

New Scientist

WEEKLY February 20–26, 2021

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Did the virus come from frozen foods?

MARTIAN INVASION

The new race to the Red Planet

SPECIAL ISSUE

A RESCUE PLAN FOR NATURE

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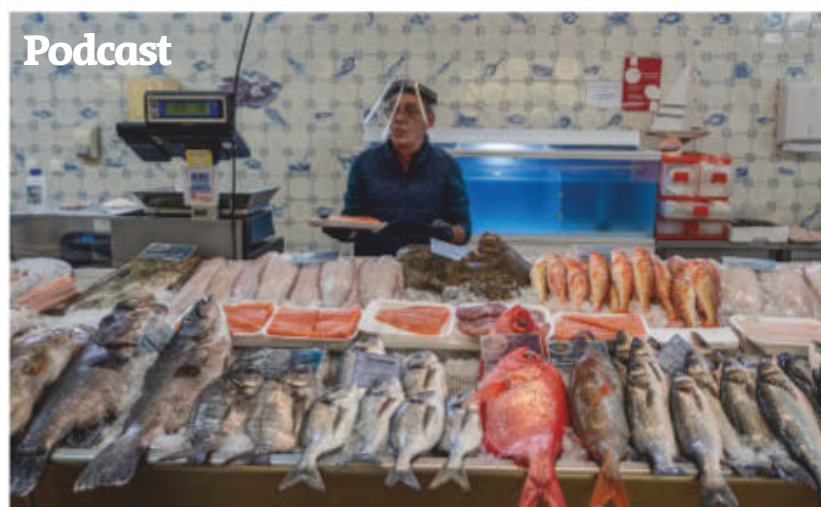
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Online

Covid-19 daily briefing

All the latest, most crucial coverage of the pandemic, with news, features and interviews. Updated each day at 6pm GMT.

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This year is an absolutely crucial moment for the environment. In November, pandemic permitting, the UK will host the COP26 climate change conference, in which the world's nations must finally come good on the commitments made in Paris a little over five years ago to limit global warming to 1.5°C. In May, a crunch meeting in China has been planned to establish global targets for conserving biodiversity over the next 10 years, which the UN has declared to be the "Decade on Ecosystem Restoration".

As you would expect, *New Scientist* will be ramping up its coverage of all things environmental over the year, examining the issues, talking to the people who matter and seeking the solutions that work.

The special feature in this issue, "A rescue plan for nature" (page 34), is just the start. We are pleased to announce that this is the first of five articles to appear in the coming weeks in association with the United Nations Environment Programme (UNEP). *New Scientist* retains full control of, and responsibility for, the content. Look out for the second feature in the series, on the links between our incursions into nature and the covid-19 pandemic, in two weeks' time. And stay tuned for a special virtual event on preserving biodiversity organised together with UNEP on 15 April, which will be free for all to attend.

In addition, this week, we are proud to present the first Planet Boost page, featuring the charity Butterfly Conservation. Part of our already well-established Signal Boost project, this will provide a platform for charitable organisations dedicated to conserving biodiversity and the natural world to talk about their work, free of charge.

That isn't the end of our ambitions, with further special feature series on all aspects of the environment and climate change planned for later in the year. As ever, with a *New Scientist* subscription, you won't miss a thing.

Richard Webb

New Scientist executive editor

"New Scientist will be ramping up its coverage of all things environmental over the year"



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The value of nature

Covid-19 is a wake-up call to halt our abuse of the ecosystems that support us

FOR a government-backed report, the recently published Dasgupta Review on the economics of biodiversity, commissioned by the UK Treasury in 2019, is blunt in its critique of mainstream economic thinking. “We may have increasingly queried the absence of Nature from official conceptions of economic possibilities, but the worry has been left for Sundays,” the distinguished University of Cambridge economist Partha Dasgupta writes in his preface. “On week-days, our thinking has remained as usual.”

The naturalist David Attenborough is still blunter about the consequences in the report’s foreword. “We are facing a global crisis. We are totally dependent upon the natural world. It supplies us with every oxygen-laden breath we take

and every mouthful of food we eat. Yet we are currently damaging it so profoundly that many of its natural systems are now on the verge of breakdown.”

Our understanding of the web of dependencies that link us to the natural world is perhaps 30 or 40 years behind the science of climate change. But we

“Clean water and air, fertile soils and reduced risk of disease aren’t ‘nice-to-have’ fripperies”

know enough to declare our assault on Earth’s biodiversity and natural ecosystems a crisis of similar magnitude – one that no government, company or individual can now afford to ignore.

This special issue on the state of the natural world and how we can restore

it appears in this context (see page 34).

It is the first of a series of features on biodiversity, produced in association with the United Nations Environment Programme, that will appear over the coming weeks. It reflects a renewed focus on all aspects of our environmental impact as the world seeks to build back better from the covid-19 pandemic.

This crisis has been a wake-up call that human health and wealth are dependent on the health of the ecosystems around us. Clean water and air, fertile soils, reduced risk of diseases jumping from animals to us, and all the other “ecosystem services” that a healthy natural world gives us for free aren’t “nice-to-have” fripperies. For all our sakes, we must work to resolve the crisis we have precipitated – every day of the week. ■

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Distributed by Time Inc. Retail, a division of Meredith Corporation, 6 Upper Pond Road, Parsippany, NJ 07054

Syndication Tribune Content Agency

Tel 1-800-346-8798 **Email** tca-articlesales@tribpub.com

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New Scientist Escape Pod

Hello and welcome to the Escape Pod. Your flight will last about 15 minutes and we expect no turbulence, just a smooth, pleasant ride.

This lockdown podcast doesn't include any references to coronaviruses or other unpleasant happenings on the planet below. The Escape Pod is pure, well, escapism. Sit back, relax and let hosts Rowan Hooper, Anna Demming and Timothy Revell whisk your mind away to worlds of inspiration and distraction.

And when you're ready to come back down to Earth and hear about what's going on in the world, don't forget the *New Scientist* Weekly podcast – your audio guide to all the essential science news of the week.

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People are tested for covid-19 in Los Angeles, where cases have surged

Recombination commonly occurs in coronaviruses because the enzyme that replicates their genome is prone to slipping off the RNA strand it is copying and then rejoining where it left off. If a host cell contains two different coronavirus genomes, the enzyme can repeatedly jump from one to the other, combining different elements of each genome to create a hybrid virus.

"This could have allowed the virus to couple a more infectious virus with a more resistant virus"

The recent emergence of multiple variants of the new coronavirus may have created the raw material for recombination because people can be infected with two different variants at once.

"We may be getting to the point when this is happening at appreciable rates," says Sergei Pond at Temple University in Pennsylvania, who keeps an eye out for recombinants by comparing thousands of genome sequences uploaded to databases. He says there is still no evidence of widespread recombination, but that "coronaviruses all recombine, so it's a question of when, not if".

The implications of the finding aren't yet clear because very little is known about the recombinant's biology. However, it does carry a mutation from B.1.1.7, called Δ69/70, which makes the UK variant more transmissible, and another from B.1.429, called L452R, which can confer resistance to antibodies.

"This kind of event could allow the virus to have coupled a more infectious virus with a more resistant virus," Korber said at the New York meeting.

Lucy van Dorp, also at University College London, says that she hadn't yet heard about the recombinant, but "would not be overly surprised if some cases start to be detected". ■

Coronavirus hybrid

Two variants combine

A merger of coronavirus variants in the US has sparked warnings that we may be entering a new phase of the pandemic, reports **Graham Lawton**

TWO variants of the SARS-CoV-2 coronavirus that causes covid-19 have combined their genomes to form a heavily mutated hybrid version of the virus.

The "recombination" event was discovered in a virus sample in California, provoking warnings that we may be poised to enter a new phase of the pandemic.

The hybrid virus is the result of recombination of the highly transmissible B.1.1.7 variant discovered in the UK and the B.1.429 variant first seen in California. This second variant may be responsible for a recent wave of cases in Los Angeles because it carries a mutation making it resistant to some antibodies.

The recombinant was discovered by Bette Korber at the Los Alamos National Laboratory in New Mexico, who told a meeting

organised by the New York Academy of Sciences on 2 February that she had seen "pretty clear" evidence of it in her database of US viral genomes.

If confirmed, the recombinant would be the first to be detected in this pandemic. In December and January, two research groups independently reported that they hadn't seen any evidence of recombination, even though it has long been expected as it is common in coronaviruses.

Unlike regular mutation, where changes accumulate one at a time, which is how variants such as B.1.1.7 arise, recombination can bring together multiple mutations in one go. Most of the time, these

don't confer any advantage to the virus, but occasionally they do.

Recombination can be of major evolutionary importance, according to François Balloux at University College London. It is considered by many to be how SARS-CoV-2 originated.

Recombination could lead to the emergence of new and even more dangerous variants, although it isn't yet clear how much of a threat this first recombination event might pose.

Korber has only seen a single recombinant genome among thousands of sequences and it isn't clear whether the virus is being transmitted from person to person or is just a one-off.

Daily coronavirus news round-up

Online every weekday at 6pm GMT

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

Analysis

New variants vs normality

Countries that are vaccinating can be optimistic about a return to normality despite new variants, finds **Michael Le Page**

WHEN the first trial results for covid-19 vaccines were announced back in November, it seemed that the end of the coronavirus pandemic was in sight. But then came news of first one dangerous new virus variant and then another. So where does that leave us? Will new variants scupper efforts to get life back to normal?

No one can say for sure what will happen next, of course. But many researchers are optimistic that in countries that get hold of enough vaccine, life could mostly return to normal in around a year or less. And in the long run, rather than us facing a never-ending battle with increasingly dangerous new variants, the expectation is still for covid-19 to turn into a mild disease.

"If it becomes endemic and mild in the way our studies predict, it really wouldn't be any worse than the common cold," says Jennie Lavine at Emory University in Atlanta, Georgia. "I'm not saying we know that's going to happen but even with what's going on now that's not an unreasonable prediction for the longer-term future."

Key questions

What happens over the next few months depends on the answers to two questions, says A. Marm Kilpatrick at the University of California, Santa Cruz.

Firstly, even if vaccines or a previous infection don't prevent infection with a new variant, will they prevent severe disease? And secondly, can a country vaccinate a large enough proportion of its population?

"If the answer to both these questions is yes, then I think a much more normal life is possible in [around six months' time]," says Kilpatrick.

Most countries aren't going to get hold of enough vaccine any time soon, says Kilpatrick. "So 'normal' life won't be possible except through infection, which would likely be terrible for many countries."

For countries where vaccination is happening, there is encouraging news from Israel, which by early February had given at least one dose of the Pfizer/BioNTech vaccine to 90 per cent of people aged over 60. Even before then, by mid-January, the number of people hospitalised with covid-19 had begun to decline, with a larger and earlier decrease among older individuals, suggesting that this is an effect of vaccines.

Unfortunately, even vaccinating most of a population doesn't necessarily guarantee an end to the pandemic. "A significant outbreak with many hospital

admissions is still possible after the completion of the vaccination programme, if controls are lifted too quickly," says Matt Keeling at the University of Warwick, UK.

The problem is that not everybody will get vaccinated and even some of those who do may not be protected against severe disease. That means many could still be vulnerable.

"In countries that can get hold of enough vaccine, life could mostly get back to normal in a year or less"

The issue then becomes preventing the virus reaching these vulnerable people. If enough people have enough immunity – the herd immunity threshold – the virus cannot spread.

The new variants make this harder to achieve. The B.1.1.7 variant

first detected in the UK is around 50 per cent more transmissible, for instance, which might raise the herd immunity threshold from 67 per cent of the overall population to 80 or 90 per cent.

"The emergence of more transmissible variants makes achieving herd immunity very unlikely with the AstraZeneca vaccine, although it should still be achievable with high-efficacy vaccines like the Pfizer, Moderna and Novavax products," says Zoë Hyde at the University of Western Australia.

Even though the Oxford/AstraZeneca vaccine has a lower efficacy than these other vaccines, it will still save lives, so countries battling outbreaks should roll it out as soon as possible, says Hyde.

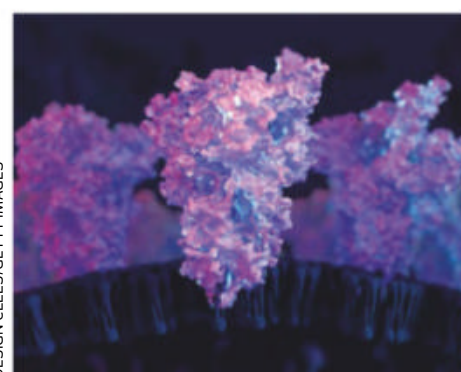
For countries that have pretty much eliminated the virus, such as Australia and New Zealand, one downside is that few people have natural immunity. By contrast, as many as a third of people in the UK may have been infected, so reaching the herd immunity threshold via vaccination will be easier.

Then we have B.1.351, the variant first detected in South Africa, and the P.1 variant first seen in Brazil, both of which can, to some extent, evade antibodies created in response to previous infections and vaccination. This means people infected with these variants are more likely to pass them on, which again makes reaching the herd immunity threshold harder.

The big worry with B.1.351 and P.1 is that they might evade these antibodies to such an extent that they cause severe covid-19. We still don't know how seriously ill someone would get if they were reinfected with one of these variants, says Lavine. "I'm still hopeful, but I think this is a really



CHRISTOPHE ARCHAMBAULT/AFP VIA GETTY IMAGES



DESIGN CELLS/GETTY IMAGES

Above: Genome sequencing of coronavirus variants. Left: The virus's spike protein, where key mutations have taken place



JOE BURBANK/ORLANDO SENTINEL/ZUMA PRESS/PA IMAGES

important question to answer.”

There is reason to be optimistic. Trials of a vaccine from Johnson & Johnson show that while it was less effective at preventing mild or moderate disease in people infected with P.1 or B.1.351 than with past variants, it was just as effective at preventing severe disease, with no hospitalisations or deaths in anyone given the vaccine.

This may be due to how immunity works in the body. Antibodies are crucial for preventing infection in the first place. They work by binding to and blocking the part of the coronavirus spike protein that helps it get into cells. B.1.351 and P.1 have several mutations, including one called E484K, that change the shape of this part, which will help it to evade those antibodies and could cause mild or moderate illness.

Once people are infected, however, T-cells, which form part of another branch of the immune system, help mop up infected cells, preventing severe disease. Crucially, T-cells are effective as long as they can recognise any part of the spike protein. This means it is much harder for the coronavirus to evolve to evade T-cells.

The Pfizer/BioNTech vaccine has been shown to produce a strong T-cell response to B.1.351, suggesting that it will remain effective at preventing severe disease even if it is less effective at preventing infections.

Another reason for optimism is that there is a limit to how much the virus can evolve and still function, says Lavine. For instance, the virus won't be able to enter human cells if the part of the spike protein that binds to them changes too much.

A family visits Disney World in Florida, in December 2020

67%

Herd immunity threshold with previous variants

80-90%

Probable herd immunity threshold with B.1.1.7, the current dominant variant in the UK

What's more, one study looking at which mutations could help the virus evade antibodies found that the E484K mutation made the biggest difference. So it may be that we have already seen the single worst mutation.

If so, we might not need to tweak vaccines more than once or twice, although of course we cannot be sure of this. There is still a chance that something unpredictable could happen, such as the virus, known as SARS-CoV-2, recombining with another coronavirus to produce a more dangerous strain (see page 7).

Cautious optimism

What we do know is that the four human coronaviruses that have long circulated in people cause only mild illnesses. This is because pretty much everyone is exposed to them in childhood, and they don't cause severe illness in children.

Since SARS-CoV-2 is also very unlikely to make children seriously ill, Lavine's work suggests that it will end up doing the same.

It might be undergoing a period of rapid evolution as it adapts to a new host that is starting to become immune, says Lavine, but things should settle down in the longer run. "The prediction of it being mild in the long term doesn't change because of the variants, it just pushes out the time frame."

Others are more cautious. "Certainly, I think we can hope this can be the case," says Emma Hodcroft at the University of Basel in Switzerland. "But even if this does become an endemic, relatively harmless virus, how long will that take? I think we should prepare for optimistic and slightly less-so scenarios." ■

Origins

Did the virus come from frozen food?

The idea is being investigated, but the science is far from clear

Adam Vaughan

COULD the virus that caused a worldwide pandemic have made the jump to humans via frozen food? That was one hypothesis put forward on 9 February by a joint World Health Organization and Chinese investigation into the origins of SARS-CoV-2.

Frozen animals were found on sale at Huanan market in Wuhan, China, the place where the virus was initially detected, the team behind the inquiry said. In a press conference, Peter Ben Embarek, the head of the investigation, said: “We know the virus can survive in conditions that are found in these cold, frozen environments, but we don’t really understand if the virus can transmit to humans.”

The idea that the coronavirus was carried inside or on the surface of frozen food, which has been advanced by Chinese state media, could place the source of the virus beyond China, in an animal imported from another country.

Yet it is far from clear whether the virus could survive in an infectious form in frozen food. “I would say it’s extremely, extremely unlikely the virus would have spread through that type of route,” says Lawrence Young at the University of Warwick, UK, who specialises in human virology.

The reason why, according to Young, is that SARS-CoV-2 is an enveloped virus, meaning it is covered with a fatty, lipid membrane that is integral to its ability to infect human cells. This membrane is very vulnerable to cycles of freezing and thawing, as can happen during the transit and sale of frozen food. Stripped of this envelope, such viruses can’t infect people.

A review by Jie Han and Zue Zhang at Xi’an Jiaotong University in Shaanxi, China,



STRAFPVIA GETTY IMAGES

Workers package frozen steak at a beef-processing plant in Binzhou, China

and their colleagues of evidence on spreading the coronavirus via food concluded that “major knowledge gaps exist” on the role that frozen food plays. “Data are lacking on the long-term survival of SARS-CoV-2 under freezing temperatures (-10°C to -20°C) that are frequently encountered on the storage and transport of frozen foods,” the team wrote.

Just one study, which hasn’t been peer reviewed, has tried to obtain that data. Dale Fisher at the National University of Singapore and his colleagues put the virus into cubes of pork, chicken and salmon, finding no decline in the viral load after 21 days in a lab at a refrigeration temperature of 4°C or at a standard freezing temperature of -20°C.

However, from this experiment, it isn’t clear whether the viral load was still infectious to humans. In addition, the experimental parameters may not reflect real-world viral loads or conditions in food supply chains.

SARS-CoV-2 may have a rough time when frozen food is transported. During air travel, for instance, temperatures drop

“I would say it’s extremely, extremely unlikely the virus would have spread via frozen food”

to between -20°C and -30°C in cargo holds when planes are airborne, then rise much higher after landing.

By ship, the virus could suffer from the “salty air issue”, in which salt levels in the air can affect the number of viruses that can survive, says Julian Tang at

the University of Leicester, UK.

Changes in humidity on frozen food’s journey may also negatively affect SARS-CoV-2, as the lipid membrane can be disrupted by taking on fluid from the air.

We do know that the virus has been found to persist on the packaging of frozen food. After two workers at Qingdao Port in China tested positive in September 2020, SARS-CoV-2 was found on 50 of 421 samples of frozen cod packaging.

However, Rodney Rohde at Texas State University says that despite the virus being found on packaging, it doesn’t mean it is in a viable state that could infect our cells. “One must remember that any viral genetic material may be found on all types of surfaces, including frozen surfaces. But molecular PCR tests [that identify the presence of the virus] do not differentiate ‘viable’ from ‘non-viable’ virus.”

The other possible route is if the virus is transported inside the frozen meat or fish itself. “If it’s part of the meat, it has more protection,” says Tang.

Even if the virus was still in an infectious form by the time it reached a person in Huanan market, there are still questions over how they were actually infected. Cooking the meat would kill the virus, as would the gastric acid in our stomachs, says Young. However, if the food was raw or not properly cooked, people could potentially be infected from surfaces during food preparation or via the upper respiratory tract while chewing the food.

“Overall, the probability [of infection via frozen food] is low. [But] if it happens once – a one-in-a-million event – and it’s enough to seed the virus in the human population, you might get that spread,” says Tang. ■

England's quarantine hotels won't stop variants

The decision that visitors from only some countries must isolate in hotels ignores scientific advice and is bound to fail, says **Donna Lu**

SINCE Monday 15 February, travellers arriving in England from a "red list" of 33 countries have been required to quarantine in a hotel for 10 days. The ruling has been criticised as inconsistent, and won't stop new coronavirus variants from entering the country.

Travellers will now be required to quarantine at their own expense, taking a covid-19 test on day two and day eight of their stay. The quarantine will be extended if a person tests positive.

Tough measures are in store for individuals who fail to quarantine with fines of up to £10,000. Anyone who provides false information about their travel arrangements could face a prison sentence of up to 10 years.

Scotland will require all arriving air passengers to quarantine in hotels, while Wales will enforce the same rules as England.

UK health secretary Matt Hancock told parliament on 9 February that he had sought advice from the Australian government on hotel quarantine measures. It is unclear, however, what lessons from Australia will be implemented.

Like many other countries that have controlled the spread of covid-19, Australia has had strict border controls in place for nearly a year. Since late March, returning residents have been required to spend 14 days in hotel quarantine.

"In the case of Australia, the goal is to eliminate the risk of international travellers bringing covid-19 into an environment where we have no community spread," says Nancy Baxter at the University of Melbourne. "But when your country has one of the world's biggest outbreaks, I'm not really sure what you're gaining by having hotel quarantine – other than being ready for when you do get your numbers to the point where international travellers pose a greater risk to your

community than just going to the grocery store."

"I think it might very well be too late," says Beverley Paterson at the University of Newcastle in Australia.

Hancock has said that the border rules are needed to "secure the nation against new variants of coronavirus". However, given that the new quarantine rules will be enforced only for passengers returning from red-listed countries, many researchers think they are unlikely to be effective. "Clearly there are political reasons that countries are or aren't on that list. It's not a risk-based plan," says Baxter.

For instance, the US isn't on the red list, despite the rapid spread of a new virus variant in California. The likelihood of a new variant being introduced from the US is enormous, says Paterson.

Labour leader Keir Starmer and Scotland's first minister Nicola Sturgeon have both criticised the incompleteness of England's approach.

The policy for travellers arriving in England also goes against advice from the UK's Scientific Advisory Group for Emergencies (SAGE)



HOLLIE ADAMS/GETTY IMAGES

A traveller arriving at London Heathrow airport in January, before the new rules came into effect

on 21 January, which concluded that "no intervention, other than a complete, pre-emptive closure of borders, or the mandatory quarantine of all visitors upon arrival in designated facilities, irrespective of testing history, can get close to fully prevent the importation of cases or new variants".

It will be important that hotel quarantine workers in the UK are adequately protected to minimise the risk of infection and further community transmission.

In Australia, infections in hotel workers have led four cities to enact snap lockdowns since November.

"No intervention, other than mandatory quarantine of all visitors, can prevent the importation of variants"

A leak from hotel quarantine was also responsible for the second wave in Melbourne in July, triggering 111 days of lockdown.

Hotel quarantine workers should be adequately remunerated so they don't need to work multiple jobs, says Baxter, and candidates should exclude individuals with close contacts working in high-risk areas, such as in care homes.

In the Australian state of Victoria, workers are tested for covid-19 daily, including on their days off, and wear fitted N95 masks. Baxter says that hotel quarantine workers must also be vaccinated as a priority.

To minimise transmission risk, UK hotels used for quarantine should be adequately ventilated, with windows and balconies that open to the outside. Staggered mealtimes may also help to stop transmission.

But these measures may end up being a waste of effort if large gaps in the system aren't addressed. "If the UK wants to do it properly, they need to quarantine every person coming into the UK," says Paterson. "There's no point in half measures." ■

Staff at St Giles Hotel near Heathrow airport use thermal scanning



EN STANSALL/AFP VIA GETTY IMAGES

Martian invasion

Landers, rovers and even a helicopter are descending on Mars this month, where they will search for signs of water and past life, says **Leah Crane**

MARS is a popular spot this month, with the United Arab Emirates's Hope orbiter, the Chinese Tianwen-1 probe and NASA's Perseverance rover all arriving at the Red Planet in quick succession.

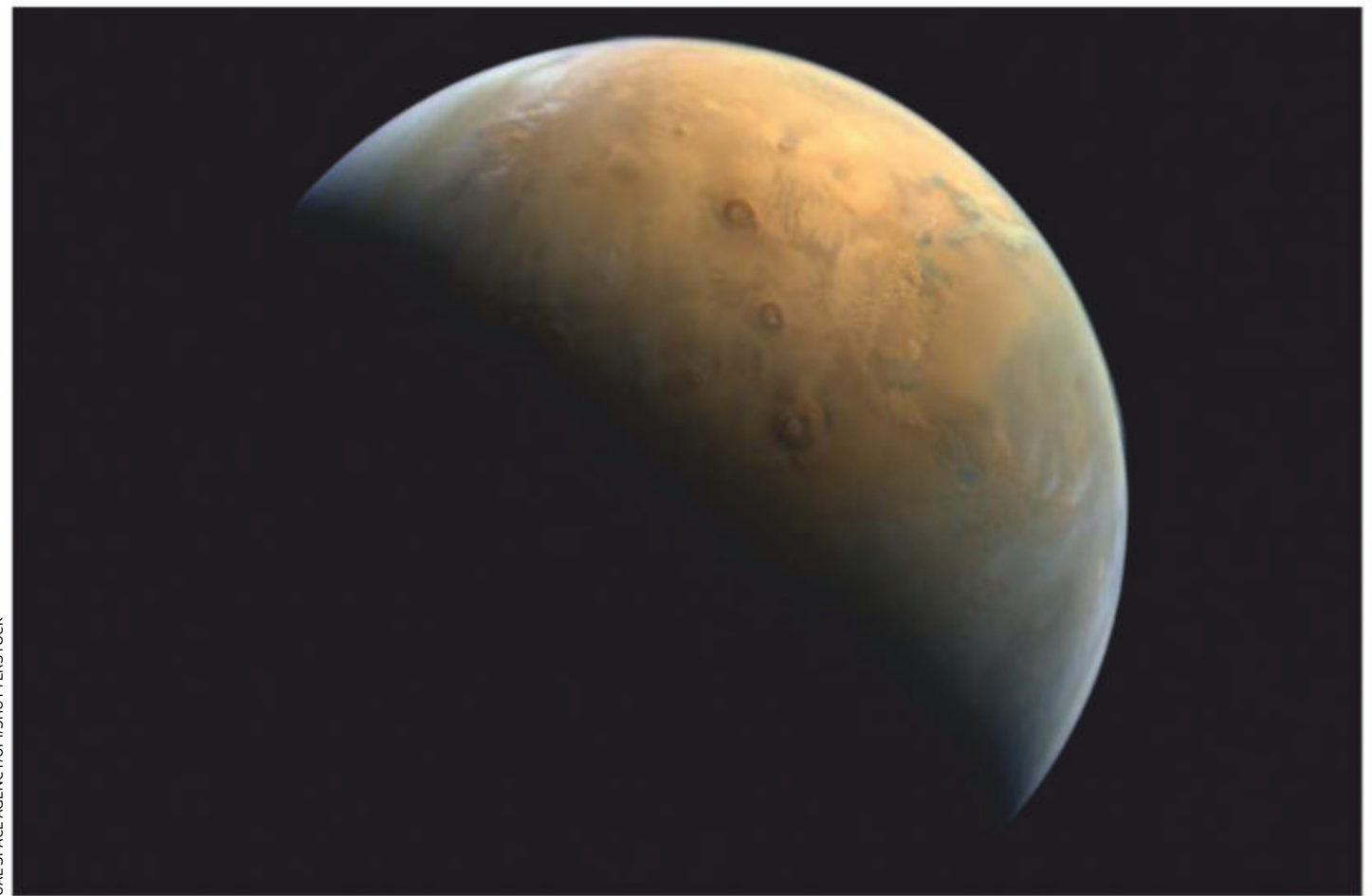
Hope and Tianwen-1 both entered Martian orbit last week (the first image of Mars beamed back from Hope is pictured right), while Perseverance, which launched on 30 July 2020, is due to touch down on 18 February. It is the largest vehicle ever to try to land on Mars, weighing in at just over 1 tonne. The rover is also carrying the first helicopter to visit another planet, a small drone called Ingenuity (see "First helicopter on another planet could glow in the dark", right).

Such a landing is difficult: about 60 per cent of the missions that have tried to set down on the surface have failed. Perseverance will follow a similar landing sequence to the Curiosity rover, which arrived successfully in 2012,

"Perseverance is the first leg of the first-ever round trip to another planet"

with a heat shield and parachute slowing it down from about 20,000 kilometres per hour to less than 4 kilometres per hour before a "sky crane" – a disposable craft that deploys thrusters to hover above the ground – lowers the vehicle gently to the surface.

Perseverance will land in Jezero crater, thought to be a dry lake bed, but we don't know the exact spot. "Once you hit Mars's atmosphere, the wind buffets you around and makes it harder to predict," says Briony Horgan at Purdue University in Indiana, part of the Perseverance team. Because of that and the rugged landscape, Jezero was thought to be too risky



UAE SPACE AGENCY/UPI/SHUTTERSTOCK

to land in, but Perseverance has a navigation system that will take pictures as it nears the surface and autonomously pick a safe-looking landing spot.

Part of Perseverance's scientific goal is to look for evidence of past life on the Martian surface. However, even with its sophisticated instruments, it is unlikely that



AP/SHUTTERSTOCK

the rover will be able to confirm signs of life with certainty.

"The hope is we'll find very strong evidence – layers of organic material layered in with microbial mat textures on an ancient shoreline, something like that," says Horgan. "But we still need to check and make sure that some weird non-biological thing didn't cause this, and to do that, we really need to bring samples back to Earth and look at them in the lab."

That is why the other part of the mission is to grab samples of dust and rocks, carefully package them in 43 test tubes and leave them behind on the surface of Mars. Another mission that is planned for 2026 will then pick them up and bring them back to Earth.

"If it sounds complicated, it is. If it sounds extreme, it most

China's Tianwen-1 probe on its way to Mars. It will stay in orbit until May

certainly is," said Lori Glaze, NASA's director of planetary science, in a press conference. But it will be worth it, she said. "We expect samples of Mars to provide new knowledge for decades to come as we study them with state-of-the-art laboratory tools we couldn't possibly carry to Mars right now."

Scientists still study the rocks that the Apollo missions brought back from the moon between 1969 and 1972, and these new Mars samples could provide a similar way to conduct in-depth studies of the Martian surface from laboratories on Earth.

Bringing the samples back also has another benefit: it may act as a sort of dress rehearsal for crewed missions to Mars, which will presumably mean bringing people back from the Red Planet after sending them there.

"Perseverance is the first leg of the first-ever round trip to another planet," said Wanda Peters

The UAE's Hope orbiter took this image showing three volcanoes in a line on the surface of Mars

60%

The proportion of Martian landings that end in failure

20,000

Speed of Perseverance in kilometres per hour as it reaches the Red Planet

90

Number of Mars days Tianwen-1 rover will roam the surface

at NASA's Science Mission Directorate during a briefing. If the landing goes smoothly, that round trip will be well on its way.

But Perseverance won't be alone on the Martian surface: aside from the Curiosity rover, which is still trundling around Gale crater, the Tianwen-1 mission is also getting ready to drop off a rover.

China's craft entered Mars orbit on 10 February, just one day after the UAE's Hope probe. This is China's second interplanetary mission, but its first without international partners. Tianwen-1 has three parts: an orbiter, a lander and a rover.

Multiple goals

"While Perseverance is a very focused mission – it's one rover that has a very clear goal of looking for life and collecting samples – I think Tianwen-1 is an attempt to see how much they

can do at once," says Horgan.

Now that Tianwen-1 is safely circling Mars, the next step is to start the preparations for sending the mission's lander to the surface. Scientists have selected a site for this in Utopia Planitia, the same region where NASA's Viking 2 lander touched down in 1976. Tianwen-1 will take pictures of the area from orbit to make sure conditions are safe. Unlike Jezero crater, Utopia Planitia is relatively flat.

If everything looks clear, the lander will be released. It will hurtle towards the Martian surface, slowing down with the help of a cone-shaped heat shield and a parachute before a set of rockets brings it softly to rest on the ground. This is expected to happen around May, giving the mission team plenty of time to assess the landing site.

Finally, assuming all goes to plan, the lander will release a solar-powered rover to explore the dusty surface for about 90 Martian days. This vehicle is equipped with cameras, ground-penetrating radar, a magnetic field detector, a weather station and an instrument to measure the chemical composition of the dust and rocks. The orbiter also carries its own scientific instruments to investigate Mars from orbit.

Together, all of these tools will aid in the search for pockets of liquid water and ice on Mars, as well as laying the groundwork for future missions. "It's pretty similar in a lot of ways to the Viking missions, which were also NASA's first landers on Mars," says Horgan.

Like NASA's subsequent Mars missions, China's future plans for the Red Planet are more complex, including an attempt to bring samples back to Earth for analysis in the late 2020s, similar to the US follow-up to Perseverance. ■

Mars reconnaissance

First helicopter on another planet could glow in the dark

Jonathan O'Callaghan

NASA is about to fly a helicopter on Mars, and it turns out that its rotors could glow in the dark.

A few weeks after the Perseverance rover lands on Mars (see "Martian invasion", left) it will deploy a 0.5-metre-high drone called Ingenuity. The drone will conduct up to five flights in a 30-day window. Each will increase in duration, to a maximum of about 90 seconds.

William Farrell at NASA's Goddard Space Flight Center in Maryland and his colleagues say the flights, which are a technical demonstration, also afford a unique scientific opportunity. The low atmospheric pressure on Mars, coupled with its dusty environment and carbon dioxide-rich atmosphere, could produce an electric charge on the blades strong enough to break down atmospheric molecules, says the team (arxiv.org/abs/2102.04181).

Modelling this breakdown in the lab showed that it is unlikely to damage Ingenuity, but could be visible at take-off and landing in low light, producing a soft glow or "corona" on the

blades. Something similar, known as the Kopp-Etchells effect, can happen to helicopters on Earth.

"We suggest that operations occur once at twilight so that any corona-like glow [can] be observed by Perseverance in the low light environment," the team writes.

Perseverance will use its cameras to record Ingenuity's flights, so might be able to see this effect. Joshua Ravich at NASA's Jet Propulsion Laboratory

"We're mostly planning to fly mid-morning because of better wind conditions"

in California, the helicopter's mechanical engineering lead, says the team hasn't yet decided whether to attempt a flight at twilight. "We think that would be pretty interesting to see," he says. "Unfortunately, we're mostly planning to fly mid-morning because of better wind conditions and thermal conditions."

Even if a twilight flight were tried, Perseverance's cameras might not be sensitive enough to see the effect. "But it would be pretty cool," says Ravich. ■

The Ingenuity helicopter will take off from the Perseverance rover



Animal communication

Chimpanzees seem to 'speak' in sentences of three or more calls

Michael Marshall

CHIMPS may be more vocally creative than we thought. It turns out that they regularly string many different calls together into sequences, which are often three calls long and sometimes even longer.

This opens up the possibility of chimps combining calls to create new meanings, a skill thought to be unique to humans – although far more evidence would be required to show this.

Chimpanzees (*Pan troglodytes*) communicate with a mix of gestures and calls, including grunts, “hoos”, barks and screams. This is far from the complex language that humans use. In particular, humans can combine words to create meanings that aren't present in the individual words, such as “this duck quacks every evening”.

It isn't clear whether chimps' calls convey complex meanings, and animals including chimps seem to be limited in their ability to combine calls in sequences.

Cédric Girard-Buttoz at the Max Planck Institute for Evolutionary Anthropology

in Leipzig, Germany, and his colleagues recorded the calls of 46 adult chimpanzees in Taï National Park in Côte d'Ivoire. They obtained 900 hours of data, including 4826 utterances. While 3232 of these were single calls, 817 were paired calls and 458 were triplets. There were also longer sequences, but these were rare: there were only two instances of a sequence of 10 calls.

Chimpanzees can produce vocal sequences containing several individual calls

The team found clear patterns in the sequences. In paired calls, grunts and hoos tended to come first, while panted barks and other sounds tended to come second. This was also true for triplet calls, which contained some call pairs more often than would be expected by chance (bioRxiv, doi.org/fvqq).

For Girard-Buttoz, this is reminiscent of the rules that structure human sentences. English sentences, for instance, often start with a subject followed by a verb and an object, like “the

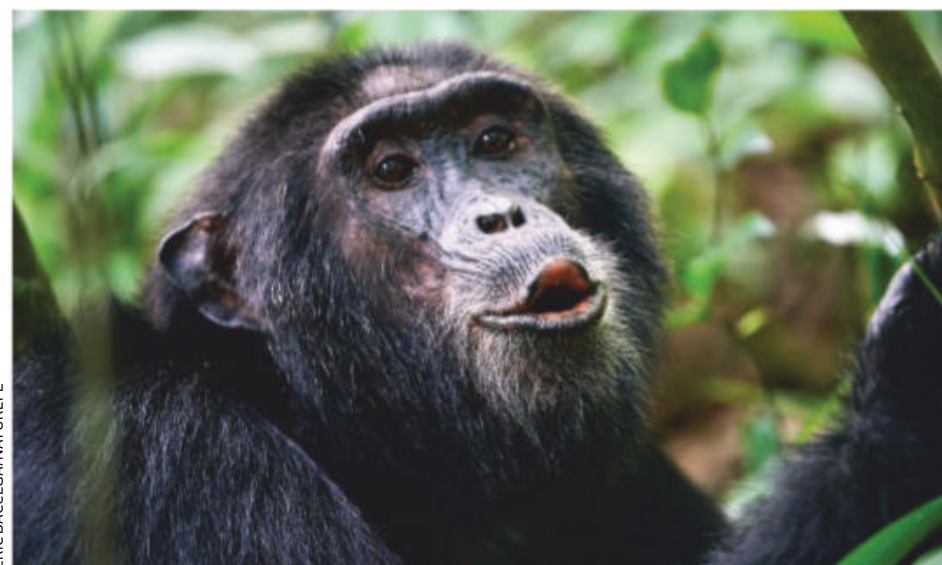
duck ate the elephant”.

“Anatomically, [chimps] can combine almost any call to any call in any order,” says Girard-Buttoz. “But there are some more-recurring sequences.”

Compiling such a large data set and hunting for patterns is “new and exciting”, says Kirsty Graham at the University of St Andrews in the UK. She studies great ape gestures and would like to see similar studies of gesture-based communication.

However, the key problem is that we don't know whether the patterns in the chimps' calls are meaningful to them. Girard-Buttoz says finding out is the next step, perhaps by playing specific sequences to chimps and seeing how they react.

Julia Fischer at the German Primate Center in Göttingen thinks it would be necessary to first show that the individual units have meaning and then that the combination of units generates new meaning. Until this is demonstrated, she says there is no reason to think chimps have taken a step towards language. ■



ERIC BACCEGA/NATUREPL

Materials science

Physicists may have solved the mystery of why ice is slippery

A PROBLEM that has been slipping through physicists' fingers for the past 150 years is finally nearing an answer. The slipperiness of ice seems to be mostly governed by water molecules bouncing around in the topmost layer of the ice.

Rinse Liefferink at the University of Amsterdam in the Netherlands and his colleagues did a series of experiments using spherical objects sliding across ice kept at various

temperatures. They found three important factors to slipperiness: the ice's temperature, the pressure put on the surface of an object on the ice and the speed of the object.

In terms of temperature, there is a sweet spot around -10°C. Higher than that, the ice got too soft and the sliding objects started to gouge into it, slowing them down. But much lower than -10°C and friction between the ice's surface and the objects rose dramatically, again slowing them down. Simulations showed that this may be due to the motion of the molecules in the ice.

“There are these water molecules

dancing at the top of the ice, and this dancing, the really high mobility of the water molecules, makes the ice slippery,” says Liefferink. “If you go to -100°C, they're not dancing, but kind of standing still.”

Too much pressure on the sliding object also restricts the molecular motion, decreasing the slipperiness (*Physical Review X*, doi.org/fvf9).

Previous work suggested that ice is primarily slippery because

“There are water molecules dancing at the top of the ice, and this high mobility makes the ice slippery”

of a surface layer of liquid water, but Liefferink's team did an experiment that contradicted that. The researchers used a dense plastic with similar properties to ice and dripped water over it to simulate that layer. They found that the objects only glided along easily after reaching a speed of about 1 metre per second.

“If there is a water layer on ice, it's only interesting at a high-speed regime,” says Liefferink. “But kids, who are not in this high-speed regime, are also able to skate on ice, so it can't be this water layer.” ■

Leah Crane

Rollercoaster Maths & Mighty Funfair Science...

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Archaeology

Stonehenge may be a recycled Welsh structure

Alison George

THE origins of Stonehenge have long been a mystery. Now new discoveries indicate that the iconic monument may have started as a stone circle in Wales that was then dismantled and rebuilt 280 kilometres away at its current location on Salisbury plain.

This is the conclusion of a team of archaeologists who uncovered the remains of what appears to be Britain's third-largest stone circle, in the Preseli hills of west Wales.

Stonehenge was built in several phases between about 3000 and 2000 BC, starting with a large circular ditch and bank together with a circle of 2-metre-high bluestones just inside. Later, these bluestones were moved, and bigger structures made from boulders known as sarsens were built.

In 2015, a team led by Mike Parker Pearson at University College London revealed that the bluestones came from quarries in the Preseli hills, 280 kilometres away in Wales. The team then looked for evidence of stone monuments close to these quarries, because the people who extracted Stonehenge's bluestones might have built stone circles here too.

The archaeologists excavated at a site called Waun Mawn, which had four large stones seemingly placed in an arc. They uncovered evidence of six holes that each originally held a stone, suggesting that there had once been a full stone circle at the site.

"The arc did continue – that was a really important moment," says Parker Pearson. Extrapolating from these positions, the team estimates that the completed circle probably had 30 to 50 stones, though arranged more



A. STANFORD

haphazardly than the original bluestone circle at Stonehenge.

A number of strands of evidence suggest that stones from Waun Mawn formed part of the original stone circle at Stonehenge. Dating studies showed that the Waun Mawn stone circle was created between 3600 and 3200 BC, a few hundred years before the first stages of construction at Stonehenge, and the types of stone at the two sites match.

One of the stone holes at the Welsh site has an unusual pentagonal shape, similar in shape and size to that of bluestone 62 at Stonehenge. "It could have been in that hole. It's not categorical proof, but it is really very suggestive," says Parker Pearson. The sizes of the two circles also match (*Antiquity*, doi.org/fvdw).

"It's a really interesting study that shows some nice arguments for a link between both stone circles," says David Nash at the University of Brighton, UK, who last year published a study identifying the origins of Stonehenge's sarsens.

Others are less convinced. "They've got a ragbag of stones

The dismantled stone circle at Waun Mawn (above) and bluestone 62 at Stonehenge (right)



and I'm rather sceptical of it being a stone circle," says Tim Darvill at Bournemouth University, UK, who has carried out many studies of Stonehenge.

Further excavations are planned at Waun Mawn to clarify the picture. But if Stonehenge was rebuilt from a Welsh stone circle, this could help explain why Neolithic people went to such lengths to construct the monument.

Studies of the isotopes in cremated remains of the earliest people interred at Stonehenge indicate that some of them probably came from west Wales. This has led Parker Pearson to conclude that Stonehenge was built to commemorate the ancestors of the original people who lived near Stonehenge. ■

Artificial intelligence

AI can identify you by the vein patterns on your hands

Matthew Sparkes

THE pattern of veins on the back of someone's hand is as unique as a fingerprint and can be used to identify them, even in images from a cheap commercial camera. The technique could be used in smart door locks or to pick out people using CCTV images.

Syed Shah at the University of New South Wales in Australia and his colleagues used images of 35 volunteers, taking 500 photos of the back of one of their hands with a commercial Intel RealSense D415 camera. It is sensitive to infrared light, so it can differentiate blood in veins from body tissue, and can detect how far away an object is with stereo lenses, helping to isolate the hand from the background.

The pattern of veins in each image was extracted and further processed for clarity, then used to train a neural network to connect a pattern to a particular person. Shah used the resulting model to identify the volunteers with an accuracy of 99.8 per cent (*IET Biometrics*, doi.org/fvck). The researchers also tested the AI's ability to detect vein patterns that weren't included in the original data set. Four new subjects were identified as unknown with 96 per cent accuracy.

The technique is more robust to hacking than existing biometric tests, says Shah. Fingerprints can be collected from smooth surfaces and used to trick sensors, while face recognition can sometimes be fooled with a photo. The team also found that vein detection works reliably on people of all ethnicities, which has been an issue for some biometric tests.

Shah believes the technology can be adapted to run on smartphones. Apple's iPhone 12 already has a built-in lidar scanner that can detect range, and many cameras are able to detect at least some infrared light. He also believes it could eventually work with CCTV cameras. ■

Ancient humans

The brains that time forgot

CRISPR gene editing helps create mini brains with Neanderthal characteristics

Ibrahim Sawal

MINIATURE brains grown in the lab are helping to reveal how modern humans survived when other hominins died out.

Neanderthals and Denisovans are some of our closest relatives. They lived alongside us about 50,000 years ago when modern humans migrated from Africa, but they went extinct shortly after we

61

Genes differing between modern and ancient humans

came into contact with them. This might be because modern humans outcompeted them, but it may have just been bad luck.

Alysson Muotri at the University of California, San Diego, and his colleagues wanted to know more about how our brains differed from these other hominins and whether this could affect survival. His team compared the genomes of modern humans, Neanderthals and Denisovans and found a total of 61 genes that differed.

One gene, neuro-oncological

ventral antigen 1 (*NOVA1*), particularly caught the group's eye. The gene is active during brain development and influences the developing nervous system. The team found that the modern human *NOVA1* gene differed from the Neanderthal and Denisovan version by a single base pair.

To find out more, the team used CRISPR genome editing to change the modern *NOVA1* gene in human stem cells to mimic the Neanderthal and Denisovan version.

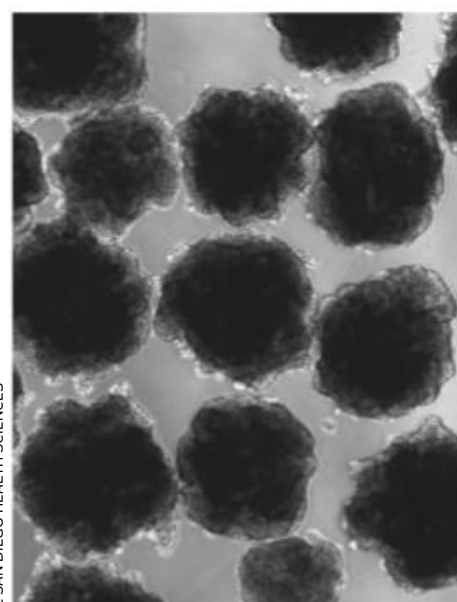
The team then prompted the cells to develop into a brain organoid – a small, simplified version of the organ consisting of clusters of brain cells in a dish. The group also did the same with standard human stem cells.

As they matured, the ancient human organoids were smaller, had a more wrinkled cell surface and their cells multiplied more slowly than the modern human ones. “They are quite distinct from modern humans, suggesting that single base alteration can change brain development,” says Muotri (*Science*, doi.org/fvdh).

This alteration also changed the expression of 277 genes compared with the modern organoids, and caused 113 alternative splicing events – a process that causes one gene to code for multiple proteins. Many of these proteins were linked to brain development.

“The fact that virtually all modern humans now carry the modern version of the gene,

Ancient human brain organoids created by altering one gene



strongly suggests that the alteration is a benefit to our species,” says Muotri. “If I might speculate, it might suggest that individuals carrying the Neanderthal *NOVA1* alteration have a potential different way to process information,” he says, and this may have affected survival.

Tony Capra at the University of California, San Francisco, says these new methods allow us to directly test Neanderthal brains. “We will be able to evaluate how the Neanderthal genome worked in more and more complex and realistic models,” he says.

However, because Muotri and his team used a modern human genome with a single change, Capra says this doesn't truly reflect the entire Neanderthal or Denisovan genome. “It is unlikely that a single ‘magic’ genetic change produced a dramatic positive change in these traits,” says Capra. He says there are many parts of our genome that contribute to cognition and that evolution may have acted on multiple variants with smaller effects. ■

Animal behaviour

Cockroaches munch each other's wings in mutual cannibalism

THE key to a monogamous relationship is cannibalism – at least for wood-feeding cockroaches.

Most cases of sexual cannibalism involve creatures like spiders eating their suitors after mating. Males are often the preyed upon. Eating them could help females fatten up on nutrients for use during pregnancy.

But males cannibalising females is rare, and mutual cannibalism is even rarer. The case of the

wood-eating cockroach may be one of the only known examples of a species that practises mutual sexual cannibalism, says Haruka Osaki at Kyushu University in Japan.

Osaki first noticed chewed wings on wood-feeding cockroaches (*Salganea taiwanensis*) that he caught in forests in Okinawa. To examine the phenomenon more closely, he and his colleagues collected wild cockroaches, divided them into 24 pairs, and videorecorded them for three days in enclosures. They found that 12 of the pairs took turns consuming each other's wings after mating.

The cannibalism was usually preambled by foreplay in the form of licking, and the recipients didn't appear to resist the love bites when they came (*Ethology*, doi.org/fvcj). The team also noted that the wings lack flesh, so wouldn't provide much in the way of nutrition.

“This wood-feeding cockroach must benefit somehow because this behaviour has evolved and been maintained,” says Osaki.

“Wood-feeding cockroaches must benefit because this behaviour has evolved and been maintained”

Osaki and his team aren't sure why, but they have a few ideas. These cockroaches usually mate with one partner for life and stay together to raise multiple broods in galleries inside rotting wood.

Clipping each other's wings may encourage both partners to stick around to help raise offspring, especially as being wingless makes them more vulnerable to predators outside the log. Or, it could help them move around in tight passages. Removing body parts that can attract mites or mould might also help keep their brood cleaner. ■

Joshua Rapp Learn

Artificial intelligence

AI can tell if people are enjoying your video call

Chris Stokel-Walker

MICROSOFT has developed an artificial intelligence for its Teams videoconferencing software that aims to put people presenting a remote talk more at ease by highlighting the most positive audience reactions.

The AI, named AffectiveSpotlight, identifies participants' faces and uses a neural network to classify their expressions into emotions such as sadness, happiness and surprise, and to spot movements like head shaking and nodding. It also uses an eyebrow detection system to spot confusion, in the form of a furrowed brow.

Each expression is rated between 0 and 1, with positive responses scoring higher. Every 15 seconds, the AI shows the presenter the person with the highest score over that time period.

A spokesperson for Microsoft Research told *New Scientist* that "spotlighting audience responses makes the presenter more aware of their audience and achieves a communicative feedback loop". The research team declined a request for an interview.

In a survey of 175 people conducted by the team, 83 per cent of those who give presentations said they often miss relevant audience feedback when presenting online, particularly non-verbal social cues.

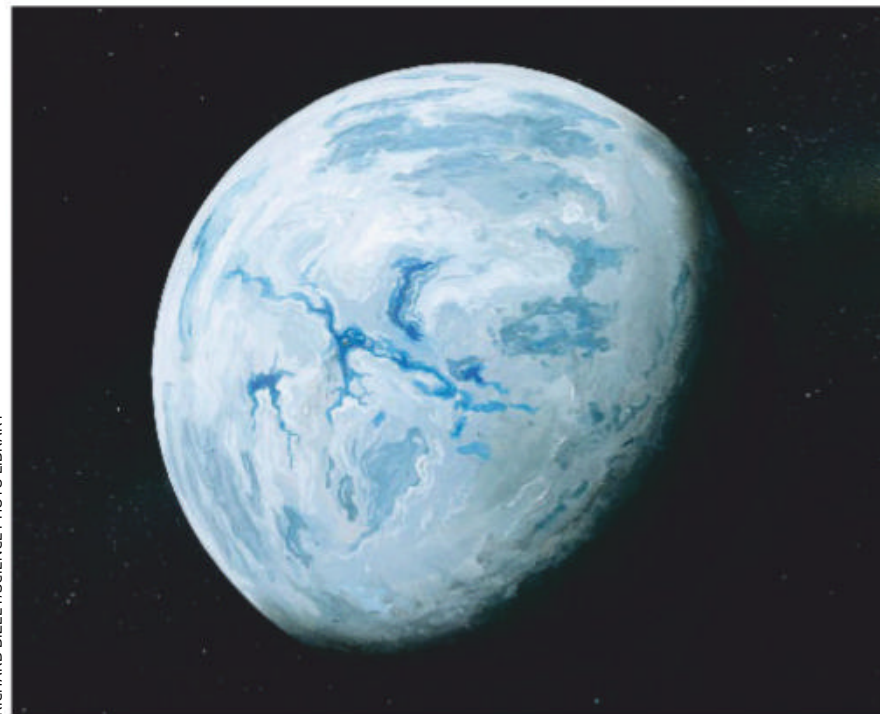
To see whether AffectiveSpotlight could help address this problem, the team tested it against software that showed audience members at random. The AI only highlighted 40 per cent of participants during talks, compared with 87 per cent by the random software.

Speakers reported feeling more positive about doing presentations with AffectiveSpotlight, although audience members couldn't discern a difference in the quality of presentation from those using the AI (arxiv.org/abs/2101.12284). ■

Genetics

Ancient icy calamity left its marks on bacterial DNA

Michael Le Page



RICHARD BIZLEY/SCIENCE PHOTO LIBRARY

SIGNS of a global catastrophe about 680 million years ago, known as Snowball Earth, have been found in the DNA of living bacteria in the oceans. Their genomes show that they nearly died out around this time, says Haiwei Luo at The Chinese University of Hong Kong.

Today, tiny photosynthetic bacteria called *Prochlorococcus* are incredibly abundant in the surface waters of oceans. A litre of seawater can contain more than 100 million of these cyanobacteria. When Luo and his colleagues studied their genomes, the researchers found that at some point in the distant past, the most common types of *Prochlorococcus* had acquired many harmful mutations and lost hundreds of genes.

This shows they went through what is called a population bottleneck. When a population shrinks to a low number, natural selection is much weaker and damaging mutations can accumulate.

The researchers published these findings in 2017, but were left puzzling over what caused

this bottleneck. The ancestors of *Prochlorococcus* evolved around 2 billion years ago, and these bacteria have long been abundant and widespread. Only a global catastrophe could explain it.

Luo and his colleagues have now worked out that this bottleneck occurred about 680 million years ago. They did this with the help of a molecular clock, which is based on the idea

680m
Years since "Snowball Earth"
almost killed off ocean bacteria

that, on average, genomes mutate at a constant rate. The team estimated that rate based partly on the ages of fossils whose appearance suggests they are ancestors of bacteria like *Prochlorococcus*.

That means the bottleneck occurred during a period of super ice ages when the planet got so cold that even the seas around the equator mostly froze over, hence the term Snowball Earth ([bioRxiv, doi.org/fvcd](https://doi.org/10.1101/12284)).

During "Snowball Earth", the planet was mostly covered in ice

This would have been a disaster for *Prochlorococcus*. "This explains very well the genetic evidence," says Luo.

Some other cyanobacteria thrive even in polar waters, but modern *Prochlorococcus* prefer the tropics and usually don't grow when the temperature is below 10°C, he says. Yet during Snowball Earth, a few might have managed to adapt to the cold and cling on in refuges like the briny water in sea ice.

Luo thinks some of the genetic changes that occurred at this time are related to cold adaptation. For instance, proteins in the cell membrane that transport substances such as nitrogen compounds work poorly in the cold, and several genes for such proteins were lost.

Instead, the bacteria may have got the nitrogen they needed from ammonia, which can diffuse into cells without a transporter. The genes necessary for this were retained.

"I think these interpretations are reasonable," says Gregory Fournier at the Massachusetts Institute of Technology, who studies how genomes change over geological timescales. But calibrating the molecular clock with fossil evidence involves a lot of assumptions, he says.

Paul Hoffman at Harvard University, who discovered key evidence supporting the Snowball Earth hypothesis, also points to the uncertainties in the dating. But Snowball Earth would have left a mark in the genomes of all the organisms that survived it, he says. "All living taxa descended from Snowball survivors." ■

The background of the entire advertisement is a dense, three-dimensional arrangement of purple cubes of various sizes. Some cubes are in sharp focus, while others are blurred in the background, creating a sense of depth. The lighting is soft, highlighting the edges of the cubes.

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Animal behaviour

Vampire bat shows soft side by adopting orphaned baby

A FEMALE vampire bat has adopted an orphaned baby bat and begun nursing it, after creating a close social bond with the baby's mother before she died. This is unusual, because while female bats live in "maternity colonies", they seem to raise their young individually.

The observation was made by Imran Razik at the Ohio State University and his colleagues at the Smithsonian Tropical Research Institute in Panama while studying the social behaviour of common vampire bats (*Desmodus rotundus*).

They had captured 23 adult female bats from three wild colonies, then put them in a single captive colony to see how they developed relationships. Female vampire bats can form social bonds with other bats, grooming each other and sharing food.

One bat fell ill during the study and died weeks after giving birth. To the researchers' surprise and relief another bat adopted the infant, says Razik. The team traced the development of the relationship between the sick mother bat (Lilith) and the adoptive bat (BD), which wasn't pregnant or nursing. They had initially shown a lot of mutual grooming, suggesting they were bonding, says Razik.

The healthy bat shared food much more often than Lilith did, a trend that increased as Lilith got sicker. BD also helped take care of Lilith's baby, grooming it and even nursing it, although she herself didn't have a baby. When Lilith died 19 days after giving birth, BD fully adopted the baby and raised it as her own (*Royal Society Open Science*, doi.org/fvbf). Christa Lesté-Lasserre



HERMANN BREHM/NATUREPL

Flight

Tiny craft may soar into forbidden zone

SUNLIGHT could be used to power microfliers travelling above the stratosphere in the mesosphere.

At present, the only vehicles that can operate in this layer of our atmosphere, between 50 and 80 kilometres up, are rockets destined for space. The lower air density doesn't allow for sufficient lift for aircraft, but it is too dense for the safe passage of satellites.

Igor Bargatin at the University of Pennsylvania and his team have come up with a microflier that might achieve sustained travel through the mesosphere.

To do so, they exploited the phenomenon of photophoresis. This relies on the transfer of solar energy – initially to an object such as the new device, and then to air molecules surrounding the object.

"When you expose [the craft] to sunlight, the molecules that hit the surfaces will absorb some of

the heat," says Bargatin. "We designed the [device] surfaces in such a way that the top surface is not very good at transferring heat whereas the bottom surface is very good at transferring heat and as a result more molecules will gain downward velocity than upward velocity."

This creates a lift force, he adds, meaning that when the discs were exposed to incident light intensity of about 0.5 watts per square centimetre at air pressures of about 10 pascals they moved through the air (*Science Advances*, doi.org/fvqr).

The team believes that in the future, versions of the microfliers fitted with sensors could be used to map wind and temperatures in the mesosphere, which could improve climate models.

Karen Aplin at the University of Bristol, UK, wondered about some practicalities of the fliers, such as getting them to the mesosphere, which would require a rocket.

Krista Charles

Technology

Now body heat could power your gadgets

SELF-HEALING and eco-friendly devices that generate electricity from body heat could power wearable gadgets.

Jianliang Xiao at the University of Colorado, Boulder, and his team used thermoelectric generators, which convert heat into electricity. The team embedded a number of these in a thin film made from a flexible polymer called polyimide and wired them together with a

liquid gallium-indium alloy to create stretchable bands that can be worn on arms, legs and fingers (pictured). The device costs less than \$10 to produce.

The team tested a wrist-worn version with someone sitting and walking. The increased body heat during walking generated enough power – 12.5 microwatts – to run small sensors such as a heart monitor or motion tracker.

The liquid metal and polyimide make the device self-healing – the team could cut it then place the two halves next to each other, and within a couple of hours it would repair with no hit to performance.

This also means the device is easy to recycle. Xiao's team soaked one in an alcohol-based solution to break down the polyimide, freeing the generators and liquid metal. A new polyimide film was created from the solution and recombined with parts from the old device to create a new one with comparable performance (*Science Advances*, doi.org/fvdv). Priti Parikh



XIAO LAB

Really brief



Very meaty cat food may deter hunting

A 12-week trial found that pet cats in the UK brought home 36 per cent less prey if they were given cat food with a high animal protein content. Most cat food contains some plant-derived protein: this may leave cats missing key micronutrients and encourage hunting (*Current Biology*, doi.org/fvdp).

Ozone layer may recover sooner

Researchers feared healing of the ozone layer would be delayed following a surge in emissions of a banned chemical between 2014 and 2017. But the latest figures suggest emissions of this CFC were lower in 2019 and perhaps also in 2020, putting ozone layer recovery back on track (*Nature*, doi.org/fvdr).

Stone Age shell can still make music

An 18,000-year-old conch shell found in a French cave in 1931 may have been a musical instrument. The pointed tip of the shell has been carefully removed to make a perfectly round hole: a modern horn player was able to produce three distinct notes by blowing through the hole (*Science Advances*, doi.org/fvdt).

Geology

Reflected whale calls provide seismic data

FIN whale songs, one of the loudest animal calls in the ocean, can be used to learn about the structure of Earth's crust.

Václav Kuna at the Institute of Geophysics of the Czech Academy of Sciences in Prague and his colleague John Nábělek at Oregon State University thought of the idea while recording seismic activity from earthquakes.

Between 2012 and 2013, the researchers deployed 54 ocean-

bottom seismometer (OBS) stations to record activity. Four stations recorded six fin whale (*Balaenoptera physalus*) songs.

"The calls travel through the water and penetrate into the ground," says Kuna. "They then bounce off the layers within the oceanic crust and come back to the surface where we record them at OBS stations."

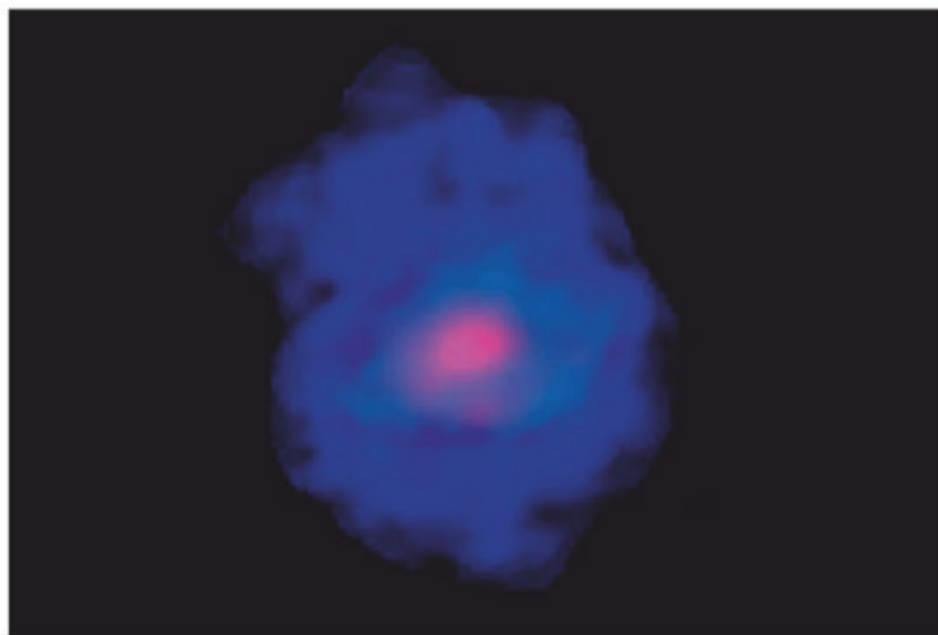
These returning sound waves allow geologists to determine the make-up and the thickness of Earth's crust as they refract and reflect through different layers.

The researchers tested this on

the sea floor surrounding the OBS stations and found that the whale songs could show the thickness of the top sediment layers. Their results matched thickness values previously observed by geologists for layers of the same crustal age (*Science*, doi.org/fvdz).

Studies of Earth's crust usually use seismic airguns, which are more effective as they emit a wider range of frequencies at a higher resolution than the whales, but there is potential to use the songs of other whales, such as sperm whales, which have a broader frequency range. **Karina Shah**

Space



Freakish young galaxy rips up the astrophysics rule book

WE HAVE spotted a galaxy we know is young, but which has features typically seen only in older galaxies. It challenges current understanding of how quickly galaxies form.

Galaxies are thought to begin as chaotic structures, with clouds of cold gas, stars and dust travelling through space. They grow by colliding and merging with smaller galaxies and can form a disc-like structure with a central cluster of stars known as a bulge. This can take up to a few billion years to complete. Unless it is the galaxy known as ALESS 073.1.

Using the Atacama Large Millimeter/submillimeter Array,

Federico Lelli at Arcetri Astrophysical Observatory in Italy and his team imaged this object, which is nearly 12.5 billion light years away. We see it as it was just 1.2 billion years after the big bang.

They examined the distribution and movement of cold gases in the galaxy and found it formed a disc rotating in a regular way. There were hints of spiral arms, another trait of mature galaxies (*Science*, doi.org/fvdk). Lelli says that this disc rotation implies the presence of a central bulge that couldn't be seen in the images, suggesting that bulges may form over less time than previously thought. **Ibrahim Sawal**

Psychology

Avatar can boost speaking confidence

OBSERVING a virtual-reality version of yourself confidently delivering a speech with bold body language can improve your public speaking – if you are a man.

Marianne Schmid Mast at the University of Lausanne, Switzerland, and her team took 76 people – mostly undergraduate students, around a third of whom were women – and asked them to give a 3-minute speech to a virtual audience. The subjects then watched a virtual talk given confidently by either an avatar made to look like themselves or an avatar of the same gender that didn't resemble them. They were then asked to give a second speech.

The team found a pattern among men who had said they weren't good speakers. Those that then watched their doppelgänger were, on average, 22 per cent more persuasive in the second speech – based on an assessment by an external viewer – than those who watched the unfamiliar avatar (*PLoS ONE*, doi.org/fvdx).

There was no observable effect on women. Schmid Mast believes this is down to women being generally more expressive than men, and therefore benefiting less from the cues in the virtual speech. **Matthew Sparkes**

Planet Boost is an initiative from *New Scientist* highlighting charitable organisations working to conserve biodiversity and protect the natural environment. Today, a message from **Butterfly Conservation**



Can you help Butterfly Conservation continue the fight back for the environment?

It's hard to imagine a world without butterflies flitting from flower to flower, but two-thirds of the UK's native species are facing devastating declines.

Our data shows that butterflies and moths are both declining faster than most other well-documented groups of plants and animals. Since 1976 UK butterfly abundance across all species has declined by 50%. This month the charity also released its most recent report on the state of Britain's moths, which shows that the total abundance of all larger moths decreased by 33% over a 50-year period between 1968-2017.

Both butterflies and moths are valuable environmental indicators, both for their rapid and sensitive responses to subtle habitat or climate changes and as representatives for the diversity and responses of other wildlife.

Falling numbers are an early warning to all wildlife that cannot be ignored.

The wildlife charity Butterfly Conservation has been working tirelessly to stop the future looking so bleak for these creatures. It employs over 70 people, including many highly qualified scientists, making it the world's largest research institute for butterflies and moths.

Over the past 40 years, it has raised awareness of the drastic decline in butterflies and moths and has created widespread acceptance that action needs to be taken. Through its conservation work, it has also begun to reverse the decline of several of the most threatened species.

These include the Pearl-bordered Fritillary, High Brown Fritillary, Duke of Burgundy, Wood White, Heath Fritillary, Marsh Fritillary, Small

Blue, and the Grey Carpet and Forester moths. The charity has also played a vital role in re-introducing the Large Blue to the UK after it became extinct.

There is, however, much more that needs to be done, but as with so many charities, Butterfly Conservation was not left unscathed from the Covid-19 pandemic. The financial impact will be felt for years to come, and the charity must now cut-back on its much-needed conservation work, unless it can make up the shortfall of funds.

As the charity's President Sir David Attenborough has said: "If we don't take action, the collapse of our civilisations and the extinction of much of the natural world is on the horizon."

Want to help?

Help Butterfly Conservation continue the fight back and work for a safer future for butterflies, moths and all wildlife by donating today at butterfly-conservation.org/how-you-can-help/give-money

The columnist

Annalee Newitz on using tech to explore ancient cities **p24**

Letters

On the debate about baby formula milk at food banks **p26**

Aperture

Royal Photographic Society's science competition **p28**

Culture

Bill Gates's fine primer on avoiding climate disaster **p30**

Culture columnist

Unity powerfully explores trauma, says **Bethan Ackerley p32**

Comment

Borrowing bee brains

We need a revolution in artificial intelligence, and learning from insects will help us achieve it, says **James Marshall**

WHERE are all the intelligent robots? Despite huge recent strides in artificial intelligence, autonomous robots answering our every beck and call are still a long way off. To make that leap, we are going to need a revolution in AI – and I believe insects will be at the heart of it.

Big ideas in AI seem to come in waves. The first was the notion that creating an intelligent machine involves writing down enough rules for it to follow. Many people believed in this approach in the 1950s and 1960s, but its limitations soon became apparent because any situation that can't easily be broken down into basic rules is out of reach. Making a machine that can play chess works, for example, but making one to recognise what is in an image doesn't.

The second wave came in the 2000s when a technique called deep learning really took off. Instead of following rules to complete specific tasks, these systems follow rules for learning how to do the tasks themselves. This approach dates back to the 1980s, but it was only when huge amounts of computing power and data became available that it really began to work. Such systems mimic the visual cortex in primates, and so do a good job of simulating human perception, like recognising images. This wave has made digital assistants, like Amazon's Alexa, possible.

But intelligence is more than



a visual cortex. Second-wave algorithms can become good at one task, but then completely fail at a different, yet similar one. Any decent robot should be able to use and adapt what it already knows to tackle things it has never come across before.

The third wave... well that's yet to be settled, but I think it will be by learning from nature that we will get the last piece of the puzzle.

Take honeybees, say. These little creatures are extraordinarily good at navigating their environment,

they can react to new and novel situations and they display a wide array of different behaviours. Yet they achieve all this while having only around 1 million neurons in their tiny brains. By comparison, deep-learning AIs can require hundreds of thousands or even millions of "neurons" to perform just one task.

There is still much that we need to learn about primate brains, but with insects, we are closer than ever to being able to recreate their brains using software.

My colleagues and I have been working on replicating the honeybee brain in silicon.

So far, we have reverse-engineered part of the visual system, and the navigation and memory centres. This has enabled us to create a fully autonomous drone in the lab with an onboard chip that directs it to avoid obstacles as it flies around. The algorithms we reverse-engineer are tremendously efficient, so use around 1 per cent of the computer power of deep learning, while running more than 100 times faster. They are also much more robust in dealing with unfamiliar situations, in the way that real brains are.

The next steps for this approach are to deploy more of the bee brain's capabilities on silicon, and take the drones out of the lab. Indeed, this is precisely what university spin-out Opteran Technologies, which I co-founded, is leading the way in doing now.

Systems like this, where their brain circuits have been reverse-engineered from nature, should give highly efficient and robust algorithms for navigating the real world. And robots utilising them would benefit from hundreds of millions of years of evolution. The next wave in AI progress may just be within reach. ■



James Marshall is at the University of Sheffield, UK, and is CSO of Opteran Technologies

This changes everything

Exploring ancient cities with futuristic tech Data archaeologists are uncovering the secrets of long-lost metropolises – including why they died out, writes **Annalee Newitz**



Annalee Newitz is a science journalist and author. Their latest novel is *The Future of Another Timeline* and they are the co-host of the Hugo-nominated podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is techsploitation.com

Annalee's week

What I'm reading

Kindred: Neanderthal life, love, death and art, by Rebecca Wragg Sykes. It is an incredible look at the diversity of hominin life in the Palaeolithic.

What I'm watching

Detectorists, for archaeology nerd realism.

What I'm working on

A virtual book tour! Four Lost Cities just came out in the US, and it will be out in the UK in March.

This column appears monthly. Up next week: James Wong

BACK in 2015, I stood in a grassy field in southern Illinois, looking at a map of the 1000-year-old neighbourhood buried right beneath my feet. Nearby, cars drove by on a narrow road and a group of squat fuel tanks cast long shadows in the early morning sun. The place looked like the outskirts of a typical farm town, but the two archaeologists with me had uncovered something that couldn't be seen with the human eye: not far below the ground were some shadowy blobs, arranged in a circular pattern.

Sarah Baires is an archaeologist at Eastern Connecticut State University and her colleague Melissa Baltus is at the University of Toledo in Ohio. They study the Mississippian civilisation, a group of culturally linked Native American settlements along the Mississippi river that existed until around 1600. This field, which now seems like the middle of nowhere, was once a dense residential area of that society's greatest city, known today as Cahokia.

Our only map of this ancient place came from a group of graduate students, who spent weeks trudging across the field with magnetometers strapped to their chests. These devices measure minute differences in Earth's magnetic field, and they are excellent at picking up spots underground where rocks have been moved or there has been a fire. Places where people have burned wood or dug out the foundations of a house have slightly different magnetic signals than the undisturbed landscape, and those perturbations show up as dark patches.

At this site, Baires and Baltus found spots that were suspiciously symmetrical – mostly rectangles. When they realised these were

arranged in a tidy circle, that sealed the deal: those blobs on the map were once houses, arranged around a circular courtyard.

Now Baires and Baltus knew where to start digging. After several field seasons, they excavated two buildings and a ceremonial feature called a borrow pit, a deep trough lined with brightly coloured clay. Researchers at Pompeii in Italy use a similar strategy: they mount ground-penetrating radar devices on wheeled carts, driving them around the areas of the city that are still buried under ash, seeking structures. That way, they don't flail around wildly with picks and drills, looking for buildings.

Some of the greatest archaeological finds of the past two decades were made without ever lifting a shovel. Angkor is an abandoned metropolis, formerly at the heart of the millennium-old Khmer Empire in what is now Cambodia, but much of that site has been overtaken by jungle. So Damian Evans, an archaeologist with the French Institute of Asian Studies, worked with a team to mount a lidar device on a helicopter and fly over the ancient street grid of the city.

Lidar measures small differences in ground elevation, and Evans's survey revealed that Angkor's neighbourhoods once stretched far and wide, housing nearly a million people outside the famous temple walls of Angkor Wat. And in Egypt, archaeologist Sarah Parcak has used satellite imagery to uncover thousands of sand-buried structures and a hidden street grid at the ancient Egyptian city of Tanis.

Over the past seven years, I have followed archaeologists around ancient cities and pestered them with questions as I researched my latest book, *Four Lost Cities: A secret history of the urban age*.

Many of these researchers call themselves data archaeologists because they need a lot of high-tech tricks to understand large settlements that had once been full of hundreds of thousands of people. When you are studying a city, it isn't enough to dig up a few statues or baubles. You want to suss out the entire street grid, the distribution of bars and temples, the water infrastructure and even the number of public toilets. Tools like magnetometry and lidar give us the panoramic view we need to comprehend large-scale habitats.

But archaeologists use other tools too, like 3D photography, so that they can capture all the details of a site to study later in an air-conditioned office. They enter each finding into databases, from ceramic pot designs to the number of pubs on a street, looking for patterns that might reveal shared beliefs or cultural connections.

Studies like these led to the discovery that cities have always had significant populations of immigrants, even 9000 years ago. They also allow archaeologists to figure out what ordinary people did for fun. At Cahokia, for instance, people played a game called Chunkey with special stone pucks that researchers have catalogued up and down the Mississippi.

Perhaps most importantly for us today, data archaeology has helped us see trends in why people abandon cities. Most settlements take at least a century to empty out, but generally people start to leave when local government is unable to deal with climate disasters like drought. Once environmental troubles and political instability have festered for decades, the population slowly moves elsewhere. We urbanites have always voted with our feet. The question is where we will take our civilisations next. ■

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**SCIENCE
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Editor's pick

On the debate about baby formula at food banks

30 January, p 23

From Ruth Eversley (food bank volunteer), Paulton, Somerset, UK

Clare Wilson raises crucial points about the importance of formula milk supply for those who can't breastfeed, but I don't think food banks deserve to be a target for this.

Under normal circumstances, food banks provide three days' supply of food for emergencies: they aren't meant to be a solution to food poverty. Food banks are generally dependent on donations collected in shops and community centres; infant formula milk is rarely donated and the odd tin isn't going to help solve the problem of supply to those on low incomes.

From Kate Evans (author of *The Food of Love: Your formula for successful breastfeeding*), Street, Somerset, UK
Nobody wants babies to go hungry, but Wilson's contribution to "unscientific debate" on the issue of whether formula milk should be made available at food banks shouldn't go unanswered.

She massively oversimplifies a complex issue when she mentions the charity Feed's statement on the lack of formula in food banks and blames "an overzealous push for breastfeeding" for this.

Breastfeeding counsellors understand and support reasons why women don't breastfeed; their job is to assist maternal choice. They aren't "overzealous".

Britain has the lowest breastfeeding rates in the world. Eleven years of austerity have seen breastfeeding services slashed, leaving new mothers isolated and abandoned. We urgently need a national conversation about how best to support maternal health, and that could include removing formula milk from the commercial arena and providing it on prescription. After all, why should those who can't breastfeed have to pay for their baby's survival?

Disharmony over talk of an AI piano tutor

30 January, p 15

From Ros Groves, Watford, Hertfordshire, UK

You report on the possible use of AI to improve piano playing. It appears to focus on assessing a performer's skill in playing the correct notes with the correct rhythms. In doing so, there is a real danger that the essence of such music as a form of emotional communication will be lost.

Where will the nuances be, such as the emphasis on certain notes or the crescendos to climactic points? Both are examples of musical interpretation, which can only be brought about through a performer's inner sensitivity.

The AI may be a useful practice supplement at elementary levels, but it is no substitute for an experienced teacher who, through establishing a sound keyboard technique, can elicit from a pupil the human bond between composer and performer. Without that, musical performance will be reduced to the equivalent of listening to an impassioned speech delivered by a Dalek.

Expedition oddities are not such a mystery

6 February, p 18

From Greg Nuttgens, Porthcawl, Bridgend, UK

Doubters of the avalanche explanation for the demise of a Russian ski expedition in the 1959 Dyatlov Pass incident point to strange aspects of the tragedy, such as victims having little clothing on in freezing conditions, to support more mysterious ideas about what happened.

However, it is well known in mountaineering circles that one of the symptoms of hypothermia

is irrational behaviour, which sometimes causes people to remove clothes and shoes.

Perfect encryption may not be worth having

23 January, p 18

From Jim Ainsworth, Kingsland, Herefordshire, UK

The quantum internet is getting ever closer, as entangled photons are now deliverable by drone, which could eventually allow encrypted communication to be impervious to hacking. It is a valid scientific aim to pursue this, of course, but it has downsides, not least by possibly letting terrorists communicate in secret.

With cars and cigarettes, early developers couldn't be expected to foresee the long-term consequences – pollution, climate change, cancer – but we know what some of the unpleasant consequences of encrypted communications can be, so there is surely an onus on developers to at least consider them.

It isn't a trivial issue, since ultimately we will have to consider whether privately owned tech giants, dictators or elected governments should have the last word on this.

Alien megastructures could be very bad news

30 January, p 44

From Craig Hutton, Southampton, UK

Your recent article on the search for Dyson spheres – theorised structures that encircle a star to use its energy – gets one thinking.

A structure that obscures the surface of a star by a few per cent, let alone by as much as 90 per cent, as stated in the article, would require more material than would be available in any given

star system by many orders of magnitude. Non-solar mass makes up 0.2 per cent of our system, and much of that is gas and ice. This begs the question: where does the material to build the Dyson sphere come from? A civilisation would need to raid a vast number of star systems for materials and shred untold planets.

From Peter Inkpen, Amersham, Buckinghamshire, UK

If we ever do find a Dyson sphere, it should set alarm bells ringing. That is because there is a good chance that this alien structure was made by an expansionist technological civilisation prone to infesting other planetary systems and ruthlessly harvesting resources in an effort to continue its unrestrained growth.

From Bryn Glover, Kirkby Malzeard, North Yorkshire, UK

I find the idea that infrared radiation can be taken as an indication of a Dyson sphere a little odd. Surely if a civilisation was so advanced that it had taken steps to encircle a star to capture its energy, it would have ways of insulating this structure so that no energy was wasted, in whatever form.

Did these ancient humans inspire a legend?

30 January, p 34

From Alan Jowett, Castle Morris, Pembrokeshire, UK

I read with interest your article on the Denisovans, including the evidence that they occupied the Tibetan plateau. I wonder, given they were probably distinct from us, whether they are a possible candidate for the folk memory of the Yeti and other similarly large, mythic humanoids in the region. ■

For the record

■ We should have said that Saul Faust is trialling the Johnson & Johnson coronavirus vaccine (6 February, p 8).



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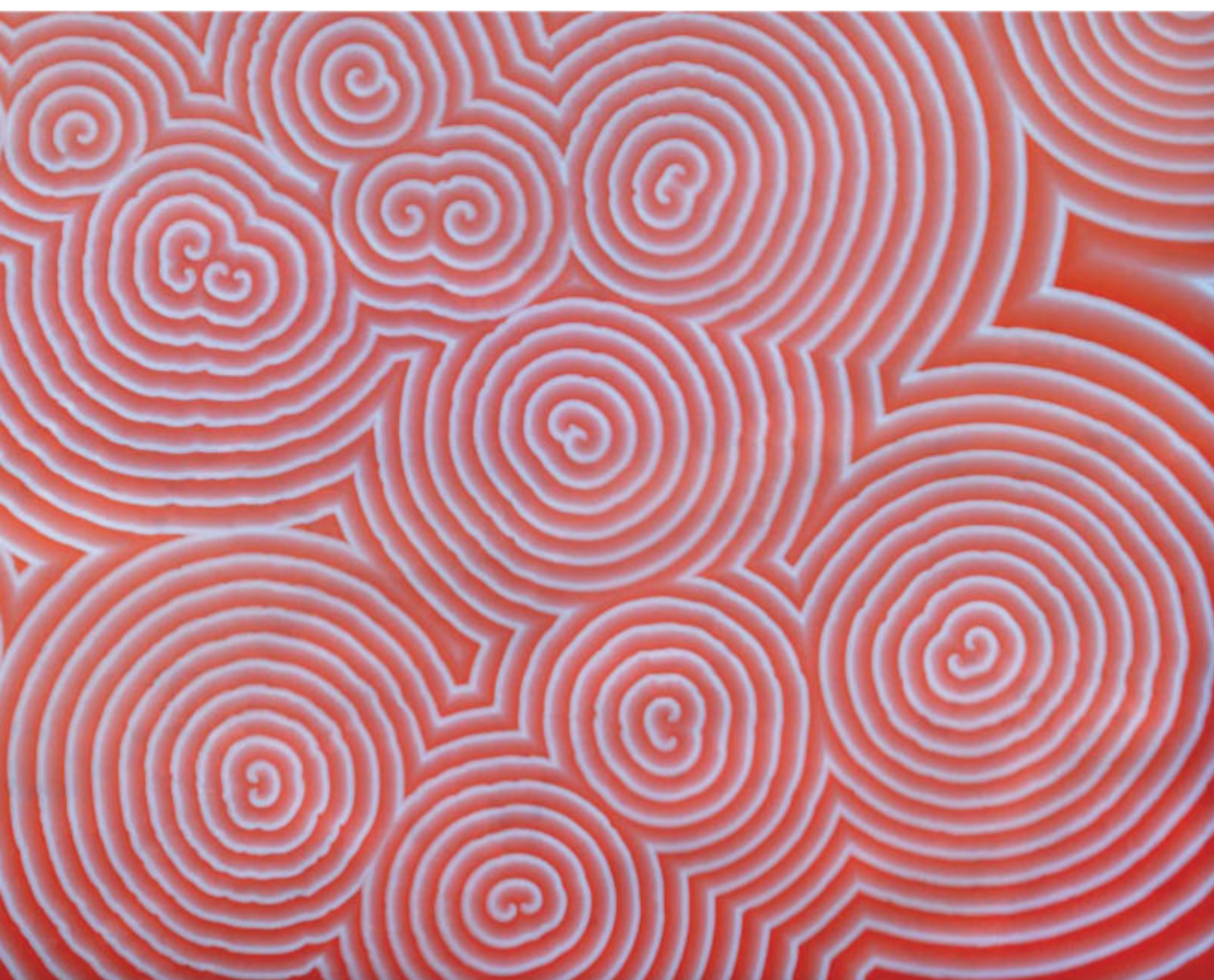
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CLOCKWISE L-R: NORTH POLE UNDERWATER SELFIE BY SUE FLOOD; RAINBOW SHADOW PATTERNS - BZ REACTION BY DR DAVID MITLAND FRPS; BUBBLE-BEAT'S SERIES: 'MY WAY' FRANK SINATRA BY KYM COX ARPS





Top of the class



The Royal Photographic Society's Science Photographer of the Year competition

THE terrifying effects of climate change are captured perfectly in *North Pole Underwater* (far left, top), taken by photographer Sue Flood. The signpost represents the geographic North Pole.

At 90 degrees north, it is Earth's northernmost point, but rising sea levels created by warmer global temperatures have been pushing it eastwards since 2005.

The shot won Flood the top prize in the climate change category in the Royal Photographic Society's 2020 Science Photographer of the Year competition. She hopes to raise awareness of the "alarming" rate at which polar ice is melting.

Katy Appleton won the Young Photographer of the Year award in the general science category for *Rainbow Shadow Selfie* (near left, top), achieved by casting her shadow onto a wall to highlight sunlight shining through a prism.

Among the competition's other selected images is *Turing Patterns* by David Maitland (near left, bottom). It shows chemicals spiralling on a Petri dish, caused by an oscillating Belousov-Zhabotinsky reaction.

In *My Way – Frank Sinatra* (far left, bottom), a composite shot from her photo series *Bubble Beats*, Kym Cox used sound to create patterns on a soap film stretched over a loudspeaker. This image was achieved with Sinatra's signature song; varying sound frequencies alter the soap's thickness, changing the colours that show up.

See the winning and shortlisted images online at the Science and Industry Museum in Manchester, UK, until 2 May. Other entries are available at rps.org/spoty. ■

Gege Li

A climate call to arms

Bill Gates may be a flawed messenger on global warming, but his book is still a fine primer on how to get ourselves out of this mess, says **Adam Vaughan**



Book

How to Avoid a Climate Disaster

Bill Gates

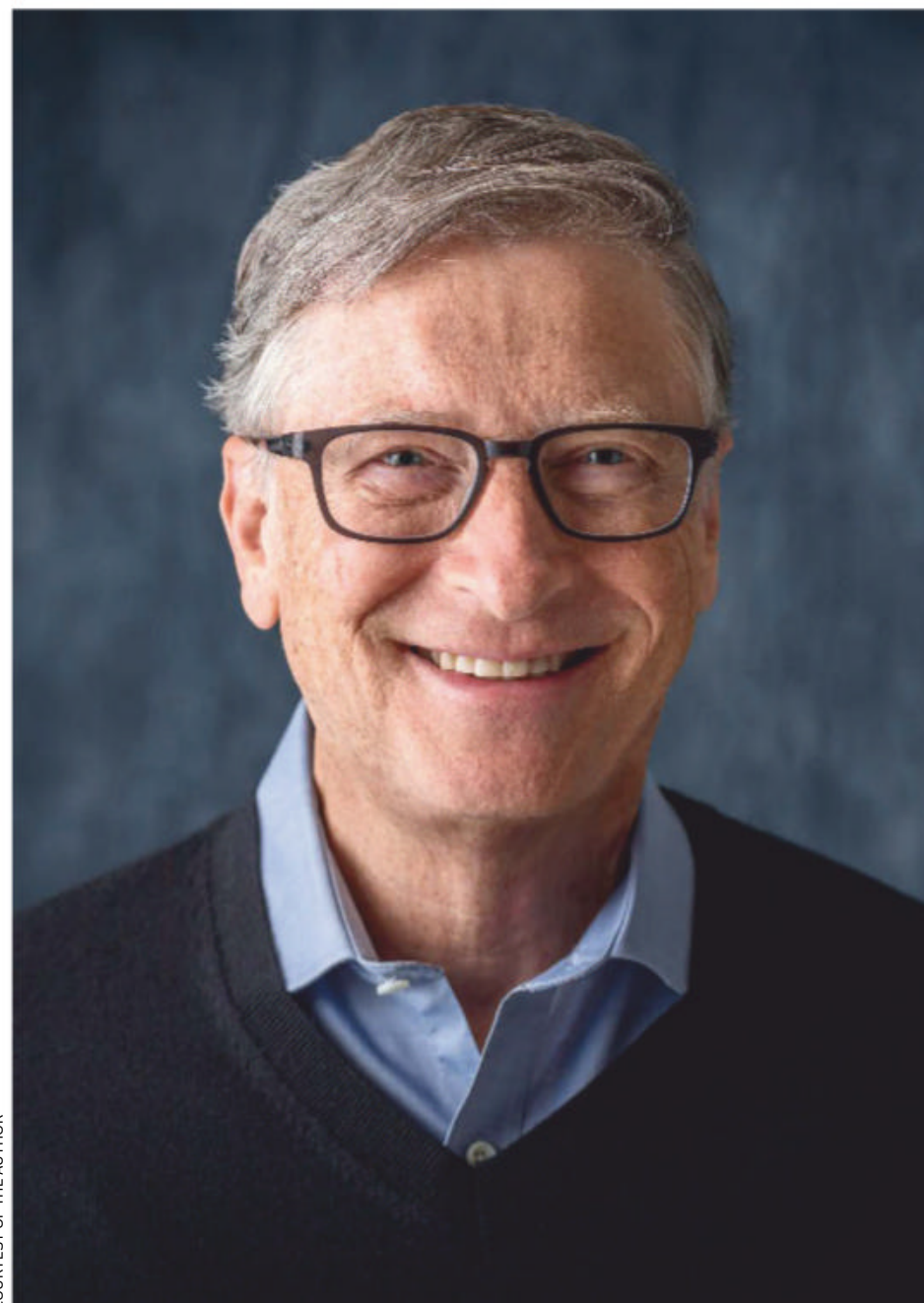
Allen Lane

"I am aware that I am an imperfect messenger on climate change," writes Bill Gates in his latest book, which spells out why he thinks the world can get to zero greenhouse gas emissions by 2050.

The philanthropist and Microsoft co-founder is, by his own admission, incredibly rich, wedded to techno-fixes and has a big carbon footprint. The latter extends to a troubling failure to walk the talk, with Gates revealing in the book that he flew to the 2015 Paris climate summit by private jet. Greta Thunberg he is not.

On the other hand, he has an eye for detail, a knack for explaining complex issues simply and an attractively unabashed interest in fertiliser depots and power stations. Moreover, his foundation's work on issues including health and poverty across the globe has given him a better awareness than many writers of how a carbon fix that works for the US may not work for India. And unlike some climate books siloed in just science or politics or business, he looks across all the sectors needed to eliminate humanity's annual output of 51 gigatonnes of greenhouse gases.

Dense with numbers and facts and peppered with charts and tables, it is clear Gates would like this book to be the climate solution equivalent of the late Hans Rosling's *Factfulness*, an excellent dissection of skewed perceptions of the state of the world. "When we have a fact-based view of climate, we can see that we



COURTESY OF THE AUTHOR

have some of the things we need to avoid a climate disaster, but not all of them," Gates writes.

For the most part, he succeeds. Gates is strong on why it will be so hard to get to zero emissions – not least the inertia in the energy industry that he identifies – and explaining how much more there is to do beyond generating more

"Gates reveals that he flew to the 2015 Paris climate summit by private jet. Greta Thunberg he is not"

solar power and making more electric cars. Pages on the inherently carbon-intensive process of making stuff that underpins the modern world, especially concrete and steel, are clear-eyed and well done.

You might not have expected it from a former software engineer, but Gates can write. Personal experience is mixed with a refreshing honesty about how hard decarbonising the world will be.

Nice prose would be for nought if his solutions were amiss. Happily, he gets the big stuff right:

Billionaire Bill Gates is exploring ways to avert a carbon catastrophe

generating loads more clean electricity, electrifying everything we possibly can and spending loads more on R&D to sort the rest (aviation, shipping, heavy industry). He is also good on the dull but vital detail of policy to make it all happen.

Gates is less strong when it comes to the role of food and land use. While overly optimistic about technologies that haven't been cracked, including nuclear fusion, he is unnecessarily pessimistic about things that evidence shows can be done, like eating less meat.

On this, he says that, for cultural reasons, "I just don't think it's realistic". Yet the trend to less consumption of animal products is under way in some countries. The UK government's sober climate advisers want and think it is realistic for people to eat at least a fifth less meat and dairy by 2050.

Other weak spots include an almost unquestioning enthusiasm for nuclear power, with scant paragraphs on the high costs holding it back and its intractable waste problem. In contrast, there are reams of pages on the challenge of intermittency posed by renewables, which is real but overblown here. The pandemic's climate consequences are alluded to, but not in any depth, which is a shame. And carbon emission removal options are only briefly touched on.

Still, these are minor flaws. *How to Avoid a Climate Disaster* is clear, concise on a colossal subject and intelligently holistic in its approach to the problem. Gates may not be the perfect messenger on this issue, but he has written a fine primer on how to get ourselves out of this mess. ■

Watch out for the comet!

Despite the familiar disaster movie premise of a comet hurtling towards Earth, *Greenland* is hugely watchable, says **Linda Marric**



Film

Greenland

Ric Roman Waugh

Amazon Prime Video

PROLIFIC stunt actor-turned-director Ric Roman Waugh reunites with his *Angel Has Fallen* star Gerard Butler in *Greenland*, an unequivocally bleak and hugely watchable disaster movie. The film was originally set to be released in cinemas in July 2020, but became another victim of covid-19 closures. It has now been released online, so anyone hoping to catch its full destructive power on the big screen will have to settle for home viewing.

Written by Chris Sparling and co-produced by Butler, *Greenland* follows a family that must fight for survival while a planet-levelling comet races towards Earth. Structural engineer John Garrity (Butler) is in Atlanta, Georgia, with his estranged wife Allison (Morena Baccarin) and their son Nathan (Roger Dale Floyd).

Having moved out after an undisclosed indiscretion, John has returned to the family home to patch things up with his wife. Meanwhile, the whole neighbourhood have gathered around John and Allison's TV to watch the near-Earth passing of a recently discovered interstellar comet, named Clarke.

Shortly before the comet is supposedly due to miss Earth by a whisker, John receives an automated call with instructions that he and his family have been selected for imminent evacuation. When the first fragment of the comet unexpectedly hits Tampa in Florida, the couple and their young,

diabetic son scramble to reach a nearby air force base where they are due to board a flight to safety with two days to go before the most devastating impact.

Since this is a Gerard Butler movie, things don't go to plan: confusion ensues as the family is separated, and they must try to reunite to stand a chance of boarding a flight to safety. You can guess where the planes are headed!

Butler may have been over the top in the recent disaster movie *Geostorm*, but thankfully there is more to his performance this time – and to *Greenland*. Beyond the poor science (we are expected to believe that no one had envisaged that the comet might even come close to hitting Earth until it does, and that its trajectory wouldn't have been calculated repeatedly), this is a spectacular production with impressive CGI of the comet and the initial impact and destruction.

Butler does what comes to him naturally and is hugely likeable as John, the gruff and not always squeaky clean hero. Baccarin gives a sedate and wonderfully understated

performance as Allison, while Dale Floyd shows once again that he has a great career ahead of him.

With plenty of soul-searching, *Greenland* is reminiscent of Mimi Leder's *Deep Impact*, largely considered to be far superior to the brash, over the top *Armageddon*. Both those earlier disaster films were released in 1998 with an almost identical premise, though *Deep Impact* featured nearly respectable science in places.

Greenland sits comfortably between the two, being nowhere as silly and preposterously sentimental as *Armageddon* and undeniably more pessimistic about the future than *Deep Impact*. The film's plot can get a bit ridiculous at times with Butler wading his way through improbable obstacles, but get past those drawbacks and it remains a genuinely impressive and thrilling experience – one that is far bleaker and more downbeat than you would expect from a Hollywood blockbuster. ■

Linda Marric is a film writer based in the UK



Panic as comet Clarke heads for a full-on collision with Earth

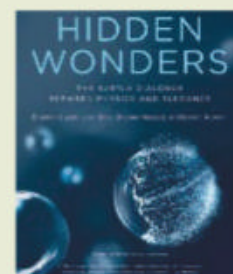
Don't miss



Explore

Is Capitalism Compatible With Environmentalism

asks broadcaster Jon Snow of a panel of experts in climate science, policy and economics at the Science Museum in London. Watch online at 7.30 pm on 26 February.



Read

Hidden Wonders

are revealed by French physicist Étienne Guyon and his co-authors in a fascinating book that explores the mathematical elegance in everyday objects and physical mechanisms, from crumpled paper to sandcastles.



Watch

Pennyworth, on Amazon Prime Video from 28 February (StarzPlay subscription required), starts its second counterfactual season with Batman's future butler still in the UK, embroiled in a devastating civil war.

The sci-fi column

Coming together In *Unity*, Elly Bangs conjures a post-apocalyptic Earth where her protagonist, once part of a hive mind, faces a dangerous, fractured future. The novel is a powerful exploration of union, trauma and consent, says **Bethan Ackerley**



Bethan Ackerley is a subeditor at *New Scientist*. Follow her on Twitter @inkerley



ALEXANDRKHAKIMULLINALAMY

Earth has experienced multiple apocalypses in the future *Unity* is set in

doesn't allow much time to process their horror.

While that helps convey humanity's numb acceptance of the latest threat, a weapon of mass destruction called Gray, Earth's degradation might have had more impact if Bangs had focused on just one disaster. Similarly, Gray's ability to turn everything into "nanobot pudding" doesn't feel as terrifying as the smaller dangers posed by Danae's enemies.

It is the personal stories about Danae's past and the ethics of melding minds that make *Unity* so interesting. We eventually learn that Danae's hive mind has unified with a variety of luminaries in order to solve humanity's problems, but that this has skewed her view of the world. "I stopped noticing that nearly all the lives I added to my gestalt were privileged ones," she realises.

Danae can still unify with others, yet chooses not to out of self-hatred. "I'm a shell of what I used to be," she says after telling Naoto that he can join her hive mind, but not meld minds with her.

She may retreat from unity for the wrong reasons, but it becomes clear that the technology that created her hive mind is also ripe for exploitation in the wrong hands. Even Danae uses it immorally at times, reluctantly invading a would-be assassin's mind to search for information about her enemies.

To reveal more would be to spoil the story, but be assured that Bangs leaves no mystery unsolved by the end. *Unity* is packed full of ideas, sometimes overwhelmingly so, but they ultimately cohere into a powerful exploration of trauma and consent. ■



Book

Unity

Elly Bangs

Tachyon Publications
(out April)

Bethan also recommends...

Book

Midnight Robber

Nalo Hopkinson

In this coming-of-age tale about recovering from trauma, a young girl is forced to leave the Caribbean-inspired planet of Toussaint for a prison colony in an alternate universe.

Film

Pacific Rim

Guillermo del Toro

When aliens emerge from a rift in the Pacific Ocean, humanity fights back the only way it knows how: by punching them in the face with giant mechs controlled by mind-melding pilots.

LAST month, with the world still reeling from the siege of the US Capitol by supporters of Donald Trump, President Joe Biden used his inaugural address to call for national unity. "The American story depends not on any one of us, not on some of us, but on all of us," he said. "On 'We the People' who seek a more perfect union."

In the days since, debate has raged as to whether such a union is achievable or even desirable. These are issues sci-fi writer Elly Bangs also wrestles with in her debut novel, *Unity*. Set in a post-apocalyptic future, we follow Danae as she flees Bloom City, an underwater colony ruled with an iron fist by the Medusa Clan.

Danae is physically and spiritually wounded: she had been one constituent of a hive mind, but is now fractured from the other souls that once made up her consciousness. Accompanied by her lover Naoto and ex-mercenary Alexei, she heads to the ruins of the US to reconcile with her other selves. Yet the trio are pursued by enemies old and

new, whose motives range from personal vendettas to potentially world-ending greed.

How and why Danae became separated from the other parts of her hive mind is one mystery among many. Who are the Keepers? What does the man with the blue tattoo want with Danae? And why does Alexei see

"The personal stories about Danae's past and the ethics of melding minds make *Unity* so interesting"

a giant floating eyeball from time to time? Part of the joy of *Unity*'s first act is how Bangs drops hints about these plot threads without favouring any particular one, all while establishing the cyberpunk world of Bloom City.

Once the trio reach dry land, however, that broad focus can be frustrating. In this future, Earth has suffered an abundance of apocalypses – nuclear war, climate change, pestilence and poisoned oceans – but the story's pace

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A rescue plan for nature

If a far-off future generation writes a complete history of human civilisation, the century from 1950 to 2050 will loom large. This was the era of the Great Acceleration, a rapacious, unrestrained plundering of Earth's natural support systems. But it was also the era of the Great Restoration, when humanity learned again how to live sustainably and in harmony with nature.

That second part hasn't happened yet. Whether this history is ever written depends on what happens now: on decisions to be made this year as the world emerges from the covid-19 pandemic, and on our actions in the coming decade. **Graham Lawton** kicks off a special report on Earth's ecosystems and biodiversity at a critical juncture by asking: how can we deliver a rescue plan for nature that is also a rescue plan for us?



ALEX MUSTARD/NATUREPL/ALAMY

The blue whale's narrow escape from extinction is a conservation success story (see page 42)

WE HAVE repeatedly been pressing the snooze button on the issue, but covid-19 has provided perhaps the final wake-up call. "2021 must be the year to reconcile humanity with nature," said António Guterres, the UN secretary general, in an address to the One Planet Summit of global leaders in Paris last month. "Until now, we have been destroying our planet. We have been abusing it as if we have a spare one."

The numbers are stark, whichever ones you choose. More than 70 per cent of ice-free land is now under human control and increasingly degraded. The mass of human-made infrastructure exceeds all biomass. Humans and domesticated animals make up more than 90 per cent of the mammalian mass on the planet. Our actions threaten about a million species – 1 in 8 – with extinction (see "Biodiversity: A status report", overleaf).

All that has happened in a blink of an eye, geologically speaking. "If you compare Earth's history to a calendar year, we have used one-third of its natural resources in the last 0.2 seconds," Guterres said in Paris.

Following a lost decade, and a year-long pandemic-induced delay to negotiations, a new international agreement to conserve the world's biodiversity is due to be signed later this year, with many other initiatives also starting up. The signs are that covid-19, a scourge caused by our dismissive regard for nature, might finally have focused minds. The question is, what needs to be done – and can we do enough in time?

Our relationship with nature started to sour around the start of the industrial revolution, but only really veered off the rails as the Great Acceleration kicked in after the second world war. In this period, booming population and trade and higher levels of prosperity led to an exponential growth of pretty much every measure of humanity's planetary impact: resource extraction, agricultural production, infrastructure development, pollution, and habitat and biodiversity loss.

This plundering was a gamble that has long since ceased paying out. Degraded land already adversely affects the well-being of 3.2 billion people and costs more than 10 per cent of

annual GDP in lost yields, poorer health and other negative impacts. Those are only going to increase. In a recent paper in the journal *Frontiers in Conservation Science*, an international group of scientists warn that the planet is facing a "ghastly future of mass extinction, declining health, and climate-disruption upheavals... this century".

"The world is facing three major crises today: the loss of biodiversity, climate change and the pandemic," says biologist Cristián Samper at the Wildlife Conservation Society in New York. "They are all interrelated, with many of the same causes and solutions."

"The science is so dramatic," says Johan Rockström at the Potsdam Institute for Climate Impact Research in Germany. In 2009, he and his colleagues developed the "planetary boundaries" concept, which aimed to delineate a safe operating space for humanity, and quantify how we were overstepping it. In a 10th anniversary update in 2019, they suggested that we have already crossed four of nine boundaries – including, crucially, in our impact on biodiversity. "For the first time, we have to consider the real risk of destabilising the entire planet," says Rockström.

"If we fail to act now, future generations will ask, why did we not act to save the Earth given all of the scientific evidence we have?" says Bob Watson, former chair of the Intergovernmental Panel on Climate Change and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), a UN-mandated body that assesses the latest research on biodiversity.

It isn't that we have lacked good intentions in the past. In 2010, the Convention on Biological Diversity – one of three UN bodies to emerge from the 1992 Rio Earth Summit, along with the Framework Convention on Climate Change and the Convention to Combat Desertification – met in Aichi, Japan. It agreed 20 biodiversity targets to be met by 2020, from phasing out subsidies for activities that harm biodiversity to ensuring the genetic diversity of farmed and wild plant and animal species. Come 2020, and the final score was biodiversity nil, environmental destruction 20.

Take a key target on the amount of land to be given over to nature. It mandated protection for 17 per cent of land and fresh water and ➤

Continued on page 39

About this feature

This is the first in a series of five features 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 two of the series, on 6 March, will look at the part our abuse of nature played in unleashing the covid-19 pandemic

JACK DYKING/NATUREPL/UREPL

Biodiversity: A status report

If we are to begin to rebalance our relationship with nature, we must first establish how out of kilter things are. But ecosystems are complex and no single measure can capture all the changes human activities have caused.

Nevertheless, there are various ways of auditing biodiversity and humanity's impact on it, from extinctions and species richness to land use and how much of the planet is set aside for nature. Almost all of them paint a worrying picture

EXTINCTIONS

Perhaps the most eye-catching metric of humanity's impact is in our acceleration of the rate of extinctions.

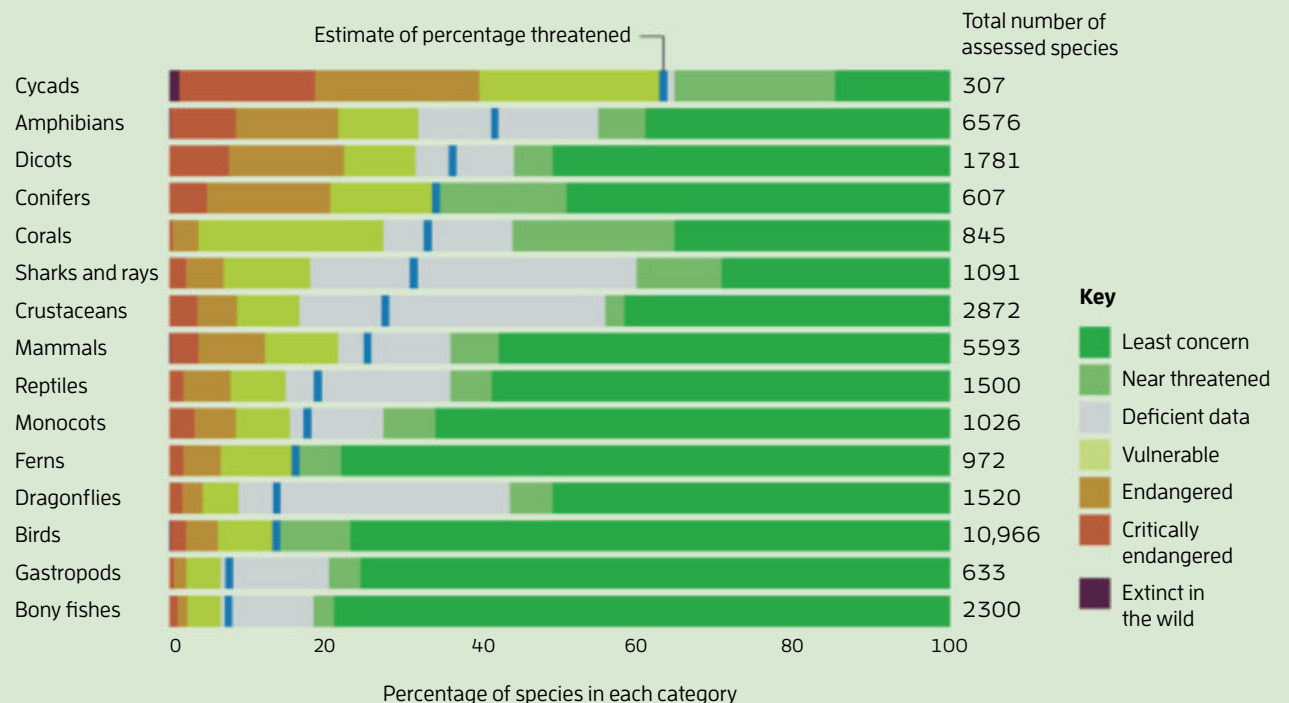
The background or natural rate is 0.1 to 2 extinctions per million species per year. Data from the International Union for Conservation of Nature's Red List of Threatened Species suggests a rate of 34 extinctions per million species per year now. It documents at least 680 extinctions and a further 750 possible extinctions among 112,400 species in the past 500 years, with mammals and amphibians hardest hit among vertebrates.

In recent years, warming, acidifying oceans have caused a drop in coral species. Looking at how many species are considered vulnerable or endangered, the group under the most pressure is the cycads, a group of tropical palm-like plants. Two other plant groups, dicots and conifers, are also up there.

The Red List covers fewer than 5 per cent of the world's known species. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) says that a further half a million terrestrial species of animals and plants may already be doomed to extinction.

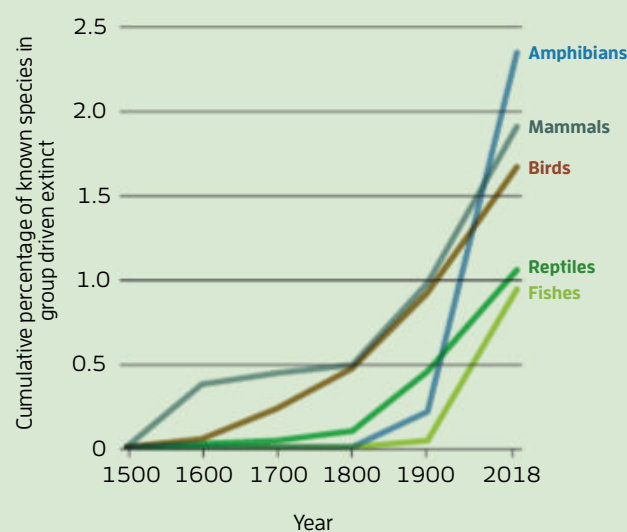
There are many taxonomic groups for which no firm conclusions can be drawn due to insufficient data. One is insects. A recent review concluded that, "Although a flurry of reports has drawn attention to declines in insect abundance, biomass, species richness, and range sizes, whether the rates of declines for insects are on par with or exceed those for other groups remains unknown."

Current global extinction risk in different species groups



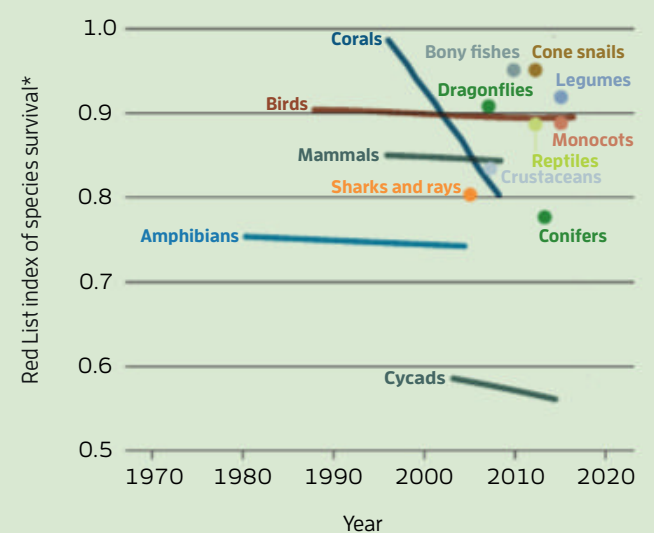
SOURCE: IPBES GLOBAL ASSESSMENT REPORT ON BIODIVERSITY AND ECOSYSTEM SERVICES

Extinctions since 1500



SOURCE: IPBES GLOBAL ASSESSMENT REPORT ON BIODIVERSITY AND ECOSYSTEM SERVICES

Declines in species survival since 1970



* An index of 1 indicates all species in the group are classified as "least concern"; an index of 0 indicates all species are extinct

SOURCE: IUCN AND BIRDLIFE INTERNATIONAL

LAND USE

A less granular measure of humanity's impact is given by various measures of the extent to which we control Earth's surface.

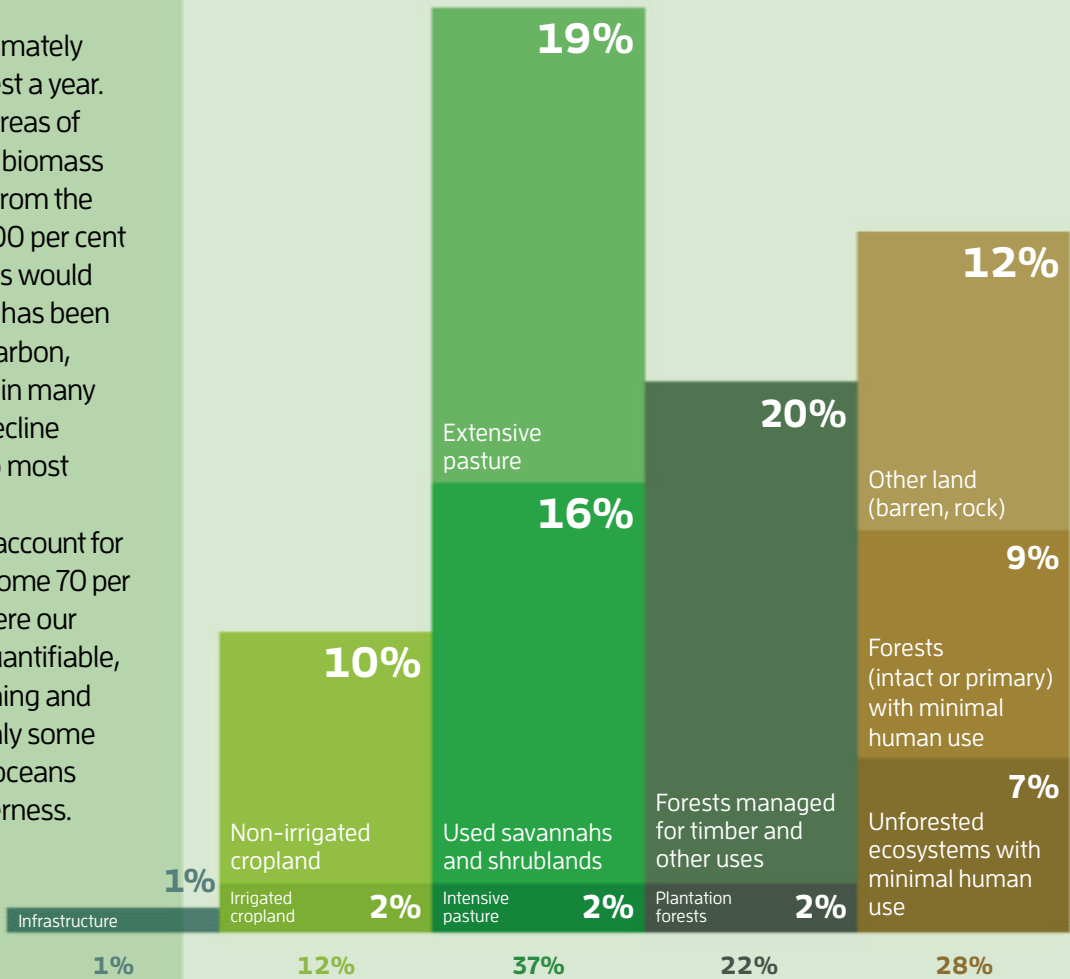
Infrastructure and intensively managed cropland, pasture and forest occupies more than half of Earth's ice-free land surface, with much of the remaining land also highly modified. Human use now directly affects more than 70 per cent of Earth's ice-free surface, with wilderness largely confined to a few areas of the Arctic, the Amazon rainforest, the Sahara desert and the Australian interior.

Over 25 per cent of forests have been permanently cleared and more than half of the original 12.6 million square kilometres of wetlands have been drained. Of the approximately 16 million km² of tropical rainforest that originally existed, less than 9 million km² remain. The current rate of deforestation is 160,000 km²

per year, a loss of approximately 1 per cent of original forest a year.

In intensively farmed areas of the world, the amount of biomass human activities extract from the land amounts to up to 100 per cent of what natural conditions would allow to grow. One result has been a decline in soil organic carbon, a measure of soil fertility, in many parts of the world. The decline in species richness is also most marked in these regions.

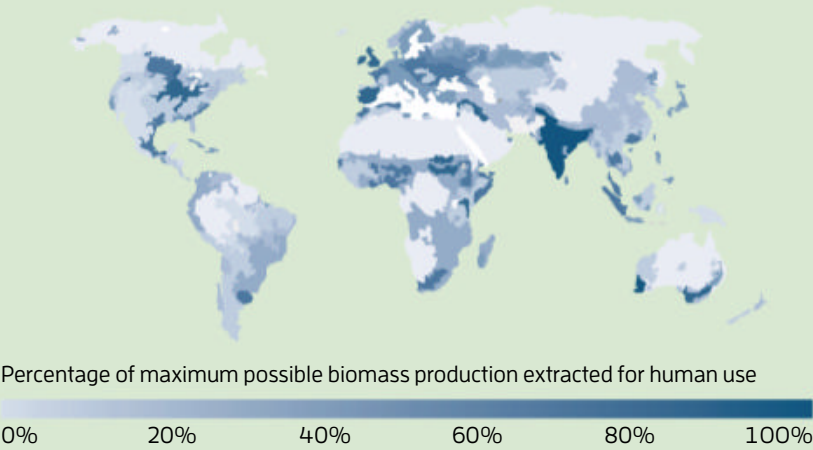
None of these metrics account for the oceans, which cover some 70 per cent of Earth's surface. Here our impacts are less easily quantifiable, but the effects of overfishing and pollution are such that only some 3 per cent of the world's oceans are considered true wilderness.



Proportion of Earth's ice-free land surface under different uses

SOURCE: IPCC SPECIAL REPORT ON CLIMATE CHANGE AND LAND

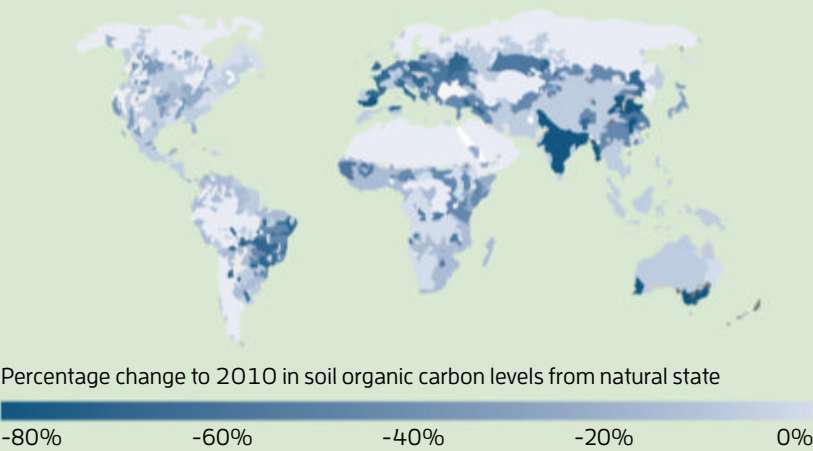
Human use of biomass



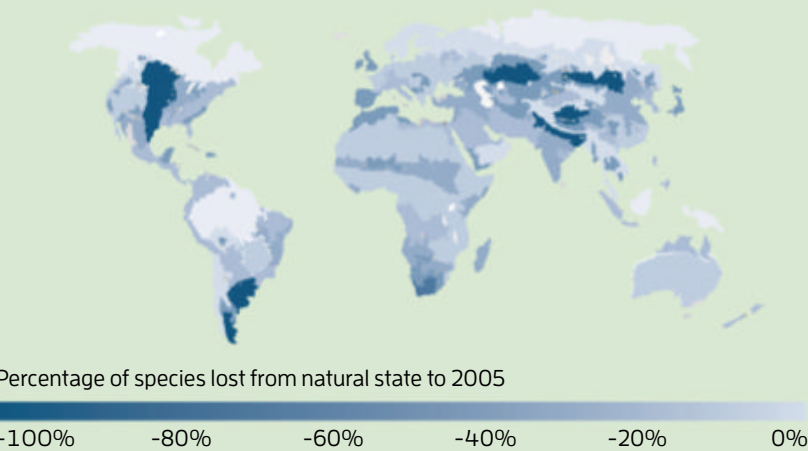
Remaining areas of wilderness in 2009



Reduction in soil richness



Loss of species richness



SOURCE: IPBES ASSESSMENT REPORT ON LAND DEGRADATION AND RESTORATION

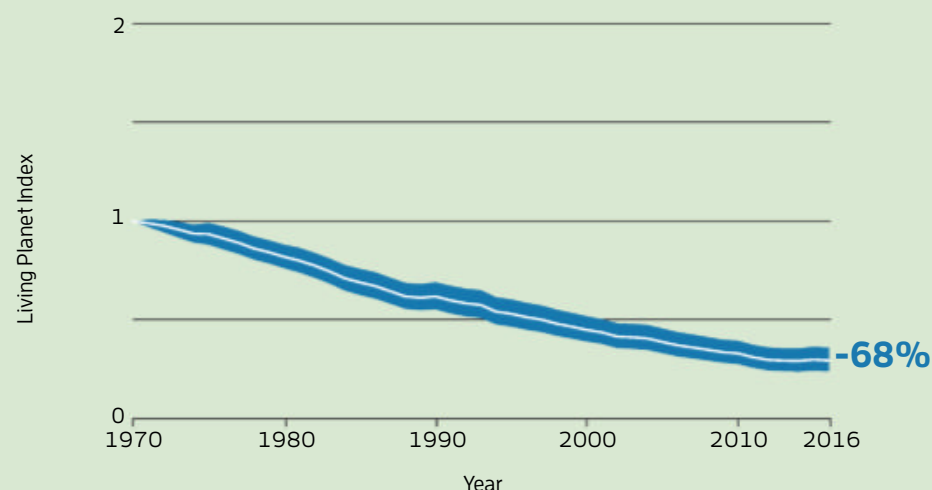
ECOSYSTEM INTACTNESS

Extinction rates tell us about the fates of individual species, but they don't capture the effects of humanity's land grab on functional diversity, a measure of overall ecosystem health. One attempt to do so is the Living Planet Index, produced by the WWF in association with the Zoological Society of London. It is computed using the size of 20,811 populations of 4392 species of mammals, birds, fishes, reptiles and amphibians from terrestrial, freshwater

and marine habitats around the world. The 2020 update shows that, since 1970, the global abundance of vertebrates has declined by 68 per cent.

The Biodiversity Intactness Index is an alternative measure of how much of pre-industrial biodiversity remains. This is seen as severely damaged if the number is below 90 per cent (in other words, a loss of more than 10 per cent of biodiversity). The global figure is currently 79 per cent, and falling.

Vertebrate abundance



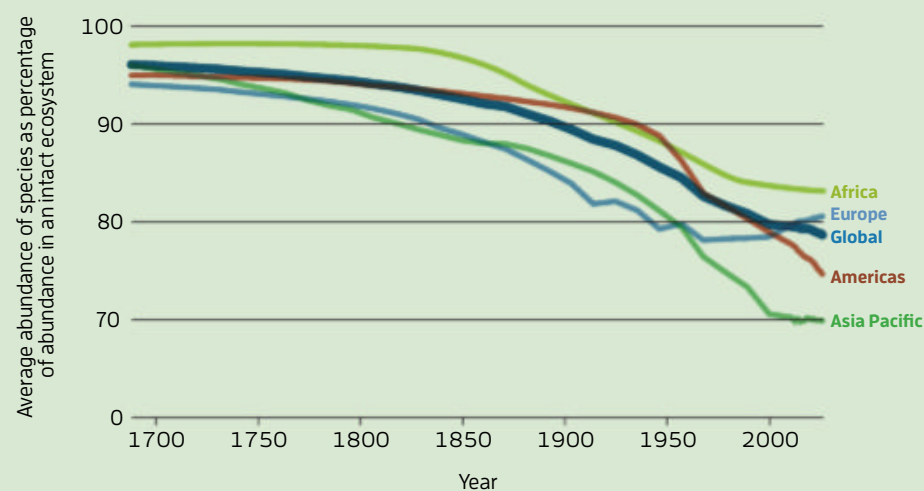
SOURCE: WWF/ZSL LIVING PLANET REPORT 2020

PROTECTED AREAS

One success story is the proportion of land important for biodiversity that has some form of protection. This has been growing across the world. The Netherlands Environmental Assessment Agency added up existing commitments

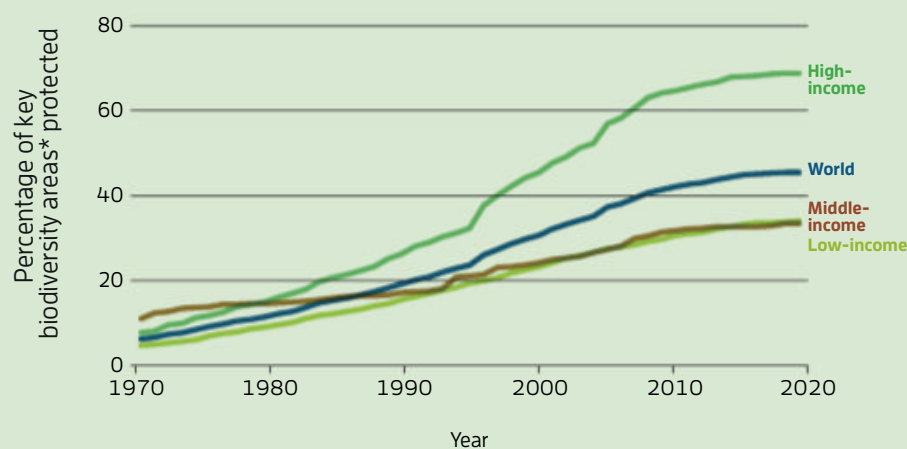
to restoration projects in 115 countries and found that they come to about 10 million square kilometres, roughly the size of China, or just under 7 per cent of total world land surface area. How that squares with reality on the ground is another question.

Loss of species richness



SOURCE: WWF/ZSL LIVING PLANET REPORT 2020

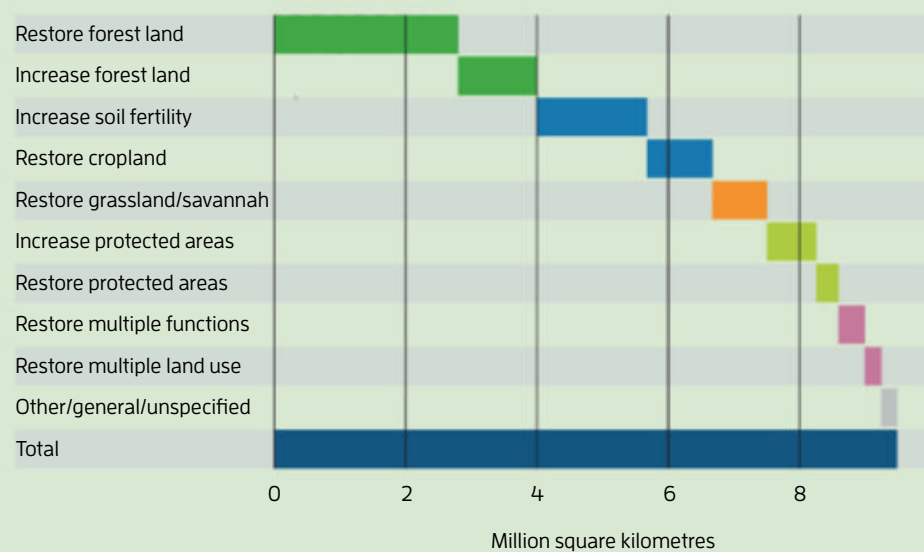
Protection of areas rich in biodiversity



* Key biodiversity areas are sites identified as contributing significantly to global terrestrial, freshwater or marine biodiversity

SOURCE: IPBES GLOBAL ASSESSMENT REPORT ON BIODIVERSITY AND ECOSYSTEM SERVICES

Total global commitments to ecosystem restoration



SOURCE: PBL NETHERLANDS ENVIRONMENTAL ASSESSMENT AGENCY, GOALS AND COMMITMENTS FOR THE RESTORATION DECADE

Continued from page 35

10 per cent of the oceans by the end of 2020. Some progress was made, says Samper, but neither goal was reached, with the current numbers being about 15 per cent and just over 7.5 per cent. Those areas that are protected are often poorly managed, too small and don't cover the full richness of Earth's environments: only some 42 per cent of 867 distinct types of ecosystem so far categorised are thought to be well-protected.

"Science tells us that we must expand protected areas to cover at least 30 per cent of the land and sea by 2030," Samper told the Paris summit. A new group, the High Ambition Coalition for Nature and People, comprising more than 50 countries co-chaired by France, Costa Rica and the UK, is now aiming to secure international agreement for this "30 by 30" pledge.

Beyond conservation

In parallel, on 5 June – World Environment Day – the UN will launch its Decade on Ecosystem Restoration. "The main aim is to prevent, halt and reverse the degradation of ecosystems worldwide," says Tim Christophersen at the UN Environment Programme (UNEP), who will be coordinating the initiative. "Nothing more, nothing less. A little bit of a daunting task."

Daunting in particular because in one sense it is already too late. "It's cheaper, of course, to conserve ecosystems, or make sure they don't degrade," says Christophersen. "But we're at a stage now where conservation is no longer enough. We also need to heavily invest in restoration."

Ecosystem restoration will be the key to success or failure over the coming decades. It takes many forms, depending on the ecosystem and how badly degraded it is. At one end of the spectrum is passive rewilding, which simply means getting out of the way and letting nature do its thing. "It's amazing, the capacity that nature has to heal itself," says ecologist Paul Leadley at the University of Paris-Saclay in France, who was a co-author of the 2019 IPBES global assessment report on biodiversity and ecosystem services.

Small-scale rewilding projects such as at Oostvaardersplassen in the Netherlands, where an area of reclaimed polder land has been given over to nature, have shown the way, but the ambition must grow – and is growing. In Europe, the biggest project aims to leave some 35,000 square kilometres of Lapland in northern Sweden and Norway

to rewild. In North America, the Wildlands Network aims to link up protected areas in "wildways" in which animals can freely roam spanning Canada, the US and Mexico.

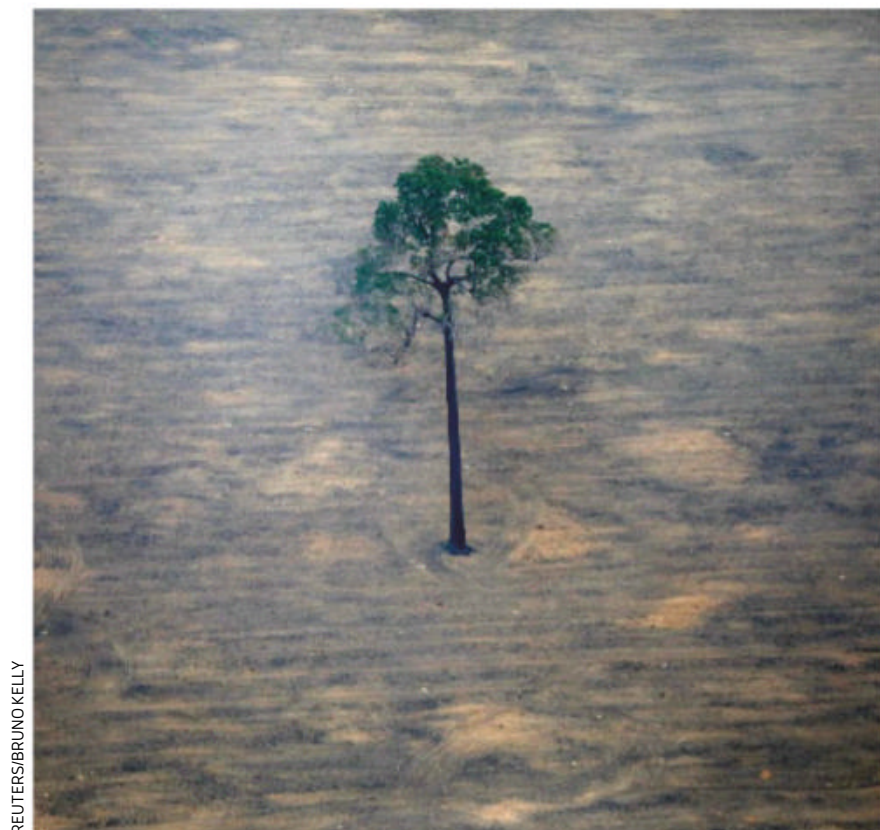
At the other end of the restoration spectrum is active engineering of entire landscapes with mass tree planting, removal of alien species and damaging infrastructure such as dams, and reintroductions of species. This can be done. South Korea adopted an active reforestation policy in the 1950s following the Korean War. The total volume of wood in the country's forests increased from some 64 million cubic metres in 1967 to 925 million cubic metres in 2015, and forests now cover some two-thirds of the country. The Green Belt Movement founded in Kenya by Nobel peace laureate Wangari Maathai has planted tens of millions of trees across Africa, and inspired many similar projects.

But while very possible, active restoration brings risks if done unscientifically, says Bernardo Strassburg at the International Institute for Sustainability in Rio de Janeiro, Brazil. "Any scaled-up restoration needs to be ecologically sound," he says. "It is not just planting trees everywhere, particularly in places where trees didn't belong in the first place, like grasslands or wetland. That will be detrimental to biodiversity." Different solutions are needed in different places (see "How to restore an ecosystem", overleaf).

Christophersen thinks the theory and practice of ecological restoration are up to ➤



JACK DYKING/NATUREPL



REUTERS/BRUNO KELLY

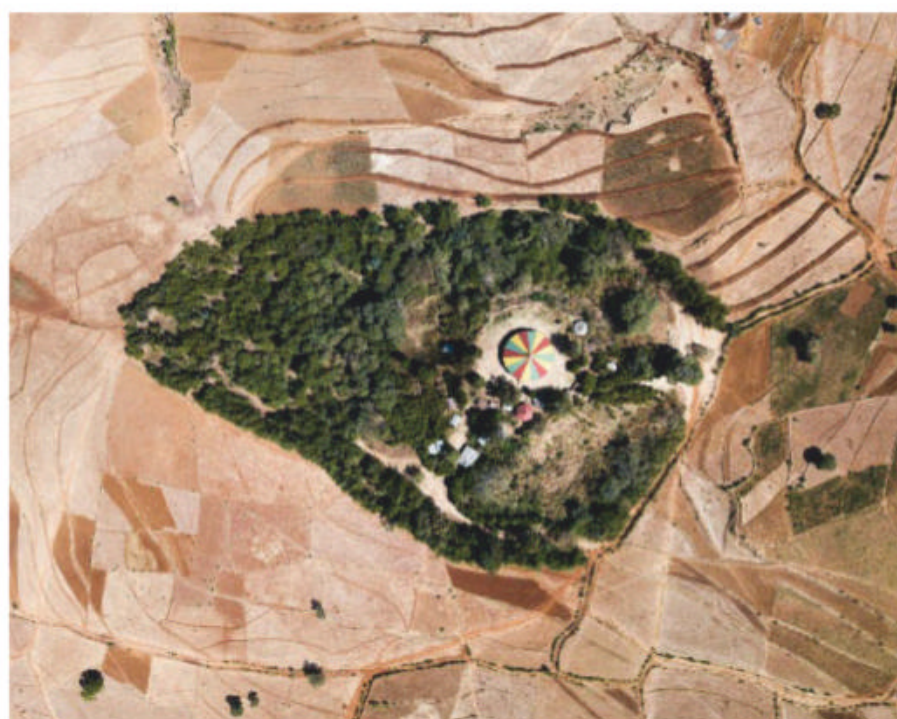
A deforested area near Porto Velho in the Brazilian Amazon

WHAT DO ECOSYSTEMS DO FOR US?

Far from being a luxury that cash-strapped economies can ill afford, spending money on restoring and preserving ecosystems is a sound investment. On average, every \$1 spent on ecosystem restoration gives a return of around \$10 in ecosystem goods and services.

Some of that is direct monetary returns, such as from sustainable wood, improved agricultural yields and ecotourism revenues. But the greater part is freebies that society would otherwise have to shell out for, such as clean air and water, pollination, pest control, nutrient recycling, carbon sequestration, fewer animal-transmitted diseases and greater resilience to extreme weather and natural disasters.

Think of it as being like building roads and bridges – they don't generate returns themselves, but lay the groundwork for increased economic activity. "It makes sound economic sense with benefits far exceeding the costs," says environmental scientist and diplomat Bob Watson.



Farmland encroaches on forest around the Debre Mihret Arbiatu Ensessa church in Ethiopia

the job. "We have decades of experience with restoration. We know enough. We don't know everything, and we will find out more as we go along. But we know enough to get started. It's one of those situations where you can't let the perfect be the enemy of the good."

The headline target of the UNEP initiative is to restore 3.5 million square kilometres of land over the coming decade – slightly more than the size of India, or just over 2 per cent of the world's land surface. That is "incredibly ambitious", says Strassburg. "If we were to achieve that, it will be the fastest reshaping of [Earth's] surface caused by us." It won't come cheap. According to UNEP, the upfront cost is about \$1 trillion, no small change in a post-pandemic recession, although it is an investment with a high rate of return (see "What do ecosystems do for us?", left).

On paper, at least, it is already in the bag. Annelies Sewell at the Netherlands Environmental Assessment Agency in The Hague and her colleagues totted up commitments to existing restoration projects in 115 countries, encompassing plans to increase protected areas, restore and improve forests, croplands and

grasslands, and more. They found that this adds up to about 10 million square kilometres, roughly the size of China or just under 7 per cent of world land surface area. "There's more than we expected," says Sewell. "But that doesn't mean that there's enough."

Crunch time

Land conservation and restoration can help solve multiple environmental challenges, but "it won't fix them on its own", says Sewell. Hence a second pillar of 2021: the negotiation of a new suite of biodiversity targets, replacing the Aichi targets, to run alongside the Decade on Ecosystem Restoration. Together these mean the 2020s will be make-or-break time. "This is the decisive decade for humanity's future on Earth," says Rockström.

These targets are due to be thrashed out at a pandemic-delayed crunch meeting of the Convention for Biological Diversity (CBD), now to be held later this year in Kunming, China. According to Elizabeth Mrema, executive secretary of the CBD, lessons have been learned from Aichi, and an international coalition of interests is now invested in making new targets work (see "We have to be optimistic", page 43). The upfront costs will be more than \$700 billion, says Mrema – but, as with ecosystem restoration, they come with a huge pay-off. "Every dollar spent will accrue between \$3 and \$75 of economic benefits from ecosystem goods and services," she says.

Despite Aichi's overall failure, another lesson of the past decade is that, where

"Every dollar spent on ecosystem restoration accrues between \$3 and \$75 in return"

HOW TO RESTORE AN ECOSYSTEM

How ecosystems are degraded by human activity varies – and ways to restore them differ too

FORESTS

Degraders: Clearance for infrastructure, agriculture and grazing; logging for firewood; pollution, invasive pests and wildfires **Restorers:** Replanting native trees; conservation of plants and animals; rewilding

FRESH WATER

Degraders: Water extraction for irrigation, industry and homes; sand and gravel mining; dams, canalisation and drainage for agriculture; pollution from chemicals, plastics and sewage **Restorers:** Controls on water extraction, fishing and mining; dam removal or redesign, restoring water flows to wetlands; wastewater treatment

OCEANS AND COASTS

Degraders: Overfishing and coastal clearance for aquaculture; plastic and nutrient pollution; wastewater discharge **Restorers:** Sustainable fishing, wastewater treatment, pollution control, management and restoration of coral reefs, mangroves and seagrasses

GRASSLANDS AND SAVANNAH

Degraders: Conversion to cropland and pasture; overgrazing and soil erosion; unsustainable resource extraction; invasive species **Restorers:** Active clearance of woody vegetation; reseeding native grasses and replanting native shrubs and trees; reintroduction and protection of native fauna

MOUNTAINS

Degraders: Forest clearance for agriculture, dams and roads; soil erosion; natural disasters such as avalanches, landslides and floods **Restorers:** Tree planting, better planning of infrastructure, use of low-impact farming techniques such as agroforestry

PEATLAND

Degraders: Peat extraction; drainage for agriculture, infrastructure, mining and fossil fuel exploration; fire, overgrazing, pollution **Restorers:** Re-wetting, conservation

FARMLAND

Degraders: Overgrazing and soil erosion; monocultures; removal of hedges and trees; pollution from fertilisers and pesticides **Restorers:** Crop rotation with more diverse crops, including trees and livestock grazing on cropland after harvest; use of natural fertilisers and pest control

CITIES

Degraders: Urban sprawl; waste and emissions from industry, traffic and homes **Restorers:** Stricter planning laws; clean-up of waterways and former industrial sites; tree planting and creation of green space and urban wetlands

governments and other groups commit to protecting biodiversity, change can happen (see “Back from the brink”, page 42). “I don’t want to sugar-coat this because this was not a great result,” David Cooper, deputy executive secretary of the CBD, told the World Biodiversity Forum 2021 in January. “But where serious actions have been taken, for example to reduce the rate of deforestation, to improve the state of fisheries, to prevent extinctions where we know the cause, significant progress has been made.”

Ultimately, success or failure will depend on progress in another key area: climate change. This year is crunch time here too, and another big, delayed UN summit to forge a way forward is to be held, pandemic permitting, this November in Glasgow, UK. Success or failure in Glasgow and Kunming will be interlinked. “Without addressing climate change, it’s not possible to bend the curve of biodiversity loss: all bets would be off,” says Cooper.

But that works two ways: conserving biodiversity and restoring ecosystems will have positive knock-on effects for the climate. “Restoration is one of the most cost-effective tools to mitigate climate change,” says Strassburg: land-use change and increased plant cover can deliver up to a third of the reduction in greenhouse gases that we need.

Ultimately, says Mrema, the next decade needs to be about synergy, with biodiversity initiatives, efforts to combat climate change

and other international programmes such as the UN Sustainable Development Goals converging on the ultimate target: harmony with nature by 2050.

There are still huge obstacles. “We know that the changes that are needed to move to sustainability are huge, they are not going to be easy,” says Cooper. But at least the right noises are being made. In Paris, luminaries including the leaders of Germany, Canada and the UK, Chinese vice-premier Han Zheng and the presidents of the World Bank and the European Central Bank lined up to swear fidelity to the cause of conserving nature. Emmanuel Macron, president of France and convener of the summit, said: “The agenda is now mature and we are ready to act.”

Crucially, there is still time, just, to manage the pivot from the Great Acceleration to the Great Restoration. “Things are in dire straits and action is really, really needed now, but we’re not in a catastrophic situation – yet,” says Leadley. “If we go towards sustainable consumption and production, set out enough protected areas and handle climate change, there’s no reason why biodiversity can’t have a positive outlook. We’re not beyond the point of no return.” ■



Graham Lawton is a feature writer for New Scientist

Rapidly growing cities such as Baoji, China, fragment nature



Back from the brink

Stories of species brought back from near-extinction show we can help nature turn the corner, says **Adam Vaughan**

LOOK at how we missed all 20 of the past decade's biodiversity targets, or shocking graphs of animals threatened with extinction, and it is easy to be disheartened about the fate of the natural world. "There's lots of doom and gloom stories around about biodiversity," says Stuart Butchart at the conservation body BirdLife International. "It would be easy to feel conservation was a pointless exercise and there's nothing we can do to slow the juggernaut down."

Butchart's work suggests that isn't the full picture, however. He was part of a team that recently estimated that conservation initiatives had prevented up to 32 bird and 16 mammal extinctions since 1993. Given that 10 bird and five mammal species are known to have gone extinct in that time, the researchers concluded that extinction rates would have been up to four times higher without action. "I think that's a positive message. It's not all bad news, always," says Friederike Bolam at Newcastle University, UK, the study's lead author.

Many of the most successful conservation efforts involve big "charismatic" species, such as the giant panda, that readily attract attention and funding. But Bolam and Butchart's team identified a number of recurring and widely applicable themes in successful conservation work: removal of invasive species, management of hunting and protection of important habitats. "Broadly speaking, we have the tools, we just need much greater resource and political will," says Butchart.

Even so, targeted actions won't turn the tide alone. Stemming biodiversity loss will also require more fundamental changes to how we value nature – and whether those will be forthcoming is the trillion-dollar question (see page 34). For now, here are 10 conservation success stories from around the globe that give some idea of what works.

CALIFORNIA CONDOR

(*Gymnogyps californianus*)

International Union for Conservation of Nature (IUCN) Red List status: **Critically endangered**

Numbers of the largest North American land bird declined so steeply in the 20th century that only 27 were left by 1987, at which point all were taken into captivity to try to save the species. "They are basically a vulture. They feed on carcasses and ingest fragments of lead shot, and because they live for decades, that can accumulate over time. It's incredibly poisonous," says Butchart. Other pressures included chicks ingesting rubbish including glass, collisions with electricity pylons and the insecticide DDT – banned in the US since 1972 – which thinned the species' eggs.

Following a successful captive breeding programme, the condors were reintroduced into the wild starting in 1991. There are now 93 mature individuals in a population of 300 birds in the wild. If numbers continue to increase, their status could be improved to "endangered" on the IUCN Red List by 2024. Lead shot used by hunters to kill animals that the birds scavenge is still a problem, although lobbying led California to ban it in 2019. For now, affected birds are recaptured so dialysis can remove lead from their blood. "They are by no means saved entirely," says Butchart.

BLACK STILT

(*Himantopus novaezelandiae*)

Status: **Critically endangered**

Regarded as a "living treasure" by the Maori in its native New Zealand, this wading bird came close to being an ex-treasure, largely because of predator species introduced to the country such as cats, stoats and rats. Likewise, non-native animals were the top threat to the 32 bird species Bolam's team identified as saved from extinction.



CLAUDIO CONTRERAS/NATUREPL

Loss of habitat to agriculture and hydroelectric schemes also contributed to black stilt numbers plummeting to just 23 in 1981, when the New Zealand government intervened with an intensive programme of captive breeding and pest control.

Numbers had recovered to 106 in 2017, but predator pressure remains: every four to five years, a bumper release of seeds from southern beech trees causes a boom in rats that prey on this bird's eggs. In 2016, New Zealand set an ambitious target to eradicate invasive predators by 2050.

TIGER

(*Panthera tigris*)

Status: **Endangered**

"The story of tigers is a story of decline of one of Earth's largest predators," says Stuart Chapman at conservation body WWF-UK. During the 20th century, this carnivore dwindled across its historical range from

"We have the tools to stem biodiversity loss – we need the will"



A radio-tagged California condor in Mexico in 2011

India to Indonesia, east Asia and the Russian far east. Habitat loss, poaching and retaliation for conflict with people and livestock were the drivers, says Elizabeth Bennett at the US-based Wildlife Conservation Society. Loss of prey contributed too: one tiger needs to eat a deer-sized animal a week. From an estimated 100,000 a century before, tiger numbers fell to 3200 by 2010.

That year, the international TX2 initiative was agreed with the aim of doubling tiger numbers by 2022 through initiatives such as protected areas, removal of snares and “tiger underpasses” beneath roads. Official estimates are due next year, but numbers are now thought to be up in India, Nepal, Bhutan, China and Russia – while tigers have vanished entirely from Cambodia, Laos and Vietnam.

“There has been a mixed bag,” says Chapman. “Without conservation interventions, they will disappear, no doubt.” A major tiger summit in St Petersburg, Russia, in October 2022 is due to take stock and look to a brighter future, including reintroductions. ➤

‘We have to be optimistic’

The new biodiversity targets to be agreed this year can be a turning point for nature, the diplomat in charge of the process, Elizabeth Mrema, tells **Graham Lawton**

Graham Lawton: What do we know about when the Convention for Biological Diversity talks are going to happen in Kunming?

Elizabeth Mrema: We’re still in consultations with our hosts, China. The dates that had been announced were the last two weeks of May, but looking at how the situation is, May is tomorrow!

But not just that: before our conference, we have subsidiary bodies that need to meet to negotiate and prepare for all the decisions that will be taken. These important discussions will guide the world for the next 10 years. We cannot negotiate virtually, we need to meet in person.

This is a crunch year all round, with other key negotiations taking place and the launch of the UN Decade on Ecosystem Restoration.

Yes, 2021 is the super year for all three Rio conventions: biological diversity, climate change and land degradation. The Decade on Ecosystem Restoration brings them all together. With ecological restoration, you are talking of an impact on land degradation but also on biodiversity, also on climate. This decade will be the decade of convergence of the conventions. There is enormous potential for synergies.

What is the state of global biodiversity?

The science is very clear. In terms of species loss, land degradation, deforestation, habitat loss and fragmentation, invasive alien species, impacts of chemicals, scientists are giving us a consistent message: we have undermined nature. And the solutions are to go back to nature.

The biodiversity targets from the 2010 Aichi Convention on Biological Diversity were all missed. How will the new ones be different?

I know, we are all worried. If Aichi has failed, what makes us think that the new framework will be better? But we learned lessons. We failed the targets because we assumed implementation was the role of governments. We missed Indigenous people, local communities, youth, women. We missed the private sector – finance, business, industry. The World Economic Forum recently found that half of global GDP depends on nature. The private sector would not want



PROFILE

Elizabeth Mrema is executive secretary of the UN Convention on Biological Diversity, based in Montreal, Canada

to lose this, and so it is coming on board. This was not the case in the last 10 years.

Has the pandemic injected urgency into proceedings?

Covid clearly demonstrated, indisputably, how human health depends on nature. And if it depends on nature, we need to protect it, and not to interfere with wild spaces and suffer what the whole world is suffering now. Human health will take a centre stage in the new framework, because now it is also seen as a framework that will provide solutions to preventing and avoiding future pandemics.

Will the change in US president make a difference?

I’m really crossing fingers. The initial signs seem positive, because the incoming administration is already talking to us. So we hope. The Convention on Biological Diversity is a universal agreement of 196 parties and we are missing only two. One is the US; the other is Vatican City.

It has been suggested that the United Nations ought to set up a body with overarching responsibility for nature, in the same way that we have ones for security, trade, food and health. Do you agree?

Personally, I will be cautious. The challenges in front of us are just too enormous and too many. The moment we set up new bodies, we take a step back for two or three years. I don’t think we lack bodies. What we are lacking is enforcement and implementation. Time will not wait for us.

I sense genuine optimism here.

We have to be optimistic! If we are not positive, we will continue to suffer. We have 10 years to make a difference.



PIKSELSTOCK/ALAMY



European bison graze in Poland's Białowieża Forest

MOUNTAIN GORILLA

(*Gorilla beringei beringei*)

Status: **Endangered**

The first case of gorillas contracting covid-19 – announced by San Diego Zoo in California on 11 January – raises a worrying new risk for the mountain gorilla. This subspecies of the eastern gorilla, the largest living primate, survives in two populations split across rainforest on extinct volcanoes in Rwanda, Uganda and the Democratic Republic of the Congo. It is a poster child for conservation rooted in ecotourism that brings people to their habitat.

Poaching and forest felling for agriculture reduced mountain gorilla numbers to around 250 in 1981. After earlier attempts to establish protected areas antagonised some local communities, ecotourism took off and made gorillas more valuable alive than dead – permits to see the animals can cost \$1500 each, says Bennett.

Numbers now stand at a minimum of 1063 – the only great ape that is on the up. Continuing threats include disease and snares set to poach other animals, says Cath Lawson at WWF-UK. “We consider it to be a conservation success story, but it’s not a done deal,” she says. Rwanda and Uganda are now resuming tourist visits, and these will include steps

to minimise covid-19 risk, after a pandemic-induced hiatus.

INDUS RIVER DOLPHIN

(*Platanista gangetica minor*)

Status: **Endangered**

This river dolphin, a subspecies of the South Asian river dolphin that relies on echolocation, is found only in the Indus river basin, mostly in Pakistan. In 1923, British colonial authorities built the first of 19 barrages across the Indus to divert water for irrigating crops, fragmenting the dolphins’ habitat. Once found throughout the 3000-kilometre-long Indus, their range shrank to 1300 kilometres. By 2001, numbers had dropped to 1200.

Satellite tracking in 2009 showed that the dolphins can sometimes pass through the barrages, but they often strand and die in the irrigation canals that run off them. Fishing nets pose a further problem. The barrages can’t simply be removed, says Uzma Khan at WWF-Pakistan. Acoustic devices help deter the dolphins from entering the canals, but educating fishing communities and recruiting local people for ecotourism and monitoring has been the key to an uptick to some 1800 animals, says Khan. “I initially saw it all as a scientist,” she says. “I learned you cannot do anything without communities.”

“The blue whale recovery shows what humans can do if they leave things alone”

ANTARCTIC BLUE WHALE

(*Balaenoptera musculus intermedia*)

Status: **Critically endangered**

"The world used to run on whales," says Jennifer Jackson at the British Antarctic Survey. Hunted mainly for their oily blubber, the Antarctic subspecies of the largest whale was particularly desirable. From an estimated 239,000 before the advent of industrial whaling in the early 20th century, by the early 1970s, whaling had whittled them down to just 360.

The species was given legal protection in the 1960s, but Soviet whalers continued hunting in the Southern Ocean regardless. "They just hoovered up the remaining whales," says Jackson. An international moratorium on whaling signed in 1986 had global scope and adherence – though it was only agreed when it was clear there were precious few whales left to catch.

Preliminary estimates show that Antarctic blue whales recovered to some 4500 individuals by 2015, says Jackson, though that number won't be formally confirmed until later this year. It will take centuries for them to revive fully, but "the blue whale recovery is symbolic of what humans can do if they just leave things alone", says Jackson. Rod Downie at WWF-UK says the biggest threat to the species today is climate change, especially changes to sea ice that affects nurseries of krill, the tiny crustaceans that nourish the largest animal to have existed on Earth.

EUROPEAN BISON

(*Bison bonasus*)

Status: **Near-threatened**

Nearly 2 metres tall and weighing up to a tonne, Europe's largest land mammal once ranged from Spain to the Caucasus. It has staged a remarkable comeback since the last wild one was killed in Poland's Białowieża Forest in 1927, the victim of hunting and habitat destruction and fragmentation.

The bison's reintroduction across Eastern Europe from the final 54 left in captivity has been an "incredible story", says Paul de Ornellas at WWF-UK. "One of the lessons is that successful reintroductions require a lot of effort, coordination and people," he says.

The IUCN relaxed the bison's status from vulnerable to near-threatened last December, after numbers rose from 1800 in 2003 to 6200 in 2019. There are now 47 free-ranging herds in countries including Germany, Poland and Romania, although only eight are

considered big enough and genetically diverse enough to be self-sustaining. Action is now focused on growing the small groups and helping herds connect.

JAVAN RHINOCEROS

(*Rhinoceros sondaicus*)

Status: **Critically endangered**

In 2010, the last of these forest rhinos on the Asian mainland was found dead in Vietnam, apparently perishing months after being shot. Poaching and habitat loss – to agriculture, including palm oil plantations, and growing human settlements – had been its nemesis.

Fortunately, around 50 survived in the Ujung Kulon National Park in the west of the densely populated Indonesian island of Java. There are now 74 in the park, says Bibhab Talukdar at the IUCN, thanks to efforts led by the Indonesian government. These included making their home a protected area and managing the invasive palm *Arenga obtusifolia*. This plant rapidly crowds out others once it gets a toehold, says CeCe Sieffert at the International Rhino Foundation.

"Other plant species cannot compete with it and it's inedible to Javan rhino," she says.

Her group hires local people to cut the palm down by hand. But with the only home for these rhinos at risk from tsunamis, volcanic eruptions and disease, suitable sites must be found for reintroductions. "It's so we don't have all the eggs in one basket," says Talukdar.

GIANT PANDA

(*Ailuropoda melanoleuca*)

Status: **Vulnerable**

Logging, expanding cities, tourism and

roads carving up its forest home drove what Qiang Xu at WWF-China calls a "very rapid decline" in the giant panda in the 20th century. Surveys between 1985 and 1988 found just 1114 animals, down from the 2459 detected between 1974 and 1977.

Political will and protected areas turned the story around. China has created 67 giant panda reserves since the 1960s, and in 1988 banned logging entirely in their habitats. "The determination and investment of the Chinese government is the key," says Xu. The fourth national survey of the animals in 2015 found 1864 of them. A year later, their official conservation status was altered to reflect this, going from "endangered" to "vulnerable".

But the surviving 20 populations remain fragmented. The recently declared Giant Panda National Park, which extends across more than 27,000 square kilometres in the Chinese provinces of Sichuan, Shaanxi and Gansu, is a major attempt to fix that. Time will tell if it works.

HAINAN GIBBON

(*Nomascus hainanus*)

Status: **Critically endangered**

The world's most endangered primate, endemic to the Chinese island of the same name, shrank from 2000 individuals to around nine by the 1980s. Hunting and rainforest clearance confined them to just one block of forest called Bawangling.

Monitoring by conservationists and local people since 2005 has deterred poaching, and hands-on interventions, such as a canopy bridge built after a typhoon to help gibbons cross a gap in the forest made by a landslide, are helping too. "They are slowly but steadily increasing," says Bosco Chan at Kadoorie Farm and Botanic Garden in Hong Kong. Last year, a fifth group of the primates was identified, and there are now believed to be around 33 individuals.

Pengfei Fan at Sun Yat-Sen University in Guangzhou, China, says that while the numbers are "still very, very small", there is commitment to their protection. Regional and central government upped investment last year, patrols are increasing and one village near their habitat may even be moved, says Fan. "It shows, even with the most doomed species, there is always hope," says Bosco. ■



An adult Hainan gibbon in the Bawangling reserve, China, in 2015



Adam Vaughan is chief reporter at New Scientist

How old are you really?

If you want to know how well your body is ageing you may be in for a surprise, finds **Marta Zaraska**

WHEN David Nurse turned 30, he wanted to find out how his biological age compared with his chronological one. A life coach with the US National Baseball Association, he hoped that the ultra-healthy lifestyle he advocates to players had kept his own body young and healthy, too. So he took a test to assess the length of his telomeres. It revealed his biological age to be 28 years. That was in 2017. Two years later, he took another test. “I was down to 25, so that was great,” he says.

If you google “telomeres”, you are likely to find them described as an ageing clock. They are segments of DNA at the ends of each chromosome that become shorter every time a cell divides. If this shortening happens slowly, it suggests that your body is wearing well. Say you are a 60-year-old with telomeres as long as those of an average 50-year-old, your mortality risk is equivalent to that of someone 10 years younger – or so the story goes. Increasing numbers of people want this information, and many companies offer tests like the one Nurse took, together with various pills claimed to lengthen your telomeres and, in turn, your lifespan.

If only it were that simple. We are now discovering that telomeres are an unreliable ageing clock, which raises questions about the validity of ageing tests based on them. The links between telomere length and lifestyle choices also aren’t as straightforward as we once thought. In fact, long telomeres can even be bad news. Nevertheless, there are some surprising ways we can look after our telomeres.

At first glance, telomere-mania seems grounded in science. In 1982, Elizabeth Blackburn at the University of California, Berkeley, and Jack Szostak at Harvard Medical School cracked the riddle of how chromosomes remain intact when cells divide: they have repeating units of DNA at their ends that stop them from unravelling. The pair called these “telomeres”. Later, they discovered that each time a cell divides, its telomeres become shorter, like the ticking of a biological clock. Meanwhile, Blackburn and Carol Greider at Cold Spring Harbor Laboratory in New York identified an enzyme, telomerase, that promotes the construction of telomere DNA.

These discoveries won Blackburn, Greider and Szostak a Nobel prize in 2009. Hype soon followed and researchers began piling into the field. However, as we find out more about telomeres, the mythology that has built up around them is starting to crumble.

For a start, it turns out that having long telomeres isn’t necessarily a sign that you have done a great job keeping your body younger and healthier than other people of your chronological age. A lot of the differences between people are down to genes. We now know that telomere length is highly heritable, with as much as 60 per cent of the variation between individuals being due to their genes. There are several genes associated with telomere length, and some of them are responsible for regulating the activity of telomerase.

What happens to a fetus while in the uterus also has a huge effect. Studies have linked shorter telomeres to prenatal exposure to



certain chemicals such as phenols and phthalates, to smoking, air pollution, maternal stress and to the mother being overweight.

Genes and prenatal conditions mean that some people are born with telomeres consisting of as few as 5000 base pairs – the building blocks of DNA – while others have as many as 15,000. Considering that adults lose between about 30 and 50 base pairs of telomeres per year, this represents a huge difference at the start line.

That disparity can increase throughout early childhood. Fast growth and rapid cell replication mean that telomere length decreases quickly in this period. However, the rate varies enormously. From birth until the age of 4, children can lose anywhere from 270 to more than 1000 base pairs of telomeres per year. One reason for this variation may be the adversity a child experiences. A recent meta-analysis of more than 40 studies showed that poverty, abuse and maternal depression

"At birth, some people's telomeres are a lot longer than those of others"

were among the factors linked to faster telomere shortening.

Where telomere length is concerned, most of our cards have been dealt before we finish primary school. Once we enter our second decade of life, telomere shortening slows. Thereafter, how our telomere length compares with that of other people of the same chronological age may not shift much, according to research by Abraham Aviv at Rutgers New Jersey Medical School and his colleagues. His team measured the telomeres of 67 pre-teen children and their parents and ranked them in order of telomere length. Fourteen years later, the ranking remained unchanged for 90 per cent of them. "If you are in the 90th percentile of the distribution, you are likely going to stay there for the rest of your life," says Aviv.

Not everyone is convinced that our telomere ranking barely budes over adulthood. Nevertheless, many do agree that popular methods touted to increase telomere length are often based on little more than hype. Despite what you might read online, for example, meditating for 15 minutes each day won't make you five years younger, nor will eating broccoli with every meal – although, ➤

admittedly, both can be good for you. Even the much-vaunted effects of exercise are equivocal: only half of studies show positive links with telomere length, most of them weak.

In fact, there is a lot of conflicting research. For example, one study may say that physically active people have longer telomeres for their age, but another will find no effects. The same goes for sleep quality and meditation. Even a healthy diet doesn't always come out as good for your telomeres, despite some studies revealing a robust connection. In 2019, for instance, Finnish researchers showed that a Mediterranean diet has little effect on telomeres, while another study in Australia found that antioxidant intake isn't associated with their length.

One reason for such inconsistencies is that telomere research has been the victim of its own success, with lots of the studies done by scientists who specialise in other areas. "They are just kind of excited about it, so they maybe publish one or two papers and then move on," says Belinda Needham at the University of Michigan. The result has been that not all of the studies are of the highest standard.

There is another possible reason why lifestyle interventions often seem to have little effect on telomere length. In 2018, researchers studying European starlings were surprised to discover that birds with shorter telomeres tended to engage in more risky behaviours than those with longer telomeres. This prompted a provocative idea: that people with short telomeres may be more likely to adopt some unhealthy behaviours. A meta-analysis of smoking and telomere length published last year seems to back this up. Smokers do have shorter telomeres than non-smokers, but smoking itself has little impact on how fast your telomeres shorten. The researchers calculated that it would take 167 years of smoking to account for the telomere length differences between smokers and non-smokers. In other words, it looks like smokers have shorter telomeres in the first place, hinting that this might make them more prone to adopting the risky habit.

So, perhaps when it comes to telomere length and behaviour, we are getting cause

and effect the wrong way around. Elissa Epel at the University of California, San Francisco, who co-authored a book called *The Telomere Effect* with Blackburn, believes researchers must explore this possibility. Causation could go in both directions, she says, and be far from simple. For example, there could be factors that drive both telomere shortening and a penchant for poor lifestyle choices, such as exposure to childhood adversity.

All this suggests that we shouldn't necessarily base our lifestyle choices on the results from telomere research. And there is another reason we should be sceptical about these studies. Many use a method called qPCR to estimate telomere length. It is cheap and easy to use, but prone to measurement errors,

"People with shorter telomeres might be more likely to adopt risky behaviours"

**Anti-ageing activity?
Yoga on a smoggy day
in New Delhi, India**



REUTERS/ANUSHREE FADNAVIS

A better biological clock?

Wrinkles, greying hair, loss of muscle tone: the ravages of time on our bodies are obvious. But many people would like a more objective measure of how they are ageing. If the length of the telomeres on the end of our chromosomes isn't the answer (see main story), there may be an alternative.

As we get older, our cells accumulate epigenetic changes – biochemical additions to the DNA that turn genes on or off without affecting the genetic sequence itself. How quickly this happens is influenced by our lifestyle. Things like diet, stress and whether you meditate can speed up or slow down the process, leaving visible marks in your DNA. What's more, studies show that people with more of these epigenetic marks are at greater risk of premature death than those with fewer marks.

Some believe that this “epigenetic clock” is a better indicator of biological age than telomere length. But geneticist Steve Horvath at the University of California, Los Angeles, points out that the two approaches measure different aspects of ageing. Epigenetic clocks are stronger predictors of lifespan, he says, but telomere length provides information about the number of cell divisions that have occurred. He also worries that epigenetic clocks might fall victim to the kind of hype that now surrounds telomeres, with commercial labs offering oversimplified tests that can be easily misinterpreted. “It's one of my worst fears,” he says.

making it difficult to compare results from different labs. “qPCR still could be a very powerful method when you are dealing with 50,000 people,” says Aviv. “But the majority of studies that report findings of qPCR are limited – sometimes to several hundred people or even fewer – and those findings in my view are not very reliable.”

Unreliable clock

Most commercial telomere tests use qPCR too. And, with a sample size of one – you – this unreliability is amplified. It is likely that if you got tested by two different labs, the results wouldn't tally: a 40-year-old, for example, might be given a biological age of 35 from one test, and 55 from another. Then there is the problem of how those biological ages are derived from telomere length. Some companies, and some researchers, calculate “biological age” by comparing a subject's average telomere length with that of a “typical person” of their chronological age. Others simply assume that a year equals somewhere between 30 and 50 base pairs and divide a person's average telomere length by that number. With so much variability in people's initial telomere length, some are beginning to question these calculations. “We are now suggesting that researchers do not talk about telomeres in terms of years of ageing, but rather report just the raw results,” says Epel.

Given all this, it is hardly surprising that some people are a little sceptical about commercially available telomere testing. “I don't think that you can use it in any way that's particularly meaningful for your health,” says Needham. “I personally wouldn't recommend anyone to have that kind of testing done – I haven't had it and I won't.”

What is more, there is now a growing realisation that the whole “longer telomeres are better” idea is too simplistic. In 2017, research revealed that having genes associated with longer telomeres increases the risk of developing nine out of 22 types of cancers, including melanoma, ovarian and testicular cancer. The effect is particularly strong for some types of cancer, especially glioma, a

type of brain tumour. The same study also showed that having long telomeres decreases your odds of developing cardiovascular disease, which might help explain what is going on. Evolutionary forces must make a trade-off to balance the risks of degeneration, which causes conditions like cardiovascular disease, against growth, and it looks like the enzyme telomerase is involved. As well as lengthening telomeres, telomerase also promotes cell growth – which isn't a good thing if the cell in question is cancerous.

Anyone tempted to buy telomere-lengthening pills online should take note. According to Epel, studies on telomerase-activating supplements don't tend to address the long-term risk of cancer. “The longest study examined both health and telomeres after one year – and we all know that cancer can take years and years to develop. So this is not sufficient to rule out the increased risk of certain types of cancers from telomerase activators,” she says. Aviv's verdict on telomerase supplements is even harsher. “Nobody knows what they do. I would not take them,” he says.

For now, telomere biology is still in large part an enigma, chock-full of controversies and conflicting results. Studies measuring telomere lengths can have “tremendous scientific value”, says Epel, whereas individual telomere tests are a poor guide to your biological age. And, while too much telomerase may increase the risk of cancer, having shorter telomeres is linked with a range of other health problems. What is clear is that the length of our telomeres changes very little in adulthood. If we do want to nurture telomeres, the best time to do it is before birth and in early childhood, by limiting exposure to things like pollution, stress and certain chemicals. After that, the lifestyle advice is simple. A healthy diet and regular exercise will do you good – even if it doesn't show up in your telomeres. ■



Marta Zaraska is a writer based in Vexin, France, and author of *Growing Young: How friendship, optimism and kindness can help you live to 100*



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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).



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The back pages

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Unusual units and overtly sexual cows: the week in weird **p56**

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Picturing the lighter side of life **p56**

Stargazing at home

How to find the ecliptic

Want an easy way to locate the planets or find out where an eclipse is likely to happen? **Abigail Beall** has the lowdown



Abigail Beall is a science writer in Leeds, UK. She is the author of *The Art of Urban Astronomy* @abbybeall

What you need

Clear night skies

A telescope (optional)

Any good astronomy app (optional)

OVER the course of a year, the sun traces a path in the sky. This invisible line, called the ecliptic, isn't created by the sun moving, but instead by Earth travelling around the sun.

The solar system's planets all orbit in a similar plane to Earth as it circles the sun – the biggest difference is Mercury, which is out by about 7 degrees. This means they can all be seen along the ecliptic in the night sky. The ecliptic is also where the zodiacal constellations are found and where eclipses occur, all of which make it one of astronomy's most important features.

The moon doesn't orbit exactly on the ecliptic. If it did, we would have a solar eclipse and a lunar eclipse every month. Instead, its orbit is angled at around 5 degrees compared with Earth's around the sun. Eclipses occur when the moon crosses the ecliptic at a full or new moon.

Even though the planets' orbits don't line up exactly with the orbit of Earth, they can, like the moon, generally be used to gauge exactly where the ecliptic is in the sky. On any night when you can see a planet or two and the moon, you can trace the line of the ecliptic. At the moment, we can do it by watching the movement of Mars and the moon for a few days.

Mars and the moon are in conjunction on 18 February, with only 3 degrees separating them in the sky. This is about the same as the width of Orion's belt. After this date, the two move further and further apart, largely because of



SHUTTERSTOCK/ASTROSTAR

the motion of the moon. This gives us a great opportunity to look at the ecliptic.

If you want to take part, pick a time in the 4 or 5 hours after sunset, not before sunrise. Try to look at the stars at around the same time each night for at least three days between 18 and 27 February.

Once you are set, go out and search for Mars, which will be in the south-west in the northern hemisphere and in the north-west in the southern hemisphere. It will be bright with a glowing red hue. If you are uncertain, use an app to ensure you have the right target.

Next, find the moon. On 20 February, Mars and the moon should still be close together. As the nights go on, the moon will appear further to the east, and by

the end of this period, it will be low in the eastern horizon just after sunset. Mars will move much more gradually, so can be used to remind you where you saw the moon on the first evening. The line that the moon has traced across the sky over these nights is the ecliptic.

At the moment, you can only use the positions of Mars and the moon in the sky to find the ecliptic, but you can observe it on most nights if you can spot a planet or the moon. During the day, it is easier to find it, of course: you just have to watch the sun. But remember, whatever you do, don't look directly at it. ■

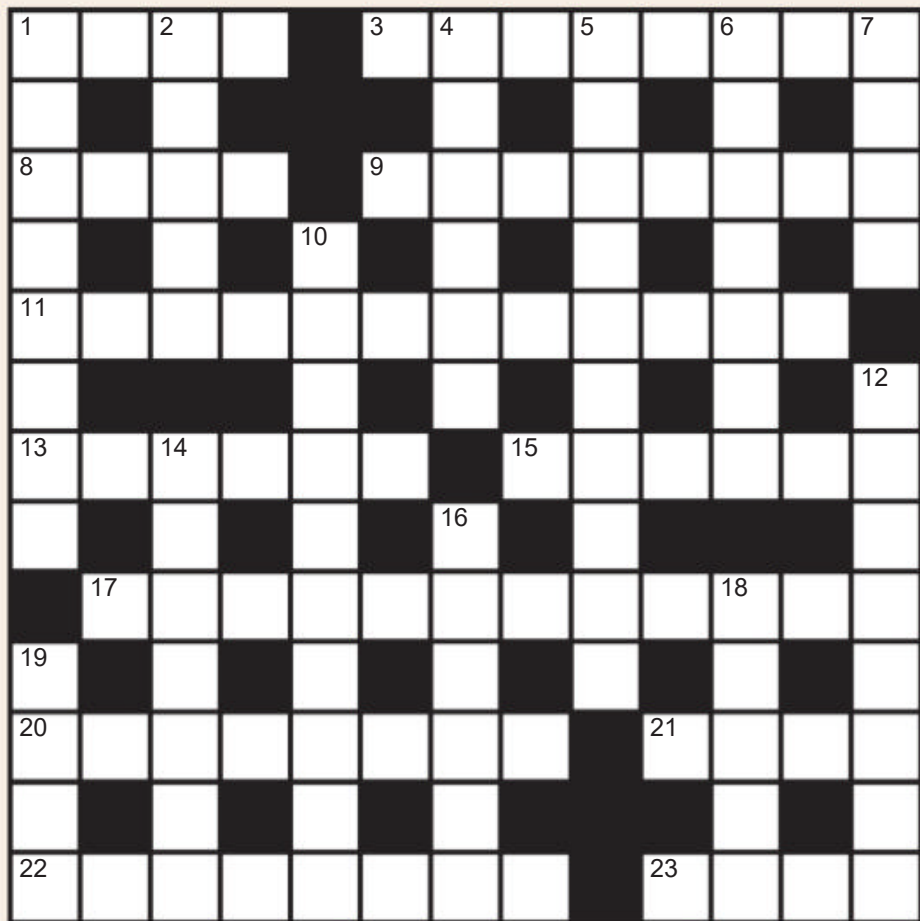
Stargazing at home appears every four weeks

Next week

Science of gardening

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

Cryptic crossword #51 Set by Wingding



Scribble zone

Answers and the next quick crossword next week

ACROSS

- 1 Meet one's desire for Smarties, rejecting every second one (4)
- 3 Dip eaten messily, a twice-monthly occurrence (4,4)
- 8 Initially, narcotic users may begin to inhibit sensation (4)
- 9 Editor's first to unite books from a collection of many parts (8)
- 11 In favour of serving some alcohol in a steady relationship (12)
- 13 Sounds like Asian dynasty has secret of comedy? (6)
- 15 Noisy creature and rogue captured by spies (6)
- 17 Trouble lit a clearing in warm spell (12)
- 20 Mombasa university dissected stomach (8)
- 21 Sedimentary rock student found by early spring (4)
- 22 Stateside, zero papers are following second wave (8)
- 23 Send support (4)

DOWN

- 1 We hear boys' bellies have dark patches (8)
- 2 Casual worker beginning to observe rhythm (5)
- 4 Hostility shown by English university at start of year (6)
- 5 Some 15s are like this magazine (10)
- 6 Art of arranging flowers like banana, to some extent (7)
- 7 Ex-artist regularly has meal (4)
- 10 Songs from doctor's tours around rising US university (10)
- 12 Fail to find place to live in UK after autumn in US (4,4)
- 14 Heavy rain at the start of the week, possibly next week (7)
- 16 Rodent's illness overcome by computer (6)
- 18 Nothing below unfinished picture showing mature insect (5)
- 19 Drinks and cycles (4)

Quick quiz #89

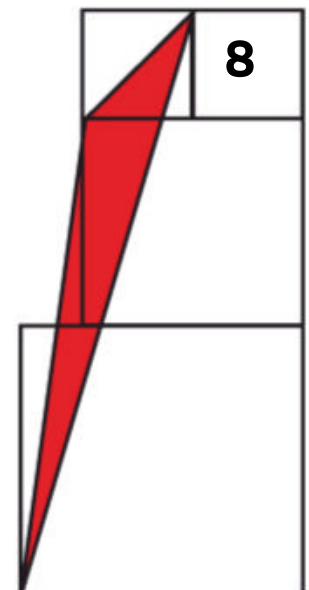
- 1 What is the collective noun for a group of apes?
- 2 How long did the Cassini spacecraft spend orbiting Saturn, to the nearest year?
- 3 Koelbjerg Man is the oldest known what?
- 4 Albert Einstein's famous "God letter", in which he discussed his religious views and identity, was addressed to which German philosopher?
- 5 Cobalamin is another name for which vitamin?

Answers on page 55

Puzzle

set by Catriona Shearer
#101 Red triangle

There are four squares in the illustration below. The small square in the top right has an area of 8 units. Can you figure out the area of the red triangle?



Answer next week



Our crosswords are now solvable online
newscientist.com/crosswords



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Fibonacci Spiral

NASA

facts
do not cease to exist
because they are
ignored
Aldous Huxley

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GLAD BY A CREATOR THAT WAS ALREADY, BUT NOT QUITE, A CHICKEN

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Shake it off

Why do dogs like to shake themselves dry beside people, rather than doing this as soon as they get out of the water?

Anna Butcher

Brookton, Western Australia

Observations on our farm have almost convinced me that dogs deliberately choose to shake themselves dry beside a person. This seems to be the way that our kelpie sheepdogs get even with me after they have been washed.

It takes a lot of hard work for them to garner the most delightful, cultured odour from all manner of dead things from around the farm.

Then, in a short space of time, all their hard work is for naught, when they have their six-weekly wash and pedicure.

However, if they have chosen to jump into a water trough to cool down or get a drink and are sopping wet, they seldom shake themselves.

Chris Warman

Hinderwell, North Yorkshire, UK

They shake themselves off next to you because they love you. Dogs are social animals and the

“Observations on our farm have almost convinced me that dogs deliberately shake themselves dry beside a person”

bonds between pack members are constantly renewed by little ceremonies.

Even if your dog has only been away for a few minutes, when it returns, it will be strongly motivated to greet you and will waste no time in doing so. Drying off can wait, and the dog won't see the connection between shaking itself off and what might seem to you like a heartless snub.

Just be thankful it is only water you are being sprayed with.



STEPHAN SCHRAMM/LAMY

This week's new questions

Offspring insight How do animals recognise their progeny? Are they conscious that they reproduce? Male lions kill the cubs of other males, but not their own, yet cuckoos get away with it. **How?** Joaquim Figueiredo, Zurich, Switzerland

Bent beam Light is electromagnetic radiation, so why can't I bend a sunbeam with a magnet? Martin Copsey, Peterborough, Cambridgeshire, UK

Mike Follows

Sutton Coldfield, West Midlands, UK

Dogs and other animals dry themselves as a survival strategy. A wet dog will chill quickly as water evaporates. The water also displaces the air trapped in layers of fur that acts as an insulator.

It is estimated that a dog would use up about 15 per cent of its normal daily food intake getting warm again each time it went for a dip without shaking itself dry.

This drying method isn't specific to dogs. Researchers at the Georgia Institute of Technology in Atlanta filmed a range of furry creatures and discovered that the smaller the animal, the faster they spin themselves in order to shake off water.

Mice spin at about 30 times a second and cats at nine times a second, whereas a Labrador retriever twists its body from side to side at a more leisurely four cycles per second.

Dogs don't set out to soak their owners when they shake themselves dry. They are social animals so probably prefer to shake themselves in the company of their packs than on their own.

David Muir

Edinburgh, UK

A dog's backbone can rotate about 30 degrees in either direction. When you combine that with the fact that most dog breeds have very loose skin, the fur can flick around 90 degrees each way. With the sharp change in rotation, the

Male lions will kill the cubs of other males, so how do they recognise their own?

whip effect can get rid of 60 to 70 per cent of the water in a wet dog's coat in a few seconds.

With the whip-flick motion of the skin and hair, dogs instinctively close their eyes to protect them. The ancestors of today's domestic dogs would have been vulnerable to predation during these few seconds.

This risk may not have been particularly high, but what better way for a dog to minimise this than by sidling up to another pack member and using their vigilant eyes and proximity to guard itself against potential predators. In the case of pet dogs, that pack member is human.

Chris Daniel

Glan Conwy, Conwy, UK

Accounts of dogs drenching their owners by shaking off water next to them may be a form of confirmation bias. People may not notice or remember other times when they were out of range while their dog did this.

If this doesn't convince most owners, they can at least marvel at the physics of the action. It starts with the head rotating from side to side at around four shakes per second. The oscillation travels down the body until the pelvis is rotating in the opposite direction to the shoulders. The centripetal force caused by rotations of almost 90 degrees each way causes the water to fly off in an impressive spiral spray, removing the majority of it from the fur. With a final shake of the tail, the dog is ready for its next adventure.

Bubble trouble

In carbonated water, larger bubbles oscillate as they float upwards. What causes this, and why is it only big bubbles?

Amir Pahlavan

Yale University, Connecticut, US
When you pour sparkling water



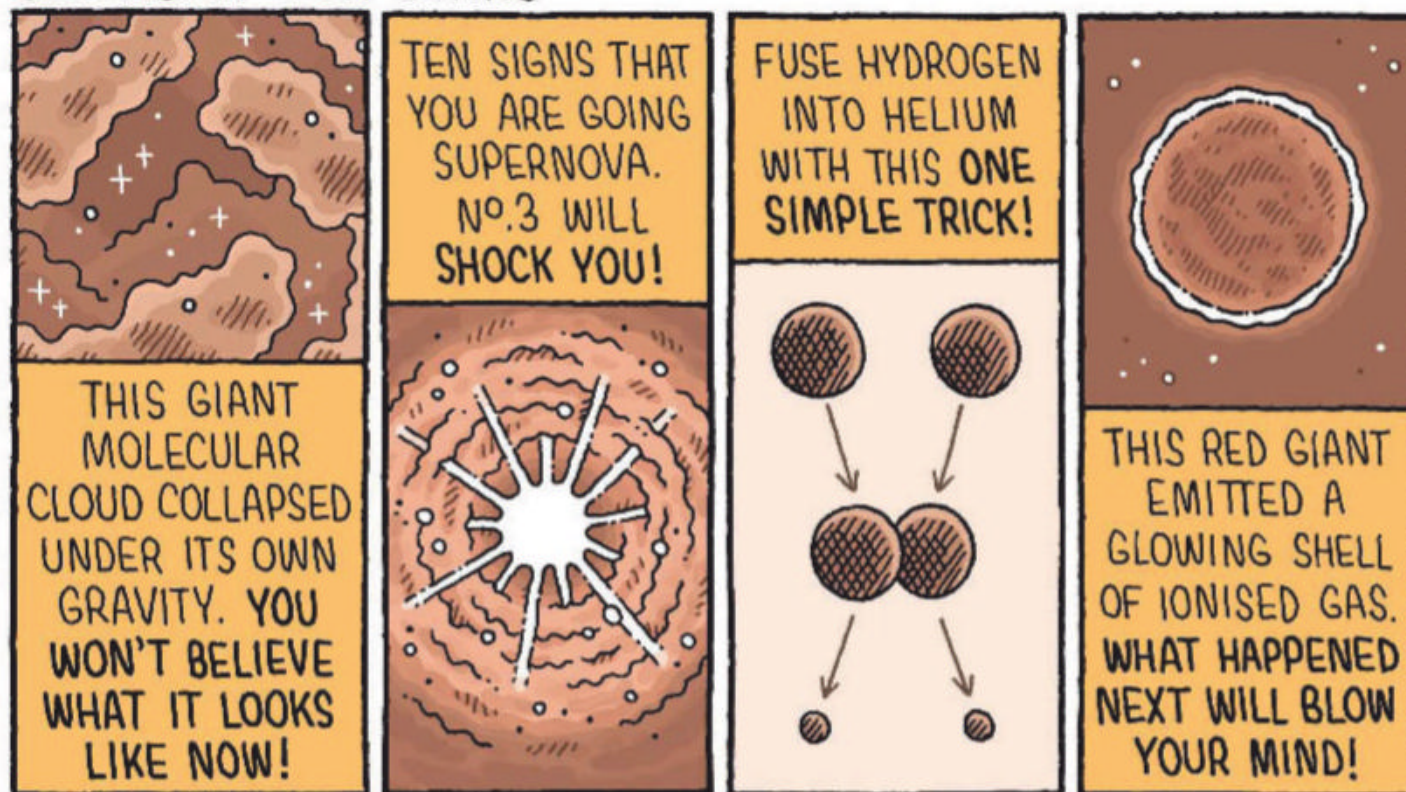
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CLICKBAIT FOR STARS



into a glass, you may notice that smaller bubbles rise in straight lines, whereas larger bubbles tend to follow a zigzagging or spiralling path.

Leonardo da Vinci was among the first to document this puzzling phenomenon. Now known as Leonardo's paradox, it remained unsolved for centuries until it was tackled by the tools of modern fluid mechanics in the past few decades, and it is still an area of active research.

The small bubbles are spherical and generate small amounts of spinning in the liquid that surrounds them. This "vorticity" can be shed behind them in a symmetrical wake structure.

The large bubbles, however, become spheroidal and generate a greater amount of vorticity that cannot efficiently be shed in a symmetrical wake.

Instead, their wake forms a more complex, non-symmetrical structure, leading to a variety of complex trajectories for the bubbles, including zigzag, spiral and even chaotic ones.

"Leonardo da Vinci was one of the first to notice the puzzling phenomenon of the zigzagging path of large, rising bubbles"

This leads to the path instability of larger bubbles as they rise.

Groan up

Why do older people groan or say "ohoo" when we sit down, stand up or do pretty much any one-shot physical action? Is it a cultural convention or is there a physiological reason? (continued)

Kate Wykes

Stoke on Trent, Staffordshire, UK

After coming down with a pain and fatigue disorder in my late 20s, I noticed that I was making "ohoo", "ooy" and "oof" sounds as I attempted physical activities.

When exerting yourself physically, it helps to brace and stabilise the body. There is also an

emotional release: the sound is a "huff" that shrugs off some of the mental distress from the pain, enabling you to continue.

I also noticed that one of my housemates at the time, who started experiencing backache, began making similar sounds to myself, which I had never heard them make before. So there are possibly cultural and social causes for this noise-making.

We are often told to hide our pain and put up with it. When in a situation or at an age where this is more acceptable, perhaps we take the opportunity to express how we feel inside and stop with the constant "I'm fine" charade.

Whatever your age, living with pain or fatigue from day to day, together with the mental effects this can cause, is enough to make you go "ohoo".

Barrie Quilliam

Mobberley, Cheshire, UK

I am 85 years old and don't groan when I stand up, but tend to fart. Is this caused by something similar? ■

Answers

Quick quiz #89

Answers

- 1 A shrewdness
- 2 13 years
- 3 Bog body
- 4 Eric Gutkind
- 5 B12

Quick crossword

#76 Answers

ACROSS 1 Macrocephalous, 10 Rigid, 11 Down house, 12 Aileron, 13 Red heat, 14 Equal, 16 Melanotic, 19 Actinides, 20 Acute, 22 Aircrew, 25 Reticle, 27 Magnetite, 28 Prime, 29 Chlorpromazine

DOWN 2 Angel dust, 3 Radar, 4 Code-named, 5 Power, 6 Anhedonia, 7 Ovule, 8 Sceptic, 9 Triage, 15 Lunar year, 17 Laser beam, 18 T-junction, 19 Anaemic, 21 Eleven, 23 Rigel, 24 Whirr, 26 Topaz

#100 Late for the gate

Solution

You get to the gate faster by tying your laces on the travelator or by running on the carpet. Imagine twins T1 and T2 walking side by side on a carpet leading to the travelator. T1 stops to tie their laces just before the travelator, while T2 stops just on the travelator, a fraction of a second later. T1 will not catch T2.

The situation with running is harder to picture, but think about the lead that T1 gains when running on the carpet, which is extended when they walk on the travelator. T2 can never make up all of the extra lead that T1 built. Generally, if your new action (for instance, tying laces) is slower than your walking speed, do it on the travelator; if it is faster than walking, use the carpet.

Recycling maths

Feedback has never been a fan of shopping, especially the type that involves passive-aggressive web formulas informing us of an invalid input before we have finished typing.

The UK's continuing lockdown has, however, given us a renewed appreciation of our local shopping precinct, devoid as it is of people and actual shops to go into. Caught there in an eddy of pavement social distancing arrows without an apparent route of escape, we are brought up short in front of an excitable hoarding over a shop that is being recycled. Adorned with adorable cartoon pictures of marine life, it is the pinnacle, we find, of our confusion surrounding measurement units in recent weeks, as it declares:

"We recycle the weight of a KILLER WHALE in plastic EVERY YEAR.

"We turn mixed waste into fuel. Enough to power 135 TV's for a year!

"We recycle the weight of TWO BLUE WHALES EVERY YEAR

"We recycle the weight of 550 SEA TURTLES in cardboard EVERY YEAR"

A pen and paper, if you will. Assuming standard blue whale, orca and sea turtle weights: (a) How much more cardboard than plastic is recycled by weight? (b) What proportion of the total waste recycled is cardboard? (c) Assuming standard calorific values, what is the average power output of a TV in kilowholes?

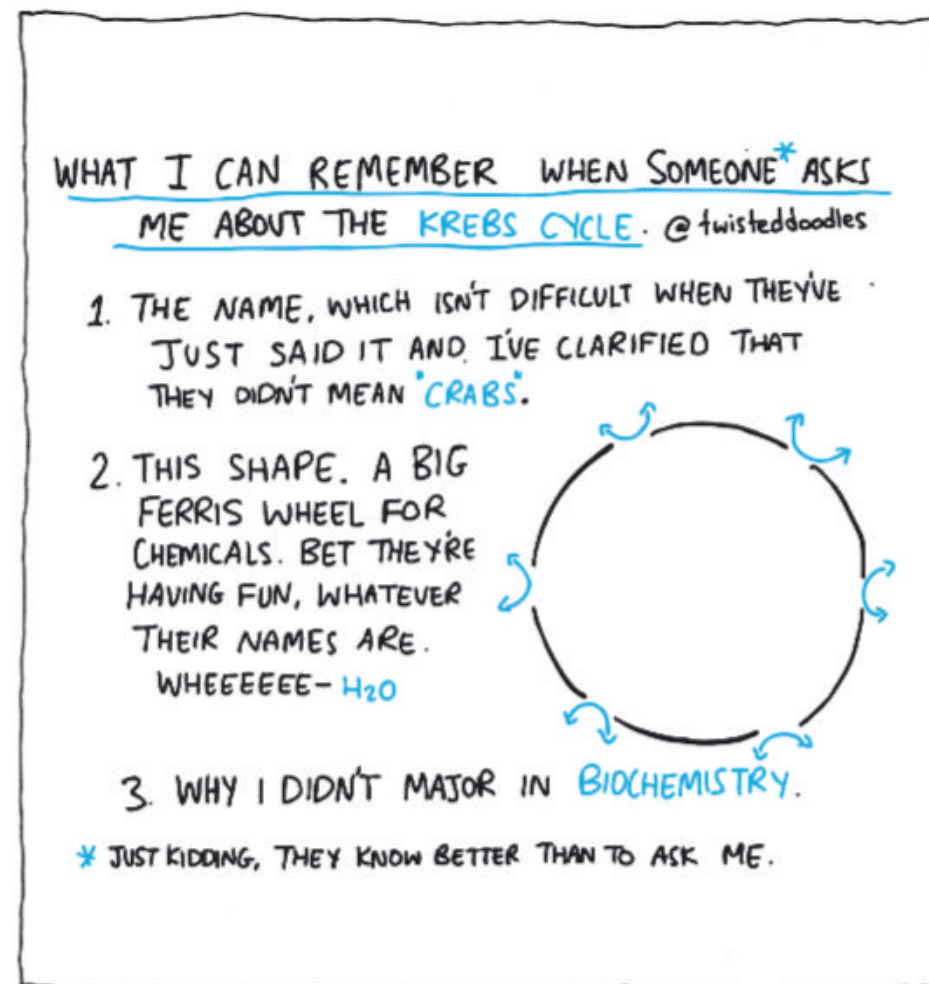
Answers on a hoarding, please.

That's the problem

Meanwhile, we are going back inside, where we find John Davies has written to us to take issue with the subject line of a *New Scientist* daily newsletter on 10 February: "Extremely unlikely" virus came from lab, says WHO team". The interpretation that SARS-CoV-2 was an extremely unlikely virus that came from a lab was probably not the intended one, he suggests.

Pending radical new insights,

Twisteddoodles for New Scientist



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Consideration of items sent in the post will be delayed

we are happy to confirm this, and rummage around in our hamper of spares for the missing "that".

Drifting off

More upliftingly, Ivan Watson writes from Melbourne – the Australian one, we presume, although apologies to any readers in Derbyshire, UK, tired of that presumption – with what he describes as his "inaugural contribution" to Feedback.

Presumptuous yourself, Ivan – but you are very welcome. We, too, are excited by the newspaper advert for a bed base with a "zero gravity" setting, also offering "anti-snore preset positions". Presumably, Ivan suggests, the sleeper can be preset to float on their front above the bed.

Due diligence reveals that anti-gravity is a Thing in the Land of Nod – indeed, choose the right bed

and this can be combined with the equally physically startling "infinite positions for head and foot".

Sadly, though, on the models we have seen, zero-gravity and anti-snore are mutually exclusive alternative settings. Which perhaps isn't such a problem: in space, after all, no one can hear you snore.

Extensive piles

Our intention to erect a hoarding a considerable fraction the size of Wales over the units issue is holed by *The Guardian* newspaper's decision to express a mass of sea cucumber excrement in terms of multiples of the Eiffel Tower.

We have no idea, either. To return to the more accepted use of the Eiffel Tower as a unit of height, thanks to the approximately 0.15 Eiffel Towers of you who sent that one in.

Shoots, leaves and eats

The entry "Holothurians, excretory peculiarities of" in our own extensive piling system contains sadly just one item, a 2013 entry on our esteemed website concerning the giant California sea cucumber *Apostichopus californicus*. In its regular, largely unhappy, encounters with its predator, the sunflower seastar (*Pycnopodia helianthoides*), we reported that it sometimes "squirts its digestive system out of its anus in a tangled, sticky mess, confusing the seastar and allowing it to get away". Thus deprived of a digestive system, it proceeds, with admirable fortitude, to switch to eating through its anus. We are sure that you are glad we checked.

Taste and decency

We include that nugget among other reasons to convince you that we aren't – yet – an AI. Just weeks after preventing people in Plymouth, UK, from offending public morals by mentioning local landmark Plymouth Hoe, and following an instance last year of a picture of onions being deemed overly suggestive (7 November 2020), Facebook – or rather, we suspect, its artificially unintelligent algorithms – is at it again.

BBC News reports that the site blocked multiple images from the owner of a digital photo gallery in the UK. Among those falling foul of the malgorithms are shots of a high-rise building and the England cricket team in a huddle (both apparently overtly sexual), a neon sign saying "disco" (promoting alcohol), ripples on a pond (selling adult products), some cows in a field (overtly sexual again) and "a set of tramlines in Reims, France, which Facebook said went against its ticket sales policy".

A good night out, a sporting occasion, a wholesome country walk, a relaxing city break – honestly, even if we could go further than the local shopping precinct, we couldn't take an AI anywhere. ■

12 days | 5 March 2022

Wildlife of Sri Lanka with George McGavin

Sri Lanka boasts an impressively high rate of endemic species, offering some of the finest wildlife watching experiences in South Asia. Embark on a wildlife expedition like no other, that takes you to the wild corners of this extraordinary island in search of leopard, elephant and whales and the more unusual species like sloth bear, pangolin and loris.

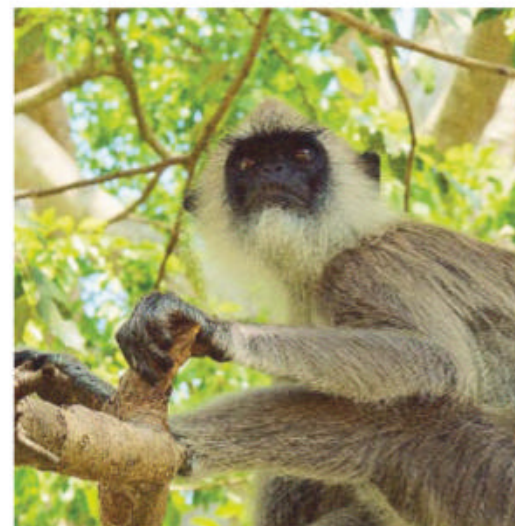
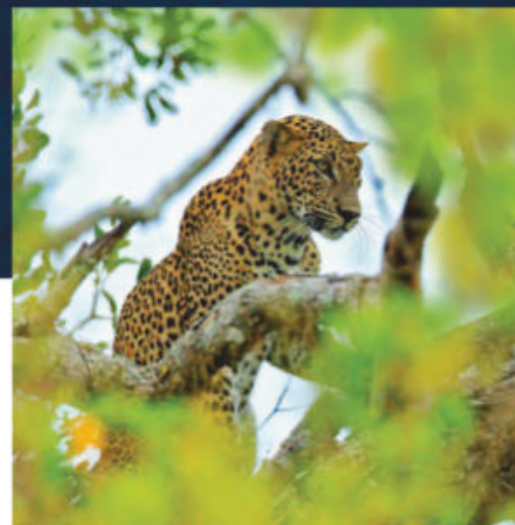
George McGavin, entomologist and TV presenter, will shine a light on all these species and provide a fascinating insight into this beautiful and exotic island.

Highlights

- Explore some of the most diverse biospheres in South East Asia including national parks, UNESCO sites, rainforests, research centres and local conservation initiatives.
- Explore Colombo's rich colonial heritage and multi-ethnic legacy with churches, mosques and temples.
- Observe the wildlife from the stunning Gal Oya Lake including crocodiles, deer, elephants and many rare and endemic species of birds, spotting wildlife from the water to truly immerse yourself in the animals' habitats.
- Take a jeep safari to the forgotten Nilgala section of Gal Oya National Park. Home to herds of elephants, wild boar, four species of deer, jackals, sloth bears and an array of rare exotic birds.
- Encounter elephant herds under open skies, sunsets with the promise of prowling cats, daybreak with monkeys, storks, ibis and crocodiles, as well as deer, sloth bears, jackals and wild buffalo during morning and evening game drives.
- Explore crystal clear waterfalls, and endemic flora and fauna.
- Visit the Rekawa Turtle Conservation Centre, a treasured location for all wildlife enthusiasts owing to its frequent habitation of nesting turtles.
- Embark on a whale watching expedition from Mirissa Harbour aboard a private small catamaran.
- In the evenings enjoy an informal talk about what you have seen that day and how that sits within the wider entomological and wildlife ecosystem.
- Accompanied throughout by entomologist and TV presenter George McGavin.
- Stay in a unique range of accommodation including tea plantations, 5-star colonial luxury, eco-lodges, and cutting-edge safari camps
- A highly immersive expedition with no more than 14 guests.

Covid-19 safety protocol includes:

- Pre-departure screening of all guests and tour leaders.
- Increased sanitisation of all accommodation and transport.
- Mandatory use of PPE where appropriate.



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