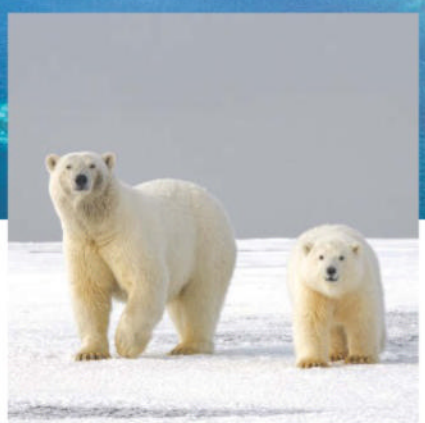

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The back pages

Debunking gardening myths

Getting your hands dirty

Can a microbe found in soil alter your brain chemistry to improve your mood? **James Wong** investigates *Mycobacterium vaccae*

James Wong is a botanist and science writer, with a particular interest in food crops, conservation and the environment. Trained at the Royal Botanic Gardens, Kew, in London, he shares his tiny flat with more than 500 houseplants. You can follow him on X and Instagram @botanygeek

THERE are so many colourful claims out there when it comes to gardening, but there is one in particular that has been doing the rounds recently: "Soil is an antidepressant."

According to this idea, espoused through countless social media posts, *Mycobacterium vaccae* – a microbe naturally found in soil – can actually boost your mood. All you apparently have to do to experience this benefit is get your hands in contact with earth. The bacteria are said to be absorbed through your skin or inhaled from the air, and they will quickly get to work transforming your brain chemistry for the better. But is all this a bit too good to be true?

While the claim may initially seem more than a little outlandish, there have actually been a range of studies investigating the effect of this microbe on a variety of conditions, from eczema to cancer. In fact, *M. vaccae* was first isolated in soil samples from Uganda by scientists looking to find a harmless close cousin of the deadly *Mycobacterium tuberculosis* that could be used as a form of immunotherapy.

Researchers' interest in its potential application for helping with depression was piqued when people with lung cancer being treated with the bacteria reported improvements in their quality of life as an unexpected, but very welcome, side effect. And so far, this mood-enhancing effect seems to have been replicated in a number of well-designed studies. Cue an avalanche of social media memes.

CAVAN IMAGES/ALAMY

Now here is the downside: all the studies that explicitly set out to test this hypothesis were conducted in mice, not humans. This is important, as the results of animal experiments are, in general, rarely replicated in people. For instance, one review of 76 animal studies found that only 37 per cent were repeated in human studies.

On top of this, the mice used in the *M. vaccae* studies were males from one particular inbred strain. If you are wondering whether researchers administered the bacteria by saturating the air in the cages with it or by applying it directly to the skin, well, neither is the case. All the studies I could find involved either injecting the bacteria into the mice's bloodstream or mixing it in their food.

As someone fascinated by the growing evidence that suggests spending time in green space can improve your mental well-being, I can't wait to see what further research on *M. vaccae* produces. However, despite the conviction with which this claim is put forward all over the internet, right now it is only true to say that "soil is an antidepressant" if you are a male mouse who has been injected with a purified form of a bacterium found in it – and since you're reading this, I assume you aren't. ■

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Debunking gardening myths appears monthly

Next week
The science of exercise

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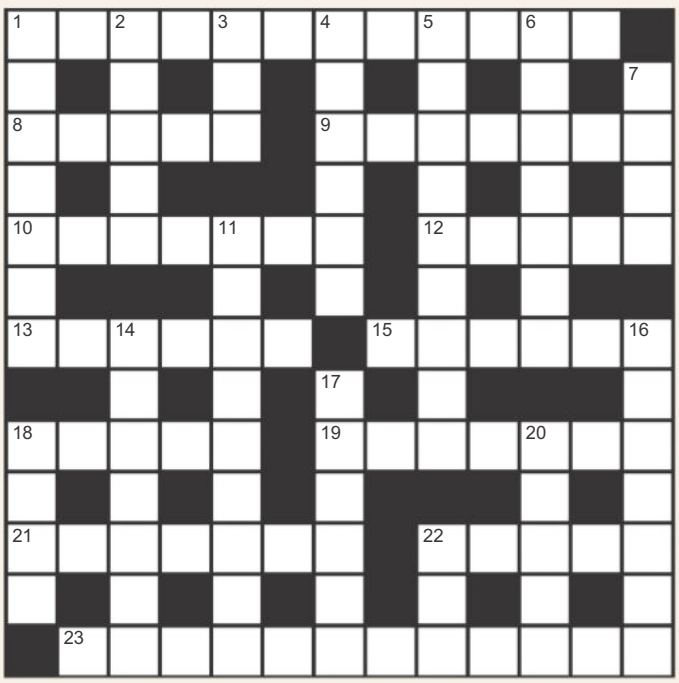
Cryptic crossword #165 *Set by Rasa*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Devious sort, past and present, offers lofty position (12)
8 Nine versions retaining decisive refusal (5)
9 Video game vibrations, e.g., that'll teach you and Papa quirky behaviours (7)
10 Quiet sailor adjusted navigation aid (7)
12 Fold edge, packing backed-up computer (5)
13 Make concrete bust by dome (6)
15 Letter from Greece encloses tip of thyme flower part (6)
18 Journal exposed nice Sudoku solver's asset (5)
19 Accepted comparatively robust medical device (7)
21 Hold louse from Spooner? (4,3)
22 Fellows describing very unstable particle (5)
23 Moulded pig iron bezel for satirical award (2,5,5)

DOWN

1 Yes, surprisingly, taking snoozes creates neural gap (7)
2 Competitor set up den about five (5)
3 It's said streaked rocky hill... (3)
4 ...leads to salt cave with this unusual metamorphic rock (6)
5 Game curtailed optimism and spirit (9)
6 A barrier is formed by this vituperation (7)
7 Regularly rush vape request from a host (4)
11 Two cups hot dip essentially filling medium chicory (9)
14 Indiscriminate gabbing is how it all started (3,4)
16 Schedule Arkansas park employee before the end (7)
17 Individual liquid gels lying around at home (6)
18 John captures black timber wolf (4)
20 Young woman and I drink (5)
22 Clean molybdenum ore away from tiny opening (3)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #309
set by Corryn Wetzel

1 What toad is known for hatching eggs from the skin on its back?

2 What does the "GPT" in ChatGPT stand for?

3 Which element has the highest melting point of any metal?

4 What was the first private spacecraft to dock with the ISS?

5 Who discovered the neutron in 1932?

Answers on page 47

BrainTwister
set by Peter Rowlett
#80 Iccanobif numbers

Iccanobif numbers are formed by following this procedure: reverse the digits of the two previous terms and add the resulting numbers together. The first two terms are 1, 1.

These numbers match the Fibonacci sequence for the first few terms. After how many terms do the sequences first differ?

There are two terms with four digits. What are they?

Unlike Fibonacci, each Iccanobif number isn't necessarily bigger than the previous one. When do they first decrease?

Solution next week

Quick dry

What's the best way to hold my hands under a hot air blower to dry them efficiently: flat or cupped? Or something else?

Chris Daniel
Colwyn Bay, Conwy, UK
During the covid-19 pandemic, lots of us had to relearn the correct technique for washing your hands: scrub for at least 20 seconds using clean, running water and soap, then rinse and dry them thoroughly. This last part is as important as the first. Damp or wet hands can promote the growth of bacteria and make it easier for them to spread onto other surfaces, risking cross-contamination.

Older types of electric hand dryers rely on the heat of a low-speed airstream to dry hands by evaporation. However, this method can take about 45 seconds, so users often abandon the process before their hands are completely dry, shaking excess water off or wiping their hands on their clothing, which can increase the spread of bacteria. Another common action is to rub the hands together to spread the remaining water more thinly over the skin to hasten drying, but this has been found to result in more bacteria being left on the hands compared with keeping the hands still.

"There are pros and cons to all methods, but the message is clear: fully dry hands are healthier and safer than wet ones"

High-speed electric dryers emit round or bladed jets of air that can be as fast as 130 metres per second and can blow water from the hands in as little as 8 to 15 seconds. But these machines have been found to spread bacteria into the air and onto the user's clothing, as well as surfaces up to 2 m away.

The technique recommended by the manufacturers of the bladed-air style of dryer is to position the hands in the air flow with the fingers extended, starting at the wrist and drawing the hands backwards to allow the water to be blown off towards the fingertips and away from the body. This process is repeated for both sides of the hands until they are dry. For dryers with round jets of air, the technique is similar, but with the hands moving in a circular pattern so that all areas are dried.

It is tempting to try to speed up the process by cupping your hands under the high-speed air flow, but this may simply have the effect of blowing excess water back into your face and into the room while not producing any benefit.

There are pros and cons to all drying methods, but the message is clear: fully dry hands are healthier and safer than wet ones.

Hillary Shaw
Newport, Shropshire, UK
"Something else" might be best for the planet. If it isn't cold outside and you aren't doing anything that needs dry hands, a quick shake and they will soon dry via evaporation. A hot air dryer may cause between 35 and 108 kilograms of carbon dioxide emissions annually. Admittedly, this is better than paper towel use, but it is still equivalent to about a week of average CO_2 emissions per person globally (4.8 tonnes). Every hot air dryer we can eliminate saves almost the same CO_2 a year as is released by driving the average car 1000 km. These are small contributions, but every little helps.

CULTURA/ALAMY

Once they eat their ice creams, will these children be warmer or colder?

Pat French
Longdon Upon Tern, Shropshire, UK
Definitely "something else". The quickest approach to using a hand dryer is to continue the movements of the washing routine recommended to combat covid-19. This way, every part of the surface of each hand is rubbed against the other.

Rubbing the hands together under the air flow smears any gathered moisture to as thin a layer as is practically possible, so that the remainder evaporates quickly. This standard routine ensures that all parts of the hands, including between the fingers, are dried to the same extent.

This constant movement also gives the person the best chance of keeping their hands under the minuscule point at which a sensor switches on the dryer. By eliminating frustration as the machine switches off prematurely, perseverance is encouraged.

It is unlikely any technique will remove the need for a final wipe on the seat of the trousers or skirt.

This week's new questions

Sweet treat **When we eat ice cream on a hot day, does it cool us down or do the calories in it warm us up?** ***Julian Goodkin****, London, UK*

Cleaning up **When I open my dishwasher, everything is dry except the plastic items, which remain covered with water droplets. Why is this?** ***Robert Fizek****, via email*

Flavour gap

Why do low and non-alcoholic beers taste so much closer to the "real thing" than non-alcoholic wines do? (continued)

Andrew Tyrtania
Lidlington, Bedfordshire, UK
There are two main types of beer: ales and lagers. Until very recently, I would have said no one has produced a drinkable non-alcoholic ale, but that has changed. Low-alcohol beer, also called small beer or table beer, has been produced for centuries, simply by starting with less sugar from less grain, or "second runnings". This is when you rinse, or "sparge", the grains a second time, producing two beers from one load of grain.

There are broadly two ways of making a non-alcoholic beverage:

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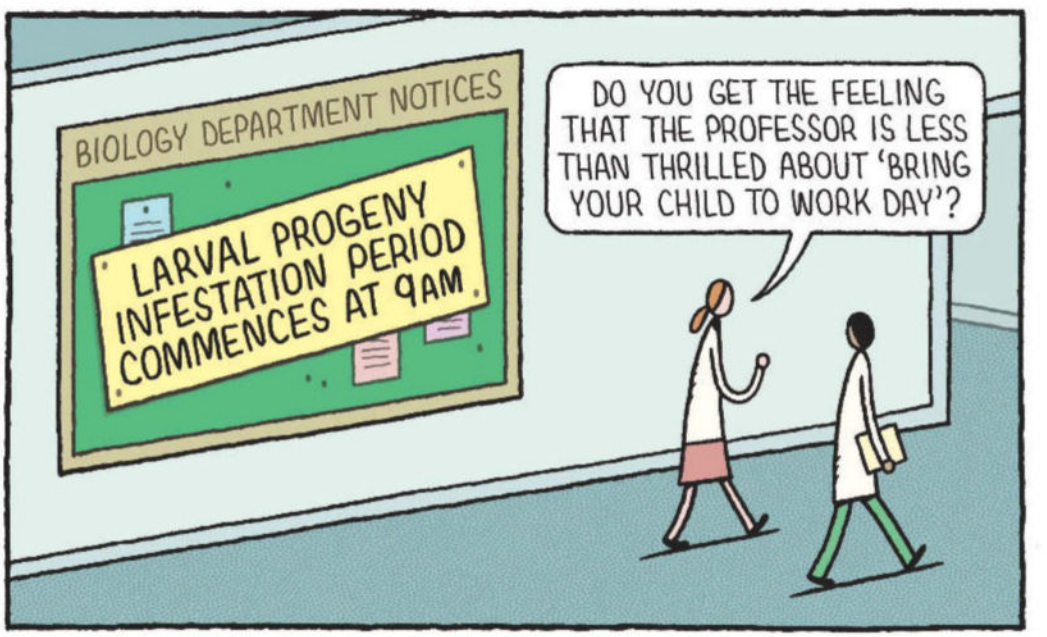
for New Scientist



manufacture it with no alcohol, or make it as before and then extract the alcohol. The former has been practised for a long time with wines – it is called pasteurised grape juice. But even the latter has been done since the 1980s, using a process known as the spinning cone column. This relies on gravity, centripetal force, heat and a slight vacuum to separate the various components, which can then be left out (i.e. the alcohol) or recombined into the final product. The simple way to remove the alcohol is to just boil the wine or beer, but this has deleterious effects on flavour for both. Using the vacuum reduces these, as boiling takes place at lower temperatures under reduced pressure.

Turning to beer production, the choice and combination of grains and the temperatures used to make the wort (the liquid foundation of beer) can make a big difference to the end product. The brewer can determine which sugars are extracted, including reducing the maltose, from which most alcohol is produced. Hop additions are also at the brewer's disposal, and these, too, have a big impact on the beer.

"Yeasts reproduce rapidly, and breeding has been employed to produce new, exciting yeast strains, as has CRISPR technology"

Consumer interest has led to massive recent innovation. Brewers now have not only pure hop oil extracts to add into their final beer, but also specialist yeasts, engineered to produce little or no alcohol while still producing the other desirable flavour compounds that contribute to the final product. Yeasts, like fruit flies, reproduce rapidly, so they lend themselves to genetic engineering. Breeding has been employed to produce new, exciting yeast strains, as has CRISPR technology.

During the same period, we have also become used to craft ales, which generally offer a fruity, hop-forward flavour profile and less malty character. Producing low- or no-alcohol beers of this character is more likely to succeed.

Mouthfeel, or body, is mostly determined by components other than alcohol, but we can still detect when it isn't there. With beers, you are typically removing 3.5 to 6.5 per cent alcohol by volume, while for wines, this may be 11 to 14 per cent – a much more noticeable change in composition.

Craft beers and all non-alcoholic beers have to be artificially carbonated, as yeast produces most of the CO_2 at the same time it is producing alcohol. Any sort of treatment to reduce alcohol, such as vacuum distillation, filtering, reverse osmosis or arrested fermentation, will remove CO_2 from the beer. As such, you are unlikely to find non-alcoholic beer on hand pump from cask any time soon (ditto for non-alcoholic champagne). But I would say watch this space – it can only be a matter of a few years before very drinkable non-alcoholic wines appear on the shelves. All eyes are on the yeast suppliers. ▮

Answers

Quick quiz #309 *Answers*

1 The common Surinam toad (*Pipa pipa*)
2 Generative pre-trained transformer
3 Tungsten
4 SpaceX Dragon
5 James Chadwick

Quick crossword #186 *Answers*

ACROSS 1 Schist, **4** Effort, **9** Four, **10** Immunology, **11** Baryon, **12** Interior, **13** Chondrite, **15** Used, **16** Base, **17** Occlusion, **21** Nembutal, **22** Badger, **24** Intertrigo, **25** Tata, **26** Reduce, **27** Stamen

DOWN 1 Stomach, **2** Hardy, **3** Skinner, **5** Finite, **6** Oil crisis, **7** Tigroid, **8** Amniotic fluid, **14** Nosebleed, **16** Brenner, **18** Lab coat, **19** Overton, **20** Static, **23** Datum

#79 Hamming it up *Solution*

The distance between 01011 and 01100 is 3. The smallest number starting with 01 with a distance of 3 from 00000 is 01011. The smallest number starting with 10 with a distance of ≥3 from 00000 and 01011 is 10101. The smallest number starting with 11 with a distance of ≥ 3 from 00000, 01011 and 10101 is 11110.

For a sixth bit, add a 0 or 1 so you always have an even number of 0s and an even number of 1s, producing, for example, 000000, 010111, 101011 and 111100. Alternatively, you can make there be an odd number of each.

Bleaker house

One of the great joys in life, Feedback argues, is the perfect opening sentence of a book – and the concomitant realisation that, yes, this one is going to be good. "It was the day my grandmother exploded." "As the manager of the Performance sits before the curtain on the boards and looks into the Fair, a feeling of profound melancholy comes over him in his survey of the bustling place." "Let's start with the end of the world, why don't we?"

So we, and many others, were horrified by a passage in a recent article in *The New Yorker* about how artificial intelligence might change reading. The suggestion was that AI might simplify challenging prose into something less tangled.

The example offered by writer Joshua Rothman was this line from the "muddy and semantically tortuous" opening of Charles Dickens's *Bleak House*: "Gas looming through the fog in divers places in the streets, much as the sun may, from the spongey fields, be seen to loom by husbandman and ploughboy." The AI Claude reworks it thus: "Gas lamps glow dimly through the fog at various spots throughout the streets, much like how the sun might appear to farmers working in misty fields."

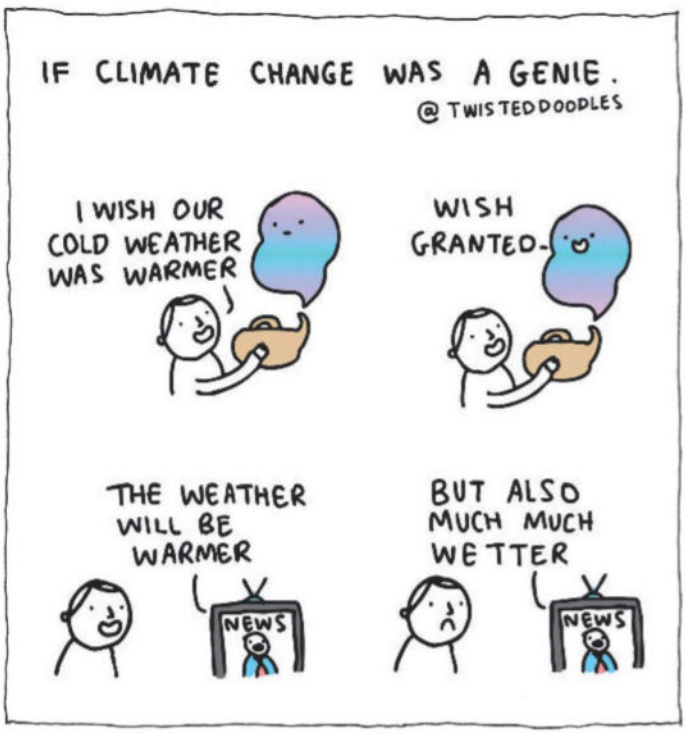
This was flagged by Tobias Wilson-Bates, an associate professor of 19th-century British literature, on Bluesky, where he said: "This article is going to turn me into the Joker."

We suppose that, on some level, Claude has managed to convey something of what Dickens was getting at, but we also suppose that things like cadence and scansion are relevant to the reading experience. The phrase "various spots" physically hurt when we read it. We also aren't sure that the passage's sole purpose is to convey that things are a bit foggy. Everyone in *Bleak House* is threatened and stymied, and words like "loom" and "spongey" set this mood.

But never mind literary criticism when we can amuse ourselves. What other dense prose passages could be summarised by AI for ease of consumption? Adam Sharp has already made some suggestions, again on Bluesky. For instance, take the opening line of Sylvia Plath's novel *The Bell Jar*: "It was a queer, sultry summer, the summer they electrocuted the Rosenbergs, and I didn't know what I was doing in New York." Sharp suggests the following abridgement: "That summer was sizzling, and so were the Rosenbergs."

And what about that overly long opener from Jane Austen's *Pride and Prejudice*: "It is a truth universally acknowledged, that a single man in possession of a good fortune, must be in want of a wife." Surely we can boil that down a bit: "Everyone knows that rich, single men want to get married." We encourage readers to identify similar prosey passages in need of AI-assisted simplification.

Twisteddoodles *for New Scientist*



Got a story for Feedback?
Send it to feedback@newscientist.com
or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

Burn before viewing

Brian Darvell recently obtained a DVD of the film *Conclave* and was thrown into theological confusion by a yellow sticker on the back that read: "Security Protected: Remove before microwaving." That is one way to make white smoke.

The stork truth

Feedback didn't anticipate, when we reminded readers that correlation doesn't necessarily equal causation, quite such a flood of responses. What could have caused it?

Jim Handman writes in to remind us of two famously bizarre correlations. The number of pirates in the world has declined in near-perfect lockstep with the rise in global temperatures, leading to the slogan, "Stop global warming: become a pirate."

Meanwhile, homicides tend to rise in line with ice cream sales. While this latter correlation "looks goofy", says Jim, "there is actually a good explanation". Warm weather encourages people to go outside, which increases social interaction, leading to "more opportunities for ice cream consumption and, unfortunately, more opportunities for crime". It certainly does: Feedback once went outside and bought an ice cream, only to have it stolen out of our hands by a seagull. Lesson learned. Feedback now eats ice cream indoors, away from marauding marine fauna.

A third correlation has already been discussed in a recent column: stork populations in some countries correlate with the number of children born. At the time, we assumed that this correlation was spurious. But three readers have offered possible mechanisms.

Hillary Shaw suggests a link with the built environment: "Storks like to nest in elevated places including house chimneys, pylons and church steeples." Wealthier societies, which have lower birth rates, have replaced "unsightly pylons" with buried cables and don't put chimneys on centrally heated houses.

Paul Vann has a similar thought: "I recall from my A-level statistics days... that there was a positive correlation between the number of storks' nests on houses in the Netherlands and the number of children in households". The explanation? "Families with more children tended to live in larger houses with more chimney stacks and therefore more storks' nests".

Finally, Brian Reffin Smith describes a site near a river in Germany "where storks abound" and "constantly stoop to pick up things". Brian claims to have twice seen "single, unopened condom wrappers" – raising the question of "whether the storks are stealing them to ensure more babies, hence more jobs for themselves". He offers a stern lesson: "Nefarious intention is so often missing as a factor in statistical correlations."

You decide which is most likely.

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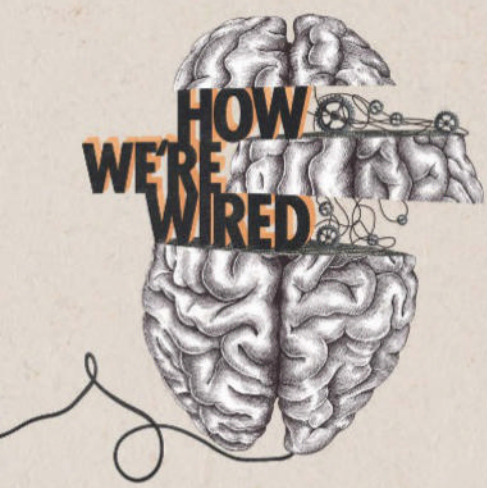

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