PEOPLE OF THE ICE

THE LOST ARCTIC CIVILIZATION THAT CHANGED THE COURSE OF HISTORY

WHY HUMANS ARE GOOD

Neurophilosopher Patricia Churchland on the surprising origin of our morality

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America’s first
The story of how humans got to the Americas isn’t a simple one

“Clovis First” was once the rallying call of archaeologists studying humanity’s settlement of the Americas. It referred to the idea that the prehistoric people who made the distinctive Clovis bone and ivory tools must have been the first human to enter the New World, about 13,000 years ago. Now we know better.

Like much of the received wisdom about human evolution, the peopling of the Americas has been subject to revision in recent years. New discoveries leave no doubt that people arrived earlier than 13,000 years ago, possibly far earlier. Some of the evidence for occupation is still hotly contested.

Who the pioneers were is also proving difficult to pin down. However, there seems little doubt that they entered the last continental landmass to be inhabited by humans from the north. They came via Beringia, an area centred on the Bering Strait between Siberia and Alaska. These people also didn’t simply migrate through this subarctic region. They took up residence there and became isolated from the rest of humanity for thousands of years, as the world was plunged into an icy period.

These were the first people known to inhabit subarctic regions. We are now starting to piece together the story of how they survived in this harsh environment, and how that experience shaped them genetically and physically (see page 34). Intriguingly, we can track some of their genetic adaptations right down into Central and South America, where they could explain puzzling anomalies found in ancient human remains and among modern indigenous Americans.

“Clovis First” has now been comprehensively refuted and a new picture is emerging. The conquest of the New World didn’t entail a single group of people marching from north to south. There were different populations, ebbing and flowing and interbreeding.

In other words, it is complicated. But that is the new normal when it comes to human evolution. And it will continue to be so. Watch this space.
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A momentous claim has been made in a paper posted on a NASA server. It says that Google has built a quantum computer and proved that it can do a calculation that would be practically impossible for even the world’s fastest supercomputer. If this is true, it is big news. Quantum computers have the potential to change the way we design materials, plan logistics, build artificial intelligence and break encryption. That is why firms like Google, Intel and IBM, along with plenty of start-ups, have been racing to reach this crucial milestone—known as quantum supremacy. However, the claim is shrouded in intrigue. The paper was quickly taken down from the server and Google hasn’t commented on it. A copy of the paper seen by New Scientist contains details of a processor called Sycamore that contains 54 superconducting quantum bits, or qubits. The paper says that Sycamore has achieved quantum supremacy and that the development “heralds the advent of a much-anticipated computing paradigm”. Only one author is identified: John Martinis at the University of California, Santa Barbara, who is known to have worked with Google to build the hardware for a quantum computer. The news isn’t entirely unexpected. In 2018, Google reached an agreement with NASA to help test its quantum chip. This may explain why the paper was posted to a NASA server. To prove the quantum supremacy of its chip, the paper says that Google set it a random sampling problem—that is, checking that a set of numbers has a truly random distribution. This is very hard for a conventional computer when there are a lot of numbers involved. But Sycamore does things differently. Although one of its qubits didn’t work, the remaining 53 were quantum entangled with one another and used to generate a set of binary digits and check their distribution was truly random. The paper calculates the task would have taken Summit, the world’s fastest supercomputer, 10,000 years. Sycamore did it in 3 minutes and 20 seconds. “The thing they’ve demonstrated is not in any way useful and the quantum computer they’ve used isn’t anywhere near the level that we’ll need to, say, break encryption. But as a scientific milestone, it’s huge,” says Ciarán Gilligan-Lee at University College London. Jim Clarke at Intel Labs said in a statement that achieving quantum supremacy was a “notable mile marker as we continue to advance the potential of quantum computing”. But he said we are still at “mile one of this marathon”. In future, quantum chips may be useful in fields including machine learning, materials science and chemistry. For example, when trying to model a chemical reaction they ought to be capable of handling vast numbers of variables to create accurate simulations. At the same time, classical computing isn’t giving up the fight. Over the past few years, as quantum computing took steps towards supremacy, classical computing moved the goalposts as researchers showed it was able to simulate ever more complex systems. This back-and-forth will probably continue. The posted paper acknowledges that classical computing’s abilities will continue to grow. “But we also expect they will be consistently outpaced by hardware improvements on larger quantum processors,” it says.

Google has built several quantum computers, including this prototype
Global warming

UN climate change summit

World leaders gathered in New York to galvanise climate goals

Adam Vaughan

SWEDISH student Greta Thunberg has accused world leaders of failing her generation by not reining in carbon emissions, and stealing her childhood by uttering “empty words” on climate change.

In a passionate and often angry address to the UN climate action summit in New York on Monday, the 16-year-old said: “I should be back in school on the other side of the ocean. Yet you all come to us young people for hope. How dare you. You have stolen my dreams and my childhood with your empty words.”

Around 60 heads of state attended the summit, which UN secretary general António Guterres called to galvanise more ambitious plans from countries to meet the goals set out in the Paris climate agreement.

But the meeting yielded modest new measures from countries, regions and businesses, rather than major carbon-curbing plans. China offered no new target, the European Union said the bloc “must go further and faster” but offered no commitment, and the US didn’t even speak.

“We are in the beginning of a mass extinction and all you can talk about is the money and fairy tales of eternal economic growth,” said Thunberg. “For more than 30 years the science has been crystal clear. How dare you continue to look away.”

Anne Hidalgo, the mayor of Paris, said in a statement that “the vast majority of nation states are not responding with the same urgency” as cities and regions on climate change.

Thunberg’s speech followed a strong attack by Guterres on support for the fossil fuel industry. “There is a cost to everything. But the biggest cost is doing nothing. The biggest cost is subsidising a dying fossil fuel industry, building more and more coal power plants and denying what is plain as day: that we are in a deep climate hole and to get out we must first stop digging,” said Guterres. Ending fossil fuel subsidies was one of his four key demands for the summit.

Guterres said 77 countries had announced efforts to hit net zero emissions by 2050, while 59 countries have indicated they will submit a tougher plan for reining in emissions, known as nationally determined contributions (NDCs), in 2020. The UK and Germany both promised more climate finance for developing countries.

Several countries took swipes at US President Donald Trump, who dropped into the summit for around 10 minutes but didn’t give a speech. French president Emmanuel Macron said: “I don’t want to see new trade negotiations with countries who are running counter to the Paris agreement.”

Wang Yi, speaking on behalf of Chinese president Xi Jinping, said “the withdrawal of certain parties will not shake the collective will” of other countries, in a veiled reference to the US.

The summit came as the UN World Meteorological Organization released a report warning that under existing NDCs the world will warm by between 2.9°C and 3.4°C by 2100, rather than the Paris deal’s goal of “well below” 2°C.

As the summit unfolded, the US National Snow and Ice Data Center said Arctic sea ice this year had hit its second lowest ever extent, tied with 2007 and 2016, at 4.15 million square kilometres.

The meeting followed a global climate strike last Friday, which saw millions of children and adults from Sydney to Mumbai, London to New York take to the streets to protest against inaction by governments. Organisers estimated a record 3 million people turned out in Europe, with events taking place at 200 locations in the UK, while 400,000 people were reported to have joined protests across Australia.

In Paris, protester Clémence Dubois said: “Listen to the scientists, so young people can go back to their classrooms.” Alarms were set off across the UK to mark a “climate alarm”, while Labour party leader Jeremy Corbyn told the strikers he was inspired by them. In London, Bronwyn Swanson, 13, from Winchester, said: “I’m just here to make a point. There is climate change and we need to stop this.”

77 countries have announced efforts to hit net zero emissions by 2050

European Union said the bloc “must go further and faster” but offered no commitment, and the US didn’t even speak.

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Astronomy

Bizarre galaxies can’t be explained by standard physics

Leah Crane

TWO recently discovered galaxies just don’t make sense. If they are relatively distant, the clusters of stars in them are too bright. If they are closer, they must be moving too fast.

In 2018, a group led by Pieter van Dokkum at Yale University announced that it had found a strange galaxy that seemed to contain very little dark matter, or possibly none at all. The galaxy is known as DF2. A year later, the group said it had discovered another one, called DF4.

Both galaxies have a low concentration of stars and this wispsiness makes it hard to say how far away they are. We work out the characteristics of galaxies, like how much dark matter and how many stars they have, partly by measuring how bright and how far away they are.

If the galaxies are about 65 million light years away, as van Dokkum’s team originally estimated, they appear to lack dark matter, and clumps of stars within the galaxies called globular clusters are far bigger and brighter than any we have seen before.

If the galaxies are closer, as others have since claimed, they are more normal, but unusually large and moving strangely fast.

Now Moritz Haslbauer at the University of Bonn in Germany and his colleagues have performed an analysis of the DF2 galaxy. The group focused on that one because we have more data on it than we do for DF4.

Haslbauer’s team used five simulations of the universe as we know it, following it as it grew to maturity. The physics that went into each is slightly different.

For example, some include the effects of magnetic fields while others don’t. The team then searched these simulations for galaxies that looked similar to DF2 at various distances from us.

Very few were a good match, and those the group did see were most commonly about 37 million light years away. But even in the simulation where DF2-like galaxies were most common,

The DF2 galaxy’s few stars are scattered throughout this picture

the chance of finding one was more than 200 times lower than that (arxiv.org/abs/1909.04663).

This means, says Haslbauer, that DF2 and DF4 are inconsistent with our standard model of cosmology.

Other astronomers say the problem might just be with the simulations, not with our model of cosmology. “These galaxies are definitely interesting, definitely weird,” says Marla Geha at Yale University. “I would put my money on the simulations being a little wrong rather than the overall paradigm.”

Measurements from the Hubble Space Telescope may soon resolve the dispute over how far away these wispy galaxies are. The measurements should at least be able to tell us in what way the galaxies are strange.

“No matter what the distance is, these galaxies are somehow special,” says Ignacio Trujillo at the Institute of Astrophysics of the Canary Islands.

Medical technology

Smartphone app could spot signs of schizophrenia

SPEAKING into your smartphone for 2 minutes could reveal whether you have a mental health condition. That is according to the developers of an app that analyses facial expressions and speech to diagnose schizophrenia.

The company behind the app, AICure, hopes it could be used to better support and monitor people with schizophrenia, and eventually those who have other mental health conditions. The current version was developed to measure symptoms of schizophrenia like low mood and difficulty thinking, says Isaac Galatzer-Levy at AICure. These are normally harder to measure than symptoms like hallucinations and delusions, he says.

To do this, the app tracks facial movements, as well as the content, tone and pitch of a person’s speech. Some people with schizophrenia move more slowly, and show less emotion on their faces, says Galatzer-Levy. The app can then send a score to the person’s doctor, rating these symptoms. However, it isn’t designed to spot other symptoms associated with the condition, such as hallucinations.

The team tested the app with 21 people who have schizophrenia and nine people who don’t. The participants made weekly recordings over 12 weeks. Each person was also evaluated by a clinician at Mount Sinai Hospital in New York at the start and end of the study.

“The app tracks facial movements, as well as the content, tone and pitch of a person’s speech”

The results of this trial suggest that the app’s ratings “are highly correlated” with those of a clinician, says Galatzer-Levy, who presented the work at the European College of Neuropsychopharmacology annual meeting in Copenhagen, Denmark.

However, AICure doesn’t yet have enough data to prove its app works, because the sample size is very small, says Saeed Farooq at Keele University, UK.

“We see these results as proof of concept more than as a complete diagnostic model,” says Galatzer-Levy.

Jessica Hamzelou
Universities

Stockpiling lab equipment

Some academics in the UK are preparing for a no-deal Brexit

Chris Baraniuk

THE threat of a no-deal Brexit is causing staff at several universities in the UK to stockpile scientific equipment, including protective gloves and fly food. Researchers say they want to ensure their experiments can continue should imports of materials be disrupted after the UK’s planned exit from the European Union on 31 October.

"Last time we miscalculated and bought too many protective gloves. The boxes were everywhere"

Giorgio Gilestro at Imperial College London says he and his colleagues have increased stores of the ingredients needed to make food for the thousands of fruit flies he uses in experiments. "The yeast is produced in France and travels via Belgium. The agar is imported from Japan. Polenta comes from Italy and fructose from Belgium," he says.

Laurence Bugeon, also at Imperial, keeps 1000 zebrafish in her lab. She says she is stockpiling food and equipment that comes from "all around the EU".

Neil Hyatt at the University of Sheffield has ordered an advance supply of the radioactive compound uranium dioxide. "We have taken measures to procure sufficient material to deliver our current research order book," he says.

One researcher says they have even been prompted to check that they have enough robots for classes on artificial intelligence.

Adele Fielding, who works on treatments for leukaemia at University College London (UCL), is also stockpiling, but didn’t want to name the items in question because she was worried about sparking a run on them.

A UCL spokesperson says the university has been in touch with manufacturers to discuss the potential effects of Brexit and has encouraged academics to take a "proportionate response".

Other universities say they aren’t engaged in "widespread" stockpiling. "We do not anticipate that large-scale stockpiling will be necessary," says a spokesperson for the University of Bath.

However, an email sent to some academics at Bath and shared with New Scientist includes the advice "stockpile if you can".

In total, New Scientist received responses about stockpiling from nearly 30 academic staff and universities. Roughly 40 per cent of respondents confirmed some level of stockpiling.

Willem van Schaik, at the University of Birmingham, says he thinks the chances of a no-deal Brexit have fallen because a bill seeking to prevent such a scenario was recently passed in parliament, and so isn’t stockpiling.

Wildlife

Frogs evolved to be more scared thanks to mongooses

THE Amami tip-nosed frog is a battle-worn survivor of an invasion of mongooses on its island home. The newcomers left their mark on the species, leaving the frogs more skittish towards potential threats.

Small Indian mongooses (Herpestes auropunctatus) were introduced to Japan’s Amami Island in 1979 to control the rat and pit viper populations there. A handful spread out from a single starting point, eventually multiplying to 6000 individuals and infiltrating much of the forested island. They preyed on – and dramatically reduced – populations of native wildlife like the Amami tip-nosed frog (Odorrana amamiensis). Following a 20-year eradication campaign, most of the mongooses have now been removed and the frog population has rebounded.

The situation was a great opportunity to see if the invaders influenced the evolution of the frogs, says Hirotaka Komine at the Tokyo University of Agriculture and Technology.

"Last time we miscalculated and bought too many protective gloves. The boxes were everywhere," he says.

"The newcomers left their mark on the island for frogs. When they spotted one, they would approach and record how close they could get before the amphibian hopped away. In places with greater impact from the mongoose invasion, frogs bounded away from potential threats faster than frogs from less affected areas (Journal of Zoology, doi.org/dbsb).

The results suggest that the frogs evolved a heightened wariness in the wake of the invasion and this has persisted even after mongoose eradication, says Komine.

The mongoose density on the island has been low for at least five years, and the lifespan of a tip-nosed frog is three years, so the tested frogs have probably never seen a mongoose. This means the skittishness is probably a genetic change, not a learned behaviour.

Jake Buehler
Pharmaceuticals

UK buyers club flies to Argentina for cheaper medicines

Clare Wilson

SIX people from England have travelled to Argentina to get supplies of two potentially life-saving medicines for cystic fibrosis, treatments that are otherwise unavailable to them because the National Health Service in England says they are too expensive.

Five of those affected need a medicine called Orkambi, which costs about £100,000 per year. There is no valid patent on the treatment in Argentina, however, so a company there sells a generic version for £24,000. The sixth person bought a similar treatment.

Orkambi, which consists of two drugs combined, was approved for use in the UK in 2016. Studies of its effectiveness have given mixed results, but one of the most favourable finds it nearly halves the rate of disease progression.

Price talks between manufacturer Vertex and NHS England are in deadlock, so some people with cystic fibrosis and their families have decided to source the cheaper version by setting up a buyers club, in which potential customers band together to negotiate lower prices.

The families flew to Argentina this month to get a three-month or six-month course of the treatments. Their NHS doctors have agreed to monitor those on the drugs during treatment to check for side effects.

“It’s a promising start, but what’s vital is that we get access for everyone,” says Rob Long, who helps run the buyers club and was one of those who made the trip.

Long says the UK should take other steps to provide the medicine.

Some families of people with cystic fibrosis are considering moving to Scotland, which has recently agreed to provide Orkambi through the NHS.

In a statement, Vertex said: “Vertex and NHS England continue to meet regularly and our intensive discussions continue.”

Archeology

Prehistoric vessels may have been baby bottles

Clare Wilson

THREE small spouted drinking vessels collected from ancient graves of small children may have been used as prehistoric baby bottles. The artefacts, found in Bronze and Iron Age settlements in Germany, contain traces of animal milk.

The pots are a window on a key stage in human history when there was rapid population growth aided by the ability to nourish babies with something other than human breast milk, says Julie Dunne at the University of Bristol, UK. “They bring you very close to the past, to prehistoric mothers and children.”

Over a hundred spouted clay vessels in assorted shapes have been found in various European prehistoric settlements dating as far back as 7000 years.

The idea that such vessels were used for babies is long-standing, especially as a few were found in infants’ graves, but an alternative idea is that they were for feeding watery foods like gruel to sick or older people.

Dunne’s team analysed chemical residues from spouted pots that were found in the graves of three young children, which dated back around 3000 years.

Two vessels had fatty acids found in milk from goats, sheep or cattle. The third had a profile suggesting it had contained both animal and breast milk at various times (Nature, DOI: 10.1038/s41586-019-1572-x).

The vessels could have been used to wean babies off breast milk or given to those whose mothers had died, says Dunne.

The appearance of animal milk in children’s diets is important because when women are breastfeeding, they are less able to get pregnant. Modern hunter-gatherers tend to breastfeed their infants for up to five years, which then spaces out their children. “They’re on the go, they don’t want to have to carry and manage lots of babies,” says Dunne.

When people took up farming, feeding infants with something other than breast milk would have let families have children in quicker succession and boost the population, says Dunne.

Animal milk wouldn’t have been the only alternative baby food to breast milk, says Francesca Fulminante, also at the University of Bristol, who wasn’t involved in the study. “Cereals and pulses might also have allowed women to stop breastfeeding earlier.”

Other studies looking at children’s bones from this time period suggest that solid foods were given from around six months of age and that children were fully weaned by two to three years.

Feeding babies with animal milk would have increased their risk of infections, says Dunne, and it wouldn’t have had the same balance of nutrients as breast milk. However, “while animal milk may have some drawbacks, it always beats starving to death”, says Amy Tuteur, who writes about breastfeeding at her website, The Skeptical OB.

Some spouted vessels found at other prehistoric sites have intricate designs. One seems designed to appeal to a child: it has an animal’s head that could have been used as a handle and two feet to stand on, with the drinking spout emerging from its bottom (pictured below, third from left). “It shows real love and care,” says Dunne.

“They think a young infant is going to laugh at this.”

Dunne’s team made a replica of one bottle and gave it to a friend’s 1-year-old, filled with apple sauce. His mother reported that he seemed to enjoy wolfing down its contents.

Spouted vessels may have helped wean children off breast milk
Autonomous killer drones set to be used by Turkey in Syria

David Hambling

TURKEY is to become the first nation to use drones able to find, track and kill people without human intervention.

Defence firms in the country recently started producing armed, human-operated drones and Turkey is reported to have used them hundreds of times in north-west Syria. Now, Turkish defence company STM has announced that the nation’s army will start using its Kargu drones early next year in Syria.

These 7-kilogram quadcopters are intended to be used as part of a cooperative swarm. A video posted on YouTube in July shows 20 Kargu drones flying together, automatically changing formation and carrying out a simulated attack on a ground target.

Like other drones, the Kargu can be directly controlled by a person. But it can also fly autonomously without a radio link, making it immune to someone trying to jam the control signal. It can be set to attack a point on the map or seek out a specific person or object when it gets to a location.

STM says a machine-learning algorithm allows the drone to locate, track and identify different types of target, such as tanks or people. Each drone carries a warhead that detonates when it flies into its target. Its battery provides up to half an hour of flying time. STM says the drone can return to base if it doesn’t find a target, and that it is cheaper than a comparable missile.

The drones look plausible, says Stuart Russell at the University of California, Berkeley. “All of the individual capabilities have been demonstrated elsewhere and most are available in commercial products,” he says. “Nothing here requires sophisticated new research.”

Previous munitions such as the Israeli Harop drone can seek out radar emitters and attack them autonomously, but the Kargu can target people. STM hasn’t replied to New Scientist’s request for comment.

“To my knowledge, this is the first that talks about ‘facial recognition’ and ‘anti-personnel’ capabilities,” says Russell.

Other nations have held back from deploying autonomous systems. The US Pentagon says its drones will always be under direct human control. However, there are no global legal restrictions on “killer robots” choosing their own targets, despite strong discussion and campaigning at the UN.

Proponents of the technology believe such drones could be better at finding their target than traditional weapons, so could result in fewer civilian casualties. However, others say autonomous weapons won’t be able to make the nuanced judgements required, for example, to distinguish a bus full of children from one carrying troops. There are also issues over who is held accountable if something goes wrong and whether machines should make life-or-death decisions.

The brain

Man sees world in miniature after having a stroke

A MAN whose brain was damaged by a stroke now sees all objects and people about a third smaller than their actual size.

The 66-year-old had a stroke in December 2017 that cut off oxygen to the back right of his brain. He noticed afterwards that everything appeared strangely smaller than normal. For example, at a clothing shop, he mistakenly picked up an extra-large T-shirt thinking it was his usual medium size, and he thought his wife must have washed their curtains in hot water because they looked like they had shrunk.

By comparing familiar objects and people with his memory of their actual sizes, he realised they now all appeared about 30 per cent smaller.

To try to understand what was going on, Nils van den Berg at the University of Amsterdam in the Netherlands and his colleagues devised a series of tests for the man, who they refer to as DN.

In one test, DN had to visually estimate the size of 10 different cubes on a table in front of him. Consistent with his subjective experience, he estimated each cube to be about 30 per cent smaller than 11 other people did.

This distorted size perception seemed to be related to problems with DN’s left visual field. For example, when he looked at two cubes sitting next to each other, he thought the left cube was smaller than the right one, even when it was the same size or bigger. Computer tests showed that he also had difficulties identifying the shape, location and motion of objects in his left visual field (Neurocase, doi.org/dbqw). This makes sense, since information from the left visual field is usually processed by the back right of the brain, which is where DN’s stroke damage occurred, says van den Berg.

DN has now learned ways to cope with his altered perception of the world. For example, he estimates the size of unknown objects – like doorways – by comparing them with familiar objects.
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A snowball fight is raging between Saturn’s moons

Leah Crane

THE inner moons of Saturn are unexpectedly bright, probably because one of the other moons is hurling snow at them.

The finding comes from radio frequency images of the planet’s satellites that were captured by the Cassini spacecraft.

Alice Le Gall at the University of Paris-Saclay in France and her colleagues analysed the probe’s radar observations and found that three moons – Mimas, Enceladus and Tethys – seem to be twice as bright as previously thought. They presented their work last week at a joint meeting of the European Planetary Science Congress and the Division for Planetary Sciences.

The brightness can be partly explained by Enceladus. It has huge geysers that spew water from its subsurface ocean into space, which then freezes and snows down on the nearby moons and on Enceladus itself. Le Gall and her colleagues calculated that this layer of ice and snow should be at least a few tens of centimetres thick. “Now we know that the snow is actually accumulating, it’s not just a thin veneer but a much thicker layer of water ice,” she says.

But even deep snow can’t fully account for how bright the moons appear. This suggests some other reflective structure must be buried in the snow or resting on it.

Le Gall and her team are now modelling possible surface features that could be responsible, including a layer of snowballs or huge ice spikes. “It’s actually quite important for future missions to find out if this is real, or if it’s something more complex,” she says.

Are consumers to blame for the Amazon fires? The production of beef for export has been linked to deforestation and fires in the rainforest, says Adam Vaughan

BRAZIL’s president Jair Bolsonaro has been called “Captain Chainsaw” for his rhetoric about the need to exploit resources in the Amazon. Many see this as the impetus for the rocketing deforestation and ensuing fires in the rainforest this year.

But there is another side to the story. The forest is often burned to make way for cattle ranches, and much of the meat they produce is sold in other countries – Brazil is the world’s biggest exporter of beef. That begs the question: are beef-eaters in countries like the UK and US partly to blame for the rainforest going up in smoke? It turns out the answer could be yes.

An investigation of Brazilian beef supply chains by Trase, a partnership of non-governmental organisations, has found that cattle ranching led to the loss of, on average, 5,800 square kilometres of forest each year between 2015 and 2017. This estimate was arrived at by cross referencing beef trade information with high-resolution satellite data showing deforestation.

A single exporting company, JBS, was linked to more than a third of all the deforestation over the period. It has made a commitment to allow zero deforestation in the Amazon. “The problem is the commitment is only partially implemented and limited in scope,” says Erasmus zu Ermgassen at the Catholic University of Louvain in Belgium, who worked on the Trase analysis.

He says that companies tend to check only that their direct suppliers aren’t engaging in deforestation. However, this leaves a blind spot further down the supply chain; those direct suppliers may have got their cattle from other suppliers that use ranches in areas that have been deforested.

JBS’s zero deforestation commitment also applies only to the Amazon. That leaves aside the Cerrado, a huge and highly biologically diverse savannah area in Brazil, where JBS also operates. The Trase analysis found a lot of deforestation linked to cattle ranches in this area.

A spokesperson for JBS says the Trase analysis is misleading and that the firm has an “unwavering commitment to combat, discourage and eliminate deforestation in the Amazon.”

Who is eating all the meat? In 2017, China was the biggest importer of Brazil’s beef, taking about 38 per cent of it. Egypt and Russia took another 10 per cent each. But high-income countries buy it too. The US imported almost 3 per cent, and though it suspended fresh beef imports in June 2017 over safety concerns, the Trump administration wants to resume them.

The UK imported almost 2 per cent and the Bureau of Investigative Journalism (BIJ) has found JBS canned beef sold at the Co-op supermarket and supplied to NHS Supply Chain, the company that supplies hospital trusts in England and Wales. The NGO Earthsight has found JBS beef at Sainsbury’s, Lidl, Asda and Morrisons too.

Peter Andrews of the British Retail Consortium says its members, which include these five supermarkets, “take every effort to ensure the products they sell have no links to deforestation”. NHS Supply Chain told the BIJ it was committed to “procuring products responsibly and sustainably”.

This means that consumers and politicians in richer countries could potentially exert leverage to reduce deforestation. “One way forward would be for the EU to ban any beef or soy products from entering the EU that could not be definitively guaranteed as sustainably produced,” says Mark Maslin at University College London.
Track snow leopards in the Himalayas

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We are used to thinking of planets orbiting stars, but it turns out they might exist around supermassive black holes too.

Scientists have floated the idea of planets orbiting smaller black holes before. But far less is known about whether this would be possible for supermassive black holes, which are millions of times more massive than our sun.

Keiichi Wada at Kagoshima University in Japan and his colleagues applied models of planet formation to these black holes to see what would happen. “This is the very first study that claims a possibility of ‘direct’ formation of planet-like objects that are not associated with stars, but with supermassive black holes,” says Wada.

Planet formation is generally thought to begin with a disc of dust and gas around a star. Gradually, this material clumps together and its gravity draws in more material, building a planet.

Wada and his team examined how similar discs known to surround supermassive black holes would behave (arxiv.org/abs/1909.06748). They showed that roughly the same process could operate. “Basically it is the same as the formation of normal planets around stars,” says Wada.

Because of their huge mass and gravitational pull, supermassive black holes can warp space-time in strange ways, creating effects such as time dilation. Orbiting planets might not feel these effects, however. Wada says they would probably orbit at a huge distance of between 10 and 30 light years from the black hole, where the extreme effects of general relativity would be “negligible”.

Planetary systems around a supermassive black hole probably wouldn’t be just like those around star systems, though. “The total amount of dust is enormous,” says Wada. This means the typical mass of planets would probably be large, about 10 times more massive than Earth, and there could be as many as 10,000 of them around a single black hole, says Wada.

Sean Raymond at the Laboratory of Astrophysics of Bordeaux, France, says the team’s logic is plausible, but that it might be possible for planets to form closer in. It is also “theoretically possible for millions of planets to orbit a supermassive black hole, but it requires a lot of things to be just perfect,” he says.

### 10,000
Number of planets that could orbit a single supermassive black hole
AN ELECTRIC patch makes hairless mice grow fur and may reverse balding in men when fitted in a cap.

At the moment, balding men can choose to treat hair loss using minoxidil lotion, finasteride pills or hair transplant surgery. But minoxidil doesn’t always work, finasteride can reduce sex drive and fertility, and surgery is expensive.

Stimulating the scalp with electric pulses has also been shown to restore hair growth. But it isn’t a practical treatment because it involves being hooked up to a machine. To overcome this hurdle, Xudong Wang at the University of Wisconsin-Madison and his colleagues have developed a flexible wireless patch that sticks to the scalp and generates electrical pulses by harnessing energy from random body movements.

Wang’s team tested the patch on mice that were hairless because of a genetic deficiency. After nine days, fur 2 millimetres long grew on their skin under the patch, whereas hairs only 1 millimetre long grew on adjacent skin areas treated with minoxidil or saline solution. Hair density was also three times greater for the patch-treated areas (ACS Nano, doi.org/dbqp).

Studying the skin of the mice under a microscope revealed that the patch seemed to work by stimulating the release of natural chemicals that encourage hair growth, such as keratinocyte growth factor and vascular endothelial growth factor. Wang also tested the patch on his father, who has been going bald for the past few years. “It helped him to grow a lot of new hairs after one month,” Wang says.

His team has now designed a baseball cap that encases the whole scalp in the pulse-generating materials to stimulate hair growth, and is seeking approval to test it in men in a clinical trial.

Wang says he is confident it will work, because hairless mice are considered good models of male balding. It shouldn’t be uncomfortable to wear because it produces very gentle electric pulses, he says.

Baseball cap zaps the scalp to reverse male balding

Alice Klein
**Human evolution**

**First glimpse of what a Denisovan could have looked like**

Michael Le Page

UNTIL recently, the only evidence for the existence of a mysterious group of ancient humans known as the Denisovans was ancient DNA extracted from a finger bone and three teeth found in the Altai mountains in Siberia. Now a team has created a portrait of a young Denisovan woman based on that finger bone DNA — but other researchers are sceptical of the method.

Like Neanderthals, Denisovans are an extinct type of human that interbred with *Homo sapiens*. But we still know little about them.

Liran Carmel at the Hebrew University of Jerusalem in Israel and his colleagues have used Denisovan DNA to generate a portrait that roughly represents what Denisovans looked like. “Our reconstruction is generalistic,” says Carmel. “We just reconstruct the face of the human group, not of a specific individual.”

Ancient DNA was used to produce this portrait of a Denisovan woman

There has long been interest in working out what people look like on the basis of their DNA alone, for instance to help identify suspects from a crime scene. But our appearance depends on thousands of variants in gene sequences, each of which usually has only a tiny effect. “Today we cannot predict very much about a person’s bone morphology,” says John Hawks at the University of Wisconsin-Madison.

Instead of looking at the DNA sequence of genes to predict appearance, Carmel and his colleagues looked at how active these genes were. When genes get switched off in cells, epigenetic tags called methyl groups are added to their DNA. The team has developed a way to identify where these tags have been added to ancient DNA.

Carmel’s group compared the methylation patterns in the ancient finger bone to those in bone cells from modern humans and chimpanzees, revealing thousands of genes whose activity was probably different in Denisovans. Next, the team tried to identify which of those changes would affect bone shape, based on what happens when mutations disable these genes in modern humans.

Finally, the group applied these findings to infer how the growth of Denisovan bones may have differed from ours. The method tells us in what way the bones differed but not by how much, says Carmel. For instance, it suggests Denisovans had wider lower jaws, but not how much wider (Cell, doi.org/dbqk).

“This doesn’t give us any idea of what individuals from the Altai looked like,” says Sheela Athreya at Texas A&M University. “It’s based on so very many assumptions that it made my head spin.”

**“This doesn’t give us any idea of what Denisovans looked like. It’s based on so many assumptions”**

The team validated the method by using it to correctly predict some known characteristics of Neanderthal bones. But Charles Roseman at the University of Illinois at Urbana-Champaign says the method missed most Neanderthal differences, meaning at best it paints a very partial picture.

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**Marine biology**

**Diet may explain why whales have such big brains**

THE largest brains ever to have evolved belong to whales. Now we have discovered that the marine mammals may have gained their big brain size in the same way we did: through massive expansion of two particular brain regions, fuelled perhaps by changes in diet.

Amandine Muller at the University of Cambridge and Stephen Montgomery at the University of Bristol, UK, looked at brain size data for 18 species of whale and dolphin, as well as for 124 different land animals, including 43 species of primate. With few exceptions, the whales, dolphins and primates all seem to have gained large brains through dramatic growth of the same two brain regions: the cerebellum and neocortex.

Both regions are important for cognitive functions such as attention and controlling the movement of the body.

It makes sense that the cerebellum and neocortex evolve in unison, says Montgomery, because they are physically connected by many brain pathways.

Grey whales and humans seem to have evolved their big brains in similar ways.

What drove these two brain regions to expand so dramatically in whales and dolphins? Muller and Montgomery found that the whale and dolphin species with a larger cerebellum and neocortex typically have an unusually broad diet, in terms of the variety of foods they consume. This may have enabled the evolution of larger brains (Journal of Evolutionary Biology, doi.org/dbq5).

It is unclear why this would be the case, but Montgomery speculates that a broad diet is more likely to provide the energetic resources needed to fuel brain expansion.

Colin Barras
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Global warming intensifies risk of bad floods in Europe

CLIMATE change will increase the chance of heavy rainfall and storm surges combining to cause extreme flooding around the UK, Germany and other parts of northern Europe. Coastal communities already face the prospect of a worst-case average sea level rise of about a metre by the end of the century, as temperatures rise. But Emanuele Bevacqua at the University of Reading, UK, and his colleagues found the risk from rising seas may be aggravated further by compound flooding, where heavy rainfall and storm surges occur at the same time to have greater impact.

The team came to this conclusion after running simulations and looking at projected changes in storm surges, precipitation and waves. The results don’t account for defences and local topography, but Bevacqua says the potential hazard from compound flooding should still be factored into risk assessments for coastal communities.

Today, the Mediterranean coast is at the greatest risk of such floods in Europe. If climate change continues at its current trajectory, however, the probability of compound flooding is projected to increase across more northerly areas.

Those projections are clearest for the UK west coast, northern France, the eastern North Sea and parts of the Black Sea (Science Advances, doi.org/dbqj). Hotspots in the UK are expected to include the Bristol channel and Devon and Cornwall coasts. However, Bevacqua says it is hard to pin down precise risk for very local areas, and this should be seen more as a broader trend for northern Europe. Adam Vaughan

Extreme weather

At last, a new way to write the number 3

JUST weeks after cracking an elusive problem involving the number 42, mathematicians have found a solution to an even harder problem for the number 3.

Andrew Booker of Bristol University, UK, and Andrew Sutherland at the Massachusetts Institute of Technology have found a big solution to a problem known as the sum of three cubes. It asks whether any whole number can be represented as the sum of three cubed numbers.

There were already two known solutions for the number 3, both of which involve small numbers: \(1^3 + 1^3 + 1^3\) and \(4^3 + 4^3 + (-5)^3\). But mathematicians have sought a third for decades. The solution found by Booker and Sutherland is: \((-5699368212219623807203)^3 + (56993682113563493509)^3 + (47271549345337032)^3 = 3\).

Earlier this month, the pair also found a solution to the same problem for 42, which was the last remaining unsolved number less than 100. The duo also found a solution to the problem for 906.

To find these solutions, Booker and Sutherland worked with software firm Charity Engine to run an algorithm across the idle computers of half a million volunteers. For the number 3, the amount of processing time was equivalent to a single computer processor running continuously for 4 million hours, or more than 456 years. Donna Lu

News

In brief

Global warming intensifies risk of bad floods in Europe

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Animals

Radio waves slow roach body clocks

WEAK radio frequency fields seem to affect the body clocks of cockroaches. If the finding is confirmed, it could mean that weak radio waves affect other animals too.

However, Martin Vacha of Masaryk University in the Czech Republic, who did the study, is “very cautious” about the results.

Many claims have been made of possible effects of electromagnetic fields on humans and other animals, in particular that radio waves from cellphones could cause cancer. But these are too weak to cause the DNA damage that leads to cancer. Nonetheless, some researchers think the fields could have more subtle effects.

To test this, Vacha and his colleagues kept cockroaches in constant dim UV light, with no clues as to whether it was night or day. They measured their activity to work out what time their body clocks were keeping.

When they exposed the animals to either static magnetic fields or weak radio fields well below the frequency of cellphone signals, their periods of activity became an hour or two longer. In other words, their body clocks were running slow (Journal of the Royal Society Interface, doi.org/dbn9).

Had the cockroaches been exposed to natural light cycles, there would probably have been little impact, says Vacha.

Such results often fail to stand up to replication, says Peter Hore at the University of Oxford. One exception is the disorienting effect of very weak radio frequency noise on small migratory songbirds held in cages, he says.

That is intriguing because the leading idea for how birds detect magnetic fields is via proteins called cryptochromes – and cryptochromes also play a key role in maintaining circadian rhythms in animals. Michael Le Page

Maths

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Sexual health

Genital herpes jab is on the horizon

HOPES have been raised that we will soon have a vaccine against genital herpes—a disease that infects more than 1 in 10 people worldwide. The herpes simplex 2 virus (HSV2) is spread by vaginal, anal or oral sex. People remain infected for life, as some of the viruses hide in nerve cells and lay dormant.

Most people never realise they are infected, but others have outbreaks of painful symptoms, including genital lesions. The virus can also cause complications such as meningitis and can be passed on to babies during birth with fatal results. People are most infectious when they have lesions but even those with no symptoms can infect others.

Now Harvey Friedman at the University of Pennsylvania and his colleagues have an experimental vaccine that looks promising. It has prevented genital lesions in all mice and guinea pigs tested. In 98 per cent of mice and 80 per cent of guinea pigs it also prevented low-level “hidden” infections, something earlier trial vaccines regarded as promising enough to test in humans have failed to do.

Many vaccines consist of modified or inactivated viruses. Friedman’s, however, consists of messenger RNA (mRNA) molecules that code for three HSV2 proteins. When these mRNAs get inside cells in the body, the cells produce the viral proteins, triggering an immune response (Science Immunology, doi.org/dbq8).

Friedman’s team is now testing whether the vaccine can also protect against herpes simplex 1, or the cold sore virus. MLP

The microbiome of C-section babies

Babies born by caesarean section have a different microbiome— but not for long. A large study found 80 per cent of C-section babies had hospital-acquired bacteria in their guts when born, compared with 50 per cent of those born vaginally. However, the difference disappeared after nine months (Nature, doi.org/dbqc).

How to make a carbon tax popular

Politicians are cautious about putting a carbon tax on fossil fuels because it could increase the cost of living. But a survey of 3000 people in the US found attitudes to it are positive if the money raised goes towards renewable energy or is redistributed to people as a rebate (Science Advances, doi.org/dbqd).

Al learns how to predict El Niño

Artificial intelligence trained on 100 years of El Niño life can predict when one may occur with more accuracy than other methods. This may improve climate predictions and give more time to prepare for bad weather linked to the Pacific Ocean phenomenon (Nature, doi.org/gf8g3n).

Wildlife

Quarter of North American birds lost in recent decades

ALMOST 3 billion birds have vanished from the US and Canada since 1970 due to human activities. Scientists are calling it an “overlooked biodiversity crisis”. This is the first published full analysis of the population changes in breeding birds in North America. It suggests that the continent has seen more than a quarter of its birds disappear in recent decades.

Kenneth Rosenberg at Cornell University in New York and his colleagues estimated population shifts in 529 species between 1970 and 2017. They used data from government bird surveys and citizen science surveys, cross-referenced with records of the biomass of migrating birds from 148 radar stations.

The most common species, such as starlings, have been hit the hardest. More than 90 per cent of the net loss of 2.9 billion birds occurred across just 12 families, including sparrows, warblers and blackbirds. Habitat loss and degradation are the biggest drivers of declines (Science, doi.org/dbq7).

Novelist and birder Jonathan Franzen says we need to pay a lot more attention to these kinds of present-day threats to the natural world because they can often be addressed at the local level. AV

Technology

Speedy tuna robot thrashes its rivals

A TUNA-INSPIRED robot can wriggle just as fast as real fish and swim faster than most other robots of its type. “Tunabot” could help us learn how fish use their fins and may someday be used for underwater surveillance.

Hilary Bart-Smith at the University of Virginia and her colleagues built Tunabot from 3D-printed steel and resin, covered in stretchy plastic skin. It mimics an adolescent tuna, but without any fins other than the tail, and is about 25 centimetres long.

The team chose a tuna design because these fish can swim very fast with high energy efficiency. They move by wriggling their bodies back and forth up to about 10 times per second. The faster they thrash, the faster they swim.

Tunabot can wiggle up to 15 times per second and reach about 1 metre per second, not quite as fast as a tuna but far faster than most swimming robots (Science Robotics, doi.org/dbq7).

Making Tunabot more similar to tuna could help us learn more about how the fish themselves swim, says Bart-Smith.

She and her team are working on adding sensors, so Tunabot can be used as a swimming surveillance system. Leah Crane
COURTS in Ohio are wrestling with an unusual question: how do you weigh up the rights of two people when one of them is a lake?

For several years, Lake Erie has been hit by an annual bloom of toxic algae caused by run-off from surrounding farmland. In some years, the contamination is so bad local people are warned against drinking water from their taps.

Existing environmental protections clearly weren’t working. So residents of Toledo, a city at the western end of the lake, took drastic action earlier this year and voted to protect Lake Erie as if it were a person. The legislation gives the lake the right to “exist, flourish and naturally evolve”. But farmers were quick to challenge the law.

Giving nature rights is a strategy for protecting the environment that is building steam. Rivers in nations including India and New Zealand now have such rights. In July, Bangladesh became the first country to grant all its rivers – some 700 in total – legal personhood. It may sound like a strange tactic, but could it also be an effective one?

The principle of human rights emerged during the 18th century, the idea being that certain fundamental things are allowed of people or owed to them. The 1776 American Declaration of Independence, for example, established a person’s right to life, liberty and the pursuit of happiness.

The case for extending legal rights to the environment was first made by University of Southern California law professor Christopher Stone in 1972. But other ways of protecting the environment became more mainstream. Many nations have laws that make it illegal to dump pollution. There are also many areas, such as national parks, where human activities that could damage the environment are tightly regulated.

This may not be enough. In May, a major UN report concluded that environmental destruction is so bad that it threatens human existence. “There is a sense that the current way of responding to the environmental crisis isn’t working,” says Maria Lee at University College London.

Frustration seems to be what fuelled the legal move related to Lake Erie. “With each step the people took in the traditional legal framework, they realised they needed to try a different approach,” says Tish O’Dell at the Community Environmental Legal Defense Fund, a non-profit law firm that helped Toledo draft its law.

Many other stretches of water around the world have been given rights in the past few years (see “Water power”, right). The strategy could work for other aspects of nature too. Laws in Bolivia and Ecuador offer blanket protection rights to the countries’ ecosystems. New Zealand is also working towards giving forests and a mountain similar rights to those it has already bestowed on the Whanganui river.

There is reason to think the strategy will be helpful. The introduction of human rights proved not to be empty words: the shift in thinking helped abolish slavery by providing a vocabulary for arguing the practice was wrong, says Guillaume Chapron at the Swedish University of Agricultural Sciences.

And although it might seem strange to give rights to inanimate objects, we have already done that on a huge scale. Companies, trade unions and nations all have legal rights. “The organisations that will be challenging the legal status of rivers have not necessarily got any more reason to exist as a legal entity than a river does,”

Douglas Heaven investigates

The Whanganui river in New Zealand (above) has been declared a legal person. So too has the Yamuna in India (below), which remains polluted with rotting flowers, cloth and other rubbish
Water power
Many rivers and a few lakes around the world are getting rights as if they were people. says Peter Higgins at the University of Edinburgh, UK. “It makes you think.”
That may be the lasting power of this movement. Defending nature’s rights in court will force us to reassess assumptions long taken for granted. For Philippe Cullet at the University of London, it is a matter of addressing the anthropocentrism at the heart of environmental law. It will make lawyers consider protection from a standpoint other than how useful a river is to us, he says.
Protection conferred by rights may also be hard to remove or weaken. If a government tried to take away anti-discrimination legislation for human minority groups, the move would be attacked as illegitimate, even if such a law was adopted through a democratic process, says Chapron. “Using rights may therefore act as a moral bulwark against the legal downgrading which has been problematic for nature laws.”
Still, the protection isn’t automatic or absolute. The UN’s Universal Declaration of Human Rights states: “Everyone has the right to life, liberty and security of person.” Yet prisoners have their liberty taken away and soldiers die for their country. “To say that a river has rights doesn’t necessarily mean that the river will be pristine,” says Lee.
What’s more, certain countries choose to ignore human rights. People are arbitrarily locked up or tortured all the time. Rights offer protection only where there is a fair legal system to uphold them. Even with that in place, it is unclear how environmental rights should be enforced in practice. In some cases, such as India’s legal rights for the Ganges river, human representatives are responsible for acting on behalf of their legal charges. Or it may be that anybody can file a lawsuit if they think nature’s rights are being violated. Either way, unless people keep an eye out and speak up for nature, giving it rights won’t help.
“I don’t think we yet have a foolproof mechanism to ensure that the rights holders can claim their entitlements,” says Cullet. As a case in point, Bolivia and Ecuador – which introduced rights for nature in 2008 and 2010, respectively – have failed to slow their environmental degradation. A bigger problem will be who pays the legal fees. In a battle between a multinational company and a river backed by concerned citizens, the side with the deeper pockets has the advantage. In several legal fights that have played out so far, rights haven’t stopped the environment from losing. Take Grant Township in Pennsylvania, where a law recognising the rights of natural ecosystems was held to infringe the rights of corporations. Lake Erie’s status is uncertain too. It’s not just challenges from farmers it has to contend with. In August, a business lobby group managed to insert a clause into a bill relating to Ohio’s state budget stating that nature doesn’t have rights. The courts have yet to decide whether this statement or Lake Erie’s rights will win out. That doesn’t mean rights for nature won’t work though. “History has shown us that when trying to change the status quo and expand rights to a new, non-rights-bearing entity, the first case rarely wins,” says O’Dell. “However, it can ignite a movement.”

1 In July, Bangladesh granted personhood to all its rivers. This means that anyone who damages one can be sued by its human representatives on a government-appointed commission.

2 Last year, 25 young people took the Colombian government to court, demanding a plan to preserve the environment. Part of the fallout was a decision to give the Colombian section of the Amazon river legal personhood.

3 The Ganges and one of its main tributaries, the Yamuna – both held sacred by Hindus – have the legal right to not be harmed, and can be parties in disputes.

4 Local Maori consider the Whanganui river (main image) in New Zealand to be an ancestor. But it has become severely degraded. In 2017, the country’s government recognised the river as a legal person in a settlement known as Te Awa Tupua.

5 Because Lake Erie is regularly polluted, residents of Toledo, Ohio, voted this year to give it legal personhood. The move is subject to ongoing legal wrangles, however, with a business group hoping to have the lake’s rights made illegal.
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LOYD BARRUS stands accused in Montana of five federal crimes, including accountability to deliberate homicide relating to the death of a police officer. The charges have to do with an incident in 2017 that appears to have started in a dispute about a traffic violation. By the end of it, both Barrus’s son and Broadwater County sheriff’s deputy Mason Moore were dead.

Barrus has yet to stand trial. In 2018, psychiatrists diagnosed him with multiple mental health conditions, including delusional disorder, and concluded that he was unfit to stand trial. In April, a judge ruled that he should be forcibly medicated, so he could give his account of the incident in court. His lawyers are appealing to Montana’s supreme court.

The case throws a public spotlight on a grey area of ethics and the law. Forcing someone to take medication so that they can stand trial and potentially be sent to prison, or even in some US states to their death, may seem barbaric. But when the question is how to balance the fair treatment of vulnerable defendants and the public right to protection, there are no easy answers.

The judge in the Barrus case was exercising her right under a controversial 2003 US Supreme Court ruling, Sell v. United States, to overrule a defendant’s refusal to be medicated. It comes with strict criteria: that the case is important enough, that the drugs are both medically appropriate and “substantially likely” to achieve the desired effect, and that there is no less invasive method of achieving the same end.

In the UK, the 1983 Mental Health Act allows forcible medication of people deemed at risk of harm to themselves or others. If this has the side effect of making someone fit to stand trial, so be it. Increased use of the practice is now under discussion as part of ongoing legal reforms. One concern in the UK is that the bar to be declared incompetent to stand trial is so high that it may not protect vulnerable people from an unfair trial. Another is that the price for being protected is often indefinite incarceration in a psychiatric facility. Forced medication may actually be in some defendants’ interests.

The US experience provides evidence that forced medication can work. A 2013 study of 132 individuals treated involuntarily in 2003 and 2009 found that medication improved the condition of 79 per cent of them enough to stand trial, and concluded that the Sell ruling was a “clear and convincing success”.

Whether you buy that partly depends on how much you think the other 21 per cent matter. But the figures demonstrate an obvious truth: that the Sell stipulation that the drugs must work is hard to prove before they are given. The judge at the Barrus hearing reached her decision in part because Barrus had been involved in a similar stand-off in 2000, and medication had improved his condition enough to stand trial and be convicted.

It also isn’t clear whether, in an overburdened justice system, the Sell criteria are always given proper consideration. Unusually, Barrus’s judge heard nearly a week of testimony. “Most of these cases are resolved in a few hours,” says forensic psychiatrist Alan Newman of the California Pacific Medical Center, who attended the hearing as an expert witness.

In the Barrus case, the lawyers are still arguing. Perhaps that is inevitable where the messy uncertainties of human psychiatry collide with the law’s need for binary certainty. The UK and other jurisdictions might want to reflect on that, before they go further down this route. If forcible medication is the answer, a rigorous system of checks and balances must ensure it enhances justice, rather than impedes it.

Laura Spinney is a writer and science journalist based in Paris. Follow her @lfspinney
The truth about ‘ancient grains’ Wellness gurus are extolling the virtues of so-called ancient grains. Are they really better for us? James Wong investigates

HORASAN, teff, emmer and amaranth. No, these aren’t planets in the next Star Wars movie, but some of the growing range of wheat alternatives that are increasingly filling supermarket shelves (and “wellness guru” Instagram feeds) everywhere. Said to be untouched by modern plant breeders, who have apparently rendered wheat an unhealthy option, these “ancient grains” can supposedly transform your health. But what exactly are these foods, and are they as beneficial as claimed?

Here’s the first thing: ancient grains are often anything but. Take quinoa. The seeds of this South American plant are thought to have been bred for human consumption as recently as 3000 years ago, making it only a third of the age of bread wheat. Even some of the oldest members of the wheat group, such as einkorn and emmer which were first bred 10,000 years ago, only predates bread wheat by a millennium or so.

In fact, many ancient grains aren’t even true grains (the seeds of grass plants), just a motley crew of seeds from a range of plant families and a few more unusual rice and maize cultivars. With no science behind this definition, it seems to be employed as a catch-all marketing term used to describe anything that isn’t bread wheat, regardless of its actual age, how intensively it has been bred or whether or not it is even a grain.

Semantics aside, are they more nutritious? This seems to have been investigated only very recently. With most of the best studies published in the past five years or so, the health claims appear to predate much of the evidence. Studies examining the nutritional composition of ancestral wheats like emmer, einkorn and khorasan compared with modern bread wheat tend to have found a wide variation between samples, which makes comparing them tricky.

This isn’t only because there is significant genetic diversity within each of these species, but also because factors like climate, cultivation techniques and soil can have a significant effect on their nutritional content. For example, wheat grown in Canada can contain up to 10 times the selenium levels of the exact same variety grown in Europe, due to differences in the levels of this mineral in soils.

“Ancient grains are often anything but. Many aren’t even true grains”

For precisely this reason, a 2015 study set out to compare data only from studies where the modern and “ancient” species of wheat were grown side-by-side in the same fields. The researchers found they varied very little in their make-up. Ancient wheats tended to be lower in fibre than modern ones and were higher in a phytonutrient called lutein, but that is where the differences stop.

How about when more distantly related crops under the ancient grain umbrella, such as quinoa, are compared with bread wheat? Despite claims that these seeds are “loaded with protein, iron, and vitamin B2” on my quinoa packet at home, the levels of these nutrients in wholemeal flour are comparable when you look at the published nutritional data. The boring old flour is also twice as high in fibre and manganese, despite a similar calorie count and a lower cost. Sorry, clean-eaters!

It would be remiss of me to not point out that there have also been a few very small clinical trials set up to answer this question. These are potentially more exciting, as they set out to feed people diets based on the different grains and compare the effects: the holy grail in nutritional research. Sure enough, these trials have reported a plethora of health benefits, including significantly reduced cholesterol and lower markers of inflammation to an improvement in symptoms for people with irritable bowel syndrome.

However, there are a few things to note about these trials. Firstly, they only compared two crops: Kamut (a trademarked brand of Khorasan grown in Canada under licence) and bread wheat. So their results can’t be extrapolated to cover any other ancient grains. Furthermore, despite being otherwise well-designed, these trials didn’t compare crops grown side-by-side, but Canadian Khorasan with wheat grown in Italy. This means the findings could potentially be attributed to any number of other factors, not just the crop itself. Why so many trials on just this brand of Khorasan? Most of these studies also acknowledge support from producers of the crop. Funny, that.

To me, this is a fascinating area. But given how incredibly early on we are in our understanding of the potential differences here, we are simply going to have to wait before we get a clear answer either way. In the meantime, enjoy your grains, however ancient they claim to be.
Editor’s pick

The ‘last mile revolution’ was closer than you think

7 September, p 42
From David Clark, Norwich, Norfolk, UK
Chris Stokel-Walker says that one company could be a single point of contact for delivery of online shopping, removing duplication of vehicles. Older readers in the UK may remember a similar service provided by the Royal Mail.

Unfortunately, legislation may now be required to reduce the half a dozen delivery vehicles coming down my road every day to just one.

From Andy Prior, Malvern, Worcestershire, UK
Stokel-Walker explains how online suppliers are looking to use technology to lower the cost of delivery to individual homes and reduce polluting van journeys.

Why not use the existing home delivery service for milk? My milk supplier delivers to our house every other day using environmentally friendly electric vehicles along optimised routes.

Any returns could be handled by leaving them on the doorstep to be collected along with empty milk bottles. As our milk is delivered before I leave for work, packages could be moved safely indoors before I leave.

The growth of the internet was accelerated by the ability to deliver digital packages to the home using the existing landline network. Perhaps the beneficiaries of that online revolution could use existing infrastructure once again.

What have the Roslings ever done for us, then?

7 September, p 46
From Jon Attack, Radcliffe on Trent, Nottinghamshire, UK
I’m all for a fact-based viewpoint, but numbers easily reframe reality. For instance, the thought that only 10.6 per cent of people are now in extreme poverty didn’t bring me cheer. It means that more than 816 million people live on the edge of starvation. We are told to be cheerful because the percentage has dropped from 67.1 per cent in 1918.

But population increase means that the number in this state has dropped from 1,207,800,000 in 1918 to 816,200,000 now – so the number in extreme poverty has dropped by only 32.4 per cent. Yes, “factfulness” and accuracy of data are vital to our understanding of the world, but the desperate state of hundreds of millions of people is far more than a statistic.

From Ian Simmons, Thorpe Bay, Essex, UK
I wish I could share Ola Rosling’s optimistic view that the world is getting better if we look at the facts. Yes, we have reduced the number of people living in extreme poverty and increased life expectancy since 1918. But back then, we used less than one Earth’s worth of natural resources a year. We now use 1.7 Earths’ worth of resources every year.

In 1918, extreme poverty was spatially distributed. All we have done is redistribute it temporally, lifting billions out of poverty today by using the resources of tomorrow, ensuring that greater poverty returns in the future. I’ll celebrate when we are able to achieve the same improvements sustainably. Otherwise, we risk today’s benefits being a blip.

From Chris Smaje, Frome, Somerset, UK
The statement “our world really is improving” is a story that can neither be proved nor disproved with data. Statistics presented to buttress such stories are inevitably more or less cherry-picked.

For example, you present a graph of plane crash deaths starting in 1929. If it had started in 1800, as your graphs for literacy and infant mortality do, we would have to conclude that plane crash deaths are a lot worse than they used to be. The graph also doesn’t show that plane crash deaths make a minute contribution to human mortality.

From Alan Taman, Birmingham, UK
Jacob Aron’s very good interview with Ola Rosling is timely in pointing out the importance of facts. Your graphics show how absolute living standards have shifted over time, with the implication that we ignore how much better things are for many of us compared with the bleak existence our ancestors faced. But the irony is that we ignore how things improve absolutely because we are creatures of comparison.

As epidemiologists Richard Wilkinson and Kate Pickett describe in The Inner Level and The Spirit Level, people generally compare themselves with the society they encounter daily. “Status anxiety” is responsible for a great deal of mental and physical ill health. Relative poverty is getting worse rather than better in many societies, including the UK.

We need every tool for emissions reduction

27 July, p 23
From Emmanuel Desplechin, ePURE European renewable ethanol association, Brussels, Belgium
Adding bioethanol to petrol will wreck the environment, not save it, says Michael Le Page. This attack on one of the most effective tools we have for reducing carbon
dioxide emissions from road transport does a disservice to the fight against climate change. Arguments deployed against biofuels in general—deforestation, food price increases, creation of poverty—aren’t relevant to European ethanol production. In the EU, ethanol is produced almost entirely from feedstock grown on existing EU farmland. This has no negative impact on food prices.

The EU’s recently adopted Renewable Energy Directive 2018 settled the question of which biofuel feedstocks create a high risk of land-use change. Those used for crop-based ethanol production in Europe—maize, wheat and sugar beet—are well below the threshold.

Achieving the EU’s goal for decarbonising the economy by 2050 will require every available tool for emissions reduction. Electric vehicles are one solution, but even in 2030, the majority of cars on the road will have internal combustion engines. Petrol blended with ethanol works in today’s engines and can be sold using existing infrastructure.

Do we really want to lose clinicians’ skills to AI?
17 August, p 7
From Andrew Vickers, Lancaster, UK
Donna Lu describes the training of AI as requiring large data sets and reminds us that the process by which AI reaches its predictions is opaque. Human clinicians learn by being exposed to data, but need considerably less information as they are guided by others who already have this expertise.

If AI comes to dominate, this expertise will be lost within about 20 years. Then we will become completely dependent on AI. Is this the brave new world we want?

Designers have a lot of back pain to answer for
31 August, p 34
From Veronica Szery, Wolumla, New South Wales, Australia
As Helen Thomson notes, a lot of back pain is due to bad posture. We need to sit and stand up straight, with our shoulders back, head held high and tail bone pointing down. That way, our core muscles support the spine and nerves don’t get pinched.

Designers have a lot to answer for, as most seating forces us into the opposite position. The choice to sit or stand should be adopted in workplaces.

From Bryn Glover, Kirkby Malzeard, North Yorkshire, UK
You present a graph of disability-adjusted life years lost to back pain. It seems to carry more information than was referred to in the article.

Between 1990 and 2015, there was a shift in the age of peak pain that could be as great as 25 years. May the root cause be traceable to some feature of childhood?

As a beekeeper, I see hints of rapid evolution
17 August, p 38
From Greg Nuttgens, Porthcawl, Mid Glamorgan, UK
You report bees in Puerto Rico evolving to become less aggressive. I believe a similar process is happening in the UK in response to the varroa mite. When I started keeping bees 15 years ago, these mites were a major problem, with all colonies in danger of dying out unless treated to reduce the numbers of mites. My colonies and others in south Wales now appear to have few or no varroa mites, even when not treated. I suspect there are two processes at work here. Some strains of bee are known to be more “hygienic” than others, being able to remove mites from the hive more effectively. A team at the University of Sussex has bred hygienic queens to be sold to beekeepers. Could this hygienic trait have evolved in British bees?

UK beekeepers also report that queens, which used to live for 3 to 5 years, now usually last for one or two seasons at most. Many become unable to lay fertile eggs in their first few months.

While the colony produces a new queen, there is a “brood break” in which there are no bee larvae in the hive. That disrupts the varroa life cycle. The rapid turnover of queens is a nuisance for beekeepers, but could this be an example of rapid evolution?

An avenue of research into pervasive gum disease
10 August, p 42
From John Tod, Hodgson Vale, Queensland, Australia
Many diseases may be caused by the spread of Porphyromonas gingivalis, as Debora MacKenzie reports. This reminded me of Colin Barras describing the recently discovered Candidate Phyla Radiation (CPR) microbes that parasitise the mouth bacterium Actinomyces odontolyticus and help it evade the immune system (10 April, p 28).

P gingivalis is a normal microbiome bacterium that dodges the immune system and causes chronic inflammation. It may be an interesting avenue of research to ask whether CPR bacteria help it do that.

A galaxy filled to the brim with utterly isolated life
31 August, p 42
From Richard Ellam, Paulton, Somerset, UK
Discussing the detection of alien life, Sarah Rugheimer notes Fermi’s paradox: where is everybody? Geometry may explain why we seem to be alone in the galaxy. Say the volume of our galaxy is about 10⁴ cubic light years. Suppose one billion technological civilisations currently exist in it.

On average, each of these could dominate a volume of about 10⁵ cubic light years—a sphere about 29 light years in radius. That suggests a mean separation of about 57 light years.

If there were only a million such civilisations, the mean separation would be 575 light years. Barring faster-than-light communication, it seems that any conversation between neighbours, let alone a friendly visit, is impractical.

Imagine the “ansible” communicators created by author Ursula K. Le Guin or warp-drive spaceships may be attractive, but we have no reason to assume that anyone out there would be able to build them if we can’t.

I suspect that the galaxy is teeming with life, but that we won’t ever be able to talk to our nearest neighbours because we are too far out of hailing distance.

How would a species without sight see time?
Letters, 31 August
From John Davnall, Manchester, UK
Martin Greenwood summarises the view of physicist Roger Penrose that much scientific and mathematical thought is non-verbal. A week earlier, another physicist, Lee Smolin, defined the “sky” of an event as a snapshot informing us of our relationships with the things around us (24 August, p 34).

Imagine a life form that had no sight, nor sensitivity to radiant heat. Would it be able to develop and test quantum and relativity theories? Might it find relativity easy to understand if its view of geometry wasn’t founded on a visual interpretation of dimensions? And to extend Derek Bolton’s question about mapping time and space to language (Letters, 31 August), how would it do that?

What a stimulating magazine!
Scary monsters

Photographer Christian Voigt

LURCHING out of the gloom like something from a gothic horror movie, this otherworldly creature (far left) is a 66-million-year-old dinosaur called Euoplocephalus. Like its relative Ankylosaurus, it was a heavily armoured herbivore with a club-like defensive tail. It was over 5 metres long and weighed around 2.5 tonnes.

The specimen resides in front of a painted diorama in the Senckenberg Museum of Natural History in Frankfurt, Germany. German photographer Christian Voigt placed a black drape behind it to isolate the bones in superb detail. He used a large-format analogue camera to shoot the skeleton, then digitised the images so he could pare away everything but bone, like a palaeontologist preparing a specimen for display.

The other portraits here, shot in museums in Paris and Berlin, use the same technique to show the small, predatory dinosaur Unenlagia (top) and a Tyrannosaurus rex skull (bottom). They are part of Voigt’s Evolution series, on display at London’s Bel-Air Fine Art gallery from this week until 20 October.

The touring exhibition also features photos of extinct reptiles and mammals, including an American mastodon and a sabre-toothed cat. Unenlagia is exclusive to the London show.

Voigt, the first fine-art photographer given access to the specimens, says he was inspired by the blue whale skeleton in the Natural History Museum in London.

Graham Lawton
The miracle that is us

Bill Bryson began as a travel writer, but science brought him his greatest success. Joshua Howgego asked him why his latest book is about the body

US-BORN Bill Bryson has now spent more than half his life living in England, everywhere from Kirkby Malham in North Yorkshire to Wramplingham in Norfolk.

That non-standard relationship to the UK gave him the edge to write Notes from a Small Island, a wry account of getting to grips with Britain’s strange customs. The book made him a household name in the late 1990s. Other books followed, all using the same formula: Bryson pokes fun at himself while discovering some new and interesting place.

Then, in 2003, a surprise: he published a book about science, A Short History of Nearly Everything, which set out to explain how the universe progressed from its earliest origins to humans in the here and now.

At the time, he told New Scientist that when it came to science, “it almost was not possible to know less in these fields than I did”.

But his journey of self-education built him a new fan base. The book won the Royal Society’s science book prize in 2004, and became a UK bestseller the following year.

Now he has followed up with The Body: A guide for occupants – a journey of a very different sort.

What do you hope people will take from your new book?

My idea was to do a kind of celebration. I didn’t want to dwell on diseases and illness and human frailties because I think the body is mostly a success story. The miracle of life is that all of these things inside you work together. You don’t have to tell your heart to beat or your lungs to inflate and deflate. We could spend our whole lives playing Pac-Man or something and not having really to think about anything because your body looks after you. To me, that’s quite a miracle.

Wasn’t there a rather personal reason that spurred you on?

Yes, one of the impetuses to write the book was that I was sent for an MRI scan to make sure there was nothing wrong with my heart. It turned out there was nothing wrong, but in the course of doing that, the scanner obviously went low enough to note that I only have one kidney.

I thought: I’m dying! One kidney has packed in and the next one is going. So I went to see a kidney specialist and he said: “No, no, you’re fine. You were probably born with one kidney or you have one very shrunken kidney which atrophied very soon after birth.” He said about one person in 100 goes through life like that.

That made me think. I mean, you could only have one kidney too. You could be part of this very select club but never know it. Because most of us go through life without having any idea what’s inside us. That made me realise, I’ve been living in this wobbly shape all these years and I have really no idea what’s in there.

One of the mind-blowing things you write about is that the brain can “predict” what will happen...

I thought that was amazing. To allow you to function in the world better, the brain is constantly “predicting” what’s going to happen a fifth of a second in the future. If what you saw inside your mind was what your eyeballs were taking in, it would just be complete chaos. For one thing, your eyes have to look through all the blood vessels and everything, and your brain filters all that out, which I find astounding.

Does the brain have any other editing tricks?

You have a big blind spot in the middle of both eyes, so your brain is constantly filling in. When you see me, you’re missing out a whole bunch because the optic nerve nullifies the central part of your vision. And there are tricks that can help you identify the blind spot that I mention in the book. But the bottom line is that, in each eye, you have a big hole in the centre of your field of vision that you’re not aware of in the same way that you’re not aware of blinking.

Another thing that rocked me
How did you find that?
I’d never done anything like that before and wasn’t sure how I would respond. I didn’t know whether it would make me queasy. Initially it did, very slightly. But you become captivated by what they’re teaching you.

The thing that I will always remember is how completely different the body is. An opened-up human body, a cadaver drained of all life and colour, is just a slab of meat – not very different from your Christmas turkey. To me that was all the more marvellous, to think that these innards I’m looking at were until recently this person who used to sit up, laugh, smile, have dreams and fall in love and do all of these things. And all that did it was this flesh, this kind of mass of undifferentiated organs. The body gets described in terms of being a machine – it’s nothing like that. It’s just tissue, and yet, miraculously, look what it does.

A few years ago, you were very involved in a UK campaign to clean up the countryside. Are things better now?
I don’t think we’re going in the right direction with anything. Seriously, I don’t think the world has ever been as crazy and as unprepared for the future as it is right now.

One thing that particularly disturbs me is how untrusted scientists have become. I grew up in a world in which anybody who had a lab coat on was believed automatically. Maybe we were a bit naive, but we’ve gone in the other direction and a lot of people are automatically suspicious of almost anything scientists tell them.

I don’t understand why, when it’s so obviously sensible to at least cautiously accept, say, global warming as something we need to do something about. The consequences are so bad if we don’t – you’re not going to make the world a worse place if you’re wrong. I struggle not to be too depressive about the world now.

What do you want to do next?
More science books?
What I’m going to do next is just nothing. The greatest luxury is to go somewhere and not have to write about it. ❚
Where there is power, there is resistance

Stephen King is among the authors serving up potent new stories with a revolutionary flavour thanks to characters and communities that stand up to authority, finds Helen Marshall

Imagine that in remote Maine, the personal and literary stomping ground of Stephen King, one of horror’s most prolific writers, there is a state-sanctioned facility set up to house those rare children gifted with psychic powers.

Twelve-year-old Luke Ellis is the latest arrival: a telekinetic who can’t do much more than rattle a pizza tray. But what he lacks in mental brawn he more than makes up for in intellect. And as the kids around him endure increasingly brutal tests designed to boost their power and break their will, it is his intelligence – surplus to requirements in the eyes of Mrs Sigsby, the institute’s coldly calculating director – that offers the only hope of escape.

A sure crowd-pleaser, The Institute is arguably a throwback to King’s early novels such as Carrie, The Shining and Firestarter. They were novels of the cold war, ushering the parapsychology of that time into the mainstream. After all, Danny Torrance didn’t just hear ghosts in The Shining’s Overlook Hotel, he was a low-level telepath particularly susceptible to psychic phenomena.

With the success of the Netflix series Stranger Things, everything old is new again. The cult, 1980s-set drama has reawoken our passion for secret government bases and clairvoyant wunderkinds. King could have simply traded on this mood of nostalgia, but The Institute is better than that, a thoroughly contemporary take on old anxieties. One of King’s best novels in years, The Institute ratchets up the tension from Ellis’s kidnapping to his violent confrontation with the powers that be.

Key to the book’s success is its emphasis on the necessity of personal resistance. Just as small-scale injustice paves the way for appalling corruption, so too can a child’s defiance open the door for wider rebellion. At a time when it takes 16-year-old Greta Thunberg to hold world leaders accountable for a lack of action on climate change, this is a message that is sure to resonate.

The debut novel of Indigenous Australian author Claire G. Coleman touched the same nerve a couple of years back. Terra Nullius refers to the legal status (“nobody’s land”) of Australia at the time of its original settlement by Europeans. Deeming the land to be empty negated the history, and threatened the lives, of more than 500 indigenous groups who did, in fact, inhabit the continent.

Postcolonial science fiction has surged in recent years, with the critical success of Nalo Hopkinson, N. K. Jemisin, Nnedi Okorafor, Tade Thompson and Jeannette Ng, to name a few. The genre, with its dependence on tales of exploration and civilisation-building, is clearly ripe for reinvention. Coleman does exactly that. With Terra Nullius and her forthcoming novel The Old Lie, she weaves together faux-historical sources and perspectives, pitting incumbents against newly arrived settlers. For the first half you may feel as if you are diving into a gritty and disquieting piece of historical fiction, but the blurb for Terra Nullius lays such thoughts to rest: “This is not Australia as we know it.” Coleman implies that those best-placed to lead the resistance may be those who have been resisting for generations.

While the psychopathic hirelings of both novels may present as cartoonishly thuggish, King and Coleman remind us that those who forget the past are doomed to repeat it.
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Some 15,000 years ago, a small band of pioneers stood on the threshold of a new world. To the south were the Americas, 40 million square kilometres of virgin territory including wide-open prairies, dense rainforests and high mountain chains. An epic journey was about to begin— but only because a remarkable adventure had just ended.

Before these original American frontierspeople ventured south, their forebears had spent millennia scratching a living in the desolate regions just south of the Arctic circle. Once they had arrived in the north, global temperatures plunged and the climate became bleaker still.

Faced with worsening conditions, these original pioneers stayed put, spending thousands of years isolated from the rest of humanity. Their fate is now coming to light, and it is clear that something remarkable happened during those missing years. The people who would eventually conquer the Americas evolved some unusual adaptations to survive, and it turns out that this genetic legacy can help trace their descendants today.

We don’t know exactly when humans first reached the New World. The consensus is that the first Americans arrived fairly recently, about 15,000 years ago. It is also widely believed that they did so via Beringia—an area centred on the Bering Strait between Siberia and Alaska, which was dry land at that time.

This implies that the story of the first Americans began with a subarctic odyssey. Whereas Europe and Asia has been home to hominins for almost 2 million years, it seems none of the earliest inhabitants—including Homo erectus, Neanderthals and Denisovans—strayed much above 55° north, roughly in line with the top of what are now Ireland and Kazakhstan. “There’s every reason not to do it,” says Ben Potter at the University of Alaska Fairbanks. It isn’t just cold. There aren’t as many animals at higher latitudes, making hunting difficult.

On current evidence, modern humans, rather than our extinct relatives, were the first to enter northern Eurasia. John Hoffecker at the University of Colorado, Boulder, suspects that key inventions opened up this subarctic region. Tailored clothing was probably necessary to cope with cooler conditions. And snares offered a solution to sparsely distributed prey. Used by modern Arctic inhabitants, they are essentially automated hunting devices that operate 24 hours a day, helping people exploit territories
dishes that perhaps served ritual purposes.
There were human remains at the site as well – two tooth fragments – and we learned this year that both contain preserved ancient DNA. The teeth belonged to children who were part of a population related to, although not directly ancestral to, modern Native Americans. But the game-changing discovery was about the size of the community. These children were so genetically distinct from each other that the Yana population may have numbered more than 500.

It is a startling finding, says Hoffecker. The Yana site was remote from the southern centres of human activity in the late Stone Age, so we might expect the population to have been tiny, isolated and inbred. “But it’s a fairly healthy and robust group,” he says. This suggests there was a degree of migration into and out of Beringia, keeping populations there genetically diverse. But even though this group may have been flourishing, there is no good evidence that these people pushed further east, despite Siberia and the Americas then being connected by dry land.

There they stayed for generations. Then, about 30,000 years ago, Earth began to lurch into a severe cold snap called the Last Glacial Maximum. Ice sheets grew across North America, and the route from Beringia to the New World froze shut. It was some 15,000 years before conditions began to improve and the route reopened. The Yana site was abandoned at the beginning of this period.

However, it seems that other groups stayed in Beringia. A decade ago, geneticists including Ripan Malhi at the University of Illinois discovered subtle genetic differences between living Native Americans and East Asians that originated thousands of years before people entered the Americas. The geneticists suggested a solution: perhaps the ancestors of the Native Americans had lived in Beringia, and become isolated as temperatures dropped 30,000 years ago. Their route south was blocked by polar deserts in Eurasia and ice sheets in North America. In theory, these people could have been cut off from the rest of humanity for 15,000 years, plenty of time for random genetic drift to give them distinctive DNA before they entered the New World. The idea was labelled the Beringian incubation or standstill.

Today, most researchers accept that there was an incubation period, although they now think it didn’t begin until about 24,000 years ago, when conditions got really bad, and that it lasted 9000 years at most. However, there is covering thousands of square kilometres.

There are disputed signs of human activity in northern Eurasia 45,000 years ago. But it is at a 32,000-year-old site in the Arctic circle that the archaeological record really begins. On the banks of the Yana river in Siberia, at the western end of Beringia, archaeologists have found hundreds of stone and bone tools, including sewing needles. The people near the Yana hunted reindeer, woolly rhinos and birds. Hares were also caught, perhaps for their pelts, if modern Arctic peoples are any guide.

Life in Beringia wasn’t unremittingly grim. Those inhabiting the Yana site had time for artistic pursuits: it has yielded dozens of beads carved from ivory and bone. Archaeologists also found strips of decorated ivory that may have been used as hairbands, and shallow ivory>

“The people who would eventually conquer the Americas evolved some unusual adaptations to survive”
disagreement about where exactly this period of isolation happened.

Potter is convinced that the ancestors of today’s Native Americans did, in fact, retreat south as conditions worsened, and spent the Last Glacial Maximum near Lake Baikal at approximately 53° north. We even have DNA from a boy who died there 24,000 years ago. Like the Yana children, he was related, although not directly ancestral, to the Native American founding population. But other researchers, including Hoffecker, are convinced that the incubation occurred in Beringia itself. The region’s geographical remoteness makes it a more likely place for a population to be isolated for millennia, they argue. Indeed, there is genetic evidence that this happened to other mammals – including elk and brown bears – during the Last Glacial Maximum.

Another clue comes from linguistics. There are similarities between some of the languages spoken in the Americas and Ket – a Yeniseian language spoken in Siberia to the west of Lake Baikal. A language family tree indicates that the oldest representatives of this group were spoken near the Beringian region, suggesting this is where it arose. Ket speakers may be descendants of Beringians who migrated back into Siberia after the Last Glacial Maximum.

Hoffecker points to more reasons why an extended stay in Beringia makes sense. As Earth’s climate cooled and ice sheets began to form, global sea levels dropped dramatically. By 28,000 years ago, the seas may have been 100 metres lower than they are today. As a result, thousands of square kilometres of new land appeared in south-central Beringia. And not just any old land. Although most of the subarctic became cold and arid after 30,000 years ago, climate models and pollen records indicate that this region was humid and mild, perhaps because Pacific currents pushed warm air over it. “There’s no other place on Earth where you got this significant expansion of viable habitat during the peak of the Last Glacial Maximum,” says Hoffecker.

Considering Beringia’s size and its benign climate, one estimate suggests that tens of thousands of people could have lived there during the peak of the Last Glacial Maximum.

There would have been big challenges. During winter, anyone living today above 46° north will struggle to get the sunlight they need to trigger vitamin D synthesis in the skin. “Even if you’re naked outside, you’re not going to get enough ultraviolet light exposure,” says Leslea Hlusko at the University of California, Berkeley. Adults can largely overcome this problem by eating vitamin D-rich foods such as oily fish, but nursing infants would be at risk of vitamin D deficiency, which can weaken the immune system and cause skeletal problems, among other things. She thinks evolution found a solution.

One variant of a gene called EDAR changes the density of milk ducts within the female breast. Hlusko suspects that this boosts the transfer of nutrients, including vitamin D, from mothers to their infants. The same EDAR variant also leaves people with strikingly thick enamel on the tongue side of their incisors. So she, Hoffecker and their colleagues looked at the global distribution of these curious teeth. They are all-but absent in most regions, present to some degree in east Asia – and almost ubiquitous among current and past Native American populations. To Hlusko, this fits with the idea that the ancestors of Native Americans, isolated in Beringia, evolved the EDAR variant, which helped them overcome their vitamin D problem and gave them thicker tooth enamel as a side effect.

“It’s a great hypothesis,” says Tábita Hünemeier at the University of São Paulo, Brazil. She also thinks the Native American founder population was isolated in Beringia – and that it evolved in response. In 2017, Hünemeier and her colleagues discovered that people in many present-day Native American populations carry unusual versions of a family of genes called FADS genes. People with these variants are better able to process the protein and fatty acid-rich diet that subarctic communities typically consume.

The pioneers of a new world

Hardy subarctic people lived near the Yana river some 32,000 years ago. It was at the edge of an area known as Beringia, which included dry land between what is now Siberia and Alaska. Then Earth began to cool and ice spread, trapping people in this habitable oasis. Isolated from the rest of humanity, Beringians developed distinct genetic variants that can help track how populations of them moved into the Americas 15,000 years ago.
variants may have been naturally selected in the Native American founder population while it was isolated in Beringia, says Hünemeier. All this research is building a picture of life on the American frontier. But until recently, the Beringian incubation was generally viewed as little more than a curious prologue to the story of the first Americans. This held that the real epic began about 15,000 years ago when the ice sheets retreated and a small, genetically homogeneous population moved from Beringia into the New World.

### American adventure

By 14,600 years ago, the founding population had split into two distinct Native American subpopulations. One, the Ancestral B group, apparently stuck largely to the very north of North America, where many of its descendants still live today. The second, the Ancestral A group, gave rise to a famous North American prehistoric culture, the Clovis, and also spread south into Central and South America over the next couple of millennia. Or that’s what we thought. But within the past year, we have learned that the Beringian people fractured into subpopulations during the incubation period. This means that several genetically distinct groups moved into the New World.

The clearest evidence for this comes from DNA locked in the bones of two children who were buried in Alaska, 11,500 and 9000 years ago. Both belong to a genetic group – the Ancient Beringians – that split from the rest of the Beringians about 22,000 years ago. The idea that this happened in Beringia and the two subpopulations then avoided mixing for thousands of years isn’t as implausible as it might seem. Malhi points out that tree species in Beringia went through a similar population fragmentation during the Last Glacial Maximum. Perhaps populations became isolated because each adapted to a unique microclimate within the area, he suggests.

At present, there is no evidence that the Ancient Beringians made much of a contribution to the peopling of the New World. Even after the ice sheets retreated, they seem to have lingered in the Beringia region, eventually vanishing when populations of Native Americans from further south pushed back north into Alaska. However, this may not have been the only subpopulation to branch off during the Beringian incubation. And others might have had a greater wanderlust.

Last year, researchers reported that the Mixe people of Mexico carry a genetic signature unlike that of their neighbours. One interpretation is that, about 9000 years ago, their ancestors mingled with a mysterious group, provisionally dubbed UPopA, which seems to be another subpopulation originating in Beringia some 25,000 years ago.

Then there is the enigmatic Population Y. In 2015, geneticists announced that some members of the Surui and Karitiana groups living in the Amazon share a curious genetic connection with some Indigenous Australasians. The simplest explanation is that this originated in a prehistoric east Asian group, Population Y, which was ancestral to the first Australasians and also contributed genetic material to the New World via Beringia. However, geneticists have found no signs of Population Y in ancient DNA from Beringians or North Americans, and some researchers began to doubt its existence. Then, last year, came the discovery that a person who died in eastern Brazil 10,400 years ago carried the Australasian-like DNA. The individual belonged to the Ancestral A line of Native Americans that we know came to occupy South America. Given that Population Y DNA hasn’t been found in Ancestral A remains in North America, the geneticists suggest the two groups met and interbred after they arrived in South America. They say this might indicate that Population Y Beringians were the very first people to push into South America. If so, the inhabitants of early sites there – such as the 14,200-year-old Monte Verde in Chile – left a genetic legacy we now see only in some Amazonian people. It is an idea that chimes with a growing realisation that the peopling of South America was more complicated than previously thought.

Some 15,000 years ago, a small band of Beringians stood on the threshold of a new world. In time, their descendants would create giant artworks in the Nazca desert of Peru, begin humanity’s love affair with chocolate in the forests of Ecuador, and build great civilisations in Mexico. Today’s Native American populations still carry the genetic legacy of those remarkable frontiersfolk.

Colin Barras is a writer based in Ann Arbor, Michigan
Phones stand accused of warping our brains and harming our children. Douglas Heaven examines the evidence

Are screens bad for our bodies?
Smartphone pinky, tech neck, bone spurs at the back of our skulls: the ailments we are meant to have inflicted on ourselves through excessive phone use all sound terrifying. Hence the headlines. In truth, there is no good evidence that such alarming conditions are caused by our tech habit.

Any harm is likely to be far less spectacular. The World Health Organization, for example, recommends limiting screen time as a way of tackling obesity, voicing no health concerns related to screens in particular. What about the effect of staring at small, bright screens on our eyesight? In the past few years, more children in the UK have been prescribed glasses, says Max Davie at the Royal College of Paediatrics and Child Health in London. This has led some to claim that phones and tablets are to blame. But Davie thinks the increase in prescriptions has more to do with aggressive management of existing conditions. “At the moment, we don’t have sufficient evidence for a causal link,” he says.

One thing that does appear to be taking a hit is sleep. Studies have shown that people who are given a book to read in bed find it harder to go to sleep if they read it on a screen rather than on paper. This is probably because of the blue light that most screens emit, which throws off our circadian rhythm and tricks us into thinking it is daytime.

Of course, most of us who look at our phones last thing at night aren’t reading a book. Much sleep disruption is related to mental stimulation: waiting for the next notification, say, or scrolling through endless news feeds. Insufficient or disrupted sleep has been linked to increased risk for all manner of health problems, including depression and other mental health concerns (see “Are screens messing with my head?”, below).

“If there are any recommendations to be adopted, not using screens in the hour before bed seems to be the one with the greatest support,” says Smith.

Are screens messing with my head?
From video games to gambling, the apps and websites we can access on our phones have sparked widespread concern. Big tech companies are also adept at tapping into our need for social validation, hooking us on likes, retweets and follower counts. In testimony to a US Senate hearing in June, Tristan Harris, a former Google designer and co-founder of the Center for Humane Technology, argued that the internet has created a culture of mass narcissism.

This has led many to worry about the emotional stresses of a hypersocial world on adolescents. A quick online search brings up dozens of papers linking screen use or social media with detrimental effects on mental health, including depression, anorexia and suicide. Some figures suggest girls are more affected. “After two decades in decline, the mental health [problems] of 10 to 14-year-old girls have shot up 170 per cent in the last eight years,” Harris said in his testimony.

Such sound bites are alarming. They are
also widely believed, thanks to popular books like *iGen* by Jean Twenge, a psychologist at San Diego State University, which claims that digital technology has wrecked a generation. The trouble is that the underlying data can be used to tell different stories, says Amy Orben at the University of Oxford, who studies the impact of digital technology – and social media in particular – on mental health.

Ultimately, social media is just one of many different things that might affect someone’s well-being. Without controlled studies, it is difficult to draw meaningful conclusions.

When Orben started looking into screen use a few years ago, she wanted to explore some of the more extreme claims researchers were making. For example, Twenge has linked social media use with teenage depression and suicide. Orben was curious to look at the evidence herself.

She found it didn’t stack up. First, she spotted shortcomings in several large studies from 2017 that claimed to reveal correlations between the use of devices with screens and depressive symptoms in users. “I found that changing how the data was analysed would give me very different results,” says Orben.

To put her and her colleagues’ results in perspective, they compared the effect of device use to other things in an adolescent’s life. For instance, they looked at the effect of wearing glasses and found that this was correlated more negatively with well-being than screen use. They also looked at how often adolescents ate potatoes. “Potatoes are in a similar ballpark to screens,” says Orben. That doesn’t mean they should be banned from schools.

Twenge stands by her findings, pointing in turn to what she considers flaws in Orben’s statistical methods. For Davie and others, however, the effect of screen time and social media use on mental health remains speculative. “We cannot regard social media overall as good or bad,” says Davie. He believes Orben has done fantastic work in myth-busting, but warns against making blanket statements about individuals. He says he would never tell bereaved parents that an Instagram post about self-harm played no part in the death of their child, for example. “We don’t know that in individual cases social media is not responsible,” he says.

### Am I addicted to my phone?

Unless you are using it for purposes we already know are addictive, such as accessing gambling websites, the answer is probably not. Yet reaching for my phone has become an annoying tic and a phantom buzz in my pocket can make me pull out my phone and check for messages that aren’t there. Whenever there is a lull in my concentration – in the middle of writing this sentence, for example – my thoughts return to my phone. What’s going on?

In front of the US Senate, Harris painted a damning picture of the methods that tech companies like Facebook and Twitter use to command our attention in what he described as a “race to the bottom of your brainstem”. He called out design tricks like pulling down on the screen to refresh it, which shares characteristics with the mechanism of slot machines. “It has the same kind of addictive qualities that keep people in Las Vegas hooked,” he said.

We are also in thrall to the recommendation algorithms that know what we want better than we do. More than 70 per cent of viewing time on YouTube consists of people watching videos suggested by the platform rather than sought out deliberately. “You sit down to watch one video and wake up 2 hours later and say ‘Oh my god, what just happened?’” said Harris. “The answer is that you had a supercomputer pointed at your brain.”

All this means we are often sucked into our phones, thoughts elsewhere, even when we have more immediate things to focus on – such as crossing a road. The risks have led authorities in a handful of towns, including Augsburg in Germany, to install traffic lights on the ground in the hope that distracted pedestrians won’t step in front of a bus.

Although the increased risk of distraction is very real, talk of addiction may be too simplistic. “I think we need to be very careful about the use of the word ‘addiction’,” says Davie. “Addiction has a specific meaning of compulsive use, requiring increasing doses and a damaging effect on your life. But there are a lot of people who spend 8 hours a day playing games and that’s just how they like to spend their time. It’s OK as long as it’s not interfering with the rest of your life.” You aren’t addicted, but you may have a terrible habit.

### How much screen time should kids have?

This is where I struggle most. Not only do I get distracted by my phone when I should be paying attention to my daughter – “Dad. Dad. Dad!” – but I use screens to distract her all the time. When I need to cook, when I need to make a work call, when I’m feeling tired, I just stick her in front of a screen. Is this a problem? It all depends who you ask and how old your child is. There are no guidelines for teenagers, for example, and even the advice for younger children is far from clear.

The American Academy of Pediatrics (AAP) discourages parents from allowing children under 2 to have any interaction with screens and recommends no more than an hour a day for 2 to 5-year-olds. The World Health Organization says that children under 3 should have no screen time and those aged 3 to 4 should be limited to an hour a day, but its focus once more is on curbing childhood obesity.

The UK government largely follows the AAP’s guidelines. But the Royal College of
of fine motor skills, such as the ability to pick up blocks and stack them in a tower. Once again, there is no causal link. It could be that those infants who happen to develop fine motor skills early are simply more likely to pick up and play with a screen. It is possible, though, that the prodding and swiping needed to work a screen trains these skills.

We shouldn’t underestimate the value of screen use for older children too. Not only do they provide unprecedented access to many forms of valuable information and entertainment, but educating children about the dangers they will find online requires them to have some familiarity with it. “In order to think critically, kids need to engage,” says Smith.

How can I learn to stop worrying and love my screens?

The explosion of mobile phone use has revolutionised our lives. I can download movies and podcasts, write articles, communicate with my family and broadcast to the world all at the push of a button. This is unprecedented power, but there are still many important questions about these maddening, valuable devices that we have been unable to answer. What is clear, however, is that many initial reactions have been more knee-jerk than evidence-based. Rather than impose arbitrary constraints, we should take a look at our use of screens and ask how they fit with the activities and lifestyles we want as individuals and families. Orben, who is 24, has grown up with social media. For her and her peers, managing how they spend time with their screens was part of growing up. “Like any social media user, there are times when I feel I should use it less, that I need to feel in control,” she says. “We all have ways in which we try to self-regulate.”

Maybe you tweak your phone’s settings to reduce the number of alerts you get, or uninstall certain apps so they aren’t readily available. Some have suggested introducing “mental speed bumps” that interrupt the habit of checking a phone too often, such as writing a note to yourself on your lock screen or simply wrapping a rubber band around the device as a reminder.

Apple and Android phones and tablets now come with widgets that let you monitor and manage screen use. You can set time limits, turn off notifications and track what you have been doing on the device. There are also “night-time” settings that cut the blue light emitted by the screen and a “wind-down” mode designed to make the screen less enticing by turning it black and white.

These all help us become more conscious of our usage. But Apple and Google could do more, says Smith. “It’s a little bit of a misdirection,” he says. For one thing, these widgets don’t allow you to explore your screen use for periods of more than a week, which you might want to do to see if any lifestyle changes are making a difference.

Every new technology with widespread impact has given rise to new fears. Orben recalls an article from 1941 that lamented how adolescents in the US were addicted to radio programmes. “In a lot of parenting magazines from that time, you could just replace the word ‘radio’ with ‘social media’ and you could probably publish that today,” she says.

So the best bet may simply be to ask yourself what level of screen use makes you and those around you happy and try to stick to it. If you find yourself overindulging, don’t panic—and certainly don’t feel guilty. Nobody knows anything worth getting scared about.

“Hold the phone”

It may feel like everyone has a smartphone, but that isn’t the case, even in richer nations.

“When it comes to negative impact, potatoes are in a similar ballpark to screens”

unworkable.” He thinks guidelines that are hard to comply with fail to help families establish good habits and are ignored. It isn’t all negative. In 2016, Smith and his colleagues found no evidence that spending time interacting with a screen—rather than moving around or interacting with other humans—delayed certain developmental milestones, such as learning to walk and talk. On the contrary, they found a correlation between screen use and earlier development.
“I am angered by the fact that we’re destroying Earth”

Helen Sharman glimpsed our planet’s fragility during her time in space. Now, she tells Adam Vaughan, she wants others to see it too.

In 1989, Helen Sharman answered a radio advertisement that would change her life. She applied to be an astronaut aboard the Soviet space station Mir, competing against 13,000 other candidates for the chance to be the first British citizen in space. She got the job. The privately funded mission, called Project Juno, almost didn’t happen because of money problems but the Soviet Union eventually picked up the bill. In 1991, aged 27, she became a household name, spending eight days in space performing scientific experiments.

After her return to Earth, she wrote books, visited schools and undertook speaking tours about science. Ironically, given her cosmic voyage, she became known for her down-to-earth manner. “It took me 2 hours to get round the supermarket to buy a can of beans because everybody wanted to know what it was like in space,” she says, smiling.

Sharman retreated from public life in the noughties, before joining the National Physical Laboratory in 2011 and then moving to Imperial College London to become operations manager at the department of chemistry in 2015.

Now, she has narrated a voiceover for a virtual reality project with Danish renewable energy company Ørsted, to help democratise access to the “overview effect”, the unique perspective astronauts get of Earth and its fragility.

In our conversation, Sharman is warm, loquacious and passionate when talking about everything from the future of space flight to the environment and Brexit.

What was your first view of Earth from space like?
As soon as you’re out of the atmosphere, the fairings jettison and light can come through the window. Luckily for me, I was on the part of the spacecraft that was pointing towards the Earth so I could see the Pacific Ocean, with the curvature of the Earth and black space above. It was really, really bright.

How would you describe the overview effect?
When you look down on the Earth, you can’t see the political boundaries. Politics means absolutely nothing because you’re seeing the natural world. When you’re zipping around in low Earth orbit, in 92 minutes you’ve gone completely around the Earth. So instead of it being this huge place that you can apparently do anything to that’s really robust, it’s actually a very tiny place where everything is affecting everything else.

We’re all part of the Earth and the Earth is as much part of us as we are of it. I am angered by the fact that we are apparently destroying the very thing that’s given us life, as opposed to what we could be doing, which is living symbiotically.

What did being in space make you realise?
Physical possessions, material stuff is absolutely meaningless. I had everything around me that I needed. I had the basic clothes that I needed. I had food, warmth and shelter.

That’s not to say it’s not nice to have the occasional nice item of clothing or that I am against fashion at all. I do buy new clothes every so often. But I think we put too much emphasis on what we own. And we identify quite often with the car we drive.

We use our possessions as an extension of ourselves. We should just think about what’s really important, and generally consume less.

You almost sound like an environmentalist. Would you describe yourself as one?
I describe myself as a scientist and as somebody who cares for the world we live in. But I’ve never been an environmentalist in the sense of somebody who’s devoted their life to protecting the environment. Being a scientist...
What concerns me most is the debris we are creating around the Earth, particularly in low Earth orbit and geostationary orbit. I think that’s probably one of the biggest challenges for space flight in the future.

In 1991, *New Scientist* was quite critical of the scientific accomplishments of Project Juno, which you participated in. What do you think it achieved?
The science was part of the Soviet space programme of science experiments. There was a large amount of agricultural science, Earth observation, materials science. It was all in there but they just weren’t British experiments. I do feel sad that they weren’t British experiments.

Looking forward, what do you think Brexit will mean for the future of UK space science?
One could argue that if the UK is not going to contribute to the EU that it might at least contribute towards the European Space Agency and CERN. But Brexit isn’t worth it because we would lose so much more in terms of the collaborations and the science.

In parallel to the official agencies, an increasing amount of space flight today is private. Do you think that is a good thing?
I think mostly good, because it’s going to reduce the cost of space flight and increase access to space for scientists. But it’s got to be managed effectively. The UN possibly needs to be more involved. We need to make sure that we don’t just allow individuals and space agencies to make their own rules.

Is NASA’s plan to return to the moon the right one?
The right idea is actually to go to Mars, and in order to get there we need to return to the moon. In order to go to Mars, a lunar base is probably what we need. We don’t need to go back to the moon for its own sake.

Are the timelines for humans landing on Mars realistic, such as SpaceX’s plan to get there in 2022, or Donald Trump’s target of 2024?
So Trump and Musk I probably don’t believe. Astronauts seem to think that towards the end of the 2030s could be a reasonably realistic estimate of when people actually set foot on Mars for the first time.

What are your biggest environmental concerns today?
Climate change over and above pretty much everything else, because that will affect every single one of us. It’s affecting us now, but it could easily make the world uninhabitable.

How do you square the carbon footprint of space flight with climate concerns, especially when you have entrepreneurs like SpaceX’s Elon Musk sending a Tesla car into space?
We didn’t need to send an electric sports car, did we? But I think space gives us a huge amount of information on the environment.

“Encouraging people to take an interest in science protects the environment”

Adam Vaughan is chief reporter at New Scientist and tweets @adamvaughan_uk

Hear Iya Whiteley speak about future Mars missions at New Scientist Live on 12 October
newsscientistlive.com
**Why do we care?**

Our genes are naturally selfish, and morality must be forced upon us. That is the established view – but a look inside our mammalian brains tells a different story, says neurophilosopher Patricia Churchland.

A SIMPLE interpretation of biological evolution says that nature selects for selfishness. Always. Selfish genes increase survival, so are the ones that get passed on. If altruistic genes happen to poke their heads up, they are quickly whacked. In this reading, the desire to do good by others must be taught – usually with the threat of punishment by a wrathful God, censorious parent or nosy cop. The only underlying motive for any altruism is fear.

But here is the thing: all highly social mammals sacrifice their own needs for others, as do birds. In the first instance, the beneficiaries are offspring, but they can also be mates, kin and friends. Chimpanzees reconcile after a squabble and console each other after a defeat, rats share food with another rat pal, and wolves, fully aware of the danger, defend each other against a grizzly bear. Male marmosets and chimpanzees have been observed to adopt orphaned young to whom they have no genetic connection. Early-hatched bluebirds help feed and guard their siblings in later broods. Humans do variants of all these things.

Charles Darwin puzzled over this selflessness in his 1871 book *The Descent of Man*. Where does our moral sense, or conscience, something that seems to fly in the face of biology, come from? A century and a half on, advances in our understanding of evolution and neuroscience are serving up some intriguing answers.

Among animals, the self-sacrifice of mammals and birds is unusual, both in its breadth and its flexibility. Other social species – insects such as termites, for example – have little behavioural flexibility. Loners such as reptiles and amphibians tend not to exhibit selflessness at all. A salamander will continue to forage rather than defend her brood. Although garter snakes do give birth to live young, hinting that some parenting might be forthcoming, the mother snake blithely abandons her 50 or so squirming babies to fend for themselves. Her brain simply isn’t made for offspring care.

But mammals and birds seem wired for love and affection. Ethologists such as Frans de Waal have documented empathic behaviour and social emotions among mammals in detail: pleasure when kith and kin are safe and fed and close by; pain and anxiety when they are threatened or suffering or far away. Self-fixated reptiles were doing very nicely before mammals and birds came to rule the roost. So what was the big advantage of selfless behaviour? It isn’t that nature suddenly went soft and sentimental. The main driver of the social brain in these animals was an ingenious new feature that emerged some 200 million years ago: being warm-blooded.

**Morality’s warm glow**

Endothermy was a master stroke in biological evolution. If you are warm-blooded, you can store energy and feed at night, while your cold-blooded competitors must wait for the sun to come up. Those competitors are also hassle-free prey: cold, dozing crickets are an easier catch than warm hopping ones. Like all upgrades, endothermy came with a cost: gram for gram, warm-blooded animals need 10 times as many calories as cold-blooded ones. This is a challenging trade-off, requiring body adaptations such as fur to prevent heat loss, and upgraded intelligence to make mammals and birds more competitive in the basic four Fs, as neurologist Paul MacLean put it – feeding.
fleeing, fighting and reproduction.

In this context, being intelligent means making more flexible decisions about how to interact with your environment: reacting on the fly to unexpected events and adapting tactics when the world changes. Wolves aiming to bring down a caribou may have a very general plan (identify a calf, attack first from the rear), but they will encounter novel obstacles to which they must respond moment by moment. Importantly, they also need to read each other’s intentions quickly and accurately throughout the hunt. Mammals and birds have some form of “theory of mind”, an understanding of what others intend to do. The intelligence of mammalian predators goes well beyond the capacity of a lizard or even a loosely assembled gang of lizards.

The pressure on endotherms for lots of calories favoured a big capacity to learn and heightened intelligence. To that end, a new and remarkably powerful neural structure emerged over millions of years of evolution: the cortex. All mammals have a cortex, and no non-mammals do, although birds have something similar. The bigger the cortex, the bigger the capacity for learning, and the greater the adaptability in problem-solving, pattern recognition and decision-making.

But what have calories and a cortex got to do with morality? The perhaps surprising answer is if you want to be a big learner, you need to be a social creature – and that brings you to the doorstep of morality.

The cost of the big learning strategy is that your potentially smart brain must be immature at birth, so its cells can sprout new wiring as they learn. To scale up learning mechanisms in a game-changing way, profound immaturity of the brain at birth is your inevitable lot. The cost of potential smartness is early helplessness. That means vulnerability to predation, starvation and cold weather – a howling handicap for neonatal survival.

The remedy was mothers, as the anthropologist Sarah Hrdy became the first fully to appreciate in the early 2000s. The sheer proximity of mother mammals when their babies are born singles them out as the convenient candidates to nurture helpless infants. In mammalian species where there is long-term pair-bonding, such as titi monkeys, prairie voles and humans, fathers share the parenting. Active fatherhood is also typical in about 98 per cent of bird species.

Simplified, the biological solution seems to have been to modify the emotions associated with self-survival (fear when threatened, discomfort when hungry) so they are also aroused for baby-threat and baby-discomfort. In effect, the mammalian mother feels her babies are part of her, which indeed they are until birth. Sharing the attachment wiring, the baby becomes increasingly connected to its mother and father, further enhancing its chance of survival. In effect, evolution expanded the ambit of “me” to include “me-and-mine”. What counts as “me-and-mine” varies across species. Attachments can form between mates, as they do in wolves, beavers and most humans, or between kin but not mates, as in baboons and vervet monkeys, or between friends as well as between mates and kin, as in marmosets and wolves. Caring can come in varying degrees. Commonly, for example, care for one’s own family is stronger than care for friends or for strangers. Biology being biology, individual variability is always present.

The underlying genetic trick was to expand the territory of the ancient hormone oxytocin from the body to the brain. In the body, it has a role in sperm ejection, egg release from the ovaries, milk discharge in lactation and contraction of the uterus when giving birth, as well as assorted jobs in the gut, adrenal glands, pancreas and eyes. In the brain, however, oxytocin triggers the discharge of neurocannabinoids – cannabis-like molecules
of Inuit life in the 19th century illustrates the probable lifestyle of early humans. Here, norms were unwritten and rarely articulated, but were well understood and heeded. Deception and aggression were frowned upon; leadership, food sharing, marriage and interactions with other groups were loosely governed by traditions. Conflict was often resolved in song duels or, failing that, in ritualised combat. Because feuding leads to instabilities, it was strongly discouraged. With life in the unforgiving Arctic being so demanding, the Inuit’s practical approach to morality made good sense.

The overlap of moral virtues across cultures is striking, even though the relative ranking of the virtues may vary with a clan’s history and environment. Typically, vindictiveness and cheating are discouraged, while cooperation, modesty and courage are praised. These universal norms far predate the concept of any moralising God or written law. Instead, they are rooted in the similarity of basic human needs and our shared mechanisms for learning and problem-solving.

Not surprisingly, this can go awry in various ways. About 1 per cent of humans seem incapable of feeling shame, remorse or genuine affection, and they are apt to lie and injure without compunction. These are psychopaths and they lack a conscience. To a lesser degree, dealing with discordant urges regarding self-care and other-care is something we all struggle with, but that is what makes mammalian life so rich and yet so complicated.

Does knowing the neurobiological story of our social nature help with the moral questions we face? In a restricted sense, no. None of it bears directly upon any specific moral question; none of it sets us on a direct path from neuronal function to the “right” moral norms. We must work through moral issues the way we always have: by discussion, negotiation, listening, trying to resolve conflicts and reaching agreements, with admittedly mixed results.

There is, however, another sense in which I think the answer is yes. Neuroscience reminds us that our social nature and cultural practices, including the ones we call morality, are products of evolution, constrained by our biological heritage. Perhaps that knowledge, of a sense of morality rooted in nothing more than our mammalian origins, makes us a little less likely to be infatuated with our own moral superiority, and more likely to cast a sceptical eye on those who peddle utopian remedies to our problems.
Research Fellow

Research Experience required in Immunology, Bioengineering, Immunotherapy, T cell Biology, Antibody Engineering or T cell Receptors. With the research experience, candidate should be well-versed in various lab experiences including tissue culture, cell-based assays measuring phenotypes of various cell subsets, cytotoxicity and proliferation, flow cytometry analyses. It could be also helpful if candidate is familiar with gene editing, molecular biology techniques, western blot analysis (immune-histochemistry, immuno-precipitations and immunoblotting), transfections, RNA/DNA extractions, PCR, purification of plasmids, and general lab organization/ordering as well as lab safety issues. Expertise in evaluation of drug efficacy studies in animal models could be also helpful.

**Education:** Ph.D with experience.

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**Postdoctoral Fellowships in Cutaneous Biology**

NIH T32-funded postdoctoral fellowships are available in the Department of Dermatology and affiliated departments. Training opportunities exist in cutaneous oncology, skin stem cell biology, skin aging, bioinformatics, and the genetics and immunology of psoriasis and other inflammatory skin diseases. Successful candidates will possess MD, PhD, or MD/PhD degrees with relevant life sciences and/or statistical training, and will be interested in a career in Dermatology/cutaneous biology research.

Core faculty in the Department of Dermatology include Drs. A. Dlugosz (dlugasza@med.umich.edu), JT Elder (jelder@umich.edu), GJ Fisher (gfisher@med.umich.edu), JE Gudjonsson (johanng@med.umich.edu), LC Tsai (alexetsai@umich.edu), and S Wong (sunnyw@med.umich.edu). Additional mentors are available in other departments.

**Information about the Training Program is available at:**

https://medicine.umich.edu/dept/dermatology/research/research-training/postdoctoral-training-grant

**Research descriptions for U-M faculty are available online at:**

https://experts.umich.edu/discover/experts_publication

Due to restrictions of the T32 funding mechanism, only U.S. citizens or permanent residents are eligible to apply.

**Please send CV and references to:**

James T. Elder, MD, PhD, Department of Dermatology, University of Michigan Medical School
email: jelder@umich.edu

Applications preferred by September 31, 2019.

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Fellowships for Postdoctoral Scholars
Woods Hole Oceanographic Institution

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Departments - Applicants who wish to conduct research on topics of general interest to one or more of the departments are encouraged to apply. Interdepartmental research, including with the Marine Policy Center, is also encouraged. The Departments are:

- Applied Ocean Physics & Engineering
- Biology
- Geology & Geophysics
- Marine Chemistry & Geochemistry
- Physical Oceanography

A joint USGS/WHOI award will be given to a postdoc whose research is in an area of common interest between USGS and WHOI Scientific Staff. The individual will interact with both USGS and WHOI based advisors on their research.

The Ocean Bottom Seismograph Instrument Center (OBSIC) will award a fellowship for research on the earth's internal structure and its dynamic processes using seafloor seismic measurements. Research areas include: seafloor seismic instrumentation, including the development and/or application of new sensors; earth structure with an emphasis on using ocean-bottom seismograph data, including the development and/or application of new analytical methodologies; earthquake-related processes using seafloor seismology and/or geodesy; the interplay between seafloor seismic measurements and oceanographic processes; and other projects within this broad scope. Award recipients may be advised by scientific staff within the five Departments as well as the USGS, or a combination thereof.

Recipients of awards are selected competitively, with primary emphasis placed on research promise. Scholarships are awarded for 18-month appointments with a stipend of $61,200 per year, a health and welfare allowance and a modest research budget. Recipients are encouraged to pursue their own research interest in association with resident Scientific and Senior Technical Staff. Communication with potential WHOI advisors prior to submitting an application is encouraged. Completed applications must be received by October 15, 2019 for the 2020/2021 appointments. Awards will be announced in December. Recipients of awards can initiate their study and research period at the Institution any time after January 1, 2020 and before December 1, 2020.

Further information about the Scholarships and application forms as well as links to the individual Departments and their research themes may be obtained through the Academic Programs section of the WHOI web pages at:

www.whoi.edu/postdoctoral

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What you need
A clear night sky
For next week
A star chart or phone with a stargazing app will be helpful but not essential

Next in the series
1 Model the equinox
2 Find the North Star and Southern Cross
3 Test your area’s light pollution
It’ll help you plan stargazing trips
4 Identify the craters of the moon
5 Orion and Sirius: how to star-hop
6 Planet spotting: Mars, Mercury and Uranus
7 Taurus and the zodiacal constellations

Stargazing at home online
Projects will be posted online each week at newscientist.com/maker Email: maker@newscientist.com

Stargazing at home Week 2
Navigate by the stars

Essential for every stargazer is the ability to find north and south using the stars. Abigail Beall shows how

IMAGINE there is a shell encasing Earth, and every star is painted on it. The shell constantly rotates, so the stars rise and set like the sun. But one bright star doesn’t move: Polaris, the North Star.

That is because its position is directly above the North Pole and therefore Earth’s axis of rotation. This means that if you are north of the equator it can be used for navigation, as it can always be seen at due north at an angle in the sky equal to the latitude you are seeing it from.

The shell of stars doesn’t make a full rotation each day, though. If you looked up at 7 pm one day, and again the next, the stars would be shifted by four degrees. This is because we measure time in solar days – the time it takes Earth to rotate with respect to the sun’s position – rather than sidereal days, the time it takes Earth to rotate with respect to the stars.

The two are different because Earth is also orbiting the sun as it rotates, meaning a solar day is slightly longer and the stars rise 4 minutes earlier each day.

Polaris is so bright despite being 433 light years away because it is a multiple star system 123 light years away, and Merak is a subgiant, meaning it has used up all its hydrogen and is now cooling.

To find Polaris, draw a line from Merak to Dubhe, and then extend it five times the distance between the stars. The line ends at the North Star.

There is no bright star over the South Pole, but you can find due south using the Southern Cross, part of Crux, the smallest of the 88 official constellations.

The Southern Cross has four main stars: Alpha Crucis, Beta Crucis, Gamma Crucis and Delta Crucis. These are easy to spot as they have the same brightness.

Plus there are two bright stars in the constellation Centaurus that point to it: Alpha Centauri and Beta Centauri. Alpha Centauri is notable for being the closest star system to Earth, at just 4.37 light years away.

Next week, I will show you how to work out the light pollution level in your area and so gauge how many planets and stars it will be possible to see.
Quick crossword #41 Set by Richard Smyth

ACROSS
8 Height (8)
9 More proximate (6)
10 Device facilitating rotation around a fixed axis (10)
11 H₂SO₄ or HNO₃, say (4)
12 County noted for its geologic era that began 541 million years ago (10)
13 Parts of the auricles (8)
14 Parts of the auricles (8)
15 Flightless bird, Struthio camelus (7)
17 Inability to process sensory data (7)
20 Rb (8)
22 Crack; interpret (6)
24 Jaeger (4)
25 Deprived of O (10)
27 Elastic coil that stores mechanical energy (6)
28 Sent digital data to a remote system (8)

DOWN
1 Proportion of sunlight diffusely reflected by a planetary surface (6)
2 Approximately 568ml (4)
3 Spectrum, range of neuronal activity (8)
4 Earwax (7)
5 Not in neutral (2,4)
6 Geologic era that began 541 million years ago (10)
7 Thiamine deficiency (8)
13 CH₃(CH)₄CO₂H (6,4)
16 Foul-smelling ice bag (5,3)
18 Koji unveiled in 1954 (8)
19 Clot (for example) (7)
21 Blue dye (6)
23 Rudolf, mechanical engineer (6)
26 Large-screen cinema system (4)

Quick quiz #22
1. The male sperm whale has the largest what of any animal on the planet?
2. Marie Curie (1903), Maria Goeppert Mayer (1963). What name and year come next?
3. Which element makes stainless steel stainless?
4. What were Tiangong-1 and Tiangong-2?
5. ARCT, GFST and MEDI are three examples of the 56 four-letter Longhurst codes used by earth scientists to refer to what?

Answers below.

Cryptic Crossword #15 Answers
ACROSS 1 Repeal, 4 Ice bag, 9 Pasteur, 10 Lardo, 11 Ad hoc, 12 Traffic, 13 Hippocampus, 14 Imaging, 15 Mutagen, 16 Q fever, 17 Stigma, 19 Tagger, 20 Regard, 24 Enigma
DOWN 1 Repel, 2 Bosch, 3 Kneecap, 5 Cilia, 6 Bird flu, 7 G-force, 8 Criticality, 14 Imaging, 15 Mutagen, 16 Q fever, 17 Stigma, 19 Tagger, 21 Cling

Quick quiz #22 Answers
1. The male sperm whale
2. Marie Curie (1903), Maria Goeppert Mayer (1963)
3. Which element
4. What were Tiangong-1 and Tiangong-2?
5. ARCT, GFST and MEDI

Puzzle set by Rob Eastaway

#23 Circling the squares

Darts player Juan Andred has noticed that on a standard dartboard, there are some neighbouring pairs of numbers that add up to a square number. For example, 20 and 5 make 25, while 6 and 10 add up to 16. He has been wondering if he can come up with a new arrangement of the numbers 1 to 20 so that all neighbouring pairs add up to a square number. And he has nearly succeeded.

He has 20 at the top of the board, and every pair of neighbours adds to a square - with one exception. On his new board, 18 doesn’t form a square with its clockwise neighbour, which is 15, or with its anticlockwise neighbour.

What does Juan’s “square” dartboard look like?

Answer next week

#22 The 9-minute egg

Solution
The slow method for boiling an egg for 9 minutes: start the 7-minute and 4-minute egg timers. When the 4 runs out, flip it. When the 7 runs out, there is 1 minute left in the 4.

Put the egg on. When the 4 runs out (after 1 minute), flip it. When it runs out, flip it again to get 9 minutes. This means I won’t get my egg for 7 + 9 = 16 minutes.

Fast method: Start timers 7 and 4 and put the egg on. When 4 runs out (elapsed time 4 minutes), flip it. When 7 runs out (after 7 minutes) flip it. When 4 runs out again (elapsed time 8 minutes), flip the 7. When the 7 runs out (total 9 minutes), the egg is cooked. So I get my egg in 9 minutes.

Get in touch
Email us at crossword@newscientist.com puzzles@newscientist.com

Answers and the next quick crossword next week.
Political seance

The UK’s parliament may be on shutdown, but London residents were recently offered the chance to quiz one titan of the political stage on Brexit matters – despite her death six years ago. Flyers posted in the city advertised an exclusive two-night speaking tour from former prime minister Margaret Thatcher, courtesy of Happy Science.

Despite sounding like a euphemism for recreational drugs, Happy Science is made of far more mind-addling stuff. The Japanese religious group – also known as the Happies – has been channelling messages from the spirit world since 1986. The group also runs a political wing to further its goal of “the realisation of love, peace and happiness on Earth”, via policies such as, uh, military expansion, nuclear weapons and disavowing Japanese war crimes.

Back in the UK, Thatcher still commands a cult-like following among neoliberal thinkers, who must be confused by her apparent new allegiance. But then, as Thatcher herself said in 2013 – through the medium of Happy Master Ryuho Okawa – in a video since posted to YouTube: “I’m not just the Iron Lady, I’m the Hot Iron Lady.” Galvanising stuff, to mix our metal metaphors somewhat.

Holy cow

In these eco-conscious days, it’s important to recycle where possible. India’s national cow commission, however, might be letting its green zeal get the better of it.

The Rashtriya Kamdhenu Aayog has raised eyebrows – and perhaps turned stomachs – with a scheme for getting rid of waste matter from cattle: feed it to women. The commission announced that it is working with the Ministry of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) to convert cow dung and urine into the traditional medicine panchgavya.

Commission chairman Vallabhbhai Kathiria told The Print, with reference to holy texts, that pregnant women who regularly consume the unusual product may give birth to “smart, highly intellectual and healthy children”. Smart enough, hopefully, to avoid such nutritional advice in future.

Food for thought

More trifles: a colleague reports that he is left famished by his switch to a vegan diet. “In a desperate attempt to get the number of calories a strapping lad like me needs, I have just bought some Trek® Cocoa Oat Protein Flapjack bars.”

These, he is informed by the packaging, are “proudly vegan”, as well as being “delicious, nourishing and REAL”. Aha! “That’s where I’ve been going wrong,” he says, “all these virtual calories!”

Feedback notes the box also warns that the bars “May contain sesame, peanuts, other nuts and milk :)” Real food, perhaps, and virtually vegan.

Frog storm

Returning to India, clerics there have divorced two frogs just months into their marriage. The pair were wedded in Madhya Pradesh in July in a ceremony to appease the rain god Indra and usher in an end to the dry season. But the frogs’ love proved to be too powerful: the monsoon season that started days later has since given rise to catastrophic floods.

Nice weather for frogs, but less so for their human officiants. Priests at the Om Shiv Seva Shakti Mandal in Bhopal have now dissolved the star-crossed lovers’ union, hoping to end the torrential rain.

What now for the two frogs and their forbidden love? Can they find happiness in the pale green arms of another? Or will they gamble the local climate with secret trysts? Keep your eye on the Madhya Pradesh weather report to find out.

Coming to a head

As wildfires rage in the Amazon, it’s been frequently said that rainforests are the lungs of the planet. Feedback isn’t going to get into the scientific accuracy of that statement – lungs tend to consume oxygen, not produce it – but it does make us wonder what other body parts are found across the globe.

The moon seems a good candidate for the appendix, removed after an angry flare-up some years ago. Logic dictates that one of the ice caps ought to have a head underneath. The UK certainly seems to be full of spleen these days, and with nativist sentiment on the rise across Europe, the bile duct must be located nearby.

Given the plentiful gas pockets found under the Middle East, we’d suggest the digestive system lies there. As for where the gut ends, well everyone has an opinion on that. Your thoughts and theories to the usual address.

Cosmic sprinkles

Your regular dose of nominative determinism. David Rogerson writes: “This is a bit late, but there was an article in your own magazine about interstellar dust being studied by Angela Speck” (24 August, p 14).
Clean limbs
There has been much speculation on Twitter recently about whether we should wash our legs when in the shower. I think legs don’t specifically need washing, and I suspect we overwash generally. How often should we wash, for health benefits or other reasons? (continued)

Pauline Keyne
Beaconsfield, Buckinghamshire, UK
The Ramblers, a walkers’ charity in the UK, advises that showering after a walk in long grass or ferns helps prevent Lyme disease. The tiny ticks that carry the disease might not easily be visible, but if removed and the bite wound cleaned early enough, the risk of infection is minimised.
So, even if you don’t wash your legs every time you clean more obviously smelly or dirty bits in the shower, a bit of extra attention after a woodland walk when wearing shorts is a good precaution.

Still waters
When a container of liquid is rotated on its base in an upright position, the liquid inside doesn’t turn with it and remains static. Why is this?

Chris Daniel
Glan Conwy, Conwy, UK
The statement that precedes your question only contains an element of truth. Take a bucket of water by its handle and rotate it quickly by, say, half a turn and back again, and most of the water won’t move.
But look carefully and you will see ripples close to the wall of the bucket. This is because a layer of water molecules is in adhesive contact with the inside of the container and moves with it as you turn the bucket. The motion of this layer of water creates a force known as shear stress that affects the rest of the liquid at a rate dependent on its viscosity.
If you turn the container for long enough, this effect continues until all the water is rotating at the same rate as the container.
To see this in action, you could try the following experiment: put a bucket of water on a rotating surface (I used an old office chair) and sprinkle a few dry leaves on the surface of the liquid to help see it moving. Rotating the bucket at about one revolution per second causes the water to turn, starting with the outer edge and spreading towards the centre. The whole body of water rotates with the bucket after about 90 seconds.
Of course, the reverse also occurs. If you stop spinning the bucket, the water will continue to turn for some time.
If you take a thicker, more viscous liquid, such as household paint, you will see this effect much more quickly. At one revolution per second, it is almost instantaneous. With a rapid half-turn of the tin you will see all of the paint try to catch up with the rotation, along with some pleasing spiral ripples in its surface.

What you see as “shorts weather” depends on where you live. Why?

Richard Swifte
Darmstadt, Germany
The answer lies with friction, or lack of it. Two surfaces in contact and trying to move against each other experience friction, due to the roughness of the surfaces along with the molecular structure and the bonding characteristics of the materials.
Generally, liquids result in less friction than solids, which is why oil is used as a lubricant between moving metal parts in machinery.
A further factor is the internal friction, or viscosity, of the liquid. An extreme case of a viscous liquid is pitch. This is technically a liquid because, given enough time (years for some types), it will gradually flow, but for practical purposes it behaves like a solid.

Battery power
Why has there never been an international standard requiring manufacturers to display the capacity of alkaline batteries?
All we have to go on is words such as “super power” or “long life” on the packaging. I want a number!

John Woodgate
Rayleigh, Essex, UK
There are international standards for batteries, which you can find on the public part of the International Electrotechnical Commission website. Look for the publications of its TC 21, SC 21A and TC 35 committees.
A battery’s capacity is measured as the current (in amps) it can provide for some amount of time, usually hours. While marking of the amp-hour capacity isn’t mandatory for all types of battery, you can get that information from manufacturer websites.

This week’s new questions

Getting used to it
I grew up in Perth, Western Australia, where summer days are often in the high 30°Cs. I found this warm, but not too hot. But after a year living in the UK, I was wearing shorts when it was just 21°C. Obviously, I had acclimatised to the local weather. Is this a psychological or physiological process? Do any changes occur in the body?

Ross Stephen-Forbes, Broome, Western Australia

Cold feat
Why is a freezer door difficult to reopen just after you shut it?

Felix Ansell, Haworth, West Yorkshire, UK

Mike Follows
Sutton Coldfield, West Midlands, UK
The liquid does spin, though it can take a little while to get going. Once spinning, the speed of the liquid varies from zero at the centre of the container to a maximum at the walls.
At this point, the surface of the liquid is no longer flat but becomes an inverted parabolic dome: the surface becomes lower at the centre and raised at the walls. The water molecules on the surface behave as if they are on a banked racing track: the faster the liquid is spinning, the steeper the slope becomes. This wouldn’t be observed with a superfluid, which has zero viscosity, but then such a liquid would probably escape by spontaneously climbing the sides of the container.

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As a child, what did you want to do when you grew up?
I always liked the idea of becoming an inventor similar to Caractacus Potts from Chitty Chitty Bang Bang and to build and fly rockets.

Explain your work in one easy paragraph.
I am part of the team at Gravity Industries that built the gas-turbine-powered Jet Suit. I design the components to be optimal for 3D printing, meaning we can produce more lightweight and more efficient parts. Almost all of the suit’s components can now be 3D printed. I also flight test the equipment. We are continually working on the design of the Jet Suit and each test helps us build a much better one next time.

How did you end up working in this field?
I previously worked on metal 3D-printed rocket engines. This propulsion work eventually led me to work on the Jet Suit.

What’s the most exciting part of your job?
Feeling the energy output of high-power systems, such as turbojets and rocket engines, are some of the most rewarding moments. You can viscerally feel it: the hot exhaust exiting at 1600 kilometres per hour from the nozzle, the flames licking from the exhaust cones during engine start-up, the low frequency vibrations through the ground, all of it. You get a strong sense of the enormous energy output these systems.

Were you good at science at school?
School provided the necessary knowledge so that I could progress to my own projects. I learned a great deal of chemistry and physics by experimenting with fuels and chemicals outside of school time. I designed, built and test-fired solid fuel rocket motors, along with flying and crashing many radio controlled planes.

If you could send a message back to yourself as a kid, what would you say?
Build, test and improve projects as often as possible and record all experiments in image and video form so that you can easily demonstrate your progress and experiences to others.

What scientific development do you hope to see in your lifetime?
Safe and reliable human access to space. Also, I hope that engineering can incorporate cinematic design elements more frequently to bring science fiction closer to real life.

If you could have a long conversation with any scientist living or dead, who would it be?
Nikola Tesla, to hear him describe his thinking profile and his approach to designing beautiful machines. I would like to explore his workshop and to see how he developed his inventions.

Do you have an unexpected hobby, and if so, please will you tell us about it?
I make short films, and I particularly enjoy using pyrotechnics and special effects for filmmaking. Pyrotechnics requires knowledge of how to control and be comfortable with fire in close proximity, which is pretty fun.

Is there a discovery or achievement you wish you’d made yourself?
I wish I had realised how adaptive a human’s balance and control can be. While the Jet Suit is flying, it is completely free in 3D space, yet a human can learn to control it and achieve a perfectly stationary hover.

What’s the best thing you’ve read or seen in the past 12 months?
The recent Apollo 11 movie by Todd Douglas Miller. It’s real footage shot at the time of the mission. Throughout the film, you have to keep reminding yourself that what you’re seeing is real and not CGI. The scale of engineering is immense.

OK, one last thing: tell us something that will blow our minds...
The arm mounted turbines on the Jet Suit spin at 117,000 revolutions per minute at full power – that’s nearly 2000 times per second.

Sam Rogers is a flight suit design engineer at Gravity Industries.

See Sam in action
Sam will fly the Jet Suit and talk about how it works at New Scientist Live
newscientistlive.com
NOT SURE WHAT TO SEE AT NEW SCIENTIST LIVE?

Here’s what the New Scientist editorial team are most looking forward to...

EMILY WILSON
EDITOR

Everything we thought we knew about early human history is being torn up and thrown out right now, so the talk I’m most looking forward to is Lee Berger on the astounding tale of Homo naledi. But I’m also very keen not to miss Megan Rossi on our microbiomes, Avi Loeb for the extraordinary things he says about aliens, and also Paul Davies’s take on the fundamental nature of life itself.

PENNY SARCHET
NEWS EDITOR

Most of all, I’m looking forward to seeing so many of the scientists who regularly appear in our articles. Like Emily, I’m excited that Lee Berger is coming from South Africa to talk about how his discoveries are rewriting the story of human evolution, and that Harvard physicist Avi Loeb will be discussing the hunt for alien life – both are unmissable. Astrophysicist Michele Bannister will be talking about objects from outer space. I can’t wait to hear her thoughts on the recently discovered interstellar comet that appears to be racing towards us. I’m excited to hear Caroline Criado Perez discuss gender data bias and to buy a signed copy of her important book Invisible Women. And I’ll be chairing a panel discussion on the future of healthcare, from genomic medicine to AI, in what should be a really thought-provoking session.

GRAHAM LAWTON
STAFF FEATURE WRITER

The Main Stage is always amazing, and day one has a real buzz about it. Fortunately, I’m guaranteed a seat because I’m hosting it. So here’s my practice run at bigging up its speakers: please put your hands together for the brilliant and uplifting Factfulness author Ola Rosling, rocket man Sam Rogers, the superhuman Rowan Hooper and, last but not least, climate change hero Christiana Figueres in conversation with my colleague Adam Vaughan. It’s going to set the bar for the rest of the show.

LILIAN ANEKWE
SOCIAL MEDIA EDITOR

I’m looking forward to interviewing the science journalist and writer Angela Saini on the Engineering Stage on Sunday. Her article on the racism problem in population genetics that is encouraging the subtle return of racist ideas in mainstream science – an argument she thoroughly, eloquently and compellingly expands in her book Superior – prompted huge debate among our audience on social media earlier this year. I’m sure it will among New Scientist Live attendees too. Hope to see you there!

TIMOTHY REVELL
ASSISTANT NEWS EDITOR

I’m already buzzing like a micro-drone for this year’s New Scientist Live. I’ll be hosting the Technology Stage, which is packed with talks you won’t want to miss. Here are my top three tips. Tony Veale and Mike Cook will reveal the bots that run riot across social media, from those that try to influence elections to those that inject whimsy. Rumour has it, the pair are making a New Scientist-flavoured bot to show off at the event too. Chloe Duckworth is also bringing her own tech to her talk, though it’s a little more old school. She’ll give a step-by-step guide on how to recreate ancient technologies, such as stone tools, to work how our ancestors did the same. Finally, you’ll want to be there when Australian TV legend Dr Karl tells us why artificial intelligence, 3D printing, genetics and medical engineering are all game-changing technologies.