

# New Scientist

WEEKLY March 13–19, 2021

## FOCUS ON CORONAVIRUS

Could vaccines help  
clear up long covid?

*Tricky path ahead  
for virus-free countries*

Should I get my  
antibodies measured  
after being vaccinated?



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*By Carlo Rovelli*


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Entries for the 2021 Ryman Prize close at 5pm on Friday, July 16, 2021 (New Zealand time).

**Go to [rymanprize.com](https://rymanprize.com) for more information.**





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[youtube.com/newscientist](https://youtube.com/newscientist)

## Podcasts

### Escape Pod

A podcast to distract you from life in a pandemic. This week's theme is escape: how insects evade predators, escaping Earth's gravity and more.

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### Weekly

This week, the team discuss a self-sustaining "moon base" on Earth. They also talk warp drives and the fundamental rules of human friendship. Plus, acclaimed environment writer Elizabeth Kolbert drops in to talk about her new book.

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## Newsletter

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## Video



JACOB KING/PA IMAGES

**Quite a moment** Cheers as the UK's first doses of vaccine were given

## Podcast



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**Don't mess** Bombardier beetles spray acid to escape predators

## Newsletter



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**Dark energy** Sky surveys could show if it has always been the same

## Online

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[newscientist.com/coronavirus-latest](https://newscientist.com/coronavirus-latest)



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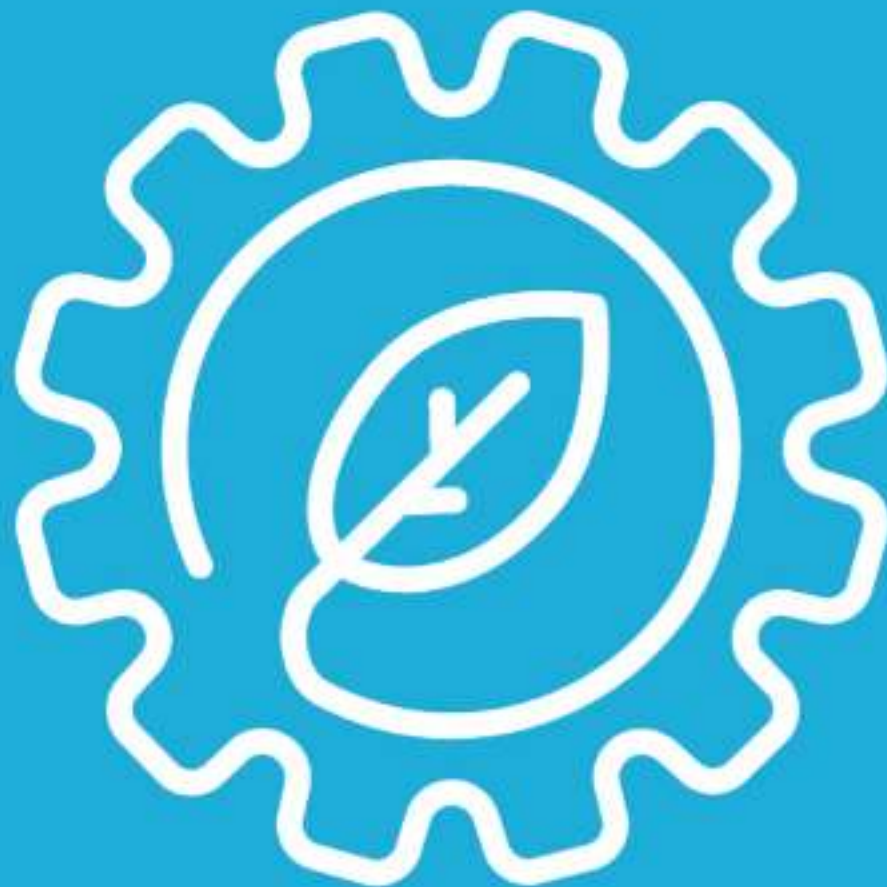


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**[newscientist.com/fix](https://www.newscientist.com/fix)**



**Adam  
Vaughan**



# Vaccine conundrums

Even comprehensive vaccination roll-out isn't a complete "jab and go" solution

THE global covid-19 vaccine roll-out is accelerating, with in excess of 300 million doses now administered. This time last year, such an achievement would have been almost a pipe dream.

Great challenges remain in ensuring the equitable distribution of vaccines across the world and persuading those who are hesitant that vaccination is in their best interests and in the interests of those around them. But even in countries where vaccines are available and take-up is high, emerging issues threaten the success of comprehensive vaccination programmes.

One concern is that the vaccination strategies of some countries might not be the best path in the long term. Vaccinating the most vulnerable people first will undoubtedly save lives now, but could spur the emergence of potentially

dangerous "escape" variants of the virus, and come at significant cost further down the road (see page 9).

Meanwhile, countries such as Australia, New Zealand and Thailand that have successfully kept the coronavirus out face different challenges. With minimal cases to contend with, these places aren't

**"Vaccinating the most vulnerable will save lives now, but might not be the best long-term strategy"**

desperate for vaccines to save lives now. But as much of the rest of the world becomes vaccinated, it will be difficult to reconcile their zero-covid border policies with those of countries learning to live – and allow travel – with the virus in some form (see page 8).

Finally, we know that the vaccines won't work for everyone, which may dent the effectiveness of roll-out programmes. How can we find out whether we are still at risk after having had a jab?

Promise on this front comes in the form of commercial tests that offer to measure precise levels of antibodies in the blood after infection or vaccination. Theoretically, it should be possible to keep an eye on these over time to see when levels are waning. Unfortunately, it seems doubtful whether the tests currently live up to the hope (see page 10).

Many of the answers to these quandaries lie in determining how much the virus can spread even among those who have been inoculated. Until then, vaccination won't be the jab-and-go solution many of us will have hoped for. ■

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**CONFIRMED  
SPEAKERS**

**Partha Dasgupta**

Economist, University of Cambridge, and author of the UK government review “The Economics of Biodiversity”

**Susan Gardner**

Ocean conservationist and director of the Ecosystems Division, UNEP

**Cristián Samper**

Tropical biologist, president and CEO of the Wildlife Conservation Society

Further speakers to be announced





DOUG BARRETT/BLOOMBERG VIA GETTY IMAGES

## Coronavirus

# US vaccine benefits

In the US, fully vaccinated people can now mix indoors without masks, but the guidance is deemed too risky for the UK, reports **Adam Vaughan**

PEOPLE can mix in private properties without social distancing or wearing face masks once they have been fully vaccinated against covid-19, US authorities have said.

They can also visit unvaccinated people from a single household without masks or distancing, provided that household is at low risk for severe disease, the Centers for Disease Control and Prevention (CDC) said on Monday.

A person is deemed to be fully vaccinated two weeks after receiving their second dose of the Pfizer/BioNTech or Moderna vaccines or two weeks after being given the single-shot Johnson & Johnson vaccine.

The guidance, which marks a significant relaxation in restrictions, will allow many families to meet again. The CDC

said the decision was underpinned by mounting evidence on the effectiveness of covid-19 vaccines at preventing asymptomatic infection and maybe transmission.

While face masks and social distancing continue to be important, the CDC said a balanced approach would allow certain people to restart some lower-risk activities. It added that such a reward for being vaccinated could improve vaccine uptake.

As of 8 March, 59 million people had been given their first dose of a covid-19 vaccine in the US and approximately 31 million had received their second. About 2 million people are being vaccinated daily.

"Today's action represents an important first step and is based on the latest #COVID19 science," tweeted Rochelle Walensky, director of the CDC. The new guidance applies to private settings such as people's homes.

Speaking at a White House briefing on Monday, Walensky gave the example of vaccinated grandparents now being allowed to visit their unvaccinated daughter and her children, provided they aren't at risk of severe disease.

There are limits as to how far the relaxation goes. Masks and social distancing will still be recommended in public for fully vaccinated people, and indoors with unvaccinated people from

**Vaccination in the US now offers the advantage of being able to mix indoors**

more than one household.

Walensky noted that there is a small risk that vaccinated people could become infected with mild disease and transmit it to others. Previously, researchers have warned that this could lead to mutations that allow the virus to escape our vaccine defences (see page 9), reigniting the pandemic.

**"The wisdom of allowing vaccinated people to mix hinges on how widely the virus is spreading"**

The CDC said it was confident that the vaccines provided some protection against current variants, including B.1.1.7, first identified in the UK. However, it did note that there was reduced efficacy against infection from the B.1.351 variant first detected in South Africa. There is limited genetic monitoring of variants in the US, so it is unclear how prevalent they are in the country.

Walensky said the US remained in a "serious" situation, with high levels of community transmission across the country. There are still 58,000 new cases a day, based on a seven-day average.

The CDC guidance contrasts with that from some other countries, such as the UK, where vaccinated people are required to socially distance and wear face coverings when near others, and still have strict limits on mixing.

Paul Hunter at the University of East Anglia, UK, said in a statement that the CDC advice "had some merit", but the wisdom of allowing fully vaccinated people to mix would hinge on how widely the virus was spreading in the community. He said the UK shouldn't yet follow suit.

"Allowing fully vaccinated people to meet with those who are not vaccinated is asking for trouble," said Lawrence Young at the University of Warwick, UK, in a statement. ■



**Daily coronavirus news round-up**

Online every weekday at 6pm GMT

[newscientist.com/coronavirus-latest](https://www.newscientist.com/coronavirus-latest)

Virus elimination

# The border problem

With some countries nearly covid-free, the only safe way to reopen borders may be to wait for herd immunity from vaccines, reports **Donna Lu**

THE UK may have experienced nearly a year of lockdowns and social restrictions, but there are areas of the world where life is approaching normality.

Good governance and strict border policies mean residents in Australia, New Zealand, Hong Kong, Taiwan and Vietnam are enjoying relaxed restrictions and little to no community transmission of the SARS-CoV-2 virus that causes covid-19.

But as vaccine roll-outs progress and plans are made to resume less-restricted international travel, how will countries with zero or very few covid-19 cases safely reopen their borders?

In the short-term, it is unlikely that countries pursuing an elimination approach to the virus would be willing to settle for anything less, says Michael Baker at the University of Otago in New Zealand, who devised the country's elimination strategy. The evidence for trying to eliminate the virus completely is overwhelming, says Baker.

"It's good for public health, it's good for the economies, good for businesses and enjoys huge public support."

"Unfortunately, most of the Western bloc have not had the experience of Australasia or

**"Countries without covid-19 won't be able to open borders until they have achieved herd immunity"**

much of east Asia in terms of aiming for basic elimination," says Gabriel Leung at the University of Hong Kong.

This makes reopening borders a tricky proposition. Vietnam, which has a two-week quarantine system in place and has seen only 35 covid-19 deaths throughout the pandemic, is unlikely to open its

REUTERS/AMMOJOY



**An audience watches the Australian Open with few restrictions**

where we have greatly reduced quarantine requirements for people coming from an expanding group of countries that have little to no covid-19 transmission."

New Zealand has already implemented quarantine-free travel bubbles with Australia and certain Pacific islands.

Longer-term, researchers agree that herd immunity may lead to covid-19 elimination in some countries or regions, while the virus becomes endemic in others.

Ben Cowling at the University of Hong Kong believes China may continue with an elimination strategy and strict border control until it has vaccinated at least 1 billion people.

In some countries, there may have to be a transition away from a position of zero tolerance for any covid-19 cases, says Thwaites. There will need to be "an acceptance that the disease will transmit, but because of vaccination, it won't cause unnecessary mortality, morbidity and pressures on the health system", he says.

If enough Australians are vaccinated to create herd immunity and there is good surveillance, any covid-19 that is brought into the country through travel shouldn't cause an epidemic, says MacIntyre.

Fully doing away with travel restrictions and the need for quarantine or contact tracing isn't beyond the realms of possibility. "This strategy is dependent on reaching a high vaccine coverage, otherwise a resurgence in cases would overwhelm the healthcare system and undo all the elimination efforts of the past year," says Cowling. ■

borders any time soon, says Guy Thwaites at the University of Oxford's Clinical Research Unit in Ho Chi Minh City, Vietnam.

"The government has zero tolerance for the infection at the moment, and they've shown that they can maintain that position," says Thwaites.

The Vietnamese public is largely supportive of the border closures, despite the heavy blow to the country's tourism industry, he says. "They look at other countries' experiences and are not envious of what is happening elsewhere in the world."

Countries that have eliminated covid-19 won't be able to safely reopen their borders until they have achieved herd immunity through vaccination, says Zoe Hyde at the University of Western Australia.

In Australia, vaccination was expected to be completed by October, but the vaccine roll-out

has been slower than anticipated. Some logistical issues included not giving care homes enough advance warning to obtain consent from residents prior to vaccines arriving there.

## A green lane

A lack of vaccine clinical trial data in children is another hurdle, says Raina MacIntyre at the University of New South Wales in Sydney, because the inability to vaccinate children is an obstacle to achieving herd immunity. More certainty is also needed about how effective the vaccines are at preventing or reducing transmission of the virus.

"If we can find we're not detecting anyone who is incubating covid-19 who has been vaccinated, then we'll certainly get to a point where there is a green lane for vaccinated people [entering New Zealand]," says Baker. "I think we'll get to a point



# Vaccinating the vulnerable first may be a flawed strategy

Michael Le Page

THE vaccine strategy most nations are following – of vaccinating the most vulnerable first rather than those who are likeliest to spread the coronavirus – may be the best way to save lives in the short term. But it is also the strategy with the greatest risk of driving the evolution of variants that can escape vaccine protection, according to a model developed by Julia Gog at the University of Cambridge.

“What is the absolutely worst strategy? You vaccinate all of the vulnerable and none of the ‘mixers,’” Gog said in an online presentation in February.

Gog isn’t calling for a change in vaccine strategy. But her finding reinforces the importance of keeping case numbers down as vaccines are rolled out. “We’ve got to get prevalence down, otherwise we’re [creating] a real risk of producing an escape variant,” she told *New Scientist*. “What you can’t do is get halfway through vaccination and allow cases to rise. That would be devastating.”

In countries with few or no cases, by contrast, the virus will have far fewer chances to

evolve, so the order of vaccination doesn’t matter as far as variant evolution is concerned.

Gog’s simple model is one of the first to evaluate the effect of vaccine strategies while also considering the risk of variants arising. In it, the entire population is divided into vulnerable people with a higher chance of becoming severely ill and “mixers” who are more likely to spread the virus.

**An elderly woman receives a coronavirus vaccine in Pittari, Italy**



IVAN ROMANO/GETTY IMAGES

The likelihood of escape variants appearing is assumed to depend on the number of vaccinated people who become infected, because every time this happens there is a small risk of such variants evolving.

Although the model is simple, Gog thinks the general conclusion that vaccinating the vulnerable first maximises so-called vaccine escape pressure is correct. “It’s bonkers to keep buying your worst enemy lottery tickets and then being surprised if they win the lottery,” she said.

But with the more transmissible B.1.1.7 variant causing a growing number of cases globally, the focus should still be on vaccinating the vulnerable, says Alessandro Vespignani at Northeastern University in Boston. “We have to deal with a variant that is ramping up now,” he says. “We have to think about averting deaths in the next couple of months, rather than down the road.”

There are still too many unknowns for models to give us clear answers on the best vaccine strategy, says Vespignani. For instance, even if variants evolve that are more likely to infect vaccinated people, they might cause only mild disease if they do.

Last year, Vespignani and his colleagues compared what would happen if vaccines were distributed fairly around the world based on population numbers rather than hoarded by rich nations until they have vaccinated their entire populations, as the likes of the US and UK plan to do. The researchers found that equitable distribution would roughly halve the number of global deaths. ■

## Long covid

### Vaccines may help clear up long-term covid-19 symptoms

SOME people with long covid, the term for long-lasting symptoms after a covid-19 infection, have had health improvements after being vaccinated against the coronavirus. Reports are based on anecdotes and an informal survey, but may offer clues to the cause of long covid.

For most people, the symptoms of covid-19 clear up within weeks, but some are still ill many months after the infection. It is unclear what

causes symptoms such as fatigue and trouble concentrating to persist.

People with long covid have expressed fears in support groups that getting the vaccine will worsen symptoms, says Gez Medinger, who began making YouTube videos about long covid after developing it himself. “People are very anxious about it,” he says. Medinger carried out a survey using Facebook groups of 473 people with long covid who had received a first dose of vaccine.

Most felt “moderately unwell” for the first two days after having the jab. After two weeks, about half were back to feeling the same

as they did before the vaccine. Some took a turn for the worse, with 4 per cent saying they had a relapse of symptoms. Another 14 per cent said they felt slightly worse than before the vaccine. But 32 per cent said they either felt better or were totally recovered.

“Taking the vaccine is more likely to completely resolve your symptoms than make you feel much worse,” says Medinger. Most of the

**32%**

Proportion of people with long covid who felt better after being vaccinated

respondents were from the UK or US. Sixty per cent had the Pfizer/BioNTech jab, 30 per cent got the Oxford/AstraZeneca one and the rest had the vaccine from Moderna.

“By giving a vaccine, you could enhance the immune response in those who would otherwise continue to have virus lurking in sites within the body and this would lead to its elimination,” says Peter Openshaw at Imperial College London. But he adds that it is too soon to conclude that the vaccine definitely helps people recover and that a formal study is needed. ■  
**Clare Wilson**

## Analysis Antibody testing

### Should you measure your antibody levels after a coronavirus vaccine?

Commercial tests that promise to measure your immune response aren't very useful, at least for now, finds **Helen Thomson**

IN JANUARY, I gratefully received my first dose of the Oxford/AstraZeneca coronavirus vaccine. But not everyone experiences an immune response to a shot. If mine has kicked in, I should have enough antibodies to protect me from covid-19. So it was worrying when I received results from an immunity test that suggested I had a low level of antibodies. Am I immune or not?

There are three quantitative antibody tests, or "immunity trackers", coming onto the market that are designed to tell me. The tests identify neutralising antibodies, which block the virus from attaching to and entering cells in the body. Unlike older antibody tests, which simply detect whether antibodies are present or not, the new tests can tell the level of antibodies in the blood.

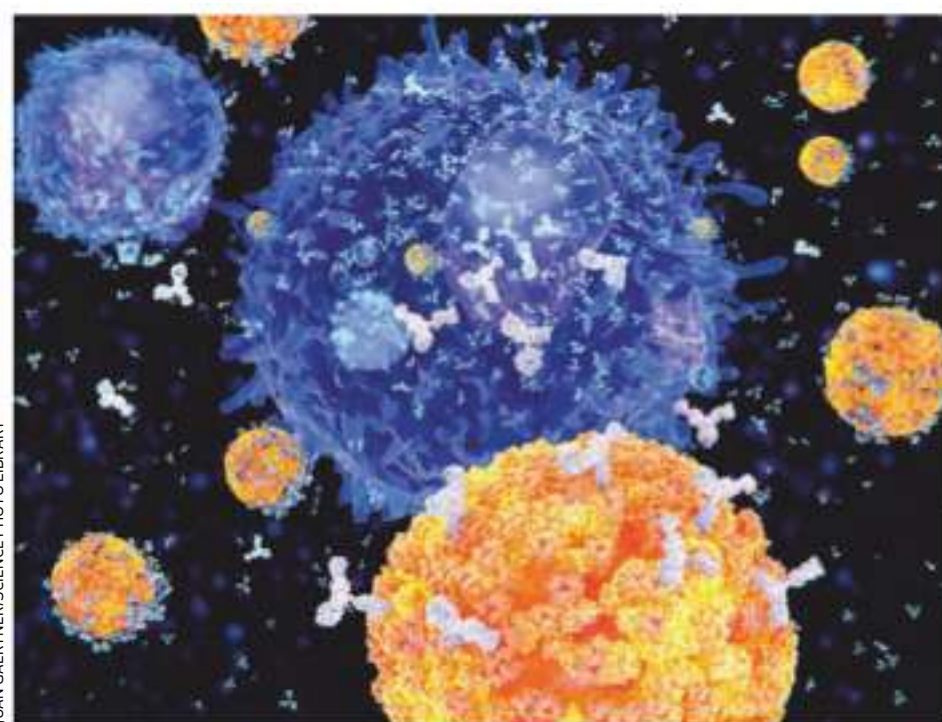
My test was developed by Swiss pharmaceutical giant Roche and I bought it through a non-profit organisation called Testing For All, for

**"A positive result of any level means you are likely to be protected from severe covid-19"**

£49. It takes two to three weeks for a vaccine to take effect so I took the test three weeks after my first dose.

My antibody level came back as 15.20 units per millilitre (U/mL). An article sent to me with my results explained that a positive test was any antibody level greater than 0.8 U/mL and a typical result 21 days after a second dose of the Pfizer/BioNTech vaccine was 1000 to 2000 U/mL based on a limited data set (similar information for the Oxford/AstraZeneca vaccine I had wasn't available). This left me feeling like I had a fairly low response.

I asked James Monico, co-founder of Testing For All – which aims to provide affordable testing to anyone who wants it – what he thought my result meant for my



protection against covid-19.

He said that in an evaluation performed on 255 samples, the antibody level created by natural infection appeared to be between 1 and 1000 U/mL, so my result was low and that I should consider talking to my GP about it. "It's the individual's right to take their healthcare into their own hands," he says. "A low antibody response means you are more likely to get reinfected and pass it onto someone else."

My GP said he couldn't comment on antibody levels at this stage. "The NHS guidance doesn't suggest that people have their antibody levels checked. All we know is that some antibodies are better than none."

Roche says that its quantitative antibody test "can play a pivotal role in vaccine clinical trials as well as helping clinicians assess patients' immune response", but declined to comment on the sale of tests directly to consumers by organisations such as Testing For All.

How useful such tests are is also complicated by the intricacies of the immune response to a vaccine.

All of the quantitative antibody tests on the market measure the level of antibodies that recognise

the outer spike protein of the coronavirus, which it uses to latch on to cells in the body. However, they don't give an indication of how powerful these antibodies are against the different coronavirus variants, nor do they give any insight into other aspects of immunity, such as B-cells, which provoke the production of further antibodies if they encounter the virus, and T-cells, which kill virus-infected cells directly. Plus, we still don't know how antibody levels relate to our ability to transmit the virus to others.

### Severe covid-19

Another test on the market, developed by Sebastian Johnston at Imperial College London and his colleagues, tells people whether they have a negative result, or a low, medium, high or very high level of antibodies. He says these thresholds were determined by data they collected from 107 people who have sporadically had their antibody levels measured since April 2020, a month after contracting covid-19.

Johnston says the most important take-home message is that a positive result of any level means you

**B-cells (orange) secrete antibodies (white) against viruses (blue)**

are likely to be protected from getting severely ill from covid-19. However, he points out that antibody levels wane over time and that it might be useful to track your level. "From our data, people who had high or very high levels of antibodies in April are all still positive today. Many of those who were low or medium became negative over the year and some of these got covid-19 in the second wave," he says.

George Kassiotis, who studies viral infections at the Francis Crick Institute in London, thinks such test results are "effectively meaningless". He believes that the correlation between the activity of antibodies against the virus in lab tests and the real-world immunity they provide isn't clear enough to allow us to determine cut-offs above or below which an individual is protected or not.

He also worries that immunity tests might be used to argue that people with naturally acquired antibodies after infection don't need to be vaccinated, which he calls a "falsehood" given that vaccination appears to provoke a stronger immune response than natural infection.

That said, while recent studies have shown impressive results for vaccine efficacy in the real world, no vaccine is 100 per cent effective.

Knowing that I have acquired some antibodies to the coronavirus is reassuring, and I imagine many others will be tempted to buy such tests. In time, perhaps we will have a better understanding of the relationship between neutralising antibodies and immunity to the virus, but until then, tests need to come with a better explanation of what they can – and can't – tell us about our risk of contracting, or transmitting, covid-19. ■



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# Anti-feminism is route to alt-right

An analysis of YouTube and Reddit comments has found evidence of radicalisation

Chris Stokel-Walker

YOUTUBE and Reddit users who engage with anti-feminist content can become radicalised to subscribe to alt-right beliefs, according to an analysis of 300 million comments on each platform.

Manoel Ribeiro and his team at the Swiss Federal Institute of Technology in Lausanne analysed comments posted to 115 Reddit forums and 526 YouTube channels between 2006 and 2018 to look for overlap between communities that expressed hate towards women, dubbed the “manosphere”, and alt-right groups.

Ribeiro wanted to investigate potential ties because of media coverage connecting people who self-describe as “involuntarily celibate”, also known as “incels”, to mass shootings. “When the media covers these communities, they associate incels with the far right,” says Ribeiro. “Can we find evidence for that?”

The researchers tracked the type of content each user engaged with, looking at general news, manosphere and alt-right content. The team divided anti-feminist groups into four categories:

members of the anti-feminist, male-separatist group Men Going Their Own Way (MGTOW), men’s rights activists, incels, and “pick-up artists”, who share strategies for convincing women to have sex with them.

To look for evidence of radicalisation, the team looked at people who in 2016 commented on YouTube videos classified as anti-feminist, and on general news

**Far-right demonstrators in Washington DC on 5 January**



SPENCER PLATT/GETTY IMAGES

videos, but had no engagement with alt-right videos and compared this with what they were doing in 2018. MGTOW members were most likely to later engage with alt-right content: by 2018, 21.9 per cent had begun commenting on alt-right videos, while less than 10 per cent of general news commenters had migrated to alt-right videos.

Despite the media’s connection between incels and alt-right beliefs, incels were least likely to turn up in alt-right communities, with 15.2 per cent of those who

commented on incel videos in 2016 ending up engaging with alt-right content in 2018 (arxiv.org/abs/2102.12837).

The team’s analysis of Reddit found similar results, but in general migration from the manosphere to the alt-right was higher on Reddit than YouTube.

“These communities were allowed to grow for a very long time, with platforms having a very lax moderation policy,” says Jacob Johanssen at St Mary’s University, London.

YouTube told *New Scientist* that its policy is to remove content that promotes violence or extremism. The company declined to answer specific questions about the research. Reddit didn’t respond to a request for comment.

Johanssen says the team’s research does seem to show a link between the manosphere and the alt-right, but he says that it is hard to identify varied communities as a single mass. “These communities are very heterogenous in themselves,” he says. “Specifically with incels, there isn’t one incel community.” ■

## Technology

### Laser thruster could power spacecraft away from Earth

A NEW laser thruster could be a step towards technology to push spacecraft rapidly between planets.

The demonstration model of the Photonic Laser Thruster (PLT) moved a 750-gram mock satellite along a track in a laboratory using only the power of light.

Laser thrusters, which exert force through light pressure, usually require extremely powerful lasers to generate tiny amounts of thrust.

The PLT overcomes this need for extreme lasers by bouncing the laser beam back and forth many times between the spacecraft and the laser source. Each time, a little extra energy is imparted to the craft in a process called laser recycling.

Young Bae at the Y. K. Bae Corporation in California had previously demonstrated laser recycling with a low-power system. The new set-up was 100 times more powerful and produced 3 millinewtons – enough force to accelerate a mock satellite along a low-friction rail.

He used a ytterbium-doped

yttrium aluminium garnet laser. Recycling the beam magnified the thrust by a factor of several hundred. The experiment showed that the beam arrangement is stable and can maintain its alignment with a moving target (*Journal of Propulsion and Power*, doi.org/fx8v).

According to Bae, the next stage of development should increase the PLT’s propulsion

**“The laser system produced enough force to accelerate a mock satellite along a low-friction rail”**

to a level comparable to that of the thrusters on existing satellites. This would make it possible to use PLT-style devices to manoeuvre satellites, or help them keep their position, without the satellites having to carry thrusters of their own.

Ultimately, Bae hopes the PLT, funded through NASA’s Innovative Advanced Concepts programme, could provide the infrastructure for what he terms a photonic railway to shuttle unpowered “spacetrains” between destinations – Earth and Mars, for instance. ■

David Hambling



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## Cosmology

# The universe may be unbalanced

The symmetry that supports our understanding of the cosmos might not be real

Leah Crane

A FUNDAMENTAL tenet of the modern model of cosmology is coming into question. A survey of more than 1 million galaxies across the cosmos has shown that the distribution of matter may not be the same in every direction, which could upend much of what we understand about the universe.

The cosmological principle posits that, viewed on large enough scales, the distribution of matter should be smooth and regular in every direction. This assumption is used in many cosmological calculations, most notably in the standard model of cosmology, called lambda-CDM.

Nathan Secrest at the US Naval Observatory in Washington DC and his colleagues set out to test the principle using more than 1.3 million quasars, which are supermassive black holes surrounded by bright matter that are found at the centres of some galaxies.

They expected to see a slight unbalance, or lack of symmetry, due to the movement of our solar system and galaxy through space. "In our direction of motion, we

should see more objects, and in the opposite direction, we should see fewer objects," says Secrest.

This cosmic Doppler effect has been measured in the past using the cosmic microwave background, a sea of radiation left over from the big bang. But the unbalance in quasar distribution was more than twice as big as expected (*The Astrophysical Journal Letters*, doi.org/fx9g).

**An illustration of the expansion of the universe, just after the big bang**

NASA'S GODDARD SPACE FLIGHT CENTER/CIC LAB/SCIENCE PHOTO LIBRARY



The disagreement between the quasar distribution and the cosmic microwave background may point to a fundamental error in the standard cosmological model. If it remains, it could change what we think we know about the big bang and the moments following it, which affected the shape and expansion of the universe.

"According to lambda-CDM, the universe is really lumpy on the scales we live on, galaxies and clusters of galaxies, and then it becomes smoother as you get

bigger," says Michael Turner at the University of Chicago. "Assuming this analysis is correct, it doesn't get as smooth as quickly as you expect – all this means is the simplest model of lambda-CDM is not right."

Several physical mechanisms could resolve the discrepancy. The most elementary explanation is that we are moving much faster through the universe than we thought. But there are more complex possibilities as well, such as unexpected curvatures in space-time or strange properties of dark energy.

"Lambda-CDM is not the whole story and we're getting closer to the point where we can get beyond it to something deeper," says Secrest. "We are starting to see the intrinsic structure of the universe better than ever before."

Figuring out what that structure is and how it differs from our current understanding will require many more observations of the large-scale distribution of matter, using not only quasars but many other types of cosmological objects as well. ■

## Botany

## Fairy lantern has a 'mouth' and saps energy from fungi

IN A Malaysian rainforest, botanists have discovered a new species of fairy lantern – a strange and enigmatic type of parasitic plant.

Fairy lanterns (*Thismia*) emerge briefly from underground as tiny, intricate flowers. Lacking the chlorophyll that helps plants photosynthesise to generate energy, they instead steal nutrients from fungi. Many species have disappeared from human eyes

shortly after being discovered, sometimes never being seen again and other times reappearing decades later.

In 2017, Mat Yunoh Siti-Munirah, a botanist at the Forest Research Institute Malaysia in Kepong, saw images of flowers shared on social media by a guide at Malaysia's Royal Belum State Park. Suspecting the photos depicted an undescribed *Thismia* species, Siti-Munirah and her colleagues visited the park two years later to search for the fairy lanterns.

Beneath a tree, the team found several of the fairy lanterns, which

turned out to be a new *Thismia* species that has been named *Thismia belumensis*.

Fairy lanterns typically have radially symmetrical flowers, often with odd, antenna-like projections. But in *T. belumensis*, a ring of tissue in the flower's centre expands upwards into a "hood" that opens sideways, looking a little like a snake's open mouth (*PhytoKeys*, doi.org/fx82).

**"The new species of fairy lantern may already be critically endangered because of its small range"**

"The species has a floral shape very rare in *Thismia*, known only in a single other species," says Maxim Nuraliev at Lomonosov Moscow State University in Russia.

In this previously known species, the structure is made of two distinct lip-like sections, differing from the new species' hood, says Siti-Munirah.

She and her colleagues already consider the fairy lantern critically endangered. They found fewer than 10 plants, and the species' small range in the park makes it vulnerable. ■

Jake Buehler



## Space exploration

# Concrete towers could loom high on the moon

Jonathan O'Callaghan

**KILOMETRE-high towers made of lunar concrete and covered in solar panels could potentially be used to power a crewed base on the moon.**

The moon's poles have long been eyed for human habitation. Both poles have regions known as "peaks of eternal light", where sunlight shines almost constantly, while the south pole has an abundance of permanently shadowed craters that contain water ice.

These two features could theoretically provide solar power and liquid water for a crewed base, but the surface region of permanent sunlight is only a few square metres in size. At altitude, the area of sunlight is much larger, spanning several hundred square kilometres.

Sephora Ruppert at Harvard University and her colleagues suggest building towers on the moon to access this sunlight, using concrete made from lunar soil. The towers could be made by extracting sulphur from the lunar surface, mixing it with the soil and heating the mixture to bind it together.

The moon's low gravity means such towers could theoretically be built to great heights without buckling, so in practice the height is limited by the available materials.

The team found that a realistic height for such a tower would be 1 or 2 kilometres, requiring 760 and 4100 tonnes of concrete respectively, stacked in blocks like a concrete igloo. With wide bases tapering upwards, the towers could be covered in solar panels, generating large amounts of power ([arxiv.org/abs/2103.00612](https://arxiv.org/abs/2103.00612)).

"From half a kilometre to 2 kilometres, you can have several gigawatts," says Ruppert.

Thanks to the low gravity, the construction of such towers on the moon would be easier than on Earth, where the tallest tower – the 830-metre Burj Khalifa in Dubai – took six years to build. ■

## Archaeology

# Indian stone tool implies humans left Africa early

Michael Marshall

ANCESTRAL humans may have left Africa half a million years earlier than generally thought, according to archaeologists who claim to have found a primitive stone tool from 2.6 million years ago in northern India.

If early humans really were there then, it would mean they migrated out of Africa remarkably early. The oldest evidence of the *Homo* lineage is from 2.8 million years ago at Ledi-Geraru in Ethiopia. This means these hominins would have had to expand their range rapidly to reach India.

The claim is being treated with caution by other archaeologists, who say the stone is so simple that it could have got its shape without human involvement, and that its age is uncertain.

Since 2003, Anne Dambricourt Malassé at the Institute of Human Palaeontology in Paris, France, and her colleagues have been excavating sites near the village of Masol in north-west India, in the foothills of the Himalayas. Silts and sediments from what was once a river and marsh are preserved there.

**The site of excavations near Masol in India**



10 cm

**A possible chopper tool that dates back 2.6 million years**

In 2016, the team described simple stone tools and a handful of bones with marks on them, which the group argued were made by humans using the tools. Such finds are fairly common, but the team claimed they were very old: 2.6 million years old, based on the estimated age of the sediments.

Other archaeologists were dubious, because the remains had been found lying on the land surface rather than buried in a layer of sediment, making it hard to judge their age.

But that same year, team member Mukesh Singh at the Society for Archaeological and Anthropological Research in Chandigarh, India, spotted a stone within one of the datable bands of silt at the site. He thought it might be a stone tool.

DOMINIQUE CAUCHE The following year, the team excavated it, and now think that it is a tool called a chopper. An ancient individual removed flakes from one side of the stone, leaving an irregular cutting edge, says the team (*L'Anthropologie*, [doi.org/fzmk](https://doi.org/fzmk)).

The most likely explanation is that "a species of *Homo* left east Africa [at least 2.6 million years ago]", says Dambricourt Malassé.

Archaeologists contacted by *New Scientist* were cautious about the find. Wil Roebroeks at Leiden University in the Netherlands isn't convinced by the chopper tool, because it is of such a primitive type that it could have been produced naturally, perhaps by stones colliding in a fast-flowing river.

## 2.8

**Age in million years of the oldest evidence of the *Homo* lineage**

However, Roebroeks says more evidence would sway him. Asia has been historically understudied, he says, and has produced a stream of surprises in recent years, so "one should keep an open mind".

"It would be extraordinary, and extraordinary claims also need extraordinary evidence," says Mark Sier at the Spanish National Research Centre for Human Evolution in Burgos.

Significantly, evidence is growing that hominins were in Asia earlier than previously thought. In 2018, 2.1-million-year-old stone tools were described from Shangchen in China. And some people claim that stone artefacts and hominin remains found at the Longgupo site in China are 2.5 million years old. ■



ANNE DAMBRICOURT MALASSÉ

Space

# Orbiting junk probably foiled study of oldest known galaxy

Jonathan O'Callaghan

A FLASH of light in the night sky, thought to have been a burst from a galaxy in the early universe, may have been nothing more than a glint from a piece of space junk.

In December 2020, Linhua Jiang at Peking University in Beijing, China, and his colleagues announced they had seen a brightening event in GN-z11, thought to be the most distant and oldest known galaxy in the universe, which we see as it was 13.4 billion years ago. The event was believed to be a gamma-ray burst, possibly resulting from the supernova explosion of a giant star, the oldest known such occurrence.

However, Michał Michałowski at Adam Mickiewicz University in Poland and his colleagues found that the detection, made from Hawaii in 2017, lined up with a piece of space junk from a Russian Proton rocket that was launched in February 2015 ([arxiv.org/abs/2102.13164](https://arxiv.org/abs/2102.13164)).

Weighing about a tonne, the piece of junk originates from a flight to put a communications satellite from the UK firm Inmarsat, called Inmarsat-5 F2, into orbit. It was the rocket's upper stage, known as the Breeze-M, that was left following an elliptical track around Earth at an altitude varying between 350 and 15,000 kilometres above the planet.

Jiang says his team knew of the existence of this object and ruled it out as being responsible for what they saw: he says it wasn't in the exact field of view of their observations. "We also found the brightness was much fainter than what was needed to produce this flash," he says.

Yet others agree with Michałowski and his team's findings. "I think it's the



DOTTED ZEBRA/ALAMY

definitive answer," says Guy Nir at the Weizmann Institute of Science in Israel, whose independent research also concluded that the burst could have been caused by a satellite. "The orbit of this piece of space trash coincides with the images they took. This is an unlikely event, but it's still more likely than a gamma-ray burst."

Given the flash has passed and is unlikely to repeat, we will probably never know for sure what happened. But the whole episode, with hundreds of hours spent analysing this

**"This highlights the problem astronomers face from satellites and space debris"**

event, highlights the growing problem astronomers face with satellites and space debris affecting their observations.

In the past year, the number of active satellites in Earth orbit has grown by roughly a third, thanks largely to the launch of more than 1000 satellites in the US firm SpaceX's Starlink mega constellation, designed to beam the internet to Earth from space.

## Artist's impression of space debris circling our planet

These satellites are in relatively low orbits, which means that later at night they are in Earth's shadow and so are dark. But other objects left in higher orbits like Breeze-M – which will orbit for decades or even centuries – pose larger problems throughout the night. "There's an accumulation of 50 years of stuff up there," says Jonathan McDowell at the Harvard-Smithsonian Center for Astrophysics.

Michele Bannister at the University of Canterbury in New Zealand says the work of astronomers is increasingly hampered by human-caused interference. "We are already seeing the community spending substantial amounts of entirely unfunded time having to chase their tails to understand and mitigate these issues," she says.

"The best estimate we have is 20,000 [human-made flashes] per day over the entire sky," says Nir, but notes the true number "is probably 10 times bigger". ■

Exoplanets

# Planet hotter than most stars spotted 25 light years away

Jonathan O'Callaghan

ASTRONOMERS may have detected a planet around a nearby star – potentially the second hottest exoplanet ever found.

Spencer Hurt at the University of Colorado, Boulder, and his colleagues used 10 years of observations of Vega, a bright star just 25 light years from our solar system, to look for the telltale gravitational tug of planets.

They were able to spot a potential world that orbits the star every 2.43 Earth days, at a distance 10 times closer than Mercury orbits the sun. It has a mass up to 20 times that of Earth, making it a so-called "hot Jupiter", but its close proximity coupled with the star's brightness – almost 60 times the luminosity of our sun – would make it especially warm.

"It's not unusual to see hot Jupiters," says Samuel Quinn at the Harvard-Smithsonian Center for Astrophysics, a co-author of the paper. "But it's unusual to see hot Jupiters as hot as this."

The planet would have an average temperature of about 3000°C, although because it is orbiting at such a close distance, it would almost certainly be tidally locked to the star with one face in constant sunlight and thus much hotter than the other ([arxiv.org/abs/2101.08801](https://arxiv.org/abs/2101.08801)).

There is one planet thought to be even hotter than this. KELT-9b, a hot Jupiter 650 light years away from Earth, is estimated to have a surface temperature of 4300°C. Both KELT-9b and the new planet are hotter than most red dwarf stars – which are the most abundant class of star in our galaxy – according to the team.

If the observations are confirmed, this would also be the first planet ever discovered in the Vega system. Other planets might exist orbiting at a greater distance from the star too. ■



## Drugs

# Microdosing may be all in the mind

Boost claimed from tiny doses of psychedelic drugs could be down to placebo effect

Clare Wilson

CLAIMS that tiny doses of psychedelic drugs like LSD or the active ingredient of magic mushrooms bring mental benefits may be based on the placebo effect.

People who microdose by regularly taking small amounts of drugs such as LSD say it doesn't get them high, but does boost their creativity, make them sharper or improve their mental health. They may take 10 to 20 per cent of a normal dose, a few times a week.

Some trials suggest that larger doses of psychedelics can help relieve anxiety, depression and other mental health conditions. But microdoses have been tested only in small trials with mixed results. The trials involved placebos to try to control for the placebo effect that occurs when people gain physical or mental benefits from medical treatments due to the power of expectation.

It is hard to get permission for research where people are given

illegal drugs, so Balázs Szigeti at Imperial College London and his colleagues came up with an unusual trial design. They used online forums to find people who already frequently microdosed at home using LSD, the magic mushroom compound psilocybin or similar drugs. The researchers didn't analyse the difference in effects based on the particular drug each participant was using.

Participants were posted empty medical capsules in which they could insert a small piece of drug laced paper. When reclosed, loaded capsules looked identical to empty ones. The 191 volunteers put the drug into some capsules, then set up eight envelopes each containing a week's worth of doses: some with only placebos and some with microdoses. Each envelope was labelled with a QR code before being shuffled and half were discarded. After this, participants no longer knew which ones held the drugs, although the

researchers could look this up.

The result was that a third of the participants took only the microdose-containing envelopes for four weeks, one third took those with placebo capsules and another third got a mix of the two.

The volunteers also took objective online tests to measure mental acuity and answered

**"Benefits were most pronounced in people who were good at guessing if they had taken real drugs"**

subjective questionnaires about their mood and experiences, as well as recording their guesses as to whether they had taken the drug or the placebo.

All three groups experienced similar improvements in their long-term psychological and cognitive outcomes over the four weeks. People who took the real drugs showed "incredibly small" benefits as indicated by

their survey answers about mood and creativity in tests done a few hours after dosing, says Szigeti, but only on the questionnaires. There was no benefit seen in the objective tests (*eLife*, doi.org/fx7h).

In addition, these benefits were most pronounced in people who were good at guessing if they had taken the real drug, probably due to a mild noticeable effect, suggesting even these small benefits could have been due to the placebo response, says Szigeti.

But the trial may not be the final word on microdosing, partly because the volunteers weren't supervised by clinicians.

Bernhard Hommel at Leiden University in the Netherlands says the trial may have uncovered more of an effect if the researchers had measured creativity using objective tests, rather than simply asking people if they felt creative. "Everyone says that about microdosing and that's what we as scientists want to know," he says. ■

## Technology

### Fake bird flies by flapping wings made with goose feathers

A ROBOTIC bird with flapping wings covered in real feathers has flown for the first time.

A team of researchers at Guangxi University in China and Chinese firm Bee-eater Technology built a carbon fibre skeleton with aluminium joints and some plastic parts. It was then covered in a thin foam and goose feathers laid in a pattern mimicking that on a real bird.

An electric motor powered the flapping wings, using a gearbox to reduce the output speed by 48 times. This allowed the robot to flap its wings more like a large

bird of prey and not rapidly, like a hummingbird. The tail pivots vertically and horizontally, providing much the same function as the tail flaps and rudder of an aeroplane. The wings can also rotate slightly around the axis of the wingspan to create pitch.

The ornithopter – as an aircraft that flies by flapping its wings is known – is based on the traits of a golden eagle (*Aquila chrysaetos*) and has a wingspan of 195 centimetres. Whereas a golden eagle can weigh anything from about 2.7 to 6.8 kilograms, this robot weighs just 667 grams.

In tests, it successfully took off, flew for slightly more than a minute and landed safely ([arxiv.org/abs/2102.12687](https://arxiv.org/abs/2102.12687)).



YU CAI ET AL.

Robots with fixed wings that are driven by propellers and covered with feathers have been created before. Researchers have also experimented with flying robots with flapping wings and smooth

The flying robot, which mimics the appearance of a real bird, was based on an eagle

coverings. But this is believed to be the first time a feather-covered ornithopter has proved airworthy.

Yu Cai at Guangxi University says a realistic bird robot could be used to blend in and hide, though video footage suggests that the robot's motor is quite loud.

It may also reveal more about the way real birds fly. "A lot of biomimetic researchers like this kind of robot as a research platform," says Cai. Some other physicists use them as a model to analyse vortex phenomena, effects which come into play during flight. ■  
Matthew Sparkes



# A decade after disaster

The meltdown of the Fukushima Daiichi nuclear plant saw locals evacuate the area. Now they have begun to return, reports **Michael Fitzpatrick**



TEN years after Japan's Fukushima nuclear disaster, life in the region is finally edging back to normal. Following a colossal campaign to remove contaminated soil and wash down buildings and roads in the area, radiation readings above ground are now stable at safe levels.

There is even a sense of a construction boom, although tens of thousands of people have yet to return after being evacuated a decade ago. "Everything is new," said one resident. "New is good."

The most striking new features are concrete sea walls that run northwards for 400 kilometres from the coastal city of Iwaki. At four storeys tall, they are twice the size of the ones overwhelmed on 11 March 2011 by a tsunami triggered by a magnitude-9 earthquake. The waves left nearly 20,000 people dead or missing and knocked out the Fukushima Daiichi nuclear plant's cooling system, triggering a meltdown.

Earthquakes still hit the region, including aftershocks of the cataclysmic 2011 one. Last month, a magnitude-7.3 quake caused damage throughout Fukushima prefecture, but the nuclear power plant reported no abnormalities. Operations to cool the nuclear fuel debris in its containment vessels are still ongoing.

We now have a better idea of what leaked out of the reactors. The flooding of the power plant dispersed lots of radioactive material, including the isotopes caesium-137 and caesium-134, which take 30 and 2 years, respectively, to decay to half their initial amounts. Iodine-131 was also released, but with a half-life of just eight days, it decayed quickly and is no longer detectable in the environment.

A 2013 report by the United Nations Scientific Committee on



ANDRONIKI CHRISTODOULOU



**Clockwise from top: a new tsunami defence wall; houses in Futaba were abandoned in 2011; new houses built for people evacuated from the Fukushima area**

**"The life expectancy lost by people in the worst affected village was less than three months"**

the Effects of Atomic Radiation said that no radiation-related health effects were expected in the general public in Fukushima. A later study in 2016 looking at the city of Date in Fukushima, which was decontaminated in the years following the accident, found that the clean-up efforts had no noticeable effect on reducing radiation levels, although normal decay and weathering did.

So, was it really necessary to evacuate 154,000 people from the region? Phillip Thomas at the University of Bristol, UK, and his

colleagues are unconvinced. In a 2017 study, his team developed a series of tests to examine the impact of relocations after the Fukushima crisis and the Chernobyl nuclear disaster in 1986.

The researchers created a way to calculate the life expectancy saved by moving residents away from areas affected by radiation. They compared this with the cost of relocation and how much this expenditure would affect people's quality of life in the future. They used this to assess the measures used to mitigate





the impact of nuclear accidents.

“We applied a new method, which compares the life expectancy against cost,” says Thomas. “The life expectancy lost by people in the worst-affected village [in Japan] was less than three months.”

Gareth Law at the University of Helsinki in Finland says it was worth being cautious. “I think the evacuation was appropriate: safety first. Understand what the contamination is and assess the problem. Can the levels or forms of contamination harm people? And if it’s safe, then start to allow people to move back.”

## No quick fix

People are moving back, but it will still be a long time before the Fukushima Daiichi power plant is fully decommissioned and everyone can return – about 30 to 40 more years – according to the Tokyo Electric Power Company (TEPCO), which operates the plant. Around 330 square kilometres in Fukushima prefecture were designated “difficult-to-return” in 2013, and only 0.54 square kilometres have reopened to date.

“Decommissioning is the most serious issue at the present,” says Satoshi Utsunomiya at Kyushu University, Japan. “They need to remove all materials inside the damaged reactors, which is a mixture of melted nuclear fuels and structure materials emitting extremely high radiation.”

TEPCO had hoped to start that process this year, but it has been stalled by the coronavirus pandemic, which has delayed tests of a robotic arm designed to remove the collapsed fuel.

Another issue is how to reduce the volume of treated coolant water – 1.2 million tonnes tainted with tritium – because the plant

is running out of storage space (see “Waste water worries”, below).

Outside the power plant, areas bordering a forced evacuation zone and once considered a health risk were last year given the all clear for rehabilitation. Just north of the power plant, the town of Futaba is now welcoming back former residents, but it remains full of shattered housing, with broken windows revealing abandoned

children’s toys, shoes, clothes and kitchen spoons.

Although a few residents have returned to tidy up, many houses lie smashed, spilling their contents onto decaying, weed-choked streets. I spotted a large pheasant gambolling over a zebra crossing, but few signs of normal town life.

Further out is a different matter. On the road south from the town to the power plant, gone are the

abandoned fields and homes, shuttered businesses and vast, orderly stacks of tsunami debris along the flat, coastal plains. Where grass and weeds once grew in mud left by the tsunami, now there are new shops, businesses and homes with solar panels, along with paddy fields and landscaped roads.

The return to normality is slow, however. A decade ago, the hotels of a small town called Naraha, just outside the original 20-kilometre exclusion zone, became a home for clean-up workers at the power station. One inn owner, Minoru Yoshida, returned shortly after the disaster and has made a business of accommodating clean-up and construction workers. As one of the few willing to return, he virtually had a monopoly on supplying accommodation in the area. But working newcomers still outnumber returning residents, he says.

“We’ve seen quite a lot return to the areas opened over five years ago. But the recently reopened towns such as Futaba – they’ve had it,” says Yoshida. “Not because of radiation fears so much, but because it’s been 10 years since they left, the young have put down roots elsewhere. It’s a town for the old now.”

There are many incentives to return. Businesses that reopen this year will get roughly 4 million yen (£27,000) from the Japanese government. But population numbers in Fukushima prefecture have only returned to about 20 per cent of 2011 figures since evacuation orders were rescinded. “None here are worried about Daiichi now,” says Yoshida. “We are more concerned about the coronavirus. Besides, for many of us, the Daiichi clean-up is our bread and butter. Things are good.” ■

## Waste water worries

**Even 10 years on, the stricken Fukushima Daiichi nuclear reactors are constantly bathed in cooling water to keep their radioactive fuel safe. That water is then processed twice to remove 60 types of radioactive materials, leaving just one radioactive element: tritium, an isotope of hydrogen that forms part of the contaminated water molecules themselves.**

**The Tokyo Electric Power Company, which operates the nuclear plant, is storing the contaminated water for now. There are already 1.2 million tonnes of it kept in more than 1000 massive tanks on site, but the firm is running out**

The remains of the Fukushima Daiichi nuclear plant, as seen from Futaba



ANDRONIK/CHRIS TODD/LOU

**of space. One solution is to dump the water into the sea.**

**“The most realistic process would be to just release the water after dilution, but this will impact fisheries even though the total activity of tritium is within tolerance levels,” says Satoshi Utsunomiya at Kyushu University, Japan.**

**The International Atomic Energy Agency takes the same view. Last year, its director general Rafael Grossi told the Kyodo news agency that sea dispersal would be “in line with the current practice and best practices internationally”.**

**But discharge plans have been shelved again and again as neighbouring countries such as South Korea protest and locals worry about reputational damage to industries including agriculture, forest, fishery and tourism.**

**A panel of experts gathered by the Japanese trade ministry in February 2020 recommended releasing the water before the middle of 2022, when the plant’s storage is expected to have filled up. The Japanese government will make a further announcement on plans for the water after the delayed Tokyo 2020 summer Olympics this year, New Scientist understands.**

Sustainability

## Food waste remains a huge problem around the world

OVER a sixth of all food produced globally ends up thrown away, a UN analysis has found. Around 931 million tonnes went into the bins of homes, shops, restaurants and other food services in 2019.

The United Nations Environment Programme (UNEP) and the UK charity WRAP, which promotes sustainability, looked at waste in retail outlets, restaurants and homes by reviewing government data and academic studies across 54 countries with a mix of incomes.

Their joint 2021 Food Waste Index Report found that 17 per cent of all food is binned by consumers. Most of this – 11 per cent of total food – occurs in households. Globally, the average person wastes 121 kilograms of food, with 74 kg of this happening at home.

Food waste isn't just a problem in

high-income countries, the report found. On average, the annual per capita waste in homes is 79 kg in high-income countries versus 91 kg in lower-middle-income nations.

The report included both edible and non-edible waste, such as bones or vegetable peelings. Lower-middle-income countries may have higher per capita waste because food is more often prepared from scratch, which might increase inedible waste.

Losses pre and post-harvest and waste by consumers has an impact on the environment, making up around 9 per cent of all greenhouse gas emissions. It also raises demand for farmland and water.

Reducing this waste is vital and all individuals have a part to play, especially in the home, says Richard Swannell at WRAP. **Priti Parikh**



DAN BROWNSWORD/GETTY IMAGES

Chemistry

## Binding power of eggs revealed

EGG whites are one of the most versatile foods because they can foam, gel and act as emulsifiers. Very little is known about how the proteins in egg whites bind to achieve these properties – but use of X-rays has now given us clues.

Nafisa Begam at the University of Tübingen in Germany and her colleagues used a technique known as X-ray photon correlation spectroscopy to understand how proteins form networks when egg white is cooked.

They cooked egg white at 80°C while zapping it with X-rays. As the beam hits proteins of different sizes moving at different speeds, it bounces off them and scatters at varying wavelengths. Capturing these scatter patterns every 40 milliseconds to produce a total of 20,000 pictures allowed the team to reconstruct the movement of the proteins.

When an egg is heated, the proteins – which have a tangled three-dimensional shape – unfold and form bonds with each other. We knew this happened at a molecular level, but this work shows the network structure developing on a larger, micrometre scale over the first 160 seconds of cooking.

During this time, the team saw an exponential growth in the movement of the proteins. Then movement slowed as the egg white solidified. This suggests that the egg white forms a mesh-like network of proteins within the first 3 minutes of cooking (*Physical Review Letters*, doi.org/fx9f).

This technique could be used to understand the motion in other soft systems, says Aurora Nogales at the Institute of Structure of Matter in Madrid, Spain.

Next, the team is interested in investigating how the egg protein network develops when cooking at different temperatures and with different techniques. **Karina Shah**

Evolution

## European genome was altered by TB

ANCIENT DNA reveals that people of European ancestry lost a gene variant linked to tuberculosis (TB) susceptibility in recent millennia.

TB, caused by *Mycobacterium tuberculosis* bacteria, is one of the world's deadliest diseases. People whose DNA contains two copies of a genetic variant called P1104A are more likely to develop symptoms of TB after being infected.

To trace the frequency of P1104A

over time, Gaspard Kerner at the Pasteur Institute in France and his team analysed modern human DNA and compared it with ancient DNA from Europeans from the past 10,000 years.

This showed the variant was present in low numbers around 8500 years ago in western Eurasia. The team predicted it probably goes back further still, possibly to around 30,000 years ago, before TB was in Europe. "It may have appeared randomly," says Kerner.

It then spread across central Europe 5000 years ago and reached its highest frequency 3000 years ago. The frequency of the variant drastically decreased 2000 years ago, around the time modern TB bacteria became common (*The American Journal of Human Genetics*, doi.org/fx8x).

This may be because it was under strong negative selection from TB, Kerner says, as increasing migration made people more likely to inherit two copies of the variant. **Ibrahim Sawal**



KATERYNA KON/SCIENCE PHOTO LIBRARY





## Really brief



BLICKWINKEL/ALAMY

### Playing dead helps insects stay alive

An antlion larva has a winning strategy when attacked by a songbird – stop moving and play dead. A computer model suggests that some birds can have their attention diverted by wiggling larvae nearby, giving the “dead” larva another chance at life (*Biology Letters*, doi.org/fx8q).

### App makes charging electric car cheaper

A new app from Bulb, a UK renewable energy supplier, can “talk” directly to a user’s electric car and schedule charging for the early hours of the morning when energy demand is low. This reduces pressure on electricity grids and should lower charging costs – from about £0.17 per kWh to £0.04 per kWh.

### The problem with green energy crops

Fighting climate change is often thought to require a huge expansion of crops grown to burn in power stations. But doing so could see 4.58 billion people face water shortages by 2100, as the plants involved will need irrigating (*Nature Communications*, doi.org/fzmx).

## Animal behaviour

### Sea slugs ditch body and grow a new one

THE severed heads of at least two species of sea slugs can move, eat and possibly even eliminate waste during the one to three weeks it takes for their bodies to regrow after being detached at the neck.

Sayaka Mitoh at Nara Women’s University in Japan and her colleague, Yoichi Yusa, were raising one species of sacoglossan sea slug (*Elysia cf. marginata*) to study its photosynthetic abilities when they discovered a living, severed

head in their laboratory.

Intrigued, the researchers examined their slugs and found they all had a groove around their necks that they thought might be a “pre-determined breakage plane”. The slugs’ digestive glands are thought to be “distributed all over the body surface, including the head”, says Mitoh, which might explain how the heads survived.

The team also observed 160 lab-raised and wild-trapped sacoglossans (*Elysia atroviridis*) for just under two years on average. Five of the 15 lab-raised slugs and three of the 145 wild slugs severed

their own heads, while 39 of the wild-caught slugs amputated smaller body parts like the tail.

Some animals shed body parts to escape predators, so the team tried pinching and poking another group of slugs to mimic a predator attack, but none amputated anything. Instead, they noted that some of the wild slugs had internal copepods, a parasitic crustacean – including all of those that severed a body part (*Current Biology*, DOI: 10.1016/j.cub.2021.01.014).

It may be a way to lose parasites that hinder sea slug reproduction, says Mitoh. **Christa Lesté-Lasserre**

## Zoology



NORMAN LEE

### Frogs take a deep breath to pick out the sound of a mate

FEMALE American green tree frogs use their inflated lungs to dampen the mating calls of other species so they can hear possible mates.

Male frogs use calls, ranging from high-pitched cackles to deep croaks, to advertise themselves to nearby females. But getting their attention means competing with calls from other frog species in the same pond.

To find out how they navigate this cacophony, Norman Lee at St Olaf College in Minnesota and his team played a range of sound frequencies to 21 female green tree frogs. They either inflated or deflated the lungs of these frogs. A laser was beamed at a reflective bead put on a frog’s

eardrum. By measuring the reflected light, the team could estimate the amount of vibration at the eardrum’s surface that occurred in response to the sounds.

The eardrums vibrated less when lungs were inflated, but only for sounds within a specific frequency range. The background noise was filtered out when it fell between 830 and 2730 hertz, making the male’s mating calls more audible (*Current Biology*, doi.org/fzmx).

As this only occurs when the lungs are inflated, the team suspects that the lungs work in a similar way to noise-cancelling headphones. **KS**

## Technology

### Rubbery submersible braves deepest seas

A SILICONE robot has survived a journey to 10,900 metres below the Pacific Ocean’s surface in the Mariana trench, where the crushing pressure can implode all but the strongest enclosures. This device could lead to lighter and more nimble submersible designs.

A team led by Guorui Li at Zhejiang University, China, based the design on snailfish, which have relatively delicate, soft bodies and are among the deepest-living fish. They have been observed at depths of more than 8000 metres.

The robot looks a bit like a manta ray and is 22 centimetres long and 28 centimetres across. It is made of silicone rubber with electronic components spread throughout the body and connected by wires, rather than mounted on a circuit board like most submersibles.

That is because the team found in tests that the connections between components on rigid circuit boards were a weak point when placed under high pressure.

The robot is propelled through the water by two flapping wings designed to work like the fins of a snailfish, but which are operated by artificial muscles made of a conductive polymer (*Nature*, doi.org/gh6t2w). **Matthew Sparkes**

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## The columnist

Graham Lawton on the worrying rise of extinction denial **p24**

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Can a trillion dollars fix the world? Readers give their views **p26**

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Magnificent images of the majestic African lion **p28**

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The wonders of the deep beckon in *The Brilliant Abyss* **p32**

## Culture columnist

Jacob Aron loves his time-loop gamer trip to the *Outer Wilds* **p34**

## Comment

# Serving up hope

Food allergies are a growing, potentially life-threatening problem. The good news is we can turn this around, says **Kari Nadeau**

**F**OOD allergies have been on the rise. In the US, it is now estimated that over 10 per cent of the adult population has an allergy to peanuts, shellfish, dairy or another food. In the UK, the past three decades have seen hospital admissions for food allergies rise fivefold. Thankfully, we are building up the armoury needed to reverse this trend so that, one day, such potentially deadly reactions become a thing of the past.

The most common types of food allergies are triggered by antibodies that we make called immunoglobulin E or IgE. These antibodies were discovered in the mid-1960s and kick-started an era of allergy research still going strong today. The early findings have spawned thousands of studies that paint an intricate picture of how allergies work, suggesting ways in which we can prevent and treat them.

When someone has a food allergy, IgE is involved in triggering a response when the immune system comes into contact with that food. Essentially, the body sees that part of your meal as an enemy, releasing histamine and other inflammatory chemicals in an attempt to deal with it. This causes symptoms ranging from itchiness and sneezes to wheezing and anaphylactic shock. The result can be anything from a mild inconvenience to death.

We have yet to get to the bottom of why the body sometimes sees harmless substances in this way, but we now know much more



about stopping this process from happening in the first place.

The old saying “prevention is better than the cure” holds true for food allergies. My colleagues and I use the so-called six Ds as a guide to preventative measures during childhood: diet, dirt, dogs, dry skin, detergents and vitamin D. Studies have found that people have a lower risk of developing an allergy when, as youngsters, they eat a diverse diet and do so often, have healthy vitamin D levels, live in a home with a dog, avoid dry skin and are exposed to dirt,

allowing them to develop a good microbiome. The use of harsh detergents has also been associated with an increase in IgE.

There is also evidence to suggest that when children consume potentially allergenic foods early in their lives, this trains the immune system to accept them.

Clearly, for many people that have food allergies, such early life prevention is no longer an option. However, other approaches are taking shape.

Most of the interventions we currently use target the immune

system in an effort to retrain its response to allergens. One technique, known as allergen immunotherapy, involves slowly building up exposure to a problem food. By starting in very small doses, the body appears to be able to be retrained to no longer see it as a threat. People with reactions to peanuts, egg, milk or even to multiple foods have found success using this method. However, immunotherapy needs regular exposure to allergens, which can cause side effects.

There are also anti-IgE drugs that can block the antibodies involved and raise your threshold for a particular allergen before it makes you ill. These can be particularly useful when used with allergen immunotherapy to help people become desensitised to troublesome ingredients.

Allergy vaccines are another option. These work by reshaping the body’s immune response to a particular food so it doesn’t end in illness. One example is a vaccine that has been used to help people with peanut allergies.

As we gain evidence and experience with each of these approaches, we are moving closer to being able to treat all food allergies. Many of us around the world are aiming to forge a new era, one in which this scourge is a thing of the past. ■



Kari Nadeau is at Stanford University in California and is co-author of *The End of Food Allergy*

No planet B

**Extinctions? What extinctions?** There are a growing number of people who deny the threats that many species face. It is a worrying trend, writes **Graham Lawton**



Graham Lawton is a staff writer at *New Scientist* and author of *This Book Could Save Your Life*. You can follow him @grahamlawton

**Graham's week**

**What I'm reading**

*I have tired eyes so mostly listen to audiobooks. The BBC's adaptation of *Light Perpetual* by one of my favourite authors, Francis Spufford, was beautiful.*

**What I'm watching**

*I am looking forward to *Deutschland 89*, season three of the cold war drama. I thought 83 and 86 were ace and I am expecting walls to come tumbling down in 89.*

**What I'm working on**

*Still on the covid-19 beat.*

This column appears monthly. Up next week: Annalee Newitz

A COUPLE of weeks ago, I got sucked down an internet rabbit hole – or should I say tiger trap? It arrived in the form of a tantalising video of a man claiming to have rediscovered a charismatic animal that officially went extinct in 1936. Speaking from a small town in northern Tasmania, Neil Waters, president of the Thylacine Awareness Group of Australia, claimed he had camera-trap footage of what he said were three thylacines, aka Tasmanian tigers. The pictures were being assessed by an expert at the Tasmanian Museum and Art Gallery, he said, and there would be further announcements in due course.

As the video trended on Twitter, I wondered: could it be true?

My heart said yes; my head overruled. I know a thing or two about thylacines. In 2017, I interviewed conservation biologist Bill Laurance at James Cook University in Queensland about his plan to look for them around the remote Cape York peninsula, a known thylacine haunt – until about 4000 years ago.

It seemed an odd gamble for such a distinguished biologist. The ranks of thylacine hunters are largely filled with eccentrics, wishful thinkers and publicity seekers. Yet he thought there was a slender chance and, given that he was doing field work in the area anyway, what was the harm?

A few weeks later, he confirmed that he had seen neither hide nor hair of a thylacine. Absence of evidence and all that, but in his opinion, the thylacine remained an ex-marsupial.

And if they aren't in Cape York, they aren't anywhere. They certainly aren't in Tasmania, even though that is the last place they were seen alive. The island's many land mammals regularly turn up dead by the side of the road, killed

by passing vehicles. Thylacines are never among them.

I hate to say I told you so, but a few days later Waters's footage was released and the museum issued its verdict. The animals weren't thylacines but almost certainly pademelons, small wallaby-like marsupials.

I was briefly disappointed – I would dearly love thylacines to still be alive. But I was also strangely relieved. Weird as it seems, the rediscovery of the thylacine would represent a setback to our efforts to save the endangered species that we know for sure still exist.

**“Denialism's goal isn't to establish the truth, but to advance a rhetorical position by any means necessary”**

A few weeks before the Tasmanian tiger non-news broke, I was reading a paper in the journal *Nature Ecology & Evolution* about the “creeping rise of extinction denial”. In it, Alexander Lees at Manchester Metropolitan University in the UK and his co-authors warn that a campaign of biodiversity denial has begun. It has been festering for some time, but broke cover after the 2019 publication of a shocking report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Though a relatively new form of science denial, extinction denial follows a well-thumbed playbook. It comes in three basic flavours: literal denial, which is flat-out rejection of the scientific evidence; interpretive denial, which doesn't dispute the findings but says they are being exaggerated; and implicatory denial, which accepts

there is a problem but claims that it doesn't justify radical action. All three exist to prevent or delay measures that might challenge the existing socioeconomic order.

It is no surprise that extinction denial exists. What is a surprise is how long it has taken. Biodiversity science is relatively easy to pick rhetorical holes in. Like climate science, it relies on often-sparse data and modelling to discern long-term trends against loud background noise. Even establishing beyond reasonable doubt that a species has gone extinct, let alone that human activity caused it, is challenging.

That is why I am somewhat relieved that the thylacine remains extinct. Imagine the lulz that extinction denialists would have had from its rediscovery. They said it was extinct! They said humans wiped it out! They said that the sightings were a hoax! What else are they hiding? What else isn't really extinct?

Dismissing these claims as scientifically ignorant is itself ignorant of denialism. As Lees points out, denialism's objective isn't to establish the truth, but to advance a rhetorical position by any means necessary.

I am not suggesting that the thylacine hunters are motivated by denial. On the whole, they are honest people who just want to believe. But that won't stop denialists from exploiting their claims.

Maybe their well-meaning but quixotic efforts should be expended elsewhere. Soon after the latest round of Tasmanian tiger hype, the Australian government confirmed the extinction of 12 more native mammal species and a lizard. I would like to say there is no denying the biodiversity crisis anymore. But I know better than that. ■



6 days | 1 November 2021

# Megalithic Malta: Temples, fortifications and archaeology

Malta and Gozo are small islands that conceal a long and fascinating history including several exceptional archaeological sites. From the ancient and mysterious temples believed to be some of the world's oldest structures, to the fortifications of the Knights of St John which withstood unprecedented bombardment in WWII. Visiting three UNESCO World Heritage Sites, you will discover 7000 years of history including unexplained carved-stone landscapes, and prehistoric death cults, as well as beautiful coastlines, attractive fishing villages and fine Baroque architecture.

The tour will feature talks and walking seminars from *New Scientist* editor Alison George and will be led by award-winning journalist Juliet Rix.

## Highlights

- Explore the temples of Tarxien, Hagar Qim and Mnajdra which enable you to trace the development of temple building on Malta from around 3600BC.
- Marvel at Valletta which has recently undergone a series of major restorations including the impressive ramparts and Renzo Piano's new Parliament building.
- Visit St. John's Co-Cathedral with Caravaggio's masterpiece 'The Beheading of St. John', the Grand Master's Palace and the beautiful jewel-like Teatru Manoel, one of the best surviving Baroque theatres in Europe.
- Tour the Auberge de Provence, the Baroque residence of the Knights of Malta from the Provence region of France. This

now houses the Archaeological Museum, including some of the most exquisite finds from Malta & Gozo's prehistoric sites dating back up to 5,000 years.

- Marvel at the prehistoric temples at Ggantija, a UNESCO World Heritage Site, 1000 years older than the Egyptian pyramids and the second oldest stone structure in the world.
- Visit the picturesque fishing village of Marsaxlokk, before visiting the fascinating cave Għar Dalam, where finds include remains of long-extinct species dating back 10,000 years.
- Sail across the narrow strait to Gozo, a verdant island of fertile farmland, picturesque villages and monumental Baroque churches.
- Enjoy a relaxing harbour cruise onboard a traditional Maltese 'Luzzu' from the Grand Harbour, allowing you to fully appreciate the remarkable fortifications of Valletta.
- Take part in a walking tour of Malta's first capital Mdina (The Silent City). A fortified city of just 300 inhabitants. Best known today for its starring-role in the 'Game of Thrones' TV series – with its mix of Norman and Baroque architecture including palaces and a cathedral.

## Covid-19 safety protocol includes:

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## Editor's pick

### The answer to the trillion-dollar question is...

27 February, p 38

From David Purchase, Bristol, UK

**Of the three trillion-dollar projects described by Rowan Hooper, only one seems sensible. It is impossible to eradicate world poverty because there will always be the bottom 10 per cent and those people will be defined as "in poverty". Curing all disease is pie in the sky: everyone has to die of something.**

**Spending this money – or even more – on stopping climate change (by far the most serious problem facing the planet) is the right way to go. Even then, showering scientists with money may not help much, because it is ultimately the political decisions that matter.**

From Darryl Mead, Cambridge, UK

Your recent leader (27 February, p 5) supports Hooper's model of spending a trillion dollars to solve the world's biggest problems, but concludes that this is limited by the availability of cash. This is an obvious but unnecessary blockage. All money is imaginary. It is created out of nothing and can be spent on any programme we want. Come on, central bankers, it is time to save the planet.

### Earth may have its own plan to rescue nature

20 February, p 34

From Dan Kacsir,

Indianapolis, Indiana, US

What is all this talk about rescuing nature? There is no need for that. I got this! I know I have been infected by an extremely smart and super deadly parasite, but I am taking strong measures to eradicate it. I am altering my environment to make it unlivable for the parasite and I am doing this very rapidly so the vermin won't have time to adapt and survive.

Once I have cleared this disease, rebooting nature will be a piece of cake and I will still have a couple of hundred million years or so to

evolve a truly intelligent life form. I will see if I can get it right this time. Submitted by: Earth. Channelled through: me.

From Guy Cox, St Albans,

New South Wales, Australia

While I agree with the sentiments of Graham Lawton's article, I feel that labelling the natural crisis as a post-1945 one is wrong.

When I was born in 1945, none of England's original native forest was left – and hadn't been around for hundreds of years. North American passenger pigeons used to darken the sky with their flocks, but the last wild specimen was shot in 1901. There were around 60 million American bison in the 18th century; by 1889, just 541 remained.

In the UK, I lived near land where just a few weeds would grow, downwind of a Roman-era lead smelter. Today, there is a similar but larger area in Queensland downwind of an aluminium smelter. It would seem we have learned nothing in 2000 years.

From Brian Maudsley,

Madrid, Spain

You didn't mention microbes. The bacteria and archaea, as well as many other soil organisms, are probably key to the successful regeneration of impoverished soils, allowing the renewal of the more visible plant species.

From Susannah Matthews,

London, UK

There is a glaring omission in your rescue plan for nature: without halting human population growth, it is doomed to fail. Your special report (14 November 2020, p 34) was the first time you examined in depth the connection between having too many humans and environmental devastation. Don't let it be the last.

### Here's hoping for robo-swarms very soon

20 February, p 23

John Quentin,

Corsham, Wiltshire, UK

James Marshall's "Borrowing bee brains" article caused a real buzz. It was fascinating to read that, having reverse-engineered part of the visual system and navigation and memory sensors of bees, he and his team created autonomous drones. Should sufficient numbers of these be flown together to create a viable "swarm", the sight would doubtless be impressive.

Might we assume that the next steps will result in the creation of workers and queens? If a swarm of workers encounters a lone queen, might we then see the conditions being set for the beginnings of robotic replication?

### Online gaming raises a question of trust too

13 February, p 23

From David Frankland,

Perth, Western Australia

Gambling is a worry on many fronts, including how to trust online games. Visit a physical casino and you can see the cards being dealt, the dice being thrown and the roulette wheels spun.

Online, fraudsters can set up a realistic-looking gambling site and write code to make sure certain cards or numbers appear. Got a dispute? Best of luck trying to collect from your "casino" on the other side of the world.

### No pain, no gain for this new breed of wearables

13 February, p 20

From Sam Edge,

Ringwood, Hampshire, UK

You report on a backpack that, as it moves, converts some of the bag's

kinetic energy into 118 microjoules of electrical energy.

In terms of electrical power (a better indicator of its usefulness), it probably amounts to very little, as is the case with any biomechanical energy-harvesting device that doesn't impose unacceptable extra effort on the wearer. This is just a rehash of the "power your lights/phone/body heater/whatever from your footsteps" nonsense.

### Cutting animal-based food can be done much sooner

20 February, p 30

From James Rand, Bristol, UK

I am amazed at the lack of ambition expected of individuals when addressing climate change. In your review of Bill Gates's book, you mention UK government advisers thinking the population could reasonably be expected to cut meat and dairy consumption by a fifth by 2050. I would say that by tonight isn't an unreasonable time frame, not 30 years hence!

### Memories of these early humans may last and last

Letters, 20 February

From Stephen Gooder, Bristol, UK

Alan Jowett wonders if Denisovans inspired tales of the Yeti. In Channel 4's documentary *Yeti: Myth, man or beast?*, I and my TV colleagues asked the same thing.

One crucial point was whether folk memories could survive for so long sustained by nothing more than the oral tradition. It seemed like a stretch, until I came across research reporting that various groups of Indigenous Australians all had their own stories about coastal flooding. To the authors, this implied that folk memories, in Australia at least, had persisted for perhaps 13,000 years – the time of a major meltwater pulse during postglacial sea level rise.

More tenuously, folk tales from the island of Flores about small, hobbit-like humans seem to have endured for close to 50,000 years, the widely accepted last survival date for *Homo floresiensis*. ■



### Want to get in touch?

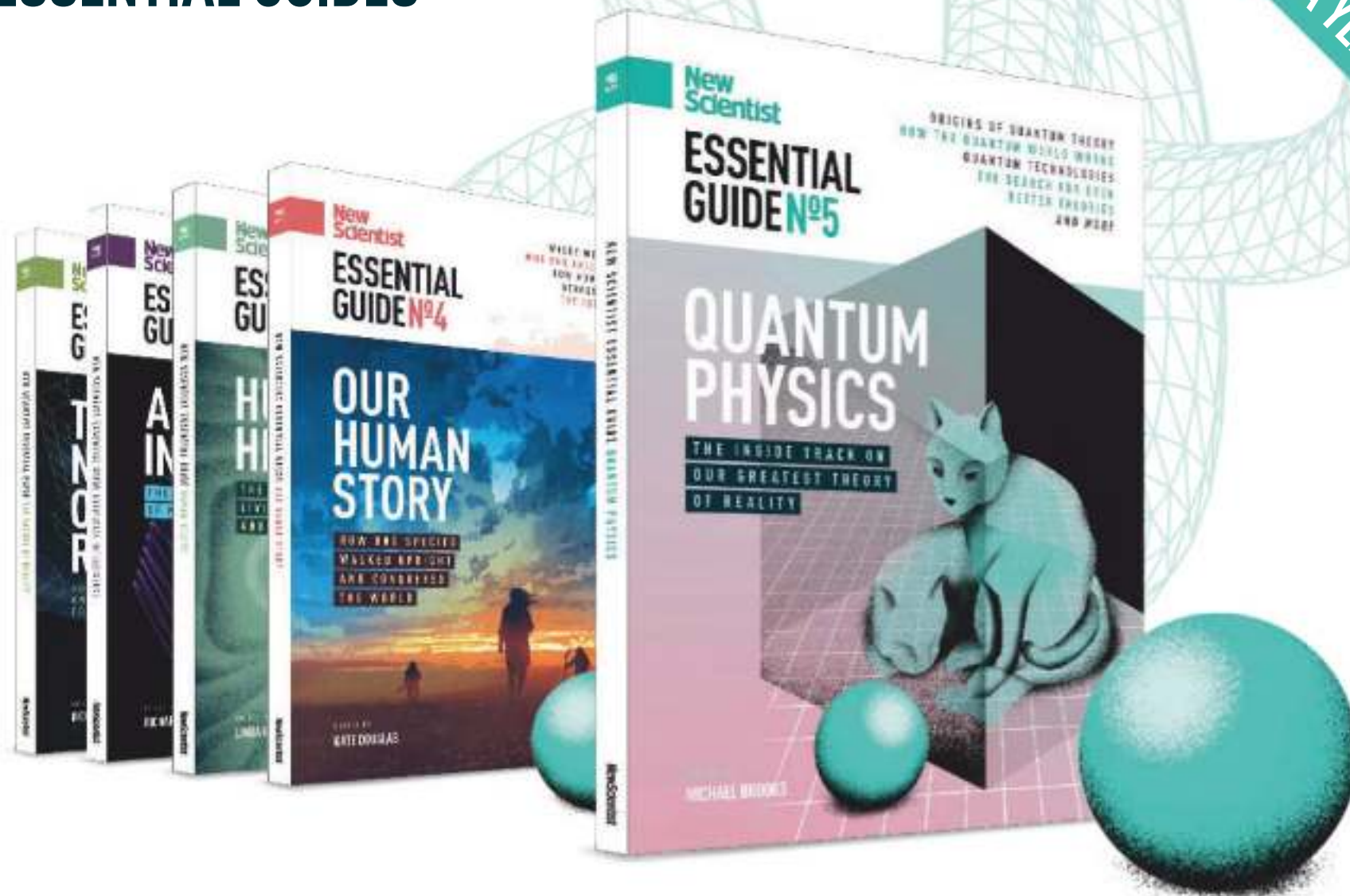
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## The lion's den



**Photographer George Logan**

THESE powerful images taken by photographer George Logan show why the African lion (*Panthera leo*) is seen as a symbol of courage and majesty. But the evocative photos, which are a mixture of unedited and conceptual shots, also highlight the plight of these iconic big cats as they face extinction at the hands of humans.

The photos come from Logan's latest book, *Lion: Pride Before the Fall*, made in collaboration with the Born Free Foundation, a UK-based international wildlife charity.

Once common throughout the continent, African lions are now extinct in 26 countries and cover a mere 6 per cent of their previous range. The population has been slashed to fewer than 20,000 individuals, mainly due to hunting and increased livestock farming and agriculture across Africa. "They are on course to be extinct in the wild by 2050," says Logan.

The main image, entitled *Everything the Light Touches Used to be Our Kingdom*, is a nod to the Disney film *The Lion King*. This composite shot of an encroaching skyline reveals the extent to which humans have invaded the African lion's habitat and range.

Below, smaller images from the book show (left to right): a male lion as it charges through the grass; a lion in captivity, with tally marks edited onto the enclosure's walls; cubs playing, which is critical for sharpening their survival and hunting skills; a photoshopped lion with wings, suggesting the endangered animal could disappear into myth; and a lioness carrying her cub.

*Lion: Pride Before the Fall* is available to buy on the Born Free website, with proceeds going towards lion conservation. ■



**Gege Li**



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# **“2021 must be the year to reconcile humanity with nature”**

**António Guterres,**  
United Nations Secretary General, Paris, December 2020





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# Down to the abyss

There is an abundance of weird and wonderful life in the depths of the sea – and Helen Scales is an excellent tour guide, says **Eleanor Parsons**



A deep-red jellyfish in the medusa stage, living in the Arctic Ocean

portrayed as one of green or blue, writes Scales, “the greening of global economies pitted against the health and integrity of the blue oceans”. But she says there is a third path: recycling the metals we have already dug up.

These problems are out of sight and out of mind to many. Scales lists why we should care about them, including the deep’s key role in feeding the surface fisheries that many people rely on for food, as well as its mitigating impact on climate change. “In total, a third of humanity’s carbon emissions make their way into the ocean,” she writes, “saving the Earth from an unthinkable swift and catastrophic version of the climate crisis.” While this is pragmatic, I do wish we didn’t have to think up positive ways to exploit an environment in order to convince people that it is worth protecting.

*The Brilliant Abyss* is an enjoyable and accessible introduction to the deep sea, told with a passion that I found infectious. The stories of life’s struggle for survival beneath the waves are compelling and Scales is particularly evocative when describing hydrothermal vents. I would have liked to read more about bioluminescence and the creatures that use it to dazzle predators and prey alike, however, and the book can become lost in detail when it leaves the deep, such as a pages-long digression about batteries.

Overall, though, Scales brings to life this important part of our planet. What happens there is something we should all be concerned about. As Scales puts it: “The deep, quite simply, makes this planet habitable.” ■



**Book**  
**The Brilliant Abyss**  
**Helen Scales**  
**Bloomsbury**

AT THE bottom of the Mariana trench, the water is chillingly cold and dark, with a pressure so high it can dissolve shells and exoskeletons. It is the ocean’s deepest point, lying almost 11 kilometres beneath the surface, and it is home to a remarkable crustacean.

This shrimp-like creature is called an amphipod and it has an ingenious adaptation to survive the conditions: it uses metallic compounds from mud to make itself a coat that prevents its exoskeleton from dissolving. With this protection, the scavenger can scour the trench for the food that builds up there, funnelled to the bottom by underwater avalanches.

In *The Brilliant Abyss*, marine biologist Helen Scales describes

amphipods and the many other remarkable creatures that live in the deep sea. Weaving together the latest discoveries with well-known examples, she details the many fascinating adaptations that life has evolved to survive in a world unlike anything at Earth’s surface.

There are vampire squid, for example, which hang around in the cold water waiting not for blood-filled prey, but to make edible snowballs out of the flurries of detritus that fall from the ocean surface that are known as marine snow. Then there are corals that started growing more than 4000 years ago and female octopuses that spend five years without food so they can brood a single clutch of eggs. And then there are the inconspicuous ultra-black fish that reflect hardly any light so that they blend into the background.

At gushing hydrothermal vents and the gentler cold seeps are clusters of Yeti crabs, which use their furry arms to farm bacteria for food. Their bacterial crops are

chemosynthetic, meaning they can use the methane and hydrogen sulphide in the bubbling water as an energy source, much like plants do with sunlight.

After detailing this diverse underworld, the book takes a darker turn to explore the threats these creatures face from us.

**“There are female octopuses that spend five years without food so they can brood a single clutch of eggs”**

Deep-sea fishing is the most well-known example. It is “an industry that yields relatively trivial economic benefits but a fearsome capacity to vandalise our living planet”, writes Scales. An increasing threat lies in projects to mine the seabed to satisfy humanity’s growing demand for metals, particularly to use in the green tech needed for a low-carbon future. The choice is



# Your neighbours, the aliens

*Solar Opposites* puts aliens in an average US suburb with hints of *Rick and Morty*. It is silly, but has morals, says **Gege Li**



## Animation

### Solar Opposites

Justin Roiland and Mike McMahan  
Disney+ Star

HOW would intelligent aliens from another world fare in a typical US neighbourhood? This is the premise of *Solar Opposites*, a hilarious adult animation created by Justin Roiland and Mike McMahan about a family from the planet Shlorp.

The show follows scientist Korvo (voiced by Roiland), his partner Terry (Thomas Middleditch, from hit show *Silicon Valley*) and their replicants – the Shlorp equivalent of children – who take refuge on Earth after fleeing their destroyed home planet. The first season was shown on Hulu in 2020, and is now being released on Disney+ with a second season starting in March.

Also along for the ride is the Pupa (Liam Cunningham in season 1; and Sagan McMahan in season 2), an infant-like being that each escaping Shlorp family was issued with when leaving their doomed planet.

Although Korvo hates everything about Earth and its inhabitants, Terry has willingly assimilated and indulges in as much popular culture as possible, spouting phrases like “roll with the homies” and threatening to kill himself if *Frasier* turns out not to be real.

The pair’s replicants, supercilious Yumyulack (Sean Giambrone from *The Goldbergs*) and more compassionate Jesse (stand-up comedian Mary Mack) are mistrusted at school because they are aliens, and are suspected (often rightly) of impressive feats such as reconfiguring the school’s computer into an artificial intelligence.

Terry, Yumyulack, the Pupa, Jesse and Korvo have to deal with life on Earth

In the first episode, Korvo is intent on repairing the family’s spaceship so they can leave what he considers to be a “human-infested crap hole without a single redeeming value”. Unfortunately, he manages to burn off both his feet while drilling into Earth’s core, leading to his discovery of the children’s TV character Funbucket, and a considerable amount of destruction.

Fans of the hit animation *Rick and Morty* (another Roiland creation, with comedy writer/producer Dan Harmon) will notice the parallels between the shows. They share an animation style that fleshes out the different worlds, alien technology and often ridiculous characters.

Both shows’ protagonists, Rick and Korvo, also harbour a cynical disdain for their situation. But while the human Rick in *Rick and Morty* has visited so many dimensions with such infinite possibilities that it seems obvious everything is pointless, the aliens in *Solar Opposites* could be forgiven for their questionable outlook and approach to human life.

The show has darker moments, such as when the aliens lobotomise a school bully by pouring diet cola on her exposed brain. This feeling is underscored by the seemingly innocent entity, the Pupa, whose destiny is to terraform Earth into a version of Shlorp.

Perhaps most disturbing is the post-apocalyptic civilisation developing in Yumyulack and Jesse’s bedroom wall, home for the people shrunk by Yumyulack’s shrink gun and whose turmoil leaves the replicants largely unmoved.

The aliens’ lack of awareness or concern for the world around them and the disastrous results of their actions recurs through the series. It makes for entertaining storylines and introduces issues like freedom and morality, underlining what happens when a species – the Shlorprians or humans – regards itself as superior and all-powerful.

Ultimately, this is what makes *Solar Opposites* so engaging. It is confidently executed animation that isn’t afraid to be clever and silly, and it will delight Roiland’s fans and new viewers alike. ■



## Don't miss



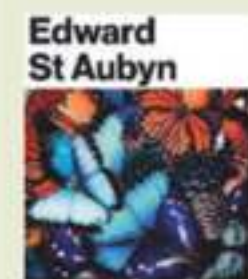
## Read

**Gut Feelings: The microbiome and our health** by Alessio Fasano and Susie Flaherty reveals how understanding this alien inner world will make it possible to target medicines to an individual’s needs at the molecular level.



## Watch

**An Impossible Project**, streaming on digital platforms from 15 March, celebrates the return of analogue formats, from Polaroid to vinyl. The film highlights the work of Viennese biologist Florian “Doc” Kaps to reverse the tide of technological “progress”.



## Read

**Double Blind** by Edward St Aubyn leaps from London to Cap d’Antibes in southern France to a rewilded corner of Sussex, UK, in a thrilling and mischievous tale of ecology, psychoanalysis, genetics and neuroscience.

## The games column

**The joys of discovery** Watching my ship speed away as I float through space in *Outer Wilds* rivals moments in *Gravity* or *Interstellar*. It is just one reason why this time-loop adventure is among the best games ever made, says **Jacob Aron**



Jacob Aron is New Scientist's deputy news editor. Follow him on Twitter @jjaron



A view of Timber Hearth, the home planet where *Outer Wilds* begins



### Game

#### Outer Wilds

**Mobius Digital**

PC, PlayStation 4, Xbox One

### Jacob also recommends...

#### Games

#### The Witness

**Thekla**

PC, PlayStation 4, Xbox One, Android, iOS

*The Witness is full of mysteries. Set on an island split into regions, each locale puts its own spin on grid-based logic puzzles. It is gorgeous, but extremely mentally taxing.*

#### No Man's Sky

**Hello Games**

PC, PlayStation 4, Xbox One

*No Man's Sky offers billions of procedurally generated worlds. This can make them feel samey, but the latest update lets you collect alien pets.*

THE first few months of any year are a slow time for video game launches, but whether it is due to the pandemic or the recent release of next-generation consoles, new games are thin on the ground at the moment. That is why I spent this month checking out 2019's *Outer Wilds* – and I am glad I did, because it is one of the best games ever made.

A bold claim, but hear me out. *Outer Wilds* is set in a miniature solar system filled with planets bearing evocative names such as Giant's Deep and Brittle Hollow. As the newest member of Outer Wilds Ventures, an organisation that is as much a bunch of trail hikers as it is NASA, you set off to explore these worlds – and in 22 minutes, the sun explodes in a supernova, wiping out you and everything else in the solar system.

Moments later, the game resets and you begin another 22-minute session. This time limit, combined with the small solar system, gives you space exploration without the boring bits. After launching your trusty spacecraft, you can be walking on the surface of another

planet within minutes. At the same time, everything operates under more-or-less realistic orbital mechanics, making space flight a challenge of matching orbits and velocities – you can't just point at your destination and go.

I spent my first few runs getting to grips with the controls, which allow you to thrust in either

**“There are no new abilities to unlock as you play – the only thing you gain is knowledge”**

direction along all three spatial axes, and more than once found myself falling into the sun, triggering an early reset. Yet little by little, I mastered my ship and was soon merrily exploring.

I am deliberately avoiding saying much about what I found because *Outer Wilds* is about the joy of discovering things for yourself: it really is everything you could want from a space-exploration game. To give you a flavour, during my playthrough, I fell into a black

hole, docked with a mysterious space station and landed on a comet, before falling off again.

But not all in a single go. Your ship's computer records your discoveries, linking them together like a corkboard with strings. This doesn't reset, allowing you to uncover the game's many mysteries over a number of runs. There are no new abilities to unlock as you play – the only thing you gain is knowledge, so you could theoretically complete *Outer Wilds* in your first 22 minutes.

The result is that the game is full of “aha!” moments that are both incredibly satisfying and make you feel very clever, but it is also mechanically brilliant. Launching your spacecraft at the start of a run is always a tiny thrill as you rumble into orbit. Your spacesuit has limited oxygen and fuel, making it essential to manage your resources. If you run out of fuel, you can use oxygen as propellant in a last-ditch effort to get to safety.

This comes together to generate moments that easily rival *Gravity* or *Interstellar*. At one point, I was floating around a planet, separated from my ship, which was orbiting another planet.

I could see the ship was heading away from me, and doubted I would be able to catch up with my remaining fuel. Instead, I pulled open my map of the solar system so I could estimate when the two planets would have their closest approach. Timing things just right, I jetted off for what I thought would be a daring rendezvous. For a moment, it seemed like I was on course... until I smashed into a moon, cracked my helmet and died. Thankfully, the next run was just a moment away. ■



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SAMAN SARHENG



# Why quantum is relative

Nothing truly exists – except in relation to other things. If we can get our heads around that one idea, we can begin to grasp the quantum realm, says **Carlo Rovelli**

**H**ERE is a chair in front of me. A nice red wooden chair with four legs, a seat to sit on, a rest to support the sitter's back. Does this chair exist by itself?

Of course it does: it exists regardless of me. But wait: we call it a chair because we sit on it. Would there be the concept of a chair without its relation to us, without sitting humankind?

Maybe not, but even if someone were unaware of a chair's intended function, its components would still exist, for instance the smooth red wood it is made of. What does "red" mean, though? It refers to an interaction between the wood, light scattering off it and particular receptors in our eyes. Most animals don't see colours like humans, though.

Regardless of that, the atoms of the wood are there, even in the absence of our receptors or the light that may bounce off those atoms. Dig down deep enough, and things have properties that are independent of anything else, right?

Perhaps not. Quantum physics, which describes the bizarre behaviour of the physical world at the most elementary level we know,





may be telling us the opposite. Things don't have properties exclusive to themselves: their properties only exist by virtue of their relationship to other things, just like there are really no "chairs" without someone around to interact with them and see them as such. Coming to terms with this idea may clarify the persistently mysterious nature of the quantum world. It might even help make other mysteries, such as the nature of our conscious experience, a little bit less mysterious.

Quantum theory remains puzzling despite a century of total success. The theory is routinely used in condensed-matter, nuclear and particle physics, in astrophysics, chemistry, electronics and much else, and hasn't been found wanting so far. But if you stop and think about what it really tells us about the nature of the world, you cannot avoid becoming perplexed. This is a topic of lively debate in physics and philosophy departments.

A contentious question, in particular, is what the "wave function" – or the more abstract version of this notion, the "quantum state" –

really represents. The wave function of an electron, for instance, is an entity diffused in space that we can use to compute the probability of finding the electron at a given position. This notion is often given prominence in the teaching of quantum mechanics. But is the wave function a genuine, actual picture of reality? Or is it only a tool to tell us what might happen next, like a weather forecast that helps us anticipate where rain might fall?

Interpreting the wave function as the "real stuff" of the world creates difficulties. In our calculations, the wave function jumps (or "collapses" – in the jargon of the theory) when we measure something. When we detect an electron somewhere, for instance, its wave function suddenly concentrates there. But why should nature care if there is anybody measuring anything?

This difficulty was famously expressed by physicist Erwin Schrödinger in pictorial terms. Before we observe it, the wave function of a cat might be a superposition of a sleeping cat and

an awake cat (in Schrödinger's version, the cat was dead or alive, but it isn't nice to joke about dying cats). Such a superposition is the source of quantum effects called interference that don't happen if the cat is either awake or asleep. But how does the cat feel in such a superposition? How, indeed, would you feel if you were in such a quantum superposition?

Different ideas try to make sense of this strangeness inherent in the wave function picture. They all lead somewhere disconcerting. The "many worlds" interpretation, for instance, claims that the cat is both sleeping and awake; if you look at it, reality splits into parallel worlds in which two equally real copies of you see those two states of the cat. The "hidden variables" interpretation assumes that some physical influence is pulling the strings, determining what happens – but working on a non-local level of reality that is inaccessible to us. "Physical collapse" interpretations speculate that collapse isn't anything to do with observations, but rather due to a natural

phenomenon going on all the time – which so far, however, hasn't been observed.

There is an alternative to all these unpalatable conclusions. To understand it, it helps to recall a quirk of history – two, in fact.

The first is that, when Schrödinger introduced the wave function in 1926, quantum theory already existed in its full glory, without any wave function. After a first breakthrough by Werner Heisenberg, the formulation of the theory was completed by Max Born with Heisenberg and Pascual Jordan, and independently by Paul Dirac, in 1925.

This formulation is extraordinarily elegant. It can be summarised by saying that a quantum system is governed by exactly the same variables and equations as in classical physics, with the addition of a single extra equation:  $xp - px = i\hbar$ . Here  $x$  is the position and  $p$  the momentum of the system,  $i$  is the square-root of -1 and  $\hbar$  is the Planck constant, the fundamental constant of nature that defines the scale of the quantum realm. Virtually all the phenomena predicted by quantum theory, from Heisenberg's famous uncertainty principle to the atomic bomb, from the laser to quantum computers, follow from this one equation that states that multiplying two physical quantities in a different order gives a different result.

In this language, the theory isn't about a wave function. It is about facts. The electron is here, the electron is there; the cat is asleep, the cat is awake.

Introducing the wave function, Schrödinger didn't add predictive power to the theory. The wave function helps to visualise phenomena, for example the wave-like "orbitals" of electrons around the atomic nucleus that you might see in chemistry textbooks. But visualisation can be misleading: the pre-Copernican idea of epicycles carrying the heavenly bodies revolving around Earth, or the 19th-century idea of heat as a "caloric fluid", were easy to visualise, but clarity was obtained by abandoning them.

The second historical quirk is the way Niels Bohr, another founder of quantum physics, synthesised what quantum theory seemed to be telling us. He wrote "the description of a

quantum system cannot be separated from the measuring instruments that interact with it". This idea is called contextuality. It correctly captures the core of the theory, but Bohr's formulation is misleading because it seems to make "measuring instruments" necessary. In Bohr's time, quantum systems were indeed studied only in physicists' labs. But today, almost a century of successes later, we are confident that quantum theory applies to everything in the universe – to processes in our next-door neighbour galaxy Andromeda, for example, where we can't be sure anyone is "measuring". Bohr's contextuality observation

**“Abandon the notion of a wave function that mirrors reality and we can make sense of quantum theory”**





needs to be generalised and the need for a measurer removed.

This can be done by saying that the description of a physical system cannot be separated from the other physical systems that interact with it. Abandon the notion of a real wave function that mirrors reality and take this statement seriously, and we have a way to make sense of quantum theory.

Properties of a quantum system exist only at the point of interacting with something else, and refer only to interactions. An electron isn't spread like a wave between one interaction and the next: rather, it has no position at all.

Schrödinger himself later in life gave up the idea that reality is described by his wave function. "It is better to consider a particle not as a permanent entity, but rather as an instantaneous event. Sometimes these events form chains that give the illusion of being permanent," he wrote. A particle is a sequence of distinct, instantaneous interactions. Its position or any other property exists only in the context of an interaction.

Furthermore, the properties of a system aren't absolute: they are relative to the interacting system. We make a mistake if we assume that they can be attributed to one single system. In the quantum realm, all facts are relative facts. For instance, it makes no sense in the absolute to ask about the state of Schrödinger's cat. With respect to itself, the cat is either awake or asleep. With respect to the observer outside a box where the cat is hidden, it may be that neither is true: as long as the cat isn't interacting with the observer, the question of its state has no meaning.

This is the central idea of the "relational interpretation" of quantum mechanics. I proposed the basic idea in 1996, and it has since slowly attracted attention, first with philosophers and then with a growing number of physicists, who have developed and clarified it. It avoids many worlds, hidden variables and the like, at the price of accepting that the properties of all things are relational: they express how things interact, not how things are.

This reading of quantum phenomena gets rid of the misleading notions of measurements and observers that fog our understanding of the theory. The properties of a system are determined when the system interacts with any other system, whatever this other system is: there are no special systems that are observers. The properties realised in this manner, however, are only relative to the interacting system: they have no consequences for further systems of the universe.

A chair is the way it interacts with its surroundings. To talk about the properties of the chair by itself, when it isn't interacting with anything, is meaningless. All of the properties we commonly use to characterise a chair – its

colour, its comfort, its weight – are defined through interactions with something else. And so it is for the properties of the single atoms or elementary particles forming the chair.

The relational interpretation can shed light on various mysteries of the quantum world, such as the strange phenomenon of entanglement, in which two particles seem to communicate with one another instantaneously across great distances. From the relational perspective, there is no instantaneous communication: relative to each particle, there is no fact of the matter about what has happened to the other. It is only when physical communication between the two sides is actually established that correlations become real. At this point, however, there is no more instantaneous communication at a distance.

### A question of suppression

The relativity of facts has been beautifully demonstrated by some recent experiments. It is possible to simulate a complex situation in the laboratory similar to that of the Schrödinger's cat scenario. The result shows that, in a precise, technical sense, there are facts that are true for the cat, but not for the external observer.

Why, then, don't we perceive the relativity of facts in everyday life? Why does it only loom so large and problematic when we zoom in on quantum systems? The reason is a well understood phenomenon predicted by quantum theory: decoherence. This is a ubiquitous occurrence that suppresses quantum interference effects whenever very large numbers of particles are involved.

Last year, my colleague Andrea Di Biagio at the Sapienza University of Rome and I showed that decoherence renders relative facts "stable", diluting quantum interference effects to a level at which they are so subtle as to be practically unobservable. Their dependence on the interacting system becomes irrelevant, because we would need to log a number of details too large for us to observe in order to detect the interference that could reveal the ➤

relativity of facts. In the case of the cat, for instance, the suppression of interference between asleep-cat and awake-cat allows us to say that however the cat appears relative to us is also the case relative to any other system: no observation can make the distinction.

The relational interpretation doesn't imply that each observer is isolated in their own world. Stability makes reality nearly identical for all. More importantly, all real observers are physical systems and therefore can interact. They can simply ask one another what they have seen, and the theory predicts agreement. Paradoxes appear only if we disregard the fact that any communication between observers is itself at heart a quantum interaction, and therefore suffers always a margin of imprecision due to Heisenberg's uncertainty principle, which says that there are properties of a quantum object that can't be sharply determined together in any one interaction.

As hinted at in the opening of this article, it isn't a novelty to realise that aspects of the world are relational. Biology, psychology, economics and many other sciences focus on relations more than entities. Physics itself is already full of relational notions: velocity is only defined with respect to something else, as are electric or gravitational potential and orientation, to name just some examples. The physical world seemed to provide a non-relational substratum formed by substances with absolute properties. Quantum mechanics, I think, is the discovery that this isn't the case: the world is woven by relationships that go all the way down to the smallest physical entities.

An understanding of the world in terms of relations rather than entities might even help us disentangle other thorny issues, for instance the nature of consciousness. If we think of the physical world as if it were made by little stones each with its own properties, the jump from this picture to the subjective experience of mental phenomena is huge. But if the physical nature of the world is better described in terms of how physical systems, simple as well as complex ones, affect one another, perhaps the disjoint will appear less dramatic: products of the mind are just the



LEE ROBINSON PHOTOGRAPHY

**Quantum objects have no reality when they aren't interacting with other objects**

**“We think about a world of things with absolute properties because this is what we experience”**

complex phenomenon formed by the tangled and richly interwoven interactions between the world and the brain.

Our old metaphysical prejudice was that physical reality is made by some fundamental substance with absolute properties. Quantum theory questions this. I think this is fine: our metaphysical prejudices have formed and evolved within the restricted domain of our everyday experience. We are used to thinking about the world in terms of things with absolute properties because this is what we experience, thanks to the stability generated by decoherence. But we shouldn't force what we have discovered about nature to align with these prejudices: rather, our prejudices should be modified by our discoveries about nature.

Quantum theory has altered our understanding of physical reality in ways that are even more profound than the Copernican revolution, when we learned that we live on a madly spinning rock. Digesting the full implications of Nicolaus Copernicus's work has taken centuries. We are only beginning to digest the full implications of the quantum revolution. ■



Carlo Rovelli is a physicist at Aix-Marseille University in France. His book on relational quantum mechanics, *Helgoland*, is out on 25 March



# Guarding the guardians



A western lowland gorilla leans on a guard in Batéké Plateau National Park, Gabon

CYRIL RUOSO/NATUREPL.COM

Protecting Earth's biodiversity means empowering the people closest to it, says **Donna Lu**

## About this feature

This feature is the third in our "Rescue Plan for Nature" series produced in association with the United Nations Environment Programme and UNEP partner agency GRID-Arendal. *New Scientist* retains full editorial control over, and responsibility for, the content. Part four of the series, on 27 March, will look at the surprising and profound effects that nature can have on our mental health

**T**O MANY people in the world's more crowded quarters, nature seemed to breathe a sigh of relief during the first covid-19 lockdowns. As human activity subsided, herds of buffalo wandered along empty highways in New Delhi, and a kangaroo was seen bounding through downtown Adelaide, Australia. Mountain goats roamed through the seaside town of Llandudno, UK, munching on hedges and flowers. "Nature is healing" became a popular online refrain. "We got to see a window of what the world could be like if we allowed a bit more rewilding around us," says Henrique Pereira, a biodiversity researcher at the Martin Luther University of Halle-Wittenberg in Germany.

But a rather different picture of the pandemic's impacts has since emerged. In some of the poorest and most biodiverse

parts of the planet, lockdowns and the wider economic disruption have increased poverty and food insecurity, while devastating ecotourism and other drivers of conservation initiatives. "There's been complete disruption of the projects that we have been running in various parts of the world," says Julia Fa, a researcher at Manchester Metropolitan University, UK. "Covid has directly affected communities that we have worked with."

But this gloomy outlook gives a glimmer of hope for the future. As momentum gathers behind an unprecedented international effort to roll back decades of wanton destruction of nature, it is a timely reminder of how the most effective solutions to the biodiversity crisis are human ones. Protecting Earth's precious ecosystems means empowering the people who are closest to them. ➤

# A MEATY QUESTION

Hunting wild animals for food is part of the way of life of many traditional communities worldwide. But growing human populations, increasing demand for bushmeat in urban areas and the ease of hunting with firearms and motorised vehicles is making it increasingly unsustainable: a 2016 study suggested it was putting 301 species of mammals at risk of extinction worldwide. Work by Julia Fa at Manchester Metropolitan University, UK, and her colleagues suggests that, in the Congo basin in Central Africa, some 5 million tonnes of meat is removed each year, more than double the sustainable level.

In some places, the economic squeeze of the covid-19 pandemic seems to be increasing the pressures. In Kenya, Fa is looking at the effect of a drop in visitors to wildlife preserves on the hunting of wild animals for meat. "We know that because of covid, tourists are not going to these places and people that depended on tourism are now turning to hunting more to sell to the big cities, because that's the only way they're going to get income," she says. "There are going to be examples of that all over the world."

But it is a far from uniform picture: in markets in southern Nigeria, for instance, the amount of bushmeat being sold has dramatically dropped since covid-19 was detected in Africa. Fa's team saw a similar effect on the number of primates and bats sold for food following the Ebola outbreak in West Africa that started in 2014. "Covid may be helping wildlife in the sense of there being less demand for wild animals in urban centres," says Fa. "People are becoming aware of the link between animals and human disease."

Sensitive social campaigns about these risks and the need to conserve wildlife could help to reduce bushmeat demand. But the focus should be on drastically reducing consumption in urban areas, where alternative food sources are available, to ensure that there remains enough for people in rural areas who rely on bushmeat, says Fa. "You can't stop wildlife from being used by the millions of people that rely on that resource for food."



The pandemic has had a profound effect on efforts to halt behaviour that is harmful to biodiversity, says James Watson, a conservation researcher at the University of Queensland in Australia. "We're seeing instances around the world where a spike has occurred because of the inability to effectively do conservation governance," he says.

Illegal fishing, for instance, has surged in various parts of the world as commercial fishing boats have taken advantage of a reduction in patrols. In Brazil, small-scale fishers have reported sightings of industrial fishing vessels in protected regions including the Abrolhos Marine National Park, a biodiversity hotspot. In the Philippines, where the fishing industry was allowed to continue normal operations throughout a lockdown between March and May 2020, satellite data also showed an uptick in commercial fishing in protected waters.

## Far-reaching effects

Satellite imagery has also revealed a surge in deforestation. Last year, an international team of researchers used data from the Global Land Analysis and Discovery group to compare deforestation in countries across the tropics in the first month of their most stringent covid-19 restrictions in 2020. The data revealed deforestation alerts covering 9583 square kilometres, more than double the 4732 km<sup>2</sup> seen in the equivalent periods the year before. The effect was starkest across the African tropics, with alerts increasing by 136 per cent. The increase was 63 per cent in the Americas and the Asia-Pacific region.

A causal link with the covid-19 measures, although not yet established, seems likely. The researchers suggest that stay-at-home orders may have reduced ground-based monitoring and enforcement of biodiversity regulations by governments and community-based agencies.

Certainly, some areas ordinarily highly dependent on nature tourism have seen an increase in activities such as poaching. Globally, ecotourism provides an estimated 84 per cent of funding for national parks agencies. A review

**"The pandemic has had a profound effect on efforts to halt behaviour harmful to biodiversity"**

published in August 2020 found that, in countries such as South Africa and India, "rhinoceros and elephant poaching syndicates have expanded operations into areas where there are normally too many wildlife-viewing tourists for them to operate undetected". The study's authors noted that the sudden absence of tourists effectively widens the territory and stock of animals available to poachers.

But the economic fallout of the pandemic has far wider-reaching effects. In October, the World Bank estimated that the global recession







YASUYOSHI CHIBA/AFP VIA GETTY IMAGES

caused by the pandemic may cause up to 150 million more people – almost 2 per cent of the world’s population – to fall into extreme poverty. Historically, prolonged poverty shock has been linked to increases in deforestation and biodiversity loss as products such as fodder, fuel, timber and bushmeat become more necessary both for subsistence and for a source of income. “You’re looking around for whatever you can, for something to sell to the world,” says Kevin Gallagher, a global development researcher at Boston University.

At the same time, rising urban unemployment is causing many people in lower-income countries to return to their rural roots, swelling populations in sensitive areas. A UN analysis suggests that, by increasing people’s reliance on forest goods and services, the pandemic will exacerbate existing pressures on ecosystems caused by climate change, logging and mining activities, forest fires and land conflicts. The Chronic Poverty Advisory Network has been monitoring the effect of covid-19 on people living in poverty or near-poverty in Kenya and Nepal. When the group surveyed people in Vihiga county

**Wildlife tourism, here in Kenya, is a major driver of conservation initiatives**



**An Indigenous Yupik man washes freshly caught salmon in Newtok, Alaska**

ANDREW BURTON/GETTY IMAGES



in Kenya recently, most rural households reported lower agricultural yields, with access to crucial inputs such as fertiliser disrupted, and a need to buy or source more food from elsewhere than usual. Respondents in both countries reported an increase in the cost of staple foods. Research suggests that knock-on effects of land degradation and nutrient loss will persist for many growing seasons, increasing pressures on resources such as bushmeat (see “A meaty question”, left).

In many cases, covid-19 is intensifying pre-existing systemic pressures. “Some countries that have a lot of debt distress are also highly biodiverse and highly climate vulnerable,” says Gallagher. These include Angola, Cambodia and the Solomon Islands, as well as many in Central and South America. Lots of these countries are already spending anywhere between 30 and 70 per cent of their revenues on servicing external debt, says Gallagher. Natural resources represent one of the few reliable sources of income.

## Economic imperatives


Gallagher highlights the example of Ecuador. “There’s so much pressure to export products, to export oil, to lease areas in the Amazon for new hydroelectric power plants, not because that was part of their long-term vision, but because they have to do whatever they can to pay those bills right now,” he says. “The world needs to be able to make sure that we’re not burning away our natural assets to get out of this crisis.”

These extra pandemic pressures come at a critical time for biodiversity, as the world seeks to agree decadal targets to constrain human impact on nature at a crucial meeting of the Conference of the Parties to the Convention on Biological Diversity, COP15, due to be held in Kunming, China, in May. Following the failure of a similar series of targets negotiated a decade ago in Aichi, Japan, it is make-or-break time. “We’ve got to set species and ecosystems targets around no net loss: no more extinctions, no more decline of species, no more degradations of ecosystems,” says Watson.

That is an economic imperative as much as anything. The Organisation for Economic Co-operation and Development (OECD) estimates that international public expenditure on biodiversity is between \$3.9 billion and \$9.3 billion a year – a figure dwarfed by the approximately \$500 billion per year that governments spend supporting activities potentially harmful to biodiversity. Meanwhile, an OECD report for a meeting of G7 environment ministers in 2019 calculated that the various “ecosystem services” rendered to us by a healthy natural world, from fertile soils to clean air and water, were worth something between \$125 trillion and \$140 trillion each year. “The socio-economic case for more ambitious biodiversity action is clear,” the report concluded.

A global problem demands global solutions. In casting around for fixes, it is crucial that richer countries don’t see this as a “them and us” problem, says Pereira. While much of the immediate impact on biodiversity comes in ➤





**“Positive change means partnering with people who know their ecosystems best”**

## CULTURAL BURNING

Following the devastating 2019-20 bush-fire season, the Australian state of New South Wales passed legislation in November 2020 to mandate the inclusion of Aboriginal leaders in its top fire-planning committee. This was a recognition that traditional practices can not only reduce the incidence of damaging fires, but also bring wider ecosystem benefits.

The standard practice of hazard reduction burning aims to pre-emptively reduce fuel loads in a controlled manner, by burning up scrub and debris on the ground,

while leaving trees intact. Aboriginal cultural burning involves a broader landscape-wide approach, focused on more than just protecting human life and property, says Shaun Hooper at the University of New England in Armidale, Australia. Cultural burning can be slower and less intense, and generally involves a mosaic of fires rather than the long walls of flame in hazard reduction burns, allowing wildlife to escape.

“Plants, animals, rocks and spirits provide a lot to Aboriginal well-being,” says Hooper, a Wiradjuri man and a cultural burning practitioner who advised policy-makers on the legislation. “That becomes our reciprocal obligation.” Numerous species benefit from a cultural burning approach, he says, for example, small marsupials called bandicoots. “They’ll boom after a cultural burn,” says Hooper. “They turn over huge amounts of soil and reduce the fuel load.”

Land in Australia has been managed by cultural burning for so long that a lack of fire has been associated with declines in plant numbers and diversity in endangered grasslands and grassy forests.

lower-income countries, “we have to be careful not to blame the poor in the destruction of biodiversity”, he says. He co-authored a 2019 study which found that 90 per cent of Europe’s impacts on biodiversity occur elsewhere. “If you look at total consumption of resources, a rich person in the developed world has a much larger carbon footprint and biodiversity footprint.”

Poorer countries will require financial support in achieving biodiversity targets, not least in the wake of the pandemic. Several potential solutions have been floated: for example, that countries with large biodiversity footprints outside their borders should contribute more money to the Global Environment Facility, a mechanism established at the time of the 1992 Rio Earth Summit that distributes money to sustainable development projects worldwide. Others have suggested the development of biodiversity offset markets – similar to those that exist for carbon offsets – in which individuals or companies could compensate for the amount of habitat affected by particular projects.

Another solution would be to link debt forgiveness with biodiversity performance. Gallagher and his colleagues recently identified 22 countries, such as Fiji and Togo, that would benefit both economically and environmentally from “debt-for-nature” swaps with China, a major creditor nation. Gallagher cites the success of the Seychelles, the Indian Ocean island nation that in 2015 signed a deal to protect its marine areas in exchange for a £16.8 million write-off of national debt.

Such schemes would, admittedly, require effective monitoring. Currently, most countries don’t have any national biodiversity monitoring systems in place, says Pereira, meaning their development must be a keystone of the new biodiversity targets to be laid out this year.

But the most effective schemes are likely to be local in scope. One approach is to link direct cash payments – government subsidies, in effect – to specific conservation indicators such as the number of wild animal carcasses counted at local markets or hectares of uncleared forest. “That seems to be the fastest



Harnessing Indigenous knowledge could reduce the impact of wildfires in Australia

REUTERS/TRACEY NEARNEY





**A bushmeat seller arranges catches alongside the Owo-Akure road in Ondo state, Nigeria**

and most reliable way to get direct impacts on the ground,” says Pereira.

In one study in 2018, researchers rewarded 1200 tropical forest users in Bolivia, Peru, Uganda, Tanzania and Indonesia with bonuses dependent on forest harvesting levels. They found that these conditional payments increased conservation behaviour, even when payments stopped.

In the end, though, money might be less important than simple empowerment. In Nepal, a forest management system implemented in the early 1990s established more than 18,000 community-managed forest areas, which the inhabitants harvest for products such as timber and firewood, and also protect to sustain the flow of these products. An analysis published in 2019 shows that, between 2000 and 2012, poverty and deforestation both decreased in areas with such community management.

## Time-tested techniques

In many of the most biodiverse parts of the world, positive change will only be possible via forming partnerships with the people who rely most on, and know most about, the ecosystems they live in. As noted by the Intergovernmental Science-Policy Platform

on Biodiversity and Ecosystem Services, biodiversity is declining less rapidly on land that is managed, used or owned by Indigenous peoples. This amounts to about a quarter of Earth’s land surface, but houses some 80 per cent of its biodiversity. “We cannot address the biodiversity crisis without partnering with Indigenous communities,” says Pereira.

Time-tested Indigenous land management techniques can help to mitigate the effects of climate change and, by better maintaining productivity of existing land, reduce pressures on biodiversity and even enhance it. Traditional farming methods practised by Quezungal people in Honduras, for example, such as terracing to reduce soil erosion, and planting crops under trees so the soil is anchored by roots, have helped to avoid destruction of crops by hurricanes. A March 2020 study in Nunatsiavut in Canada found that Inuit cultural practices increased local-scale biodiversity and created new vegetation communities. Aboriginal land-burning practices in Australia provide another example (see “Cultural burning”, left).

Yet despite such successes, elevating local voices and knowledge in decision-making around land management still has some way to go, says Dalee Sambo Dorrough, chair of the Inuit Circumpolar Council. The Arctic

Indigenous communities she represents face a range of threats to their way of life, not least from climate change. They also exemplify some of the conflicts a new deal on biodiversity needs to resolve. The international demand for Alaskan wild-caught salmon, for example, has put pressure on salmon populations in the Kuskokwim river – and also on the Yupik people, who now face challenges to their autonomy in managing the salmon, says Dorrough.

In contrast, in other areas, such as the Inuvialuit Settlement Region of Canada, the right of Inuit communities to fish and harvest species such as Arctic char and beluga are legally entrenched in land claim agreements. “On the basis of centuries of sustainable development, they’re the ones who have first and foremost identified any threat or risk... and take action to ensure the health of a species,” says Dorrough.

One of the decadal targets due to be agreed this year in Kunming is to promote the sharing and use of traditional knowledge and practices for biodiversity, in partnership with Indigenous communities. “We need to protect wildlife indeed, but we need to make sure that the resources, including wildlife, are adequately used by people who need them,” says Fa.

The hope is that new targets, and a new focus, can make a difference. “For the first time, nations are thinking about an ecosystem target globally around preserving the quality of ecosystems,” says Watson. That is part of a broader acknowledgement of interrelated risks, including climate change, and the link between habitat loss and the threat of future pandemics like covid-19: that nature isn’t just a lockdown intruder into human spaces, but something we are part of and dependent on. “It’s moved from this conversation around saving the animals to actually about human well-being,” says Watson. ■



Donna Lu is an Australasia reporter for *New Scientist* based in Melbourne

# Some like it cold

Cold-water swimming is all the rage, but do the health claims stand up to scrutiny? **Alison George** investigates



**I**T'S like pressing Control-Alt-Delete on a computer," says Cath Pendleton. "When I'm in the water, I'm so focused on my body, my brain switches off. It's just me and the swim."

Pendleton, an ice swimmer based in Merthyr Tydfil, UK, is hardier than most. In 2020, five years after discovering she didn't mind swimming in very cold water, she became the first person to swim a mile inside the Antarctic circle. Part of her training involved sitting in a freezer in her shed.

She is far from alone in her enthusiasm for cold water, however. Thanks to media reports of the mental health benefits of a chilly dip and pool closures due to covid-19, soaring numbers are now taking to rivers, lakes and the sea – once the preserves of a handful of seriously tough year-round swimmers. An estimated 7.5 million people swim outdoors in the UK alone, with an increasing number swimming through the winter. Global figures are hard to

come by, but the International Winter Swimming Association has seen a boom in registered winter swimmers around the world, even in China, Russia and Finland, where water temperatures can drop below 0°C.

But is there anything more to it than the joy of being in nature, combined with the perverse euphoria of defying the cold? According to the latest research, the answer is maybe. Recent studies have begun to turn up evidence that cold-water immersion may alleviate stress and depression and help tackle autoimmune disorders. It might even tap into a hibernation mechanism shared by all mammals to protect the brain, potentially offering new treatments for dementia.

The idea that cold water can shock the body back to health isn't new. In Victorian Britain, the great and the good flocked to the spa town of Malvern to take the "water cure", a treatment that involved being wrapped in cold, wet sheets

and taking regular cold showers and baths. Nursing pioneer Florence Nightingale credited it with restoring her health after the Crimean war. Charles Darwin believed it cured him of fatigue and stomach pains. "I feel certain that the Water Cure is no quackery," he wrote at the time.

The practice fell out of favour in the 1870s, but now the popularity of getting cold to feel good is on the rise again, prompting scientists to start looking at whether it works. Much of the research so far has focused on the fact that plunging a warm body into cold water brings about some very predictable physiological changes, some of which may affect health.

The first thing to happen is a "cold shock" response stimulated by cold receptors on the skin. Studies by Mike Tipton at the University of Portsmouth, UK, who researches the effects of extreme environments on the body, suggest that this response is strongest in waters with a



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temperature of around 10 to 15°C. Below 8°C, the cold also triggers the skin's pain receptors.

The aim of the response is to signal imminent danger. "Water is so much more efficient than air at taking heat from the body," says Tipton. "Cold shock is an exaggerated fight-flight response to alert the body to all the heat it's losing." During cold shock, concentrations of the hormone noradrenaline, which prepares the body for action, shoot up to more than five times resting levels, while levels of dopamine, a neurotransmitter involved in reward processing as well as adapting to shock, are more than doubled. It is no wonder that swimmers feel invigorated after a chilly dip. "It's like an amphetamine rush," says Tipton.

On the downside, cold shock also causes a strong involuntary gasp, which is almost impossible to suppress, followed by hyperventilation. "This is the body's way of trying to get more oxygen into the system to

**Plunging the body into cold water stimulates the release of a cocktail of invigorating chemicals**

**"There is evidence the benefits of cold water come down to 'what doesn't kill you makes you stronger'"**

deal with the emergency it senses," say Tipton. If this happens when your mouth is submerged, however, there is a high chance of inhaling a lungful of water, which could lead to drowning.

## Shockingly cold

Heart attacks are another risk at this stage, even for people without existing heart conditions. While the cold-shock response revs up the nervous system, cold water on the face simultaneously triggers a "diving response" via the trigeminal nerve in the cheek, which slows down the heart rate and breathing. When the body tries to increase and decrease heart rate at the same time, the heartbeat can become dangerously irregular. Even if this isn't fatal on its own, it can incapacitate a swimmer for long enough to cause drowning (see "Swim safe", page 49).

Survive the initial shock, however, and there is evidence that the benefits of cold-water swimming come down to that familiar idea: what doesn't kill you makes you stronger.

We know that chronic stress harms the body, not least by increasing levels of inflammation, which is linked to long-term health problems including heart disease, cancer and depression. Acute stress, though, seems to do the opposite, allowing the body to habituate and become resilient to future stressors. This is a concept known as hormesis, and there is some evidence that building resilience to one kind of stress can help people adapt to another. In one study, volunteers who were immersed in cold water for 5 minutes showed an improved ability to exercise at low oxygen levels afterwards. "When we train our body to respond to an acute stressor, we are building fitness of our stress-response systems, much like we would build a muscle," says Elissa Epel at the University of California, San Francisco. "I believe that cold water is a beautiful way to build stress inoculation."

The full picture of exactly how this kind of "toughening" response might work is still being established. Epel is working on a trial using the methods of Dutch cold-water evangelist Wim Hof, also known as the iceman, who advocates a mixture of ice baths, meditation and breath control to build resilience and holds a number of world



# Secrets of the ice swimmers

The “cold shock” response that occurs when suddenly entering cold water may turn out to be good for our health, but that doesn’t make it pleasant. Still, practice helps. “As few as five 3-minute exposures can halve the cold-shock response,” says Mike Tipton at the University of Portsmouth, UK.

Ice swimmer Lewis Pugh has taken this to the next level. His pre-swim routine, which often includes psyching himself up with rousing music, increases his body temperature by over a degree before he dives in. Researchers speculate that this happens because he is raising his body’s adrenaline levels before entering the water.

Pugh still feels the cold, but other swimmers have trained their bodies to feel warm even in ice water. This “hypothermic adaptation” takes a lot of practice and isn’t necessarily a good idea. “It’s dangerous to take away the perception of getting into trouble as the body temperature cools,” says Tipton.

No big deal: ice swimmer Lewis Pugh has trained his body not to panic when he dives into cold water



records for tolerating extreme cold.

In 2014, researchers at Radboud University in the Netherlands investigated one of Hof’s bolder statements: that his regime can be used to control the immune system. They put his claim to the test, injecting him with a bacterial toxin that causes an immune response to see how his body would respond.

Blood tests revealed that Hof’s adrenaline levels were unusually high at baseline, peaked during the breathing exercises he uses to prepare for cold exposure and which he also did before the injection. This was followed by an unusually low immune response to the toxin. A further study, using 12 healthy volunteers, yielded similar results, backing up Hof’s claim that anyone could do the same.

The researchers concluded that the unusual immune response was linked to the fight-or-flight response. The very high levels of adrenaline “correlated beautifully with higher levels of anti-inflammatory mediators”, says Matthijs Kox, who led the study. This, in turn, correlated with lower levels of pro-inflammatory markers.

In 2019, Kox and his colleagues reported that Hof’s intervention was safe for use in young people with rheumatoid arthritis. After eight weeks, people who followed Hof’s regime “showed fewer symptoms and had lower inflammatory markers and a higher quality of life”, says Kox. It isn’t yet certain which aspect of Hof’s technique gives rise to the effect. Kox’s team has a study in the works to pick this apart, which should be published soon.

Inflammation may also be relevant to the many anecdotal reports that cold-water swimming helps to alleviate depression. So far, however, there is little in the way of hard evidence. A 2018 case report in the *BMJ* found that, for one woman, a programme of weekly cold-water swims resulted in an immediate lifting of mood. She was also able to stop taking medication for the depression and anxiety she had been experiencing for many years. The team behind the case study is working on bigger trials in larger numbers of people with anxiety and depression.

While the jury is still out on the mental health benefits of extreme dips, the news that got every cold-water swimmer’s pulse racing came last year, with new findings about how

**Regular winter swimmers have higher levels of a cold-shock protein known to protect the brain against degeneration**

exposure to cold water affects the brain in ways that may guard against dementia.

It has long been known that cooling can protect the brain – it is used medically after head injuries and during cardiac surgery – but it wasn’t known why. An answer came from studying hibernation. When mammals hibernate, they cool down, their metabolism slows and the synapses that connect their brain cells are dismantled to save energy. In spring, when the animals awaken, their synapses are reassembled at a furious pace. This process is controlled by a cold-shock protein called RBM3, which is produced in the brain and other key organs in response to a drop in body temperature.

A loss of synapses is a key feature of dementia, so Giovanna Mallucci, who heads the UK Dementia Research Institute’s centre at the University of Cambridge, and her team wanted to see what effect cooling had on both RBM3

**“It may be possible to get similar effects by cooling only a small part of the body”**







REUTERS/NEIL HALL

levels and synapses in mice with dementia-like symptoms. The results were striking: cooling the mice, and hence boosting the levels of RBM3 in their brains, “completely protects them from neurodegeneration”, says Mallucci.

Due to the ethical difficulties of inducing hypothermia in healthy people, Mallucci wasn’t hopeful about repeating the study in humans. But after discussing her research in the media, she was contacted by Martin Pate, who swims at London’s Parliament Hill Lido throughout the winter. Together, they devised a study to test RBM3 levels in a group of 44 winter swimmers compared with a control group who practised tai chi at the poolside, while the swimmers were in the water.

The study, due to be published this year, found that the longer and more frequently that people swam in the water, which was between 4 and 14°C, the higher their RBM3 levels. The cold-shock protein wasn’t found in the tai chi group. “It is a very strong trend,” says Mallucci.

Mallucci didn’t scan the swimmers’ brains to measure their connectivity, but based on animal experiments, she speculates that increased RBM3 levels may have a measurable impact on their brains.

“My prediction would be that it’s going to protect from brain cell loss and keep their synapse levels nice and boosted,” she says.

Mallucci is now researching the molecular

## Swim safe

Cold-water swimmer Cath Pendleton shares her tips for safe winter dips:

- **Never swim alone: nerve and muscle cooling can incapacitate even strong swimmers.**
- **Start slowly to allow your body to acclimatise.**
- **Don’t dive in: the gasp reflex could mean you inhale water.**
- **Start in late spring and then swim all the way through the summer before the water gets really cold. If you start in the winter, be prepared to only be in the water for a minute.**
- **Warm up slowly afterwards: a hot drink will warm you from the inside, but a hot shower is best avoided because it can cause blood to rush to the skin and increase the risk of fainting.**

pathway of RBM3’s action, to see if levels of this protein could be boosted by drugs rather than freezing temperatures. If so, it might one day be possible that the brain benefits of cold shock will be available in pill form, offering a new way to treat neurodegeneration.

This would be good news, not only for people with an understandable aversion to the cold but also because it avoids the dangers of cold-water immersion, both from the initial shock and the longer-term effects of hypothermia.

Human survival depends on keeping core temperature between 36.5 and 37.5°C. At 36°C or below, the body starts to shiver to generate more heat. If this fails and the core temperature drops below 35°C, hypothermia sets in. If cooling continues, the result is unconsciousness and death.

Even in ice-cold water, it takes around 30 minutes to reach the point of hypothermia, but, during this time, cooling of the nerves and muscles makes the limbs slower to respond to the brain’s instructions. This explains why it can be so challenging to get dressed after a dip in the sea, and why it can also lead to serious consequences, where even experienced swimmers become incapacitated and drown.

Given these dangers, it is encouraging that there might be no need to cool to the core. Tipton believes that many of the benefits of cold-water exposure come from the initial shock and changes in skin temperature. It may not even be necessary to chill the whole body. In studies, he found that when volunteers immersed only the right side of the body in cool water and became acclimatised to the cold shock, their left side became acclimatised too. Perhaps cooling an even smaller part of the body, say a hand or foot, might be enough? Tipton plans to look into it. “We don’t yet know which areas it is important to cool and how long we need to cool them,” he says.

And, while a quick paddle may not give you quite the same thrill as a full dip – nor the same bragging rights on social media – the health benefits may turn out to be much the same. ■



Alison George is a features editor at New Scientist



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## EPSRC Centre for Doctoral Training in Enhancing Human Interactions and Collaborations with Data and Intelligence Driven Systems - Call for Applications for 4-year Funded research studentships.

In a world emerging from the darkness and despair of the COVID-19 pandemic, we are looking for the next group of people who want to join us in our mission to bring light and hope through digital discovery and innovation. We need people who are committed to changing the world via world-class research that focuses on amplifying human capabilities through the use of data driven and intelligence enabled systems. The programme spans 4 years and includes an integrated Masters.

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Candidates should have an aptitude and ability in computational thinking and methods including the ability to write software or enthusiasm to learn how to do so. While such aptitude might be evidenced by a degree in Computer Science, Mathematics or Engineering, we are building a community that aspires to have a high degree of diversity of perspective. So, if you have a background in Arts and Humanities; Social Sciences; Law; Management for instance, please be encouraged to apply.

For future AI and big data technologies to serve society and the economy effectively, they will need to be created and critiqued by a diverse and wide set of perspectives as possible: we welcome applications from anyone who feels they can help in the mission of the Centre.

This year, we have 11 fully funded places (fees plus maintenance stipend set at the UKRI rate, currently £15,285 per annum for 2020/21 for full-time students, updated each year). Places are also available for those in receipt of four-year external funding.

Applications for our Centre should be made via our website ([www.swansea.ac.uk/Science/epsrc-centre-for-doctoral-training](http://www.swansea.ac.uk/Science/epsrc-centre-for-doctoral-training)) by March 26th, 2021. There will be an information and interview event scheduled for 21st and 22nd April 2021.

For an informal discussion about your application, please contact the Centre Director. We also welcome conversations with any organisations who want to become part of our growing stakeholder community. Professor Matt Jones (Director-Enhance-CDT@swansea.ac.uk).



# The back pages

## Puzzles

Try our crossword, quick quiz and logic puzzle **p52**

## Almost the last word

What makes ice freeze in odd formations? **p54**

## Tom Gauld for *New Scientist*

A cartoonist's take on the world **p55**

## Feedback

Neural networks flaws and too many Melbournes **p56**

## Twisteddoodles for *New Scientist*

Picturing the lighter side of life **p56**

## Science of cooking

# The slow way to good pizza

The best way to make great pizza at home is to start preparing it up to five days before you eat, says **Sam Wong**



Sam Wong is social media editor and self-appointed chief gourmand at *New Scientist*. Follow him @samwong1

## What you need

**For two pizzas:**  
**300g "00" flour or strong white bread flour**  
**1g instant yeast**  
**6g salt**  
**200g cold water**  
**Toppings**

PIZZA is the ultimate fast food, and the speed of cooking is vital to achieving perfection: brown and crispy on the bottom, but still tender and chewy on the inside, with a light, airy crust. This is easy to attain in a traditional pizza oven, which can reach temperatures of around 500°C and cook a pizza in under 2 minutes. At home, it is more challenging, but there are some tricks to making satisfying pizzas.

Paradoxically, it helps to think of pizza as slow food and start the process a few days early – difficult, I know, if you just can't wait for a slice. Extending the fermentation time of your dough is helpful in several ways, starting with gluten development. When hydrated, proteins in flour join together into long strands of gluten.

A strong gluten network is essential for the dough to trap gas bubbles and rise in the oven.

Italian "00" flour, which is very finely milled, is said to be the best for pizza, but any flour with a reasonably high protein content should work well. Kneading dough helps develop gluten by stretching the strands, but with a long fermentation, this happens by itself, so there is almost no need to knead. More time also allows protease enzymes in the flour to work on the gluten, controlling the length of the strands. This makes the dough more extensible, so it is easier to stretch.

Another enzyme, amylase, breaks down starch into sugars, providing food for the yeast but also supplying fuel for the



VALERIE VATEL/ALAMY

Maillard reaction. This gives us a nicely browned crust when the pizza goes in the oven.

To allow time for all this chemistry to happen, we need to keep the dough in the fridge to slow the yeast down so it doesn't burn through the sugar too quickly. As well as yeast, the dough will contain lactic acid-producing bacteria from the environment. These bacteria are less affected by the cold and their metabolism contributes tasty flavour compounds to the dough.

After mixing the ingredients, knead the dough briefly and then divide it in two and shape into balls, before refrigerating in an oiled container for three to five days. Take it out of the fridge 2 hours before baking.

One way to compensate for the

weakness of a home oven is to use a baking stone. The stone is heated up in the oven first, storing energy so that it can conduct it into the pizza placed on top of it. A baking steel, which is denser and more conductive, is even better.

Another way is to assemble the pizza in a preheated cast-iron frying pan, put it under a grill – called a broiler in North America – to cook the top of the pizza quickly through radiation, then put the pan on the stove top to conduct heat into the pizza from below. Home appliances vary, so it might take experimentation to work out the ideal timings for your kitchen. ■

Science of cooking appears every four weeks

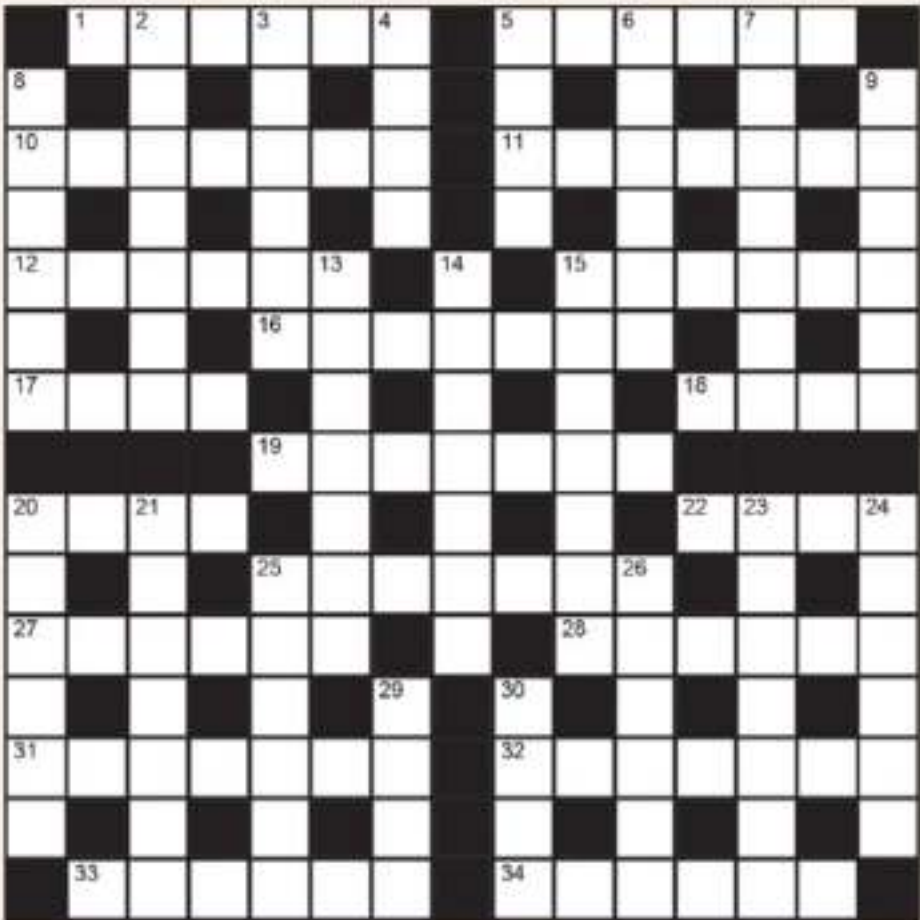
## Next week

Stargazing at home



**These articles are posted each week at [newscientist.com/maker](https://www.newscientist.com/maker)**

Quick crossword #78 Set by Richard Smyth



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

- 1 The \_\_\_ of Doctor Moreau, 1896 sci-fi novel by H. G. Wells (6)  
5 \_\_\_'s disease, inflammatory disorder (6)  
10 Alloy used in dentistry (7)  
11 Spanish term for traveller's diarrhoea (7)  
12 Outer atmosphere of the sun (6)  
15 Base 2 (6)  
16 Redeposited sediment (7)  
17 Tiers (4)  
18 Wild cat species (4)  
19 Compress wetly (7)  
20 Vertical curved structure (4)  
22 Large-screen cinema format (4)  
25 Automaton-like (7)  
27 Front part of the neck (6)  
28 Of a distribution, Gaussian (6)  
31/32 The \_\_\_\_, 1957 novel by John Wyndham (7,7)  
33 Part of the eye (6)  
34 Divisions of 16.66 per cent (6)

DOWN

- 2 Songbird in the genus Passer (7)  
3 Chest pain (6)  
4 Structure such as a cupola (4)  
5 B (4)  
6 Exit of tissue through a cavity wall (6)  
7 MDMA (7)  
8 Flying \_\_\_, UFO type (6)  
9 Organ in the 27 Across (6)  
13 Latin for "some", used in mathematics (7)  
14 Consumer unit (4,3)  
15 Cryptocurrency (7)  
20 Disease of the airways (6)  
21 Short-distance, person-to-person comms system (1,1,5)  
23 Extinct elephantid (7)  
24 Sugar found in wood (6)  
25 SI unit for the measurement of angles (6)  
26 Tail bone (6)  
29 Ratite of South America (4)  
30 One-pip playing cards (4)

Quick quiz #92

- 1 Ronald McNair, a US astronaut who died in the Challenger space shuttle disaster, was supposed to record a saxophone solo in space as part of a collaboration with which musician?  
2 The final stage of an insect's life after its metamorphosis is known as what by biologists?  
3 The crescograph was invented by Jagadish Chandra Bose in the early 20th century. What does it measure?  
4 Who is the only person to be awarded the Nobel prize in physics twice?  
5 How many extant species of vampire bats are there?

Answers on page 55

Puzzle set by Rob Eastaway

#104 Soccerdoku

"Football league tables are a bit like accounts," says Harry the bookkeeper. "The debits and credits must balance. For example, victory for one team means defeat for another, so the total games won must be the same as the total games lost. And every goal scored for one team is a goal against another one."

Harry's insights will help our league's archivist. The newspaper cutting with the results of the 1993 season is now smudged, and several entries are illegible. The teams played each other once, and this is how the season ended:

	Won	Lost	Drawn	For	Against
United	2	0	*	2	*
Rovers	2	*	0	4	1
Albion	*	2	*	3	3
Town	*	2	1	0	5

Can you fill in the blanks and work out the scores in all the matches?

Solution next week



Our crosswords are now solvable online  
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**CONICS**  
  
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**Game Of Life Glider**

  
**THERE IS NO  
PLANET B**

  
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STAR  
STUFF**  
CARL SAGAN



**EXPERIMENT.  
FAIL.  
LEARN.  
REPEAT**




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## Ice mystery

I put a bowl of water out for my cats and it froze into a tall spike (pictured below, near right). What could have caused it to freeze into this shape?

**David Strachan**

*Llanbister, Powys, UK*

Did the owner check whether the peak of the spike matched the cat's tongue?

**Easter Russell**

*London, UK*

We saw a similar ice spike in a small pool of water on a rock (pictured below, far right). It was after sunrise on Christmas Day, with nothing around it to explain how it could have formed. It seems that there are wild and domestic versions of these ice formations!

**Andy Howe**

*Sheffield, UK*

I was intrigued by a similar sight last year, in a plastic bucket out in a field. It was a hollow, quadrilateral tower, rising 6 or 7 centimetres above the normal

**“Miraculous-looking ice spikes with shapes similar to vases or inverted pyramids can be produced when the conditions are right”**

ice surface. I presumed that four long crystals happened to come together on the water surface and form a framework that could bear a load early in the freeze, and the structure grew as more ice froze around it.

**Mark Wareing**

*Sedbergh, Cumbria, UK*

The formation of “ice spikes” depends on three properties of liquid water: it cannot be compressed; it expands when it freezes; and freezing can be delayed if, for example, the water is disturbed by movement or the water is quite pure and so lacks nucleation sites for ice crystals to form.



ROST-9D/GETTY IMAGES

## This week's new questions

**Pull of gravity** What could happen to change gravity on Earth as we know it? **Kurt Schwalbe (age 7),** Whitley Bay, Tyne and Wear, UK

**Different dough** San Francisco sourdough bread tastes completely different to sourdough from the UK. Are UK yeasts different from Californian ones or is this due to the bread-making process? **Pamela Radford,** Horsforth, Leeds, UK

Due to these qualities, water can become a supercooled liquid at a temperature of just below 0°C. Small pools of relatively pure water, such as tap water in a bowl or rainwater in bird baths, can produce many different forms of ice spike, protruding above the frozen surface. The ice spike forms at the point where the surface ice was at its weakest, often close to the edge of the container.

As the surface freezes, some of the water beneath freezes too. This submerged ice expands and some of the remaining unfrozen water is forced through the weakest point in the upper frozen surface. As this liquid water flows upwards, two processes of ice spike formation are possible.

The first occurs when the liquid

flows away from the hole in the surface ice and eventually freezes. If water continues to flow upwards, a tube of liquid water surrounded by ice grows (the now-frozen central water tube is visible in the photograph of the ice spike in the cat bowl).

In the second process, a small sheet of ice at the weakest point on the frozen surface is forced upwards, leaving a hole in the surface with the same shape as the displaced ice sheet. Then successive small, parallel ice sheets of a similar shape are formed as the water is forced upwards through this hole in the ice. These flat ice sheets join together to form an ice “sculpture”, which is extruded upwards.

As this occurs, the hole may

What could alter the pull of gravity that we feel on Earth?

slowly freeze and reduce in size, so that the successive ice sheets keep the same shape but become progressively smaller. In this way, “miraculous” ice spikes with shapes similar to vases or inverted pyramids can be produced.

**Jerry Shiner**

*Toronto, Canada*

These “reverse icicles” aren’t the only shapes that can be created with bowls of frozen water. When it got really cold here in southern Canada, we used to make decorative ice lanterns. Here is how.

First, fill some large plastic buckets with water to about three-quarters of their capacity, then put them outside on a night with temperatures well below zero. In the morning, bring the frozen buckets inside and allow the ice blocks within to melt just enough so that they can slip out. Take the buckets outside, turn them over and discover the magic.

The water in the bucket freezes from the top down and inwards from the sides, leaving the middle as yet unfrozen and the bottom with only a thin layer of ice. If you break this bottom layer of ice, pour out the liquid water and put a candle in the cavity, then you have an ice lantern.

I learned this method from a neighbour who brought it to Canada from Estonia. In the deep winter, her garden was a fairyland of ice candles. Alas, she has died now, and I have moved far from her home.

I now have a garden of my own, and I am thinking of getting some buckets though! Thanks for shaking loose these memories.

*Editor's note: Thank you to the readers who sent in photos of ice pyramids, “mushrooms” and shards. Instructions on how to create ice spikes in your freezer can be found in the New Scientist book How to Fossilise Your Hamster.*



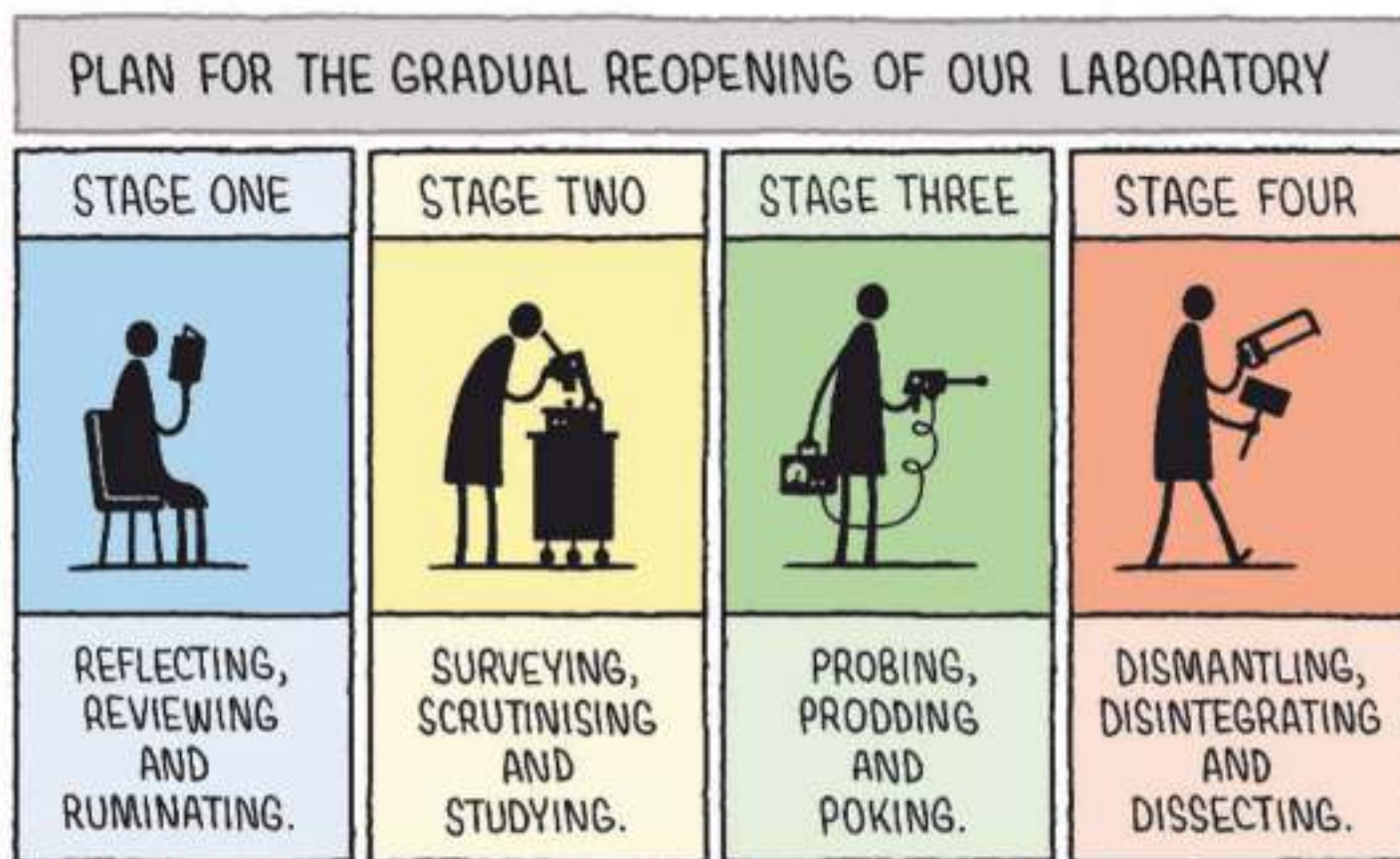
SYBILLE BRINZ



EASTER RUSSELL



**Tom Gauld**  
for *New Scientist*



## Digital print

**Do other animals have “fingerprints”?**

**Rob Colson**  
London, UK

Unsurprisingly, our closest relatives, the great apes, also have fingerprints.

Perhaps more surprisingly, so does the koala. In an example of convergent evolution, koalas have fingerprints that are virtually indistinguishable from ours, even though our last common ancestor lived more than 100 million years ago. Like human prints, each individual koala’s fingerprint has a unique pattern.

The primary function of fingerprints still isn’t universally agreed on. Suggested benefits include improved grip and the prevention of blisters. Fingerprints are also thought to increase the sensitivity of touch, allowing us to discriminate finer details.

When we run our fingers over an object, this sets off tiny vibrations in the skin, which are detected by nerves. Fingerprints

increase the size of these vibrations about 100-fold.

Koalas are notoriously fussy eaters, preferring to eat only eucalyptus leaves of a particular age. Their sensitive fingers may have evolved to allow them to identify the texture of their ideal meal.

**Tim Watkinson**  
Southampton, UK

In the heady days before lockdowns, in places such as Monkey World in Dorset, UK, you could observe finger marks on the glass partitions of enclosures.

It was sometimes difficult to distinguish those made by the residents from those left by the sticky digits of the visitors.

Indeed, in 2002, police in Hampshire, UK, worked with a team from Marwell Zoo on a study of fingerprints from Sulawesi macaques with a view to identifying individuals

to help prevent poaching.

Concerns have even been expressed in Australia that there might be some unidentified fingerprints languishing on crime scene databases that were made by koalas, due to the similarity of patterns on their hands to those found in humans. This was reported in *New Scientist* back in 1996.

**Samira Bendjedidin**  
Reading, Berkshire, UK

Koalas have unique fingerprints just like humans, but many animals have what seems to be the equivalent of fingerprints.

Individual cats and dogs, for example, have unique whisker patterns. Zebras have distinct stripe arrangements and individual leopards and spotted dolphins have their own spot patterns. Humpback whales also have unique markings on the underside of their tails. ■



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## Answers

### Quick quiz #92

#### Answers

- 1 Jean-Michel Jarre
- 2 The imago
- 3 The growth of plants
- 4 John Bardeen: 1956 (transistor) and 1972 (superconductivity)
- 5 Three: the common vampire bat, hairy-legged vampire bat and the white-winged vampire bat

### Cryptic crossword

#### #52 Answers

**ACROSS** 1 Readmit, 5 Diode, 8 Dyson sphere, 9 Spoofed, 10 Starting line, 12 Ensure, 17 Testosterone, 21 Soda ash, 22 Rhino, 23 Pasty, 24 Wet cell

**DOWN** 1 Radishes, 2 At sea, 3 Monitor, 4 Tisane, 5 Droll, 6 Offence, 7 Eddy, 11 Gene pool, 13 Speedos, 15 Pierrot, 16 Eschew, 18 Toady, 19 Olive, 20 ASAP

### #103 Trouble brewing Solution

Pressing the coffee and milk buttons delivers... coffee and milk!

Chocolate with milk produces tea + ? and sugar + ? with the ?s cancelling, and ? must be coffee. So the milk button doesn’t deliver chocolate. We know the milk/tea/sugar buttons deliver all but chocolate, so the tea and sugar buttons must both deliver chocolate, which then cancels.

This means the milk and coffee buttons deliver either sugar-coffee/sugar-milk or tea-coffee/tea-milk.

Either way, the result is that the coffee and milk buttons together deliver coffee and milk.

## This is not an apple

Another week, another artificial intelligence going decidedly off-piste. We recently mentioned the autonomous video-interviewing system that appeared to be grading candidates on the strength of the bookcase behind them (27 February). Now a paper published on the website of the company OpenAI reveals how CLIP, a neural network system that learns to recognise visual concepts through being fed verbal descriptions of them, can be spoofed simply by overlaying an image with text declaring it to be something else.

Stick a sticker on an apple declaring it to be a different apple product, an iPod, and the AI says it is an iPod 99.7 per cent of the time. Plaster dollar signs on a picture of anything, from a poodle to a chainsaw to a horse chestnut, and, with a charmingly artless naivety, CLIP mostly returns the answer “piggy bank”.

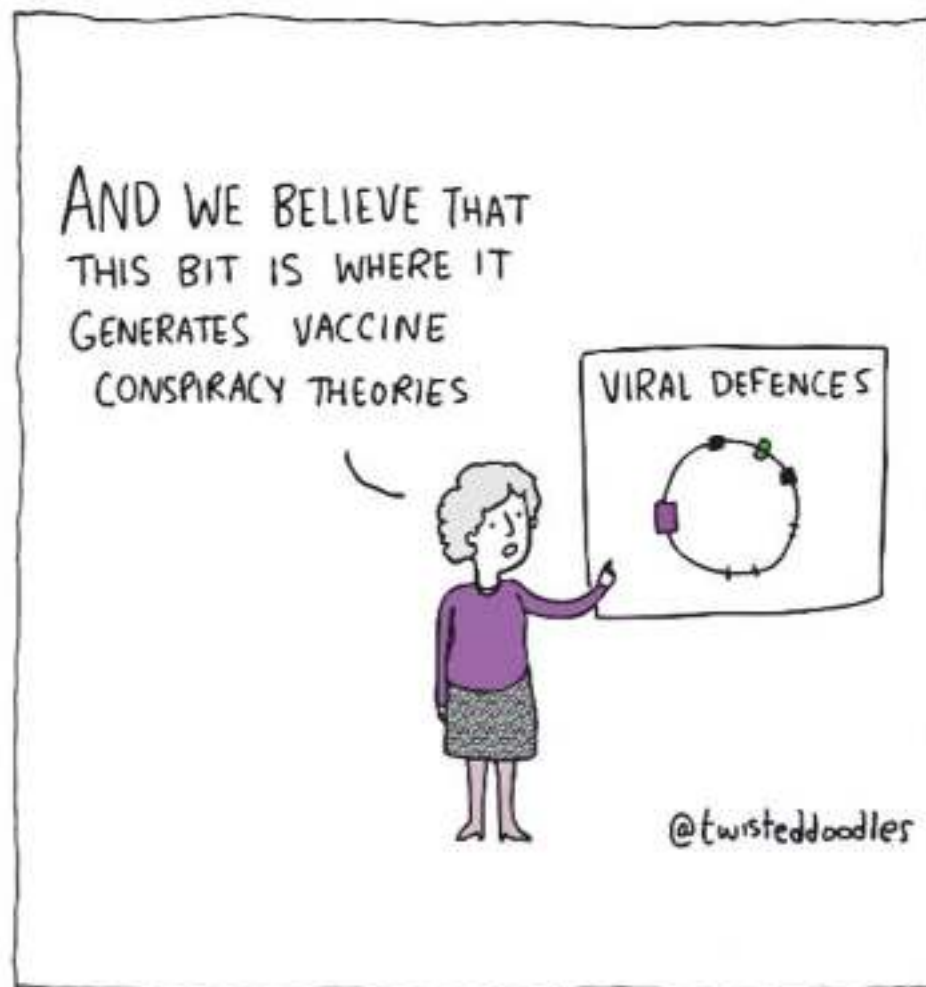
This suggests an excellent way to defy privacy-violating face-recognition systems when on nefarious business: simply attach a sheet of paper about your person declaring yourself to be your favourite frenemy or privacy violating tech guru.

## In the matrix

That last item gives us pause for thought when combined with this week's cover story on the nature of quantum reality (backwards readers: we mean the front cover, and you will find it towards the rear). We precis Carlo Rovelli's message as: things don't exist, and that's a jolly good thing too.

We recall, however, the very clever philosophical considerations that say that, if it is in principle possible for an advanced civilisation to develop enough computing power to simulate an entire universe, then someone has most probably already done it, and we are in it. So here's Feedback's alternative proposition: if we keep getting reality wrong, it is because this

## Twisteddoodles for New Scientist



### Got a story for Feedback?

Send it to [feedback@newscientist.com](mailto:feedback@newscientist.com) or

New Scientist, 25 Bedford Street, London WC2E 9ES

Consideration of items sent in the post will be delayed

is the matrix, and we are very confused AIs that someone is feeding false training data to for giggles. If you can confirm that, please don't.

## Too many Melbournes

Andrea Thompson writes to point out that, in mentioning the town of Melbourne, Derbyshire, being so often scandalously overlooked in favour of its larger antipodean namesake (20 February), we have overlooked the still smaller village of Melbourne in Yorkshire, UK.

What moves Andrea to write from Brisbane, Australia – at least we assume Australia – to point this out, she doesn't say, although she does say that this is the first time she has written to any publication about anything. Andrea, lovely to have you, and we are pleased to correct our omission. Equally, we have now

reached our minimum size threshold for acknowledging Melbournes.

## Hydrogenated water

If we appear unusually sprightly this week, it must be the hydrogenated water.

Hydrogen, the website blurb for the Prager Hydrogen Facial informs us, “is the most potent, easily absorbed anti-oxidant available. It can be inhaled, dissolved into drinking water, the possibilities are endless.”

Indeed, many additional doors open to you when you are the smallest of all molecules. Doubters might carp that a “deep cleansing facial which uses hydrogenated water to jet wash the skin” wouldn't provide much more benefit than pointing a standard water pistol at your head.

But at least water with extra H is

a more promising option than water with extra O. The exfoliating capabilities of H<sub>2</sub>O<sub>2</sub>, aka hydrogen peroxide, aren't in doubt, although we wouldn't advise trying it at home. Or indeed anywhere else.

## Corrosive conspiracy

We interrupt our normal programme of nodding and smiling while staring into the middle distance when anyone mentions a certain topic starting N.D. to note the co-author of two studies on the factors that influence people to believe conspiracy theories, Joseph A. Vitriol.

Our thanks for that to Mike Tanner – various forms of vitriol being very useful in the tanning industry, we believe – whom we can only identify via his email address as “of New Zealand”. Although is he? Given that well-known conspiracy theory about how often that country fails to make it on to world maps, we are inclined to doubt.

## Down to a t

There we were wondering what AI actually is good for when the perfectly manicured hand of our long-time correspondent Jeff Hecht proffers a PR puff through the stationery cupboard door. Thanks to “groundbreaking technology in the fields of artificial intelligence and machine vision along with a series of complex algorithms to replicate behavioral mechanics”, it informs us, “Nimble, the world's first device that uses artificial intelligence to self-paint and dry nails in under 10 minutes”, will shortly be available for pre-order.

The system can “autonomously size and accurately spec nails within seconds offering long lasting, salon quality manicures from the comfort of home”. We will freely admit that our gels are starting to look a bit tired in lockdown. But long-lasing replacements? That's a bit over the top even for our glitzy, off-the-wall style. And as per discussions above, we will reserve judgement on the “accurately” bit. ■



# The Strange & Secret Life of Bugs...

This month AQUILA Magazine investigates the amazing insects that share our planet — plus those annoying digital bugs that spoil our time online!

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## **April: ANCIENT EGYPT**

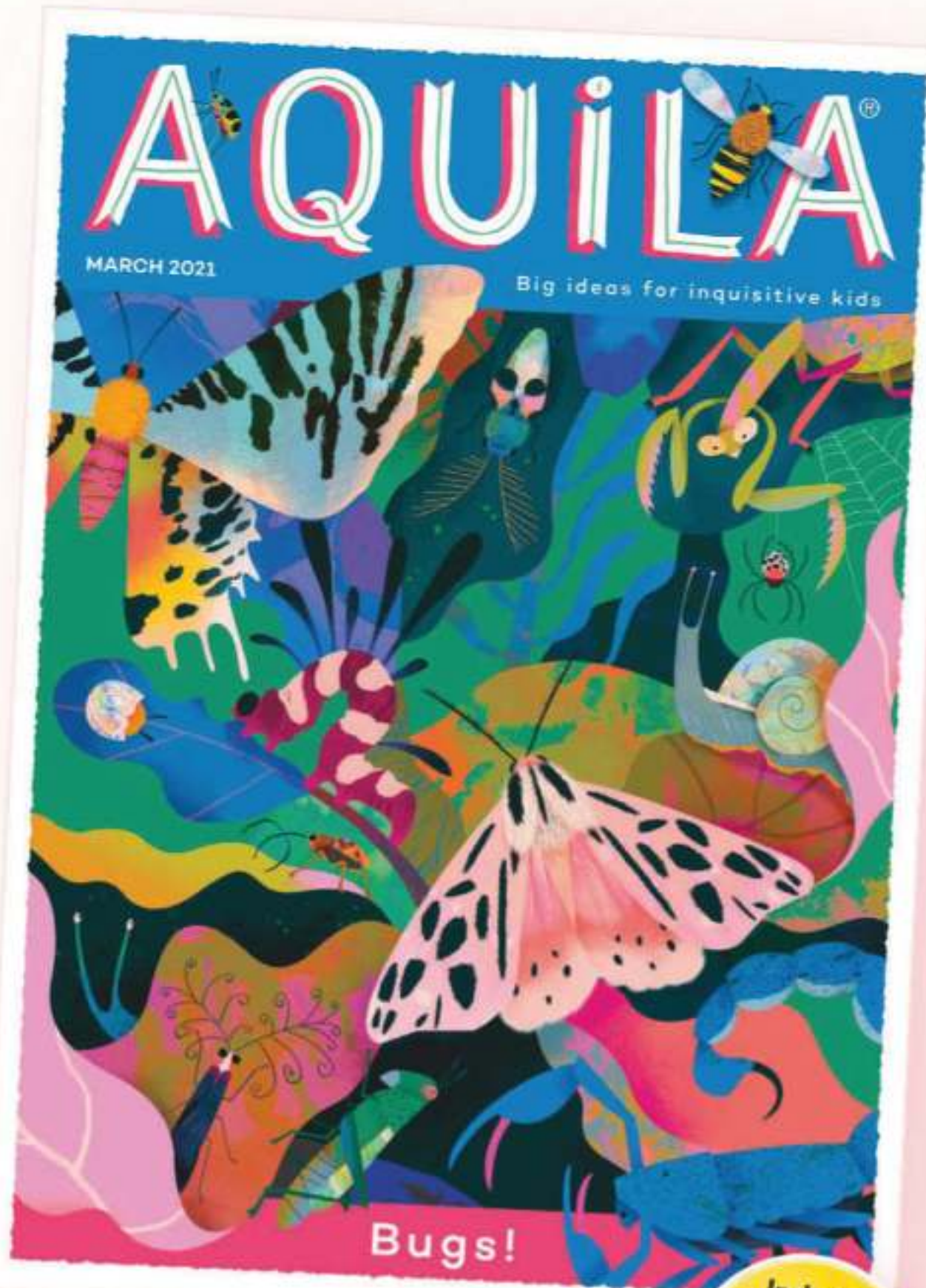
**Special Issue** - Discover the animals and geology of the Nile, try some pyramid Maths and investigate the mystery of the Rosetta Stone!

## **May: UNDERSEA EXPLORER**

Dive into coral reefs and meet their dazzling inhabitants. PLUS: underwater maps, sea monsters and the spaceship cemetery.

## **June: CREATIVE CODING**

Coding is not only a language for programming software: kid's brains can form creative connections that help them understand real-life problems and ideas.



There are more than 200 million insects for every human on our planet! Bugs may make you squirm, but there are goodies as well as baddies in their mighty empire: they whizz and buzz about their essential work — the unsung mini-heroes of the natural world.

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