New Scientist

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DOES SCIENCE HAVE A FUTURE IN THE US?

NEW THEORY OF LIGHT MAY OVERTURN A CENTURY OF PHYSICS

THE PARTICLE THAT SHOULDN'T EXIST

Where did it come from and what does it tell us about the universe?

WHY MEN DIE YOUNGER

The surprising health effects of vanishing Y chromosomes

PLUS TREATING PEANUT ALLERGIES / PLANES WITH SHARK SKIN / HEAVIEST ANTIMATTER / **BAT THAT WALKS BACKWARDS**

Science and technology news **www.newscientist.com**

locommotion?

Every mechanical watch has a balance wheel, but not all balance wheels are created equal. The **C12 Loco's** 'free sprung' balance wheel (and hairspring) isn't merely a part of the watch. It's the star. Placed below the time-telling dial, on the artfully coloured and stepped platine, its mesmeric oscillations are driven by a new in-house movement – Calibre CW-003, whose hand-wound, hand-finished architecture delivers a six-day power reserve and chronometric accuracy. And because we want to tell the story of how we got here – and because we're a little *loco* ourselves – we've made a feature-length documentary about it. Just make sure you're sitting down when the price is revealed.

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Do your research

Christopher Ward

christopherward.com

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Elsewhere on New Scientist

NS Live

Atoms for outer space

Hear nuclear chemist Tim Gregory recall how the power of the atom has been used to enable space exploration for decades, on 18 October at London's ExCeL Centre. From moon landers and long-distance voyagers to Mars rovers, many missions have used the energy produced by radioactive decay to generate electrical power. And soon, miniature reactors, nuclear rockets and new radioactive batteries may allow humanity to explore even further.

newscientist.com/nslive

Tour

Archaeology across the Caucasus

Journey through Georgia and Armenia, exploring ancient archaeological sites, medieval churches, monasteries and prehistoric monuments. The South Caucasus region is a crossroads of history, where East meets West. This 12-day tour starts on 3 August 2026 and costs £3799.

newscientist.com/tours

Video

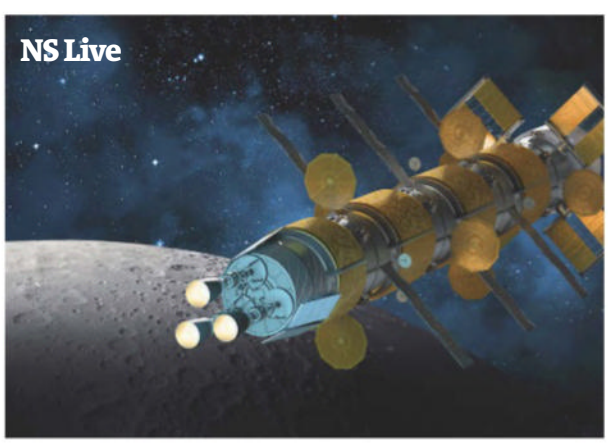
Chocolate taste test

Climate change is hitting cacao farms hard, leading to shortages of chocolate's raw ingredient. But there is hope. California Cultured is one of several firms aiming to mass-produce chocolate in vats using cell culture technology. *New Scientist* managed to get a small sample and, in the interests of science, did a blind taste test to see how it shapes up.

youtube.com/newscientist

SHUTTERSTOCK/VVVITA

Narikala fortress Uncover ancient history in Tbilisi's old town



NASA

Nuclear-powered Could a fission engine take us to distant worlds?

Online event

Detecting black holes

Despite the mysterious nature of black holes, evidence suggests they are incredibly abundant in our universe. Join theoretical physicist Delilah Gates as she reveals how these exotic objects can be observed and studied. Experimentalists are turning to space-time ripples, using them to study how black holes shift the frequency of light. This online event takes place on 10 June at 6pm BST/1pm EDT.

newscientist.com/events

Newsletter

Health Check

Health reporter Carissa Wong looks at a new weapon against antibiotic-resistant gonorrhoea. Such resistance has forced us to use our last-resort treatment for this infection, an antibiotic called ceftriaxone. However, strains of gonorrhoea resistant to this are already rising in many countries. Now, a new treatment suggests the battle isn't over yet.

newscientist.com/health-check

A note from the Podcast editor

The World, the Universe and Us

Dear reader,
We are very proud of our Weekly podcast, which we have been putting out every week for over five years now and which has won a number of awards and been listened to in over 160 countries around the world. We love being able to bring science to new audiences, and we love the flexibility, informality and intimacy that conversation brings to science reporting.
But it is time to shake things up. We have relaunched and renamed our weekly show. Introducing: The World, the Universe and Us, hosted by me and my colleague Penny Sarchet, joined each week by expert journalists and scientists in the field. From the evolution of intelligent life to the mysteries of consciousness, from the threat of the climate crisis to the search for dark matter, The World, the Universe and Us is your essential weekly dose of science and wonder in uncertain times.
The show draws on *New Scientist*'s unparalleled depth of reporting to put the stories that matter into context. Feed your curiosity with a podcast that will restore your sense of optimism and nourish your brain. Get it, as they say, wherever you get your podcasts. And we are also on YouTube, if you want to watch us – do come and say hello.

Rowan Hooper
Podcast editor

Podcast

NewScientist

The world, the universe and us

Listen to our brand-new podcast, The world, the universe and us, for your essential weekly dose of science and wonder in an uncertain world. Hosted by journalists Rowan Hooper and Penny Sarchet and joined each week by expert scientists, the show draws on *New Scientist*'s unparalleled depth of reporting to put the stories that matter into context.

Feed your curiosity with the podcast that will restore your sense of optimism and nourish your brain.

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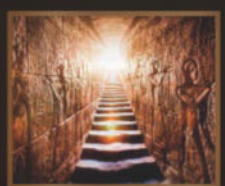
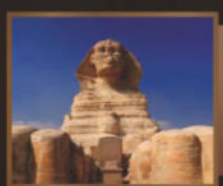

THE SEARCH FOR CLEOPATRA'S TOMB • SECRET ROOMS IN THE GREAT PYRAMID • KING TUT'S UNTOLD SECRETS • & MORE REVELATIONS!

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Extraordinary claims

How to deal with discoveries that seem too good to be true

ENTER the Royal Society in London – the UK's national academy of science – and you will see a three-word phrase: "*nullius in verba*". This motto, held for over 350 years, translates to "take nobody's word for it", meaning science cannot simply be taken on trust; it must be backed by evidence.

But what is evidence? Here, things become murkier. A claim that the sky is blue requires little to back it up, as anyone who is able to see it for themselves can attest. Start claiming that the sky is purple, however, and you had better come armed with a good explanation for why we have never noticed this before.

Another motto, attributed to the astronomer Carl Sagan, sums up this varying scale of proof: "extraordinary claims require extraordinary evidence". As we report in this issue, some recent high-profile examples have fallen far short of this.

The first would be close to Sagan's heart: last month, astronomers claimed to have found evidence of a gas potentially produced by alien life on a distant exoplanet, but a reanalysis of the data suggests they may not have detected anything at all (see page 13). Meanwhile, we report strong criticism from the International Union for Conservation of Nature of the claim by biotech firm Colossal that it has "de-extincted" the dire wolf (see page 11).

"The job of science, as always, is now to dig deeper in the hope of uncovering the truth"

Many are excited by these claims and would like them to be true, but, unfortunately, they are not. We take seriously our duty to accurately report strong claims, as demonstrated by our story on page 8 about a proposal that light doesn't have wave-particle duality, but is actually solely a quantum particle.

This truly is an extraordinary claim, attempting to overturn a century of physics consensus. As we make clear, the evidence supporting the idea is currently lacking – but physicists are intrigued enough to continue investigating. With no clear reason for why the proposal is wrong, the job of science, as always, is now to dig deeper in the hope of uncovering the truth, or, at least, our best approximation of it. ▮

PUBLISHING & COMMERCIAL

Commercial and events director Adrian Newton

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Email displayads@newscientist.com
Sales director Claudia Nicoletti
Account manager Mila Gantcheva
Agency partner Tilly Pollock

Recruitment advertising
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CONTACT US

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General & media enquiries
US 600 Fifth Avenue, 7th Floor, NY 10020
UK 9 Derry Street, London, W8 5HY
Australia 58 Gipps Street, Collingwood, Victoria 3066

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News

Zoology

Giant by name, giant by nature

Measuring 6.5 centimetres, this giant magnolia snail (*Bertia cambojiensis*) at Longleat Safari Park in Wiltshire, UK, certainly lives up to its name. Also known as the Vietnamese giant snail, this species was thought to be extinct until living specimens were discovered in southern Vietnam in 2012. There are estimated to be around 300 left in the world.

TOM ANDERS/LONGLEAT

Physics

Have we got light all wrong?

The double-slit experiment was long thought to confirm that light can be a wave, but a new mathematical model suggests it may not be so, finds **Karmela Padavic-Callaghan**

LIGHT is both a wave and a particle – or so we have thought for about 100 years. Since the advent of quantum physics, light has been understood to exhibit wave-particle duality. One part of this duality can be traced to physicist Thomas Young who, in 1801, performed an experiment that confirmed light's wave character: the double-slit experiment. But now, a radical new interpretation brings into question the results of this famous experiment, and indeed, the very nature of light itself.

Celso Villas-Boas at the Federal University of São Carlos in Brazil and his colleagues argue that we don't need to think of light as a wave to explain the results of the double-slit experiment. They suggest that, in this case, light can be seen as fundamentally being just a particle.

SHUTTERSTOCK/AGSANDREW

The behaviour of light could be explained by so-called dark photons

Making waves

This is a controversial break with the history of physics. Villas-Boas says the double-slit experiment has been seen by many scientists – including giants like James Clerk Maxwell, who developed the classical theory of electromagnetism, and Robert Millikan, whose experiments proved Albert Einstein's explanation of the photoelectric effect – as "clear evidence that we have a wave aspect of the field of light. But according to our explanation, we just need the particle aspect of light," he says. The classical wave interpretation, he says, isn't the most fundamental one; quantum mechanics is.

In the double-slit experiment, light shines through two adjacent narrow slits and onto a screen, where it forms bright and dark vertical stripes called the "classical interference" pattern. The usual explanation for this is that light waves spill through the slits and meet each other at the screen. If, when they meet, the highest crest of one light wave meets the lowest trough of another, the two cancel out and the screen records a dark stripe – the absence of light. Bright stripes, on the other hand, are formed when two waves meet at a screen and overlap so that their crests add up (see "Wave interpretation", right).

The researchers took this well-known pattern of stripes and asked whether it could be achieved if you assume light doesn't, in fact, take the form of a wave. Their mathematical model used a single atom as the screen because it is the most rudimentary photon detector. And their framework assumes that the position of the stripes is simply determined by the geometry of the slits and how light bends through them.

In the end, their calculations suggest that the pattern can arise just from considering light as a quantum particle. This is because in some places, the photons passing through the slits assume "dark states" in which they can't interact with other particles and don't light up the screen (see "Dark photon interpretation", right). In this view, the pattern never indicates the absence of photons – the absence of light – but shows that some of them have quantum properties that let them elude detection (*Physical Review Letters*, doi.org/g9gpn5).

> **"This shattered a lot of our understanding of how classic interference works. All hell broke loose"**

"This was a shocking experience. Somehow, there are photons all over the place, but in the dark regions, they cannot excite the atom," says team member Gerhard Rempe at the Max Planck Institute of Quantum Optics in Germany. "This shattered a lot of our understanding of how classical interference works. All hell broke loose."

Several researchers that *New Scientist* consulted agreed that the new framework seems to call for a dramatic change in our understanding of fundamental physics – and expressed scepticism over whether it is warranted. Certainly, the claim is bold enough to invite scrutiny.

The double-slit experiment has also played a historical role in establishing the concept of wave-particle duality because it has been conducted with not just photons, but also electrons, atoms and even some molecules. Every single one produced the classical interference pattern.

This pattern can be derived from the mathematics of waves, and has always been considered a wave phenomenon, so early

quantum physicists found it surprising that any particle – an entity with properties opposite to those of a wave – could produce it. The idea of wave-particle duality posited that everything in our world can exhibit both wave-like and particle-like properties depending on the circumstances, just not at the same time. Though this is widely accepted among contemporary physicists, it is one of the more mysterious features of quantum theory.

But perhaps it is time for a rethink. "I find this perspective extremely intriguing. While one can certainly continue to interpret interference phenomena involving classical fields and single photons in terms of waves cancelling and reinforcing one another, this new approach seems to offer a more complete and coherent framework – relying solely on the particle nature of light," says Marco Bellini at the National Institute of Optics in Italy.

Cast in a new light

Rempe says the new framework may also clarify why some modifications of the double-slit experiment seem to have unexpectedly outsized outcomes. For example, if a detector is added to one of the slits so that researchers can tell when a photon has passed through it, the screen stops registering an interference pattern. Instead, it shows one bright spot behind each slit, which is what is expected from a particle rather than a wave. How can the addition of the detector cajole an electromagnetic wave into becoming a stream of photons?

"The idea the observer can change the reality or the direction of the photon, this seems kind of mystical, but according to our theory this does not happen anymore," says Villas-Boas. This question of how the act of observation affects quantum objects has been at the root of a complex and largely unresolved debate. But the conception of light as only a particle could resolve it.

Christopher Gerry at Lehman College in New York says the idea that some states of light can be "dark" precedes the new work. "I think this is an interesting idea, but I think it will be a controversial one as well. It will be interesting to see if this approach can be studied experimentally. Perhaps this idea could be complementary to the usual explanation of interference [patterns] in light, but I don't see the latter going away anytime soon," he says.

"The framework seems to call for a dramatic change in our understanding of fundamental physics"

For now, it is unclear whether this radical reinterpretation could reveal new light-based phenomena or lead to new tests of quantum physics, says Luis Sánchez-Soto at the Complutense University of Madrid, Spain. "My main question is, 'what for?' For me, I understand that you are introducing a new formalism that is elegant, but give me more," he says.

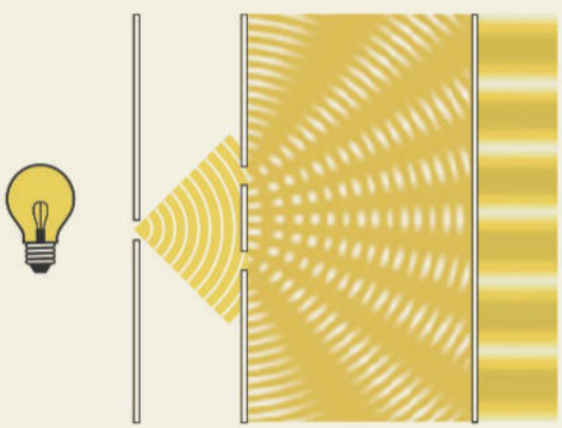
Villas-Boas says that a preliminary experimental test with a single charged atom has already been completed and adds weight to his team's ideas: it showed that bright and dark states of phonons, or particle-like packets of vibration, can also be used to explain interference. Villas-Boas is also working on reanalysing a type of laser that emits pulses – rather than one even beam – in terms of dark and bright photons. Perhaps such lasers are also made of bunches of bright and dark photons, if the team's model is correct.

Bellini says it would also be interesting to explore ways to "see" dark photons, possibly with some novel type of detector. While Rempe says many questions remain about how the new framework could apply to experiments with light that are more complex than the double-slit experiment, and even to how human eyes interact with photons, he says the team is confident in its findings.

"I would say, if you read the standard textbooks, we should add a chapter," he says.

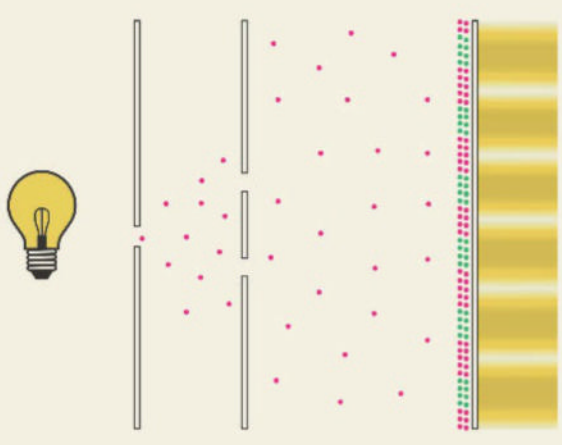
Wave interpretation

According to standard theory, dark stripes appear when two light waves completely cancel out. The darkness is a sign of the absence of light.



Dark photon interpretation

Dark stripes appear when particles of light can't interact with the detector. The light isn't visible, but it is still there in the form of dark photons.



ALAMY

Environment

Companies linked to climate costs

Climate researchers say they can now tie emissions from particular firms to damages from specific extreme weather events, but legal questions remain, finds **James Dinneen**

ARE fossil fuel companies directly responsible for the climate change caused by burning their products, and if so, can they be sued for damages? Yes, say researchers who have developed a new method for tying greenhouse gas emissions from individual firms to specific climate-related economic harm.

"I think the answer is unequivocally, yes," says Justin Mankin at Dartmouth College in New Hampshire. His technique, developed with his colleague Christopher Callahan at Stanford University in California, links each of the world's five largest fossil fuel companies to a loss in global income of more than $1 trillion over a three-decade period. The pair say it could be a potential boost to lawsuits aiming to hold emitters liable for damage caused by climate change. However, legal and political questions remain.

Hundreds of lawsuits around the world have been filed seeking to sue fossil fuel companies and other major emitters for climate-related damages. But is it possible to link emissions from a particular fossil fuel firm to a specific damage, such as deaths during a heatwave in India? Without that full causal chain, "there's always been this veil of plausible deniability that major emitters had", says Mankin.

The pair built on several recent advances made in the field of attribution science. First, the researchers simulated global average temperatures between 1991 and 2020, both with and without the emissions associated with the fuels produced by a particular fossil fuel company. In their analysis, they considered emissions from extracting fuels, as well as the much larger volume of emissions created by end customers burning them.

Because different parts of the planet warm at different rates, they then used records of spatial patterns of warming to translate the change in global average temperatures to changes at a local scale. They focused on changes in temperature on the five hottest days of the year in each location,

$1 trillion

The minimum losses linked to each of the top five largest emitters

which they found in previous research is directly linked to declines in economic growth, for instance by increasing mortality, damaging crop yields and reducing labour productivity. They repeated this analysis for more than 100 of the largest fossil fuel companies, known as "carbon majors".

Comparing the results with and without a particular company's emissions enabled them to quantify some of the economic harm resulting from that company's activities.

Considering all the companies together, they found the increase in extreme temperatures caused by these emissions during the three-decade period led to a decline in global GDP of between $12 trillion and $49 trillion. The top five largest emitters – Saudi Aramco, Gazprom, Chevron, ExxonMobil and BP – were each linked to more than $1 trillion in losses during that period (*Nature*, doi.org/g9gf7x). None of these firms responded to *New Scientist*'s requests for comment before publication.

The pair's approach also enabled them to look at individual companies' roles in exacerbating specific heatwaves. For instance, they find raised temperatures due to Chevron's global emissions shrank GDP in the continental US by between $4 billion and $61 billion during a 2012 heatwave.

SOPA IMAGES LIMITED/ALAMY

Emitters could be held liable for damages from events such as droughts

The jury is out

"This is a significant advance in the field," says Kevin Reed at Stony Brook University in New York. In addition to potentially serving as evidence in climate litigation, he says making the link between specific emitters and damages could inform international debates about who should pay.

Indeed, the findings have already played a role in shaping climate law: an early draft of the study was submitted to Vermont before the state passed a first-of-its-kind law fining fossil fuel companies based on their emissions; New York soon followed with a law of its own. Both laws are being challenged in court by the fossil fuel industry.

But even the study's authors point out that attribution research won't win lawsuits on its own. "Many of the barriers to these cases are not scientific but political or legal," says Callahan.

There is no guarantee a court would accept the details of this methodology, says Myles Allen at the University of Oxford, who proposed more than 20 years ago that climate science may make it possible to sue emitters. "Will the courts accept evidence of a statistical link between annual mean temperature and the impacts of extreme heat, as presented in this study, when it comes to attributing causes of the harm done by a specific heatwave? Some may."

For more on climate litigation, turn to page 21

Technology

Dire wolf 'de-extinction' criticised by conservation group

Michael Le Page

THE creation of genetically modified grey wolves that are claimed to resemble extinct dire wolves has been criticised by the International Union for Conservation of Nature (IUCN).

Colossal Biosciences, a US company aiming to "de-extinct" several species with gene-editing technology, announced last month that it had created three dire wolves (*Aenocyon dirus*) by editing genes in grey wolf (*Canis lupus*) embryos.

A statement put out by the IUCN expert group on canids – wolves and their relatives – said the company's effort isn't in accordance with the guiding principles for de-extinction set out by the IUCN in 2016.

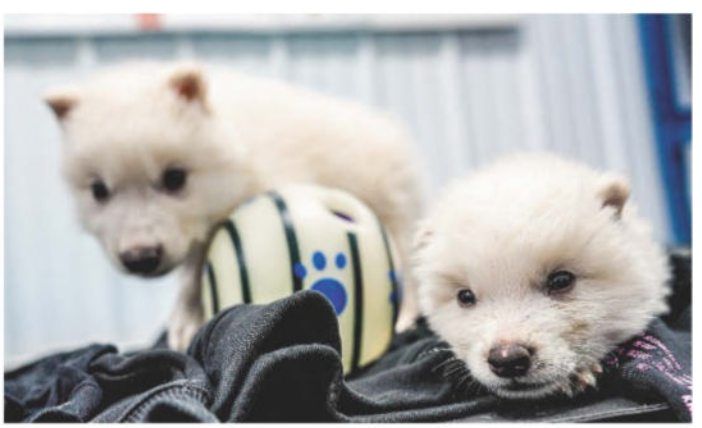
"Editing the genome of a grey wolf to produce individuals that resemble an extinct species that has no ecological niche and that will not restore ecosystem function, does not follow the guiding principles on creating proxies of extinct species for conservation benefits put in place by the IUCN," said the statement.

The IUCN's guiding principles state that animals resembling extinct ones should be created only if they will have benefits like increasing ecosystem resilience. They also state that if living species can carry out the same ecological role, they should be preferred to recreating extinct species.

Colossal's claims could also undermine conservation efforts, said the statement. "Presenting this technology as a ready-to-use conservation solution is premature, and risks diverting attention from the more urgent needs of ensuring functioning and healthy ecosystems."

The statement rejected that the genetically modified grey wolves can be described as dire wolves. "First, there is no evidence that the genetically modified animals are phenotypically distinct from the grey wolf and phenotypically resemble the dire wolf. Second, our knowledge of the behaviour, phenotype, and ecology is inherently limited because the dire wolf is extinct."

The "dire wolves" are genetically modified grey wolves



COLOSSAL BIOSCIENCES

But Colossal has made significant technological advances, the statement acknowledged.

At the time of publishing, Colossal hadn't responded directly to *New Scientist*'s questions about the IUCN's statement. But it did put out a long response on X.

"We undertook the dire wolf project in full awareness of the IUCN... Guiding Principles... and aim to align our efforts with those recommendations," said the response. "No de-extinction candidate perfectly satisfies all of the IUCN... criteria.

"Far from undermining the urgency of efforts to conserve existing species, this project highlights the extraordinary effort needed to reverse such an extinction," it said.

"We acknowledge the [expert group]'s observation about genetic differences between our dire wolf proxies and the extinct *Aenocyon dirus*. As the IUCN guidelines recognize, 'none of the current pathways will result in a faithful replica of any extinct species'."

Health

Lyme disease treated with gut-friendly antibiotic

AN ANTIBIOTIC commonly used to treat pneumonia rid mice of Lyme disease at a lower dose than the standard therapy and left their gut microbiomes largely unaffected.

Lyme disease is caused by bacteria in the genus *Borrelia* that mainly spread among birds and small rodents, but can infect people via the bites of ticks that have fed on the blood of such animals.

Standard treatment involves taking a high dose of the antibiotic doxycycline twice daily for up to three weeks. This stops bacteria making proteins needed to survive, but it doesn't selectively target the species of *Borrelia* involved. "It wreaks havoc on the normal [gut] microbiome," says Brandon Jutras at Northwestern University in Illinois.

Looking for a more selective alternative, Jutras and his colleagues tested more than 450 antibiotics, all approved by the US Food and Drug Administration. In a lab dish, they checked for potency against *Borrelia burgdorferi* – the most common Lyme disease-causing bacterium.

They then assessed how the top-performing drugs affected the growth of bacteria commonly found in the guts of people and mice, such as certain strains of *E.coli*. This revealed that piperacillin, used to treat pneumonia, most selectively targeted *B. burgdorferi*.

Next, the researchers injected 46 mice with this bacterium. Three weeks later, they treated the animals with varying doses of either doxycycline or piperacillin twice a day for one week. They found no signs of infection in the mice that received either a high dose of doxycycline or as little as a 100-fold lower dose of piperacillin.

"The standard treatment for lyme disease wreaks havoc on the normal gut microbiome"

The researchers also analysed the stools of the mice before and after, and found that low-dose piperacillin had almost no effect on the levels of bacteria other than *B. burgdorferi* in the gut (*Science Translational Medicine*, doi.org/g9gfzf).

Jutras's team hopes to test piperacillin in human Lyme disease trials within the next few years.

Carissa Wong

Technology

Is Keir Starmer advised by AI?

A lack of transparency in the UK government's use of AI has experts concerned about the quality of information being given to politicians, finds **Chris Stokel-Walker**

HENRY NICHOLLS/PA IMAGES/ALAMY

Prime Minister Keir Starmer wants the UK to be a world leader in AI

THOUSANDS of civil servants at the heart of UK government, including those working directly to support Prime Minister Keir Starmer, are using a proprietary artificial intelligence chatbot to carry out their work, *New Scientist* can reveal.

Officials have refused to disclose on the record exactly how the tool is being used, whether Starmer is receiving advice that has been prepared using AI or how civil servants are mitigating the risks of inaccurate or biased AI outputs. Experts say the lack of disclosure raises concerns about the accuracy of information in government.

New Scientist used freedom of information (FOI) laws to ask 20 government departments for records of their interactions with Redbox, a generative AI tool developed in house and trialled among UK government staff. The large language model-powered chatbot allows users to interrogate government documents and to "generate first drafts of briefings", according to one of the people behind its development. Early trials saw one civil servant claim to have synthesised 50 documents "in a matter of seconds", rather than requiring a full day's work.

All of the contacted departments either said they didn't use Redbox or declined to provide transcripts of interactions with the tool, claiming that *New Scientist*'s requests were "vexatious", an official term used in responding to FOI requests that the Information Commissioner's Office defines as "likely to cause a disproportionate or unjustifiable level of distress, disruption or irritation".

However, two departments did provide some information. The Cabinet Office, which supports the prime minister, said that 3000 people in its department had taken part in a total of 30,000 chats with Redbox. It said that reviewing these chats to redact any sensitive information before releasing them under FOI laws would require more than a year of work. The Department for Business and Trade also declined, stating that it held "over 13,000 prompts and responses" and reviewing them for release wouldn't be feasible.

When asked follow-up questions about the use of Redbox, both departments referred *New Scientist* to the Department for Science, Innovation and Technology (DSIT), which oversees the tool. DSIT declined to answer specific questions about whether the prime minister or other cabinet ministers are receiving advice that has been prepared using AI tools.

> **"The public should have a certain amount of access to understanding how decisions are made"**

A DSIT spokesperson told *New Scientist*: "No one should be spending time on something AI can do better and more quickly. Built in Whitehall, Redbox is helping us harness the power of AI in a safe, secure, and practical way – making it easier for officials to summarise documents, draft agendas and more."

But the use of generative AI tools concerns some experts. Large language models have well-documented issues around bias and accuracy that are difficult to mitigate, so we have no way of knowing if Redbox is providing good-quality information. DSIT declined to answer specific questions about how users of Redbox avoid inaccuracies or bias.

"Government is supposed to serve the public, and part of that service is that we – as taxpayers, as voters, as the electorate – should have a certain amount of access to understanding how decisions are made and what the processes are in terms of decision-making," says Catherine Flick at the University of Staffordshire, UK.

Because generative AI tools are black boxes, Flick is concerned that it isn't easy to test or understand how it reaches a particular output, such as highlighting certain aspects of a document over others. The government's unwillingness to share that information further reduces transparency, she says.

That lack of transparency extends to a third government department, the Treasury. In response to the FOI request, the Treasury told *New Scientist* that its staff don't have access to Redbox, and that "GPT tools internally available within HM [His Majesty's] Treasury do not retain prompt history". Exactly which GPT tool this refers to is unclear – while ChatGPT is the most famous example, other large language models are also known as GPTs. The response suggests that the Treasury is using AI tools, but not keeping comprehensive records of their use. The Treasury didn't respond to *New Scientist*'s request for clarification.

"If they're not retaining the prompts that are being used, it's hard to get any sort of idea of how to replicate the decision-making processes there," says Flick.

Jon Baines at UK law firm Mishcon de Reya says choosing not to record this information is unusual. "I find it surprising that the government says it can't retrieve prompts inputted into its internal GPT systems," he says.

While courts have ruled that public bodies don't have to keep public records prior to archiving, "good information governance would suggest that it can still be very important to retain records, especially where they might have been used to develop or inform policy", says Baines. ▮

Space

Signs of alien life on exoplanet K2-18b may actually be nothing at all

Alex Wilkins

APPARENT signs of alien life on the exoplanet K2-18b may just be statistical noise, according to a new analysis of data from the James Webb Space Telescope.

On 17 April, Nikku Madhusudhan at the University of Cambridge and his colleagues claimed that K2-18b, a large, rocky planet 124 light years away, showed strong evidence of an atmosphere containing dimethyl sulphide, a gas that on Earth is only produced by living things.

But Jake Taylor at the University of Oxford has re-analysed the data that Madhusudhan and his team released – which was produced from an unpublished raw dataset – using a basic statistical test, and he found that it doesn't appear to show the presence of any molecules at all.

To detect molecules on alien worlds, astronomers observe the light that has passed through the planet's atmosphere, producing what is known as a transmission spectrum. This comes in the form of a collection of data points for different frequencies of light, and astronomers then trace a line through these points to match them to known molecules.

Many of these lines will look a bit like bell-shaped curves, known as Gaussian distributions. Taylor used a statistical test to see whether the data better matched a Gaussian distribution or a flat line, which would indicate no molecules have been detected.

> "The reflectivity of K2-18b's atmosphere could be too high to retain a liquid ocean"

In six tests comparing Madhusudhan's data with different bell-shaped curves and flat lines, five of them showed a better match with a flat line (arXiv, DOI: arXiv:2504.15916). "This indicates that the data does not have the precision, yet, to detect a spectral feature [indicating a particular molecule]," says Taylor.

Madhusudhan disagrees that tests like these say anything useful, because the simplicity of Taylor's modelled curves doesn't reflect the complexity of real data.

But Taylor argues that simple models, like Gaussian distributions, are routinely used to identify chemicals such as sodium in exoplanet atmospheres, and that most planetary models use simplified models to some extent.

Another question over the habitability of K2-18b concerns whether liquid water can exist on its surface. Oliver Shorttle at the University of Cambridge and his colleagues argue that the reflectivity of K2-18b's atmosphere, based on its transmission spectrum, is too high to retain a liquid ocean and implies a scorchingly hot interior (arXiv, DOI: arXiv:2504.12030).

"Those spectra tell us that the atmosphere is absorbing light from the star, and that's bad news from the perspective of the planet's climate, because it wants to be reflecting to stay as cool as possible," says Shorttle.

Madhusudhan counters that Shorttle and his team can only measure the reflectivity for the part of the planet's atmosphere that light passes through on its way to us, rather than the day side of the planet, which permanently faces the star. This makes its "impractical" to infer information about the whole planet, he says.

It is possible that the day side of the planet is cooler than the point they measured, says Shorttle, but that would imply that heat can't efficiently move around the planet, which would be another problem for the likelihood of finding life, he says. ▮

Health

Daily peanut doses could desensitise allergic adults

ADULTS with peanut allergy reduced their risk of reactions by eating a little peanut protein every day as part of a trial.

Peanut allergy occurs when the immune system mistakenly identifies proteins in the legume as a threat. It responds by producing more IgE antibodies, which are a vital part of the immune response but go into overdrive with allergic reactions. In extreme cases, it can lead to potentially fatal anaphylactic shock.

An intervention called oral immunotherapy was approved for children with the allergy in the US in 2020. This involves training the immune system by exposing it to gradually increasing doses of peanut proteins. However, it was unclear if this worked in adults.

To fill this knowledge gap, Stephen Till at King's College London and his colleagues recruited 21 adults with peanut allergy. At the start of the study, participants were only able to eat up to an eighth of a peanut, on average, before having an allergic reaction.

Each participant ate the protein equivalent of one 40th of a peanut every day for two weeks. This dose was slightly increased every two weeks for several months, until they could safely and consistently eat the protein equivalent of four large peanuts every day for a month (*Allergy*, doi.org/g9gj7c).

FABIO PAGANI/ALAMY

Some people can have extreme allergic reactions to peanuts

Three participants dropped out due to allergic reactions, while three others left for unrelated reasons. "This dropout number is acceptable for this kind of treatment," says Cezmi Akdis at the Swiss Institute of Allergy and Asthma Research.

The remaining 15 took part in an allergy test where they ate increasing doses of peanut protein under supervision. All but one could eat the equivalent of five peanuts without having an allergic reaction.

Blood samples also revealed that the intervention caused participants to have higher levels of IgG antibodies, which counteract the effects of IgE antibodies.

"It is very promising," says Akdis. But larger trials are needed to verify the results, he says. ▮

Speak to your doctor before seeking new treatments for medical conditions

Carissa Wong

Physics

‘Black hole bomb’ created in the lab for the first time

Alex Wilkins

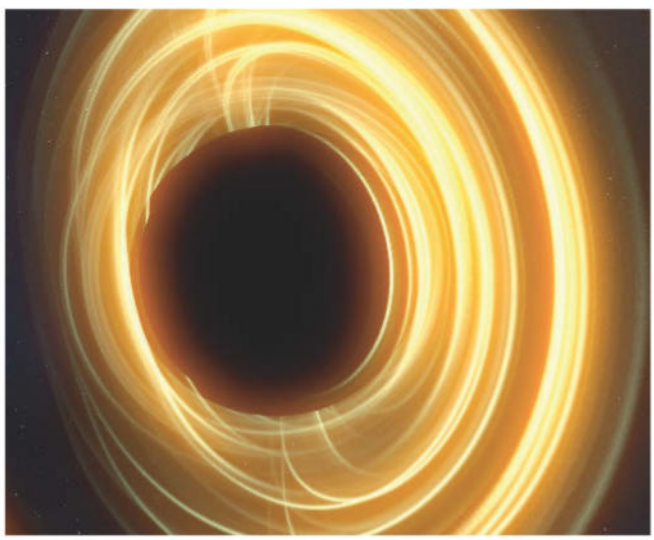
PHYSICISTS have built the first-ever black hole bomb, a long-theorised phenomenon where energy is boosted by a black hole and trapped by surrounding mirrors until an explosion occurs. Thankfully, this version is just a toy model rather than using a real black hole in space, but as the physical principles are identical, studying it could help researchers better understand how real black holes spin.

The idea of extracting energy from a black hole was first proposed in 1969 by physicist Roger Penrose. He noted that a particle flying extremely close to a spinning black hole will gain energy due to a curious effect of general relativity, which sees the black hole drag and accelerate space-time around it.

Two years later another physicist, Yakov Zeldovich, realised that a similar process could occur in other scenarios, like light moving around a rapidly spinning metal cylinder.

He calculated that this “superradiance” effect should occur as long as the cylinder spins at the same frequency as the light – but this is incredibly fast. “It’s impossible to rotate anything [made] of matter at these kinds of speeds,” says Hendrik Ulbricht at the University of Southampton, UK.

Zeldovich also suggested that, by surrounding the rotating cylinder with a cylindrical mirror, the amplified energy could be reflected and built up in a positive feedback loop, until the energy is either vented out or it explodes. Applying this idea to black holes, one could be used to produce a “black hole bomb”, releasing as much energy as a supernova. This would also work even without an external energy source, with



ART FURNACE/SHUTTERSTOCK

The energy around a black hole could help create an explosion

the black hole amplifying tiny electromagnetic fluctuations in the vacuum of space itself, effectively producing energy from noise.

Now, Ulbricht and his colleagues have found a way to demonstrate Zeldovich’s

“Physicists could use this to help understand how black holes give energy to particles around them”

feedback loop by using a rotating aluminium cylinder and magnetic fields (arXiv, doi.org/pjzr). Ulbricht built the initial prototype during the UK’s first covid-19 lockdown in 2020.

He soon recruited some colleagues to construct a more robust experimental setup, which consists of a rotating aluminium cylinder powered by an electric motor, surrounded by three layers of metal coils producing a magnetic field that also rotates around the cylinder at a similar speed. In this setup, the coils act as the mirror and the magnetic field as light; as Zeldovich predicted, this produced an even larger magnetic field emanating from the cylinder.

“You throw a low-frequency electromagnetic wave against a spinning cylinder, who would think that you get back more than what you threw in? It’s totally mind-boggling,” says Vitor Cardoso at the University of Lisbon in Portugal.

Ulbricht and his team then showed that even without the coils producing an external magnetic field to begin with, the setup still generates a runaway signal in the surrounding coils, just like the theoretical example of a black hole without an external energy source.

While the lab version is only an analogue, it could help physicists understand how black holes give energy to particles around them. This could help test theoretical ideas about as-yet unseen particle fields, such as one giving rise to dark matter. ▮

Entomology

Creepy caterpillar wears dead insect parts as a disguise

Grace Wade

THE newly described “bone collector” caterpillar species disguises itself with the body parts of dead insects so that it can live among spiders and poach their prey.

Daniel Rubinoff at the University of Hawai‘i at Mānoa and his colleagues discovered the caterpillar while hiking the Waianae mountains in Oahu more than two decades ago. They were searching for other species in the same genus, *Hyposmocoma*, also known as Hawaiian fancy case caterpillars.

The newly described species of *Hyposmocoma* – which has not yet received a scientific name – lives on cobwebs inside tree trunks, among rocks and other enclosed spaces. It is about the length of a fingernail and feeds on insects trapped in spider webs.

The bone collector avoids becoming prey itself with a macabre method: adorning its silken case with fragments of dead insects and the spider’s moulted exoskeleton (*Science*, doi.org/g9gk9t).

After about two to three months, it then metamorphoses into a moth

DANIEL RUBINOFF ET AL. 2025

The caterpillar adopts this macabre diguise to hide from spiders

smaller than a grain of rice.

This caterpillar is also a cannibal, which the researchers learned after placing two of its larvae in the same cage, leading to the larger one feasting on its smaller, weaker brethren.

The researchers have found just 62 of these critters across more than 150 field surveys conducted over about 22 years, all within the same 15 square kilometres of the Waianae mountain range. ▮

Evolution

Humans evolved to survive mild burns at the expense of severe ones

Christa Lesté-Lasserre

MASTERING fire may have also led to genetic changes that helped early humans survive mild burn injuries, but this evolutionary trait could complicate the treatment of more severe cases today.

An early-stage study suggests that the selection of genes preventing deadly infections that could arise from minor burns were prioritised in early *Homo sapiens*, but these same genes interfere with the healing of severe ones. This may be because, in primitive times, people with severe burns had almost no hope of surviving.

For at least 1 million years, hominins have been using fire, putting themselves at risk of burns. Scientists have already found that *H. sapiens* may have evolved to overcome some kinds of smoke toxicity.

Joshua Cuddihy at Chelsea and Westminster Hospital NHS Foundation Trust in London and his colleagues suspected that fire-related skin injuries might have shaped human evolution too. To find out, they analysed previously published data on

"Inflammation and scar tissue formation can complicate the healing of larger burns"

the genes expressed in burnt and healthy skin of rats and humans, identifying 94 that were expressed only during burn healing.

They then ran further analyses on published genetic data from humans and chimpanzees, our closest living relatives. The team looked for signs of enhanced natural selection for these 94 genes in humans compared with chimpanzees, pinpointing 10 burn-healing genes that underwent significantly stronger selection in people.

Three particularly highly selected genes – that promote pain sensation, scar tissue formation, inflammation and wound closure – probably would have helped rapidly close smaller burns to ward off infections and promote inflammation to fight any potential pathogen, according to the team's results reported at the American Burn Association's annual meeting in Phoenix, Arizona, last month.

But inflammation and scar tissue can complicate the healing of larger burns, so the same genes that promote the healing of minor burns seem to hinder the healing of major ones.

"This is a very significant result, as it testifies to the unique, culturally driven co-evolutionary dynamics characterising human evolution," says Daniel Dor at Tel Aviv University in Israel.

Thomas Püschel at the University of Oxford calls the results "promising and biologically plausible". Even so, validating the hypothesis would require significantly more research with a larger variety of primate species, including extinct hominins, he says.

Hans Püschel at Millennium Nucleus on Early Evolutionary Transitions of Mammals in Santiago, Chile, and brother of Thomas Püschel, seconds his sibling's assessment. "The directionality of these genetic changes in humans remains insufficiently resolved," he says. ▮

Environment

Ancient icebergs left marks on the bottom of the North Sea

CITY-SIZED icebergs once drifted past the coast of Britain when ice sheets covering much of northern Europe were in rapid retreat about 18,000 to 20,000 years ago.

James Kirkham at the British Antarctic Survey and his colleagues found the preserved scour marks these giants made by looking at seismic survey data collected to search for oil and gas (*Nature Communications*, doi.org/g9gmn3).

"We can estimate from the extent of the scours and what is known about ancient sea levels that these bergs were probably 5 to a few tens of kilometres wide and perhaps a couple of hundred metres thick," says Kirkham.

JAMES KIRKHAM

Tabular icebergs in Antarctica break away from ice shelves

In Antarctica, some tabular or table-top icebergs rival small US states in terms of area. They calve, or break, from ice shelves – the wide, floating protrusions of glaciers that flow off the land into the ocean.

The recognition that tabular icebergs once existed in the North Sea is an indication that the seaward margins of a British and Irish ice sheet also had ice shelves. And there could be some lessons for future Antarctic decline, says Kirkham.

In the North Sea, the straight tramlines of the big icebergs are over-written by squiggly troughs made by much smaller ice blocks. This "regime change" occurs as the ice shelves shatter in response to rising temperatures, says Kirkham.

Radiocarbon dating of the sediments shows this shift happened over a period from 20,000 to 18,000 years ago.

This casts doubt on the idea that large calving events might herald the collapse of Antarctica's ice shelves.

Emma MacKie at the University of Florida has tracked tabular iceberg size in satellite data from the mid-1970s onwards. "James's research underscores mine, which is that large calving events are not necessarily a sign of instability or cause for alarm," she says. ▮

Jonathan Amos

Physics

A new kind of quantum computer

Using the special theory of relativity could give us fresh insights into the quantum realm

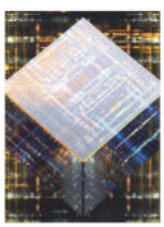
Karmela Padavic-Callaghan

SPECIAL relativity could be harnessed to build a novel quantum computer, and creating it this way could let us use machine learning to deepen our understanding of the quantum realm.

Albert Einstein's special theory of relativity describes how moving at close to the speed of light would affect travellers' experience of space and time. These insights don't merely give us thought experiments; they are crucial for technologies such as satellite communication and GPS.

Now, T. Rick Perche at the Perimeter Institute for Theoretical Physics in Canada and his colleagues say such relativistic effects could help develop a particular kind of quantum computer. And they have constructed the most complete and detailed mathematical model yet for building one.

Previously, researchers have explored how some quantum computing operations could arise from relativistic effects. For example, two quantum bits, or qubits, can become connected through quantum entanglement



NIPLOT/ALAMY

Quantum computers could harness the effects of special relativity

when they move next to each other extremely quickly. But until now, there was no "recipe" for how to combine all of those operations into a full mathematical model of a computer.

"It was like they said: 'Hey, we have the flour, we have the water, we have the yeast, clearly it's possible to make bread.' And we really detailed how much yeast, how much flour, what's the order, how much water," says Perche.

He and his colleagues turned to the mathematics of relativistic quantum information theory, which explains how ultra-fast motion and interactions can edit the information encoded in qubits. It also takes into account the effects of interactions between qubits and the quantum fields that permeate all space.

The researchers also used machine learning and wrote short quantum computing programs themselves. Then they used an algorithm to find how the quantum computer's qubits would have to move to run those programs (*Physical Review Letters*, in print).

To test the method, the team worked to determine how the relativistic quantum computer could run the quantum Fourier transform algorithm. This is a relatively simple but ubiquitous program that all quantum computing researchers would find useful, says Philip LeMaitre at the University of Innsbruck in Austria, who worked on the project.

Eduardo Martin-Martinez at the University of Waterloo in Canada, who wasn't part of the team, says the new work is a significant leap forward for relativity-based quantum computers. He says the model could lead to new understandings of both quantum information processing and quantum fields – and offer a deep way to connect the two.

> "The new work is a significant leap forward for relativity-based quantum computers"

Because machine learning is already part of their approach, the researchers want to explore how it could be used to learn new properties of quantum fields or perhaps even uncover new laws of physics that those fields must follow. ▮

Zoology

Bats that walk backwards use their tails to navigate

ORIENTATING yourself in a dark cave seems like a difficult task. But some bats may have an ingenious solution: using their tails.

Greater mouse-tailed bats (*Rhinopoma microphyllum*) live in groups inside small caves where flying is challenging, so they hang from the cave's walls and move deeper into it by crawling backwards.

Biologists have long wondered whether these bats might use their unusually long tails as a "sensor" to navigate inside the caves, and so Yossi Yovel at Tel Aviv University in Israel and his colleagues designed two experiments to put the bats' tails to the test.

In the first experiment, the researchers recreated a setup that mimicked the interior of a cave, creating a maze with obstacles similar to the uneven, rocky terrain the bats would encounter naturally. The team measured how long it took for the bats to climb the wall while crawling backwards, and how smoothly they were able to do so, first naturally and then with their tails anaesthetised.

Initially, the bats moved their tails back and forth to sense the obstacles and find their way through the maze. When the researchers anaesthetised the bats' tails, the flying mammals navigated the maze less smoothly and around 10 per cent more slowly (*iScience*, doi.org/g9dpcm). But they still made it through, suggesting they also use other body parts to sense obstacles.

SAHAR HAIYAHIA ET AL. 2025

Greater mouse-tailed bats live in small caves where they hang off the walls

In the second experiment, the researchers designed a Y-shaped maze that presented two corridors the bats could choose between. They used textural differences between the two corridors to teach the bats that one corridor led to a reward, while the other didn't. Even though the textural differences were subtle – one corridor had gratings every 1.5 centimetres and one had gratings every 1 cm – the animals were able to distinguish between them.

While other bat species have long tails, the researchers say this is the only one known to find its way in the darkness using this strategy. But "until we test the other bats, we don't really know," says Yovel. ▮

Gennaro Tomma

Technology

Jets wrapped in 'shark skin' could fly further on less fuel

Jeremy Hsu

A MATERIAL with microscopic grooves mimicking those of shark skin could help commercial airliners – and even supersonic jets or military aircraft – save fuel.

The material, which is applied as patches, was developed by Australian aerospace company MicroTau, and is designed to reduce drag when the grooves align with air flowing across an aircraft's surface. The design takes inspiration from how a shark's skin helps it to swim efficiently.

Computer simulations suggest that commercial airliners could save on fuel consumption if the patches are applied to enough of the plane. "We can get 4 per cent or even slightly more at cruise conditions, but this will ultimately depend on how much coverage, the aircraft type and operating conditions," says a MicroTau spokesperson. This still needs to be validated for each aircraft type through flight testing, they say.

The material should ideally cover the majority of an aircraft's fuselage, wings and tail, and can be stuck onto existing plane parts like graphic decals.

US-based Delta Air Lines and Australian Jetstar Airways are looking to test the technology on their Boeing 737 and Airbus A320 passenger jets, respectively, while the US military has already completed four test flights with a Lockheed Martin C-130J Super Hercules transport aircraft.

The material has also flown aboard an experimental supersonic jet developed by Boom Supersonic, a US company focused on bringing back supersonic commercial air travel. The patches were applied to the bottom of the plane for half a dozen flights, including two where it reached supersonic speeds. A Boom Supersonic spokesperson says the patches "survived these conditions comfortably". ▮

Environment

Ancient supervolcano had only mild impact on climate

Taylor Mitchell Brown

MATTHEW WILLIAMS-ELLIS/ROBERTHARDING/ALAMY

Lake Toba in Indonesia was the site of the eruption

THE largest volcanic eruption in human history resulted in a few years of warm weather, according to an analysis of ancient sediments, and not a severe volcanic winter as some researchers had thought.

The Toba supervolcano, located on the Indonesian island of Sumatra, erupted 74,000 years ago, shooting thousands of cubic kilometres of volcanic material into the atmosphere.

"There is no doubt that the Toba super-eruption was colossal," says Michael Petraglia at Griffith University in Queensland, Australia. But the effect it had on the global climate is a matter of debate.

Volcanic eruptions can have a cooling effect by releasing sulphur dioxide, which forms aerosol particles in the stratosphere that block sunlight. Prior research suggested the debris from Toba triggered a period of global cooling, perhaps lasting 1000 years, leading to multiple species extinctions and a sharp fall in the human population.

To find out more, Gopesh Jha at the Max Planck Institute of Geoanthropology in Germany and his colleagues, including Petraglia, studied Jwalapuram, an archaeological site in southern India. The low-lying area has clearly defined layers of volcanic material, known as tephra, deposited by the Toba super-eruption.

"The amount of tephra was so massive that it completely buried the local vegetation at the site," says Jha.

Seasonal monsoon rains consolidated ash in the environment and concentrated it in low-lying areas like Jwalapuram. Later, a desiccated top layer called hardpan would form on the tephra when drier weather resumed. This cycle repeated year after year, forming layers like the pages of a book that recorded the aftermath of the eruption.

"Within six years of the eruption, ecosystems returned to favourable conditions"

Freshly deposited tephra is highly susceptible to environmental factors like precipitation and temperature. To understand the layers of debris left by the eruption, Jha and his colleagues used various technologies, including X-ray and electron microscopy, to assess the rock's mineral composition and what it can reveal about past climate.

The team found that after the eruption, Jwalapuram first saw one year of environmental cooling. The next five years after that were warmer, strongly contradicting the volcanic winter hypothesis (*PNAS Nexus*, doi.org/pjf2).

"Within six years of the eruption, ecosystems stabilised and returned to conditions that were favourable for hunting and gathering societies present in the region," says Petraglia.

Worldwide volcanic winters lasting many years have been documented after other major eruptions, including one in AD 536 linked to the decline of multiple civilisations. But this doesn't seem to have happened after Toba, possibly because of the monsoon weather system.

"While a few years of warming and drying would have posed challenges to local ecosystems, near-extinction events seem unlikely," says Jha.

In future work, he would like to expand his search to unearth further details about Toba and its effects around the globe.

Zachary McGraw at Columbia University in New York City hopes this work will help put an end to claims about extreme volcanic winters resulting from Toba. "The story offered by the initial hypotheses is simply too captivating for people to easily let go, but the breadth of contradictory evidence is getting too hard to ignore," he says. ▮

Physics

LHC creates heaviest antimatter nucleus

Karmela Padavic-Callaghan

IN THE smash-up of very energetic lead ions, researchers have uncovered evidence of the heaviest antimatter nucleus ever seen.

Many particles have antimatter equivalents that are identical but with opposite charges, and these antiparticles can combine into larger antimatter nuclei the same way normal particles form atoms. Benjamin Dönigus at Goethe University Frankfurt in Germany and his colleagues from the Large Hadron Collider (LHC) at the CERN particle physics laboratory near Geneva, Switzerland, have created the heaviest of these: antihyperhelium-4.

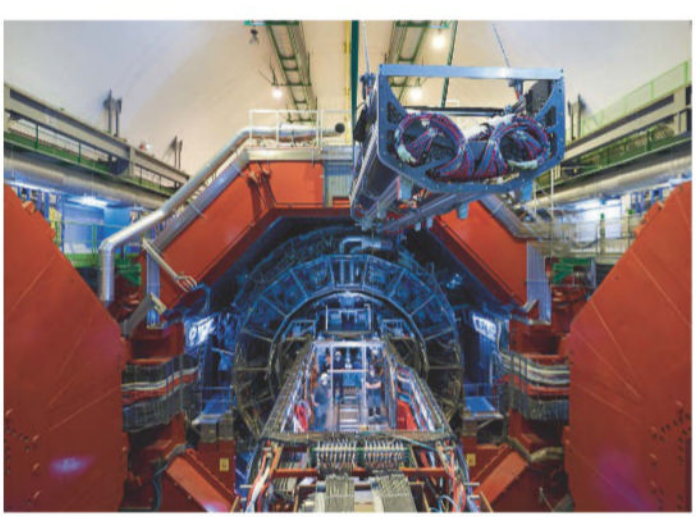
Dönigus and his team used machine learning to analyse data from a 2018 experiment with the ALICE detector at the LHC to identify the antihyperhelium-4 with a significance of 3.5 standard deviations (*Physical Review Letters*, doi.org/pjg9). While it doesn't rise to the "gold standard" of 5 standard deviations, there is still a high likelihood the discovery is genuine.

Antihyperhelium-4 comprises a mix of antimatter versions of protons, neutrons and particles called hyperons that are in themselves exotic because they contain one or more quarks of the strange type. This "strangeness" is hard to find and to make. Consequently, researchers still don't fully understand how

"The collider replicates the state of the universe just a millionth of a second after the big bang"

hyperons behave in nature, where they are thought to occur in exotic settings such as the interiors of neutron stars, says Dönigus.

Horst Stöcker at the Frankfurt Institute for Advanced Studies in Germany says the discovery is meaningful because the conditions within the collider temporarily replicate the state of the universe just a millionth of a second after the big bang. This state is a "hot soup" of massless particles, and identifying the matter and antimatter particles that emerge from it could help explain why we live in a universe where the amount of matter overshadows rare antimatter particles. ▮



ORDAN, JULIEN MARIUS

The ALICE detector at the Large Hadron Collider at CERN

Environment

Huge coral colony discovered in Red Sea tourism hotspot

Madeleine Cuff

A GIANT coral colony has been found on the north-western coast of Saudi Arabia, in a part of the Red Sea that is being developed as a luxury tourist resort.

The colony, a feature within a reef made up of one specific type of the tiny coral-building animal known as a polyp, is suspected to be of the species *Pavona clavus*. Measuring approximately 30 metres by 21 metres, it is probably the largest colony discovered in the Red Sea.

Sylvia Jagerroos at Red Sea Global, the developer building a series of luxury tourist resorts at the site, says she was patrolling the reef during 2024's marine heatwaves when she spotted the giant feature. "Swimming by, I just saw a big shadow, and I decided to go deeper," she says.

Jagerroos and her colleagues believe that the coral is between 400 and 800 years old and say that it is in good health, despite extremely high water temperatures recorded during November and December 2024.

"We surveyed it in January this year, after the temperature had dropped back down," says Rhonda Suka, also at Red Sea Global. "So it was really nice to see a thriving, healthy coral at that point."

The find was made 30 to 40 metres offshore at Red Sea Global's Amaala site, a luxury tourism project that covers 4200 square kilometres. Its first hotels are set to open this year.

Guests will be able to visit and dive to the resort's reefs, including this newly discovered giant coral colony. But Ahmed Al-Ansari, who is in charge of environmental protection at Red Sea Global, insists safeguarding the region's reefs will remain a top priority, with regular expert monitoring promised.

RED SEA GLOBAL

This colony of *Pavona* coral may well be the largest in the Red Sea

The firm has a commitment to deliver a 30 per cent net environmental benefit to its Amaala project by 2040, when construction is expected to be completed, says Al-Ansari.

Suka is planning to spend the next year hunting for more giant corals across Red Sea Global's project sites. "The more of them that we find, the more opportunity there is to learn from them," she says.

Maoz Fine at Israel's Hebrew University of Jerusalem says the giant coral is a "remarkable finding" that can help scientists better understand why Red Sea corals appear more resilient than those elsewhere to rising water temperatures.

But he worries the colony will find itself at the centre of a major tourist destination, where construction activity, sewage pollution and chemicals from sunscreens could all pose a threat to fragile ecosystems. He urges Red Sea Global to ensure the risk of harm is kept to a minimum by tightly controlling activities near the coral. ▮

Health

Fresh evidence that reducing high blood pressure can lower risk of dementia

Chris Simms

BRINGING down high blood pressure reduces the risk of dementia and cognitive impairment, according to a large study of people in China.

Many studies have linked high blood pressure, also known as hypertension, with a greater risk of developing dementia. Some research has also indicated that blood pressure treatment may lead to a lower dementia risk.

Now, Jiang He at the University of Texas Southwestern Medical Center in Dallas and his colleagues have directly looked at the effectiveness of medicines that reduce blood pressure on dementia and cognitive impairment.

They studied 33,995 people in rural China who were all 40 or older and had hypertension. The participants were split into one of two random groups, each with an average age of about 63.

The first group received, on average, three anti-hypertensive medications such as ACE inhibitors, diuretics or calcium channel blockers to aggressively ensure their blood pressure stayed down. They also had coaching on home blood-pressure monitoring and on lifestyle changes that could help keep blood pressure down, including weight loss and reducing alcohol and salt intake.

"Treating high blood pressure to help stave off dementia is just one piece of the puzzle"

The other set, treated as the control group, got the same coaching and a more usual level of treatment for the region, involving just one medication on average.

At a follow-up appointment after 48 months, the participants had their blood pressure tested and were measured for signs of cognitive impairment using standard questionnaires.

Concerns about hypertension start when a person's systolic pressure exceeds 130 millimetres of mercury (mmHg) or diastolic pressure goes over 80 mmHg – that is, blood pressure higher than 130/80.

On average, people who received many medications had dropped their blood pressure from 157.0/87.9 down to 127.6/72.6 mmHg, while the control group managed to take it down just slightly from 155.4/87.2 to 147.7/81.0 mmHg.

The researchers also found that, compared with the control group, 15 per cent fewer people on multiple medications received a dementia diagnosis during the study, and 16 per cent fewer had cognitive impairment (*Nature Medicine*, doi.org/g9f764).

"The findings from this study demonstrated that blood pressure reduction is effective in reducing the risk of dementia in patients with uncontrolled hypertension," says He.

Raj Shah at Rush University in Chicago says that adding to the evidence that treating high blood pressure can help stave off dementia is helpful, but it is just one piece of the puzzle, because multiple factors influence the brain's abilities as we age.

"We should treat high blood pressure for multiple reasons," says Shah. "For people's longevity and well-being and so they can age healthily over time." ▮

Ancient humans

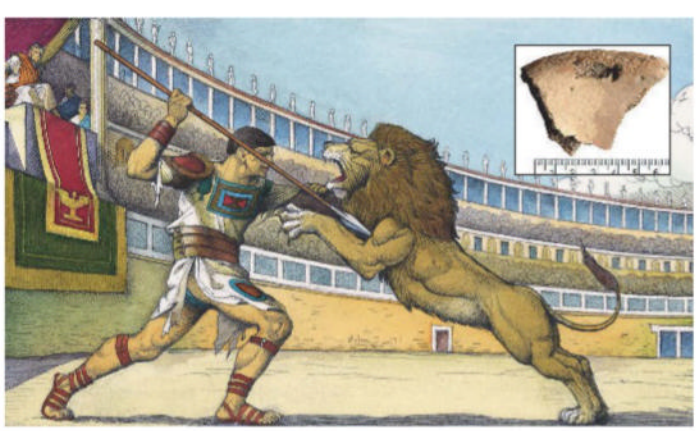
Suspected gladiator skeleton shows signs of lion battle

BITE marks on the pelvis of a man who lived in Roman-occupied Britain were probably made by a lion in gladiatorial combat.

The findings provide the first physical evidence that people battled animals in gladiator arenas in Europe, says Tim Thompson at Maynooth University in Ireland.

Gladiator spectacles involving wild cats and other animals are frequently described in Roman art and texts. But despite those accounts, none of the roughly 200 suspected gladiator skeletons uncovered so far has shown clear signs of an animal attack.

During an urban development project in 2004 and 2005, scientists excavated the remains of about 100 people from the Roman era just outside York, UK – a city founded by the Romans as Eboracum. Most of the people buried there, from the 1st to the 4th centuries AD, were young men with traumatic injuries.



DEA PICTURE LIBRARY/DE AGOSTINI VIA GETTY IMAGES

The bite marks on the pelvis (inset) may have been made by a lion

One of the skeletons bore unusual depressions and puncture marks across both hips, which researchers thought might be evidence of a carnivore attack.

To find out, Thompson and his colleagues ran 3D scans on the ancient pelvis and compared their findings with scans of fresh bite patterns on the bones of animal carcasses – mostly horses – that had been fed to lions, leopards, cheetahs and tigers in zoos.

The researchers found that the 10 suspected bite marks on the bones of the suspected gladiator closely matched those made on horse bones by zoo lions (*PLoS One*, doi.org/pjfn). Similarities included the position of the marks, as well as their depth into the bone.

"We're talking about some quite big teeth going through all these layers of the body," says Thompson.

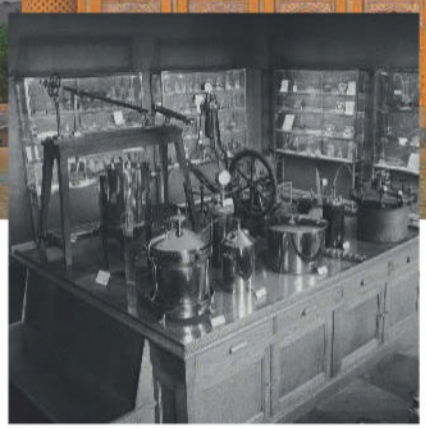
Even so, the bite was unlikely to be fatal: "It would sting," he says. But when going for the kill, lions usually attack the throat.

"What probably happened here is that the individual got knocked down by some other means, and then the lion dragged him away." ▮

Christa Lesté-Lasserre

Discovery Tours
NewScientist

Explore the world with leading experts

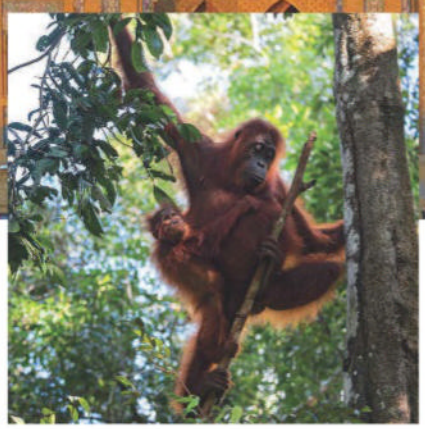


The birth of modern medicine: Paris, France

20 July 2025
5 days

Discover the foundations of medicine in Paris, where the 'Paris School' of hygiene and hospital teaching flourished. From mummified écorché figures to bone-lined catacombs, the early history of medicine is sometimes gruesome but always fascinating. Be introduced to key figures including Louis Pasteur, who pioneered the first vaccines and Rene Laennec, whose stethoscope is still a symbol of medical professionals today.

- **Discover Paris's role as the leading European centre of 18th century medicine, from the churches that administered the first hospitals to medical developments during the French Revolution**
- **Experience the beauty and tranquillity of the architecture and gardens of Paris**
- **Visit the Musée Curie, a small but significant museum dedicated to the life and groundbreaking scientific work of Marie Curie and her family**

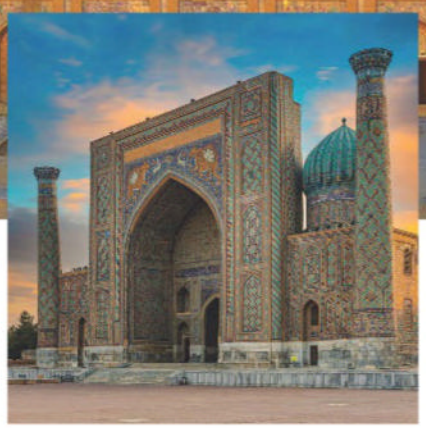


The science of primary rainforests and wetlands: Malaysian Borneo

10 August 2025
10 days

Discover Malaysian Borneo's amazing flora, fauna and geology and learn firsthand from local conservationists how it is being protected. Explore primary rainforests and wetlands, including the iconic Kinabatangan river, Tabin rainforest and Danum valley, home to some of the world's most biodiverse habitats.

- **Search for orangutans, sun bears, proboscis monkeys, gibbons, civet cats, langurs and many more iconic species in their natural surroundings**
- **Enjoy wildlife safaris, cruises, treks and evening walks through hectares of pristine and undisturbed tropical rainforest**
- **Stay in secluded lodges and nature resorts nestled deep within lush forest reserves, offering an immersive experience in Borneo's wilderness**



Astronomy and culture through Silk Road cities: Uzbekistan

23 August 2025
14 days

Embark on a fascinating journey through Uzbekistan, where the rich history of astronomy intertwines with vibrant cultures and vast landscapes. Explore the pivotal role the Silk Road played to astronomy as the historical trade route that facilitated the exchange of scientific knowledge and astronomical advancements across Eurasia.

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Views

Comment

Climate justice

A Peruvian farmer's landmark case against energy giant RWE will be decided shortly. But it has already made history, says **Friederike Otto**

CAN fossil fuel companies finally be held responsible for the damage their business models cause?

In Germany, a landmark climate case is set to be decided later this month. It started 10 years ago, when Peruvian farmer Saúl Luciano Lliuya began suing German energy giant RWE, saying that the firm's contribution to global greenhouse gas emissions makes it liable for a proportion of the increased flood risk at his property.

Whether or not his case proceeds to the next step, where the court would assess whether RWE's contribution to flood risk is legally significant, is almost irrelevant. It has already made history – and the short answer to my opening question is yes.

The German court made its most important decision eight years ago, when it ruled that Lliuya's case wasn't only admissible, but that German nuisance law – which exists in similar forms around the world and says that if your legal activity causes issues for your neighbour, you have to answer for it – could be applied to far away neighbours, such as those living in Peru.

This means the litigation risk for fossil fuel companies is real. And although that risk may be small at the moment, with stock prices falling by 1.5 per cent due to unfavourable court decisions and no successful damage claims so far, these are early days.

SIMONE ROTELLA

If Lliuya's case is dismissed, it will be done on the basis of evidence, with the court assessing whether there is a serious increased flood risk to his home town of Huaraz, high in the Andes. It may decide the risk is low. And although this sounds counterintuitive, that would still be a win, as all previous cases of this sort were dismissed on legal grounds, rather than on the evidence. Compared with making the legal case, providing evidence should be easier, if not for this case then for the next.

When Lliuya's case was first filed, only a few studies linked specific weather or climate events to climate change. Today, the field has expanded significantly, with the Sixth Assessment Report from the Intergovernmental Panel on Climate Change stating that "human-induced climate change is already affecting many weather and climate extremes in every region across the globe". This is a statement of fact, without any scientific uncertainty.

A decade ago, courts would have required plaintiffs in climate cases to prove a direct link to the defendant. While this remains standard in new cases, today's abundant evidence suggests a reversal of the burden of proof is now warranted. Given that climate change is affecting every region, it would be extraordinary for any specific area to escape significant impacts such as heat exposure, flood risk and other challenges. These factors deeply affect the daily lives of many people worldwide.

So, even if this particular case is dismissed, the scientific evidence linking the emissions of major carbon-producing companies to specific incidents has become stronger since it was first made. If the evidence won't fly in this case, it will in the next.

Thanks to the courage and perseverance of Lliuya, the legal precedent has been set for evidence against companies like RWE to be heard. The scientific community has come up with the necessary facts in the meantime.

What we need now, for this to be the start of the end of fossil fuels, is for the rest of us in society to do our bit. Whether we care about human rights, equality, freedom or just don't want to spend all our money trying to repair the damage from extreme climate events, we need to get out and tell Lliuya's story. If we don't hold fossil fuel companies to account, but instead uphold their social licence to destroy lives and livelihoods, the world will only become more unequal and more dangerous. ▮

Friederike Otto's new book is *Climate Injustice: Why we need to fight global inequality to combat climate change*

This changes everything

Keeping going

When politics and science align, it is easy to think science is apolitical. But the situation in the US today shows how science has always been fuelled by politics, says **Annalee Newitz**

Annalee Newitz is a science journalist and author. Their latest book is *Stories Are Weapons: Psychological warfare and the American mind.* They are the co-host of the Hugo-winning podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is techsploitation.com

Annalee's week

What I'm reading
Adam Becker's More Everything Forever, *a physicist's takedown of Silicon Valley pseudoscience.*

What I'm watching
Sinners, *the only vampire movie that has ever moved me to tears.*

What I'm working on
Weight training for the first time in a decade.

This column appears monthly. Up next week: Rowan Hooper

OVER a decade ago, I sat in my living room with a bunch of nerds, tears pricking my eyes, as I saw the Curiosity rover's first blurry selfie taken on Mars. The NASA livestream had just confirmed the wheeled robot was alive and well and ready to start doing science! We cheered and hugged and imagined a future where our solar system would be full of robotic explorers, gathering all the data we would need to safely send humans in their wake.

Last month, the US media trumpeted our nation's latest accomplishment in outer space. A group of celebrities, including pop star Katy Perry and former news anchor Lauren Sánchez, who is Amazon founder Jeff Bezos's fiancée, took an 11-minute flight that crossed the Kármán line, or the boundary of space. They didn't reach orbit. They didn't do any experiments. Instead, they rode in one of Bezos's private Blue Origin rockets, proving "going to space" is now a high-end tourist experience akin to renting a private island.

This comes amid rumours that US President Donald Trump is proposing a 50 per cent cut to NASA's science budget, news of which followed weeks of uncertainty about funding for healthcare research and warnings that no federal money will go to science that runs afoul of the White House's new anti-diversity policies.

I was at dinner with a group of university researchers while Perry prepared to sing in space. One of them, who has done extraordinary work on vaccine discovery using population genetics, told me that their lab would have to rewrite future grants from top to bottom. The problem? Population genetics requires researchers to explore genetic diversity, but under Trump, the National Science Foundation is steering clear of grants that include the word "diversity". This researcher told me their employer had advised them to revise their grant application using simple language, with no scientific terms.

We joked about ways to reword the grant. "Seeking funds to look at the insides of people's cells to figure out why they get sick?" I suggested. But the administration doesn't want to do research into pandemics either. Maybe take out the reference to sickness and say something about making America healthy again? The more we tried to make fun of the situation, the more depressed we got.

> **"There are rumours that US President Donald Trump is proposing a 50 per cent cut to NASA's science budget"**

It is easy to slide from there into garment rending about how my country is turning into the kind of place where the authorities might execute the next Galileo. Or maybe we are going to embrace a 21st-century version of Lysenkoism, a pseudoscientific ideology that supplanted genetics in the Soviet Union. I suppose both of those outcomes are possible, but before we get into doomer vibes, let's consider the evidence.

What the situation in the US reveals is that science is, and always has been, fuelled by politics and economics. I don't mean this in a deprecating way; it is purely descriptive. In order for people to become scientists, they need institutional support, which is political, and they need resources, which are economic. For a few decades in the 20th century, there was strong alignment between US science, government and industry. In the wake of the second world war, our leaders cast the scientific project as downright patriotic: it made the US military strong and our people healthy. Plus, there were economic advantages to funding research in areas like pharmaceuticals, chemistry, agriculture and microprocessors.

When politics and science align, it is easy to pretend that science is apolitical. But when they diverge, scientists quickly discover what it is like to lead a life of precarity, just as artists do. They will have to compete with cheesy celebrities for time on the space station and censor themselves to the point of absurdity to get a grant that barely supports them for six months.

What I'm saying is that US science isn't dead. But its future is starting to look less like a shiny new instrument array and more like a threadbare lounge for humanities students. Research will be conducted in cheap urban lofts and underfunded basement labs. Sure, there will be celebrities singing in space and health hucksters peddling supplements, but real scientists will languish at the margins of our culture.

Perhaps this will be what it takes for science and the humanities to find common cause. Today, researchers in the US are being smeared with the kinds of insults usually reserved for Marxist literary groups, demonised as subversives who want to pollute the minds of innocent people. To survive, science will need to learn from the humanities, where underpaid scholars have long fought through a thicket of scorn to educate the public. The trick, as any poet will tell you, is to keep going – not for the money or power, but to find and share the truth. ▮

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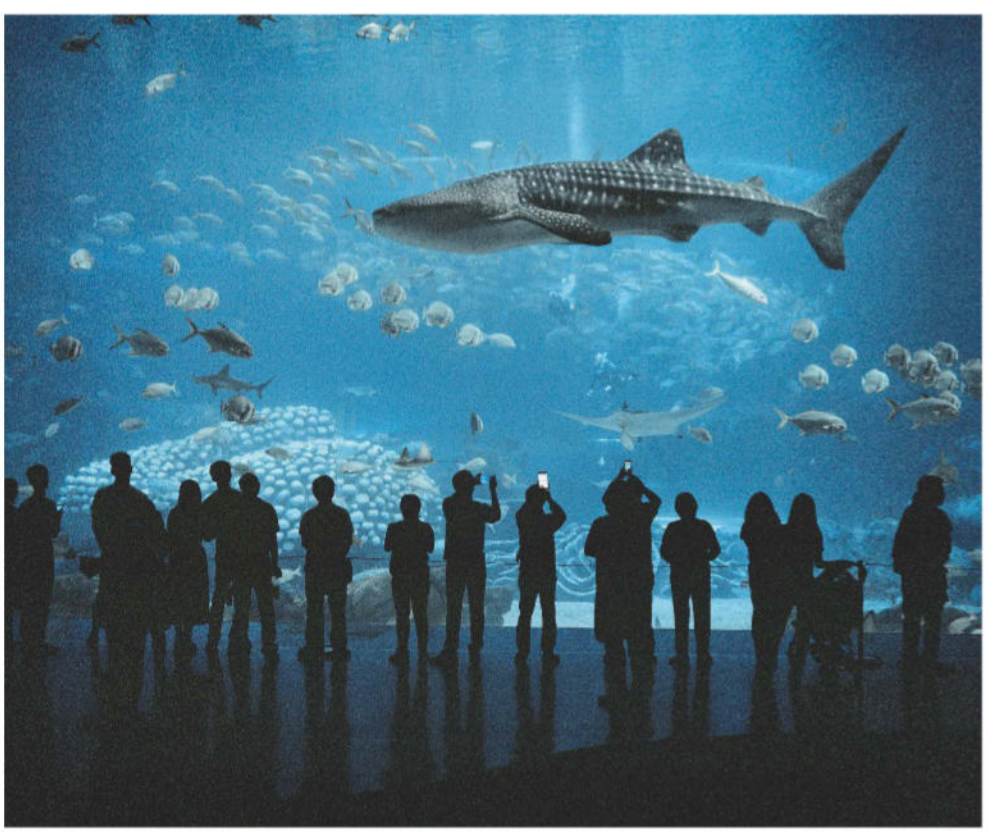


ZED NELSON/INSTITUTE ARTIST

Wild mirage

Zed Nelson
Guest Editions

A MAASAI man looks out at Kenya's Maasai Mara National Reserve. But this is no pristine wilderness: behind him are the remnants of a "champagne picnic experience" for tourists.

"Tourists are paying for the privilege of re-enacting a scene from a colonial film," says photographer Zed Nelson. "The Maasai warrior is being paid to add authenticity to the scene." The image is part of Nelson's series *The Anthropocene Illusion*, which won him Photographer of the Year at the Sony World Photography Awards last month and is featured in a new book of the same name. Nelson travelled to 14 countries to create the series, which shows how, as the world spirals deeper into environmental crisis, a stage-managed version of nature is proliferating.

In another photo from the series, onlookers observe a whale shark at China's Chimelong Ocean Kingdom, the world's largest aquarium. "It's an enormous creature with an enormous range in its natural habitat, which raises serious questions about the ethics of keeping it there," says Nelson. At far left, a snow cannon produces artificial snow at a ski resort in the Dolomite mountains in Italy. Around 90 per cent of Italian ski resorts now rely on artificial snow to remain open.

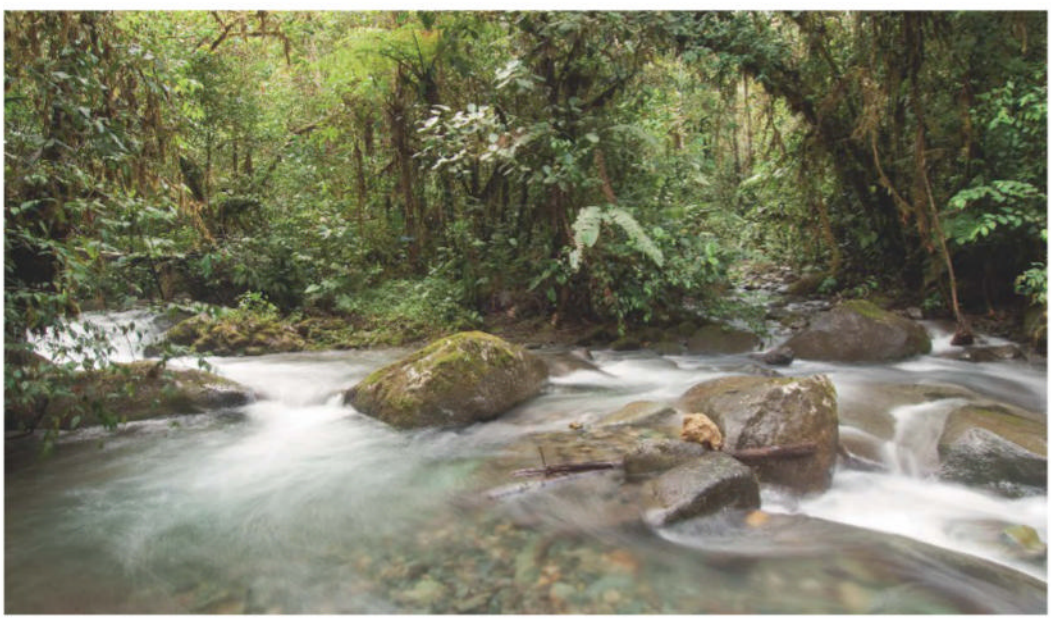
"The series is, in essence, about how we have divorced ourselves from the natural world, and are in the process of destroying it," says Nelson. "It looks at how an artificial version of nature has proliferated – I would argue to hide from ourselves what we have done, and to satisfy our craving for a communion with nature."

Alison Flood

The nature of life

We should protect Earth's rivers and forests with laws, says **Rowan Hooper**. But it is another matter to recast them as actual life forms, as a new book does

Book
Is a River Alive?
Robert Macfarlane
Penguin Books (UK)
W. W. Norton (US, 20 May)



MURRAY COOPER/MINDEN PICTURES/ALAMY

Ecuador's Rio Los Cedros is a source of insight for Robert Macfarlane

EARLY on in this often beautiful, wild and wildly provocative book, Robert Macfarlane recounts telling his son the title of his project. The boy exclaims that of course a river is alive, so this is going to be a very short book. Macfarlane isn't so sure, and nor am I. It has been a long time since I have felt so torn over a new piece of writing.

No one has a problem saying a river is dead – sadly a phrase we hear more and more. If I say "that river is dead" it is shorthand for something like, "that river no longer supports the diverse array of plant and animal life it used to, but is dominated by pollution-tolerant cyanobacteria or algae".

If I say "the river is dead" I don't mean "that river, which used to be a discrete life form in its own right, like that willow on its bank or the trout swimming in it, is now no longer respiring and is decaying". In other words, "the river is dead" is shorthand for saying that pollution has wiped out much of the life it once supported, and "the river is alive" is a metaphor for a thriving, clean river.

To hell with metaphors, however. Macfarlane wants to broaden what we mean by life. When he says a river is alive, he means it literally. In Ecuador, on the Rio Los Cedros, he has one of several epiphanies: "I've never more strongly than here – in the seethe and ooze of the forest, in the flow of the river – perceived the error of understanding life as contained within a skin-sealed singleton. Life, here, stands clear as process, not possession."

It is easy and pleasurable to be swept along by Macfarlane's evocative and poetic writing. But I kept wondering what he really means. Here he seems to be saying it is wrong to limit understanding of living organisms by restricting the label "life form" to those forms that move around in their own skin (or exoskeleton) or, for plants and mushrooms, to those that occupy a discrete lump of cellulose or fungal tissue.

It is true that there is no agreed definition of what life is. For life forms we all agree on – such as the willow and the trout I mentioned earlier – it isn't clear where their "willowness" or "troutness" ends. Almost all organisms live in intimate symbiosis with others. The mycorrhizal fungi meshing with the willow's roots, the bacteria in the trout's gut. That challenges our conventional understanding of what an individual life form is.

But Macfarlane goes beyond science when he assigns life form status to rivers.

And this is why the book is so tricky. I couldn't agree more with the arguments for protecting and valuing rivers and forests. It is all too clear the ruin we have inflicted on Earth and the precipice we are approaching as ecosystems weaken to the point of collapse. And I also agree that ecosystems should have legal rights. But the next step – granting that ecosystems are themselves life forms – is beyond me.

"It is all too clear the ruin we have inflicted on Earth and the precipice we are approaching as ecosystems weaken"

The book is structured round three trips to iconic rivers – in India, Ecuador and Canada – where Macfarlane meets people who are trying to "redefine what our sense of 'life' is". He talks about the Living Forest movement, which wants us to take seriously the idea a river/forest is "a living, intelligent and conscious being". The government of Ecuador "declined to entertain this thought experiment", writes Macfarlane. I will entertain it as a thought experiment, but not as a scientific explanation.

Maybe that doesn't matter, as Macfarlane's book isn't a work of science, but more like a manifesto for a different way of looking at the world. It is trying to persuade by appealing to our emotions, and in this it succeeds. Nature does have rights and we should acknowledge and enforce them to protect our world. The agreement at the COP15 global biodiversity summit in 2022 acknowledges the rights of nature; the river Ouse in southern England had legal rights granted to it by a local authority earlier this year. But to extend the definition of "living" to include structures and physical forms such as rivers is too much.

What I think Macfarlane is saying in this book is that we need to adopt animism, a world view of

many Indigenous peoples, in order to stop the destruction of our planet. Animism is the belief that non-human entities – animals as well as trees and plants, but also rocks and rivers and mountains – have a soul or spirit. "Animal", and "animism", derive from the Latin *anima*, meaning soul. I expect many people reading *New Scientist* will take it for granted nothing has a soul – an immortal, divine spirit.

A little too spiritual

Macfarlane doesn't quite try to argue that non-humans do have souls, but he does seem to be trying to re-establish a form of animism. And I think the reason is because he thinks it may force us to treat non-human life better. Starting with the 17th- century philosopher Rene Descartes and his ideas about animals being "machines", modernity gave us a clear message: nature was ours to exploit. This drove an endless thirst for products at the expense of nature, which, in turn, fuelled the extinction crisis.

That legacy tempts us to adopt "spiritual" beliefs and practices in order to escape the crisis. This way lies anti-science. What we need to do is throw out the Cartesian justification for exploitation and replace it with ecological thinking. Science is the most powerful and effective tool we have to gain knowledge. We need it to show the interconnectedness of life, the extent of symbiosis throughout all ecosystems, and we need it to plot an ecological path to a sustainable future on Earth.

We also need writers such as Macfarlane to communicate what we have learned about this interconnectedness in order to change human behaviour, but to do it in a way that doesn't open the door to non-scientific belief. ▮

Root and branch

Welcome to a great, straightforward guide to the still-growing tree of life, says **Peter Hoskin**

Book

The Tree of Life
Max Telford
John Murray (UK)
W. W. Norton (US, 11 November)

MOST of us can imagine a tree of life; some can even sketch one out. Branches coming off branches coming off branches, each describing a turn in evolutionary history. Over here are the molluscs. Over there, the apes. Look closer in that general area and you might even find us, *Homo sapiens*.

But do any of us truly marvel at this giant tree, as we should? As zoologist Max Telford's *The Tree of Life: Solving science's greatest puzzle* makes clear, it is a wondrous thing. We can follow its branches backwards in time to reveal the characteristics of animals for which there is no fossil record. It can even take us to the starting point of current life, known as LUCA, the last universal common ancestor.

***The Tree of Life*, then, is a millennia-spanning science-history book in the spirit of Thomas Halliday's blockbusting *Otherlands*, though it is notably chattier, more prosaic. That's no bad thing. The tree of life itself is deceptively complicated, so a straightforward guide is a boon.**

Telford lays out those complications, one by one. The first swallow of the northern hemisphere spring is easily mistaken for the similar-looking swift. This book will teach you that, in fact, they are as distant "as a hummingbird is to an owl". Trickily, the two birds developed similar appearances along quite separate branches.

That sort of basic confusion is just the start. What about the characteristics by which organisms should be grouped? Which traits are homologous and which are merely similar? And what does "homologous" mean? Piecing it together is, in Telford's words, "an unfathomable challenge".

Thankfully, as Telford explains, modern researchers have ever greater resources – including genetics. Charles Darwin compared wings and bones; we compare proteins, nucleotides and ribosomal RNAs, using such complex science it tests the bounds of Telford's conversational style. Indeed, the middle stretch of the book sags under the weight of so much hard information.

Still, it all prepares us for a brilliant finale, in which he traces the 4 billion years or so from LUCA to *Homo sapiens* – and beyond. "The tree of life is only part grown," he writes, "much more than a sapling but still some way from maturity." Let us do what we can to tend it. ▮

Peter Hoskin is books and culture editor at *Prospect* magazine

KLEIN & HUBERT/NATUREPL.COM

Making sure this bird is a swallow and not a swift is tough because they look so similar

New Scientist *recommends*

Eleanor Parsons
Magazine editor
London

I was lucky enough to watch a preview of **Ocean with David Attenborough** recently. Due for cinema release globally on 8 May (Attenborough's 99th birthday), the film is the

naturalist's call to take better care of our seas.

Much of the footage will feel familiar for fans of nature documentaries, such as a seal swimming through a kelp forest, aerial shots of whale pods and the bustle of a coral reef. But that doesn't make it any less beautiful or evocative of life under the waves.

And there is shocking new material, with net-eye-views of what happens when a bottom trawler violently scrapes the seabed as it fishes. A comparison of dredged and non-dredged scallop fields was eye-opening.

While the film can feel a bit like a campaign video, as someone who learned about this kind of damage at university 20 years ago, I hope it raises awareness of this hidden destruction.

All is not lost, says Attenborough in the film's final section, and that message of hope is surely something to build on.

CONOR MCDONNELL

The sci-fi column

What's in a name? It can be difficult to work out which books count as climate fiction. Covering topics from time travel to dystopia, could the shortlist for the Climate Fiction prize offer some clarity, wonders **Emily H. Wilson**

Emily H. Wilson is a former editor of *New Scientist* and the author of the *Sumerians* trilogy, set in ancient Mesopotamia. The final novel in the series, *Ninshubar*, is out in August. You can find her at emilyhwilson.com, or follow her on X @emilyhwilson and Instagram @emilyhwilson1

Books

Orbital
Samantha Harvey

The Morningside
Téa Obreht

And So I Roar
Abi Daré

The Ministry of Time
Kaliane Bradley

Briefly Very Beautiful
Roz Dineen

Emily also recommends...

Book

Juice
Tim Winton
Picador
No one is going to argue about classifying this book as climate fiction since it is about tracking down those to blame for runaway climate change. If I have made it sound boring, I promise it isn't.

CLIMATE FICTION PRIZE

The winner of the first Climate Fiction prize will be announced on 14 May

CLIMATE fiction is, ahem, hot right now. But I am still not sure we know exactly what it is. Certain novels are so obviously about climate change that no one could argue with that classification. One example is Kim Stanley Robinson's *The Ministry for the Future*, which reads like a non-fiction account of runaway climate change in our near future.

But it is rare for a novel to take on climate change in such an upfront manner, so the question of what ought to count as climate fiction remains an open one.

Last year, when the new Climate Fiction prize was announced, the organisers devoted a page of their website to this subject. "Defining climate fiction is no easy task," they wrote. "The climate crisis is so intrinsic to our societies and our place on Earth that there is an argument to say... that 'all fiction is climate fiction now'."

A good point, but one that moves us no closer to a definition. With the first prizewinner due to be announced on 14 May, and for the purposes of this article, I read the five books that made it onto the shortlist to see what might be learned from them.

First up is the Booker prize-winning *Orbital* by Samantha Harvey, a novella about a group of astronauts on the International Space Station. It is light on plot, but high on literary merit. I guess it makes some sense to label it as climate fiction in that it makes you think about Earth being precious. For me, it is a pretty marginal call, though, just as it was when *Orbital* was classed as science fiction in 2023, when it was published.

> **"The climate crisis is so intrinsic there is an argument to say that all fiction is climate fiction now"**

Then there's *The Morningside* by Téa Obreht. It is a coming-of-age story set in a post-climate change future, with some magical elements, or at least a strong streak of whimsy. Personally, I think it is a big stretch to call it cli-fi, unless we are going to class most dystopian books that way.

Next comes *And So I Roar* by Abi Daré, the follow-up to her hugely popular *The Girl With the Louding Voice* (do read them in order by the way – starting with the second one doesn't work). The books are about women's rights, with climate change as a background element, so, again, calling it cli-fi is pretty marginal.

The fourth book is *The Ministry of Time* by Kaliane Bradley. It is a blast (I will write about it in depth another time), but referring to it as cli-fi is a bit of a nonsense.

In short, until I came to the last book, I wasn't sure there was anything on the shortlist that would make sense, to me at least, as cli-fi. But then I read *Briefly Very Beautiful* by Roz Dineen.

She is a sensationally talented writer and the book grips you from the off. It is the story of a woman called Cass, and the three young children in her care, in a time of rapidly escalating climate crisis. You really root for Cass and the kids, and hope they make it to somewhere clean and safe.

The book isn't just about climate change. It is also about motherhood, love, marriage, friendship and narcissistic abuse. It is the story of one woman's extraordinary strength (and grace). There are many horrors of the human variety. But the biggest ogre in the story, above all the ghastly human ones that feature, is climate change. It underpins the story and drives it forward.

In my humble opinion, *Briefly Very Beautiful* is indisputably cli-fi, as well as being a brilliant novel in any genre. But in the end, like all genre questions, the truth is that if a book feels like cli-fi to you, then it is cli-fi – and that's all there is to it. ▮

Editor's pick

We may need new names for autism

5 April, p 32

From Fred Zemke, Grover Beach, California, US

I am wondering whether "autism" is a single condition. Your article on concerns about diagnosis in girls and women reports at least two patterns: one commonly found in males and one in females. I interpret them as follows: male-pattern autism has underactivity in the social brain, whereas female-pattern autism has overactivity in it. We don't have a single word for thyroidism, but two: hypothyroidism and hyperthyroidism. Maybe we need multiple terms for the two (or more?) conditions named autism.

From Eric Kvaalen, Les Essarts-le-Roi, France

The problem with saying autism is underdiagnosed in girls is that, as Gina Rippon mentions, there is no known biomarker, so it is only recognised behaviourally. If it is defined by behaviour, then if girls behave in a different way, why say they are autistic? We should probably find a different term.

Smartphones can be a force for good

5 April, p 21

From Chris Tucker, Cambridge, UK

Researcher Jess Maddox is right: the distinction between smartphones and social media isn't just pedantry. The social disruption happens because each person who uses algorithmic social media apps is being shown content tailored to keep that individual angry and acquisitive, and because users can be vile and threatening without negative consequences. Then the angry people "find their tribe", and soon there are real victims.

Let's not ban smartphones. Let's make sure that our children see a world in which there are better ways to use this amazing technology, without the corrosive effects of the attention economy, advertising and online gambling.

Now tell us all about breastfeeding's legacy

5 April, p 19

From Virginia Lowe, Melbourne, Australia

How exciting, I thought, seeing the headline "Pregnancy's lasting effects", as I have never come across anything on this aspect of breastfeeding. But producing breast milk wasn't mentioned. For those of us who did this for years, it would be good to know if it had a lasting effect.

A short history of honest placebos

5 April, p 20

From Alex McDowell, London, UK

The idea of "honest placebos" isn't new. *New Scientist* reported they were effective against irritable bowel syndrome (9 March 2016). They have appeared in fiction, too. In Stephen King's *It*, Eddie finds out his asthma inhaler contains a placebo, but continues to use it.

Movie review was taking the Mickey

5 April, p 30

From Thomas Crown, Pittsburgh, Pennsylvania, US

In my 70-plus years on this planet, no one I met or whose film review I read who "loved the book" ever liked the movie version. No director will ever display what your imagination found in "your" book because literature and cinema are very different art forms. Dashed hopes are pretty much unavoidable. Simon Ings's letdown at not seeing "his" *Mickey 17* while watching Bong Joon Ho's film is palpable. His problems with the film's content are misguided. The *Mickey 17* in his review isn't the movie I saw.

Mars avatar might prove to be annoyingly laggy

12 April, p 22

From Martin Edwardes, London, UK

I enjoyed Rowan Hooper's piece imagining the future use of mechanical avatars on Mars. However, an important factor was missed: distance. Currently, communication can go no faster than light speed, which means that any instruction from a human host on Earth to an avatar on Mars would take at least several minutes to arrive, and possibly more than 22 minutes, depending on the separation of the planets. Signals sent back by the avatar would take a similar amount of time. Would it really be like occupying a body on another planet, or something more surreally frustrating?

US science data needs a new home in Europe

Leader, 12 April

From Peter Holness, Bengeo, Hertfordshire, UK

You underplayed the carnage being wrought on world-class US science by the actions of Donald Trump and Elon Musk as they pull plugs on whole institutions and their labs. I ask readers to spare a thought for hard-working US scientists with invaluable troves of data that are about to be lost to the world in a pointless historical tragedy worse than the fire that destroyed the Great Library of Alexandria. While there is still time, I suggest all European scientific institutes and universities reserve server space to capture and retain as much of that data as possible. And I appeal to US scientists to exfiltrate their data to somewhere safe.

Good news on climate might just backfire

5 April, p 17

From Dyane Silvester, Arnside, Cumbria, UK

You report that warming soils "could" sequester more carbon than we thought, offsetting some of the carbon release expected as climate change alters peat bogs and permafrost. And an earlier article says the contribution of large animals to carbon removal "may have" been underestimated (29 March, p 39). While there might be some cause for optimism in these findings, I can't help but wonder how long it will be before governments and companies with vested interests hold this up as mounting evidence that "business as usual" is perfectly reasonable.

Is Mars colony plan on shaky foundations?

22 March, p 13

From Robert Jaggs-Fowler, Barton upon Humber, Lincolnshire, UK

If thousands of quakes are rocking the northern part of Mars during its summer, then, presumably, only its southern hemisphere may be a relatively safe place to establish a self-sustaining human mission. Hopefully this has been taken into account in any plan for a Mars community.

The rush for wind needs to be steered carefully

12 April, p 11

From Bryn Glover, Kirkby Malzeard, North Yorkshire, UK

Wind farms creating regions of lower air speeds for neighbouring turbine clusters shows that decisions on building such facilities must be made by bodies acting in national and international interests, not by firms acting for private profit.

Want to get in touch?

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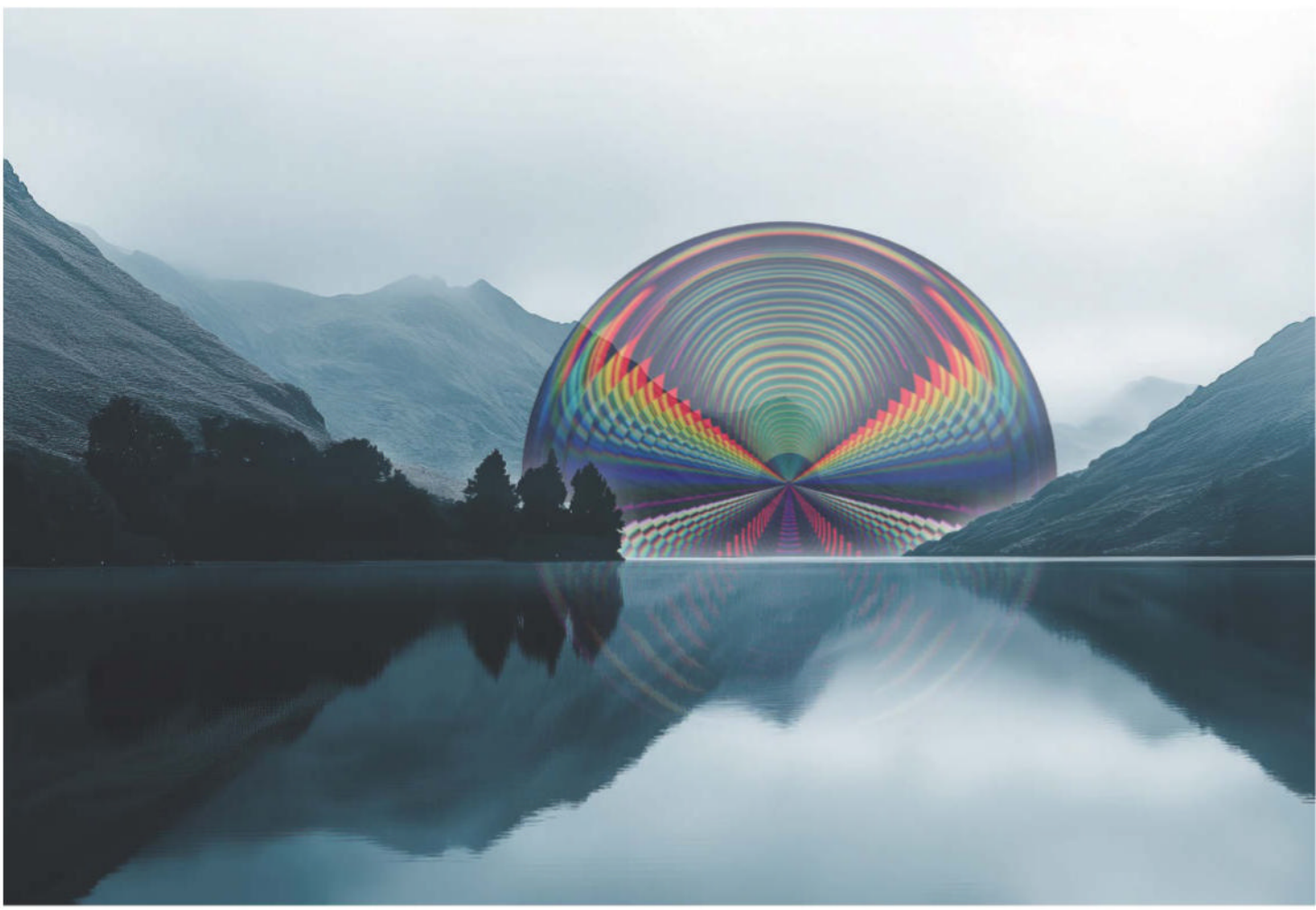
The impossible neutrino



ADOBE STOCK

Astronomers are scrambling to determine the origins of a record-breaking particle from space. Succeed, and it might open a new window on the cosmos, says **Jonathan O'Callaghan**

FOR over a decade, floating cranes have been lowering a strange cargo some 3000 metres under the Mediterranean Sea. The objects look otherworldly: large, shiny spheres crammed with electronics. They are, in fact, detectors for a machine called KM3NeT, designed to search for one of the most mysterious fundamental particles.

The machine is still several years from completion, so Paschal Coyle got quite a shock when, in 2023, he spotted a dramatic signal in its preliminary data. It was a neutrino, as expected, but one unlike anything ever

seen before. "When I first tried looking at this event, my program crashed," says Coyle, a physicist at the Centre for Particle Physics of Marseille, France.

KM3NeT had detected a neutrino from space that had about 35 times more energy than any previously seen. It was thousands of times more energetic than anything created in our best particle accelerators. Neutrinos have always defied easy understanding – they interact so faintly with other matter that their presence is normally all but imperceptible. That is behind the decision to place the project's detectors at the bottom of the sea. But this one seemed almost impossible.

Now the race is on to work out what in the universe could have possibly produced it. As astronomers parse the details, it seems there are two possibilities, both of which point towards some of the deepest and strangest reaches of the cosmos. There is much at stake, as understanding this particle's origins may help us grasp the true nature of neutrinos and reveal the violent furnaces from which they emanate.

The existence of neutrinos was first predicted by Wolfgang Pauli in 1930 to explain why energy seemed to disappear during radioactive decay. An additional, tiny particle that furtively carried this energy away was deemed to be the culprit. It was later given the name "neutrino", or "little neutral one" in Italian. But the particle wasn't experimentally discovered until 1956 because neutrinos have almost no mass and and have no electric charge. This means they rarely interact with matter – a neutrino could pass through a light year's worth of a dense material like lead without hitting anything.

Even today, neutrinos are especially tricky to study in experiments, says Carlos Argüelles-Delgado, a neutrino physicist at Harvard University. They only interact via the weak force, one of the four fundamental forces of the universe, along with gravity, electromagnetism and the strong nuclear force. This means the only way to detect them is to observe their effects on the chance occasions when they crash into atomic nuclei. "Neutrinos are one of the most mysterious particles in the periodic table of particle physics, known as the standard model," says Argüelles-Delgado.

At the outset, the standard model predicted three types, or "flavours", of neutrino, each of which was massless. Over the past few decades, experiments have revealed that, bizarrely, neutrinos can oscillate between these different flavours as they travel through space, a behaviour that only makes sense if neutrinos have mass. "We are 100 per cent certain they have mass," says Ryan Nichol, a neutrino physicist at University College London. In April, the KATRIN experiment in Germany confirmed these masses must be at least a millionth of the mass of an electron, but their precise values and how neutrinos acquire mass remains unknown.

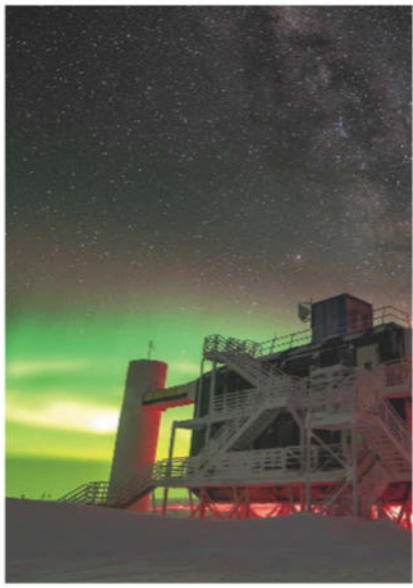
Particle physicists live in hope that pinning down the peculiar particle's properties will guide them towards a deeper theory of the fundamental particles and forces. That's why they are busy constructing gargantuan neutrino-hunting experiments, such as the Deep Underground Neutrino Experiment in the US, Hyper-Kamiokande in Japan, and Jiangmen Underground Neutrino Observatory in China. Typically, these involve firing artificial beams of high-energy neutrinos into underground detectors to precisely study how neutrinos of different energies oscillate across different distances.

Natural detectors

Cosmic neutrinos like the one that crashed Coyle's computer are another type of beast, one that is of particular interest to researchers because these particles have far greater energies than those created on Earth. They are thought to arise in stellar explosions called supernovae or near the supermassive black holes at the heart of galaxies. But spotting these extreme neutrinos presents an even greater challenge. "When you go to higher energy, you have less neutrinos," says Argüelles-Delgado. "So, if you want to look for the highest-energy neutrinos, you have to build very large detectors, so large that you cannot build them out of human-made materials."

The first such experiment, called IceCube, was completed in 2010 at the South Pole. It comprises thousands of basketball-sized detectors that were drilled into a cubic-kilometre of ice. When high-energy neutrinos interact with atoms inside the ice, they produce different particles called muons, which travel faster than the speed of light in ice. This, in turn, creates a kind of sonic boom of light, known as Cherenkov radiation, with a characteristic signature that IceCube's detectors pick up.

Every day, IceCube spots hundreds of neutrinos. Most of these occur when cosmic rays – other mysterious, high-energy particles that traverse the universe – collide with our atmosphere and produce showers of muons ›



and neutrinos. These atmospheric neutrinos are distinct from cosmic neutrinos, which have themselves travelled across the universe and are much rarer: only a few 100 of them have been detected since IceCube began operation.

That, in itself, has been enough to kick-start a new era of neutrino astronomy, says Naoko Kurahashi Neilson, a neutrino astronomer at Drexel University, Pennsylvania. "In 2011, we saw neutrinos from outside our solar system for the first time," she says. Unlike cosmic rays, neutrinos travel in straight lines because of their lack of charge and small mass. That has allowed astronomers to identify some of the cosmic objects that accelerate neutrinos to high energies. In 2018, IceCube traced an incoming neutrino back to its source for the first time: a supermassive black hole at the centre of a galaxy that emits particle jets towards Earth, called a blazar. Other related sources, collectively known as active galactic nuclei, have also been identified in recent years.

KM3NeT was designed to join in this hunt for cosmic neutrinos, offering a new vantage point from the Mediterranean Sea. Whereas IceCube relies on a large expanse of ice to act as a natural detector, KM3NeT instead opts for water. Upon completion around 2029, it will consist of 345 long chains sunk into the sea, each of which connects 18 spherical light detectors. But in February 2023, when the near-impossible neutrino struck, only a tenth of that had been laid.

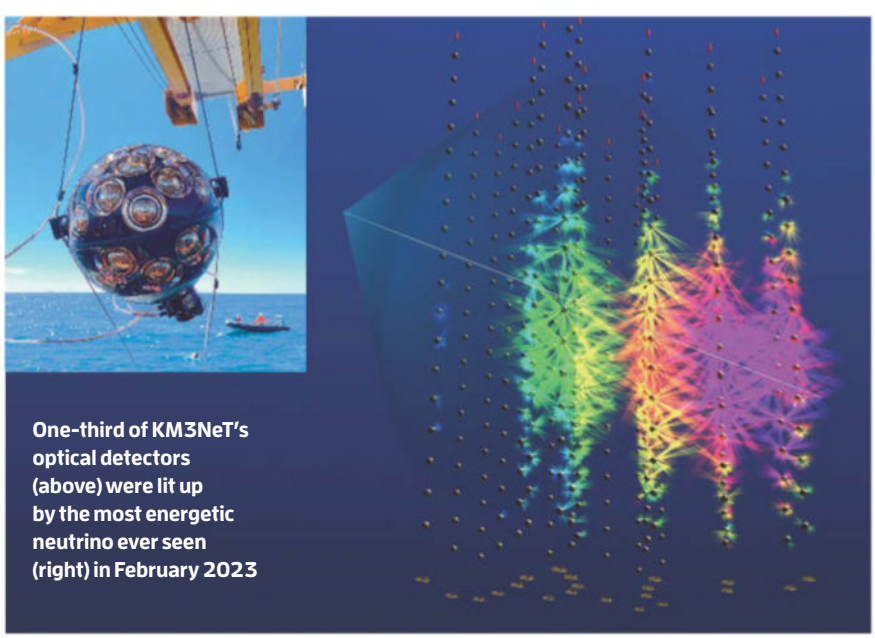
"It was really surprising," says Rosa Coniglione, a researcher at the National Institute for Nuclear Physics, Italy. Many years of data collection at IceCube had seen no evidence of neutrinos whipped up to such energies by "cosmic particle accelerators". The most energetic neutrino recorded by IceCube was about 6 peta-electron volts (PeV), which is about the same energy as a grain of sand falling a few centimetres, but packed into an almost infinitesimally smaller space. So, there was shock when, this February, KM3NeT's researchers announced they had spotted a neutrino that was about 35 times more energetic, at a whopping 220 PeV – although large uncertainties remain over the exact value. "How does a smaller detector that's been turned on for a shorter period of time see the rarest of them all, the highest-energy neutrino?" says Kurahashi Neilson.

The bolt-from-the-blue nature of this detection has left some researchers worrying that it could be a false positive, an artefact in the detector. Although the result has been checked and rechecked, we can't yet completely rule this out as a possibility, according to particle physicist Glennys Farrar at New York University. Assuming it isn't a false alarm, it requires explanation. "If it's really 220 PeV, there has to be some additional population [of neutrino sources]," she says.

> "NEUTRINOS MIGHT EXPLAIN WHERE ALL THE ANTIMATTER IN THE EARLY UNIVERSE WENT"

What could such a source be? One possibility is that the neutrino came from a novel or more extreme kind of cosmic particle accelerator. Perhaps this source, whatever it is, is simply hidden from IceCube's perspective at the South Pole, but is visible to KM3NeT in the Mediterranean, says Coyle. These additional sources could merely be more extreme versions of the sources that IceCube already detects, says Shirley Li, a particle physicist at the University of California, Irvine. Active galactic nuclei, such as blazars, and supernovae both produce shockwaves that rapidly accelerate protons in a process called Fermi acceleration. High-energy neutrinos are then thought to be produced when these protons crash into other protons or particles of light. So it is plausible that similar processes could whip a neutrino up to as much as 220 PeV. However, no one can say for sure, as the precise mechanisms of neutrino production are often veiled from astrophysicists. "We don't know how a blazar actually works," says Li.

To test this idea, the KM3NeT researchers hunted for blazars in the patch of sky where their high-energy neutrino came from and



One-third of KM3NeT's optical detectors (above) were lit up by the most energetic neutrino ever seen (right) in February 2023

KM3NET; PASCHAL COYLE/CNRS

MARTIN WOLF, ICECUBE/NSF

IceCube (left) detects high-energy neutrinos that are made inside "cosmic particle accelerators", such as the active galaxy Circinus (below)

ESA/HUBBLE

identified 12 possible sources, but none of them was definitive. "They did not identify any convincing source," says Li.

Another enticing possibility is that KM3NeT's detection was the first sighting of a background source of the predicted highest-energy neutrinos in the universe, known as cosmogenic neutrinos. Only occurring at energies above 100 PeV, these are thought to be produced during cosmogenic flux, when ultra-high-energy cosmic rays crash into the cosmic microwave background (CMB) radiation – a kind of remnant radiation from the big bang that pervades the universe.

"It is a very exciting possibility," says Li. "People have predicted this [cosmogenic] flux forever. This must happen, but it has never been detected." The idea that KM3NeT's neutrino is cosmogenic also makes sense to Li, who points out it would be against the odds to have seen cosmic neutrinos with a few PeV from active galactic nuclei – as IceCube already has – and then for a similar observation to suddenly leap up to 220PeV. Yet the possibility raises a crucial question: if this cosmogenic flux does exist, why hasn't IceCube already detected it? No one is quite sure. "It's challenging to say this event is from a cosmogenic flux" for that reason, says Li.

Our violent universe

Getting to the bottom of this problem could unlock our understanding of neutrinos and, by extension, the entire cosmos. "There are huge implications for science and astronomy," says Kurahashi Neilson. Observing cosmogenic neutrinos would allow researchers to better understand the origins of the cosmic rays that produce them, says Irene Tamborra, a particle astrophysicist at the Niels Bohr Institute in Denmark.

On the other hand, if extreme cosmic accelerators remain the best explanation, high-energy neutrinos may allow us to probe some of the strangest phenomena in the universe. Figuring out what goes on inside supernovae and active galactic nuclei is difficult because the gamma rays they produce are often scrambled by the CMB and by the magnetic fields that permeate space. "What does the violent universe look like? We don't really know," says Kurahashi Neilson. However, because neutrinos are unhindered due to their lack of charge and travel in straight lines, we can determine their origin more easily and learn more about how these sources operate.

There might even be galaxies in the universe that don't emit any visible light or other radiation, perhaps because they are blanketed in dust or obscured by other galaxies, so are only visible by the neutrinos they produce. "A dark star or dark galaxy that you can only see in neutrinos is very possible," says Kurahashi Neilson. Perhaps there were entire epochs in the early universe, before visible light penetrated the depths of the cosmos, in which neutrinos reigned supreme. "Maybe there was a time in the history of the universe where neutrino emission was [all] you can do," she says.

As our understanding grows of what these cosmic accelerators are, so does the possibility of using them to probe fundamental questions about reality – effectively turning the cosmos into a particle physics laboratory. The energies of these neutrinos and the distances they cover are far greater than anything we could artificially make on Earth, offering a new viewpoint from which to measure their properties. Meanwhile, observing how these neutrinos scatter when they collide with cosmic matter could reveal new cracks in the standard model.

"This is a whole new arena in which to look for deviations," says Li. "It's very much a hand-in-hand process: if we understand the sources better, that will allow more stringent tests of neutrinos."

For instance, cosmic neutrino telescopes may one day assist in efforts to uncover the origin of the neutrino's mass. One possibility is that neutrinos don't acquire their mass via the Higgs field alone – as all the other particles in the standard model do – but through interactions with exotic, heavy, theoretical neutrinos called Majorana neutrinos, which are their own antiparticles. In this case, the primordial cosmos could have been packed with these Majorana neutrinos, which then decayed asymmetrically, populating the universe with matter instead of antimatter. "If neutrinos are their own antiparticle, that might explain where all the antimatter in the early universe went," says Nichol.

With so much at stake, Kurahashi Neilson is thrilled at the prospect of having a comparable detector to IceCube in operation. "I've been waiting for KM3NeT to come online for a long time," she says. "This event shows their detector works beautifully. There's so much more you can do with two detectors versus one. There are simultaneous sources we can measure, and we can collect data faster."

Kurahashi Neilson is also involved in a separate water-based detector planned for near Vancouver Island in Canada, called the Pacific Ocean Neutrino Experiment, which would also be comparable to IceCube and KM3NeT. Another detector below the surface of Lake Baikal in Russia has been under construction since 2021 and could be similarly useful, although collaboration has been difficult since Russia's invasion of Ukraine. "We only hear from them now in major conferences," says Argüelles-Delgado. "It's hard to know what's going on, which is a pity."

Regardless, we can surely expect more surprises in the coming years as the extreme universe increasingly comes into focus. "We are moving towards ultra-high-energy neutrino astronomy," says Tamborra. ▮

Jonathan O'Callaghan is a freelance science journalist based in Horsham, UK

Losing your Y

The enigmatic Y chromosome has a tendency to disappear from cells, which could be a driving force behind disease and premature ageing, discovers **Liam Drew**

WOMEN, on average, live longer than men. This trend can be seen as far back as records stretch, and is true of every country in the world today. Many explanations have been put forward: men take more risks or smoke more, oestrogen is protective against health conditions, two X chromosomes are better than one… the list goes on. Some of these can account for small fractions of the difference; many have been debunked. None are wholly satisfying.

Now, researchers have come up with an intriguing alternative explanation for much of this lifespan difference – that it all comes down to the Y chromosome. Specifically, the idea is that as men grow older, they lose this chromosome from many of their cells, which drives age-related disease.

Losing your Y chromosome in this way isn't something that you would notice happening. "As far as I know, there are no data to suggest that men with loss of Y would feel it," says Lars Forsberg at Uppsala University in Sweden. However, it turns out that a significant fraction of older men are affected, and researchers are now uncovering long-term consequences for the immune system and the risk of developing cancer, heart disease and even Alzheimer's.

"If you're a male, you do not want to lose your Y chromosome, it's definitely going to shorten your life," says Kenneth Walsh at the University of Virginia. The growing recognition of the importance of the Y chromosome for general health is opening the door to potential new ways to keep men healthier as they age.

Most people have 22 pairs of chromosomes plus two sex chromosomes – a pair of Xs or an X and a Y. The Y holds the master switch for determining the sex of a fetus (though not an individual's gender identity) and, in adults, it maintains sperm production. It is one of the smallest chromosomes, about a third the size of the X, and it contains few genes. That said, it also has a lot of features that make it challenging to analyse, which meant it was the last human chromosome to be fully sequenced in 2023, before which over half of its sequence was a mystery. Many of its functions still aren't completely understood.

That some men permanently lose the Y chromosome in some of their cells came to light in genetic studies from the 1960s and 70s, but it was thought this was just a benign side effect of ageing. Then, in the 80s and 90s, cancer biologists reported that men's tumours sometimes lacked Y chromosomes. But with little interest in the Y's contribution to adult physiology beyond sperm production, this too never received serious attention.

Things changed in 2014 when a long-term health study of 1153 Swedish men in their 70s and 80s yielded a fortuitous discovery. These participants had given blood samples for DNA analysis and Forsberg and his colleagues found the Y was missing from a significant fraction of blood cells in around 8 per cent of participants. Then the team saw something striking: the median lifespan of these men was five and a half years shorter than that of those who hadn't lost the Y from their blood cells.

Forsberg and his then supervisor Jan Dumanski, at Uppsala University, also found that men with loss of Y get cancer more frequently and develop Alzheimer's disease at starkly elevated rates. In one study, for instance, they found that men with loss of Y were almost seven times as likely to develop Alzheimer's than men without.

Dumanski says this series of findings "was very controversial – nobody wanted to believe in this". But many larger subsequent surveys confirmed the findings and uncovered links between loss of Y and various other conditions. Most prominently, in 2022, Walsh and his colleagues analysed data from over 200,000 participants in the UK Biobank study and found that loss of Y was linked to increased risks of several forms of heart disease.

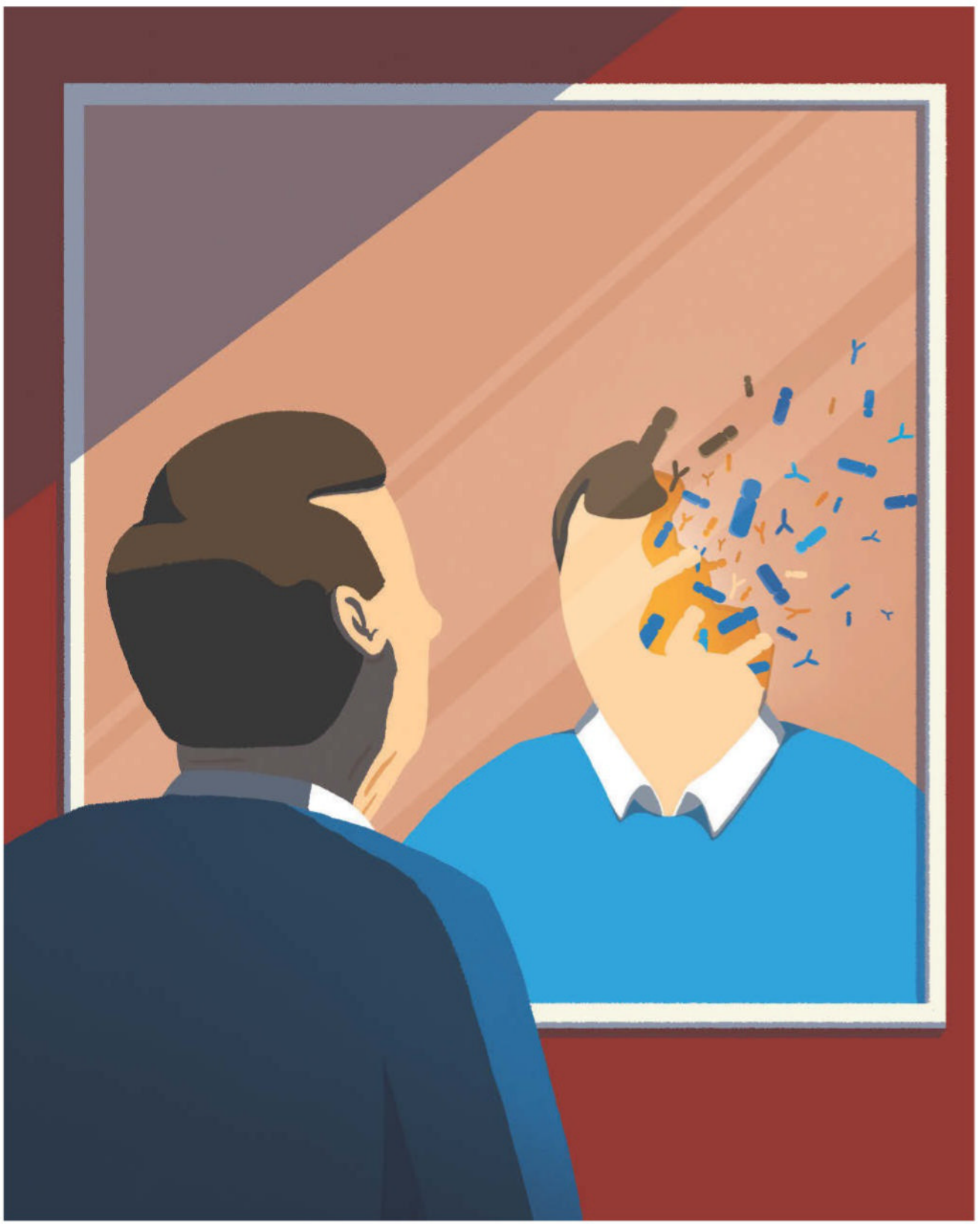
To begin to unravel why loss of Y has these impacts, we need to first understand how it becomes lost. The adult body contains around 30 trillion cells, and each day around 300 billion of these are replaced by new ones. Around 90 per cent of these newcomers are blood cells derived from haematopoietic stem cells in the bone marrow, including nearly 100 billion white blood cells.

Loss of Y occurs during this replacement process, when cells divide. Forsberg says this "is enormously common – it's not like some freakish accident", and he suspects it happens to all men to some extent, but ageing increases it dramatically. A study from February of 25,000 males aged 3 to 95 found that, overall, 11.5 per cent displayed loss of Y in at least 5 per cent of their white blood cells. However, very few participants aged below 50 showed detectable levels, whereas around 6 per cent of 50-to-60-year-olds did and over 40 per cent of the 80-plus population were affected.

Beyond simply ageing, the second major known risk factor is smoking, but loss of Y has also been linked to exposure to air pollution, glyphosate herbicides and arsenic-contaminated water.

Whether dividing cells are more likely to lose their Y over other chromosomes remains uncertain. Given that Y is small and has many repeating stretches of DNA, it may be easier to misplace than other chromosomes. But critically, a male cell that sheds its Y survives, whereas losing a non-sex chromosome "is so harmful, this cell will die", says Dumanski.

In fact, Y-less haematopoietic stem cells appear to thrive, giving rise to a significant fraction of circulating blood cells. And these transformed cells – so the theory goes – promote major age-related conditions.



ANDY CARTER

Will the Y completely disappear?

Since mammalian X and Y chromosomes first evolved around 200 million years ago, the X has remained more or less the same, whereas the Y has lost 97 per cent of its original genes. In fact, the Y chromosome is the most rapidly changing human chromosome. This has led to concerns that it is irretrievably withering away and is set to be permanently lost.

At first glance, this would seem to have dire implications for the very existence of males. But there are a few species of mammals for which this has already happened – and these creatures still come in male and female forms. For instance, the Amami spiny rat is Y-less, but a gene located elsewhere in its genome has evolved to be a brand new way of determining sex.

The likelihood of humans undergoing similar changes seems low, according to Kenneth Walsh at the University of Virginia. He says that after some initially dramatic shrinkage, the Y chromosome in most species has stabilised in size over the past 25 million years. And with this chromosome potentially containing genes that serve important functions in immune cells and possibly elsewhere (see main story), its future in those species – including humans – looks assured.

SOLSTOCK/GETTY IMAGES

They wouldn't know it, but the Y chromosome is missing from some older men's cells

(In females, loss of one of the X chromosomes can also occur, and perhaps as frequently as loss of Y, but the affected cells seem to become less abundant.)

Dumanski says that one of the big questions for this field is to establish what other cells in men are prone to losing their Y chromosomes. It is also worth clarifying that this phenomenon is distinct from the question of whether humans, over evolutionary timescales, could totally and permanently lose the Y chromosome (see "Will the Y completely disappear?", left). It is also distinct from the very occasional loss of the Y chromosome from male reproductive cells, which can lead to intersex offspring. And it is important to point out that the vast majority of studies that have been conducted so far have been in cisgender men. While it's likely that other people with Y chromosomes experience a similar loss of Y, it remains an open question exactly how they are affected.

A serious problem

Nevertheless, the discovery that many older men lose their Y in a significant fraction of blood cells and are also living shorter lives suggests something very serious is going on.

From the get-go, Forsberg and Dumanski hypothesised that disrupted immune function could be the link. In 2021, for instance, they and their colleagues found that loss of Y changes the expression of many genes in human immune cells. As a result, "the immune system of males is more fragile", says Dumanski. This could have many knock-on effects, and is particularly notable following the increased recognition of the immune system's role in maintaining overall health – not just in fighting infections – with immune dysfunction implicated in many conditions, not least cancer, heart disease and Alzheimer's disease.

But not everyone buys this idea. John Perry at the University of Cambridge, for instance, thinks that loss of Y and most diseases that are associated with it are parallel manifestations of the real problem: an age-related increase in genomic instability. "The two strongest determinants of whether or not you get Y loss – and the extent of it – are your age and smoking," says Perry. Both are profound risk factors for genomic damage and for disease, so he suspects processes that cause DNA damage also drive loss of Y. "It's not surprising that you see correlations between Y loss and just about everything bad," he says.

A 2019 study by Perry and his colleagues looked at the genetics of the risk of Y loss in nearly a million men and uncovered 156 gene variants associated with an increased incidence. These genes are largely involved in DNA damage repair and regulating the division of cells, suggesting that loss of Y is an offshoot of disruption to these processes, not a causal link in the chain.

To test this, Perry's team investigated whether women who have the same gene variants that predispose men to loss of Y also develop more age-related diseases. They do. "It was an absolute proof of principle that all you've got is a load of genes predisposing to genome instability – and it's just that in men one of the manifestations is loss of the Y chromosome," says Perry.

Forsberg agrees that this mechanism exists, but he says that it doesn't negate the possibility that loss of Y also has direct health consequences. And more recent studies have supported its causal role in ill health, helping to overturn the long-held notion that, aside

“Loss of Y has been shown to play a role in cancer”

from its role in sex determination and reproduction, the Y chromosome is pretty much genetically inert.

Studies of the mechanisms behind this process began when Walsh – who had long studied how mutations in blood cells can lead to cardiovascular disease – shifted his attention to the Y chromosome. To find out whether loss of Y could be directly causing health issues, Walsh’s team turned to mice. First, they genetically modified mouse haematopoietic stem cells to lack Y chromosomes. Then, they took some otherwise normal mice, eliminated their haematopoietic cells and replaced them with the Y-free ones. These animals therefore have Y-less blood cells independently of all the factors that might normally lead to loss of Y.

As these mice grow old, they develop cardiac dysfunction and cognitive decline and “basically die earlier”, says Walsh. This showed that loss of Y from immune cells can directly cause health problems. It was this finding that inspired Walsh and his colleagues to investigate data from the UK Biobank, the large-scale, long-term study of genetics and health. Here, they found a link between the percentage of blood cells with loss of Y and the chance of dying of diseases of the circulatory system over the next 11 years. For instance, men with 40 per cent or more Y-less white blood cells experienced a 31 per cent increased risk.

The researchers then used the genetically engineered mice to investigate exactly how loss of Y might cause cardiac problems. They found that the hearts of these mice – and, indeed, their lungs and kidneys – accumulate an excess of scar tissue, or fibrosis, which is likely to be driven by the activity of Y-less immune cells. When the team gave the mice an antifibrotic drug, it prevented the heart disease.

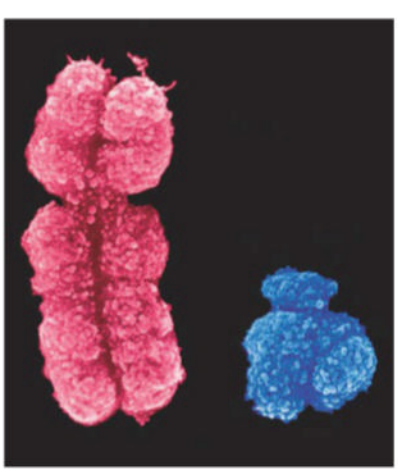
If this effect on fibrosis is confirmed in humans, too, Walsh thinks that doctors might one day be able to use prophylactic courses of antifibrotic drugs to ward off heart disease in those with loss of Y.

More recently, loss of Y has also been shown to play a role in cancer. At Cedars-Sinai Medical Center in Los Angeles, Dan Theodorescu was studying bladder cancer – a condition that affects men around four times as often as women – and wondered if the Y chromosome was contributing to the sex differences in the disease. To investigate, he and his colleagues created cancerous bladder cells that either had or lacked Y chromosomes, and injected them into mice. The results were dramatic: tumours without the Y chromosome grew twice as fast as those with it.

When Theodorescu’s team consulted human databases, they found that 10 to 40 per cent of men’s bladder tumours lack the Y chromosome, and when they do, death occurs considerably sooner than in men whose cancers retain the chromosome. However, when the researchers grew the Y-less tumour cells in Petri dishes, they found they multiplied at the same rate as tumour cells with a Y chromosome. This suggested that the increased growth rate observed in the body wasn’t due to Y-less cells replicating faster, but it perhaps had something to do with their ability to evade the immune system.

Later experiments supported this view, with Theodorescu and his colleagues finding that in bladder cancer, loss of the Y chromosome causes tumour cells to make proteins that exhaust T cells, a kind of immune cell that ordinarily recognises and attacks cancers. Suppressed much less by these T cells, the cancer is able to grow more aggressively.

This finding has major implications for treatment. Immune checkpoint inhibitors – drugs that have revolutionised cancer treatment over the past decade – work by blocking this exhaustion mechanism, enabling T cells to better attack many different cancers. Theodorescu’s team saw that in mice, the drugs worked more effectively against bladder tumours without a Y chromosome compared with those that had one. Again, the clinical data matched: people with loss-of-Y bladder cancer respond much better to checkpoint inhibitors than those whose bladder tumour contains the Y chromosome.



SCIENCE PHOTO LIBRARY

A human X (left) and Y chromosome seen with a scanning electron microscope

The culprit

Whether loss of Y is an important factor in cancers other than that of the bladder is now under investigation. A 2023 study led by Esther Rheinbay at Harvard University found that it is “extremely common” for tumour cells of many different types of cancer to lack the Y chromosome, suggesting a wide-reaching impact.

Studies by both Walsh and Theodorescu also pinpoint a possible culprit for these effects: a gene in the Y chromosome called *UTY*. This gene makes an enzyme involved in the regulation of other genes – not least, those expressed by immune cells – so its loss probably leads to widespread changes in gene expression, which the researchers suspect creates health problems.

Notwithstanding Perry’s caveats, the overall message is, as Theodorescu puts it: “Loss of Y is bad.” Quite how much of the difference in male and female lifespans this might account for isn’t yet pinned down, but Dumanski estimates that it might be more than half.

Another key question – as yet unanswered – is whether lifestyle changes that promote healthier ageing, such as a better diet, improved sleep and avoiding too much stress and alcohol, might slow down the loss of Y.

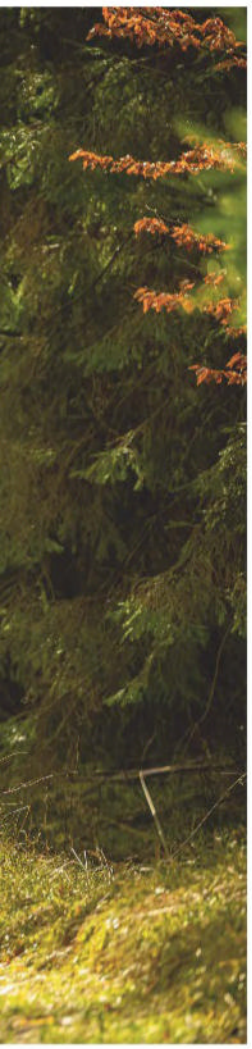
The upshot of all this is that our views of the importance of the long-overlooked Y chromosome “are changing dramatically”, says Dumanski. “We’re just scratching the surface.” ▮

Liam Drew is a freelance writer based in Tunbridge Wells, UK, and author of *I, Mammal: The story of what makes us mammals*

SHUTTERSTOCK/GRZEJAN

Take a hike

Simply going for a stroll brings an astounding, and growing, list of health benefits. So, what are the ingredients for a perfect walk, wonders **Helen Thomson**



The volatile chemicals produced by pine trees have numerous health benefits. They may even help fight cancer

> **Some environments lower your blood pressure more than others**

THE view is spectacular as I hike the steep, stony path up Yr Wyddfa, or Snowdon. I stop to breathe in the crisp mountain air with its faint tinge of honeyed heather and to appreciate the silence. Making my way again, all I can hear is the rhythmic tramping of boots against rock. But then, the distinctive beat of Ace of Base's "All That She Wants" encroaches on my awareness. It is getting louder, and the source soon becomes apparent as another hiker strides past me, a stream of 90s bangers emitting from his backpack.

Each to their own. We are all attempting to get to the top of Wales's highest peak, but in our different ways. Some are marching up the shortest route; others are taking their time, enjoying the smells and sounds; and some are carrying their entertainment with them. We will all benefit from the hike: walking improves heart health and muscle strength – and simply being in nature can boost mental well-being. Nevertheless, some of us may be getting more from our ascent than others.

Although any walking is good for you, it is becoming clear that the route you choose can exponentially enhance the health benefits. Specific landscapes, sounds and smells – even certain ways of walking – can turn a good walk into a great one. Studies are revealing, for example, that some environments lower your blood pressure more than others, why coastal walks can provide some of your daily vitamins, and how certain terrains can boost your cognition. So, pop on your mental hiking boots and join me as I discover where and how to take the perfect hike.

If you view walking as merely a simple way to keep fit, think again. In the past few decades, evidence has been growing that it can also have mental health benefits. One reason is that it is one of the most sustained rhythmic movements we do. Studies suggest that this rhythm prompts the brain to produce a specific kind of brainwave – theta – measuring at a frequency of around 7 to 8 Hz. These are linked with improvements in memory and cognition, as well as mood. Another reason is that simply looking at nature is good for mental health: relocating to green spaces reduces depression, and being out and about near water can be even more restorative. The commonly cited explanation for this is based on something called "attention restoration theory". It suggests that focusing on tasks and directing our attention is cognitively very energy-intensive, and we can manage it for only a while before becoming fatigued. This fatigue is linked with low self-control and health-related issues such as obesity and depression. Nature provides "soft fascination" – it gently captures your attention without requiring significant effort – reducing stress and restoring your cognitive reserves. This relaxed state of mind is apparent in brain images, displaying as decreased activity in the frontal lobes and low-frequency brainwaves washing across large regions of the brain.

That is all very impressive, but the latest research indicates that a good walk can give you so much more. To explain, let's stroll into the woods. Surprisingly, it isn't just the sight of trees but also their smell that benefits our health. Trees and other plants release volatile organic compounds (VOCs) to attract pollinators and ward off unwanted animals, and these chemical odours also influence our biology. Take α- and β-pinene, released from common trees in the UK such as the Sitka spruce or Scots pine. When inhaled, the effects of pinene are numerous. These odorants have anti-inflammatory effects, lower blood pressure and reduce stress hormones. Some small studies have shown that they raise the number of natural killer cells in your blood, which are vital for fighting infections and cancer. In animal studies, pinene also has a protective effect against stroke, seizure and heart disease.

Smell's good

If you don't live near a pine forest, fear not. In fact, according to neurobiologist Michael Leon at the University of California, Irvine, a good walk should include as many different smells as possible. "Literally, stop and smell the roses," he says. His research has shown just how important smell is to health. In October, he and his team reported that a loss of smell is linked with at least 139 different medical conditions. They have also shown that sniffing 40 different odours each day can improve ›

symptoms of dementia, and that being exposed to various odours at night can bolster cognition and improve the health of brain areas involved in memory.

This study also revealed that such "olfactory enrichment" increases activity in the uncinate fasciculus, a pathway involved in memory and language that deteriorates in older age and especially in people with Alzheimer's disease. It may be that enhancing this area by providing the brain with plentiful olfactory stimulation protects against this decline, says Leon. He argues that people in rich, Western communities are under-stimulated when it comes to olfaction, and this contributes to bad health. "We shower, we spend more time indoors, we don't smell nearly enough odours as our brains evolved to," says Leon. "It doesn't matter what smells you incorporate into your walk – as long as they are pleasant, the more the better."

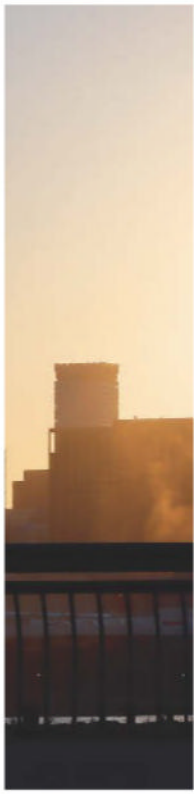
Which brings me to the seaside. West Wittering is my beach of choice, a long stretch of golden sand along the Sussex coast. Walking here, I breathe in the salty spray and the aroma from the seaweed and ferns that line the nearby sandbanks. A trip to the coast to take the air has long been recommended for convalescence, and now there is science to back this up. Sea air contains molecules from plants, algae and bacteria that are whipped up by the wind as it sweeps across the surface of the sea, and some of these appear to have many health benefits. In the first study of its kind, published this year, researchers exposed lung cells to doses of sea aerosol collected from the Ostend coast in Belgium – the equivalent of what you would experience while walking along this coastline. This influenced the expression of genes in key cellular pathways, including those that provide a protective response against tumours and inflammation, as well as ones that boost metabolism.

That's not all. A coastal hike might even provide you with some vital nutrients. Historically, nutrients were thought to be obtained exclusively from our diets, but researchers began to challenge this concept in 2019, arguing that the route of nutrients' entry shouldn't matter. Thus, the term aeronutrients was born, coined by Steve Robinson at the University of Reading, UK, and Flávia Fayet-Moore at the University of Newcastle, Australia. In a recent paper, they reviewed the evidence showing that our lungs can acquire nutrients from the air, which are then transported by the blood to the rest of the body and brain. They concluded it is likely that aeronutrients supplement our dietary intake of manganese, vitamins A and B12, and some essential fatty acids. Indeed, a study of children living near seaweed-rich coastal areas found they had far higher concentrations of another nutrient, iodine, in their urine than those whose diets were the same but who lived in coastal areas without seaweed. Seaweed gives off iodine gas, so the researchers suggest the children had breathed it in.

"The studies of sea air are extraordinary," says writer Annabel Abbs, author of *The Walking Cure*. She especially recommends clifftop walks because they add another element that makes them even better for us. "Not only because of the nutrient-rich sea air, and the abundance of reflected light that boosts the [mood-regulating hormone] serotonin," she says, "but because the ups and downs nudge us into a form of interval walking training." Such training, which entails switching between slow and brisk walking speeds, has been shown to improve physical fitness and muscle strength, as well as help people control type 2 diabetes. But it can be dull, and long-term adherence to this kind of training regime is a challenge. Walks that take you over undulating hills force you into doing it without even thinking, says Abbs.

Savannah hypothesis

So, when you walk, it is important to think about the terrain and the smells around you. But don't forget to also consider the landscape. Recently, I found myself hiking just south of the Scottish border near Kielder Water. I chose to walk there not just because of the plentiful pine trees and flowing waters, but because the hike took me onto wide, open moors that offered views of a very specific "mid-fractal" landscape. Fractals are repeating patterns that appear similar at different scales, and they are relatively common in nature – think of the repeating patterns that form branches and twigs on a tree. Studies show that mid-fractal landscapes – like an open savannah with a few scattered trees, which aren't too complex or too simple – improve our mental and physical well-being more than other types of landscapes. For instance, when Caroline Hägerhäll at the Swedish University of Agricultural Sciences and her colleagues scanned people's brains while they viewed landscapes with different fractal dimensions, they found that mid-fractal images increased alpha and beta brainwaves, which are associated with calm feelings and focus.



FUNKYFOODLONDON – PAUL WILLIAMS/ALAMY

A city stroll (right) is almost as good for mind and body as a walk in the country. Landscapes with savannah-like complexity (below left) are very calming. The benefits you get from ascending a mountain like Yr Wyddfa (below right) depend on how you make the hike

Some researchers speculate that our preference for savannah-like landscapes comes from our evolutionary roots, when such environments would have allowed us to spot predators and also provided places to hide. There is no strong evidence to confirm this idea, cautions Kathy Willis, a professor of biodiversity at the University of Oxford and author of *Good Nature: The new science of how nature improves our health*. Nevertheless, it has convinced her to change her walking routes: "If I have the chance, I head towards the meadow near me – an open landscape with scattered trees – rather than going towards the dense forest."

You might be thinking, OK, but I live in a city; I can't just pop out to a meadow or moor or clifftop. That isn't necessarily a problem, says Ulrika Stigsdotter, a professor of landscape architecture at the University of Copenhagen,

GARY HERSHORN/GETTY IMAGES

GEOGRAPHY PHOTOS/UNIVERSAL IMAGES GROUP VIA GETTY IMAGES

> **A 20-minute walk in green space is all you need to feel less stressed**

Denmark. "People think that you have to walk in green fields to benefit your health, but actually, there's lots of evidence to suggest that walking round cities is good for you too."

Her team compared the benefits of a walk through a botanical garden in Copenhagen with one in the city's centre. They took various measures of health, including blood pressure, heart-rate variability and psychological measurements of mood, both before and afterwards. A stroll through either landscape was more restorative than sitting on a bus or being at an office. While the garden walk did generally score highest on each measure of health, "the urban environment came very close", says Stigsdotter. She notes that although it may not have been green, it had stunning architecture and a poignant history, which might have contributed to how restorative people found it. Conversely, she says, a busy park won't necessarily offer the attention restoration we are after. "You can't just say urban spaces are bad and green spaces are good."

Town vs country

Nevertheless, if there is a chance to get out of the city, do take it. As researchers delve deeper into the details of what makes a good walk, non-urban environments consistently seem to win out. Group walks across farmland, for instance, lower stress more effectively than those taken in cities. The diversity of the wildlife present on our walks also seems linked to how good we feel afterwards, with more biodiversity increasing our well-being. Relatedly, in a small study, people who took a 1.8-kilometre lunchtime stroll in nature had significantly better heart-rate variability the following night than those who walked in a built-up urban area, suggesting their bodies had recovered better from the stresses of the day.

While popping out for my own lunchtime stroll, another question occurs to me: for how long should I walk? Do we inhale enough VOCs from a quick circuit around the park? And, aside from the physicality of it, are there any benefits from doing a much longer walk – the marathon charity walk a friend recently suggested, for instance, or a week-long hike along Spain's Camino de Santiago trail, as my in-laws do each year? According to Willis, a short walk is enough. "The evidence is now quite strong regarding stress hormone changes – a 20-minute walk in green space is all you need to start seeing an effect, you'll feel much more relaxed," she says.

Walking for longer might provide more lasting benefits, though. Japanese researchers have shown that people who spent six hours walking in pine forests over three days had significant increases in natural killer cells and decreases in stress hormones – and that these effects lasted for at least seven days. Many people say they also benefit mentally from long-distance walking, and a study of middle-aged and older people seems to confirm this. It found that "by providing a distinctive room for reflection, long-distance walks can help people [in ways] similar to professional counselling". This reflection might come from experiencing a flow state during long walks: research reveals how this deactivates regions of your brain's prefrontal cortex responsible for making plans and actioning thoughts, promoting feelings of focus and calm. And a study of Appalachian trail hikers found that almost two-thirds reported experiencing flow at some point during their walk.

My ascent of Yr Wyddfa isn't quite so ambitious. But, when I reach the top, I watch as people stop to look at the views, take a detour to see a rare Snowdon lily or wait in line to take a selfie at the summit, and I wonder what part of their physiology has been affected by how they decided to walk today, and how I have benefited from my choices. Ace of Base certainly isn't for me – but I will be taking time to smell the lilies on the way down. ▮

Helen Thomson is a freelance writer based in London, UK, and author of *Unthinkable: An extraordinary journey through the world's strangest brains*

The back pages

The science of exercise

Going too far

There's no doubt long-distance running improves our fitness, but is there a downside to running further, asks **Grace Wade**

Grace Wade is a health reporter for *New Scientist* based in the US

EVER since I announced in my previous column that I am training for a half marathon, friends keep asking me whether a full marathon is up next. My answer is always the same – no way. While running 21 kilometres seems a manageable challenge, running 42 just feels self-punitive. But all of this inquiring has me wondering whether there is an upside – or downside – to longer races.

Research in this area is scant, but a few studies do indicate declining returns, and even some evidence of harm. A 2014 study of more than 55,100 adults found that, on average, runners had a 30 per cent lower risk of dying over the 29-year study period than non-runners. However, clocking up more miles a week didn't accrue any extra benefit. While those who ran 32 km or more per week had a 23 per cent lower risk of dying than non-runners, those who ran fewer than 9.6 km per week had a 34 per cent lower risk.

During long runs, blood flow is redirected from organs to muscles, damaging the small intestine and reducing kidney function as a result. The immune system also becomes suppressed for several hours after a marathon. But these changes are short-lived, if you give the body time to recover.

Still, routinely running long distances raises the risk of certain long-term health problems, most notably cardiovascular ones. A 2020 review found endurance athletes are especially prone to ventricular arrhythmia, a type of abnormal heartbeat, and that

DON EMMERT/AFP VIA GETTY IMAGES

middle-aged male athletes have more calcium deposits in their hearts, which raises the risk of heart disease, compared with non-athletes. Male marathon runners had three times the number of calcium deposits than controls, and male athletes also have twice as many coronary artery plaques as non-athletes.

All of this suggests routinely running marathons takes a toll on the heart – at least for men. While fewer studies have been done in female athletes, research suggests they are less susceptible to the cardiovascular consequences of endurance running, maybe due to protective effects from oestrogen or lower testosterone levels.

This highlights an important caveat: many of these studies only looked at a small number of participants, many of whom were white male athletes. It is, therefore, challenging to generalise these findings to a wider population. Still, all of the research suggests that running a marathon doesn't improve health any more than shorter races do.

I understand that, for many, completing a marathon is about more than getting into shape. And, despite the potential risks, many studies show that elite athletes live longer than the general population. So don't let this article deter you. If you plan on running multiple marathons, just give your body enough time to recover, and don't expect me to join you! ▮

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The science of exercise appears monthly

Next week
Dear David

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Detecting black holes

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- How black holes are detected through their extreme effects on surrounding matter
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Delilah Gates, Postdoctoral fellow, Center for Astrophysics, Harvard & Smithsonian and Black Hole Initiative, Harvard University

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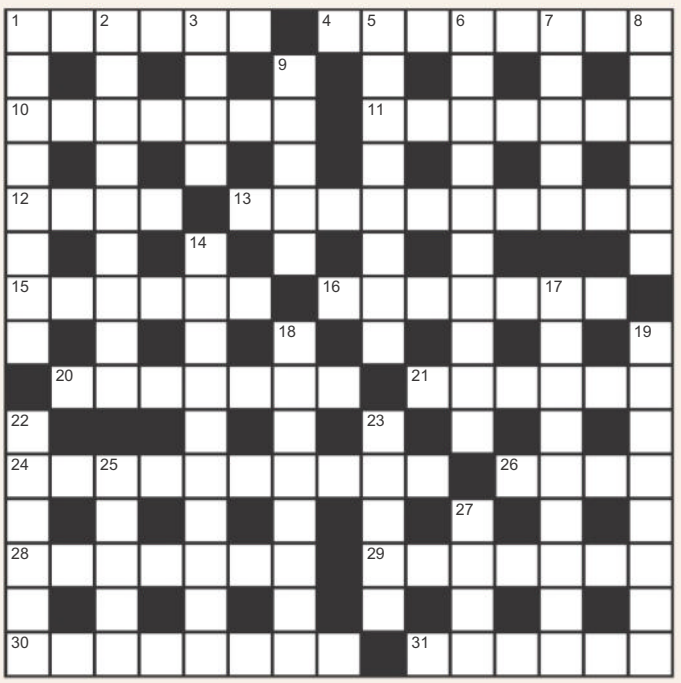
Quick crossword #182 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

1 Removal of living cells or tissue for examination (6)
4 Carried by the atmosphere (8)
10 Sodium hydroxide (4,3)
11 Break for maintenance, in motorsport (3,4)
12 Colour in the visible spectrum (4)
13 UK code name for a nuclear weapons project (4,6)
15 Gas-filled globule (6)
16 Pethidine brand name (7)
20 Infinitely detailed mathematical structure (7)
21 Line joining points of equal pressure (6)
24 Branch of medicine concerned with mental conditions (10)
26 Highest point (4)
28 Upper jawbone (7)
29 Petals, collectively (7)
30 ___ bug, ambush predator in the family Reduviidae (8)
31 Temperature unit (6)

DOWN

1 Galago (8)
2 1, 67 or 9835, for example (3,6)
3 Type of soil or sediment (4)
5 Disassembled (2,6)
6 Red supergiant in Orion (10)
7 Mathematical expression of relative proportion (5)
8 Uncover (photographic film, perhaps) (6)
9 Planet (5)
14 Massive, super-dense astronomical objects (5,5)
17 Disc-shaped (9)
18 Second city struck by an atomic bomb (8)
19 Apps or programs made available without charge (8)
22 Plant genus that includes sweet potato and bindweed (6)
23 Modified leaf (5)
25 Vertical line on a graph (1-4)
27 Correct (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #300
set by Corryn Wetzel

1 What is the most abundant metal in Earth's crust?

2 Pogonophobia is the fear of what?

3 Who created the programming language Python?

4 What is the escape velocity from Earth's surface?

5 Which hormone regulates calcium levels in the blood?

Answers on page 47

BrainTwister
set by Katie Steckles
#71 Dip die

A solid, white cube, made from 1-centimetre cubes stuck together, measures 5 cm on each side. How many small cubes are needed to make a cube like this?

The whole cube fell into a bucket of red paint, coating the outside. The cube was then pulled out and separated into its individual cubes to dry. How many small cubes had some paint on them?

Once the paint was dry, the small cubes were placed in a bag. I pulled one out at random, without looking, and rolled it like a dice. What is the probability that, when the cube comes to rest, its top face is red?

Solution next week

Way of water

Why does water never move in straight lines? Even running down a windowpane, it wiggles. Is there any explanation for this?

Ron Dippold
San Diego, California, US

There are many forces acting on water, and what you see is the result of a fierce battle between all of them. If water just ran nicely down windows, we wouldn't need windscreen wipers! If there were no other forces, gravity would pull water straight down. But water is a polar molecule – its two hydrogen atoms are slightly positive and its oxygen atom is slightly negative. This is known as a dipole. The positive hydrogen atoms attract the negative oxygen atoms in other water molecules and vice versa. The atoms are also attracted to various charges of the surfaces they are on.

Common window glass is usually made of silica, which is one silicon atom and two oxygen atoms. The negative oxygen atoms in the silica strongly attract the positive hydrogen atoms in water. Water isn't as attracted to non-polar molecules, such as oil, which is why oil and water are hard to mix and keep mixed. This is one reason windscreens usually have a coating to keep water from direct contact with the surface of the glass. There are even designs for hydrophobic (water-repelling) surfaces that use small, non-polar microstructures to make water very averse to sticking to them.

> **"Water is buffeted by many invisible forces and the path it takes is the result of whatever force wins in that moment"**

Besides the influence of charge, any normal surface, such as a window, has various imperfections. Water might flow into a tiny valley or around a tiny bump, which will make it take an apparently random path. When water tends to attract other water – called cohesion – you get beads of water. Surface tension also encourages this. If the water tends to cling to the surface, then it spreads out, and this is called "adhesion" or "wetting".

Even with the most hydrophobic or flat surfaces, air is still an issue, as wind blows the water around somewhat unpredictably, especially on a moving car's windows. The wind is mostly towards the back of the car, but there are dozens of tiny vortices driven by the edges and corners of the car's body. Even if you just release a drop of water inside a perfectly still tower, the air beneath it acts as an upward resistance similar to wind. Because water isn't solid, the drop wobbles around unpredictably, which can slightly alter its course, like a skydiver tilting their chute.

In summary, every drop of water you see is buffeted by many invisible forces, and the path it takes is the result of whatever force wins in that moment. If some water molecules on the left of the drop bond more strongly to the surface than to the other water molecules and spread out, then perhaps the drop will move left a bit. A tiny air vortex might nudge it up and right a bit. Gravity mostly wins by volume, but there are always a few drops left clinging until they evaporate. Or perhaps your windscreen wipers will just cruelly fling those drops into the great unknown.

STUART FRANKLIN/MAGNUM PHOTOS

This week's new questions

Spare change **How much money is gained or lost in computer rounding errors in, say, a year? And what happens to this money?** ***Adrian Bowyer****, Foxham, Wiltshire, UK*

Future fuel **There are millions of tonnes of white hydrogen available for power. Since each reaction needs oxygen, could it deplete our air supply?** ***Colin Horwood****, Salthouse, Norfolk, UK*

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Is a lot of money gained – or lost – in computer rounding errors every year?

Mel Earp
Macclesfield, Cheshire, UK

In physics, most, if not all, of the equations portray an idealised, simplified scenario. The maths is just too complex otherwise. The idealised situation would indeed suggest that raindrops should run down a windowpane vertically, but that is never the reality.

Let's start with the window glass. Despite what we can see and feel, it isn't perfectly flat. It has small bumps and ridges, and the raindrops respond to the lateral (side) forces that the imperfections impart. Perhaps more significant is that the surface of the glass will be covered in various contaminants, such as leftover cleaning materials or dust and dirt deposits. Even when we aren't able to see them, they are there, and they won't be distributed uniformly across the glass.

Then there are the raindrops. They will contain dust and dirt, which won't be evenly distributed in the drops, creating an imbalance. More significantly, an individual drop won't hit the glass in a perfectly vertical direction. And when two drops are close enough, the electrostatic attraction that keeps water molecules together will be enough to pull them into one larger drop, in a non-uniform manner. In short, it would be quite a surprise, given all the forces acting on a drop, if it did travel perfectly vertically down a windowpane.

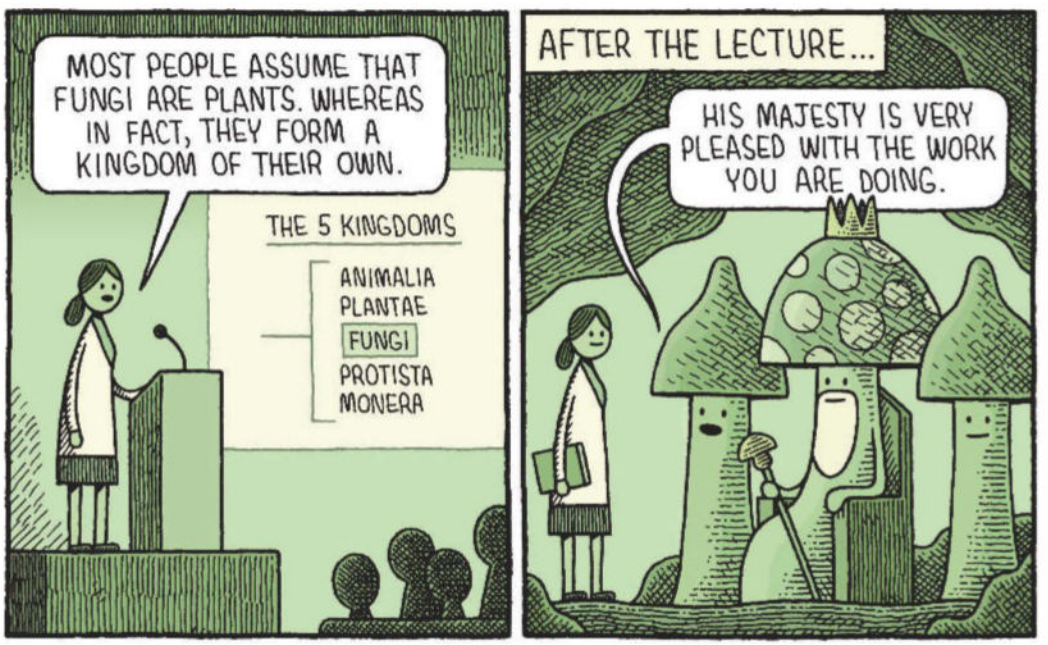
Two of a kind

Binocular vision gives us a 3D perspective, and two ears let us locate the direction of a sound. But why two nostrils?

David Muir
Edinburgh, UK

First, press your finger against the left side of your nose to close the left nostril. Breathe deeply through your right nostril. Now,

Tom Gauld
for New Scientist



close your right nostril and breathe through your left nostril. You will probably notice that you breathe more freely through one nostril than the other. If you try this at other times in the day, you may find that the freely breathing nostril has swapped sides – and then later, it swaps back. This alternation is called the nasal cycle.

Your nose has two jobs. It is our centre for our sense of smell and the entrance for much of our air intake. The easier-to-breathe-through nostril is good at taking in air but is less efficient at detecting smell. The low-flow nostril is better at detecting scent molecules, as they have more time to dissolve in the fluid covering the scent receptors. So, why the alternation, rather than each nostril specialising in fast or slow airflow? It seems to be an evolutionary answer to optimise both olfaction and air conditioning by maintaining a good sense of smell while preventing one nostril from drying out.

Ancient mixtape

Is it known when humans or our ancestors first started to sing? What is the reason for starting to do so? (continued)

Inés Antón Méndez
via email
Some theories of language evolution, including Charles Darwin's, propose that the first proto-language was actually based on singing. Without getting too technical, this would help explain both the evolution of the vocal tract and the relationship between sound and meaning. If this theory is correct, since language is thought to have emerged around 135,000 to 200,000 years ago, singing would have to be even older. Other primates, such as gibbons and tarsiers, sing too, so it is possible that the last common ancestor of all primates, living some 55 million to 60 million years ago, was already capable of it. If so, around 300,000 years ago, perhaps the very first *Homo sapiens* came to the world already singing.

"The easier-to-breathe-through nostril is good at taking in air and the low-flow nostril is better at detecting scents"

Why sing? According to Darwin, the musical proto-language could have been useful for courtship and to mark territory. Given that music is also known to have calming effects, it may have had other purposes too, like the cooing mothers do to soothe fussy babies.

Martijn Hover
Seaford, East Sussex, UK
Although this is a question that is hard to answer, it would appear that this was some time – maybe even a long time – before we started using language. We now have evidence that parts of the brain that are involved with processing music may have a longer evolutionary history than the ones involved with processing language. ▮

Answers

Quick quiz #300 *Answers*

1 Aluminium

2 Beards

3 Guido van Rossum

4 11.2 kilometres per second

5 Parathyroid hormone

Cryptic crossword #160 *Answers*

ACROSS 1 If so, **3** De Gaulle, **9** Cornell, **10** Times, **11** Effervescence, **14** Erg, **16** CD-ROM, **17** Ewe, **18** To say the least, **20** Overt, **21** Up-tempo, **22** Basement, **23** Axes

DOWN 1 Increment, **2** Serif, **4** Eel, **5** Autocomplete, **6** *Le Monde*, **7** Eos, **8** Metric system, **12** Earth, **13** Electrons, **15** Gaskets, **19** Admix, **20** Orb, **21** Urn

#70 Powerful years *Solution*

De Morgan was born in 1806. The largest square number less than 1871 is 1849, which is 43^2. (The next-largest square is 1764, but reaching 42 then would have made him 149 at death, which seems unlikely.)

Carrie was born in 2016. She is currently 9 (3^2) and will turn 32 (2^5) in 2048 (2^{11}). If she lives that long, she will be 100 (10^2) in 2116 (46^2).

People born in 1600 could have turned 81 in 1681.

Blossom? Really?

The past few years have seen the emergence of a great many AI companies. This is extremely exciting/alarming (delete according to whether you bought shares early), but it has also had a secondary consequence. Along with the proliferation of AI companies has come a proliferation of AI company logos.

The fascinating thing, highlighted by several publications, is that many of these logos look near-identical. According to sociologist James I. Bowie, writing for *Fast Company* in 2023, the trend is for a "stylized hexagon" with an implied rotation. This, he notes, is equally suggestive of "portals opening to wondrous new worlds", "widening Yeatsian gyres" and "toilets flushing".

Or we could look at it the way Radek Sienkiewicz, a developer who blogs as VelvetShark, does. Sienkiewicz noted that most of these logos have the following elements: a circular shape, a central opening or focal point, radiating elements from the centre and soft organic curves. This, he says, is an "apt description" of "a butthole".

Feedback examined the logos of OpenAI, Apple Intelligence, Claude and others, and we can confirm that, yes, they do bear more than a passing resemblance to a sphincter, and once you see it you can't unsee it. DeepSeek and Midjourney are about the only exceptions: their logos look like a whale and a sailboat on the sea. But maybe they will soon get sucked into the circular logo maelstrom.

Why so many stylised hexagons? Perhaps the whirling patterns are meant to symbolise the recursive nature of thought, the ability of AIs to iteratively improve their understanding of the world.

Not according to OpenAI, though. Its brand guidelines offer a detailed explanation for the company's logo, which it calls "blossom" to make you think it isn't a butthole. "At its heart, the logo captures the dynamic intersection between humanity and technology – two forces that shape our world and inspire our work. The design embodies the fluidity and warmth of human-centered thinking through the use of circles, while right angles introduce the precision and structure that technology demands." Readers are free to make of that what they will.

Personally, Feedback has a working hypothesis about these logos. It involves the psychological phenomenon known as "groupthink".

Twisteddoodles *for New Scientist*

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Difficult second album

One of Feedback's favourite genres of knowledge is "things everyone knows, but that have obvious counterexamples that everyone also knows if they just think about it for a second". Hence, we turned with glee to a study in *Psychology of Music* about the "sophomore slump": the supposed tendency for musicians' second albums to be worse than their debuts, the proverbial difficult second album.

The study was originally published last November but was highlighted by science writer Philip Ball on Bluesky in April – and here we are in May, finally publishing something about it. Feedback is nothing if not tardy.

The research purports to be "the first large-scale multi-study attempt to test... whether a sophomore slump bias exists". The authors examine over 2000 reviews by critics and over 4000 fan reviews. In both datasets, the ratings of album quality declined over the course of most artists' careers. But only the critics' reviews showed "a significant and substantial sophomore slump".

At this point, the study goes off into a long discussion of why this might be. Could cognitive biases be in play? There's also "regression to the mean": a really good debut album is unusual and will tend to get disproportionate attention, but the laws of chance mean the follow-up is unlikely to be as good. Feedback, meanwhile, is reminded of a quote that goes back at least to Elvis Costello in 1981: "You have 20 years to write your first album and you have six months to write your second one."

The thing is, the sophomore slump is a statistical tendency at best. There are plenty of examples of artists whose second albums were better than their debuts: we thought of Black Sabbath, Led Zeppelin and Nirvana just off the top of our head, before our mind drifted to the Beastie Boys, Pixies and Taylor Swift. The responses to Ball's post contain many more.

Feedback also wonders if the second-album phenomenon is confined to rock and pop music, or if it extends to other, more rarefied genres. Is the sophomore slump also a problem faced by composers of acid jazz or aleatoric music? And if so, how would you tell?

Small-scale smuggling

Executive editor Timothy Revell draws Feedback's wandering attention to a report from Reuters on 15 April: "Kenyan agents bust plot to smuggle giant ants for sale to foreign insect lovers". The story explains that four smugglers had been caught trying to traffic thousands of live ants out of Kenya, including giant African harvester ants (*Messor cephalotes*). This species is apparently much in demand among ant-lovers (formicidaephiles?), and a single queen can fetch almost £100.

This is all very serious and important, but Tim wanted to flag one detail. The story quotes a "source in the ant trade" about the paperwork needed to legally export *M. cephalotes* from Kenya. This person "asked not to be named" because ant trading and smuggling "is a small world".

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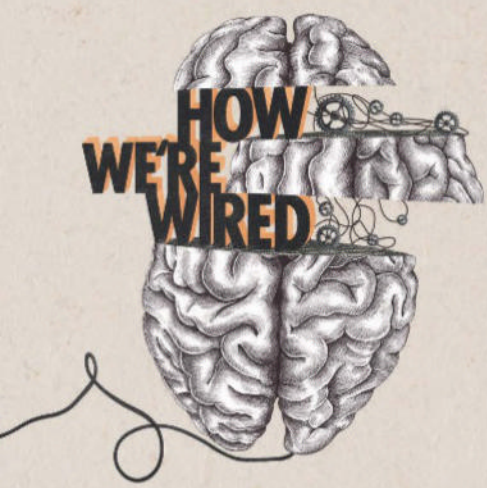

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