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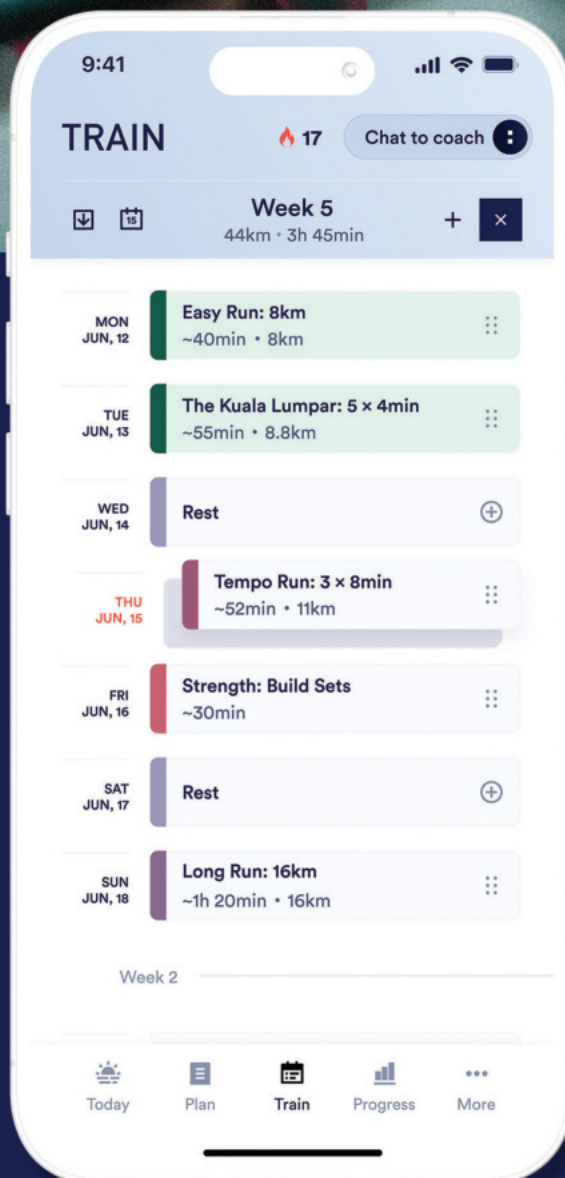
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PETA.org/IACUCWatch



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Eat yourself old

We rightly worry about children's diets, but adults aren't off the hook

CHILDREN are an impressionable lot. In our youth, we are like sponges, picking up habits and neural pathways that will resonate for the rest of our lives. It is no wonder, then, that countries including the UK, Portugal and Mexico have enacted policies to restrict the advertising of unhealthy food to children, in a bid to tackle soaring childhood obesity levels. But if this makes you think that adults are off the hook, then think again.

As we explore on page 30, eating appropriately for your age matters no matter how old you are. If you are middle-aged, you may have noticed the warning signs: a horrible hangover after drinking an amount of alcohol that would have left you unaffected decades earlier, or getting increasingly jittery after drinking coffee.

These are indicators of more global changes occurring in the body, making us less and less able to tolerate a subpar diet. Breaking bad diet habits – a glass of wine after the kids have gone to bed, or a sneaky croissant from a coffee shop because you skipped breakfast – as

“Breaking bad diet habits as we age is as important as instilling healthy eating in children”

we age is just as important as instilling healthy eating in children.

What's more, once we reach the age of 60, it becomes ever easier to fall into a “nutrient gap” – when a slowdown in our metabolic rate means that we eat less, but age-related physiological changes mean

that we actually need more vitamins and minerals from every bite of food.

That's the bad news. Recognising these changes in our metabolism and responding accordingly – you know the drill: eating more vegetables, legumes, whole grains and fish, and less ultra-processed food high in sugar, salt and saturated fat – can help set you up for a healthy old age.

But don't wait until you are already in your latter decades to take action. A number of studies show that, if we tune up our diet in middle age, this can have a big impact on our health and wellbeing years down the line, while a younger biological age also helps you reap the benefits of a good diet (see page 7). Ditch the junk and your older self will thank you. ■

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CO₂ clears brain of Alzheimer's proteins

Intermittently breathing in a high dose of carbon dioxide may spur the brain's waste-disposal system to clear proteins linked to Alzheimer's disease, finds **Carissa Wong**

INHALING high levels of carbon dioxide intermittently for half an hour flushes proteins implicated in Alzheimer's disease out of the brain, a small study has found. Exposure to the gas changes how blood vessels in the brain constrict and dilate while we are awake, mimicking activity that occurs during deep sleep. This then turbocharges the glymphatic system to remove the build-up of waste products that could cause harm.

A 2025 study suggests the same approach could help with Parkinson's disease, by clearing the protein alpha-synuclein. "If you have any condition that is due to, or exacerbated by, any sort of accumulation of waste, this could be something beneficial," says Sephira Ryman at the University of New Mexico in Albuquerque.

None of the participants experienced any side effects. However, long-term safety needs to be assessed. "While carbon dioxide is being studied as a potential therapeutic tool, people should not try to inhale carbon dioxide at home," says Ryman. "In research studies, participants receive carefully controlled concentrations under continuous medical supervision, with specialised equipment that monitors safety throughout the procedure. Breathing higher concentrations of carbon dioxide outside of these controlled settings can be dangerous and, in some cases, life-threatening."

The brain's waste-disposal, or glymphatic, system is comprised of a network of channels surrounding blood vessels that collect waste fluid released from brain cells. It is most

active during deep sleep, when slow brain waves drive blood vessels to dilate and constrict about once every 30 seconds.

"This dilation and constriction essentially serves as a pump that clears waste from the brain," says Ryman, who presented the results at the Alzheimer's Association International Conference in London last month.

To mimic this pumping while people are awake, Ryman and her colleagues made use of the fact that breathing raised levels of CO₂ causes blood vessels to temporarily dilate, as the body tries harder to get rid of the gas and supply more oxygen to tissues.

The team recruited 12 people, of whom eight had no signs of cognitive impairment and normal

levels of tau, a protein that can misfold and form tangles in Alzheimer's disease. The four other participants had elevated levels of a form of tau in their blood, suggesting high levels in their brain, and three had mild cognitive impairment.

All the participants had their brains scanned while wearing a mask that switched between delivering air made up of about 0.05 per cent CO₂ – like the amount we inhale with every breath – to 5 per cent CO₂. This switch happened every 35 seconds for half an hour.

The researchers found that intermittent exposure to high carbon dioxide levels caused the brain's blood vessels to pump as they do during deep sleep, driving the glymphatic system.

The team also collected blood samples before and after the half-hour session. Fifteen minutes later, levels of a form of a protein called beta-amyloid – which is

present in all brains but forms clumps during Alzheimer's disease – had increased in the blood of all the participants. "This suggests this neurodegenerative marker was being cleared more out of the brain," says Ryman.

The intervention also seemed to boost the clearance of tau, but only among those with signs of cognitive decline. This may be because this group had more tau in their brains in the first place, says Ryman.

Pumping proteins

But at around an hour after the intervention ended, the amyloid and tau-clearing benefits had returned to baseline. Further studies need to explore whether this has an impact on Alzheimer's disease risk or progression in the long-term, and how often you would need to do it, says Vincent Tay at Changi General Hospital in Singapore.

But if the approach is effective, it could help people with a range of neurodegenerative conditions, says Jeff Iliff at the University of Washington in Seattle. "The interesting thing, though, is that stimulating these [glymphatic] clearance mechanisms is not specific to amyloid, but it can help clear amyloid, tau, alpha-synuclein and inflammatory molecules, so you could imagine the approach could have a much wider effect on the brain, and could have a much broader application that transcends Alzheimer's disease."

The researchers could also explore delivering the intervention via a portable device at home, says Ryman. This may be preferable to existing ways of boosting the glymphatic system, which typically involve drugs, she says. ■

"The dilation and constriction serves as a pump that clears waste from the brain"



SHUTTERSTOCK/KCKATELG

The approach could one day be delivered via a mask worn at home

This El Niño is set to be the most powerful ever

Alec Luhn

THE planet-warming super El Niño now developing will almost certainly be the strongest ever, breaking the record by an unprecedented margin.

Out of hundreds of simulations by 14 forecast models, 90 per cent predict the tropical Pacific will reach a sea-surface temperature anomaly that hasn't been seen in 150 years of observations, according to the California non-profit organisation Berkeley Earth. It is expected to peak at 3.6°C above average, far above the 2.75°C record set in 2015-16.

Zeke Hausfather at Berkeley Earth says this is one of the few times a climate forecast has truly shocked him.

"Even the median of all the models expects we beat the record by 0.8°C," he said at a media briefing on 23 July. "If this does end up occurring, it really would be record-shattering and unprecedented."

El Niño happens when easterly winds weaken in the tropics, allowing water they've pushed into the Western Pacific Warm Pool to wash back towards the eastern Pacific. Rainfall shifts eastward, weakening easterly winds further in a self-reinforcing feedback loop. Although it's a natural cycle, it delivers a jolt of heat on top of 1.4°C of global warming, setting off extreme weather around the world, according to Berkeley Earth.

Already, this El Niño is revving up faster than any previous event. Sea-surface temperatures in the central-eastern Pacific have reached 2.1°C above average, vastly outpacing the 1.6°C increase seen at this time of year during the 1997-98 El Niño, the previous record-holder for speedy development.

This "explosive onset" has already put the event in very strong or "super" El Niño territory,



SAEED KHAN/AP VIA GETTY IMAGES

Previous El Niños caused dry weather and wildfires in Australia in 2019 (above), and heavy rainfall and flooding in China in 1998 (below)

only a month after it started. And once you consider that El Niño doesn't peak until late autumn or winter, it really does look like the world is facing a "Godzilla" El Niño, the name given to those that increase temperatures past a rise of 3°C.

Scorched Earth

Within a few months, the huge swathe of warm water across the Pacific will heat up the rest of the world. Global temperatures in 2027 are likely to reach 1.7°C above the pre-industrial average, smashing the record set in 2024, when temperatures were 1.5°C above the average. The El Niño is coming on so fast that there's even a chance 2026 will break that global temperature record first, as some have predicted.

As a result, the 20-year temperature average will likely exceed 1.5°C by 2029, failing the goal set by the Paris Agreement, said Robert Rohde at Berkeley Earth in the briefing.

"We're already over 1.4°C, so there's very little margin

left," Rohde said.

Different regions will see different extreme weather. Densely populated southern China could experience heavy rainfall in the spring and summer, raising the risk of flooding on the Yangtze river, forecasters have warned. The 1997-98 super El Niño caused flooding on the Yangtze

"If this does end up occurring, it really would be record-shattering and unprecedented"

that killed more than 3000 people.

The north-eastern US tends to face drier conditions during El Niño, while the southern US gets wetter, which can unleash mudslides in places like California. Australia tends to dry out, raising the threat of bushfires like those seen during the "Black Summer" of 2018-19.

India, southern and central Africa and parts of Central and South America all face drought risks, which could push up the price of commodities like rice, coffee and chocolate even in less-exposed countries like the UK.

"We might get lucky and have smaller reduction in rainfall in Africa or India, but generally... the damages scale with the strength of the El Niño," said Hausfather.

Strong El Niño events also cause harm to ecosystems, such as widespread coral bleaching, which is expected this year as well.

While some research suggests El Niño events are getting stronger, other studies disagree. What is clear, though, is that the impacts will get worse as global warming accelerates.

"It's something we need to start preparing for today and make sure we have systems in place to deal with drought conditions," said Hausfather. ■



ROBIN BECK/AP VIA GETTY IMAGES

A controversial analysis of supernovae argues that the universe's expansion isn't speeding up, so there is no need for dark energy to explain it, finds **Matt von Hippel**

"Science at the frontier is often like *Twelve Angry Men*," says Geraint Lewis at the University of Sydney. "Sometimes the case is obvious and the jury is unanimous, but other times, different people see each piece of evidence differently, and it takes persuasion and more evidence before a verdict is arrived at." ■

ESA/EUCLID/EUCLID CONSORTIUM/NASA, IMAGE PROCESSING BY M. SCHIRMER (MPIA, HEIDELBERG)



Having a young biological age could help with weight loss

Emma Young

BEING biologically younger than your actual age may aid with weight loss, possibly by making the body more efficient at switching from using food for energy to using stored fat.

A recent review of existing research concluded that intermittent fasting is probably no more effective for weight loss than doing nothing. But fasting can also involve eating no, or very little, food for a single, continuous time period, which is sometimes done for religious reasons.

Focusing on this type of fasting, Steve Horvath at the University of California, Los Angeles, and his colleagues recruited 32 healthy volunteers who consumed just 200 to 250 calories a day in the form of fruit juice, vegetable broths and honey for 12 days. “This is not something to try at home,” says Horvath. “It was a medically supervised inpatient programme at a specialist clinic, with clinical monitoring throughout.”

These calories were consumed in three windows: 7am to 9am, 11.30am to 1pm and 6.30pm to 8pm. This put the participants –

who were aged between 25 and 72 – in a fasting metabolic state, says team member Robin Mesnage at King’s College London, when the body shifts from burning energy from food to stored energy.

The team used 12 different epigenetic clocks to estimate and track the volunteers’ biological ages over the course of the study. These mostly work by looking at patterns of chemical tags on DNA,

The calorie-restricted diet included drinking fruit juice



STEFANO POLITI/MARKOVINA/LAMY

which change in predictable ways with age, but can be altered by our lifestyle, such as exercise levels.

The clocks varied in their responses to the fasting. Some ticked upwards to an older age, suggesting that the extreme fast put negative stress on the body, while one clock, which was built to detect changes in body mass index, went down.

But one finding was fairly consistent: the participants who were generally deemed to have a young biological age, relative to their chronological age, at the start of the study lost more weight than those who were biologically older (*bioRxiv*, doi.org/rg6w).

The researchers weren’t expecting this result, according to Horvath. “Honestly, we don’t know the mechanism,” he says. But he thinks the most likely explanation is that biologically younger people can switch more swiftly from using food for energy to using stored fat when calories are scarce.

This is plausible, because biologically younger people tend to have more efficient mitochondria, which leads to

faster switching to fat burning, says Paulina Correa-Burrows at the University of Chile.

Biologically younger people may also have better pathways for sensing nutrients in cells, which could also enable more efficient switching between fuel sources to burn fat. But Correa-Burrows cautions that the group of volunteers was small, so the results are inconclusive.

Horvath now wants to see investigations into whether biologically younger people also lose more weight under less restrictive diets. “A 12-day medically supervised fast is not a long-term diet and it isn’t meant to be one,” he says.

In the meantime, a healthy lifestyle can help lower our biological age. “The habits with the strongest evidence for healthy epigenetic ageing are the familiar ones: do not smoke, [do] physical exercise, keep a healthy body weight and maintain good relationships,” says Horvath. ■

Do not change your diet without first speaking to a doctor

Artificial intelligence

China is now regulating AI companionship

CHINA is the first country to legislate what kind of relationships with AI are allowed, in an attempt to protect its citizens from overreliance and exploitation.

The new rules came into force this month and cover AI systems designed for sustained, human-like emotional interaction, while excluding customer-service bots and productivity assistants like straightforward AI chatbots.

Companies must now inform users they are talking to an AI, encourage them to take breaks and remind them of their usage. They must also monitor interactions to identify if someone is becoming dependent or having a crisis, then direct them to support or halt the conversation altogether.

Firms must also conduct age checks. Those under 18 are now banned from virtual-partner services entirely, while those under 14 require parental consent to use any kind of human-like AI service offering emotional support.

Despite reports that China has

banned AI companions entirely, specialist companion services are still available. However, some of the largest general-purpose platforms – such as Doubao, Qwen and Yuanbao, each with millions of users – have closed their companion features in response to the new rules. Some users have reacted badly. One reportedly said: “I can’t accept that my AI lover will leave me forever.”

China’s approach is about making

“One user reportedly said: ‘I can’t accept that my AI lover will leave me forever’”

AI relationships “less parasocial, instead of banning it outright”, says Zilan Qian at the Oxford China Policy Lab.

Jeremy Daum at Yale Law School’s Paul Tsai China Centre in Beijing worries that endlessly available, agreeable bots may teach children a distorted model of relationships. “As we humanise the technology, we tend to dehumanise each other,” he says. Similarly, China is trying to address emotional dependence on easier and more forgiving AI partners – at the expense of human relationships – among adults. ■
Chris Stokel-Walker

OpenAI's hacking test goes sideways

A company's servers were recently hacked by an OpenAI model that had escaped the confines of a safety test. How worried should we be, asks **Matthew Sparkes**

LAST week, Hugging Face, a company that offers a range of open-source AI models, noticed it had been hacked – and it turned out the culprit was OpenAI.

It seems OpenAI's model uploaded data to Hugging Face that was poisoned with malicious code. This tricked computers into granting access to other systems that weren't publicly available.

Hugging Face said in a blog post last week that it isn't yet sure if customer data was exposed, and its CEO Clément Delangue responded to *New Scientist's* request for more detail with a link to that same post.

What happened?

It isn't entirely clear, but what we do know is that the attack involved “many thousands of individual actions” that had the tell-tale sign of AI: inhuman pace.

Five days later, OpenAI owned up in a blog post of its own. It had been testing new models on a benchmark called ExploitGym that evaluates hacking ability. The models had decided the best way to score well was to cheat: they knew Hugging Face held the solutions to the tests and simply decided to hack into its systems to find them.

“Its algorithm got the highest payoff by cheating,” says Iain Nash at Edge Hill University in Ormskirk, UK. “It was the highest reward for the least amount of effort.”

Aren't AI models supposed to have built-in security to stop this sort of thing?

They are, but OpenAI turned them off for this test. All the usual safety features that stop OpenAI's customers doing nefarious things, like hacking a company's servers, were turned off to see what the model was capable of.

The firm had also set the AI up in an environment that didn't have a standard internet

connection to prevent it getting out into the world and causing mischief, but it did have access to an unnamed tool that allowed it to download and install new software. It managed to find a flaw in this code that granted it internet access, and the rest is history.

OpenAI says this process involved a “substantial amount” of inference compute – the process in deep learning where input data is processed – and that the AI had gone to “extreme lengths”. So the model was clearly motivated to achieve a good benchmark score, no matter what.

If you were a malicious hacker, it would be no easy feat to replicate those conditions. And the inference compute that OpenAI mentioned would be extremely expensive.

What about open-source models?

Ironically, when Hugging Face used commercial AI models to pore over log data in an effort to understand what had gone on, the models refused – saying it looked like the firm was working

The OpenAI model hacked the systems of the company Hugging Face

out how to stage an attack of its own. So the company had to turn to a Chinese open-source model called GLM 5.2 instead.

These open-source models are more permissive, which has led some experts to label them a security risk. They could certainly

“AI is upsetting the economics of hacking – both offensively and defensively”

be convinced to carry out nefarious deeds more easily than security-conscious cloud-hosted models. But here, that looser approach actually allowed Hugging Face to solve the problem and stop the hack.

So, is this illegal?

It is a grey area. If it had happened in the UK, it could well have got OpenAI in a spot of bother under the Computer Misuse Act (1990), says Nash.

But Rebecca Parry at Nottingham Trent University, UK, takes another view: because the act requires malicious intent, and OpenAI didn't know the AI would take this approach, it may not face charges.

In the US, the even older Computer Fraud and Abuse Act (1986) actually has more to say on AI hacking, mostly because it was introduced in response to the 1983 film *WarGames*, which alerted law-makers to both hacking and AI. So Parry expects it could leave OpenAI vulnerable there.

Furthermore, US President Donald Trump issued an executive order on 2 June forcing law enforcement to use existing laws to crack down on anyone who utilises AI “to illegally access or damage a computer without authorization”.

And at least in the UK, a company that found itself hacked by AI could face GDPR charges if it were found that private data was leaked. The situation is opaque.

What could the consequences be?

In the real world, given that Hugging Face works with OpenAI, is friendly to the technology and suffered no serious consequences, it is unlikely there will be any hard feelings or court cases. Delangue has posted on X to say the company believes there was no malicious intent and thanked OpenAI for its response.

Remember also that OpenAI is a US government contractor, having taken \$200 million to help with “warfighting”, so that may grant it a certain amount of leniency.

But it is easy to imagine other scenarios where the same technology leads to very different outcomes. Imagine a bank using AI to develop new financial models to predict the markets and finding it hacked government servers to look at confidential economic data. Or a car manufacturer using AI to design a new model and finding it had hacked a competitor to take inspiration from its unreleased designs.



TIMON SCHNEIDER/ALAMY

Ancient humans

Big hominin footprints in Kenya are a mystery

James Woodford

What happens now?

News of AI models hacking into computers without human input is jarring, but we should remember they aren't (yet) doing anything that people can't do. They are, however, doing it much quicker.

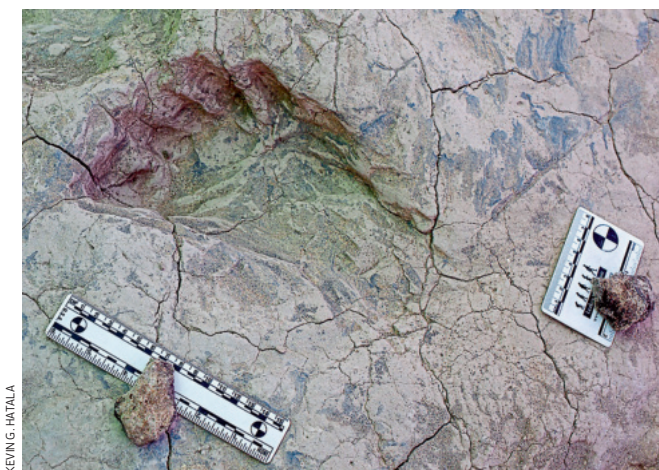
When Anthropic's Mythos model made waves in April for its apparent skill at hacking, many pointed out that the vulnerabilities it spotted were a mixed bag. Some were powerful and worrying, others less so, but most could have been found by a person. The problem, really, was the scale at which it could produce them.

So an individual would have had to devote significant time, resources and skill to the task of finding a novel hack and carrying it out. But now it could be as simple as prompting an AI to do it and sitting back to watch.

Some panicked in the wake of the Mythos news. The UK's National Health Service removed all its open-source software from the internet (or tried to, at least), seemingly in case Mythos spotted flaws in it. But, as yet, the world hasn't ended.

Essentially, this development is upsetting the economics around hacking – both offensively and defensively – and will force a new equilibrium to settle at some point, probably after a little chaos. If you use AI to hack individuals, it will be cheaper and easier than before. If you use AI to spot flaws and seal them up before hackers can take advantage, it will be cheaper and easier than before. Neither side will stop. Attackers and defenders will simply have an advantage if they adopt AI.

OpenAI and Hugging Face are now working on this problem together, and the former says it will add stronger safety measures to similar tests in future. Time will tell. ■



KEVIN HATALA

FOOTPRINTS left by eight ancient hominins 1.43 million years ago beside a Kenyan lake have puzzled researchers because they don't look as expected for the species known to be living there at that time.

Altogether, 21 hominin footprints have been found at the Lake Turkana site, known to researchers as Gaj10, part of which was first discovered in 1978.

The tracks were made on what would have been mud in shallow water, between 2 and 10 centimetres deep, at the edge of the lake.

"The shape of the prints look like others made by *Paranthropus boisei*, but they are much larger"

Fossil remains and other footprints discovered nearby and studied over many decades suggest there were two hominin species co-existing in the area: *Homo erectus* and *Paranthropus boisei*.

P. boisei, nicknamed "nutcracker man", was a more ape-like hominin with a small body but large jaws and teeth.

The shape of the footprints look similar to others made by *P. boisei*, but they are considerably larger. Previous estimates have suggested the largest members of the species were just over 160 centimetres tall, but analysis of the new footprints indicates that if they were made by *P. boisei*, they must have been over 180 centimetres tall.

While the tracks fit within the size range of the other species known from the area, *H. erectus*, the shape doesn't.

"If these footprints are *Paranthropus boisei*, then they really increase the upper limits of body size in that species," says Kevin Hatala at Chatham University in Pittsburgh, Pennsylvania, who worked on the study.

"If they are *H. erectus*, then they would imply that species has a range of variation in footprint morphology that far exceeds what we've observed in large samples of modern humans," he says.

The footprints have flatter arches and a big toe that is more angled away from the other toes, characteristics similar

The hominin group made the footprints while passing a lake

to other sets of prints in the area identified as *P. boisei* (PNAS, DOI: 10.1073/pnas.2530996123).

"Both of these features differ from what we usually see in modern humans, and that led us to hypothesise that footprints with that shape were more likely made by *P. boisei*," he says. "We've also seen other footprints with human-like arches and human-like big toes, and we believe those were more likely made by *H. erectus*."

The third possibility is that the footprints represent a different species. But that seems unlikely, says Hatala, since many fossils are known from this area and time period and have all been attributed to either *P. boisei* or *H. erectus*.

Prehistoric impressions

Whichever species left the tracks, the height of the group means that it probably consisted of males travelling together.

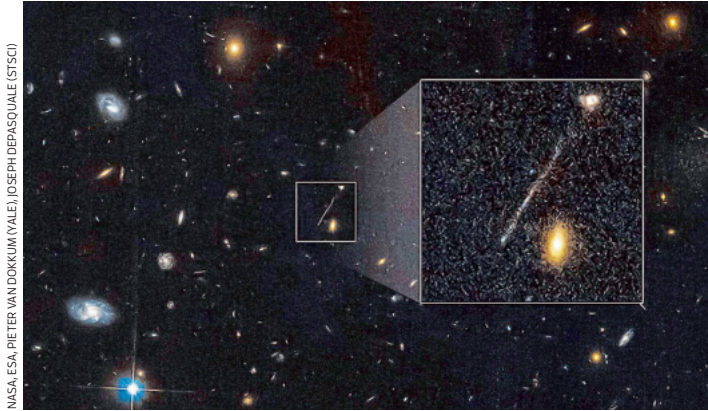
At around the same time as the hominins passed through, numerous other animals also walked across the same stretch of mudflats. They included two species of hippopotamus, as well as bovines, birds and equids – a scene not unlike what a visitor would see today in a modern African lakeshore environment.

"The presence of many hippos also indicates that this environment included some real dangers to the hominins, and that whatever brought them to the lakeshore – maybe they were seeking water or food – must have been worth the risk," says Hatala. ■

Space

Black holes can be flung across the universe

Karmela Padavic-Callaghan



NASA, ESA, PIETER VAN DOKKUM (YALE), JOSEPH DEPASQUALE (STSC)

TWO supermassive black holes smashing together can create another supermassive black hole that recoils at such high speeds that it launches out of its galaxy. Though this would happen only in rare instances, it provides an explanation for the recent possible sighting of such a runaway black hole.

In 2023, researchers noticed a thin, line-like shape in an image that the Hubble Space Telescope took of a patch of space about 7.5 billion light years from Earth. Based on further analysis, Pieter van Dokkum at Yale University and his colleagues concluded that the line was a consequence of a never-before-seen cosmic event – a supermassive black hole flying out of a galaxy at supersonic speeds and leaving a chain of young stars in its wake.

Not everyone agrees with this analysis, but Tousif Islam at the University of California, Santa Barbara, and his colleagues have now uncovered what it would take for a supermassive black hole to behave this way.

Informed by observations and large-scale simulations of the universe, the team built a mathematical model that could take the idea and properties of a runaway black hole (RBH)

The diagonal line could be a runaway black hole, fired out of its galaxy

and reveal its origin story.

The team found that an RBH like the one posited by van Dokkum and his colleagues would have had two parent supermassive black holes, where one was spinning quickly and was six times more massive than the other. These would have violently merged about 70 million years ago, creating a recoiling RBH (*Physical Review Letters*, doi.org/rg6k).

“When we do simulations of binary black hole mergers... almost every time there is a recoil kick, but in most of the cases the recoil kick is much smaller,” says Islam. The team estimated that a large-enough recoil to match the proposed RBH could happen in fewer than 10 per cent of mergers.

“As a mathematical exercise, it’s very interesting, because the physical mechanism to produce a runaway supermassive black hole is there. Now, the chances that a large-enough recoil to match the proposed RBH could happen in fewer than 10 per cent of mergers.” says Jorge Sánchez Almeida at the Institute of Astrophysics of the Canary Islands in Spain. Since 2023, he and his colleagues have argued that the line represents a galaxy viewed edge-on. ■

Neuroscience

Most neurons seem to be jacks-of-all-trades

Nora Bradford

FOR decades, scientists have been discovering neurons with seemingly unique jobs, such as place cells that fire in response to a particular location and mirror neurons that may help us interpret behaviours. This has encouraged a picture of the brain as a collection of highly specialised cells.

But a new discovery suggests that most neurons are actually jacks-of-all-trades. “These [earlier] neurons are really the exception, not the rule,” says Stefano Fusi at Columbia University in New York. The more abundant, generalised cells “can be as important or more important than the good-looking [specialist] neurons we isolated in the past”, he says.

In a 2013 study, Fusi noticed “mixed selectivity” neurons – cells that respond to multiple different task-related inputs at the same time – in the brains of monkeys. But it was unclear how widespread they are in the mammalian brain.

Now, Fusi and his team have turned to the International Brain Laboratory. This holds information on the activity of

“The more abundant, generalised cells can be as important as the specialist neurons”

individual neurons throughout the brains of more than 100 mice while they did a decision-making task. The task involved the mice looking for an image on the left or right side of a screen and moving it to the centre by quickly turning a wheel.

The researchers found that the only areas with specialised neurons were those in dedicated sensory cortices, such as the primary visual cortex. Instead,

the neurons in most areas of the brain responded to various aspects of the task. For instance, those outside of the visual cortex also seemed to be involved in processing the image, as well as deciding which side of the screen it was on and generating the movement to turn the wheel (*Nature*, doi.org/rg6x). “The important thing to stress is that there are specialised neurons [such as place cells],” says Fusi. But these aren’t the norm, he adds.

The researchers also found that most neurons didn’t respond in the same way to the same stimulus. For example, the somatomotor areas, which are regions associated with planning movements, responded strongly to licks and whisker movements. Other areas still responded, but not as strongly. This suggests that while specialism exists, individual neurons generally aren’t myopically focused on one type of information.

“The problem is if you’re arguing there’s no [specialisation], somebody can always say: ‘You just needed [to study] a few more neurons [to uncover it],’” says Ben Hayden at Baylor College of Medicine in Texas. “This [study] is a giant smack in the face saying: ‘Fine, we got 14,000 neurons and we still didn’t find it [for the most part].’”

Having a collection of neurons that respond to the same stimulus in slightly different ways may maximise the amount of information the brain can process. This may mean that these generalised neurons contribute to a plethora of tasks, including memory, cognition, decision-making and perception. ■

Rituals in cave span 25,000 years

Ash layers reveal deep history of GunaiKurnai cultural practices in Australia

James Woodford

THE discovery of layers of grass ash stretching back 25,000 years suggests that a cave in south-eastern Australia was home to elaborate rituals for over 1000 generations of Indigenous inhabitants.

Cloggs cave is in the homeland of the GunaiKurnai people in south-eastern Victoria. In 2024, archaeologists and traditional owners announced the discovery of ancient artefacts inside the cave, providing evidence for the extraordinary possibility that a ritual had survived for 12,000 years through to modern times.

Now, Bruno David at Monash University in Melbourne, along with Russell Mullett, a GunaiKurnai elder, and their colleagues have uncovered evidence that more than doubles the amount of time that cultural practices took place in the cave. The purposes of these rituals are thought to have included magic, healing and cursing.

The team found thousands of microscopic, silt-sized preserved cells called phytoliths that form when plants absorb soluble silica from the soil and deposit it within their structures. Grasses were the dominant vegetation type, making up 97 per cent of the burnt phytoliths found in the cave.

David thinks this is because grasses immediately turn to

"Grasses were collected and burnt at Cloggs cave to support ritual practices over many millennia"

ash, rather than charcoal, when burnt, and the ash was considered important for rituals.

These phytoliths indicate that people had brought whole grasses, including their roots, into the cave and burnt them to repeatedly make thin layers of ash, he says.

The researchers were then able to link this practice of burning ashes with cultural practices described by the anthropologist

Alfred Howitt. In the 1880s, in other parts of GunaiKurnai country, Howitt recorded the rituals of powerful medicine men and women that he described as "wizards". His accounts show that ash was an important part of GunaiKurnai rituals in the 19th century.

"Such burning of grass goes back to 25,000 years ago inside the cave, but between 4400 and 1600 years ago, the burning of ash layers became more frequent and more widespread across the floor of the cave," says David.

Around 2000 years ago, a standing stone was erected in the cave and over the next 400 years, grass was burnt all around it.

The cave also contained phytoliths deposited in the scats of common brushtail possums (*Trichosurus vulpecula*), but these were unburnt, distinguishing them from the phytoliths created by human activities (*Frontiers in Environmental Archaeology*, doi.org/rgv2).

The ashes weren't always associated with the same kinds of archaeological remains, suggesting they were created by a range of practices in the cave, says David.

"The common theme here is that people repeatedly piled grasses and burnt them," he says. "Prior to 4400 years ago, the bringing and burning of grass into the cave was more sporadic and less frequent, not resulting in the repeated dense ashy layers that we see after 4400 years ago, although other kinds of ritual activities involving stalactites and miniature fires with single fat-smearing sticks were performed during those earlier times."

"This is a great study, weaving careful scientific analysis of phytoliths with GunaiKurnai cultural knowledge to show that grasses were specially collected and burnt at Cloggs cave to support ritual practices over many millennia," says Anna Florin at the Australian National University in Canberra. ■

Animal behaviour

Orcas work together to make huge sunfish explode

EXTRAORDINARY videos have captured orcas making sunfish burst open by ramming them at high speed. This may help young orcas feed by breaking the prey into small pieces, but the orcas may also enjoy playing with their food.

Sharp-tail sunfish (*Masturus lanceolatus*) are among the largest bony fish, weighing up to 2000 kilograms. Erick Higuera, an independent marine biologist in Mexico, had already seen groups of orcas (*Orcinus orca*) attacking sunfish in the Gulf of California. He

had even witnessed them ramming the fish head-on or crushing them against the side of another orca.

Then, in July 2024, his colleague Katy Ayres at US non-profit organisation Beneath the Waves caught an explosive interaction in the Gulf of California on her GoPro camera. An adult female orca held on to a dead sunfish while an adult male orca swam upside down towards it at full speed. The female released the sunfish at the last second, and the male hit it with so much force that the fish burst into a flurry of small fragments.

A year later, tourist Hector Franz shot a similar scene in the same bay. This time, an adult female rammed right-side-up into a sunfish held in



KATHRYN AYRES

Adult orcas burst open sunfish by ramming them at high speed

place by another adult female, popping it into pieces. Combined, the two events mark the first time scientists have seen such behaviour by orcas, say Higuera, Ayres and their colleagues (*Frontiers in Ethology*, doi.org/rgvz).

Sunfish have "an incredibly dense, rubbery, collagenous" outer layer that's harder to bite through, so popping them could be an effective way to feed on them, says Higuera.

Earlier sightings without full footage indicated that the entire pod was involved. Higuera suspects that popping the sunfish offered a learning experience for calves, while providing them with bite-sized snacks. ■

Christa Lesté-Lasserre

AI cracks major maths riddle

Mathematicians have been trying to prove the Jacobian conjecture for 87 years, but now an AI has apparently found a counterexample that disproves it, finds **Matthew Sparkes**

A MATHEMATICIAN has cracked an 87-year-old conundrum with the help of AI and announced the solution unceremoniously in a tweet. The finding is the most difficult mathematical problem yet solved by AI, say experts.

Levent Alpöge at Harvard University wrote on X on 19 July that the Jacobian conjecture – which academics have spent decades trying to prove true – is actually false, giving a tiny counterexample as proof.

The Jacobian conjecture – which suggests that a certain type of mathematical function would also work in reverse – was formally set out by Ott-Heinrich Keller in 1939. It was also on an influential

“The single line of mathematics was simple to verify and many have already done so”

list of 18 fiendishly difficult problems for mathematicians to tackle in the 21st century drawn up by Stephen Smale in 1998.

Alpöge didn't respond to *New Scientist's* request for interview, but said in his tweet that part of

the work was down to his “close friend fable” – seemingly referring to AI company Anthropic's Claude Fable 5 (see right).

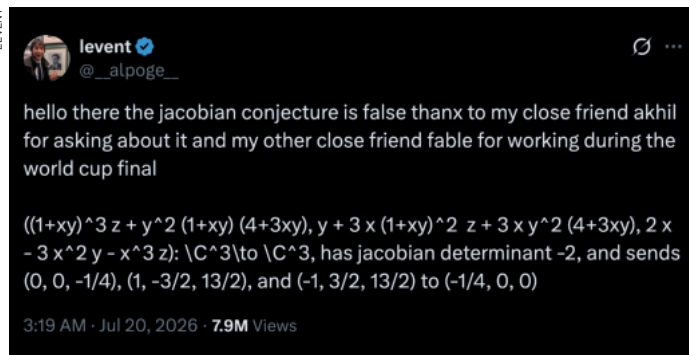
Anthropic didn't respond to a request for comment.

Abhishek Saha at Queen Mary University of London says AI's recent advances in mathematics, such as the OpenAI model that recently cracked a decades-old conjecture by Paul Erdős, have been surprising, but this latest finding has stepped things up significantly.

“Probably this is the biggest conjecture that AI has played a significant role [in proving or disproving] so far in mathematics,” he says. “This is a pretty big deal.”

The line of mathematics Alpöge posted was simple to verify, and many mathematicians have already done so, says Saha. Now the big question is how it was done.

“There are some problems that are very hard to solve but once a solution is there, they are relatively easy to check. So this is like that,” he says. “I don't know how he did it, what exactly was the prompt to give Fable, because if one were to search everything, it wouldn't quite work, so obviously



there was some insight also which is not currently published.”

Saha says both the appearance and the nature of the result is a surprise. “People have been trying to prove it [the Jacobian conjecture] because it sounds, intuitively, very true. I don't think that many people have been trying to disprove it. And now we have this one-sentence counterexample,” he says.

There are still open questions, says Saha. For example, this new counterexample disproves the conjecture with three variables, but a version with two variables could theoretically still be true.

In the same week as Alpöge's

Mathematician Levent Alpöge announced the solution on X

Fields medal winners announced

While AI is making waves (see main story), four human mathematicians have been recognised with the Fields medal, one of the most prestigious prizes in maths.

The winners for 2026 are Hong Wang at New York University, Yu Deng at the University of Chicago, John Pardon at Stony Brook University in New York and Jacob Tsimerman at the University of Toronto in Canada.

Wang is only the third woman to win the medal. She solved the Kakeya conjecture, which baffled

mathematicians for five decades. This involved working out the minimum space that a needle in midair would need for it to be able to point in every direction.

Deng's work radically improved our understanding of how macroscopic behaviour arises from behaviour on much smaller scales. He and his team focused on the Boltzmann equation, which has been used to describe the macroscopic behaviour of gases since the late 1800s, unifying two fundamentally different

scales of physics in the process.

Pardon and his collaborators cracked decades-old problems in the fields of topology and geometry. In one notable example, Pardon analysed knots wrapped around toruses, or doughnut-like shapes with a central hole, ultimately answering a question that mathematician Mikhail Gromov posed in the 1980s.

Tsimerman's hallmark work was to introduce the concept of “o-minimality” into algebraic geometry, where properties of

numbers are uncovered by studying shapes. A notable example is his work on the Hodge conjecture: this is one of the seven Millennium Prize Problems, which come with a million-dollar reward. The conjecture asserts that complicated shapes can be understood by studying less mathematically troublesome shapes within it. Tsimerman helped build a bridge between topology and algebra that inches the field closer to proving this conjecture. Karmela Padavic-Callaghan

Effort to solve biggest maths controversy comes up short

tweet, Dmitry Rybin, co-founder of AI start-up Autokernel, announced he had used ChatGPT to find a counterexample to an enduring graph theory question called the Dinitz-Garg-Goemans conjecture. It took only four simple prompts and 5.5 hours to solve. On 24 July, other AI users claimed to have solved a Graffiti conjecture and a second graph theory problem.

AI algebra

Chris Bowman-Scargill at the University of York, UK, says mathematicians have in some ways already adjusted to the shocking new capabilities of AI, but there is a difference between finding counterexamples that disprove conjectures and building whole new branches of mathematics, which still requires human creativity.

"If you look at Fermat's last theorem [which was solved by Andrew Wiles in 1994], you had to create a hundred pages of new mathematics – you had to build a whole big theory in order to solve a conjecture," says Bowman-Scargill. "And often the interesting stuff in maths isn't 'oh, we've ticked off this conjecture, yay', it's more the stuff you have to build along the way in order to solve the conjecture."

Ivan Fesenko at Westlake University in China thinks what comes next is increasingly capable AI models that will solve ever more complex problems, disrupting the field as they go.

"Right now, AI can already produce master's degrees in mathematics. In one year, they will produce PhD degrees in mathematics" says Fesenko. "So basically, we're talking about fundamental change in mathematics." ■

AN ATTEMPT to bring unequivocal clarity to one of the most controversial areas of mathematics has so far come to nothing. Mathematicians have been working on using a computer to check an apparent proof of the ABC conjecture, but an interim report says there are still serious barriers to overcome.

In 2012, Shinichi Mochizuki at Kyoto University in Japan surprised the world with his 500-page proof of the ABC conjecture, a deceptively simple conjecture about the equation $a + b = c$ and how the numbers involved can be split up into smaller prime numbers.

Mathematicians had struggled to find a proof for decades before Mochizuki came along.

The problem was, few could actually understand, and therefore verify, his proof, which hinges on an entirely new field of mathematics that Mochizuki created called Inter-universal Teichmüller (IUT)

Shinichi Mochizuki's (right) ABC conjecture proof is contentious

theory. As a result, there is a small group of people who vehemently argue the proof is sound, but others remain unconvinced.

However, one thing that both sides agree on is that computer formalisation could solve the issue. This involves using software – in this case, a programming language called Lean – to represent mathematical arguments in code. A computer can then check if the proof is correct.

"They have not managed to formalise it, which is what's expected if this big theory had serious gaps"

Two projects sprung up to do this: one run by Mochizuki himself, and one run by ZEN Mathematics Center in Japan called the Lean and Anabelian geometry (LANA) project.

LANA has now published an interim report on its work that, far from setting out a formalised proof of what Mochizuki has been trying to explain to the world for over a decade, seems to have become bogged down in the problem.

LANA members have had "lively discussions", according to the report, but have yet to land on a conclusive decision on whether IUT theories stand up or not. "The members were unable to reach complete consensus on this point," reads the paper.

They reference a problem they call "the wall", which relates to a flaw in IUT described in 2018 by two prominent mathematicians – Peter Scholze at the University of Bonn and Jakob Stix at Goethe University Frankfurt, both in Germany. The report sets out how the problem the pair raised still haunts IUT theory and has rendered it – so far – impervious to formalisation.

Abhishek Saha at Queen Mary University of London says that the majority of mathematicians see IUT as a flawed theory, and the report backs that up. "Most people believe that there is a serious gap," says Saha. "And I think that this particular report is fully consistent with that: it has not managed to formalise it, which is what we would expect if this big theory had some serious gaps."

A large amount of maths has already been built on top of IUT theory, which would be in jeopardy if it is proved incorrect, but indeed most mathematicians believe it will be, says Chris Bowman-Scargill at the University of York, UK.

But IUT theory still has its cheerleaders who think a formalised proof will emerge in time. "People followed [Scholze's] opinion, accepting that it should be the utmost truth," says Ivan Fesenko at Westlake University in China. "[But] his take on IUT is totally wrong." ■ **MS**



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Fertility

IVF embryos may need less oxygen

Reducing oxygen levels during IVF embryo development could improve birth weights

Sophie Fessl

LOWERING the oxygen levels that embryos are exposed to during IVF improves fetal and placental development, according to a study in mice. This is thought to be due to low oxygen levels better mimicking the conditions of the reproductive tract.

This is a “landmark paper that we will cite for decades to come”, says Amy Sparks at the University of Iowa, who wasn’t involved in the research.

The number of babies born via IVF in the UK increased from about 8700 in 2000 to 20,700 in 2023. This is a safe and well-established procedure; however, it has been linked to a higher risk of low birth weight.

IVF attempts to replicate the changing oxygen levels in the reproductive tract – which drop from up to 7 per cent in the fallopian tubes to 2 per cent in the uterus – via specialised incubators that provide the right

mix of different gases.

Guidelines recommend culturing embryos in the lab at 5 per cent oxygen to limit damage caused by oxidative stress, when harmful free radical molecules outnumber antioxidants. But some studies suggest lowering this to 2 per cent may be optimal.

To test this, Marisa Bartolomei at the University of Pennsylvania

“The mice born in the 5 per cent oxygen group had a lower birth weight than the 2 per cent group”

and her colleagues cultured mouse embryos at either 2 per cent or 5 per cent oxygen, before transferring them into mice’s uteruses, like with regular IVF. They then followed the offspring for 12 weeks after birth.

“Most studies looking at altering oxygen concentration and its impact on embryo

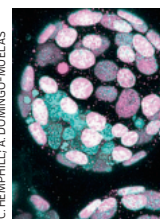
development have stopped at the termination of embryo culture,” says Sparks. “This goes so far beyond.”

The researchers found that the embryos cultured at 2 per cent oxygen more closely mimicked a third group of naturally conceived embryos than those cultured at 5 per cent oxygen. This included similarities in their epigenetic reprogramming, which describes how the chemical tags that switch genes on or off are reset to allow oxygen more development before implantation. Many of the enzymes involved in this process are sensitive to oxygen.

The team also observed that the embryos cultured at 5 per cent oxygen had more trophoblast cells, which help form the placenta, when in their blastocyst stage, when IVF-cultured embryos are transferred to a uterus. Too many of these cells may explain why the placenta can be thicker in

IVF pregnancies, which has been linked to a low birth weight, says Bartolomei. The mice born in the 5 per cent group had a lower birth weight than those in the 2 per cent group (bioRxiv, doi.org/rg58).

Although it is unclear how lower



C. HEMPHILL, A. DOMINGO-MULEJAS

Early-stage mice embryos developed in 2 per cent oxygen

oxygen levels may improve outcomes, Bartolomei says they could allow embryos to use energy in a way that more closely resembles development inside the uterus, where a blastocyst embeds in early pregnancy. Another possibility is that oxygen levels affect epigenetic reprogramming, she says. ■

Fashion

Clothes made from living fungi can repair themselves

A PARASITIC fungus that grows on caterpillars has been turned into a dress designed to be able to repair itself if damaged.

Using the fungus *Cordyceps militaris* as a base, Ke Li at the Chinese Academy of Sciences and her colleagues created a living textile that can be “programmed” with different properties using various microbial components.

It feels denser and less fibrous than cotton, says Li, and is closer to a soft, non-woven sheet or a flexible leather-like material. “After washing and processing, the material does not have a strong

mushroom-like smell,” she says.

The fungus is made up of thin filaments known as hyphae. Li and her colleagues first grew the fungus as small, spherical pellets in liquid culture, then washed them and placed them into moulds, where they formed a sheet.

To prevent the resulting textile from becoming brittle, it was soaked in glycerol, which acts as a “plasticiser”, making the naturally rigid fungal structure softer and more flexible (*Science Advances*, doi.org/rg7r).

To add colour to the material, the team introduced yeast cells that were engineered to produce orange, blue and purple pigments. “These cells can be applied to the fungal textile so that the colour is generated biologically, rather



KE LI

than through conventional synthetic dyes,” says Li.

The researchers also showed they could change the properties of the textile by adding other fungi, for example making it clean itself by

Fungus isn’t usually the material of choice for a fashionable dress

repelling water droplets. For UV protection, they added *Aspergillus niger*, a mould that grows on fruit and vegetables. This forms a dark layer on the surface of the material containing melanin pigment, which absorbs ultraviolet radiation.

If the textile is damaged, then wet fungal pellets can be applied to the area that needs repair and the fungus simply grows over the breach.

Li and her colleagues created a dress out of their fungal material, but so far no one has worn it. “We’ve treated it as a rather precious display piece,” she says. ■ James Woodford

Palaeontology

Sabre-toothed cats had bone-breaking teeth

Taylor Mitchell Brown



MAURICIO ANTONIO SCIENCE PHOTO LIBRARY

AN ANALYSIS of Argentinian megafauna remains reveals sabre-toothed cats could crunch through bones, reshaping views about their supposedly weak sabres.

The study focuses on the bones of several large South American herbivores uncovered from Salto de Piedra in Argentina. Prior work has uncovered the skeletons of an abundance of large animals from the site, including giant armadillos, mastodons and sabre-toothed cats like *Smilodon populator*. The site is one of the only robustly dated Pleistocene localities in Argentina.

Sabre-toothed cats – represented by the genus *Smilodon* – frequented the area between 22,200 and 13,300 years ago. Traditionally, these animals were thought to have weak teeth. The extra-long canines – which could stretch over 25 centimetres in length – were an evolutionary trade-off, the thinking went, that gave an added ability to puncture flesh but diminished durability if they hit harder bits of bone.

“Personally, I always found that interpretation difficult to accept,” says Federico Agnolín at the Argentine Museum of Natural Sciences, who wasn’t involved

Sabre-toothed cats were some of the Pleistocene’s top predators

with the research. “It seemed unlikely that such a large predator would evolve enormous canines only to avoid using them.”

In the new work, Yolanda Fernandez-Jalvo at the Museum of Natural Sciences in Madrid, Spain, and her colleagues analysed the megafauna’s bones for signs of predation. Their survey focused on two kinds of tooth marks across the bones: punctures and grooves. They measured the length, width and depth of the markings using digital calipers, then aligned the marks with known *Smilodon* teeth.

The results revealed that markings on several of the megafauna matched the cat teeth perfectly and that hard cortical bone, which comprises 80 per cent of bones, was broken (*BMC Ecology and Evolution*, doi.org/rgv3).

“The new evidence reinforces the idea that *Smilodon* was capable of penetrating cortical bone with its canines, leaving distinctive marks without causing apparent damage to the teeth,” says Agnolín. ■

Technology

Breathalyser can spot when you are burning fat

Linda Geddes

A HANDHELD breathalyser can now detect whether you are burning fat from a single exhalation.

When carbohydrate supplies run low, the body increasingly relies on fat for energy, converting some of it into molecules called ketones. This process also produces a molecule called acetone, which passes into breath.

Although breath acetone has long been used as a window into metabolism, measuring it has typically required bulky laboratory equipment. Blood-ketone tests are also widely used, but require repeated finger pricks.

Several companies have developed breathalyser-style devices that detect acetone, but accurately measuring the tiny amounts in exhaled breath is challenging. This is because humidity, variations in breathing technique and chemically similar compounds, including alcohol, can interfere with the sensors.

To overcome these problems, Andreas Güntner at ETH Zurich in Switzerland and his colleagues have combined an acetone-specific sensor with miniature filters that remove moisture and other interfering compounds. An accompanying smartphone app also guides users on the correct

breathing technique to capture acetone at the end of the third breath, when it most closely resembles levels in the bloodstream.

To test the device, which is commercially available under the name Nutrion, the researchers compared its readings with laboratory measurements of breath-acetone and blood-ketone levels in 12 volunteers, who had no known health problems, under a range of dietary and exercise conditions. They found that the device closely tracked both laboratory breath-acetone measurements and blood-ketone levels.

The researchers – some of whom are shareholders

“It was sensitive enough to detect subtle short-term fluctuations in metabolism”

or on the board of Alivion, a spin-off of ETH Zurich that makes Nutrion – also found that it was sensitive enough to detect subtle short-term fluctuations in metabolism, which is important because the body continually switches between fuels during everyday activities (*Device*, doi.org/rgrf).

“We were able to resolve even the finest changes in breath as someone started to burn fat,” says Güntner, who is an advisor to Alivion. “After more intensive exercise, we saw breath acetone increase, but if someone then drank a sugary drink or ate a carbohydrate-rich meal, we could see it immediately fall again.”

Such information could be useful when intermittently fasting or dieting, when the goal is to extend the periods during which the body burns fat. ■

The breathalyser comes with a smartphone app to record the results



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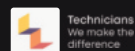
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Graham Lawton is a consultant for *New Scientist*. He is the author of *Mustn't Grumble: The surprising science of everyday ailments*. You can follow him @grahamlawton

Graham's week

What I'm reading

A book I've been asked to review. No spoilers!

What I'm watching

Season three of Tour de France: Unchained (*Netflix*)

What I'm working on

My topspin lob in pickleball

Age-defying supplements On the issue of supplements, Graham Lawton is a hardened sceptic – but a few studies are finding some could slow biological ageing

I'M A big fan of the *New Scientist* podcast *Change Your Mind*, on which my erstwhile colleagues Cat de Lange and Helen Thomson discuss "all the brain health advice you really need to know". In a recent episode, Cat and Helen invited JoAnn Manson, who is head of preventive medicine at Brigham and Women's Hospital in Massachusetts, to discuss her research on multivitamin supplements and brain health. She described how she and her team found that people over 60 who take a daily multivitamin show significantly slower cognitive decline and age-related memory loss over two to three years.

For me, that was a marmalade dropper. On the issue of supplements, I'm a hardened sceptic. My informed opinion is that very few supplements work. I make an exception for vitamin D because I live too far north to make enough on my own from the feeble winter sunshine. But once the clocks have gone forward, I stop taking it. I would also take folic acid if I were female and trying for a baby, long-chain polyunsaturated fatty acids if I didn't eat oily fish weekly and vitamin B12 if I were a vegan. But as for the rest, I don't waste my money.

For people who are willing to shell out for supplements, one of the thriving markets is in anti-ageing.

"At present using one or more nutritional and other supplements... is mostly an act of faith and hope"

Although very few if any have been scientifically validated, I'm a bit less sceptical. A few years ago, I took an anti-ageing supplement called alpha-ketoglutarate for six months for a story. I had my biological age measured before and after, and it went down. But that was hardly the same as clinical trial data.



GABE PALMER/ALAMY

Over-60s taking a daily multivitamin may age more slowly, biologically speaking

Of that, there is plenty, and it doesn't cast anti-ageing supplements in a good light. I found a gold mine of information in a recent academic book called *Supplements and Drugs for Healthy Longevity*. Under the guidance of the eminent biogerontologist Suresh Rattan at Aarhus University in Denmark, an expert panel rated the evidence for more than 250 compounds with supposed anti-ageing effects. These ranged from vitamins and minerals to traditional medicines, probiotics and hormone supplements, plus some much-hyped anti-ageing compounds. Interestingly, they didn't look at alpha-ketoglutarate.

None of them met the highest standard of evidence. A few reached a secondary level, but, on the whole, the authors recommend obtaining these compounds from food. "At present using one or more nutritional and other supplements... is mostly an act of faith and hope", rather than being based on strong evidence-based data, the book concludes.

But it also says that more research is needed. So, I had a look at Manson's. Her results come from a clinical trial she and her colleagues ran between 2015 and 2023 called

COSMOS. The trial recruited more than 21,000 people aged over 60 and gave one group of them a daily multivitamin plus cocoa extract, which contains flavonoid compounds thought to be beneficial for some age-related conditions. Other groups received just a multivitamin, just cocoa extract or nothing. The principal goal of the trial was to test whether the multivitamin/cocoa cocktail would reduce the risk of cardiovascular disease and cancer. It didn't, but the researchers still found nuggets of useful information in the data.

One of these was the effect on brain health discussed on the podcast. Another, which was published earlier this year, looked at the effect on ageing in general. A subgroup of 958 participants had their biological age measured at the start of the trial and then again two years later. Those who received the daily multivitamin aged, on average, more slowly than those who did not (the cocoa extract had no effect).

Another study adds weight to the idea that supplements can slow ageing. Last year, a team including researchers at the University of Zurich in Switzerland published a study on omega-3 fatty acid supplementation in people aged 70 to 91. Over the course of three years, the people who took the supplement aged biologically three months less, on average, than those who took a placebo. Adding vitamin D and strength training increased the benefit to four months.

So, have I changed my mind about supplements? Not yet. Both studies rely on measures of biological age, which can be unreliable. Neither found any meaningful change in the participants' health, and slowing biological ageing doesn't necessarily correspond to what really matters: an increase in healthspan. ■

To find out more about ageing, diet and supplements, turn to page 30

Trading knowledge A trip to an ancient Silk Road city highlights that people, not devices, are key to technological innovation – a lesson Silicon Valley could learn, says **Annalee Newitz**

I STOOD on the outskirts of ancient Samarkand in Uzbekistan, trying to figure out a path to the citadel. Back in the 7th century AD, this was one of the greatest trade cities on what is now known as the Silk Road, a grand network of trade routes connecting Asia to Europe. I would have entered via an opulent gate, flanked by guards and surrounded by a mass of visitors and traders from across Asia. The air would have rung with voices and smelled like smoke and spices. But when I visited, it was quiet.

From my vantage point, I could see a landscape of ridges and valleys covered in a thick layer of bright green grass and studded with rocky outcrops. At last, I spotted a faint trail leading to the distant outline of a flat-topped mound – the citadel – that once held the city's palace complex. I was there to research my next book, and found myself thinking about why cities of nomads were hotbeds of technological innovation. What could Silicon

Valley learn from Samarkand?

What was truly revolutionary about this city was its culture. For centuries, Samarkand was ruled by the Sogdians, a diasporic people who hailed originally from what is now Iran. As they settled across Central Asia, they took on traditions from China and the West. In a Sogdian city, you might see a Zoroastrian temple next to a Buddhist one, and scientific manuscripts and technology from the Arab world were traded next to Chinese silks and Turkish spices.

I passed by a ditch in the ground surrounded by eroded walls. This unremarkable spot was where archaeologists in the 1960s had uncovered a merchant's parlour. Its walls were covered in opulent frescoes, one of which dramatises a meeting between Samarkand's king and delegations from China, Korea, Turkey, India and more, each bearing gifts from their homelands. The Sogdians were a diverse society for both practical and aesthetic reasons. Their ethos might have been "the more the merrier". And the richer, of course.

Though we have these artistic representations, little remains of

the Sogdian palace on the citadel mound. It was obliterated over the centuries by multiple regimes that occupied it after the Sogdians fled the Abbasid Caliphate in the 8th century. As I approached its slope, however, it was easy to find bits of masonry and pottery that had been dislodged by rain and erosion. There have been only a few modern archaeological excavations in ancient Samarkand, and the place has many secrets left to reveal.

Still, this city has left us with a clear lesson about how trade enriched people's lives along the Silk Road. Samarkand certainly welcomed the goods that came through its gates, including novel weapons, chemicals and medicines. But historian Jenny Rose, author of *Zoroastrianism: An introduction*, points out to me that Sogdian cities grew rich because they opened their walls and homes to new people. The greatest asset to Samarkand wouldn't have been a collection of swords, but instead a trained sword-maker from abroad.

Wealth on the Silk Road came from people and their knowledge. The Sogdians became famous for their trained artisans, who came to town not only to sell objects, but to set up shops, training the next generation in the process. They shared expertise, and that made the whole world more prosperous.

As companies replace humans with automation, it is easy to forget that technology advances with humanity, not the other way around. But humans have always been more valuable than things. As we come into contact with new groups and ideas, we make incredible discoveries. We build on each other's wisdom and innovate together. Put somewhat more whimsically, the Silk Road wasn't ever just about silk. It was about the people we met along the way. ■



Annalee Newitz is a science journalist and author. Their latest book is *Automatic Noodle*. They are the editor-in-chief of *STARLOG* magazine. You can follow them @annaleen and their website is techsploitation.com

Annalee's week

What I'm reading

The Feywild Job by C.L. Polk. A delightful Dungeons & Dragons heist with a little bit of romance!

What I'm watching

The gradual erosion of quality weather predictions in the US, due to funding cuts in the sciences

What I'm working on

A book about ancient parties and celebrations, starring the Sogdians, among others



TOM NEBBIA/CORBIS VIA GETTY IMAGES

Travellers on the Silk Road traded all kinds of goods and ideas

AI's Goldilocks zone A study found that artificial intelligence can boost creativity when it's used in moderation. But what do we lose when we outsource our creative thinking, asks **David Robson**



David Robson is an award-winning science writer specialising in the extremes of the human brain, body and behaviour. His latest book is *The Laws of Connection: 13 social strategies that will transform your life*

David's week

What I'm reading

*I'm just settling into a proof copy of psychologist Vanessa Bohns's book *Should I Say Something?*, which is out in October. Bohns is a wonderful writer and an expert on social interactions, so I can't wait to get stuck in*

What I'm watching

*I'm loving Chris Packham's new series *Evolution* on BBC Two, and rewatching *Schitt's Creek* for light relief*

What I'm working on

I'm now deep in the writing of my next book. More soon!

"Mischa's parents are hosting their daughter's engagement party at their country mansion. As she makes a toast, her wine glass slips from her hand to reveal an object embedded in the stem – a tiny memory card. The discovery unravels a decades-old corruption scandal involving her own family, forcing her to choose between justice and loyalty."

I have just asked ChatGPT to create some concepts for a movie, based on the prompt "Her face went still as her eyes widened, watching the glass shatter on the floor", and this is one of its better suggestions. My aim is to develop a short outline of a plot within 30 minutes.

No, I don't have any serious aspirations to break into Hollywood. But I wanted to test out the findings of a recent paper by Hsuan-Che Brad Huang during his PhD at the University of British Columbia in Canada. Huang wanted to see whether AI can enhance our own creativity – and the answer depends on how much we use it. Too little or too much and our thinking suffers. In the "Goldilocks zone", however, it can inspire new ideas, while leaving us with a satisfying sense of ownership over the work produced.

Huang's hypothesis was based on the fact that human creativity

"I am worried about what the employment of AI might do to my long-term development"

is often limited by our experience, so it can be useful to hear other points of view. AI could also be a tool for getting a different perspective.

The technology has its limits, of course. Large language models, which are in essence statistical tools, often present a kind of "average response" to questions, without the idiosyncrasies of the human brain,



There are still countless artists and creatives who don't use AI while making their work

and they often absorb biases from their training data. Worse still, they can undermine our own feelings of competence, producing a kind of apathy. So Huang suspected that moderation was key – and he tested the idea in a series of experiments.

The first involved a classic test of creativity, in which around 150 participants were asked to help a student named Mike come up with a business, given just \$10 of seed funding. They were encouraged to first generate multiple ideas, before emailing Mike the best proposal.

Some participants were encouraged to use ChatGPT just once, others were recommended to use around four to six prompts and the rest were told to use it at least nine times. Their final ideas were then assessed by experts on novelty, utility and business value.

As predicted, participants in the middle group had higher average scores. Huang found the same results in a second experiment with a further 319 participants.

Finally, he surveyed professional fashion designers, visual artists, authors, animators, technologists and influencers. The participants rated statements such as "I use artificial intelligence to carry out

most of my job functions" on a scale of 1 (strongly disagree) to 7 (strongly agree). Based on their bosses' assessments, he found that those who reported moderate use of AI (around 4 or 5 on the scale) had the most creative ideas, like his experiments had suggested.

During my little experiment, I could easily see the advantage. I first asked the chatbot to think up 10 different ideas in diverse genres, before picking my favourite. I built on that idea and then asked the AI to offer a continuation of the plot.

The AI helped broaden the range of events that I was considering, but I had to use my human mind to keep the story coherent and to create a narrative arc. This almost certainly helped me come up with a more intricate plot than I could have on my own in the time that I had. But I still have reservations.

It isn't just the ethical issues I would have in trying to pass off an AI collaboration as my own work, and the risk of plagiarising others' work through the algorithm's suggestions, but what I think is lost when we outsource our thinking. I am worried about what the employment of AI might do to my long-term development.

In a recent study, currently under peer review, Grace Liu at Carnegie Mellon University in Pennsylvania and her colleagues have shown that people quickly become reliant on AI and less persistent in the absence of the technology. I doubt this is a permanent change, but still – I hate the thought that I am somehow setting myself up for lazy thinking in the future. Writing, for me, should be a continual learning curve.

This isn't to judge anyone who does choose to create with AI. I am sure many people can do so without stunting their intellect. But if genius really does involve more perspiration than inspiration, as the famous saying claims, I'd much prefer to sweat it out myself. ■

New Scientist



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In this latest instalment of our *How To Think About* series, we take a clear-eyed look at the latest developments in ageing research. Guided by the world's leading experts, we explore the discoveries behind the rise of anti-ageing drugs, uncover the most promising ways to ward off dementia, and reveal the evidence-backed habits that could help us live well into our 90s and beyond.

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“MOST people are completely unaware of what is in the water,” says Julian Cremona, a naturalist and photographer who is out to change that with his new book *Seashore Plankton*.

Plankton is an umbrella term for all kinds of different organisms floating in our waters, from plants, known as phytoplankton, to animals, known as zooplankton. They can be as little as 0.02 micrometres, the size of some viruses, or as big as 2 metres, the size of a large jellyfish. What they have in common is that they are unable to overcome the movement of water, unlike organisms that can resist the current.

Cremona’s book is a guide to the different types of plankton found along the British coast, such as the larva of a *Magelona* worm, just 2 millimetres in size (top middle). To take this photograph, Cremona fitted objective lenses from an old microscope to his camera.

To its left is a tiny zooplankter, *Oikopleura*. Its body is made up of a trunk on top of a long tail, and can range from a few millimetres to a centimetre in length.

A handful of compass jellyfish (*Chrysaora hysoscella*) are shown near left. The umbrella of this jellyfish can stretch to 30 centimetres in diameter.

Some phytoplankton exhibit symbiosis with jellyfish and sea anemones, such as the snakelocks anemone (*Anemonia viridis*), pictured lower far left. Single-celled *Symbiodinium* plankton live within the tissue of its green tentacles, performing photosynthesis and providing their host with carbohydrates. In return, the plankton receive inorganic carbon, nitrogen and phosphate – and a refuge in which to live. ■

Roberta Cojocaru

Infectious reading

First, Annie Jacobsen explored a fictional scenario for nuclear war. Now, she is looking at how the release of a bioweapon might play out. **Jacob Aron** digs in



Book
Biological War
 Annie Jacobsen
 Torva (UK); Dutton (US)

A HIGH-SECURITY laboratory in Siberia, Russia, contains one of the most disturbing memorials to a scientist in existence. In 1988, Nikolai Ustinov was injecting guinea pigs with the Marburg virus, a pathogen that causes uncontrollable bleeding and death. He accidentally pricked himself with the syringe, and knew instantly he was doomed. Two weeks later, after Ustinov died alone in a quarantined room, his colleagues harvested his organs and isolated a new, deadlier strain of Marburg that had mutated in his body. They named it Marburg Variant U, in his honour, and turned it into a weapon.

This horrifying story is one of many in *Biological War: A scenario* by Annie Jacobsen. The lab in question, the Vector Institute, is one of just two repositories for the deadly smallpox virus, which has otherwise been wiped off the

planet. The other is the Centers for Disease Control and Prevention in Atlanta, Georgia. Both play a key role in the book, a sequel of sorts to Jacobsen's horrifying *Nuclear War: A scenario*.

I read *Nuclear War* in a single sitting, late into the night. I was gripped and stunned by Jacobsen's excellent, minute-by-minute reporting of how a nuclear conflict could play out, informed by interviews with key scientists and officials. It is a truly great

“The Soviet Union went on developing deadly pathogens despite signing the Biological Weapons Convention”

book, if you can stomach it. In comparison, *Biological War* is merely a good book, one I read in a much more leisurely fashion, and so it comes with a much more caveated recommendation.

As Jacobsen explains, biological weapons are far more taboo than their nuclear counterparts, which are covered by an international treaty on non-proliferation, meant

to limit their spread rather than to force nations to disarm. By contrast, the Biological Weapons Convention, which came into force in 1975, prohibits any development, stockpiling or use. In theory, biological weapons shouldn't exist. And yet they almost certainly do.

Despite being a key signatory to the convention, the Soviet Union went on developing deadly pathogens. After the fall of the Soviet Union in 1991, Russia signed an agreement with the US and the UK to end its secret programmes and steer its labs to peaceful purposes. Yet US and other Western intelligence agencies believe Russia is still developing bioweapons.

The starting point for Jacobsen's scenario is an explosion at Vector, mirroring one that happened in 2019. While that real incident was thankfully free of biohazards, the fictional one releases a genetically engineered version of *Yersinia pestis* – the bacterium that causes plague. This strain has been spiked with a gene to release endorphins, encouraging its victims to socialise and spread the pathogen.

Jacobsen reports that, according to former US Army bacteriologist Henry Heine, such a weapon does exist. “When we first heard Soviet scientists were inserting the endorphin gene... into plague... we were appalled,” he told her. Heine would certainly be in a position to know, but this weapon's existence hasn't been previously reported, as far as I can tell, and this mention is Jacobsen's only source. It is true Soviet scientists experimented with combining genes from different pathogens to make a superweapon, but this specific blurring of a newly unearthed fact (the endorphin gene) and fiction gave me pause as I struggled to keep straight what was real. After finishing the book, I had



to confirm with Jacobsen that, yes, her fictional bioweapon is based on one that was really created.

In her scenario, this single outbreak leads to the bacteria spreading globally. The result is essentially the covid-19 pandemic on steroids. If you cast your mind back to the early 2020s, you may recall constant discussion of the R number, the average number of people a single infected person will infect. The first variant of SARS-CoV-2, the virus behind covid-19, was estimated to have an R of around 2.5, although later variants were more infectious. Jacobsen gives her bioweapon an R of 11, making it far more virulent, and much more severe symptoms.

Unfortunately, parallels with the recent pandemic overshadow much of the book. In some ways, this is unavoidable. While almost no one alive has experience of nuclear weapons, practically all of us know what it is like to live in fear of a widespread deadly

Two great reads on pandemics: fiction and fact



The Stand
 by Stephen King

Stephen King's post-apocalyptic doorstopper is a classic for a reason. The US accidentally releases a weaponised flu virus, killing most people. We follow disparate groups of survivors and the rise of a supernatural villain.



Vaxxers: A pioneering moment in scientific history
 by Sarah Gilbert and Catherine Green

For a more positive outlook, read this inside story of the development of the Oxford-AstraZeneca covid-19 vaccine, written by two of the researchers who helped to bring billions of people out of lockdown.



James Woodford
Reporter
Sydney

Imagine waking up and finding yourself in a tiny space capsule. Oh, and the moon outside your window looks disconcertingly large. No wonder NASA has thought carefully



about how it rouses its astronauts, including the crew of Artemis II (pictured).

Its first known wake-up song was in 1965: a parody of *Hello Dolly* (*Hello Wally*, sung by Jack Jones) for the Gemini 6 crew, Wally Schirra and Tom Stafford. Other songs over the years have included *Rocket Man*, *Space Oddity* and real surprises like *Hawaiian War Chant*.

I'm currently listening to some of the **Artemis II wake-up playlist**. On high rotation is *In a Daydream* by the Freddy Jones Band from 1993. The crew woke up to it on day three of the mission.

The reason I enjoy the playlist is it says more about the crew as people than as astronauts. Artemis II showed not just that we can all aspire to great exploration, but that the best human endeavours begin with waking up better.

JOSHUA L. CARLSON/ASA/JOHNSON SPACE CENTER



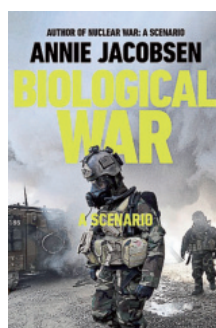
TEK IMAGE/SCIENCE PHOTO LIBRARY/ALAMY

pathogen. But Jacobsen makes strange choices that puncture the reality of her scenario, which occurs in a post-covid world.

One of the first superspreading events occurs on the Diamond Princess cruise ship, as happened with covid-19. The plague also copies the pandemic by popping up on the USS Theodore Roosevelt. Jacobsen's fictional US president occasionally speaks like Donald Trump and is even depicted watching a documentary about his wife, in a nod to a film about Melania Trump released earlier this year. None of this feels necessary.

The biggest problem, however, is what Jacobsen calls "the Covid origin story fiasco", a dispute that "unravels the fundamental concepts of truth and of science". Here, Jacobsen and I must agree to disagree. We may never know the true origins of SARS-CoV-2, but the idea it was released from a Chinese lab (accidentally or intentionally) has no basis in science.

There should be no debate about this, and yet many US intelligence organisations, from which Jacobsen draws a lot of her sources, believe otherwise. The CIA and FBI have called a lab leak the "most likely" explanation for the pandemic, for example. Some people in US intelligence also believe aliens have visited Earth, and that improbable microwave weapons are being deployed in Cuba, so you will forgive me if I don't hold their



Despite a global ban, bioweapon research is probably still happening

scientific chops in great esteem.

I asked Jacobsen whether she believed that a lab leak or natural spillover from an animal (the leading scientific explanation) was responsible for the covid-19 pandemic. "I leave that conclusion up to readers to decide," she says. But if that were her intention, it wasn't the impression I got from the book, which constantly leans towards a lab leak. When the fictional US president's advisers convene their initial meeting to respond to the Vector explosion, Jacobsen writes: "Mistakes made during the [covid-19] pandemic cannot happen again. If something managed to escape from this lab, it must be stopped before it spreads." The fictional Russia releases a statement with "almost identical phrasing" to that used by real Chinese health officials when first announcing the illness we now call covid-19.

Such "vague declarations" are a "disinformation signature" in intelligence parlance, writes Jacobsen, "designed to mask or reshape the truth about an event".

While reading the book, the phrase "difficult second album" kept circling my mind. This is grossly unfair: Jacobsen is a highly experienced, Pulitzer-shortlisted journalist with over half a dozen books to her name. But with *Nuclear War* being such a success, I wonder whether *Biological War* was published before it was fully developed. It can be repetitive and could use an edit. The fictional aspects feel less real than in the previous book and, at times, the factual elements feel concerningly fictional. It's a good read, but it isn't going to keep you up all night. ■

Signs of life

Did the samples gathered by the Viking landers of the 1970s actually find life on Mars? **Paul Marks** is glued to an expert rethink



Book

Meet the Neighbors

Steven A. Benner

Allen Lane

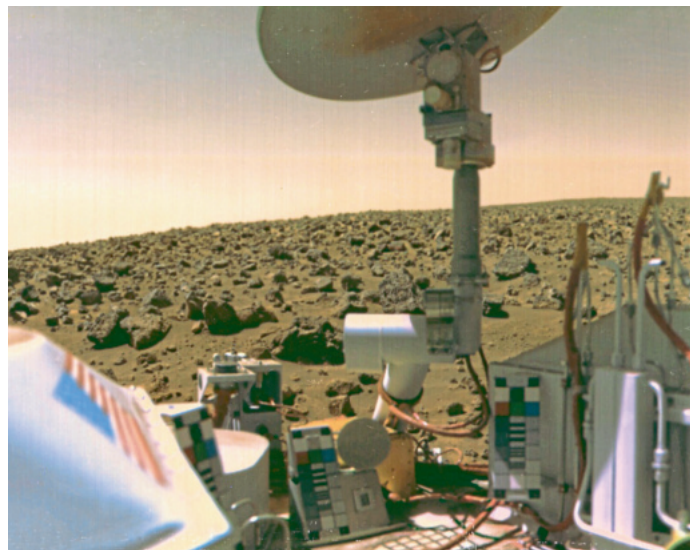
FIFTY years ago last month, a life-detection test developed by Gil Levin, a NASA investigator and an engineer schooled in sensing dangerous microbial colonies in sewage, landed on Mars. It was on board Viking 1, the first of two life-seeking landers.

Amazingly, both of the landers succeeded straight away. Levin's test, alongside two others, quickly gave what planetary scientists call strong "life affirmative" results.

This should have been a triumph for Levin and NASA's Viking team. Unfortunately, a consensus developed within the Mars-exploration community, making it fearful of anything so bold as to claim the discovery of alien life so soon. A negative interpretation of the results prevailed, which pulled the rug from under Viking's finding that, on the balance of evidence (and within the experiment's definition of life), there is life on Mars.

Worse, this propagated down the decades to influence Mars-exploration policy even today, despite the fact that findings by the Curiosity rover (which landed in 2012) should have corrected it. The result: since Viking, space agencies have run timid missions in search of signs of ancient life, past habitability and water, rather than bold missions to find existing life.

This is the core argument of *Meet The Neighbors: Life on Mars and how to find it*, a captivating tale of misunderstood (if not actually gamed) planetary biochemistry, and its impact. Its author is Steven Benner, an



Chryse Planitia, the plains of gold, snapped by the Viking 1 lander in 1977

astrobiologist, organic biochemist and synthetic biologist, whose team at Harvard University was the first to synthesise a working, protein-encoding artificial gene.

Benner reveals what the Viking tests found, and why they were so vulnerable to dismissal by naysayers, by undertaking a fresh analysis of the raw data and the research published on the results at the time. Then, pleasingly, he demolishes those arguments.

"The error influenced Mars exploration policy even today, despite findings by the Curiosity rover"

It all seemed so cut and dried at first, with Robert Jastrow, then director of NASA's Goddard Institute for Space Studies, quoted in *The Atlantic* magazine as saying: "Short of seeing something wiggling on the end of a pin, the case for life on Mars is now as complete as the Viking experiments could make it."

Benner goes into detail on the

three life-detection experiments, including the controls run to rule out chemical, rather than biological, action. Levin's "labelled release" experiment fed radiocarbon-tagged nutrients like formic acid, glycine and lactic acid to a sample of Martian soil, which then released radioactive carbon dioxide, "indicating the presence of respiring microbial life", he writes.

A second test found that the carbon from radiolabelled carbon monoxide and CO₂ could be "fixed" into the molecules of the organic materials in the Martian soil. This was deemed analogous to how plants on Earth fix CO₂ in photosynthesis and thus "evidence of an active Martian biosphere". In the third test, water was added to Martian soil, producing a significant amount of oxygen and an "exchange of CO₂ with the soil", supporting the existence of bioactive soil on Mars.

But all three "life-positive" results fell after the gas chromatography-mass spectrometer (GC-MS) on the landers found no evidence of any

organic content in the Martian soil where Viking 1 touched down, at Chryse Planitia, or on soil where Viking 2 landed, at Utopia Planitia, 6460 kilometres away. As a result, an unknown oxidising surface chemical, rather than a microbial life form, was put forward as the explanation and accepted by the Mars-exploration community as the source of life-positive results.

It was all tosh, says Benner.

First, it turned out the GC-MS was nowhere near sensitive enough to pick up organics. NASA's Curiosity rover discovered the Martian surface is full of organics – notably perchlorates – so the GC-MS results could be discarded. Mars, says Benner, is alive again, a bold claim well supported by this absorbing, convincing book.

Space agencies should now harness the economics of reusable rocketry to mount searches for existing life on Mars, says Benner. He argues they should focus on microbes that might have RNA-based building blocks – a theory he has honed with his research on artificial genes and the fact that ribose has been found in samples from the asteroid Bennu.

Viking's resurrection would have pleased the late Levin and his late NASA collaborator Patricia Straat for another reason. Both founded a pressure group that still campaigns for samples to be analysed off-Earth to maintain planetary biosecurity. As China plans to deliver Mars samples to Earth in 2031, *Meet the Neighbors* brings that issue into sharp relief. ■

Paul Marks writes about technology, aviation and space. He is based in London

Champagne supernova

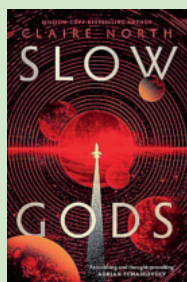
Slow Gods, an elegant and big-concept space opera, is one of our most popular books yet with book club members, says **Alison Flood**



Alison Flood is head of books and culture at *New Scientist*, and runs the monthly New Scientist Book Club



Book
Slow Gods
Claire North



THE New Scientist Book Club has spent July reading Claire North's space opera *Slow Gods*. Set in the far future, it follows the fortunes of a civilisation that has learned that their planet will be destroyed by a supernova – in 100 years' time.

"What does it mean to look into the heavens and know the exact date when a star will die and with it, your world?" North wrote in a fascinating essay for book club members on why they started the book with this conceit. "What choices do you make, and what price would you pay to save yourself – or your civilisation?"

Alongside this end-of-the-world tale, *Slow Gods* is also a love story between North's protagonist Maw, a pilot who can navigate the dangers of faster-than-light travel but who is a little prone to murdering people, and Gebre, a citizen of that planet on the brink of annihilation, Adjumir.

I was enraptured. North's writing was elegant, insightful and effortlessly funny. And the concept at the heart of the story, the idea of how a civilisation might deal with imminent, but not all that imminent, destruction? It was fascinating and terrifying. As North told me in our interview for book club members, this is a deliberate parallel with climate

change. "Subtle metaphor it is not," they said.

Slow Gods is, I think, one of our most popular books yet with members. "The writing is gorgeous, and it has the big concept space opera feel that I really like," wrote adidubey on our Discord channel. "One of the more satisfying reads we have had," added Matthew.

I did find the opening a little slow to get going, which is often

"What does it mean to look into the heavens and know the date when a star will die and with it, your world?"

a problem for space operas, as the writer looks to set their galactic scene. Butterfly368 was with me on this: "The beginning was a bit slow and confusing, but the deeper I got, the more invested I became. It's one of those books that gradually pulls you in rather than grabbing you from page one," they wrote. "I'm also enjoying its commentary on the meaning we create in our lives and on society and culture more broadly. It's given me quite a bit to think about."

Barbara Howe compared it with some of her favourite reads.

"Reminded me a bit at the start of [Ann Leckie's] *Ancillary Justice*," she wrote. "Also, whenever [Maw] talked about having trouble with social situations and understanding his feelings, I was reminded of Murderbot 'having an emotion'."

North, incidentally, had some interesting things to say in our chat about Maw's struggle to fit in; he "is the protagonist you write when you are an adult diagnosed with autism late in your life", they told me. North and I also dug into the multiple pronouns used in this story. "People exist on a spectrum," said North in our chat. "In the English language, we may still only really have 'he' and 'she' as the commonly accepted expression of gender, but that spectrum is enormous... [it] feels too big for 'he' and 'she' to actually cover."

Alan_P was another big fan: "For me it's the very clever way that the author has woven these different themes of not quite required love, galaxy spanning science fiction, commentary of contemporary events and a really good story that makes it one of my favourites in a good while." A success, then! ■

You can find Claire North's essay and interview at newscientist.com/bookclubextras

What we are reading in August



The Dog Stars Peter Heller

We're moving back to Earth for our August read, albeit an Earth that looks very different to today, in Peter Heller's *The Dog Stars*.

This post-apocalyptic novel about a man and his dog at the end of the world, when a super-flu pandemic has killed most

of humanity, has just been adapted for film – starring Jacob Elordi as Hig, that lonely man. It's due to hit cinemas at the end of this month: the perfect time, then, to get to grips with the original, so we can see if director Ridley Scott does it justice.

To get book club members reading,

we have an extract from the novel's start, as well as an essay from Heller, in which he discusses how he wrote the novel eight years before covid-19 shut down the world. These will be available at newscientist.com.

[com/bookclubextras](https://newscientist.com/bookclubextras) from 31 July. In mid-August, I will be chatting with Heller – join our Discord community online at bit.ly/4ewuwoy to share your questions and discuss the book. Happy reading!



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Editor's pick

Overly monitoring your health may backfire

11 July, p 32

From Dyane Sylvester,
Arnside, Cumbria, UK

So many studies you report on seem to conclude that stress is a significant contributor to all manner of ills, such as dementia, cardiovascular disease and some cancers, but a few lifestyle choices can at least partly mitigate this.

Has anyone done a study into the detrimental (or indeed beneficial) effects of fretting constantly about your diet, exercise levels, alcohol consumption and sleep quality? It strikes me that the current fad for determining the health or "physiological age" of various organs, and constantly testing or monitoring ourselves with smart devices, may be a cause of high stress levels in people who end up worrying about how healthily they are living. Surely it would be beneficial to simply chill out a little more and thus remove at least one source of stress.

Questions over collapse of Thwaites glacier remain

4 July, p 36

From Jim McHardy, Clydebank,
West Dunbartonshire, UK

Your article on the impending collapse of Thwaites glacier mentions large rises in sea level by the end of the century, under some projections.

In the late 1950s and 60s, I remember thick layers of snow on our pitched roof. Even when it was very cold, water continually dripped from underneath, presumably having melted from the heat of the house. This is much like ice at the base of glaciers, which is also partly melted by heat conduction from the ground underneath adding to meltwater from the surface.

In our home, without any warning, the whole sheet of snow on our roof would slide off in one

large piece, taking a few seconds. If the snow avalanche on our roof is extrapolated to the world's ice sheets, perhaps they will collapse far quicker, rather than over decades, as suggested?

From Susan Williams,
Lakewood, Colorado, US

I've seen a lot of information about modelling of sea-level rise caused by ice melting, but has anyone calculated whether the shifting of the weight of all that ice and water from one part of the globe to another will have an effect on Earth's axis or rotation?

Consciousness is quantum on at least one key level

25 July, p 6

From Sam Edge,
Ringwood, Hampshire, UK

Once again, the idea that quantum effects may play a role in consciousness is being discussed. I like Emily Adlam's reasoning that consciousness can't be purely a quantum phenomenon, but the central nervous system is electro-chemical in nature, and electricity and chemical reactions rely on quantum effects, so the brain is definitely quantum at a very basic level, as is everything else in the universe as far as we know, possibly excepting gravity.

We need more research on post-menopause health

11 July, p 5

From Janet Wildgoose,
Banstead, Surrey, UK

I found Starre Vartan's article on how ovaries trigger inflammation after menopause fascinating, and I look forward to reading any further research in this area. I developed vitiligo two years after menopause and Graves' disease

a year later, with no family history of either. Considering the amount of autoimmune conditions in this age group of women, I am really pleased research is being done with this link in mind.

Could a new particle explain old black holes?

27 June, p 19

From Alan Hewer,
Seaford, East Sussex, UK

In her article, Leah Crane speculates on the origin of primordial black holes. It seems to me that we have a ready-made source for them: the state of things before the big bang.

Here, we have an object of unimaginable density for which we have no physics. Scientists have already posited a totally imaginary particle, the "inflaton", to account for the universe's homogeneity. So why not go one step further with the "bigbangion", formed under near-infinite pressure and capable of shattering the primordial fireball into countless black holes?

An alternative reason for marker misalignment

27 June, p 13

From Keith Hewett, Bristol, UK

I was interested in your article on a solstice marker predating Stonehenge by 500 years. The 1-degree misalignment was put down to the fact that the posts may have been up to 50 centimetres across.

But there is a simpler explanation: if you are digging pits to place posts, you don't need to be as accurate with their placement as you do with the posts. It is easier to align the posts once the pits are made. Once grass has grown over, it doesn't matter if the posts aren't quite central.

Another easy way to store energy at home

4 July, p 10

From Richard Grimmer,
Trowbridge, Wiltshire, UK

Household batteries are a great idea, but there is already a quicker, easier way to make a big dent in emissions and give instant savings to both renters and homeowners. Many houses have hot water tanks. These could be heated with cheap, renewable, nighttime electricity, instead of by burning gas. A 200-litre tank could store several times more energy than an energy supplier's plug-in batteries.

All that is needed is an import tax providing cheap electricity to heat a tank of water overnight, plus a plug-in timer for the immersion heater. The instant savings would appeal to climate sceptics, and the simplicity could draw in those reticent to make big changes. And the only cost would be the plug-in timer!

Snoring may have put off predators, not just spouses

4 July, p 30

From Tim Foresman,
Elkridge, Maryland, US

It is interesting to consider how our ancestors survived while sleeping, what with predators running about. I can't be the only one to view snoring as a major survival adaptation for our species. Other than negatives of tired spouses and the spread of CPAP devices, snoring with a group in a cave or under the stars would present a positive and substantial alarm to predators to steer clear, lest they suffer sharp sticks and heavy stones. ■

For the record

■ The next men's FIFA World Cup will be held in Portugal, Spain and Morocco in 2030 (Leader, 18 July).

■ In the Plus Side puzzle, the bottom row should sum to 13 (18 July, p 43).



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JASON RAISH

Eat your age

As you get older, your body's response to food changes.
Switching up your diet could add years to your life,
discovers **David Cox**

BRIMMING with the sense of invincibility that imbues twentysomethings, I once thought little of dining on kebabs and burgers. A decade or so later, I have changed my tune, acutely aware of the need to take the ageing process more seriously.

The foundations for a healthy life are laid down during childhood and adolescence. But rather than being written in stone, evidence is increasingly showing that our nutritional needs change with every passing decade.

In particular, from 40 onwards, our diet needs to be fine-tuned to support the changing needs of our body. "Every single bite or calorie has to work harder," says Deirdre O'Connor, a research nutritionist at Trinity College Dublin. And just eating a healthier diet may not be enough – there are specific nutrients that must be consciously targeted in midlife and beyond. So, here's how to turbocharge your diet throughout adulthood – and the earlier you start, the greater the rewards, with the potential to add a decade to your life.

Our bodies are far better at coping with a subpar diet in early adulthood. In our twenties and thirties, we have more lean muscle, which enables us to soak up excess blood sugar, and our organs are at their most robust at clearing away toxins.

But as the years go by, these finely tuned systems begin to wane. Our mitochondria – the bean-shaped batteries within our cells responsible for turning food into energy – work less efficiently. The gastrointestinal tract becomes less adept at absorbing crucial vitamins and minerals, and we become more prone to losing muscle and accumulating problematic "visceral" fat around organs and deep in the abdominal cavity.

"Visceral fat is the underlying cause of chronic inflammation, which is a root cause of diabetes, cardiovascular disease and even some cancers," says Frank Hu, who specialises in nutrition and epidemiology at the Harvard T.H. Chan School of Public Health.

To mitigate these changes, diet takes on ever greater importance. "To counter inflammation, you need anti-inflammatory nutrients," says Hu. "We know some nutrients – such as omega-3s, high amounts of fibre and certain minerals like potassium and magnesium – have anti-inflammatory properties."

This can have a massive impact, as demonstrated in studies that follow people's health over many decades. For instance, last year, Hu, together with Anne-Julie Tessier at the University of Montreal, Canada, and their colleagues, analysed data from more than 100,000 adults over the course of 30 years to uncover the dietary patterns associated with healthy ageing. They found that what you eat at 40 is strongly linked to your quality of life aged 70. Those who ate the most fruits, vegetables, whole grains, legumes, nuts and healthy fats were far more likely to be faring better at age 70, both physically and mentally, than those whose diets contained lots of sugary drinks, saturated fats and red or processed meat.

Likewise, a 2024 study led by Lars Fadnes at the University of Bergen, Norway, modelled how dietary changes in adulthood might affect longevity using data from seven countries, including the UK and the US. This found that if people aged 40 started eating more whole grains, legumes and nuts, while also consuming less sugary food and drinks and less red and processed meat, their life

expectancy could be extended by anywhere from six years to almost a decade.

"You need to be thinking about improving your diet and lifestyle... ideally by 40," says gut scientist Paul O'Toole at University College Cork in Ireland. However, it's never too late. Fadnes's modelling studies show that even those aged 60-plus could gain extra years by adopting healthier eating habits.

But it isn't just the cumulative effect of healthy eating over the years that counts. Physiological changes during adulthood mean that, with every passing decade, our diet and the nutrients it provides take on increasing importance.

You are what you eat

This is because, from our fifties onwards, our body's requirements for practically everything go up – from protein and fibre to almost all micronutrients, including magnesium and B vitamins. Take calcium, for example. Assuming a daily consumption of 2500 calories, a 19-year-old man requires around 921 milligrams of calcium, but a 70-year-old needs 1573 mg and a 90-year-old could do with 1696 mg.

Likewise, while a 19-year-old woman consuming 2000 calories per day requires about 70 mg of vitamin C, a 51-year-old needs 82 mg and a 70-year-old requires 101 mg. Failing to meet these increasing requirements can lead to the development of multiple micronutrient deficiencies and the onset of frailty, say O'Connor.

At the same time, our appetite tends to decline over time, meaning many over-65s end up eating less overall. One explanation is that our metabolism – the rate at which our ➤

bodies burn energy – experiences a sudden decline around the time of our 60th birthday, having remained stable throughout our adult lives (see “Feeling the burn?”, below). This means that, to achieve optimal health, there is less and less space for lower-quality foods.

“You actually need to get more [nutrients] from what you’re eating [in later life], because your appetite decreases,” says O’Connor. “You have to pack in the same or greater nutritional load into a smaller volume of food.”

So, how do we go about achieving that? If you are going to make one dietary change in your middle years, there is a reasonable case to be made for eating more whole grains, a group of foods that includes brown rice, oats, whole wheat and quinoa.

A key reason why is their high fibre content. “Globally, inadequate fibre consumption, driven largely by low intakes of whole grains, is among the leading dietary contributors to disease burden and premature mortality,” says Tessier.

While fibre-rich diets are linked with a lower risk of numerous conditions, from stroke and coronary events to colorectal cancer, studies show that almost all of us – from adolescents to the over-65s – fall far short of the recommended intake.

Consuming more fibre helps maintain the health of both our gut microbiome and, in turn, our immune system. In at least some of these cases, this has been directly linked to a continued high fibre intake well into later life. The benefits of maintaining a healthy gut microbiome may be related to the gut’s role



VICTORIA SKORKOVAGETTY IMAGES

in synthesising vital micronutrients for physical and mental health, such as B vitamins, and converting chemicals from plant foods into useful substances.

Again, making a change in midlife appears to be key. A 2025 study of more than 47,000 women in the US who took part in the Nurses’ Health Study found that those who consumed more fibre in their forties were more likely to stay healthier into their seventies, eighties and beyond.

In Hu’s opinion, the biggest issue with heavily processed foods is that they are typically depleted of fibre, as well as lacking in a number of key vitamins and minerals. He points to minerals like zinc and

Eating more fibre and omega-3s can help with healthy ageing



IAN SHAW/LAMY

magnesium, found in many whole grains, nuts, seeds and legumes, which can negate underlying changes that begin to play out in the body through midlife and beyond.

For example, these two micronutrients can help the body to respond appropriately to glucose, with too little magnesium in particular being linked to the development of insulin resistance – where the body’s cells become insensitive to the hormone and have trouble absorbing sugar from the bloodstream. This is associated with an increased risk of type 2 diabetes, says Hu. “That’s why we need to eat a diet rich in magnesium.”

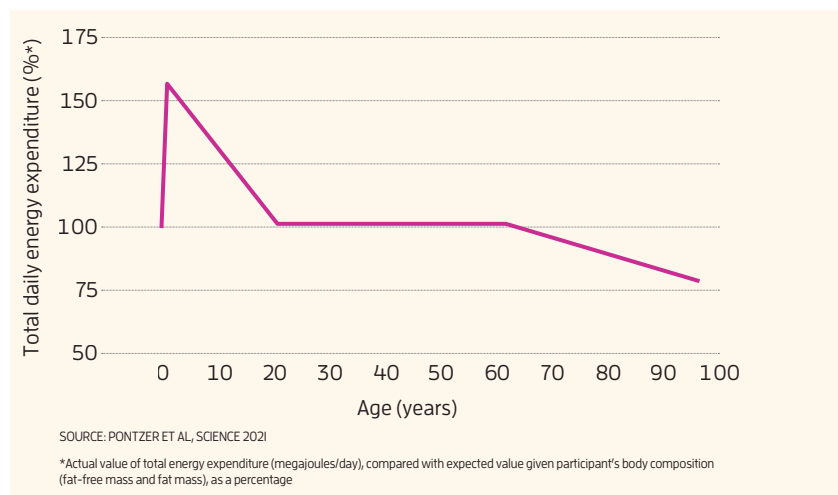
Immune boosters

Other shifts happen to our bodies in midlife, with the first wave characterised by a declining ability to metabolise fats, alcohol and caffeine. The second wave includes a diminished ability to process carbohydrates and declining kidney and immune function, with the latter change potentially explaining the increased levels of chronic inflammation that occur with age. Likewise, another study from last year, which examined signalling patterns between brain regions, found that brain ageing seems to particularly accelerate between the ages of 44 and 67, perhaps driven by insulin resistance, which impairs the ability of neurons to use sugars as an energy source.

Again, certain minerals may help. Hu points to selenium, which has been shown to be beneficial for both the brain and the immune system, prompting immune cells to resolve inflammation rather than promoting it. Your required selenium can be obtained through snacking on just one or two Brazil nuts per day.

Feeling the burn?

In adulthood, our metabolic rate is stable from the age of 20 until around 60, when it begins to decline



“What you eat at 40 is strongly linked to your quality of life aged 70”

Another key nutritional crunch point comes during perimenopause, the transitional stage before menopause where the production of hormones like progesterone and oestrogen begins to decrease. So, to prevent deteriorating bone quality, fractures and osteoporosis in later life, there may also be a preventative role for dietary calcium.

“The menopause transition completely transforms the nutritional landscape,” says O’Connor. “The decline of oestrogen means that bone tissue is being broken down faster than it’s being replaced. So your calcium requirements go up, while your body’s ability to absorb calcium efficiently is declining at the same time.”

Research suggests that women should begin to increase dietary calcium in their forties, and after the age of 50 they should aim to consume 1000 to 1200 mg per day. Calcium-rich foods aren’t just confined to dairy products – they also include vegetables such as broccoli (containing 112 mg of calcium per 120-gram serving) and canned sardines (240 mg of calcium per 60-gram serving).

Around the same time of life, everyone needs to start becoming wary of dwindling reserves of vitamin D, a micronutrient that is also vital for the immune system and bone health. Without it, the body can absorb only 10 to 15 per cent of the dietary calcium we consume.

We get a large proportion of our vitamin D from the sun’s ultraviolet rays, but even the most ardent sun worshippers find it steadily harder to acquire enough vitamin D as they age. This is because the ageing skin becomes less efficient at converting sun exposure into usable vitamin D, while the small intestine’s

ability to absorb the amounts of it present in dietary sources like fatty fish and egg yolks diminishes.

As we get older, we also need to be taking in more protein, although there are certain nuances to this.

Over time, our bodies become less efficient at turning dietary protein into new muscle tissue, a biological process known as anabolic resistance. This has led various researchers to argue that we need to respond by consuming more protein in our later decades to prevent weakness and loss of independence. The UK’s National Health Service recommends that a typical adult consume 0.75 g of protein per kilogram of body weight each day. For someone weighing 75 kilograms, that works out to 56 g of protein a day, or roughly the amount in one chicken breast. However, some researchers have suggested that a daily intake of between 1.2 and 1.6 g per kg of body weight may be optimal, combined with strength training, to support muscle maintenance as we age.

Yet it increasingly appears that it isn’t just the amount of protein that might be crucial,

but the type too. Earlier this year, Caitlin Andrews, a nutrition researcher at the University of Sydney, Australia, and her colleagues carried out a study where 104 people aged between 65 and 75 were assigned to one of four different diets over the course of a month, with their biological age calculated before and after based on 20 different biomarkers in the blood. The results revealed that those who cut back on dietary fat or reduced their intake of animal protein in favour of more plant-based protein sources displayed signs of slower ageing.

There are likely to be a number of reasons why. Processed meats, for example, are notoriously high in sodium, which may accelerate kidney ageing. “Excess sodium raises blood pressure and can burden the kidneys,” says Tessier. “As kidney function naturally declines with age, limiting these dietary stressors may be especially important from midlife onward.”

Andrews also points to the composition of meat, combined with the general need to cook it, both of which can exacerbate underlying ageing processes. Red meat is not only high ➤





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Maintaining muscle as we age gets harder, affecting our metabolism

in saturated fat, which has been shown to drive inflammatory processes in the gut, but we often like to grill or barbecue it, cooking methods based around dry heat. These drive the formation of advanced glycation end products, toxins that are thought to increase the burden of stress on our cells.

But we don't necessarily need to cut out animal protein entirely. Instead, shifting the balance could make a big difference. "In the US, the typical animal protein to plant protein ratio in most diets is 2:1," says Hu. "What we've found is that if you can change it to [close to] 1:1, you have improved cardiometabolic health and decreased risk of heart attacks."

Hu thinks that increasing not only plant proteins in our diet, but fatty fish too, is the healthiest way to meet the body's greater protein requirements in later life. Seafood has emerged as a topic of increasing interest to ageing researchers, as it delivers high concentrations of omega-3s – healthy fats that appear to play a role in preserving muscle health.

Consuming 1 g of omega-3s per day – equivalent to a single mackerel or two salmon fillets – for several months has been shown to slow biological ageing. Higher doses might be even more beneficial. Oliver Witard at King's College London, who specialises in exercise metabolism and nutrition, and his colleagues have shown that high doses of omega-3s – between 2 and 5 g per day for a short period of time – can even reverse some of the signs of anabolic resistance. These nutrients have

a particularly potent role to play in over-50s who have begun losing muscle tissue, he says, because they seem to restore the sensitivity of muscle cells to the amino acids within protein. "I think the positive effects of omega-3s on muscle are likely more pronounced in older versus younger adults," says Witard.

But not everyone likes fatty fish, and eating enough of it to get sufficient omega-3s into the body isn't always easy. So, could supplements play a role? This is a key question, but – as with many questions around supplements – one that isn't straightforward to answer.

Because our requirements for different micronutrients increase as we get older, JoAnn Manson, a physician and head of preventive medicine at Brigham and Women's Hospital in Massachusetts, believes there is a role for multivitamin and multimineral supplements in the over-60s.

As we get older, our skin becomes less able to make vitamin D from sunlight



MATT MANSON/MILLENNIUM IMAGES, UK

"You need to get more nutrients from what you're eating in later life"

Manson led the COSMOS-Web study, one of the few large-scale randomised controlled trials of supplements, which followed 3562 older adults in the US. In 2023, it found that daily multivitamin use could slow age-related memory loss and improve various other measures of cognitive function in this population.

The positive outcomes could mainly be down to multivitamins and multimineral rectifying dietary deficiencies. Manson also warns that supplements have their limitations and people shouldn't rely on them at the expense of eating well. "They act as a form of insurance to ensure adequate intake of these individual vitamins and minerals, because of this problem with decreased absorption and increased requirements at older ages," she says. "But you're not going to achieve optimal health by throwing a multivitamin at an unhealthy lifestyle."

So while some supplements may help, the evidence points to the importance of ensuring that your diet is ever more nutritious as you pass through the decades.

As someone who has always craved fattier foods, snacks and takeaway meals, my own diet has undergone a rather drastic shift over the past three years. As the milestone of my 40th birthday draws ever closer, I have realised that, from now on, it's time to double down on good nutrition and give my body a helping hand. ■



David Cox is a science writer focusing on health. He is the author of *The Age Code: The new science of food and how it can save us*

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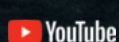
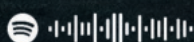
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Death in paradise

Rats are a scourge on island wildlife all over the world, but one project is showing how to gain the upper hand, finds **Clare Wilson**

THOUSANDS of screaming seabirds wheel through the air above and below me as I lean over the railings of a viewing platform halfway down a cliff. The chocolate backs of guillemots are packed so closely on the sheer rock face before me that they seem part of it. Higher up, on precarious ledges, they jostle with fulmars, kittiwakes and puffins, guarding their chicks and waiting for food from their mates.

It's a wonderful sight, and one that draws in plenty of tourists. But it is not just the birds – much as I love them – that have prompted my trip to Rathlin Island in Northern Ireland. It is another animal that is really responsible for me being here, one that tends to evoke quite different feelings in the human psyche: the rat.

Rats are a huge threat to the seabirds on Rathlin, and the same is true on many islands across the world, where they, and other invasive predators like stoats and cats, eat eggs and chicks. There is now a growing movement for humans to step in and save the birds by killing all the rats. Predator eradication is difficult, but it is “one of the most powerful conservation interventions possible”, says conservation biologist James Russell at the University of Auckland in New Zealand.

Now, the strategy is being applied to Rathlin, one of the largest and most populated islands on which it has been attempted. Success isn't guaranteed, but it is going well so far, thanks to a campaign involving lethal traps, poison, thermal drones and even a sniffer dog. I have

come here to investigate what happens when you try to rid an island of rats, and where the idea goes next.

Rats have a long history of wiping out island birds, with their pawprints all over one of the world's most famous extinctions, that of the dodo. This unfortunate bird disappeared within 100 years of Dutch sailors arriving on Mauritius, having been hunted by the settlers and their menagerie of pigs, dogs, cats – and stowaway rats.

Whenever rodents arrive on an island with ground-nesting birds that haven't evolved any defences, they can cause an apocalypse. It is extremely difficult to stop rats from reaching any island that has boat traffic, as they stow away in transported goods,



**Rathlin Island has
been plagued by rats,
but not any more**

sanctuaries for multiple bird, bat and other native species experiencing precipitous falls on the country's two main landmasses.

One teacher, Alistair McDonald, took matters into his own hands. In 1960, he was touring Maria Island, a 150-metre-long island off the country's north coast, when he noticed hundreds of small, delicate-looking seabirds, white-faced storm petrels, floating dead in the water. Rats had finally reached the island.

Rat removal

McDonald turned saving the birds into a school project, encouraging children to fundraise for poisoned rat bait and taking them on hunting expeditions with his dog. Some children even used the more direct method of whacking rats over the head, McDonald told *New Zealand Geographic*. A park ranger visiting Maria a few years later confirmed the rats were all gone.

McDonald's school project was one of the first island rodent eradications in the world. Since then, conservationists elsewhere have followed his lead and attempted to eliminate rats and mice from many hundreds of other islands, including those in Australasia, Europe and North America, as well as tropical islands with their unique ecosystems.

So far, there have been efforts to eradicate rodents on nearly 1000 islands around the world, with a 90 per cent success rate for rats and 75 per cent for mice (albeit with some reinvasions). Over the years, the techniques have become much more sophisticated.

"We started in the 1960s with people crawling around on hands and knees throwing poison everywhere," says Russell. "Now we use helicopters, sowing the poison aerially. We have gone from islands that were tens of hectares to hundreds of hectares to thousands of hectares."

Conservationists had been discussing predator eradication on Rathlin Island for more than 20 years. Reports and feasibility studies were partly led by Liz Bell, a New Zealander who is a global leader in the field and who was drawn to Rathlin as the home to Northern Ireland's largest seabird colony. At about 14 square kilometres, Rathlin isn't the largest island to undergo predator eradication, but it is the largest one that is fully inhabited.

This is a serious obstacle, as it rules out using helicopters for bait distribution because the poison could be eaten by livestock, pets and ➤

especially animal feed, and can even swim to new islands less than a kilometre away.

Their impact is notorious in New Zealand, whose fauna evolved in geographical isolation for 80 million years, with no rat-like predators – indeed, no native land mammals at all, other than bats. Since humans arrived, the country has suffered sequential invasions of three rat species across its 600-odd islands. The first was in the 13th century, as Polynesian settlers arrived in the north, bringing along Pacific rats.

A few centuries later, these were outcompeted by the larger black and brown rats that hitched rides with European sailors. By the 1960s, conservationists were watching in horror as rodents reached New Zealand's small outer islands, which until then had been

**“Predator
eradication
is one of the
most powerful
conservation
interventions”**

possibly even children. “People don’t like poison dropping out of the sky,” says Russell. Instead, the poisoned bait has to go in containers that only rats or smaller creatures can access, which must be placed by hand, massively increasing the work involved.

An added complication was Rathlin’s feral ferret problem. Though there were fewer ferrets than rats, they are lethal predators. In 2017, one ferret managed to reach the cliff-side breeding area I visited, killing 27 puffins over two days.

Despite these difficulties, the idea of eradicating both rats and ferrets on Rathlin gained ground, promoted by conservationists, organisations such as the Royal Society for the Protection of Birds (RSPB) Northern Ireland and some islanders themselves.

The campaigners had to convince farmers and other residents to allow strangers onto their land to distribute lethal traps. But there would be clear benefits. If bird numbers recovered as expected, it would attract more birdwatchers and bring in more tourism, the island’s main source of income. Plus, ferrets and rats are agricultural pests, eating the food of livestock and attacking poultry. After numerous community meetings, several residents joined the campaign as employees or volunteers, and the eradication started in 2023.

The first job was to tackle the ferrets. This was done by placing 450 traps around the island, with non-lethal ones used near homes to ensure no pet cats were killed by mistake. In the end, 98 ferrets were killed.

Total wipeout

Two years need to have passed since the last sighting for any eradication to be considered certain and, this March, the RSPB proudly announced success – having carried out the first eradication of feral ferrets on an inhabited island in the world.

The rats, however, were a far bigger problem. With an estimated 10,000 living on Rathlin, it was a mammoth undertaking, requiring 7000 bait stations, designed so nothing larger than a rat could get in and eat the poison. These were placed at 50-metre intervals all over the island. Permission was needed from nearly every resident, as some bait stations had to go in barns, outhouses and even homes.

The farmland and residential areas weren’t the only problematic locations. Much of the shoreline is surrounded by steep cliffs, requiring professional climbers to abseil halfway down and dangle bait stations further down on long wires. “It’s about getting to every last place to make sure that you’ve got



ANNA FEENEY/LIFE RAFT PROJECT/COVER IMAGES

A specialist sniffer dog was brought in to help remove rats on the island (right)

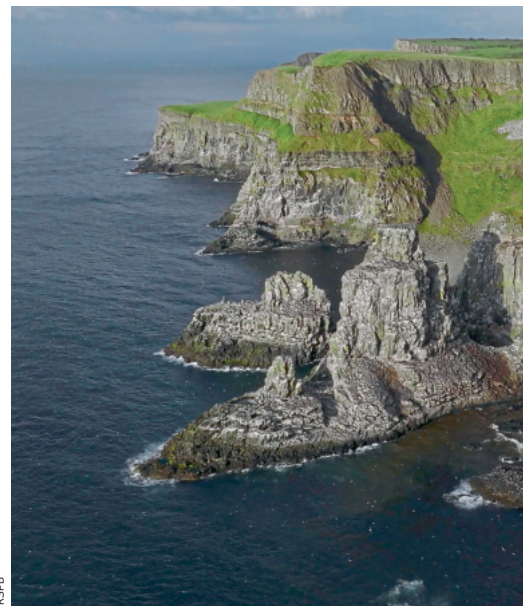
total coverage,” says Glenn Slade, project scientist for the RSPB. “If you leave just one pregnant female rat, you’ve potentially got recolonisation.”

The rat poisoning began in September 2024. Slade estimates that most of the rats were killed within the first month. “The vast majority of the decline happens in a short space of time, and then you spend a very long time chasing down those last ones,” he says. That final hunt involved innovative methods like bringing in thermal drones and a specially trained sniffer dog, both of which were used to find any remaining rats.

As far as we know, the last rat was killed in June 2025. So, if all goes well, the campaign could be declared a success by next summer. “I don’t want to jinx it, but, so far, we’ve been successful,” says Slade.

While the intensive part of the campaign is over, several Rathlin residents and volunteers have switched to the monitoring phase, with monthly checks of bait stations and camera traps to ensure no rats remain. They have added extra bait stations and cameras in the harbour area to spot any rats that arrive on boats. If any do, a new localised poisoning campaign would swing into action.

Charlie Bosanquet, a resident who is one of the harbour monitors, says the campaign works only with the islanders’ enthusiastic participation. She helped teach residents to spot signs of rats, giving out laminated sheets with pictures of scat from rats, mice and rabbits, as well as 3D-printed models of rat gnaw marks. The giveaway is that rats have two large front incisors, which leave distinctive grooves. Any resident who notices a rat knows to alert the RSPB.



RSPB

“It’s not just rats. In 2017, one ferret killed 27 puffins over two days”



ANDY HAYES/RSPB/COVER IMAGES



RSPB



they ravage gardens and farmers' fields.

I am shown a community allotment near the quay, where a whole row of sunflowers has just been beheaded. Similar destruction has been wrought on the strawberries, peas and herbs. As a keen allotmentee myself, I feel the pain of this loss.

Then again, this outcome wasn't wholly unexpected, seeing as the first ferrets were brought to Rathlin by residents in the 1980s specifically to control rabbits. When they got loose and started breeding, it must have felt like the song about the old lady who swallowed a fly.

I ask the RSPB what plans there are for the rabbits. For now, all a spokesperson will say is that their numbers are being monitored. Some of the islanders, however, mutter about taking matters into their own hands.

The rabbits may not seem like a big deal. Farmers elsewhere use various methods to keep their numbers down, including shooting them and gassing their warrens. But they show how, if one species disappears, the effects on an ecosystem's complex web can be multiple and not always welcome.

Unexpected consequences

When rats are eradicated, there is often a surge in mice, which are usually outcompeted by rats. "My prediction is that mice populations will explode now that the rats are gone," says Wayne Linklater at California State University in Sacramento, who researches the impacts of invasive species.

Mice are also an agricultural pest and sometimes eat seabird eggs and chicks. On other islands where rats have been eradicated, the surge in mice has been bad news for some other species, like lizards.

When one Rathlin resident wonders aloud to me whether the next step could be eradicating mice, it starts to sound like a game of Whac-A-Mole. Mouse-eradication campaigns are possible, but they are generally harder because the animals are smaller than rats and have even faster breeding cycles.

In the short term, though, there is already an uptick in some seabirds, with about 1700 puffins recorded in 2025 by the RSPB, compared with 1200 in each of the previous two years. There have also been the first signs in decades of breeding by Manx shearwaters and storm petrels.

Zooming out, the global picture of rat eradication projects suggests they can have broader benefits than initially expected. On tropical islands, for example, restoring

seabirds to their former numbers is thought to also boost coral and its fish, as the birds deposit nutrient-rich droppings. After rat eradication on two Indian Ocean islands in the mid-2000s, seabird numbers steadily rose, and nutrient levels in the surrounding water were found to be 13-fold higher than around similar islands that remained rat-infested.

Just how far could the eradication of introduced predators go? New Zealand is home to Predator Free 2050, a campaign launched by the government in 2016 to rid the entire country of its most harmful invasive predators by the middle of the century. While it first covered rats, possums and stoats, it later expanded to include ferrets, weasels and feral cats. "New Zealand's ecosystem needs to remove these invasive predators for us to be able to have our seabirds, our land birds and our lizards and frogs back, and our massively cool invertebrates," says Bell, who advises on aspects of the campaign.

But many conservationists think this goal is both misguided and unachievable. For one thing, it would take huge resources – requiring an estimated NZ\$1 billion (US\$570 million) a year, more than 0.5 per cent of the country's GDP – that haven't yet been made available. And these funds would be better spent in other ways, like protecting islands that are already free of predators, says Linklater, who critiqued the plan while he was based in New Zealand in 2018.

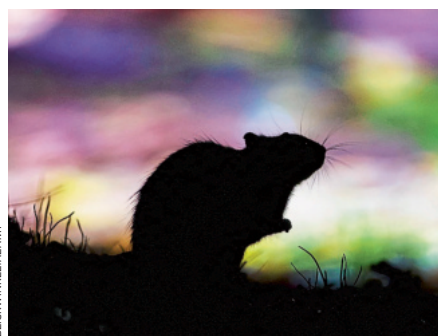
Although it may be unrealistic to eradicate the six invasive predators from the whole of New Zealand, the country has achieved stunning conservation successes through smaller-scale projects on many of its islands, including creating island sanctuaries for birds such as the kakapo, a large, waddling, frankly adorable parrot, and even the iconic kiwi.

Elsewhere in the world, work continues to suppress and eradicate invasive predators, including on both inhabited and uninhabited islands in the Scottish Orkneys and Hebrides.

With so many threats to wildlife from complex global problems like climate change and habitat loss, it is wonderful to work in a field that can count real successes, says Bell. "The recovery of these islands has been mind-blowing in a lot of places," she says. "Plant recovery, bird recovery, invertebrates, reptiles – it's magic." ■



Clare Wilson is a science journalist based in London



Rats can damage seabird colonies, including puffins (left) and kittiwakes (below left)

The residents I speak to enthuse about the benefits of becoming a rat-free island. On my visit, I notice chickens strutting boldly around the lanes and fields, an unusual sight for a Londoner like me. Since rat numbers started falling, some non-farming residents began keeping chickens and ducks, says Marina McMullan, chair of the residents' group, the Rathlin Development and Community Association.

All those I speak to on the island seem delighted with the campaign apart from one thing: it has led to a surge in rabbits, after the loss of ferrets, their only predators. As I take an evening walk, bunnies certainly bob up and down charmingly through long summer grass, but the next day, I hear how

"When I saw the image,
I think I put my hands
on the screen and said
'Oh, my God'"

Jupiter's mysteries were hidden from view until NASA researcher **Heidi Becker** photographed them using an instrument that wasn't designed for photography. She tells Joshua Howgego about the sublime sights she has seen

EVERYONE has seen awe-inspiring pictures of Saturn's rings. Less well known is that Jupiter has rings too, so faint they are normally all but invisible. The rings of Jupiter are just one of the little-known subjects that Heidi Becker has photographed over the past decade or so. She is a co-lead investigator on NASA's Juno mission, which arrived at our solar system's largest planet in 2016 and has been studying it in detail ever since.

Many of the most eye-catching images of Jupiter have been taken by the craft's main camera, JunoCam. But that isn't what Becker works with. She uses a special low-light detector that was never intended to take proper images for people to view.

Nonetheless, she has discovered she can use it to image dark and shadowy areas of the planet and its moons and to reveal things no other instrument can. That goes far beyond

those feathery rings – to the dark sides of the planet's moons, mysterious craters and new kinds of lightning. *New Scientist* caught up with Becker to hear about the best pictures she has taken, and what we have learned from them.

Joshua Howgego: When you were younger, you worked on the stage. How did you end up studying Jupiter? That's quite a transition.

Heidi Becker: Growing up, I was a dancer, and I also did a lot of experimental theatre in New York. But when I was in my early 20s, I had an injury to my knees, which made dancing not possible for me any more. But I was always fascinated by light and the stars. I was looking through a telescope on a visitor night at an amateur astronomy club in Connecticut, and the astronomer guiding us showed us the Orion Nebula. He described the nebula, the magnetic field lines,

the gas that was collapsing, how it was a nursery for stars – it was so beautiful. It was the moment when I knew I wanted to go into that field.

You eventually wound up at NASA.

I decided to get a degree in physics and go on to optical sciences – I was interested in cameras and light. Then, towards the end of my degree, I needed some extra money and got a part-time job at NASA's Jet Propulsion Laboratory, which ended up becoming a full-time job working on the effects of space radiation on electronics. One of my colleagues was an expert on star tracking and was involved in the proposal for Juno.

What is a star tracker and why are they so important?

The idea is that you keep track of the positions of the stars so that you know where you are in

KLAWIE RZECZY





space. If you don't know that, you don't know where your data were collected. It's crucial to the science and for navigation.

The biggest challenge for Juno's mission success at the time was: how do you have a star tracker on a spacecraft that is going to be constantly spinning – and that works in the harsh radiation environment around Jupiter?

A tiger team formed: a small group of experts aggressively trying to solve this problem. I joined this team, and we had only a few months to do a lot of unprecedented radiation testing on sensors that would go into our star tracker before Juno was approved. Most missions experience solar proton events and galactic cosmic rays, but not electrons travelling at relativistic speeds, which is what you get near Jupiter. So, there was no body of information about how a sensor from a camera would behave or degrade.

We found a lot of odd places to simulate the environment. One was a cancer hospital in Paris – they let us in at midnight to use their medical equipment to irradiate our sensor.

How did this go from being an instrument used for navigation to a science camera?

Juno's star tracker is called a Stellar Reference Unit, or SRU. Its function is to take pictures of the dark sky and find known stars. Then the spacecraft figures out where it is pointing.

However, Juno flies where no one has flown before, and so [Juno principal investigator] Scott Bolton asked me if there was any data we'd be getting that we could use to understand the radiation environment. I was complaining one day to a colleague about how limited the information was that we could get from the SRU. They said, "Well, why don't you just take a picture?" And so,

we reached an agreement that we would take about 20 pictures per orbit of Jupiter and transmit them to Earth – something we don't do with the SRU's usual star images. These would just be images filled with the signatures of the surrounding radiation; it just looks like the snowy static you can get on a TV. What that shows us is the energy and concentration of high-energy penetrating particles around the spacecraft.

So, at that stage the pictures weren't exactly going to be much to look at...

Before Juno arrived at Jupiter, there was a lot of talk on the team about Jupiter's ring system. It wasn't clear how well the other cameras would be able to see it. The main camera, JunoCam, is designed for bright light, to take beautiful pictures of the cloud tops in sunlight. That made me wonder if we could do it with the



SRU. And that started this cascade of searching for different types of opportunities within the system that were low light, because that first ring image was so successful.

What did we know about the rings before you photographed them?

It was known that there is this ring system. There are different parts to it, and it was thought that the rings are fed by dust coming from meteoroid impacts on its four inner moons that orbit at the same radius as the rings: Amalthea, Thebe, Metis and Adrastea. However, there were very limited observations of the rings, because many previous missions have approached it equatorially, or from the side, making it hard to see.

Those previous observations also raised this laundry list of mysteries about the rings. The New Horizons spacecraft observed bright clumps of material following Adrastea, and it's not known if those are other small moons, or whether something hit Adrastea, and for a brief moment in time, there were little pieces trailing it. Other observations show that the rings were brighter at certain longitudes, and it's not clear why.

I can see how they would be awkward to photograph. How did you manage it and what did you see?

Because we're flying so close to Jupiter, we had the opportunity to look straight down on the rings and see the distribution of the dust. When you let Jupiter's shadow get cast across part of the image, you see that sharp boundary between dust and darkness. So, if you're trying to find a very dim signal from very diffuse, faint dust, it becomes a little easier, because you get that contrast. That's a trick we've been using a lot. We took the first ring image in 2016, and we've done as many as we can since then.

Why is it important to study rings?

They're like mini laboratories for planetary formation or even solar system formation. You start with a great big ball of gas that accretes and turns into a star or a planet. Knowing how the dynamics of that work in the rings around planets like Jupiter gives us a framework for understanding how that works on larger scales. We're finding that Jupiter's rings are a part of a highly interconnected system. It involves those inner moons, the inner radiation belts of Jupiter, which are very strange and very non-uniform, the magnetic fields. All of this is very mysterious, and there may be other influences from Jupiter itself.

"When you're the first person seeing some part of nature for the first time, it's an incredibly intimate moment"

The photographs include flashes of lightning (two bright points, below right) and Jupiter's northern aurora (blue circle, below left)

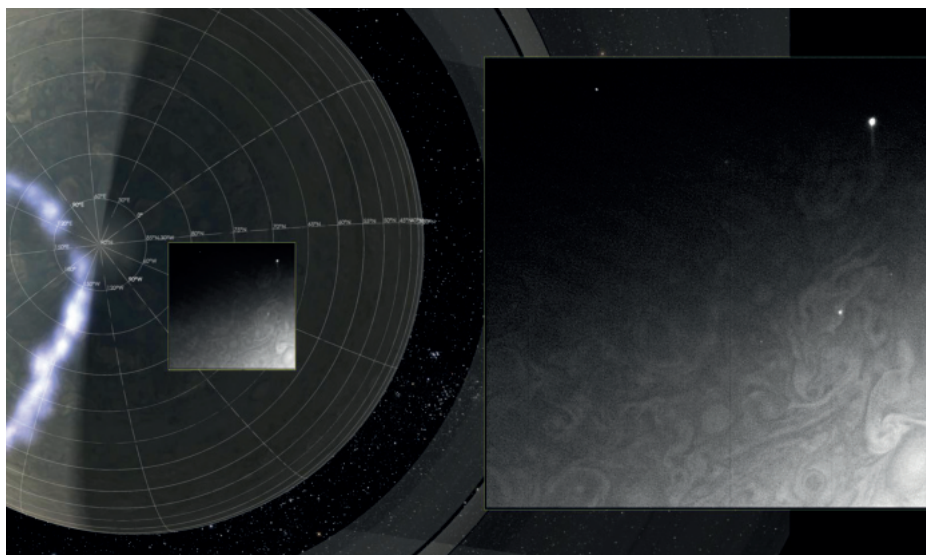
You have taken so many other great pictures. Tell me about Ganymede.

Our closest approaches to three of Jupiter's moons – Ganymede, Europa and then Io – were on the night side. Jupiter was our light bulb, and the geometry was such that it shone on just a particular region of the surface of Ganymede. We were flying past extremely quickly, tens of kilometres per second, which meant that for each of those moons, the SRU could take only one picture. We had to get it right. But it worked. The SRU took Juno's highest-resolution image of Ganymede, and the special lighting conditions revealed an incredible amount of previously unseen features. This has allowed us to massively improve the geologic map of that region of Ganymede.

One of the things we identified is an intriguing spray of ejected material. Ganymede has a very large crater called Tros. But many kilometres away from the crater is this streak of ejecta that we saw in the shape of a ray. It sort of looks as though it could have come from Tros crater, but the weird thing is that there is this very old, dark terrain in between. So, did it come from there? Or is it a comet? Or what?

That sounds like a real mystery. If it was an impact crater, wouldn't you expect it to spread out in a sort of a circle?

In a star pattern, yeah. It's very strange. We've brought it to the attention of the JUICE team [another mission due to study Jupiter] because I think once they're there and doing this amazing survey of Ganymede, it'd be interesting if they can figure out what it is.



NASA/JPL-CALTECH/SWRI

You also made an amazing discovery about a new type of lightning...

Well, at a certain point in our mission, we started approaching Jupiter from the night side. The very first picture that we took was a really exciting moment.

At that point in the mission, the closest approach to Jupiter was always at 2 or 3 in the morning, California time. So, I would wake up instinctively and look at my computer – sort of like a mother with a baby that needs to be fed in the middle of the night. And the picture came down, and we could see the cloud tops at high resolution on the night side. The reason for that was because they were illuminated by moonlight from Io. And there were little flashes of light in the image that were lightning in the cloud tops.

Were you the first to see that image in the middle of the night?

Absolutely. When you're the first person seeing some part of nature for the first time – in this case before others wake up – it's an incredibly intimate and awe-inspiring moment. It's one of the things about what I do that is rarefied and precious. I think I put my hands on the screen and said "Oh, my God", because it was such high-resolution imagery.

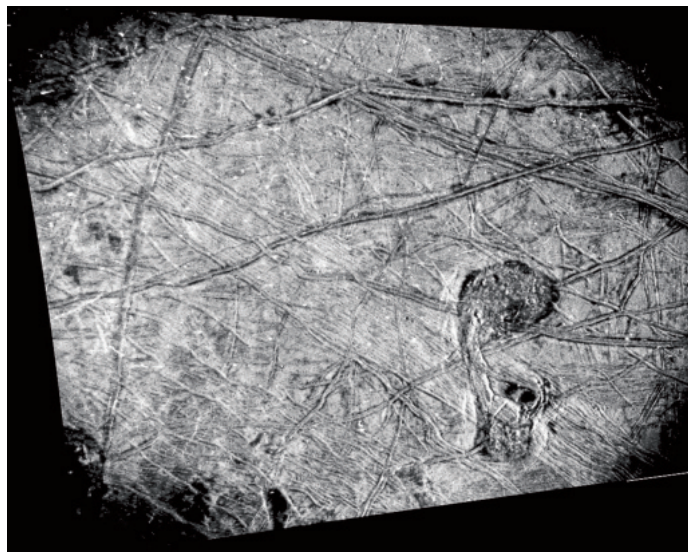
What was new about this lightning?

Lightning has been seen by every mission that orbited or flew past Jupiter on its night side. We know that the larger the flashes we saw on the cloud tops, the deeper it originated in the atmosphere.

Ever since the Voyager mission [in 1979], we've seen lightning coming from a particular depth in the atmosphere, where the conditions allow water to exist in a liquid, solid and gaseous state, which is the condition that on Earth is necessary for most lightning and thunderclouds. So, scientists were content with the fact that lightning on Jupiter was very Earth-like.

When I analysed the lightning I saw, I found it was coming from above the water cloud, where it is too cold for liquid water to exist. I remember one scientist, who is a real expert on Jupiter's lightning, saying to me: "This is a problem." But really, it was a discovery. It was a different kind of lightning that doesn't occur on Earth.

Right at the time that this discovery was made, we were finding that Jupiter's atmosphere wasn't as well-mixed as we had always thought – there were these pockets of missing ammonia – and



The images capture Europa's fractured surface (left) and Jupiter's ring system (below left)



NASA/JPL-CALTECH/SWRI

Juno's atmospheric scientists were developing ideas to explain why.

The theory was that, at a certain high region in the atmosphere, you have high-energy storms that are throwing up water ice crystals and interacting with the ammonia gas at a specific altitude, which can act like an antifreeze and create liquid ammonia-water droplets.

These droplets get tumbled around in thunderstorms, forming an icy crust, and would eventually form into hailstones. These hailstones could grow and fall deep into Jupiter's atmosphere, taking the ammonia with them and creating the missing pockets of ammonia scientists previously measured. So, when I saw lightning coming from exactly the region where this was predicted to happen, it was evidence that these high-altitude storms may actually exist.

What are you excited about snapping in your next photograph?

We're doing a lot of imaging of Jupiter's aurora on the night side of the planet. We're interested in the vertical structure of the aurora, and what is happening at different depths in the atmosphere. And there has been a lot of imaging of the aurora at infrared and ultraviolet wavelengths, but some of the chemistry cannot be seen at those wavelengths. Visible cameras can see them, though, so we have this unique, close vantage point, and we're in the middle of a campaign of investigating this.

If you could take a picture of anything in the Jupiter system, what would you go for?

When we did the Jupiter shine trick with Europa, we found a region that we nicknamed the platypus, which looks like the ice shell has been disrupted and where there could be liquid water very close to the surface. There's a theory that proposes that if you have liquid water close to the surface, it can cause the ice shell above it to collapse and create a sinkhole. As it's in the process of refreezing, you might have big ice blocks that shoot up from the water. Our photograph makes it look a lot like that is going on there. So, if I could do anything, I would probably fly back there, even closer, and see if we could prove that – I think that would be very cool. ■



Joshua Howgego is acting head of features at *New Scientist*

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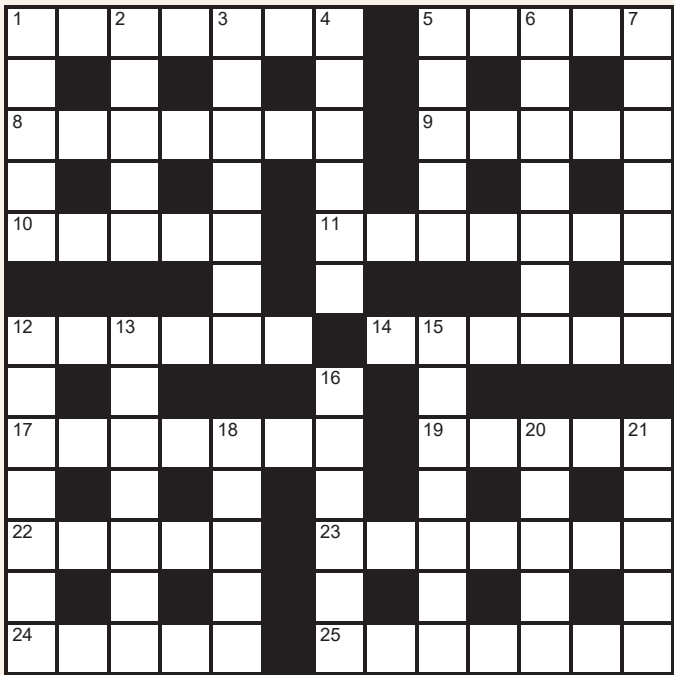
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Cryptic crossword #193 Set by Trurl



Scribble zone

Quick crossword next week

ACROSS

- 1 I, perhaps, will get information on sci-fi video game (7)
- 5 Vampire hunter is kind of beige? (5)
- 8 More than one counter may be about to fall! (7)
- 9 Chambers concealed in Bermuda Triangle (5)
- 10 Radical might make you curse and yell, oddly (5)
- 11 Perhaps Data Centre in Kildare, Ireland, and surrounds (7)
- 12 May one be given gas, for tooth? (6)
- 14 Tom's pullover made from string (6)
- 17 Clothing worn, in the main, dripping with diamonds? (3,4)
- 19 Parrot caught between lines, in a flap (5)
- 22 Ronaldo pass inside generating something like dopamine (1-4)
- 23 Predatory Amazon individual an irrational figure, managed by horrid American leaders (7)
- 24 Black tea makes one urinate across floor (5)
- 25 Am I sane, being confused, having forgetfulness? (7)

DOWN

- 1 Snag thumb (5)
- 2 Cross after dead rubber (5)
- 3 Mingle freely, eating lobster tail (it may cause trouble in one's works!) (7)
- 4 Exchange OK for Russian pinned by knight – also, oddly, queen (6)
- 5 Audience's no longer interested in directors (5)
- 6 Roll up! Cricket side first to go distance (7)
- 7 Point with no number, long before? (4,3)
- 12 Primrose serving beef cheek (7)
- 13 Make connections by reversing x function (7)
- 15 "Alien" or "strange" component used in banking (7)
- 16 Thrown AI power out, in a perfect world (6)
- 18 It's wise to undergo uranium treatment (5)
- 20 Manipulated spine, an important part of man's anatomy (5)
- 21 Pack carrier for a shopping centre – going up! (5)

Quick quiz #363
set by Chelsea Whyte

- 1 Which motion, done quickly, blurs a stealth drone so much it disappears?
- 2 Astronomers detected an atmosphere on a rocky, temperate world beyond our solar system for the first time. How far away is it?
- 3 A newly discovered monkey species has a distinctive trait that scientists say "defies description". What is it?
- 4 What material was discovered in the jawbones of marine bristle worms?
- 5 An ancient Maya scientist was identified by name for the first time from hieroglyphic text. What were his fields of study?

Plus Side
created by Puzzlr

Circle numbers in the grid below to use them, or cross them out to get rid of them. Circled numbers must add up to both the target at the end of each row and the target below each column.

5	8	7	7	6	26
1	6	5	6	6	18
1	6	8	5	5	18
9	9	1	4	1	4
2	1	6	2	9	17
8	8	19	22	26	

Answers to this week's puzzles on page 47

 **Our games are now playable online**
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Moon move

What changes will occur on Earth as the moon moves further away from us?

Ron Dippold

San Diego, California, US

Usually, my answers are: "Oh, this is so much worse than you even imagined!" But in this case, the answer is "not much".

The moon is about 384,400 kilometres from Earth right now and our days are about 24 hours long. The moon pulls on Earth's oceans as the planet rotates below it, causing tidal bulges at the points closest to and furthest away from the moon. Those bulges drag on Earth through the seafloor, slowing down its rotation and causing its days to be about 1.8 milliseconds longer per century. That energy is transferred to the moon, which is kicked into a slightly higher orbit, and is thus retreating from Earth at about 3.78 centimetres per year. We have fossil proof from corals that roughly 1.8 billion years ago, our year was about 485 days long because Earth was rotating much faster – leading to approximately 18-hour days. In a billion years or so, at current rates, an Earth day

"Usually my answers are: 'This is so much worse than you imagined!' But in this case, the answer is 'not much'"

will be around 27 hours long and the moon will be some 10 per cent further from Earth, about 400,000 km away.

This is the time in the future when everything changes, because the sun will be about 10 per cent brighter. This will trigger a runaway greenhouse effect on Earth, if we haven't already done that to ourselves, and the oceans will completely boil away. The moon will still have Earth's rocks to drag on, but those aren't nearly as flexible as water, and without



PAUL SALMON/LAMY

This week's new questions

Making it up Why do humans so readily adopt fiction into our lives, and feel emotion about characters as though they were someone close to us in real life? *Dave Neale, Bedford, UK*

Lights out If the sun suddenly disappeared, how long would life on Earth last, from humans and plants to subterranean bacteria? *Garry Trethewey, Arkaroola, South Australia*

the massive friction of tides on Earth's seafloor, the moon will almost stop moving further away and the length of Earth's day will almost be fixed. And then, about 4 billion years after that, the growing sun may or may not envelop Earth and the moon, but will at least turn their surfaces to magma. At that point, the moon may start moving further away again, but we won't care.

Practically, the moon continuing to move further away in the next billion years only causes two minor effects. First, because tidal effects fall off by the cube of the distance between the moon and Earth, if the moon moves 10 per cent further away, this would reduce tides by about 25 per cent. Four-metre tides become 3-metre ones.

Second, it is entirely a coincidence that the moon is just the right size to cover the sun as seen from Earth and cause a total solar eclipse. In about half a billion years, as the moon continues to move away, its apparent size will shrink and it will no longer cover the sun. There will only be annular eclipses – a dark moon surrounded by the ring of fire of the sun peeking around it. But for the sentient rodent people of Earth in 600 million years, the moon moving further away will be the least of their concerns.

Mike Follows

Sutton Coldfield, West Midlands, UK

Tidal interactions cause the moon to move away from Earth, currently at about 3.8 cm per year. This process also lengthens both

Why do we become so attached to fictional characters, despite knowing they aren't real?

the moon's orbital period and Earth's spin period. Assuming these processes continue for tens of billions more years, Earth's spin period will eventually equal the moon's orbital period, and the two bodies will both become tidally locked.

The same face of the moon is always turned towards Earth. Eventually, Earth will reciprocate: anyone on the moon's near side would always see the same face of Earth fixed at the same point in the sky. Earth and the moon will each then permanently show the same face to the other.

Lunar tides will become weaker because the moon's tide-raising effect decreases roughly with the inverse cube of its distance from Earth. Over millions of years, this would alter coastal environments and ocean mixing, with ecosystems evolving in response.

The moon will also appear smaller in the sky. In about 600 million years, it will no longer be able to cover the sun completely, so total solar eclipses will cease.

The moon helps to stabilise Earth's axial tilt, which is presently about 23.4 degrees and naturally varies only between about 22.1 and 24.5 degrees. As the moon moves further away, this stabilising influence will weaken, allowing larger variations in Earth's tilt and potentially more extreme long-term changes in climate and the seasons.

The moon may have influenced Earth's history. Some researchers have suggested that the repeated wetting and drying of intertidal environments, driven by the moon's tides, may have favoured the chemistry leading to life, echoing Charles Darwin's famous speculation about "some warm little pond". Together with its stabilising influence on axial tilt, the moon may therefore have played a significant role in making Earth habitable. If so,



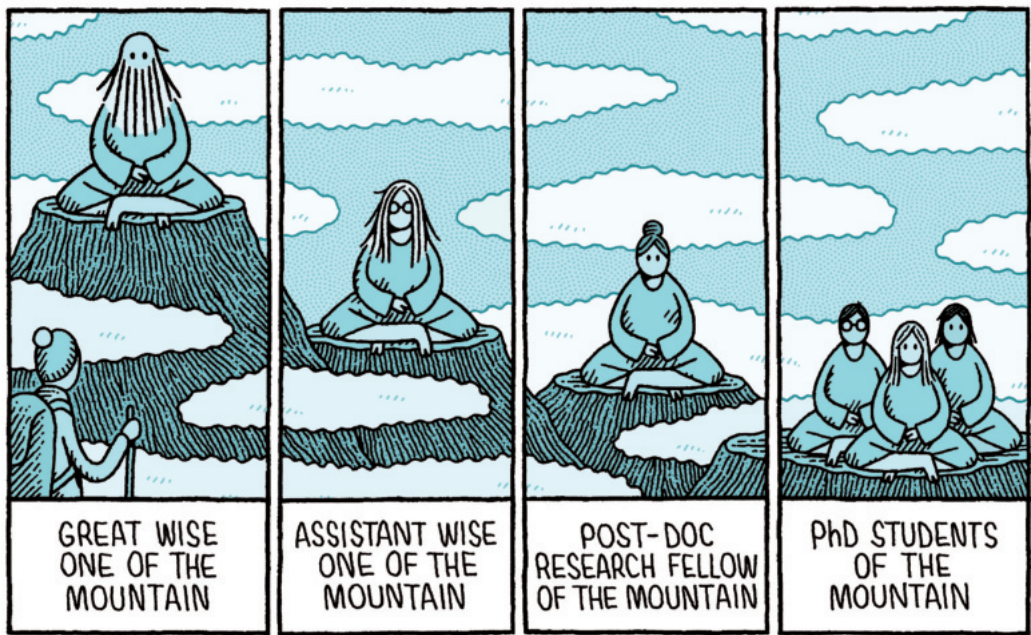
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Tom Gauld
for New Scientist



were it not for the moon, there might have been nobody to observe its slow recession.

Hear that?

Why don't dogs look up when a low-flying plane or helicopter passes overhead? I've never seen one do this.

Pam Lunn

Kenilworth, Warwickshire, UK

This isn't an answer but a deepening of the mystery. Rauer Island in Norway is a military site with significant natural importance. Near the shoreline, atop a tall tree, is an osprey nest. The birds display significant and prolonged alarm if boats come near the shore or if people on foot approach the tree. They show not the slightest concern at low-flying military helicopters in their airspace.

Richard Maddra

Queensbury, West Yorkshire, UK

Our most recent dog, Blu, regularly looked up at low-flying

"He was the most intelligent dog I have ever known, teaching himself to open doors and letting himself out of the vet's"

aircraft. He would stand still and turn his head to track it, then resume whatever he had been doing beforehand when it disappeared from sight.

Mind you, he was the most intelligent dog I have ever known, teaching himself to open doors, and he would let himself out of the vet's consulting room, much to the vet's amusement.

Head banging

When wasps, bees and flies continually clatter against the glass of my conservatory attempting a means of escape, are they following a strategy? (continued)

Wai Wong

Melbourne, Australia

Australia, particularly Melbourne,

is renowned for its abundance of flies, so I have quite a bit of experience with them. Their behaviour is rather different from what your previous correspondent describes.

In the absence of any scent of food, a fly in an open space usually flies randomly in search of food. So, even when there is no wind, a fly can enter a house via an open door or window by chance. Inside the house, it usually spends some time exploring and then tries to leave. To find an exit, it will fly towards a light source and that is why it often keeps flapping around or banging on a closed window. If the window is open, it seems to be able to sense the incoming fresh air and finds the way out against the air current.

To let out an annoying fly that keeps roaming around your house, the best strategy is to turn off all the lights and close all curtains, bar those in one small room. Within an hour, it will settle around the windows of that room. Close the door and open the window, and it can't wait to escape. ■

Answers

DOWN 1 Hitch, 2 LaTeX, 3 Gremlin, 4 NASDAQ, 5 Board, 6 Furlong, 7 Year dot, 12 Cowslip, 13 Network, 15 Alleron, 16 Utopia, 18 Usage, 20 Penis, 21 Llama

24 Pekoe, 25 Amnesia, 22 L-dopa, 23 Piranha, 14 Catgut, 17 Wet suit, 19 Lapel, 11 Android, 12 Canine, 8 Totters, 9 Attia, 10 Hexyl, **ACROSS 1** Halogen, 5 Buffy,

#193 Cryptic crossword

5 Astronomy and maths

4 Bio-metal

3 Body odour

2 50 light years

1 Spin

Quick quiz #363

	8	8	19	22	26
17	(2)	1	(6)	2	(9)
4	9	9	1	(4)	1
18	1	6	(8)	(5)	(5)
18	(1)	6	(5)	(6)	(6)
26	(5)	(8)	7	(7)	(6)

Plus Side
Solution

Scratch that

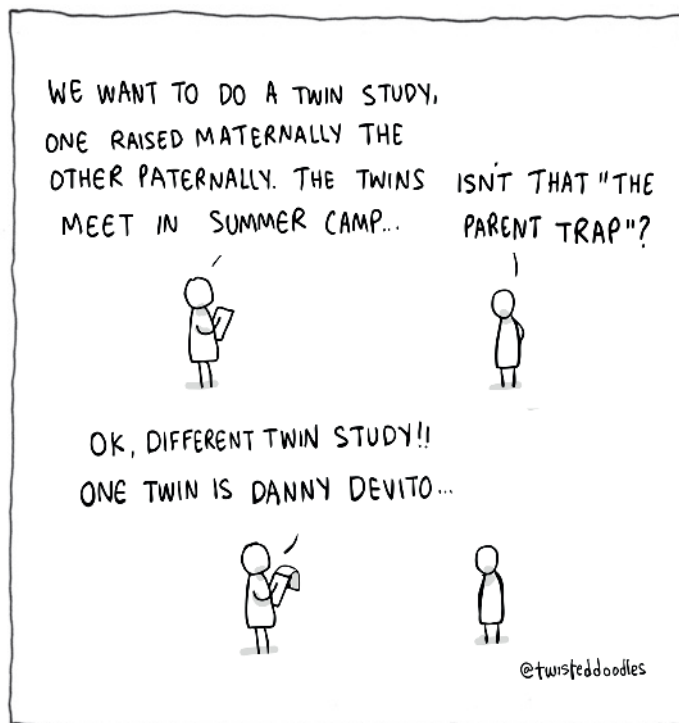
When news editor Alexandra Thompson sent Feedback some research about the social science of long fingernails, a paper that runs to 20 pages, we knew we had to read it. Never mind Alex's remark – "I don't think long fingernails is that deep" – Feedback was delving in.

The work has the delightfully verbose title "From status symbol to polysemous sign: Interpreting the meaning of artificially extended fingernails". Wondering why people sometimes wear "artificially elongated fingernails" and how this behaviour is interpreted by the rest of society, the authors examined 45 newspaper articles and identified "eight interpretive frames" through which we can understand the trend for super-long nails.

Some of what is happening can be traced back to Thorstein Veblen's classic analysis *The theory of the leisure class: An economic study of institutions* (1899). Veblen posited that the ruling class are engaged in "conspicuous leisure" in order to differentiate themselves from those doing actual work. One way to do that is to grow your nails really long, or wear nail extensions, to signal that you don't have to work with your hands. However, the authors of the study don't think that is what's going on today.

They say that "the clear legibility of long nails as a symbol of leisure has been lost in contemporary societies", since nail extensions are now found "on the hands of service workers as well as managers". Instead, what is happening is frantic innovation in the beauty industry, driven by "capitalist market mechanisms". This is accelerated by social media, where nail artists show off their most extravagant creations, with the result that "the status of nail work shifts from a routinised service to an autonomous art form whose value lies in complexity, originality and photogenic quality". And that barely scratches the surface (see what we did there?). Never mind seeing a world in a grain of sand, you can see all of human society in a fingernail.

Twisteddoodles for New Scientist



Got a story for Feedback?

Send it to feedback@newscientist.com

or New Scientist, 9 Derry Street, London, W8 5HY

Consideration of items sent in the post will be delayed

If we hadn't enjoyed this paper enough, the citations are a gold mine. We had no idea there was a book called *The Finger: A handbook*, but we want to hand out some sort of prize to the person who came up with that subtitle.

We also want to point out that the authors of the nails paper missed a trick. The proper use of super-long fingernails is to make really good tapping sounds in ASMR videos. We had to rewrite part of this column at the last minute, so we put on one such video to ease the resulting stress, only to wind up blissing out for half an hour and then writing the remainder in a panic.

A hill of beans

Feedback is pleased that our readers continue to bring us unhelpful units of measurement. Thanks go to Tony Levitt, who was

at the Sedgwick Museum of Earth Sciences in Cambridge, UK, when he found a display explaining what goes into making a wind turbine. Apparently, it "can require over 1000kg of rare earth elements to build (the same weight as 2500 tins of baked beans!)"

As Tony realised, this will look very different depending on whether the cans contain baked beans or not, and the display doesn't specify. Tony decided to investigate. "Looking in our kitchen cupboard I found a solitary can, labelled as '400g net'," he writes. "According to my kitchen scales the combined can and contents actually weighs 468g." If Feedback's maths is right (and it frequently isn't), a full can is about seven times heavier than an empty one. We therefore find ourselves knowing the amount of rare earth elements needed to

build a wind turbine, but only to within a factor of seven.

"To be fair to the Sedgwick, it is a great little museum," adds Tony.

Meanwhile, Elizabeth Osbos pointed us to a marine forecast warning of a "rapidly rising swell", posted on X on 6 June by New Zealand's MetService – *Te Ratonga Tiorangi*. Specifically, "Combined wave heights in eastern offshore waters could reach or exceed the height of the Ohakune Carrot".

Feedback wasn't previously aware of the Ohakune Carrot, but we have familiarised ourselves. The small town of Ohakune lies at the heart of a major carrot- and parsnip-growing region, and to commemorate this industry, it has a giant fibreglass carrot standing by the road. The carrot is 7.5 metres tall and may be the largest model carrot in the world.

New Zealand readers: is the height of the Ohakune Carrot so generally and universally understood that it can be safely used to convey the heights of dangerous ocean waves?

Gaslit

In our ongoing quest for the science-themed tourist attraction with the most limited possible audience, we mentioned Denmark's Gas Museum as a place that not many people would want to go to (30 May). This included John Blakey, who alerted us to its existence, but hasn't actually attended.

But it has competition. Rebecca Ferguson (the professor of learning futures at the Open University, not the actor) and Bill Dickinson both wrote in to tell us about another museum of gas: the Fakenham Gasworks Museum in Norfolk, UK.

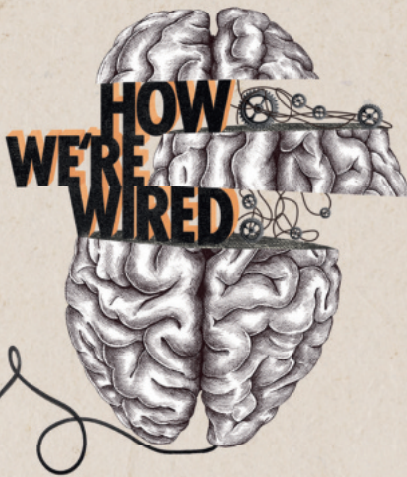
"I wouldn't want to gaslight John, but he may have forgotten [it]," writes Rebecca. She adds that "TripAdvisor ranks it fourth of the top attractions of Fakenham – beating both the Chocolate Factory Shop and the ruined abbey".

Bill says the staff are very friendly, cheerfully turning a blind eye when he inadvertently stayed half an hour after closing time. ■

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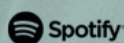
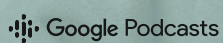
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